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Istituto Superiore per la Protezione
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RAPPORTI

Italian Greenhouse Gas Inventory 1990-2012 National Inventory Report 2014

198 / 2014

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Rapporti 198/2014

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ISBN 978-88-448-0654-5

Cover design
Franco Iozzoli

Cover photo
"Diversi Globi Terr-Aqvei..." - Matthaeus Seutter Publisher Augsburg: Anjezo im verlag beij Tobias Conrad Lotter, c.a. 1740 http://www.vobam.se/varldskartor.htm

Typographic coordination
Daria Mazzella
ISPRA - Section for Publishing

Text available on ISPRA website at www.isprambiente.gov.it

Annual Report for submission under the UN Framework Convention on Climate Change and the Kyoto Protocol

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PREMESSA

Nell'ambito degli strumenti e delle politiche per fronteggiare i cambiamenti climatici, un ruolo fondamentale è svolto dal monitoraggio delle emissioni dei gas-serra.

A garantire la predisposizione e l'aggiornamento annuale dell'inventario dei gas-serra secondo i formati richiesti, in Italia, è l'ISPRA su incarico del Ministero dell'Ambiente e della Tutela del Territorio e del Mare, attraverso le indicazioni del Decreto Legislativo n. 51 del 7 marzo 2008 e, più di recente, del Decreto Legislativo n. 30 del 13 marzo 2013, che prevedono l'istituzione di un Sistema Nazionale, *National System*, relativo all'inventario delle emissioni dei gas-serra.

In più, come è previsto dalla Convenzione-quadro sui cambiamenti climatici per tutti i Paesi industrializzati, l'ISPRA documenta in uno specifico documento, il *National Inventory Report*, le metodologie di stima utilizzate, unitamente ad una spiegazione degli andamenti osservati.

Il *National Inventory Report* facilita i processi internazionali di verifica cui le stime ufficiali di emissione dei gas serra sono sottoposte. In particolare, viene esaminata la rispondenza alle proprietà di trasparenza, consistenza, comparabilità, completezza e accuratezza nella realizzazione, qualità richieste esplicitamente dalla Convenzione suddetta. L'inventario delle emissioni è sottoposto ogni anno ad un esame (*review*) da parte di un organismo nominato dal Segretariato della Convenzione che analizza tutto il materiale presentato dal Paese e ne verifica in dettaglio le qualità su enunciate. Senza tali requisiti, l'Italia sarebbe esclusa dalla partecipazione ai meccanismi flessibili previsti dallo stesso Protocollo, come il mercato delle quote di emissioni, l'implementazione di progetti con i Paesi in via di sviluppo (CDM) e l'implementazione di progetti congiunti con i Paesi a economia in transizione (JI).

Questo processo di *review* è tanto più importante nella fase conclusiva del primo periodo di impegno (2008-2012) del Protocollo di Kyoto, alla fine del quale sarà accertata la rispondenza tra gli impegni di riduzione assunti dai Paesi industrializzati e le rispettive emissioni di gas-serra. Il rapporto "Italian Greenhouse Gas Inventory 1990-2012. National Inventory Report 2014", in particolare, descrive la comunicazione annuale italiana dell'inventario delle emissioni dei gas serra dal 1990, anno-base del Protocollo, al 2012, ultimo anno del primo periodo di impegno.

Oltre a rappresentare uno strumento indispensabile nell'ambito della Convenzione-quadro sui cambiamenti climatici e del Protocollo di Kyoto, il presente documento rappresenta un riferimento fondamentale per la pianificazione e l'attuazione di tutte le politiche ambientali da parte delle istituzioni centrali e periferiche. Accanto all'inventario dei gas-serra, l'ISPRA realizza ogni anno l'inventario nazionale delle emissioni in atmosfera, richiesto dalla Convenzione di Ginevra sull'inquinamento atmosferico transfrontaliero (UNECE-CLRTAP) e dalle Direttive europee sulla limitazione delle emissioni. In più, tutto il territorio nazionale è attualmente coperto da inventari regionali sostanzialmente coerenti con l'inventario nazionale, realizzati principalmente dalle Agenzie Regionali e Provinciali per la Protezione dell'Ambiente.

Nonostante i progressi compiuti, l'attività di preparazione degli inventari affronta continuamente nuove sfide legate alla necessità di considerare nuove sorgenti e nuovi inquinanti e di armonizzare gli inventari prodotti per diverse finalità di *policy* (come quelli predisposti per i Piani di azione comunali richiesti dal Patto dei Sindaci). Il contesto internazionale al quale fa riferimento la preparazione dell'inventario nazionale costituisce una garanzia di qualità dei dati, per l'autorevolezza dei riferimenti metodologici, l'efficacia del processo internazionale di *review* e la flessibilità nell'adattamento alle nuove circostanze.

Domenico Gaudioso

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EXECUTIVE SUMMARY

ES.1. Background information on greenhouse gas inventories and climate change

The United Nations Framework Convention on Climate Change (FCCC) was ratified by Italy in the year 1994 through law no.65 of 15/01/1994.
The Kyoto Protocol, adopted in December 1997, has established emission reduction objectives for Annex B Parties (i.e. industrialised countries and countries with economy in transition): in particular, the European Union as a whole is committed to an 8% reduction within the period 2008-2012, in comparison with base year levels. For Italy, the EU burden sharing agreement, set out in Annex II to Decision 2002/358/EC and in accordance with Article 4 of the Kyoto Protocol, has established a reduction objective of 6.5% in the commitment period, in comparison with 1990 levels.
Subsequently, on 1st June 2002, Italy ratified the Kyoto Protocol through law no.120 of 01/06/2002. The ratification law prescribed also the preparation of a National Action Plan to reduce greenhouse gas emissions, which was adopted by the Interministerial Committee for Economic Planning (CIPE) on 19th December 2002 (deliberation n. 123 of 19/12/2002).
The Kyoto Protocol finally entered into force in February 2005.
As a Party to the Convention and the Kyoto Protocol, Italy is committed to develop, publish and regularly update national emission inventories of greenhouse gases (GHGs) as well as formulate and implement programmes to reduce these emissions.
In order to establish compliance with national and international commitments, the national GHG emission inventory is compiled and communicated annually by the Institute for Environmental Protection and Research (ISPRA) to the competent institutions, after endorsement by the Ministry for the Environment, Land and Sea. The submission is carried out through compilation of the Common Reporting Format (CRF), according to the guidelines provided by the United Nations Framework Convention on Climate Change and the European Union’s Greenhouse Gas Monitoring Mechanism. As a whole, an annual GHG inventory submission shall consist of a national inventory report (NIR) and the common reporting format (CRF) tables as specified in the Guidelines on reporting and review of greenhouse gas inventories from Parties included in Annex I to the Convention, implementing decisions 3/CP.5 and 6/CP.5, doc. FCCC/SBSTA/2002/L.5/Add.1.
Detailed information on emission figures and estimation procedures, including all the basic data needed to carry out the final estimates, is to be provided to improve the transparency, consistency, comparability, accuracy and completeness of the inventory provided.
The national inventory is updated annually in order to reflect revisions and improvements in the methodology and use of the best information available. Adjustments are applied retrospectively to earlier years, which accounts for any difference in previously published data.
This report is compiled according to the guidelines on reporting as specified in the document FCCC/SBSTA/2002/L.5. It provides an analysis of the Italian GHG emission inventory communicated to the Secretariat of the Climate Change Convention and to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism in the year 2014, including the update for the year 2012 and the revision of the entire time series 1990-2011.
The assigned amount for Italy, pursuant to Article 3, paragraphs 7 and 8 and calculated in accordance with the annex to decision 13/CMP.1, has been established together with the commitment period reserve (CPR), required in accordance with paragraph 18 of decision 15 CMP.1, during the in country review in 2007. The calculated figures are reported in the document FCCC/IRR/2007/ITA and amount to 2,416,277,898 tonnes CO_2 eq. for the assigned amount and 2,174,650,108 tonnes of CO_2 eq. for the CPR. The CPR is calculated on the basis of the assigned amount and it has not changed from the previous submission.
Emission estimates comprise the six direct greenhouse gases under the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride) which contribute directly to climate change owing to their positive radiative forcing effect and four indirect greenhouse gases (nitrogen oxides, carbon monoxide, non-methane volatile organic compounds, sulphur dioxide).
This report, the CRF files and other related documents are available on website at the address http://www.sinanet.isprambiente.it/it/sia-ispra/serie-storiche-emissioni.
The official inventory submissions can also be found at the UNFCCC website http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/7383.php.

ES.2. Summary of national emission and removal related trends

Total greenhouse gas emissions, in CO_2 equivalent, excluding emissions and removals from land use, land use change and forestry, decreased by 11.4% between 1990 and 2012 (from 519 to 460 millions of CO_2 equivalent tons), where the national Kyoto target is a reduction of 6.5%, as compared to the base year levels, by the period 2008-2012. Considering the variation between the average of emissions in the 2008-2012 period and the emissions in the base year, the level of emissions decreased by 4.6%.
The most important greenhouse gas, CO_2, which accounted for 84.0% of total emissions in CO_2 equivalent in 2012, showed a decrease by 11.0% between 1990 and 2012. In the energy sector, specifically, CO_2 emissions in 2012 reduced of 8.8% as compared those in 1990.
CH_4 and N_2O emissions were equal to 7.6% and 6.0%, respectively, of the total CO_2 equivalent greenhouse gas emissions in 2012. Both gases showed a decrease from 1990 to 2012, equal to 20.6% and 25.9% for CH_4 and N_2O, respectively.
Other greenhouse gases, HFCs, PFCs and SF_6, ranged from 0.1% to 2.0% of total emissions.
Table ES.1 illustrates the national trend of greenhouse gases for 1990-2012, expressed in CO_2 equivalent terms, by substance and category.

Table ES.1. Total greenhouse gas emissions and removals in CO_2 equivalent [Gg CO_2 eq]

GHG emissions	1990 *base year*	1995	2000	2005	2008	2009	2010	2011	2012
				Gg CO_2 equivalent					
CO_2 including net CO_2 from LULUCF	429,213	420,729	444,257	458,089	437,299	386,425	393,426	393,585	366,803
CO_2 excluding net CO_2 from LULUCF	434,656	444,944	462,278	488,078	463,696	414,810	424,993	413,379	386,667
CH_4 including CH_4 from LULUCF	45,254	44,686	46,692	41,440	38,566	38,464	37,547	36,208	35,793
CH_4 excluding CH_4 from LULUCF	43,766	44,342	45,850	41,102	38,141	37,947	37,233	35,722	34,747
N_2O including N_2O from LULUCF	37,808	38,670	39,765	37,863	29,841	28,311	27,264	27,059	28,016
N_2O excluding N_2O from LULUCF	37,462	38,499	39,561	37,754	29,686	28,126	27,129	26,889	27,754
HFCs	351	680	1,838	5,148	7,162	7,769	8,299	8,804	9,246
PFCs	2,487	1,266	1,217	1,715	1,501	1,063	1,331	1,455	1,314
SF_6	333	601	493	465	436	398	373	351	356
Total (including LULUCF)	**515,446**	**506,632**	**534,263**	**544,719**	**514,803**	**462,430**	**468,239**	**467,463**	**441,527**
Total (excluding LULUCF)	**519,055**	**530,333**	**551,237**	**574,262**	**540,620**	**490,113**	**499,359**	**486,601**	**460,083**

GHG categories	1990 *base year*	1995	2000	2005	2008	2009	2010	2011	2012
				Gg CO_2 equivalent					
1. Energy	417,716	431,113	449,688	471,903	448,933	404,866	414,914	403,641	379,863
2. Industrial Processes	38,390	35,937	36,101	42,339	35,317	30,348	31,265	31,049	28,201
3. Solvent and Other Product Use	2,455	2,235	2,301	2,123	1,947	1,818	1,669	1,648	1,516
4. Agriculture	40,830	40,602	40,218	37,442	36,091	34,852	33,783	33,572	34,289
5. LULUCF	-3,609	-23,700	-16,974	-29,543	-25,817	-27,683	-31,119	-19,139	-18,556
6. Waste	19,665	20,445	22,929	20,454	18,331	18,229	17,728	16,691	16,214
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA

ES.3. Overview of source and sink category emission estimates and trends

The energy sector is the largest contributor to national total GHG emissions with a share, in 2012, of 82.6%. Emissions from this sector decreased by about 9.1% from 1990 to 2012. Substances with decrease rates were CO_2, whose levels reduced by 8.8% from 1990 to 2012 and accounts for 97.0% of the total in the energy sector, and CH_4 which showed a reduction of 26.0% but its share out of the sectoral total is only 1.8%; N_2O, on the other hand, showed an increase of 1.5% from 1990 to 2012 but it is not relevant on total emissions, accounting for 1.2%. Specifically, in terms of total CO_2 equivalent, an increase in emissions was observed in the transport sector, and in the other sectors, about 2.9% and 8.2%, from 1990 to 2012, respectively; in 2012 these sectors, altogether, account for 22.4% of total emissions.

For the industrial processes sector, emissions showed a decrease of 26.5% from the base year to 2012. Specifically, by substance, CO_2 emissions account for 60.3% and showed a decrease by about 40.2%, CH_4 decreased by 49.3%, but it accounts only for 0.2%, while N_2O, whose levels share 0.8% of total industrial emissions, decreased by 96.5%. The decrease in emissions is mostly due to a decrease in chemical industry (due to the fully operational abatement technology in the adipic acid industry) and metal production emissions. A considerable increase was observed in F-gases emissions (about 244.3%), whose level on total sectoral emissions is 38.7%. It should be noted that, except for the motivations explained, the economic recession has had a remarkable influence on the production levels of most the industries and consequent emissions in the last three years.

Emissions from the solvent and other product use sector, which refer to CO_2 and N_2O emissions except for pollutants other than greenhouse gases, decreased by 38.3% from 1990 to 2012. The reduction is mainly to be attributed to a decrease by 39.0% in CO_2 emissions, which account for 66.1% of the sector. As regards CO_2, emission levels from paint application sector, which accounts for 50.8% of total CO_2 emissions from this sector, decreased by 39.7%; emissions from other use of solvents in related activities, such as domestic solvent use other than painting, application of glues and adhesives, printing industries, fat edible and non edible oil extraction, vehicle dewaxing, glass wool enduction, which account for 43.2% of the total, show a decrease of 30.4%. Finally, CO_2 emissions from metal degreasing and dry cleaning activities, decreased by 66.0% but they account for only 6.0% of the total. The level of N_2O emissions shows a decrease of 36.7%, accounting for 33.9% of total emissions in the sector in 2012.

For agriculture, emissions refer to CH_4 and N_2O levels, which account for 40.6% and 59.4% of the sectoral total, respectively. The decrease observed in the total emissions (-16.0%) was mostly due to the decrease of CH_4 emissions from enteric fermentation (-13.1%), which account for 31.1% of sectoral emissions and to the decrease of N_2O from agricultural soils (-15.0%), which accounts for 48.5% of sectoral emissions.

As regards land use, land-use change and forestry, from 1990 to 2012 total removals in CO_2 equivalent increase by 414.2%; CO_2 accounts for almost the total emissions and removals of the sector (93.8%).

Finally, emissions from the waste sector decreased by 17.5% from 1990 to 2012, mainly due to a decrease in the emissions from solid waste disposal on land (-25.9%), which account for 69.7% of waste emissions. The most important greenhouse gas in this sector is CH_4 which accounts for 86.9% of the sectoral emissions and shows a decrease of 18.5% from 1990 to 2012. N_2O emission levels increased by 4.8%, whereas CO_2 decreased by 66.5%; these gases account for 12.1% and 1.0%, respectively.

Table ES.2 provides an overview of the CO_2 equivalent emission trends by IPCC source category.

Table ES.2. Summary of emission trends by source category and gas in CO_2 equivalent [Gg CO_2 eq])

Category	1990 *base year*	1995	2000	2005	2008	2009	2010	2011	2012
	Gg CO_2 equivalent								
1A. Energy: fuel combustion	**406,935**	**421,041**	**440,664**	**464,056**	**441,589**	**397,729**	**407,396**	**396,235**	**372,624**
CO_2: 1. Energy Industries	136,503	139,841	151,894	159,829	156,106	131,167	132,557	130,562	125,639
CO_2: 2. Manufacturing Industries and Construction	85,276	85,037	82,245	78,551	70,905	54,580	60,015	59,852	53,656
CO_2: 3. Transport	101,269	111,445	120,101	125,825	122,053	117,629	117,066	116,069	104,845
CO_2: 4. Other Sectors	76,634	76,047	78,596	91,847	85,117	87,092	90,631	82,757	81,812
CO_2: 5. Other	1,046	1,440	806	1,198	738	844	627	495	326
CH_4	1,611	1,849	1,656	1,474	1,515	1,490	1,562	1,601	1,683
N_2O	4,596	5,381	5,365	5,333	5,155	4,926	4,937	4,899	4,664
1B2. Energy: fugitives from oil & gas	**10,781**	**10,072**	**9,024**	**7,847**	**7,344**	**7,137**	**7,518**	**7,406**	**7,239**
CO_2	3,344	3,178	2,588	2,117	2,264	2,170	2,322	2,315	2,223
CH_4	7,425	6,883	6,423	5,716	5,067	4,955	5,184	5,080	5,006
N_2O	12	12	13	14	13	12	12	11	11
2. Industrial processes	**38,390**	**35,937**	**36,101**	**42,339**	**35,317**	**30,348**	**31,265**	**31,049**	**28,201**
CO_2	28,434	26,038	24,571	27,186	25,093	19,951	20,563	20,086	16,996
CH_4	108	113	63	64	61	38	52	57	55
N_2O	6,676	7,239	7,918	7,760	1,066	1,130	647	295	234
HFCs	351	680	1,838	5,148	7,162	7,769	8,299	8,804	9,246
PFCs	2,487	1,266	1,217	1,715	1,501	1,063	1,331	1,455	1,314
SF_6	333	601	493	465	436	398	373	351	356
3. Solvent and other product use	**2,455**	**2,235**	**2,301**	**2,123**	**1,947**	**1,818**	**1,669**	**1,648**	**1,516**
CO_2	1,642	1,463	1,275	1,299	1,220	1,134	1,043	1,071	1,001
N_2O	812	772	1,027	823	727	684	626	577	514
4. Agriculture	**40,830**	**40,602**	**40,218**	**37,442**	**36,091**	**34,852**	**33,783**	**33,572**	**34,289**
CH_4: Enteric fermentation	12,278	12,348	12,246	10,914	10,996	11,007	10,732	10,753	10,667
CH_4: Manure management	3,467	3,289	3,281	3,151	2,963	2,875	2,569	2,115	1,704
CH_4: Rice Cultivation	1,576	1,671	1,391	1,472	1,386	1,565	1,565	1,550	1,533
CH_4: Field Burning of Agricultural Residues	13	13	13	14	15	14	14	13	14
N_2O: Manure management	3,934	3,791	3,871	3,717	3,781	3,818	3,706	3,713	3,742
N_2O: Agriculture soils	19,557	19,487	19,411	18,169	16,947	15,569	15,193	15,423	16,624
N_2O: Field Burning of Agricultural Residues	4	4	4	4	5	4	4	4	5
5A. Land-use change and forestry	**-3,609**	**-23,700**	**-16,974**	**-29,543**	**-25,817**	**-27,683**	**-31,119**	**-19,139**	**-18,556**
CO_2	-5,443	-24,215	-18,020	-29,989	-26,397	-28,385	-31,567	-19,794	-19,864
CH_4	1,488	343	842	338	424	517	313	486	1,046
N_2O	346	171	204	109	155	185	134	170	262
6. Waste	**19,665**	**20,445**	**22,929**	**20,454**	**18,331**	**18,229**	**17,728**	**16,691**	**16,214**
CO_2	507	454	202	226	200	242	168	173	170
CH_4	17,288	18,178	20,775	18,295	16,139	16,003	15,556	14,552	14,085
N_2O	1,870	1,814	1,952	1,933	1,993	1,984	2,004	1,966	1,959

Category	1990 *base year*	1995	2000	2005	2008	2009	2010	2011	2012
					Gg CO_2 equivalent				
Total emissions (with LULUCF)	***515,446***	***506,632***	***534,263***	***544,719***	***514,803***	***462,430***	***468,239***	***467,463***	***441,527***
Total emissions (without LULUCF)	***519,055***	***530,333***	***551,237***	***574,262***	***540,620***	***490,113***	***499,359***	***486,601***	***460,083***

ES.4. Other information

In Table ES.3 NO_X, CO, NMVOC and SO_2 emission trends from 1990 to 2012 are summarised.
All gases showed a significant reduction in 2012 as compared to 1990 levels. The highest reduction is observed for SO_2 (-89.9%), while CO and NO_X emissions reduced by about 61.1% and 57.4% respectively; NMVOC levels showed a decrease by 54.6%.

	1990	1995	2000	2005	2008	2009	2010	2011	2012
				Gg					
NO_X	2,068	1,910	1,453	1,229	1,058	990	965	947	882
CO	8,870	7,408	5,730	3,585	3,093	2,921	2,724	2,885	3,447
NMVOC	1,998	1,975	1,555	1,220	1,074	1,006	951	940	907
SO_2	1,805	1,327	756	407	286	235	215	196	182

Table ES.3. Total emissions of indirect greenhouse gases and SO_2 (1990-2012) [Gg]

Sommario (Italian)

Nel documento "Italian Greenhouse Gas Inventory 1990-2012. National Inventory Report 2014" si descrive la comunicazione annuale italiana dell'inventario delle emissioni dei gas serra in accordo a quanto previsto nell'ambito della Convenzione Quadro sui Cambiamenti Climatici delle Nazioni Unite (UNFCCC), del protocollo di Kyoto. Tale comunicazione è anche trasmessa all'Unione Europea nell'ambito del Meccanismo di Monitoraggio dei Gas Serra.

Ogni Paese che partecipa alla Convenzione, infatti, oltre a fornire annualmente l'inventario nazionale delle emissioni dei gas serra secondo i formati richiesti, deve documentare in un *report*, il *National Inventory Report*, la serie storica delle emissioni. La documentazione prevede una spiegazione degli andamenti osservati, una descrizione dell'analisi delle sorgenti principali, *key sources*, e dell'incertezza ad esse associata, un riferimento alle metodologie di stima e alle fonti dei dati di base e dei fattori di emissione utilizzati per le stime, un'illustrazione del sistema di *Quality Assurance/Quality Control* a cui è soggetto l'inventario e delle attività di verifica effettuate sui dati.

Il *National Inventory Report* facilita, inoltre, i processi internazionali di verifica cui le stime di emissione dei gas serra sono sottoposte al fine di esaminarne la rispondenza alle proprietà di trasparenza, consistenza, comparabilità, completezza e accuratezza nella realizzazione, qualità richieste esplicitamente dalla Convenzione suddetta. Nel caso in cui, durante il processo di *review*, siano identificati eventuali errori nel formato di trasmissione o stime non supportate da adeguata documentazione e giustificazione nella metodologia scelta, il Paese viene invitato ad una revisione delle stime di emissione.

I dati di emissione dei gas-serra, così come i risultati dei processi di *review*, sono pubblicati sul sito web del Segretariato della Convenzione sui Cambiamenti Climatici http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php.

La serie storica nazionale delle emissioni è anche disponibile sul sito web all'indirizzo: http://www.sinanet.isprambiente.it/it/sia-ispra/serie-storiche-emissioni.

Da un'analisi di sintesi della serie storica dei dati di emissione dal 1990 al 2012, si evidenzia che le emissioni nazionali totali dei sei gas serra, espresse in CO_2 equivalente, sono diminuite dell'11.4% nel 2012 rispetto all'anno base (corrispondente al 1990). Considerando la media delle emissioni del periodo 2008-2012, la riduzione rispetto all'anno base è di 4.6% a fronte dell'impegno nazionale di riduzione del 6.5% nello stesso periodo.

In particolare, le emissioni complessive di CO_2 sono pari all'84.0% del totale e risultano nel 2012 inferiori del 11.0% rispetto al 1990. Le emissioni di metano e di protossido di azoto sono pari a circa il 7.6% e 6.0% del totale, rispettivamente, e presentano andamenti in diminuzione sia per il metano (-20.6%) che per il protossido di azoto (-25.9%). Gli altri gas serra, HFC, PFC e SF_6, hanno un peso complessivo sul totale delle emissioni che varia tra lo 0.1% e il 2.0%; le emissioni degli HFC evidenziano una forte crescita, mentre le emissioni di PFC decrescono e quelle di SF_6 mostrano un lieve incremento. Sebbene al momento tali variazioni non sono risultate determinanti ai fini del conseguimento degli obiettivi di riduzione delle emissioni, la significatività del trend degli HFC potrebbe renderli sempre più importanti nei prossimi anni.

PART I: ANNUAL INVENTORY SUBMISSION

1. INTRODUCTION

1.1 Background information on greenhouse gas inventories and climate change

In 1988 the World Meteorological Organisation (WMO) and the United Nations Environment Program (UNEP) established a scientific Intergovernmental Panel on Climate Change (IPCC) in order to evaluate the available scientific information on climate variations, examine the social and economical influence on climate change and formulate suitable strategies for the prevention and the control of climate change.

The first IPCC report in 1990, although considering the high uncertainties in the evaluation of climate change, emphasised the risk of a global warming due to an unbalance in the climate system originated by the increase of anthropogenic emissions of greenhouse gases (GHGs) caused by industrial development and use of fossil fuels. More recently, the scientific knowledge on climate change has firmed up considerably by the IPCC Fourth Assessment Report on global warming which states that “Warming of the climate system is unequivocal (…). There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities (…). Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations”. Hence the need of reducing those emissions, particularly for the most industrialised countries.

The first initiative was taken by the European Union (EU) at the end of 1990, when the EU adopted the goal of a stabilisation of carbon dioxide emissions by the year 2000 at the level of 1990 and requested Member States to plan and implement initiatives for environmental protection and energy efficiency. The contents of EU statement were the base for the negotiation of the United Nations Framework Convention on Climate Change (UNFCC) which was approved in New York on 9th May 1992 and signed during the summit of the Earth in Rio the Janeiro in June 1992. Parties to the Convention are committed to develop, publish and regularly update national emission inventories of greenhouse gases (GHGs) as well as formulate and implement programmes addressing anthropogenic GHG emissions. Specifically, Italy ratified the convention through law no.65 of 15/1/1994.

On 11/12/1997, Parties to the Convention adopted the Kyoto Protocol, which establishes emission reduction objectives for Annex B Parties (i.e. industrialised countries and countries with economy in transition) in the period 2008-2012. In particular, the European Union as a whole is committed to an 8% reduction within the period 2008-2012, in comparison with base year levels. For Italy, the EU burden sharing agreement, set out in Annex II to Decision 2002/358/EC and in accordance with Article 4 of the Kyoto Protocol, has established a reduction objective of 6.5% in the commitment period, in comparison with the base 1990 levels.

Italy ratified the Kyoto Protocol on 1st June 2002 through law no.120 of 01/06/2002. The ratification law prescribes also the preparation of a National Action Plan to reduce greenhouse gas emission, which was adopted by the Interministerial Committee for Economic Planning (CIPE) on 19th December 2002 (deliberation n. 123 of 19/12/2002). The Kyoto Protocol finally entered into force on 16th February 2005.

As a Party to the Convention and the Kyoto Protocol, Italy is committed to develop, publish and regularly update national emission inventories as well as formulate and implement programmes to reduce these emissions.

In order to establish compliance with national and international commitments, air emission inventories are compiled and communicated annually to the competent institutions.

Specifically, the national GHG emission inventory is communicated through compilation of the Common Reporting Format (CRF), according to the guidelines provided by the United Nations Framework Convention on Climate Change and the European Union’s Greenhouse Gas Monitoring Mechanism (IPCC, 1997; IPCC, 2000; IPCC, 2003; IPCC, 2006; EMEP/CORINAIR, 2007; EMEP/EEA, 2009; EMEP/EEA, 2013).

The inventory is updated annually in order to reflect revisions and improvements in methodology and availability of new information. Recalculations are applied retrospectively to earlier years, which account for any difference in previously published data.

The submission also provides for detailed information on emission figures and estimation methodologies in the annual National Inventory Report.

As follows, this report is compiled according to the guidelines on reporting as specified in the document FCCC/SBSTA/2002/L.5. It provides an analysis of the 2012 Italian GHG emission inventory, and a revision of the entire time series 1990-2011, communicated in the framework of the annual submission under the Climate Change Convention and the Kyoto Protocol. It is also the annual submission to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism.

The assigned amount for Italy, pursuant to Article 3, paragraphs 7 and 8, of the Kyoto Protocol, and calculated in accordance with the annex to decision 13/CMP.1, has been established during the last in country review in 2007 (UNFCCC, 2007 [a]). The commitment period reserve (CPR), required in accordance with paragraph 18 of decision 15/CMP.1, has also been calculated and confirmed during the review. The determined figures are reported in the document FCCC/IRR/2007/ITA and amount to 2,416,277,898 tonnes CO_2 eq., for the assigned amount, and 2,174,650,108 tonnes of CO_2 eq., for the CPR. The CRP is calculated on the basis of the assigned amount and it has not changed from the previous submissions.
Regarding the selection of LULUCF activities under Article 3, paragraph 4, of the Kyoto Protocol for the commitment period 2008-2012, Italy has elected forest management and intends to account for Article 3.3 and 3.4 elected activities for the entire period.

Emission estimates comprise the six direct greenhouse gases under the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride) which contribute directly to climate change owing to their positive radiative forcing effect and four indirect greenhouse gases (nitrogen oxides, carbon monoxide, non-methane volatile organic compounds, sulphur dioxide).
The CRF files, the national inventory reports and other related documents are available at the address http://www.sinanet.isprambiente.it/it/sia-ispra/serie-storiche-emissioni. Information on accounts, legal entities, Art.6 projects, holdings and transactions is publicly available at http://www.info-ets.isprambiente.it.
The new internet address of the Italian registry is: https://ets-registry.webgate.ec.europa.eu/euregistry/IT/index.xhtml.
The official inventory submissions can also be found at the UNFCCC website http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/4303.php.

1.2 Description of the institutional arrangement for inventory preparation

1.2.1 National Inventory System

The Legislative Decree 51 of March 7th 2008 instituted the National System for the Italian Greenhouse Gas Inventory.
Article 5.1 of the Kyoto Protocol established that Annex I Parties should have in place a National System since the end of 2006 for estimating anthropogenic greenhouse gas emissions by sources and removals by sinks and for reporting and archiving inventory information according to the guidelines specified in the UNFCCC Decision 20/COP.7. In addition, the Decision of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions (EC, 2005) required that Member States established a national greenhouse gas inventory system since the end of 2005 at the latest and that the Commission adopts the EC’s inventory system since 30 June 2006.
The ‘National Registry for Carbon sinks’, instituted by a Ministerial Decree on 1st April 2008, is part of the Italian National System and includes information on units of lands subject of activities under Article 3.3 and activities elected under Article 3.4 and related carbon stock changes. In agreement with the Ministerial decree art.4, the Ministry for the Environment, Land and Sea is responsible for the management of the National Registry for Carbon sinks. The Decree also provides that ISPRA and the State Forestry Corps are involved by the Ministry as technical scientific support for specific activities as defined in the relevant protocol. ISPRA is responsible for the preparation of emission and removals estimates for the LULUCF sector and for KP LULUCF supplementary information under art.7.1 of the Kyoto Protocol.
The National Registry for Carbon sinks is the instrument to estimate, in accordance with the COP/MOP decisions, the IPCC Good Practice Guidance on LULUCF and every relevant IPCC guidelines, greenhouse gases emissions by sources and removals by sinks in forest land and related land-use changes and to account for the net removals in order to allow the Italian Registry to issue the relevant amount of removal units

(RMUs). Detailed information on the Registry is included in Annex 10, whereas additional information on activities under Article 3.3 and Article 3.4 is reported in paragraph 1.2.2.

The Italian National System, currently in place, is fully described in the document 'National Greenhouse Gas Inventory System in Italy' (ISPRA, 2014 [a]). No changes with respect to the last year submission occurred in the National System.
A summary picture is reported herebelow.

As indicated by art. 14 bis of the Legislative Decree, the Institute for Environmental Protection and Research (ISPRA), former Agency for Environmental Protection and Technical Services (APAT), is the single entity in charge of the preparation and compilation of the national greenhouse gas emission inventory. The Ministry for the Environment, Land and Sea is responsible for the endorsement of the inventory and for the communication to the Secretariat of the Framework Convention on Climate Change and the Kyoto Protocol. The inventory is also submitted to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism.
The Institute prepares annually a document which describes the national system including all updated information on institutional, legal and procedural arrangements for estimating emissions and removals of greenhouse gases and for reporting and archiving inventory information. The reports are publicly available at http://www.sinanet.isprambiente.it/it/sia-ispra/serie-storiche-emissioni.
A specific unit of the Institute is responsible for the compilation of the Italian Atmospheric Emission Inventory and the Italian Greenhouse Gas Inventory in the framework of the Convention on Climate Change and the Convention on Long Range Transboundary Air Pollution. The whole inventory is compiled by the Institute; scientific and technical institutions and consultants may help in improving information both on activity data and emission factors of some specific activities. All the measures to guarantee and improve the transparency, consistency, comparability, accuracy and completeness of the inventory are undertaken.
ISPRA is responsible for the general administration of the inventory and all aspects related to its preparation preparation, reporting and quality management. Activities include the collection and processing of data from different data sources, the selection of appropriate emissions factors and estimation methods consistent with the IPCC Guidelines, the IPCC Good Practice Guidance and Uncertainty management and the IPCC Good Practice Guidance for land use, land-use change and forestry, the compilation of the inventory following the QA/QC procedures, the assessment of uncertainty, the preparation of the National Inventory Report and the reporting through the Common Reporting Format, the response to the review process, the updating and data storage.
Different institutions are responsible for statistical basic data and data publication, primary to ISPRA for carrying out emission estimates. These institutions are part of the National Statistical System (Sistan), which provides national official statistics, and therefore are required to periodically update statistics; moreover, the National Statistical System ensures the homogeneity of the methods used for official statistics data through a coordination plan, involving the entire public administration at central, regional and local levels.
The National Statistical System is coordinated by the Italian National Institute of Statistics (ISTAT); other bodies, joining the National Statistical System, are the statistical offices of ministries, national agencies, regions and autonomous provinces, provinces, municipalities, research institutes, chambers of commerce, local governmental offices, some private agencies and private subjects who have specific characteristics determined by law.
The Italian statistical system was instituted on 6th September 1989 by the Legislative Decree n. 322/89, establishing principles and criteria for reforming public statistics. This decree addresses to all public statistical bodies and agencies which provide official statistics both at local, national and international level in order to assure homogeneity of the methods and comparability of the results. To this end, a national statistical plan which defines surveys, data elaborations and project studies for a three-year period was established to be drawn up and updated annually. The procedures to be followed with relation to the annual fulfilment as well as the forms to be filled in for census, data elaborations and projects, and how to deal with sensitive information were also defined.
The plan is deliberated by the Committee for addressing and coordinating statistical information (Comstat) and forwarded to the Commission for the assurance of statistical information; the Commission adopts the plan after endorsement of the Guarantor of the privacy of personal data.
Finally, the plan is approved by a Prime Ministerial Decree after consideration of the Interministerial Committee for economic planning (Cipe). The latest Prime Ministerial Decree, which approved the three-year plan for 2011-2013, updated for 2013, was issued on 21st March 2013. The statistical plan 2014-2016 is

under formalization. Statistical information and results deriving from the completion of the plan are of public domain and the system is responsible for wide circulation.
Ministries, public agencies and other bodies are obliged to provide the data and information specified in the annual statistical plan; the same obligations regard the private entities. All the data are protected by the principles of statistical disclosure control and can be distributed and communicated only at aggregate level even though microdata can circulate among the subjects of the Statistical System.
Sistan activity is supervised by the Commission for Guaranteeing Statistical Information (CGIS) which is an external and independent body. In particular, the Commission supervises: the impartiality and completeness of statistical information, the quality of methodologies, the compliance of surveys with EU and international directives. The Commission, established within the Presidency of the Council of Ministers, is composed of high-profile university professors, directors of statistical or research institutes and managers of public administrations and bodies, which do not participate at Sistan.

The main Sistan products, which are primarily necessary for the inventory compilation, are:

- National Statistical Yearbooks, Monthly Statistical Bulletins, by ISTAT (National Institute of Statistics);
- Annual Report on the Energy and Environment, by ENEA (Agency for New Technologies, Energy and the Environment);
- National Energy Balance (annual), Petrochemical Bulletin (quarterly publication), by MSE (Ministry of Economic Development);
- Transport Statistics Yearbooks, by MIT (Ministry of Transportation);
- Annual Statistics on Electrical Energy in Italy, by TERNA (National Independent System Operator);
- Annual Report on Waste, by ISPRA;
- National Forestry Inventory, by MIPAAF (Ministry of Agriculture, Food and Forest Policies).

The national emission inventory is also a Sistan product.

Other information and data sources are used to carry out emission estimates, which are generally referred to in Table 1.1 of the following section 1.4

1.2.2 Institutional arrangement for reporting under Article 3, paragraphs 3 and 4 of Kyoto Protocol

The 'National Registry for Carbon sinks' was instituted by a Ministerial Decree on 1st April 2008 and is part of the National Greenhouse Gas Inventory System in Italy (ISPRA, 2014 [a]). In 2009, a technical group, formed by experts from different institutions (ISPRA, Ministry of the Environment, Land and Sea, Ministry of Agriculture, Food and Forest Policies and University of Tuscia), set up the methodological plan of the activities necessary to implement the registry and defined the relative funding. Some of these activities (in particular IUTI, inventory of land use, see Annex 10) have been completed, resulting in land use classification, for all national territory, for the years 1990, 2000 and 2008. For 2012, land use and land use changes data were assessed through the survey on a IUTI's subgrid. Verification and validation activities have been undertaken and the resulting time series have been discussed with the institutions involved in the data providing; details are provided in paragraph 7.1.
Italy has chosen to elect Forest Management (FM) as an activity under Article 3.4. In accordance with the Annex to Decision 16/CMP.1, credits from Forest Management are capped in the first commitment period. Following the Decision 8/CMP.2, the cap is equal to 2.78 Mt C (10.19 $MtCO_2$) per year, or 13.90 Mt C (50.97 $MtCO_2$) for the whole commitment period.
The description of the main elements of the institutional arrangement under Article 3.3 and activities elected under Article 3.4 is detailed in Annex 10.
Italy has decided to account for Article 3.3 and 3.4 elected activities at the end of the commitment period; information on accounting for activities under art. 3.3 and 3.4 of the Kyoto Protocol, for the years 2008-2012, is reported in Table 11.1 (par. 11.6), while detailed information on supplementary information under art. 3.3 and 3.4 of the Kyoto Protocol is reported in Chapter 10 KP-LULUCF.

1.2.3 National Registry System

Between March 2006 and June 2012 Italy has been operating a national registry under Article 19 of Directive 2003/87/CE establishing the European Emission Trading Scheme (EU ETS) and according to Regulation No. 2216/2004 of the European Commission. Italy has had such registry system tested successfully with the EU Commission on February the 6th 2006; the connection between the registry's production environment and the Community Independent Transaction Log (CITL) has been established on March the 13th 2006 and the Registry went live on 28 March 2006.
This registry was conceived for the administration of emissions allowances allocated to operators participating to the EU ETS and it was developed according to the UN Data Exchange Standards document. As a consequence, the registry established under Directive 2003/87/CE could also be used as a registry for the administration of Kyoto Protocol units.
Consequently, the Italian registry for the EU ETS could go through an initialization process and a go-live phase with the UNFCCC in order to become part of the Kyoto system of registries. In particular, Italy successfully performed and passed the SSL connectivity testing (Oct. 26th 2007), the VPN connectivity testing (Oct. 15th 2007), the Interoperability test according to Annex H of the UN DES (Nov. the 9th 2007), and submitted all required information through a complete Readiness Questionnaire.
Following this process, the Italian registry fulfilled all of its obligations regarding conformity with the UN Data Exchange Standards and has been deemed fully compliant with the registry requirements defined in decisions 13/CMP.1 and 5/CMP.1.
After successful completion of the go-live process on 16th October 2008, the Italian registry commenced live operations with the International Transaction Log (ITL) and it's been operational ever since, ensuring the precise tracking of holdings, issuances, transfers, cancellations and retirements of allowances and Kyoto units.

Directive 2009/29/EC adopted in 2009 provided for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and decision 24/CP.8.
With a view to complying with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011, in addition to implementing the platform shared by the consolidating Parties, the registry of EU has undergone a major re-development. The consolidated platform which implements the national registries in a consolidated manner (including the registry of EU) is called Consolidated System of EU registries (CSEUR) and was developed together with the new EU registry on the basis the following modalities:

1. Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;
2. Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;
3. Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;
4. Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;
5. The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;
6. The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public would be fulfilled by each Party individually;
7. All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:

With regards to the data exchange, each national registry connects to the ITL directly and establishes a distinct and secure communication link through a consolidated communication channel (VPN tunnel);
The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated;
With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorized manipulation;
The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;
In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.
Following the successful implementation of the CSEUR platform, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on 20 June 2012. During the go-live process, all relevant transaction and holdings data were migrated to the CSEUR platform and the individual connections to and from the ITL were re-established for each Party.

With regards to the administration of the Registry, the Italian Government adopted Legislative Decree N. 30 of 13 March 2013 which enforces European Directive 2009/29/EC amending Directive 2003/87/EC. According to this Decree ISPRA is responsible for the administration of the national section of the Union Registry and the Kyoto National Registry; the Institute performs this task under the supervision of the national Competent Authority.
The Decree 30/2013 also establishes that the economic resources for the technical and administrative support of the Registry will be supplied to ISPRA by account holders paying a fee. The amount of such a fee still has to be regulated by a future Decree.

ISPRA set up an operational unit ("Settore del Registro nazionale dei crediti di emissione") for the administration of the National Registry. In the reporting period, three persons have been working for this unit in order to maintain the Registry:

- the Registry Administrator (chief of the unit)
- two Registry Managers in charge of Registry functions and operations, resolution of problems, manual intervention, coordination with the "Competent Authority", helpdesk and administrative tasks (e.g. documentation archiving).

A description of the Italian registry system is presented in Annex 11.
Information on accounting of Kyoto Protocol units, including a summary of information reported in the standard electronic format (SEF) tables is provided in Chapter 11, while information on changes in the National Registry is reported in Chapter 13.
SEF tables including all data referring to units holdings and transactions during the year 2013 can be found in Annex 8.

1.3 Brief description of the process of inventory preparation

ISPRA has established fruitful cooperation with a number of governmental and research institutions as well as industrial associations, which helps improving some leading categories of the inventory. Specifically, these activities aim at the improvement of provision and collection of basic data and emission factors, through plant-specific data, and exchange of information on scientific researches and new sources. Moreover, when in depth investigation is needed and a high uncertainty in the estimates is present, specific sector analyses are committed to ad hoc research teams or consultants.
ISPRA also coordinates with different national and regional authorities and private institutions for the cross-checking of parameters and estimates as well as with ad hoc expert panels in order to improve the completeness and transparency of the inventory.

The main basic data needed for the preparation of the GHG inventory are energy statistics published by the Ministry of Economic Development Activities (MSE) in the National Energy Balance (BEN), statistics on

industrial and agricultural production published by the National Institute of Statistics (ISTAT), statistics on transportation provided by the Ministry of Transportation (MIT), and data supplied directly by the relevant professional associations.
Emission factors and methodologies used in the estimation process are consistent with the IPCC Guidelines and Good Practice Guidance and supported by national experiences and circumstances. Final decisions are up to inventory experts, taking into account all the information available.

For the energy and industrial sectors, emissions and backgroung data collected in the framework of the European Emissions Trading Scheme, the National Pollutant Release and Transfer Register (Italian PRTR) and the Large Combustion Plant (LCP) Directive have yielded considerable developments in the relevant sectors of the inventory. In fact, these figures are used either directly in the estimation process or as verification of emission estimates, improving national emissions factors as well as activity data. Other small plants voluntarily communicate their emissions which are also considered individually.
In addition, final estimates are checked and verified also in view of annual environmental reports by industries.

Emission estimates are drawn up for each sector. Final data are communicated to the UNFCCC Secretariat filling in the CRF files.
The process of the inventory preparation takes place annually. In addition to a new year, the entire time series from 1990 onwards is checked and revised during the annual compilation of the inventory in order to meet the requirements of transparency, consistency, comparability, completeness and accuracy of the inventory. Measures to guarantee and improve these qualifications are undertaken and recalculations should be considered as a contribution to the overall improvement of the inventory.
In particular, recalculations are elaborated on account of changes in the methodologies used to carry out emission estimates, changes due to different allocation of emissions as compared to previous submissions and changes due to error corrections. The inventory may also be expanded by including categories not previously estimated if sufficient information on activity data and suitable emission factors have been identified and collected.
Information on the major recalculations is provided every year in the sectoral and general chapters of the national inventory reports; detailed explanations of recalculations are also given compiling the relevant CRF tables.
In Figure 1.1 the most important steps to guarantee the continous improvement of the national GHG emission inventory are outlined.

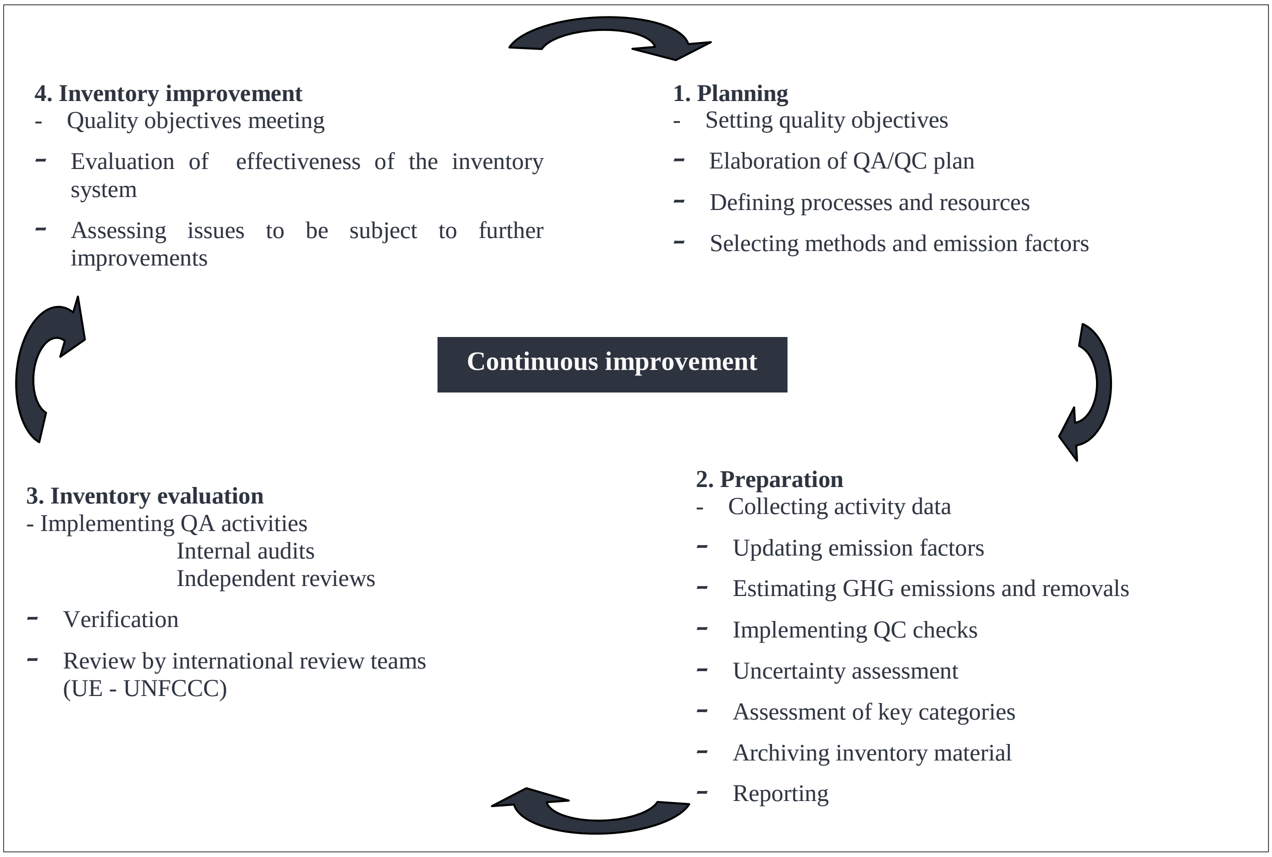

Figure 1.1 National Greenhouse Gas Inventory: annual inventory process

All the reference material, estimates and calculation sheets, as well as the documentation on scientific papers and the basic data needed for the inventory compilation, are stored and archived at the Institute. After each reporting cycle, all database files, spreadsheets and electronic documents are archived as 'read-only-files' so that the documentation and estimates could be traced back during the review process or the new inventory compilation year.

Technical reports and emission figures are publicly accessible by website at the address http://www.sinanet.isprambiente.it/it/sia-ispra/serie-storiche-emissioni.

1.4 Brief general description of methodologies and data sources used

A detailed description of methodologies and data sources used in the preparation of the emission inventory for each sector is outlined in the relevant chapters. In Table 1.1 a summary of the activity data and sources used in the inventory compilation is reported.

Methodologies are consistent with the IPCC Guidelines, IPCC Good Practice Guidance and EMEP/EEA Guidebooks (IPCC, 1997; IPCC, 2006; IPCC, 2000; IPCC, 2003; EMEP/CORINAIR, 2007; EMEP/EEA, 2009; EMEP/EEA, 2013); national emission factors are used as well as default emission factors from international guidebooks, when national data are not available. The development of national methodologies is supported by background documents.

In Table 1.2 a summary of the methods and emission factors used in the compilation of the Italian inventory is reported. A more detailed table, describing methods and emission factors for the key categories of the national inventory for 2012, is included in Annex 9.

Table 1.1 Main activity data and sources for the Italian Emission Inventory

SECTOR	ACTIVITY DATA	SOURCE
1 Energy 1A1 Energy Industries	Fuel use	Energy Balance - Ministry of Economic Development Major national electricity producers European Emissions Trading Scheme
1A2 Manufacturing Industries and Construction	Fuel use	Energy Balance - Ministry of Economic Development Major National Industry Corporation European Emissions Trading Scheme
1A3 Transport	Fuel use Number of vehicles Aircraft landing and take-off cycles and maritime activities	Energy Balance - Ministry of Economic Development Statistical Yearbooks - National Statistical System Statistical Yearbooks - Ministry of Transportation Statistical Yearbooks - Italian Civil Aviation Authority (ENAC) Maritime and Airport local authorities
1A4 Residential-public-commercial sector	Fuel use	Energy Balance - Ministry of Economic Development
1B Fugitive Emissions from Fuel	Amount of fuel treated, stored, distributed	Energy Balance - Ministry of Economic Development Statistical Yearbooks - Ministry of Transportation Major National Industry Corporation
2 Industrial Processes	Production data	National Statistical Yearbooks- National Institute of Statistics International Statistical Yearbooks-UN European Emissions Trading Scheme European Pollutant Release and Transfer Register Sectoral Industrial Associations
3 Solvent and Other Product Use	Amount of solvent use	National Environmental Publications - Sectoral Industrial Associations International Statistical Yearbooks - UN
4 Agriculture	Agricultural surfaces Production data Number of animals Fertiliser consumption	Agriculture Statistical Yearbooks - National Institute of Statistics Sectoral Agriculture Associations
5 Land Use, Land Use Change and Forestry	Forest area, biomass increment and stock Biomass burnt	National Forestry Service (CFS) - National and Regional Forestry Inventory Statistical Yearbooks - National Institute of Statistics Universities and Research Institutes
6 Waste	Amount of waste	National Waste Cadastre - Institute for Environmental Protection and Research , National Waste Observatory

Table 1.2 Methods and emission factors used in the inventory preparation

SUMMARY 3 SUMMARY REPORT FOR METHODS AND EMISSION FACTORS USED

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2		CH_4		N_2O		HFCs		PFCs		SF_6	
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor
1. Energy	**T1,T2,T3**	**CS,D,OTH**	**T1,T2,T3**	**CR,CS,D**	**T1,T2,T3**	**CR,CS,D**						
A. Fuel Combustion	T1,T2,T3	CS	T1,T2,T3	CR,CS,D	T1,T2,T3	CR,CS,D						
1. Energy Industries	T3	CS	T3	CR,D	T3	CR,D						
2. Manufacturing Industries and Construction	T2	CS	T2	CR,D	T2	CR,D						
3. Transport	T1,T2,T3	CS	T1,T2,T3	CR,CS	T1,T2,T3	CR,CS						
4. Other Sectors	T2	CS	T2	CR	T2	CR						
5. Other	T2	CS	T2	CR	T2	CR						
B. Fugitive Emissions from Fuels	T1,T2	CS,D,OTH	T1,T2	CR,CS,D	T1	D						
1. Solid Fuels	T1	OTH	T1	CR,CS,D	NA	NA						
2. Oil and Natural Gas	T1,T2	CS,D	T1,T2	CS,D	T1	D						
2. Industrial Processes	**D,T2**	**CR,CS,D,PS**	**D,T2**	**CR,CS,PS**	**T2**	**D,PS**	**CS,D,T2**	**CS,D,PS**	**CS,T2**	**PS**	**CS,T3**	**CS,PS**
A. Mineral Products	T2	CS,D,PS	NA	NA	NA	NA						
B. Chemical Industry	D,T2	PS	D,T2	CR,CS,PS	T2	D,PS	NA	NA	NA	NA	NA	NA
C. Metal Production	D,T2	CR,CS,PS	D	CR,CS,PS	NA	NA	NA	NA	T2	PS	NA	NA
D. Other Production	NA	NA										
E. Production of Halocarbons and SF_6							CS	PS	CS	PS	NA	NA
F. Consumption of Halocarbons and SF_6							CS,T2	CS,D,PS	CS	PS	CS,T3	CS,PS
G. Other	NA	NA	NA	NA	NA	NA	D	PS	NA	NA	NA	NA
3. Solvent and Other Product Use	**CR,CS**	**CR,CS**			**CS**	**CS**						
4. Agriculture			**T1,T2**	**CS,D**	**CS,T1,T2**	**CS,D**						
A. Enteric Fermentation			T1,T2	CS,D								
B. Manure Management			T1,T2	CS,D	T2	CS,D						
C. Rice Cultivation			T2	CS								
D. Agricultural Soils			NA	NA	CS,T1	CS,D						
E. Prescribed Burning of Savannas			NA	NA	NA	NA						
F. Field Burning of Agricultural Residues			T1	CS,D	T1	CS,D						
G. Other			NA	NA	NA	NA						
5. Land Use, Land-Use Change and Forestry	**T1,T2,T3**	**CS,D**	**T1,T2**	**CS,D**	**T1,T2**	**CS,D**						
A. Forest Land	T1,T2,T3	CS,D	T2	CS,D	T2	CS,D						
B. Cropland	T1	CS,D	T1	D	T1	D						
C. Grassland	T1,T2,T3	CS,D	T1	CS	T1	CS						
D. Wetlands	NA	NA	NA	NA	NA	NA						
E. Settlements	T1	CS,D	NA	NA	NA	NA						
F. Other Land	NA	NA	NA	NA	NA	NA						
G. Other	NA	NA	NA	NA	NA	NA						
6. Waste	**D**	**CS**	**CS,D,T1,T2**	**CR,CS,D**	**D,T1**	**CR,CS,D**						
A. Solid Waste Disposal on Land	NA	NA	T2	CS								
B. Waste-water Handling			D	D	D	CR,D						
C. Waste Incineration	D	CS	D,T1	CR,CS,D	D,T1	CS,D						
D. Other	NA	NA	CS	CS	NA	NA						
7. Other (as specified in Summary 1.A)	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Use the following notation keys to specify the method applied:

D (IPCC default) | **T1a, T1b, T1c** (IPCC Tier 1a, Tier 1b and Tier 1c, respectively) | **CR** (CORINAIR)
RA (Reference Approach) | **T2** (IPCC Tier 2) | **CS** (Country Specific)
T1 (IPCC Tier 1) | **T3** (IPCC Tier 3) | **OTH** (Other)

If using more than one method within one source category, list all the relevant methods. Explanations regarding country-specific methods, other methods or any modifications to the default IPCC methods, as well as information regarding the use of different methods per source category where more than one method is indicated, should be provided in the documentation box. Also use the documentation box to explain the use of notation OTH.

Use the following notation keys to specify the emission factor used:

D (IPCC default) | **CS** (Country Specific) | **OTH** (Other)
CR (CORINAIR) | **PS** (Plant Specific)

Where a mix of emission factors has been used, list all the methods in the relevant cells and give further explanations in the documentation box. Also use the documentation box to explain the use of notation OTH.

Activity data used in emission calculations and their sources are briefly described here below.

In general, for the energy sector, basic statistics for estimating emissions are fuel consumptions provided in the Energy Balance by the Ministry of Economic Development. Additional information for electricity production is supplied by the major national electricity producers and by the major national industry corporation. On the other hand, basic information for road transport, maritime and aviation, such as the number of vehicles, harbour statistics and aircraft landing and take-off cycles are published by the National Institute of Statistics and the Ministry of Transportation in the relevant statistical yearbooks. Other data are communicated by different category associations.

In the last years, a lot of information on productions, fuel consumptions, emission factors and emissions in specific energy and industrial sub sectors is obtained from data collected by operators under the European Emissions Trading Scheme (ETS).

To implement the European Directive 2003/87 (EU, 2003), amended by Directive 2009/29/EC (EU, 2009) establishing the EU ETS, Italy, according to Legislative Decree n. 216/2006 (Legislative Decree, 2006) and Legislative Decree n. 51/2008 (MATTM, 2008), established the national registry and the national ETS commitee. The criteria of data reporting are defined by Decision 2007/589/EC (EC, 2007), Monitoring and

Reporting Guidelines for GHG emissions under ETS, and adopted at national level by Deliberation of the national ETS Committee n. 14/2010 (MATTM, 2010).
In compliance with the above mentioned legislations, independent certifications and verifications of activity data, emission data and emission factors are required. At national level, data verification has to be carried out by verifiers accredited by the national ETS Committee according to the ministerial decree DEC/RAS/115/2006. The verification of data submissions ensures reliability, credibility, and precision/accuracy of monitoring systems for data and any information relating emissions by plant.
Data from the Italian Emissions Trading Scheme database are incorporated into the national inventory whenever the sectoral coverage is complete; in fact, ETS data not always entirely cover energy categories whereas national statistics, such as the national energy balance and the energy production and consumption statistics, provide the complete basic data needed for the Italian emission inventory. Nevertheless, ETS data are entirely used to develop country-specific emission factors and check activity data levels.

For the industrial sector, the annual production data are provided by national and international statistical yearbooks. Emission data collected through the National Pollutant Release and Transfer Register are also used in the development of emission estimates or taken into account as a verification of emission estimates for some specific categories. According to the Italian Decree of 23 November 2001, data (reporting period 2002-2006) included in the Italian pollutant emissions register were validated by competent authorities within 30 June each year and communicated by ISPRA to the Ministry for the Environment, Land and Sea every year and to the European Commission every three years according to EC Decision 2000/479 (two reporting cycles: data related to 2002 and 2004 were reported respectively in 2003 and in 2006). Since 2008 the national pollutant emissions register has been replaced by the national pollutant release and transfer register (the Italian PRTR) to comply with Regulation EC n.166/2006; data are collected annually at facility level and sent, after validation, by competent authorities to European Commission within 31 March every year for data referring to the previous year. These data are used for the compilation of the inventory whenever they are complete in terms of sectoral information; in fact, industries communicate figures only if they exceed specific thresholds; furthermore, basic data such as fuel consumption are not supplied and production data are not always split by product but reported as an overall figure. Anyway, the Italian PRTR is a good basis for data checks and a way to facilitate contacts with industries which, in many cases, supply, under request, additional information as necessary for carrying out sectoral emission estimates.
In addition, final emissions are checked and verified also taking into account figures reported by industries in their annual environmental reports.

Both for energy and industrial processes, emissions of large industrial point sources are registered individually; communication also takes place in the framework of the European Directive on Large Combustion Plants, based upon detailed information such as fuel consumption. Other small plants voluntarily communicate their emissions which are also considered individually.
ISPRA directly collects data from the industrial associations under the ETS and other European directives, Large Combustion Plant and INES/PRTR, and makes use of these data in the preparation of the national inventory ensuring the consistency of time series.

For the other sectors, i.e. for solvents, the amount of solvent use is provided by environmental publications of sectoral industries and specific associations as well as international statistics.
For agriculture, annual production data and number of animals are provided by the National Institute of Statistics and other sectoral associations.
For land use, land use change and forestry, forest areas are derived from national forest inventories provided by the Ministry of Agriculture, Food and Forest Policies (National Forest Service); the National Forest Service is also the provider of official statistics related to the areas subject to fires.
For waste, the main activity data are provided by the Institute for Environmental Protection and Research and the Waste Observatory.
In case basic data are not available, proxy variables are considered; unpublished data are used only if supported by personal communication and confidentiality of data is respected.

As for data disclosure, the inventory team is obliged to ensure confidentiality of sensitive information by legislation when data are communicated under specific directives or requested by data providers. In case of data collection in the context of the ETS, P-RTR, large combustion plants etc., the database of the complete information is available only to a specific group of authorised persons which has the legal responsibility for the respect of confidentiality issues. In the other cases, each expert is responsible for the data received, and data should be kept confidential if requested by the data provider. In any case, all data are placed on a password protected access environment at ISPRA and available only to authorised experts of the inventory team.

All the material and documents used for the inventory estimation process are stored at the Institute for Environmental Protection and Research. Activity data and emission factors as well as methodologies are referenced to their data sources. A 'reference' database has also been developed to increase the transparency of the inventory.

1.5 Brief description of key categories

A key category analysis of the Italian inventory is carried out according to the Approach 1 and Approach 2 described in the 2006 IPCC Guidelines (IPCC, 2006). These guidelines provide a harmonized method to deal with both sources and removals and correct some inconsistencies between the previous IPCC Good Practice Guidance and Guidelines, which dealt with and without the LULUCF separately (IPCC, 2000; IPCC, 2003). According to the IPCC guidelines, a key category is defined as an emission category that has a significant influence on a country's GHG inventory in terms of the absolute level and trend in emissions and removals, or both. Key categories are those which, when summed together in descending order of magnitude, add up to over 95% of the total emissions or 90% of total uncertainty.

National emissions have been disaggregated into the categories proposed in the IPCC guidelines; other categories have been added to reflect specific national circumstances. Both level and trend analysis have been applied to the last submitted inventory; a key category analysis has also been carried out for the base year emission levels.
For the base year, 20 sources were individuated implementing Approach 1, whereas 17 sources were carried out by Approach 2. Including the LULUCF in the analysis, 26 categories were selected by Approach 1 and 22 by Approach 2. The description of these categories is shown in Table 1.3 and Table1.4.

Table 1.3 Key categories (excluding LULUCF) by the IPCC Approach 1 and Approach 2. Base year

Key categories (excluding the LULUCF sector)	
CO_2 stationary combustion liquid fuels	L
CO_2 stationary combustion solid fuels	L
CO_2 stationary combustion gaseous fuels	L
N_2O stationary combustion	L
CO_2 Mobile combustion: Road Vehicles	L
CO_2 Fugitive emissions from Oil and Gas Operations	L
CH_4 Fugitive emissions from Oil and Gas Operations	L
CO_2 Cement production	L
N_2O Adipic Acid	L1
N_2O Nitric Acid	L1
CH_4 Enteric Fermentation in Domestic Livestock	L
N_2O Manure Management	L
CH_4 Manure Management	L
Direct N_2O Agricultural Soils	L
Indirect N_2O from Nitrogen used in agriculture	L
CH_4 from Solid waste Disposal Sites	L
CO_2 Iron and steel production	L1
CO_2 Mobile combustion: Waterborne Navigation	L1
CO_2 Limestone and dolomite use	L1
CO_2 Ammonia production	L1
CO_2 Emissions from solvent use	L2

L1 = level key category by Approach 1
T1 = trend key category by Approach 1
L2 = level key category by Approach 2
T2 = trend key category by Approach 2
L = level key category by Approach 1 and Approach 2
T = trend key category by Approach 1 and Approach 2

Key categories (excluding the LULUCF sector)	
N_2O from animal production	L2
CH_4 Emissions from Wastewater Handling	L2

Table 1.4 Key categories (including LULUCF) by the IPCC Approach 1 and Approach 2. Base year

Key categories (including the LULUCF sector)	
CO_2 stationary combustion liquid fuels	L
CO_2 stationary combustion solid fuels	L
CO_2 stationary combustion gaseous fuels	L
N_2O stationary combustion	L
CO_2 Mobile combustion: Road Vehicles	L
CH_4 Fugitive emissions from Oil and Gas Operations	L
CO_2 Cement production	L
CH_4 Enteric Fermentation in Domestic Livestock	L
CH_4 Manure Management	L
N_2O Manure Management	L
Direct N_2O Agricultural Soils	L
Indirect N_2O from Nitrogen used in agriculture	L
CH_4 from Solid waste Disposal Sites	L
CO_2 Forest land remaining Forest land	L
CO_2 Land converted to settlements	L
CO_2 Fugitive emissions from Oil and Gas Operations	L1
CO_2 Mobile combustion: Waterborne Navigation	L1
CO_2 Iron and steel production	L1
N_2O Adipic Acid	L1
N_2O Nitric Acid	L1
CO_2 Limestone and Dolomite Use	L1
CO_2 Ammonia production	L1
N_2O from animal production	L2
CH_4 Emissions from Wastewater Handling	L
CO_2 Grassland remaining Grassland	L
CO_2 Lime production	L1
CO_2 Land converted to Grassland	L2
CO_2 Land converted to Forest Land	L
CO_2 Cropland remaining Cropland	L2
CO_2 Emissions from Solvent use	L2

Applying the analysis to the 2012 inventory, without the LULUCF sector, 28 key categories were totally individuated, both at level and trend. Results are reported in Table 1.5.

Table 1.5 Key categories (excluding LULUCF) by the IPCC Approach 1 and Approach 2. Year 2012

Key categories (excluding the LULUCF sector)	
CO_2 stationary combustion liquid fuels	L, T
CO_2 stationary combustion solid fuels	L, T
CO_2 stationary combustion gaseous fuels	L, T
CO_2 Mobile combustion: Road Vehicles	L, T
CH_4 Fugitive emissions from Oil and Gas Operations	L, T
HFC, PFC substitutes for ODS	L, T
CH_4 Enteric Fermentation in Domestic Livestock	L
Direct N_2O Agricultural Soils	L, T2
Indirect N_2O from Nitrogen used in agriculture	L
CO_2 Cement production	L, T

Key categories (excluding the LULUCF sector)	
N_2O Manure Management	L, T2
CH_4 Manure Management	L2, T
CH_4 from Solid waste Disposal Sites	L, T
CO_2 Fugitive emissions from Oil and Gas Operations	L1, T2
N_2O stationary combustion	L, T2
N_2O Adipic Acid	T
CO_2 stationary combustion other fuels	L1, T1
CO_2 Emissions from solvent use	T2
N_2O from animal production	L2
CH_4 Emissions from Wastewater Handling	L, T2
CO_2 Mobile combustion: Waterborne Navigation	L1
CO_2 Iron and steel production	T1
CO_2 Ammonia production	T1
N_2O Nitric Acid	T1
PFC Aluminium production	T1
CH_4 stationary combustion	T2
CO_2 mobile combustion aircraft	L1
CH_4 Mobile combustion: Road Vehicles	T2

If considering emissions and removals from the LULUCF sector, 31 key categories were individuated as reported in Table 1.6.

Table 1.6 Key categories (including LULUCF) by the IPCC IPCC Approach 1 and Approach 2. Year 2012

Key categories (including the LULUCF sector)	
CO_2 stationary combustion liquid fuels	L, T
CO_2 stationary combustion solid fuels	L, T
CO_2 stationary combustion gaseous fuels	L, T
CO_2 Mobile combustion: Road Vehicles	L, T
CH_4 Fugitive emissions from Oil and Gas Operations	L1, T
HFC, PFC substitutes for ODS	L, T
CH_4 Enteric Fermentation in Domestic Livestock	L
Direct N_2O Agricultural Soils	L
CO_2 Forest land remaining Forest land	L, T
CO_2 Cropland remaining Cropland	L, T
CO_2 Grassland remaining Grassland	L, T
CO_2 Land converted to Grassland	L, T
Indirect N_2O from Nitrogen used in agriculture	L
N_2O Manure Management	L, T2
CH_4 from Solid waste Disposal Sites	L, T
CO_2 Cement production	L1, T
CO_2 Land converted to Settlements	L, T
CH_4 Manure Management	L2, T
CO_2 stationary combustion other fuels	L1, T1
CH_4 Emissions from Wastewater Handling	L, T2
N_2O stationary combustion	L
CO_2 Mobile combustion: Waterborne Navigation	L1
N_2O Adipic Acid	T
CO_2 Iron and steel production	T1
CO_2 Ammonia production	T1
N_2O Nitric Acid	T1
N_2O from animal production	L2
CO_2 Land converted to Forest land	L, T
PFC Aluminium production	T1

Key categories (including the LULUCF sector)	
CO_2 Fugitive emissions from Oil and Gas Operations	L1
CH_4 stationary combustion	T2

Key category analysis for KP-LULUCF was performed according to section 5.4 of the IPCC GPG for LULUCF (IPCC, 2003).
CO_2 emissions and removals from *Afforestation/Reforestation* and *Deforestation* activities (art. 3.3) and from *Forest management* (art. 3.4) have been assessed as key categories. Their figures have been compared with Table 1.6, key categories for the latest reported year (2012) based on the level of emissions including LULUCF. The respective associated UNFCCC subcategories are *Land converting to forest land*, which has been identified as key category, at level and trend assessment, *Land converted to settlements* and *Land converted to grassland*, which has been identified as key category at level and trend assessment, and *Forest land remaining Forest land*, which is a key category at level and trend assessment.

The analysis of key categories is used to prioritize improvements that should be taken into account for the next inventory submissions. First of all, it is important that emissions of key categories, being the most significant in terms of absolute weight and/or combined uncertainty, are estimated with a high level of accuracy. For the Italian inventory, higher tiers are mostly used for calculating emissions from these categories as requested by the Good Practice Guidance (IPCC, 2000) and the use of country specific emission factors is extensive. As reported in Table A9.1, in the Annex, there are only a few key categories which estimates do not meet these quality objectives, in terms of the methodology and the application of default emission factors. Among these categories, prioritization is made on account of the actual absolute weight, the expected future relevance, the level of uncertainty and a cost-effectiveness analysis. Therefore improvements are planned for the LULUCF sector. In addition to this evaluation, also categories estimated with higher tiers but affected by a high level of uncertainty are considered in the prioritization plan. For istance, activities are planned for HFC, PFC substitutes for ODS in order to improve the accuracy of the Italian inventory and reduce the overall uncertainty.

1.6 Information on the QA/QC plan including verification and treatment of confidentiality issues where relevant

ISPRA has elaborated an inventory QA/QC plan which describes specific QC procedures to be implemented during the inventory development process, facilitates the overall QA procedures to be conducted, to the extent possible, on the entire inventory and establishes quality objectives.
Particularly, an inventory QA/QC procedures manual (ISPRA, 2013) has been drawn up which describes QA/QC procedures and verification activities to be followed during the inventory compilation and helps in the inventory improvement. Furthermore, specific QA/QC procedures and different verification activities implemented thoroughly the current inventory compilation, as part of the estimation process, are figured out in the annual QA/QC plan (ISPRA, 2014 [b]). These documents are publicly available at ISPRA website http://www.sinanet.isprambiente.it/it/sia-ispra/serie-storiche-emissioni.

Quality control checks and quality assurance procedures together with some verification activities are applied both to the national inventory as a whole and at sectoral level. Future planned improvements are prepared for each sector by the relevant inventory compiler; each expert identifies areas for sectoral improvement based on his own knowledge and in response to the UNFCCC inventory reviews and taking into account the result of the key category assessment.
The quality of the inventory has improved over the years and further investigations are planned for all those sectors relevant in terms of contribution to total CO_2 equivalent emissions and with a high uncertainty.
In addition to *routine* general checks, source specific quality control procedures are applied on a case by case basis focusing on key categories and on categories where significant methodological and data revision have taken place or on new sources.
Checklists are compiled annually by the inventory experts and collected by the QA/QC coordinator. These lists are also registred in the ‘reference’ database.

General QC procedures also include data and documentation gathering. Specifically, the inventory analyst for a source category maintains a complete and separate project archive for that source category; the archive includes all the materials needed to develop the inventory for that year and is kept in a transparent manner.

All the information used for the inventory compilation is traceable back to its source. The inventory is composed by spreadsheets to calculate emission estimates; activity data and emission factors as well as methodologies are referenced to their data sources. Particular attention is paid to the archiving and storing of all inventory data, supporting information, inventory records as well as all the reference documents. To this end, a major improvement which increases the transparency of the inventory has been the development of a 'reference' database. After each reporting cycle, all database files, spreadsheets and official submissions are archived as 'read-only' mode in a master computer.

Quality assurance procedures regard some verification activities of the inventory as a whole and at sectoral level. Feedbacks for the Italian inventory derive from communication of data to different institutions and/or at local level. For instance, the communication of the inventory to the European Community results in a pre-check of the GHG values before the submission to the UNFCCC and relevant inconsistencies may be highlighted.

Every year, emission figures are also subjected to a process of re-examination once the inventory, the inventory related publications and the national inventory reports are posted on website, specifically www.isprambiente.gov.it, and from the communication of data to different institutions and/or at local level.
In some cases, sectoral major recalculations are presented and shared with the relevant stakeholders prior to the official submission.

For the energy and industrial sectors, different meetings have been held in the last years jointly with the industrial associations, the Ministries of the Environment and Economic Development and ISPRA in the framework of the European Emissions Trading Scheme, specifically for assessing carbon leakage in EU energy intensive industries and the definition of GHG emission benchmarks; also in this context, estimations of the emission inventory for different sectors have been presented.

Generally, in the last years ISPRA has held different meetings with the industrial associations in the context of different European legislation. ISPRA collects data from the industrial associations and industrial facilities under the ETS and other European legislation such as Large Combustion Plant Directive and E-PRTR Regulation. The inventory team manages all these data and makes use of them in the preparation of the national inventory ensuring the consistency of time series among data by the comparison of the information collected under the directives with other sources available before the first available years of data collected (2000 and 2002, reporting years for data collected under ETS and INES/ PRTR facilities, respectively). Emissions and activity data submitted under the ETS are mandatorily subject to verification procedures, as requested and specified by the European Directive 2003/87/EC (art. 15 and Annex V). Also the quality of the Italian PRTR data is guaranteed by art.9 of the Regulation 2006/166/EC and by art.3(3) of the Presidential Decree n.157/2011.
In addition, ISPRA manages all this information in an informative system to help in highlighting the main discrepancies among data, and improving the management of the time series consistency. The informative system is based on identification codes to trace back individual point sources in different databases.

Other specific activities relating to improvements of the inventory and QA/QC practises in the last year regarded the progress on the building of a unique database where information collected in the framework of different European legislation, Large Combustion Plant, INES/PRTR and Emissions Trading, are gathered together thus highlighting the main discrepancies in information and detecting potential errors. The actual figures are considered in an overall approach and used in the compilation of the inventory.

In the current year, ISPRA finalised the provincial inventory at local scale for the year 2010 and updated the previously published figures 1990, 1995, 2000 and 2005; in fact, every 5 years, in the framework of the Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) under the Convention on Long-range Transboundary Air Pollution (CLTRAP), Parties has to report their national air emissions disaggregated on a 50*50 km grid. Specifically, ISPRA has applied a top-down approach to estimate emissions at provincial areas based on proxy variables. The results were checked out by regional and local environmental agencies and authorities; data are available at ISPRA web address http://www.sinanet.isprambiente.it/it/sia-ispra/inventaria and a report which describes detailed methodologies to carry out estimates is published (Liburdi et al., 2004; ISPRA, 2009). Comparisons between top-down and local inventories have been carried out during the last year and will continue in the next years; results are shared among the 'local inventories' expert group leading to an improvement in methodologies for both the inventories.

The inventory is also presented to a Technical Committee on Emissions (CTE), coordinated by the Ministry for the Environment, Land and Sea, where all the relevant Ministries and local authorities are represented; within this context emission figures and results are shared and discussed. Especially in the last years, there has been an intensification of these activities in order to establish national policies and measures to meet the 2020 EU target and implement national programmes for the post Kyoto period. In this regard, and as a basis for emission scenarios, the importance of the emission inventory is primary.
Moreover, from 2011, a report concerning the state of implementation of commitments to reduce greenhouse gases emissions, and describing emission trend and projections, is prepared by ISMELS in consultation with other relevant Ministers. The report is annexed to the economy and financial document (DEF) to be annually approved by the Government.

Expert peer reviews of the national inventory also occur annually within the UNFCCC process, whose results and suggestions can provide valuable feedback on areas where the inventory should be improved. Specifically, in June 2007, Italy was subjected by the UNFCC Secretariat to the in-country review of the national initial report and the GHG inventory submitted in 2006, which results and recommendations can be found on website at the addresses http://unfccc.int/resource/docs/2007/arr/ita.pdf, http://unfccc.int/resource/docs/2007/irr/ita.pdf, (UNFCCC, 2007 [a]; UNFCCC, 2007 [b]). The last in country review occurred in October last year. The results and the final report are still under finalization. The results of the last centralised review are reported in UNFCCC (2013). The issues raised during the process were addressed and implemented; details are reported in Annex 12 and in relevant sections.

At European level, reviews of the European inventory are undertaken by experts from different Member States for critical sectoral categories in the context of the European GHG Monitoring Mechanism. Moreover, in the context of the European Effort Sharing Decision (EC, 2009) defining the 2020 emission limit of a Member State in relation to its 2005 emissions, a technical review will be carried out to review and verify emission data of each Member State, for the reference years 2005, 2008 and 2009, prior to determining their annual emission allocations. The review process took place in 2012, recommendations and improvements were implemented by Member States but results of the process are not publicly available.

An official review, apart from those by the UNFCCC, was performed by Ecofys, in 2000, in order to verify of the effectiveness of policies and measures undertaken by Italy to reduce greenhouse gas emissions to the levels established by the Kyoto Protocol. In this framework an independent review and checks on emission levels were carried out as well as controls on the transparency and consistency of methodological approaches (Ecofys, 2001).
More recently, VITO, Öko-Institut and the Institute for European Environmental Policy, for DG Environment, undertook a review on the methodologies and EU Member States best practices used for GHG projections to indentify possible ways to improve GHG projections and ensure consistency across the EU. The results were presented at the Workshop 'Assessing and improving methodologies for GHG projections' in 2008. Further analyses were presented during the Workshop on 'Quantification of the effects on greenhouse gas emissions of policies and measures'.
Also, in 2012, Italy was subjected to a broad review of its environmental performance by OECD which identified good practices and made recommendations to improve environmental policies and programmes; the issues reviewed included policy-making environment, towards green growth, multi-level environmental governance of water and climate change. Results of the analysis are reported in the relevant document (OECD, 2013) and available on website at the address http://www.oecd.org/env/country-reviews/reviewingenvironmentalperformance.htm.

An agreement to conduct a bilateral independent review between Italy and Spain was established in 2012, with a focus on the revision of the GHG inventories of both the Parties. Two in-country visits were held in 2012; the Italian team revised part of the energy sector of Spain, specifically the categories public power plants, petroleum refining plants, road transport and off-road, whereas the Spanish team revised the Industrial processes and solvent and other product use, and the LULUCF sectors of Italy. Results of these analyses are reported in a technical report. Aim of the review was to carry out a general quality assurance analysis of the inventories in terms of the methodologies, the EFs and the references used, as well as analysing critical cross cutting issues such as the details of the national energy balances and comparison with international data (Eurostat and IEA), and use of plant specific information. Revisions of the other inventory sectors are still planned for the year 2014.

In addition, an official independent review of the entire Italian greenhouse gas inventory was undertaken by the Aether consultants in 2013. Main findings and recommendations are reported in a final document, and regard mostly the transparency in the NIR, the improvement of QA/QC documentation and some pending issues in the LULUCF sector. These suggestions have been considered to improve the 2014 submission.

The preparation of environmental reports where data are needed at different aggregation levels or refer to different contexts, such as environmental and economic accountings, is also a check for emission trends. At national level, for instance, emission time series are reported in the Environmental Data Yearbooks published by ISPRA. Emission data are also published by the Ministry for the Environment, Land and Sea in the Reports on the State of the Environment and the National Communications as well as in the Demonstrable Progress Report. Moreover, figures are communicated to the National Institute of Statistics to be published in the relevant Environmental Statistics Yearbooks as well as used in the framework of the EUROSTAT NAMEA Project.
At European level, ISPRA also reports on indicators meeting the requirements of Article 3 (1)(j) of Decision N° 280/2004/EC. In particular, Member States shall submit figures on specified priority indicators and should submit information on additional priority and supplementary indicators for the period from 1990 to the last submitted year and forecasts for some specified years. National trends of these indicators are reported in the document ‘Carbon Dioxide Intensity Indicators’ (ISPRA, 2014 [c]).

Comparisons between national activity data and data from international databases are usually carried out in order to find out the main differences and an explanation to them (ENEA/MAP/APAT, 2004). Emission intensity indicators among countries (e.g. emissions per capita, industrial emissions per unit of value added, road transport emissions per passenger car, emissions from power generation per kWh of electricity produced, emissions from dairy cows per tonne of milk produced) can also be useful to provide a preliminary check and verification of the order of magnitude of the emissions. This is carried out at European and international level by considering the annual reports compiled by the EC and the UNFCCC as well as related documentation available from international databases and outcome of relevant workshops.
Additional comparisons between emission estimates from industrial sectors and those published by the industry itself in their Environmental reports are carried out annually in order to assess the quality and the uncertainty of the estimates.
The quality of the inventory has also improved by the organization and participation in sector specific workshops. Follow-up processes are also set up in the framework of the WGI under the EC Monitoring Mechanism, which addresses to the improvement of different inventory sectors. Specifically in the last years, two workshops were held, one related to the management of uncertainty in national inventories and problems on the application of higher methodologies to calculate uncertainty figures, the other on how to use data from the European emissions trading scheme in the national greenhouse gas inventories. Previous workshops addressed methodologies to estimate emissions from the agriculture and LULUCF sectors, involving the Joint Research Centre, from the waste sector, involving the European Topic Center on Resource and Waste Management, as well as from international bunkers, involving the International Energy Agency and EUROCONTROL. Presentations and documentation of the workshops are available on the website at the address: http://air-climate.eionet.europa.eu/meetings/past_html.
A national conference on the Italian emission inventory was organized by ISPRA in October 2006. Methodologies used to carry out national figures and results of time series from 1990 to 2004 were presented detailing explanations for each sector. More than one hundred participants from national and local authorities, Ministries, Industry, Universities and Research organizations attended the meeting.
In 2007, in the context of the national conference on climate change a specific session was dedicated to the national emission inventory. In addition, a specific event was held on the results of the 2005 national GHG inventory. In 2010, the time series of emission figures 1990-2008 were presented in a specific national Kyoto Protocol event.

A specific procedure undertaken for improving the inventory regards the establishment of national expert panels (in particular, in road transport, land use change and forestry and energy sectors) which involve, on a voluntary basis, different institutions, local agencies and industrial associations cooperating for improving activity data and emission factors accuracy. Specifically, for the LULUCF sector, following the election of the 3.3 and 3.4 activities and on account of an in-depth analysis on the information needed to report LULUCF under the Kyoto Protocol, a Scientific Committee, *Comitato di Consultazione Scientifica del Registro dei Serbatoi di Carbonio Forestali*, constituted by the relevant national experts has been established by the Ministry for the Environment, Land and Sea in cooperation with the Ministry of Agriculture, Food and Forest Policies.
In addition to these expert panels, ISPRA participates in technical working groups within the National Statistical System. These groups, named *Circoli di qualità*, coordinated by the National Institute of Statistics, are constituted by both producers and users of statistical information with the aim of improving and monitoring statistical information in specific sectors such as transport, industry, agriculture, forest and fishing. As reported in previous sections, these activities improve the quality and details of basic data, as well as enable a more organized and timely communication.
A summary of all the main QA/QC activities over the past years which ensure the continuous improvement of the inventory is presented in the document 'Quality Assurance/Quality Control plan for the Italian Emission Inventory. Year 2014' (ISPRA, 2014 [b]).
A proper archiving and reporting of the documentation related to the inventory compilation process is also part of the national QA/QC programme.
All the material and documents used for the inventory preparation are stored at ISPRA.
Information relating to the planning, preparation, and management of inventory activities are documented and archived. The archive is organised so that any skilled analyst could obtain relevant data sources and spreadsheets, reproduce the inventory and review all decisions about assumptions and methodologies undertaken. A master documentation catalogue is generated for each inventory year and it is possible to track changes in data and methodologies over time. Specifically, the documentation includes:

- electronic copies of each of the draft and final inventory report, electronic copies of the draft and final CRF tables;
- electronic copies of all the final, linked source category spreadsheets for the inventory estimates (including all spreadsheets that feed the emission spreadsheets);
- results of the reviews and, in general, all documentation related to the corresponding inventory year submission.

After each reporting cycle, all database files, spreadsheets and electronic documents are archived as 'read-only' mode.

A 'reference' database is also compiled every year to increase the transparency of the inventory. This database consists of a number of records that references all documentation used during the inventory compilation, for each sector and submission year, the link to the electronically available documents and the place where they are stored as well as internal documentation on QA/QC procedures.

1.7 General uncertainty evaluation, including data on the overall uncertainty for the inventory totals

The 2006 IPCC Guidelines (IPCC, 2006) define two approaches to estimating uncertainties in national greenhouse gas inventories: Approach 1, based on the error propagation equations, and Approach 2, corresponding to the application of Monte Carlo analysis.
For the Italian inventory, quantitative estimates of the uncertainties are calculated using Approach 1 which application is described in Annex 1, with or without emissions and removals from the LULUCF sector. Emission categories are disaggregated into a detailed level and uncertainties are therefore estimated for these categories.
For the 2012 total emission figures without LULUCF, an uncertainty of 3.6% in the combined global warming potential (GWP) total emissions is estimated, whereas for the trend between 1990 and 2012 the analysis assesses an uncertainty by 2.5%.
Including the LULUCF sector into national figures, the uncertainty according to Approach 1 is equal to 4.9% for the year 2012, whereas the uncertainty for the trend is estimated to be 3.8%.

The reduction in the uncertainty levels, including the LULUCF sector, as compared the 2013 submission, are mainly due to the improvements in basic data and recalculation in the LULUCF sector and consequent different weights of the categories and their uncertainties.
The assessment of uncertainty has also been applied to the base year emission levels. The results show an uncertainty of 3.5% in the combined GWP total emissions, excluding emissions and removals from LULUCF, whereas it increases to 4.1 % including the LULUCF sector.
Following the recommendations of UNFCCC reviews, Approach 2 was implemented in the previous two years' submissions to estimate uncertainty of some key categories, for 2009 emission levels. The results show that uncertainty values are lower than those derived from the application of Approach 1. Details on the categories for which the analysis has been implemented are reported in Annex 1. The study will be progressively extended to other inventory categories.
Monte Carlo analysis had also been applied some years ago, following the IPCC Good Practice Guidance (IPCC, 2000), to specific categories of the inventory. Also in that case, the results show that, applying methods higher than the Tier 1 does not make a significant difference in figures if information on uncertainty levels is not sufficiently detailed. Tier 2 was applied to CO_2 emissions from road transport and N_2O emissions from agricultural soils; in the first case measurements were available for emission factors so a low uncertainty was expected, in the other no information on EFs was available and a high uncertainty was supposed. A combination of Montecarlo and Bootstrap simulation was applied to CO_2 emissions, in consideration of the specific data availability assuming a normal distribution for activity data and for the emission factor of natural gas. The overall uncertainty of CO_2 emissions for road transport resulted in 2.1%, lower than that resulting from Approach 1 which estimated a figure of 4.2%; the reason of the difference is in the lower uncertainty resulting from the application of bootstrap analysis to the emission factor of diesel oil, all the other figures are very similar. For N_2O emissions from agricultural soils, a Montecarlo analysis was applied assuming a normal distribution for activity data and two tests one with a lognormal and the other with a normal for emission factors; the results with the normal distribution calculated an uncertainty figure equal to 32.4%, lower than the uncertainty by Approach 1 which was 102%; in the case of the lognormal distribution there were problems caused by the formula specified in the IPCC guidelines which is affected by the unit and needs further study before a throughout application. The importance of these results is that in neither of the cases does the uncertainty estimation of the national sectors result in an underestimation.
Results and details of the study, 'Evaluating uncertainty in the Italian GHG inventory', were presented at a EU workshop on Uncertainties in Greenhouse Gas Inventories, held in Finland in September 2005, and they are also available on website at the address
http://air-climate.eionet.europa.eu/docs/meetings/050905_EU_GHG_Uncert_WS/meeting050905.html.
A further research on uncertainty, specifically on the comparison of different methodologies to evaluate emissions uncertainty, had also been carried out in the past (Romano et al., 2004).

QC procedures are also undertaken on the calculations of uncertainties in order to confirm the correctness of the estimates and that there is sufficient documentation to duplicate the analysis. The assumptions which uncertainty estimations are based on are documented for each category. Figures used to draw up uncertainty analysis are checked both with the relevant analyst experts and literature references and are consistent with the IPCC Good Practice Guidance and Guidelines (IPCC, 2000; IPCC, 2003; IPCC, 2006).
More in details, facility level data are used to check and verify information from the industrial sector; these data also include information from the European Emissions Trading Scheme, the Italian PRTR register which is also collected and elaborated by the inventory team. Most of the times there is a correspondence among activity data from different databases so that the level of uncertainty could be assumed lower than the one fixed at 3%; the same occurs for emission factors coming from measurements at plant level, and even in this case the uncertainty may be assumed lower than the predetermined level. Since the overall uncertainty of the Italian inventory is relatively low due to the prevalence of the energy sector sources, which estimates derive from accurate parameters, out of the total, it has been decided to use conservative figures; this occurs especially for energy and industrial sectors.

The results of the uncertainty analysis, generally associated with a key category assessment by Approach 2, are used to prioritize improvements for the next inventory submissions.
Emissions of key categories are usually estimated with a high level of accuracy in terms of the methodology used and characterised by a low uncertainty; some exceptions may occur and categories estimated with higher tiers may be affected by a high level of uncertainty. For instance, in the agriculture sector, direct N_2O

emissions from agricultural soils and indirect N_2O from nitrogen used in agriculture are affected by a high level of uncertainty especially in the emission factors notwithstanding the advanced tiers used.

For the categories with a high uncertainty, generally, further improvements are planned whenever sectoral studies can be carried out.
For example, last year, the priorization of improvements related to the results of uncertainty analysis led to a revision of the net carbon stock changes and further activities are planned for the LULUCF sector to improve the accuracy and reduce the overall uncertainty.

1.8 General assessment of the completeness

The inventory covers all major sources and sinks, as well as direct and indirect gases, included in the IPCC guidelines.
Details are reported in Table 1.7 and Table 1.8. Sectoral and background tables of CRF sheets are complete as far as details of basic information are available. For instance, multilateral operations emissions are not estimated because no activity data are available.
Allocation of emissions is not consistent with the IPCC Guidelines only where there is no data available to split the information. For instance, for fugitive emissions, CO_2 and CH_4 emissions from oil and natural gas exploration and venting are included in those from oil production because no detailed information is available. CH_4 emissions from other leakage emissions are included in distribution emission estimates. N_2O emissions from oil and natural gas exploration and refining and storage activities are reported under category 1.B.2.C oil flaring. Further investigation will be carried out closely with industry about these figures. For industrial processes, emissions from soda ash use are included in glass production emissions because the use of soda is part of that specific production process.

Table 1.7 Source and sinks not estimated in the 2012 inventory

Sources and sinks not estimated (NE)[1]			
GHG	**Sector[2]**	**Source/sink category [2]**	**Explanation**
Carbon	5 LULUCF	5.D.1 5.D.1 Wetlands remaining Wetlands	Up to now, no information is available in order to estimate GHG emissions from wetlands
Carbon	5 LULUCF	5.D.2.2 Cropland converted to Wetlands	Up to now, no information is available in order to estimate GHG emissions from cropland converted to wetlands
Carbon	5 LULUCF	5.D.2.3 Grassland converted to Wetlands	Up to now, no information is available in order to estimate GHG emissions from grassland converted to wetlands
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Up to now there is a lack of data concerning urban tree formations. Therefore it is not possible to give estimates on the C stock changes in living biomass
Carbon	5 LULUCF	5.D.1 5.D.1 Wetlands remaining Wetlands	Up to now, no information is available in order to estimate GHG emissions from wetlands
Carbon	5 LULUCF	5.D.2.2 Cropland converted to Wetlands	Up to now, no information is available in order to estimate GHG emissions from cropland converted to wetlands
Carbon	5 LULUCF	5.D.2.3 Grassland converted to Wetlands	Up to now, no information is available in order to estimate GHG emissions from grassland converted to wetlands
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Up to now there is a lack of data concerning urban tree formations. Therefore it is not possible to give estimates on the C stock changes in living biomass
Carbon	5 LULUCF	5.D.1 5.D.1 Wetlands remaining Wetlands	Up to now, no information is available in order to estimate GHG emissions from wetlands
Carbon	5 LULUCF	5.D.2.2 Cropland converted to Wetlands	Up to now, no information is available in order to estimate GHG emissions from cropland converted to wetlands
Carbon	5 LULUCF	5.D.2.3 Grassland converted to Wetlands	Up to now, no information is available in order to estimate GHG emissions from grassland converted to wetlands
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Up to now there is a lack of data concerning urban tree formations. Therefore it is not possible to give estimates on the C stock changes in dead organic matter
Carbon	5 LULUCF	5.E.2.2 Cropland converted to Settlements	Up to now there are no sufficient data for estimating C stock changes in dead organic matter.
Carbon	5 LULUCF	5.E.2.3 Grassland converted to Settlements	Up to now there are no sufficient data for estimating C stock changes in dead organic matter.
Carbon	5 LULUCF	5.D.1 5.D.1 Wetlands remaining Wetlands	Up to now, no information is available in order to estimate GHG emissions from wetlands
Carbon	5 LULUCF	5.D.2.2 Cropland converted to Wetlands	Up to now, no information is available in order to estimate GHG emissions from cropland converted to wetlands
Carbon	5 LULUCF	5.D.2.3 Grassland converted to Wetlands	Up to now, no information is available in order to estimate GHG emissions from grassland converted to wetlands
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Up to now there is a lack of data concerning urban tree formations. Therefore it is not possible to give estimates on the C stock changes in soils
Carbon	5 LULUCF	5.C.1 other wooded lands	Tier 1 approach has been used, on the basis of data and documentation demonstrating that this pool is not a source.
Carbon	5 LULUCF	5.A.1 stands	Tier 1 approach has been used, on the basis of data and documentation demonstrating that this pool is not a source.
Carbon	5 LULUCF	5.A.1 rupicolous and riparian forests	Tier 1 approach has been used, on the basis of data and documentation demonstrating that this pool is not a source.
Carbon	5 LULUCF	5.A.1 coppices	Tier 1 approach has been used, on the basis of data and documentation demonstrating that this pool is not a source.
Carbon	5 LULUCF	5.A.1 plantations	Tier 1 approach has been used, on the basis of data and documentation demonstrating that this pool is not a source.
CH4	1 Energy	1.C2 Multilateral Operations	information and statistical data are not available
CO2	1 Energy	1.C2 Multilateral Operations	information and statistical data are not available
N2O	1 Energy	1.C2 Multilateral Operations	information and statistical data are not available

Table 1.8 Source and sinks reported elsewhere in the 2012 inventory

Sources and sinks reported elsewhere (IE)				
GHG	**Source/sink category**	**Allocation as per IPCC Guidelines**	**Allocation used by the Party**	**Explanation**
CH4	1.B.2.B.5.1 at industrial plants and power stations	1.B.2.B.5.1	1.A.1 /1.A.2	Emissions are reported under the respective sectors where they occurr
CH4	1.B.2.B.5.2 in residential and commercial sectors	1.B.2.B.5.2	1.A.4	Emissions are reported under the respective sectors where they occurr
CH4	1.B.2.C.1.2 Gas	1.B.2.C.1.2	1.B.2.B.2	Emissions are included in 1.B.2.B.2 Gas production
CH4	2.C.1.4 Coke	2.C.1.4	1.B.1.b	CH4 emission from coke production are fugitive emissions due to the door leakage during the solid transformation and are reported under the 1.B.1.b category, fugitive emissions from solid fuel.
CH4	6.B.1 Industrial Wastewater	6.B.1 Industrial Wastewater/Sludge	6.B.1 Industrial Wastewater/Wastewater	Emissions are reported under 6.B.1 Industrial Wastewater/Wastewater
CH4	1.AA.3.B Road Transportation	1.AA.3B biomass	1.AA.3B liquid fuel	emissions are included in liquid fuel - gasoil/diesel category
CO2	1.B.2.B.5.1 at industrial plants and power stations	1.B.2.B.5.1	1.A.1 /1.A.2	Emissions are reported under the respective sectors where they occurr
CO2	1.B.2.B.5.2 in residential and commercial sectors	1.B.2.B.5.2	1.A.4	Emissions are reported under the respective sectors where they occurr
CO2	1.B.2.C.1.2 Gas	1.B.2.C.1.2	1.B.2.B.2	Emissions are included in 1.B.2.B.2 Gas production
CO2	2.A.4.2 Soda Ash Use	2.A.4.2	2.A.7	Emission from soda ash use are included in other processes (glass, paper,etc).
CO2	5.A.1 Forest Land remaining Forest Land	5.A.1. - 5(V) - Biomass Burning - Wildfires	5.A.1 Carbon stock change	CO2 emissions due to wildfires in forest land remaining forest land are included in table 5.A.1, Carbon stock change in living biomass, Losses
CO2	5.A.2 Land converted to Forest Land	5.A.1. - 5(V) - Biomass Burning - Wildfires	5.A.1 Carbon stock change	CO2 emissions due to wildfires in forest land remaining forest land are included in table 5.A.1, Carbon stock change in living biomass, Losses
CO2	5.B.1 Cropland remaining Cropland	5 (IV) CO2 emissions from agricultural lime application - Dolomite CaMg (CO3)2	IE in 5 (IV) CO2 emissions from agricultural lime application - Limestone Ca CO3	CO2 emissions from agricultural dolomite CaMg(CO3)2 application have been included in CO2 emissions from Limestone application, as national statistics on amount of lime applied don't allow to disaggregate the two component (limestone and dolomite)
N2O	1.B.2.A.4 Refining / Storage	1.B.2.A.4	1.B.2.D	emission are included in 1.B.2.D flaring in refineries
N2O	6.B.1 Industrial Wastewater	6.B.1 Industrial Wastewater/Sludge	6.B.1 Industrial Wastewater/Wastewater	Emissions are reported under 6.B.1 Industrial Wastewater/Wastewater
N2O	6.B.2.1 Domestic and Commercial (w/o human sewage)	6.B.2.1 Domestic and commercial/Wastewater	6.B.2.2 Human sewage	Emissions are reported under 6.B.2.2 Human sewage
N2O	6.B.2.1 Domestic and Commercial (w/o human sewage)	6.B.2.1 Domestic and commercial/Sludge	6.B.2.2 Human sewage	Emissions are reported under 6.B.2.2 Human sewage
N2O	1.AA.3.B Road Transportation	1.AA.3B biomass	1.AA.3B liquid fuel	emissions are included in liquid fuel - gasoil/diesel category
SF6	2.F.7 Semiconductor Manufacture	2.F.7 Semiconductor Manufacture/SF6/Amount of fluid in operating systems	2.F.7 Semiconductor Manufacture/SF6/Amount of fluid in new mnufactured products	Data are included in new manufactured products
SF6	2.F.7 Semiconductor Manufacture	2.F.7 Semiconductor Manufacture/SF6/Amount of fluid remained in products at decommissioning	2.F.7 Semiconductor Manufacture/SF6/Amount of fluid in new mnufactured products	Data are included in new manufactured products
SF6	2.F.7 Semiconductor Manufacture	2.F.7 Semiconductor Manufacture/SF6/Actual emissions from stocks	2.F.7 Semiconductor Manufacture/SF6/Actual emissions from manufacturing	Emissions are included in emissions from manufacturing
SF6	2.F.7 Semiconductor Manufacture	2.F.7 Semiconductor Manufacture/SF6/Actual emissions from disposal	2.F.7 Semiconductor Manufacture/SF6/Actual emissions from manufacturing	Emissions are included in emissions from manufacturing

2 TRENDS IN GREENHOUSE GAS EMISSIONS

2.1 Description and interpretation of emission trends for aggregate greenhouse gas emissions

Summary data of the Italian greenhouse gas emissions for the years 1990-2012 are reported in Tables A8.1.1- A8.1.5 of Annex 8.
The emission figures presented are those sent to the UNFCCC Secretariat and to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism.
Total greenhouse gas emissions, in CO_2 equivalent, excluding emissions and removals from LULUCF, have decreased by 11.4% between 1990 and 2012, varying from 519 to 460 CO_2 equivalent million tons (Mt), whereas the national Kyoto target is a reduction of 6.5%, as compared the base year levels, by the period 2008-2012. Considering the variation between the average of emissions in the 2008-2012 period and the emissions in the base year, the level of emissions decreased by 4.6%.
It should be noted that the economic recession has had a remarkable influence on the production levels affecting the energy and industrial process sectors, with a consequent notable reduction of total emissions, in the last four years.
The most important greenhouse gas, CO_2, which accounts for 84.0% of total emissions in CO_2 equivalent, shows a decrease by 11.0% between 1990 and 2012. In the energy sector, in particular, CO_2 emissions in 2012 are 8.8% lower than in 1990.
CH_4 and N_2O emissions are equal to 7.6% and 6.0% of the total CO_2 equivalent greenhouse gas emissions, respectively. CH_4 emissions have decreased by 20.6% from 1990 to 2012, while N_2O has decreased by 25.9%.
As for other greenhouse gases, HFCs account for 2.0% of total emissions, PFCs and SF_6 are equal to 0.3% and 0.1% of total emissions, respectively. HFC emissions show a strong increase, while PFC emissions show a decrease and SF_6 emissions show a slight increase. Although at present, variations in these gases are not relevant to reaching the emission reduction objectives, the meaningful increasing trend of HFCs will make them even more important in next years.
Figure 2.1 illustrates the national trend of greenhouse gases for 1990-2012, expressed in CO_2 equivalent terms and by substance; total emissions do not include emissions and removals from land use, land use change and forestry.

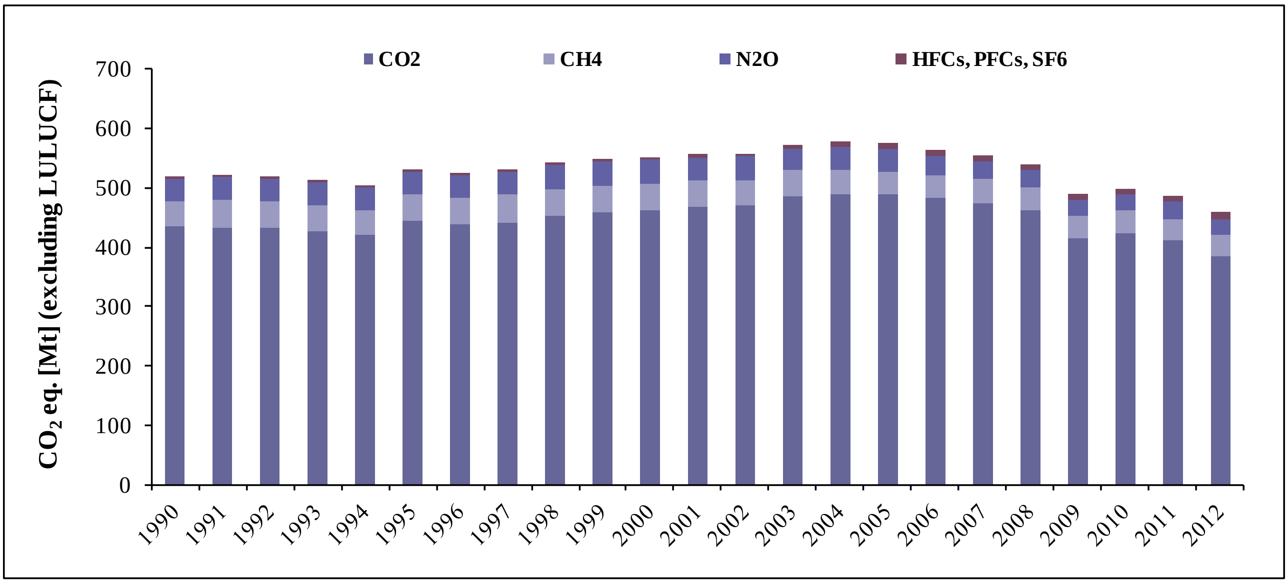

Figure 2.1 National greenhouse gas emissions from 1990 to 2012 (without LULUCF) (Mt CO_2 eq.)

The share of the different sectors, in terms of total emissions, remains nearly unvaried over the period 1990-2012. Specifically for the year 2012, the greatest part of the total greenhouse gas emissions is to be attributed to the energy sector, with a percentage of 82.6%, followed by agriculture and industrial processes,

accounting for 7.5% and 6.1% of total emissions, respectively, waste contributing with 3.5% and use of solvents with 0.3%.
Total greenhouse gas emissions and removals, including LULUCF sector, are shown in Figure 2.2 subdivided by sector.
Considering total GHG emissions with emissions and removals from LULUCF, the energy sector accounts, in 2012, for 79.4% of total emissions and removals, as absolute weight, followed by agriculture (7.2%), industrial processes (5.9%), LULUCF which contributes with 3.9%, and waste (3.4%).

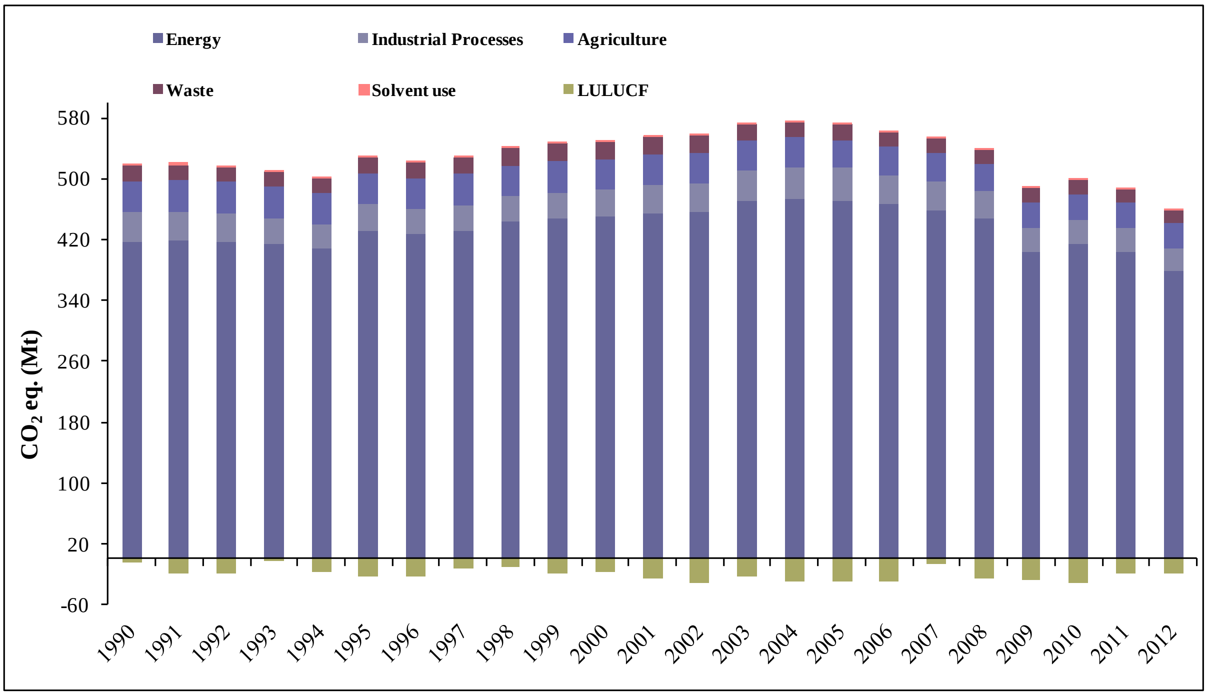

Figure 2.2 Greenhouse gas emissions and removals from 1990 to 2012 by sector (Mt CO_2 eq.)

2.2 Description and interpretation of emission trends by gas

2.2.1 Carbon dioxide emissions

CO_2 emissions, excluding CO_2 emissions and removals from LULUCF, have decreased by 11.0% from 1990 to 2012, ranging from 435 to 387 million tons.
The most relevant emissions derive from the energy industries (32.5%) and transportation (27.1%). Non-industrial combustion accounts for 21.2% and manufacturing and construction industries for 13.9%, while the remaining emissions derive from industrial processes (4.4%) and other sectors (0.9%).
The performance of CO_2 emissions by sector is shown in Figure 2.3.

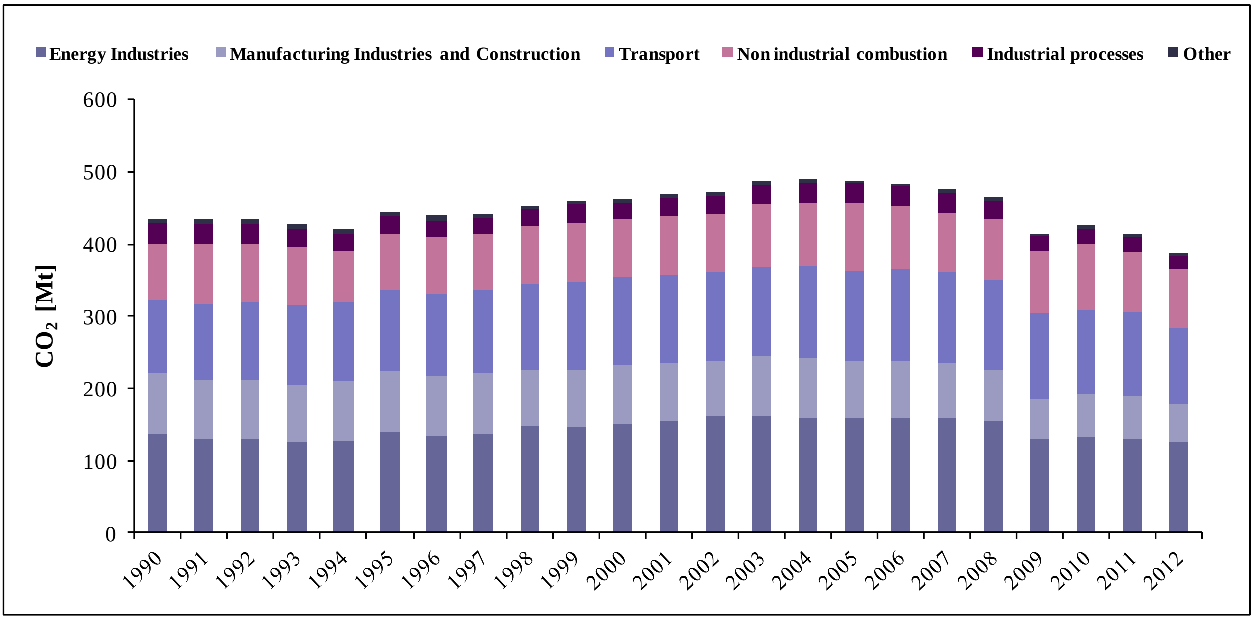

Figure 2.3 National CO_2 emissions by sector from 1990 to 2012 (Mt)

The main sectors responsible for CO_2 emissions are transport and energy industries; in the period 1990-2012, emissions from transport have increased by 3.5% from 1990 to 2012 while those from energy industries decreased by 8.0%. Non industrial combustion emissions have increased by 5.7% and those from industrial processes decreased by 40.2%; emissions from manufacturing industries and construction show a decrease of 37.1%, emissions in the 'Other' sector, fugitive emissions from oil and natural gas, emissions from solvent and other product use and emissions from waste, reduced by 38.2%.

Figure 2.4 illustrates the performance of the following economic and energy indicators:

- Gross Domestic Product (GDP) at market prices as of 2005 (base year 1990=100);
- Total Energy Consumption;
- CO_2 emissions, excluding emissions and removals from land-use change and forests;
- CO_2 *intensity*, which represents CO_2 emissions per unit of total energy consumption.

CO_2 emissions in the 1990s essentially mirrored energy consumption. A decoupling between the curves is observed only in recent years, mainly as a result of the substitution of fuels with high carbon contents by methane gas in the production of electric energy and in industry; in the last years, the increase in the use of renewable sources has led to a notable reduction of CO_2 intensity.

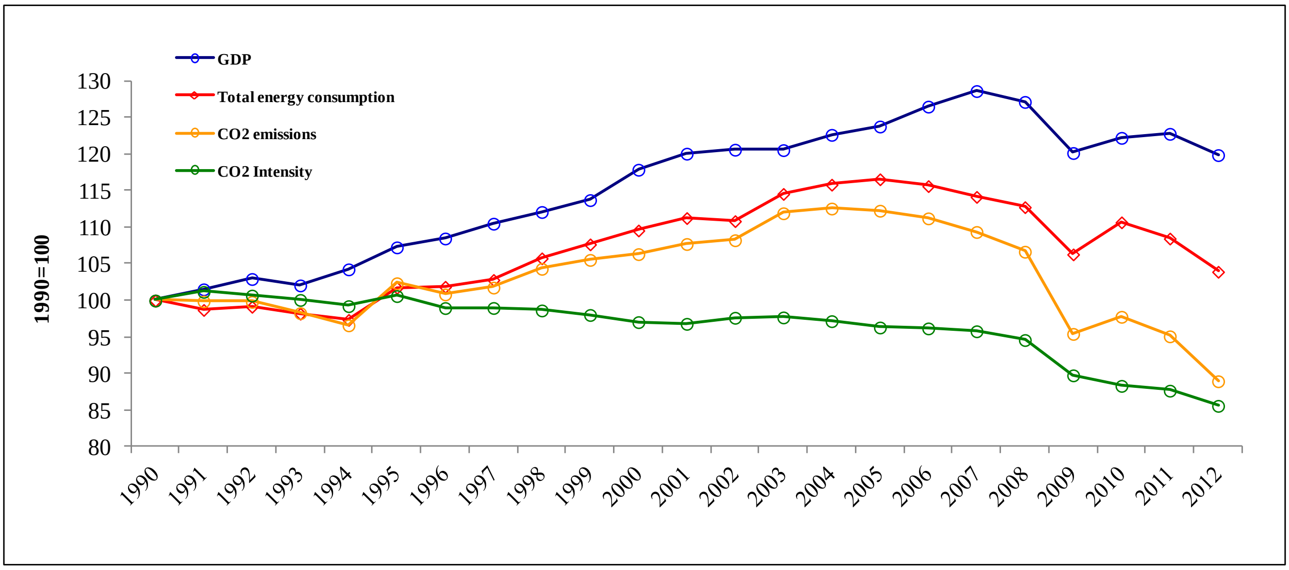

Figure 2.4 Energy-related and economic indicators and CO_2 emissions

2.2.2 Methane emissions

Methane emissions (excluding LULUCF) in 2012 represent 7.6% of total greenhouse gases, equal to 34.7 Mt in CO_2 equivalent, and show a decrease of 9.0 Mt (-20.6%) as compared to 1990 levels.
CH_4 emissions, in 2012, are mainly originated from waste sector which accounts for 40.5 % of total methane emissions, as well as from the agriculture (40.1%) and energy (19.2%) sectors.
Activities typically leading to emissions in the waste-management sector are the operation of dumping sites and the treatment of industrial waste-water. The waste sector shows a decrease in emission levels, 18.5% compared to 1990; the solid waste disposal on land, which represents the largest emission sectoral share (80.2%), decreases of 25.9%, while the highest increases concern waste-water handling (37.0%) and waste incineration (15.8%) subcategories.
Emissions in the agriculture sector regard mainly the enteric fermentation (76.6%) and manure management (12.2%) categories. The sector shows a decrease of emissions equal to 19.7% as compared to 1990.
In terms of CH_4 emissions in the energy sector, the reduction (-26.0%) is the result of two contrasting factors: on the one hand there has been a considerable reduction in emissions deriving from energy industries, manufacturing industries and construction, transport, fugitive emissions from fuels (caused by leakage from the extraction and distribution of fossil fuels, due to the gradual replacement of natural-gas distribution networks), on the other hand a strong increase in the civil sector can be observed, as a result of increased use of methane and biomass in heating systems. Figure 2.5 shows the emission figures by sector.

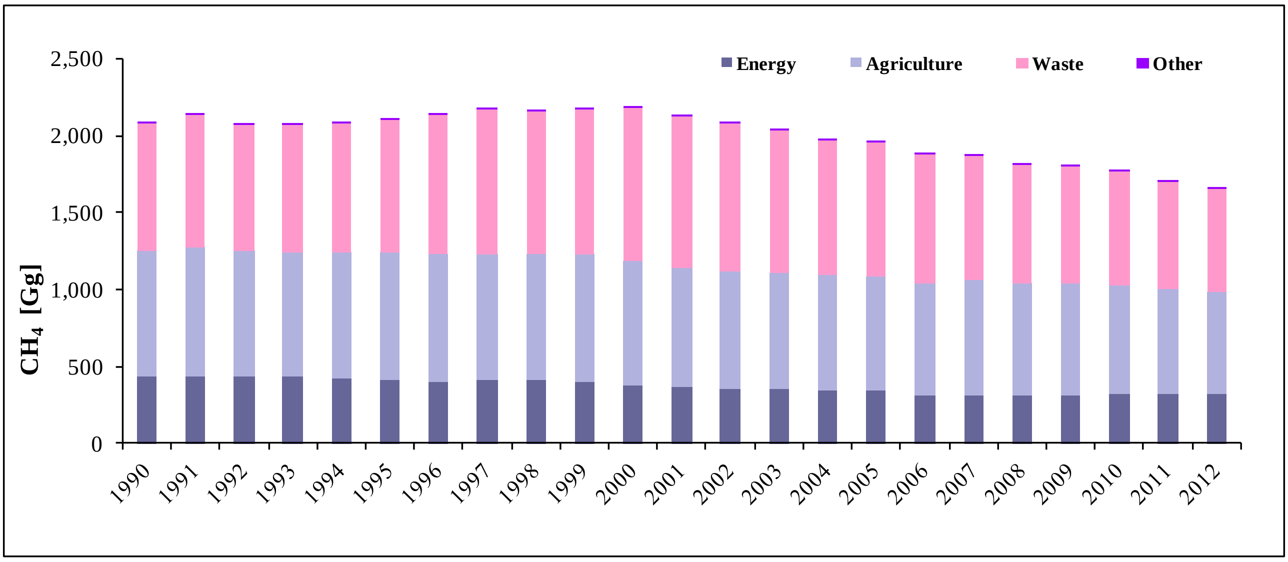

Figure 2.5 National CH_4 emissions by sector from 1990 to 2012 (Gg)

2.2.3 Nitrous oxide emissions

In 2012 nitrous oxide emissions (excluding LULUCF) represent 6.0% of total greenhouse gases, with a decrease of 25.9% between 1990 and 2012, from 37.5 to 27.8 Mt CO_2 equivalent.
The major source of N_2O emissions is the agricultural sector (73.4%), in particular the use of both chemical and organic fertilisers in agriculture, as well as the management of waste from the raising of animals. These emissions show a decrease of 13.3% during the period 1990-2012.
Emissions in the energy-use sector (16.8% of the total) show an increase by 1.5% from 1990 to 2012; this growth can be traced primarily to the road transport sector and it is related to the introduction of catalytic converters. However, a high degree of uncertainty still exists with regard to N_2O emission factors of catalysed automobiles. Emissions from production of nitric acid have decreased of 92.9% from 1990 to 2012 with a notable decrease in the last years due to the introduction of the abatment systems in the main production plant; emissions from production of adipic acid show a decrease from 2005 to 2012 of 98.6% because of the introduction of an abatement technology, showing a global reduction of 98.1% from 1990.
Other emissions in the waste sector (7.3% of national N_2O emissions) primarily regard the processing of industrial and domestic waste-water.
Figure 2.6 shows national emission figures by sector.

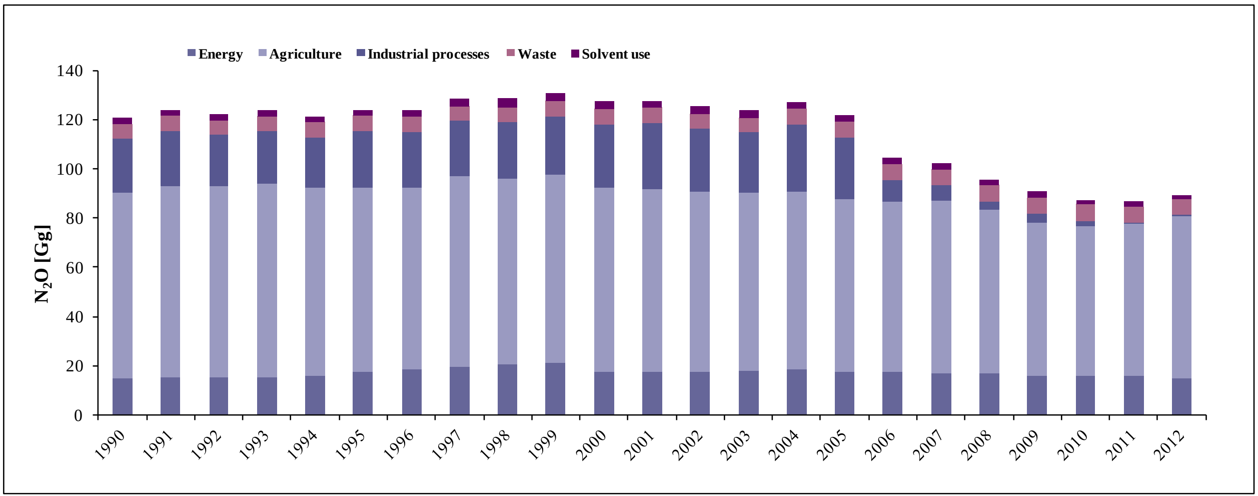

Figure 2.6 National N_2O emissions by sector from 1990 to 2012 (Gg)

2.2.4 Fluorinated gas emissions

Italy has set 1990 as the base year for reduction in the emissions of the fluorinated gases covered by the Kyoto Protocol, HFCs, PFCs and SF_6. Taken altogether, the emissions of fluorinated gases represent 2.4% of total greenhouse gases in CO_2 equivalent in 2012 and they show an increase of 244.3% between 1990 and 2012. This increase is the result of different features for the different gases.

HFCs, for instance, have increased considerably from 1990 to 2012, from 0.4 to 9.2 Mt in CO_2 equivalent. The main sources of emissions are the consumption of HFC-134a, HFC-125, HFC-32 and HFC-143a in refrigeration and air-conditioning devices, together with the use of HFC-134a in pharmaceutical aerosols. Increases during this period are due both to the use of these substances as substitutes for gases that destroy the ozone layer and to the greater use of air conditioners in automobiles.

Emissions of PFCs show a decrease of 47.2% from 1990 to 2012. The level of PFCs emissions in 2012 is 1.3 Mt in CO_2 equivalent, and it is due to by product emissions in the production of halocarbons (90.0%), the production of primary aluminium (2.5%) and the use of the gases in the production of semiconductors (7.4%).

Emissions of SF_6 are equal to 0.4 Mt in CO_2 equivalent in 2012, with an increase of 6.8% as compared to 1990 levels. In 2012, 86.4% of SF_6 emissions derive from the gas contained in electrical equipments and 13.6% from the gas used in the semiconductors manufacture. From 2005 to 2006, emissions of SF_6 have fallen by 12.8%, and between 2006 and 2012 a decrease of 12.4%.

The National Inventory of fluorinated gases has largely improved in terms of sources and gases identified and a strict cooperation with the relevant industry has been established. Higher methods are applied to estimate these emissions; nevertheless, uncertainty still regards some activity data which are considered of strategic economic importance and therefore kept confidential.

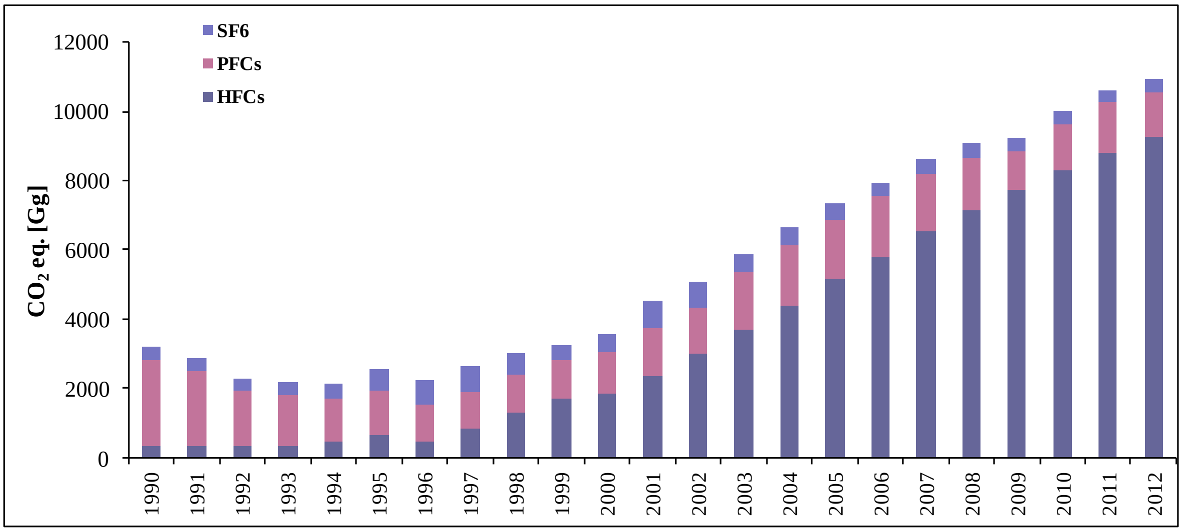

Figure 2.7 National emissions of fluorinated gases by sector from 1990 to 2012 (Gg CO_2 eq.)

2.3 Description and interpretation of emission trends by source

2.3.1 Energy

Emissions from the energy sector account for 82.6% of total national greenhouse gas emissions, excluding LULUCF.
Emissions in CO_2 equivalent from the energy sector are reported in Table 2.1 and Figure 2.8.

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
					Gg CO_2 eq.						
Total emissions	**417,716**	**431,113**	**449,688**	**471,903**	**466,722**	**458,062**	**448,933**	**404,866**	**414,914**	**403,641**	**379,863**
Fuel Combustion (Sectoral Approach)	406,935	421,041	440,664	464,056	459,355	450,853	441,589	397,729	407,396	396,235	372,624
Energy Industries	*137,214*	*140,541*	*152,556*	*160,552*	*161,698*	*161,469*	*156,806*	*131,796*	*133,182*	*131,227*	*126,298*
Manufacturing Industries and Construction	*86,948*	*86,586*	*83,811*	*80,239*	*79,187*	*75,903*	*72,473*	*55,903*	*61,374*	*61,226*	*54,922*
Transport	*103,085*	*114,103*	*122,443*	*127,441*	*128,732*	*128,733*	*123,507*	*119,012*	*118,435*	*117,418*	*106,057*
Other Sectors	*78,569*	*78,300*	*81,003*	*94,533*	*88,680*	*83,780*	*88,001*	*90,098*	*93,735*	*85,837*	*84,991*
Other	*1,120*	*1,511*	*851*	*1,291*	*1,058*	*969*	*801*	*920*	*669*	*527*	*355*
Fugitive Emissions from Fuels	10,781	10,072	9,024	7,847	7,367	7,208	7,344	7,137	7,518	7,406	7,239
Solid Fuels	*127*	*66*	*75*	*70*	*54*	*86*	*74*	*45*	*66*	*71*	*62*
Oil and Natural Gas	*10,654*	*10,007*	*8,949*	*7,777*	*7,313*	*7,122*	*7,270*	*7,092*	*7,451*	*7,335*	*7,177*

Table 2.1 Total emissions from the energy sector by source (1990-2012) (Gg CO_2 eq.)

Total greenhouse gas emissions, in CO_2 equivalent, show a decrease of about 9.1% from 1990 to 2012; in particular, an upward trend is noted from 1990 to 2004, with an increase by 13.4%, while between 2004 and 2012 emissions have decreased by 19.8%.
CO_2 emissions, accounting for 97.0% of the sectoral total, have decreased by 8.8% from 1990 to 2012; N_2O shows an increase of 1.5% but its share out of the total is only 1.2% whereas CH_4 shows a decrease of 26.0% from 1990 to 2012, accounting for 1.8% of the total emission levels.
It should be noted that from 1990 to 2012 the most significant increase, in terms of total CO_2 equivalent, is observed in transport and in other sectors, about 2.9% and 8.2%, respectively; in 2012 these sectors,

altogether, account for 50.3% of total emissions. In the period 1990-2012, energy industries emissions have decreased by 8.0%, accounting for 33.2% of total emissions.
Details on these figures are described in the specific chapter.

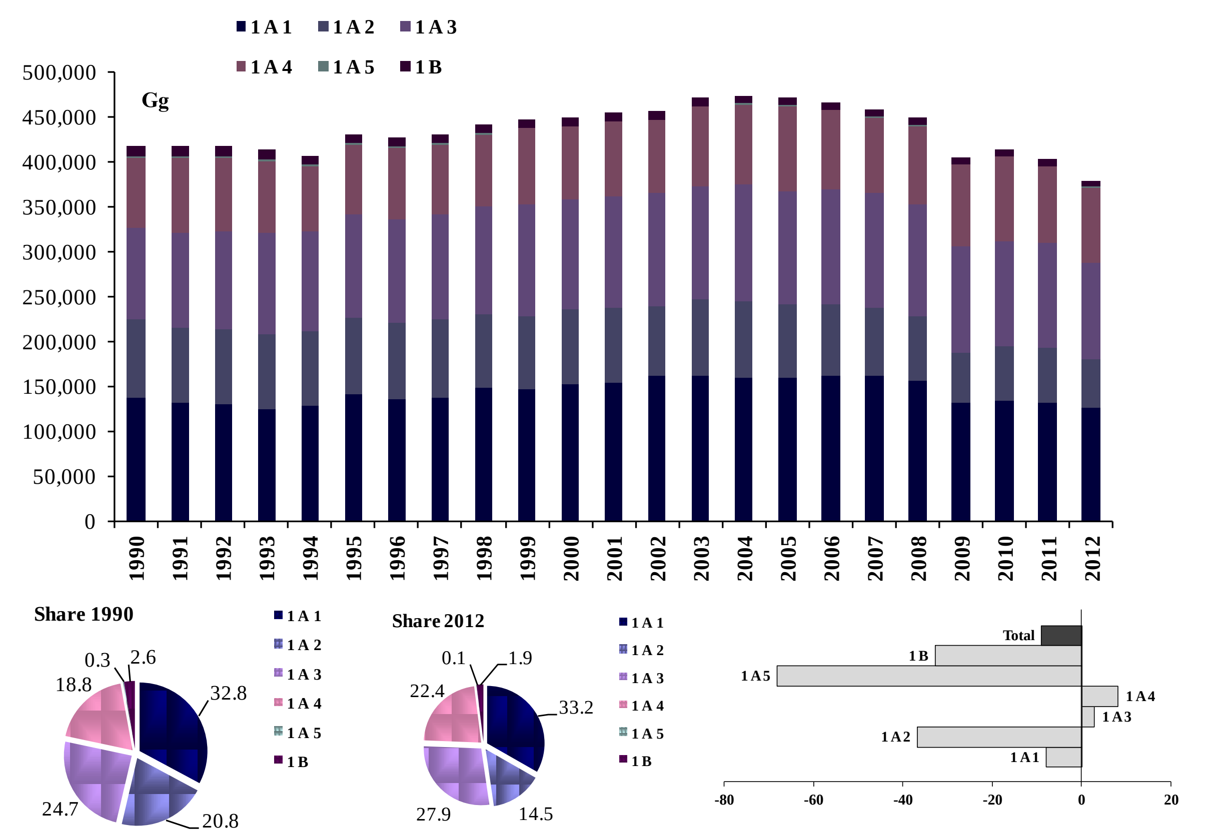

Figure 2.8 Trend of total emissions from the energy sector (1990-2012) (Gg CO_2 eq.)

2.3.2 Industrial processes

Emissions from industrial processes account for 6.1% of total national greenhouse gas emissions, excluding LULUCF.
Emission trends from industrial processes are reported in Table 2.2 and Figure 2.9.
Total emissions, in CO_2 equivalent, show a decrease of 26.5%, from the base year to 2012. Taking into account emissions by substance, CO_2 and N_2O decreased by 40.2% and 96.5%, respectively; these two gases account altogether for about 61.1% of the total emissions from industrial processes (CO_2 for 60.3 and N_2O for 0.8%). CH_4 decreased by 49.3% but it accounts only for 0.2%.
The decrease in emissions is mostly to be attributed to a decrease in chemical industry and metal production emissions. The decrease of GHG emissions in the chemical industry (-82.5%) is due to the decreasing trend of the emissions from nitric acid and adipic acid production (the last production process sharply reduced its emissions, due to a fully operational abatement technology). Emissions from metal production decreased by 71.3% mostly for the different materials used in the pig iron and steel production processes.
On the other hand, a considerable increase is observed in F-gas emissions (244.3%), whose share on total emissions is 38.7%.
Details for industrial processes emissions can be found in the specific chapter.

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
						Gg CO_2 eq					
Total	**38,390**	**35,937**	**36,101**	**42,339**	**37,871**	**38,292**	**35,317**	**30,348**	**31,265**	**31,049**	**28,201**
CO_2	28,434	26,038	24,571	27,186	27,205	27,711	25,093	19,951	20,563	20,086	16,996
CH_4	108	113	63	64	66	65	61	38	52	57	55
N_2O	6,676	7,239	7,918	7,760	2,647	1,891	1,066	1,130	647	295	234
F-gases	3,171	2,548	3,549	7,328	7,953	8,625	9,098	9,229	10,003	10,610	10,916
HFCS	*351*	*680*	*1,838*	*5,148*	*5,834*	*6,546*	*7,162*	*7,769*	*8,299*	*8,804*	*9,246*
PFCS	*2,487*	*1,266*	*1,217*	*1,715*	*1,714*	*1,652*	*1,501*	*1,063*	*1,331*	*1,455*	*1,314*
SF_6	*333*	*601*	*493*	*465*	*406*	*428*	*436*	*398*	*373*	*351*	*356*

Table 2.2 Total emissions from the industrial processes sector by gas (1990-2012) (Gg CO_2 eq.)

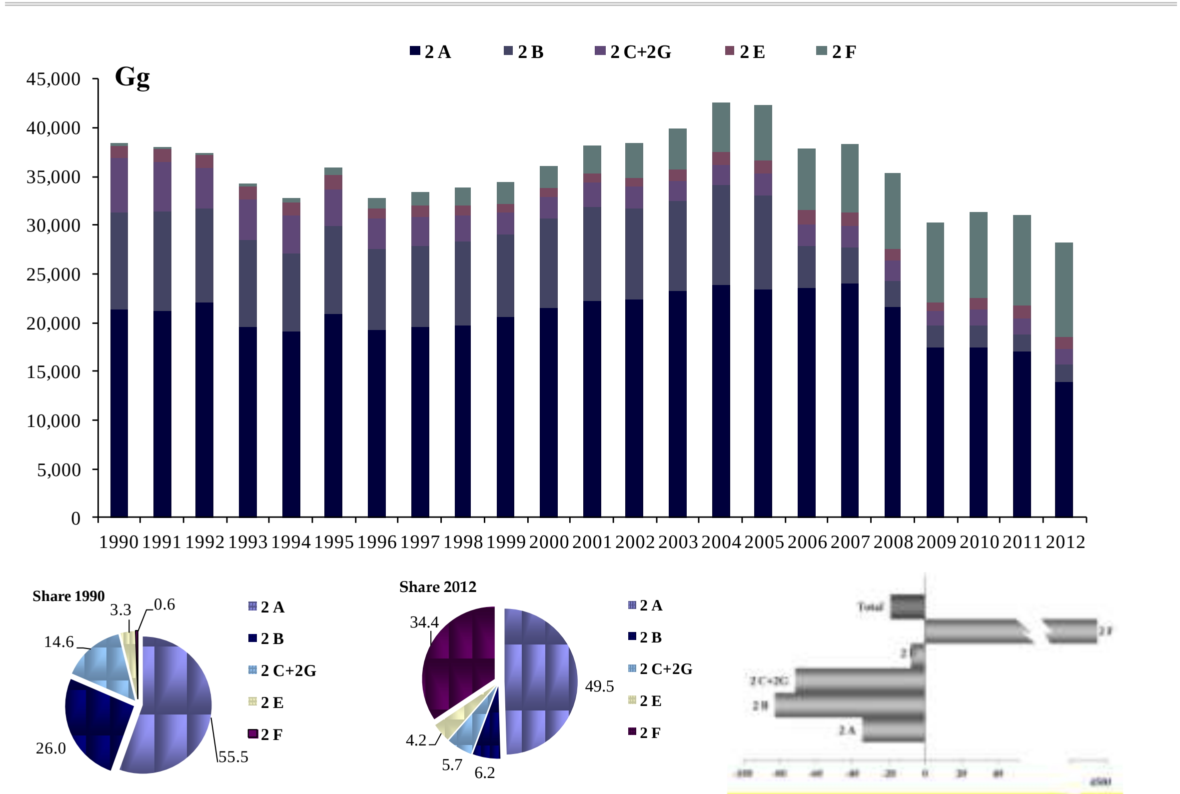

Figure 2.9 Trend of total emissions from the industrial processes sector (1990-2012) (Gg CO_2 eq.)

2.3.3 *Solvent and other product use*

Emissions from the solvent and other product use sector refer to CO_2 and N_2O, and to other substances that are not greenhouse gases. A considerable amount of emissions from this sector is, in fact, to be attributed to NMVOC.
Emission trends for CO_2 and N_2O from the sector are reported in Table 2.3 and Figure 2.10.

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
						Gg CO_2 eq.					
Total emissions	**2,455**	**2,235**	**2,301**	**2,123**	**2,117**	**2,070**	**1,947**	**1,818**	**1,669**	**1,648**	**1,516**
CO_2	1,642	1,463	1,275	1,299	1,308	1,282	1,220	1,134	1,043	1,071	1,001
N_2O	812	772	1,027	823	808	788	727	684	626	577	514

Table 2.3 Total emissions from the solvent and other product use sector by gas (1990-2012) (Gg CO_2 eq.)

In 2012, solvent use is responsible for 0.3% of the total CO_2 equivalent emissions (excluding LULUCF).

The share of CO_2 emissions, in this sector, is 66.1% out of the total, while N_2O emissions represent 33.9% of the sectoral total; a decrease by 38.3% is noted from this sector from 1990 to 2012, which is to be attributed to different sources. As regards CO_2, emission levels from paint application sector, which accounts for 50.8% of total CO_2 emissions from this sector, decreased by 39.7%; emissions from other use of solvents in related activities, such as domestic solvent use other than painting, application of glues and adhesives, printing industries, fat edible and non edible oil extraction, vehicle dewaxing, glass wool enduction, which account for 43.2% of the CO_2 total emissions, show a decrease of 30.4%. Finally, CO_2 emissions from metal degreasing and dry cleaning activities, decreased by 66.0% but they account for only 6.0% of the total.
N_2O emissions from this sector, in 2012, represent 1.9% of the total N_2O national emissions.
The level of N_2O emissions shows a decrease of 36.7%. From 1990 to 1995, a quite stable level of N_2O emissions is observed, afterwards from 1995 to 1998 emissions increased by 36.7%. From 1999 onwards, a reduction in N_2O emissions is observed, due to a decrease in the anaesthetic use of N_2O, which has been replaced by halogen gas. Further details about this sector can be found in the specific chapter.

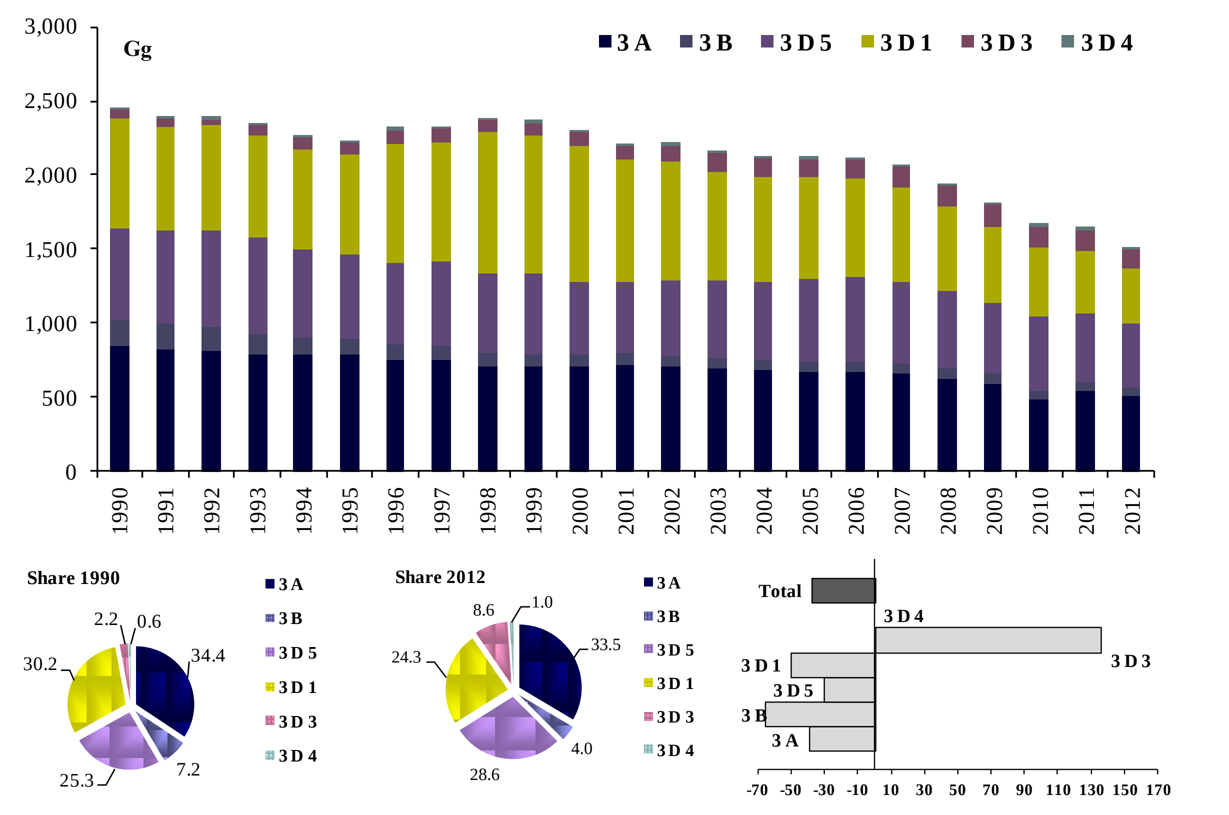

Figure 2.10 Trend of total emissions from the solvent and other product use sector (1990-2012) (Gg CO_2 eq.)

2.3.4 Agriculture

Emissions from the agriculture sector account for 7.5% of total national greenhouse gas emissions, excluding LULUCF. Emissions from the agriculture sector are reported in Table 2.4 and Figure 2.11.

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
				Gg CO_2 eq.							
Total emissions	**40,830**	**40,602**	**40,218**	**37,442**	**36,845**	**37,508**	**36,091**	**34,852**	**33,783**	**33,572**	**34,289**
Enteric Fermentation	12,278	12,348	12,246	10,914	10,699	11,099	10,996	11,007	10,732	10,753	10,667
Manure Management	7,401	7,080	7,152	6,868	6,638	6,842	6,744	6,693	6,275	5,828	5,446
Rice Cultivation	1,576	1,671	1,391	1,472	1,475	1,516	1,386	1,565	1,565	1,550	1,533
Agricultural Soils	19,557	19,487	19,411	18,169	18,014	18,033	16,947	15,569	15,193	15,423	16,624
Field Burning of Agricultural Residues	17	17	17	18	18	18	19	18	18	18	19

Table 2.4 Total emissions from the agriculture sector by source (1990-2012) (Gg CO_2 eq.)

Emissions refer to CH_4 and N_2O levels, which account for 40.6% and 59.4% of the total emissions of the sector, respectively. The decrease observed in the total emissions (-16.0%) is mostly due to the decrease of CH_4 emissions from enteric fermentation (-13.1%) and to the decrease of N_2O (-15.0%) from agricultural soils, which account for 31.1% and 48.5% of the total sectoral emissions, respectively.
Detailed comments can be found in the specific chapter.

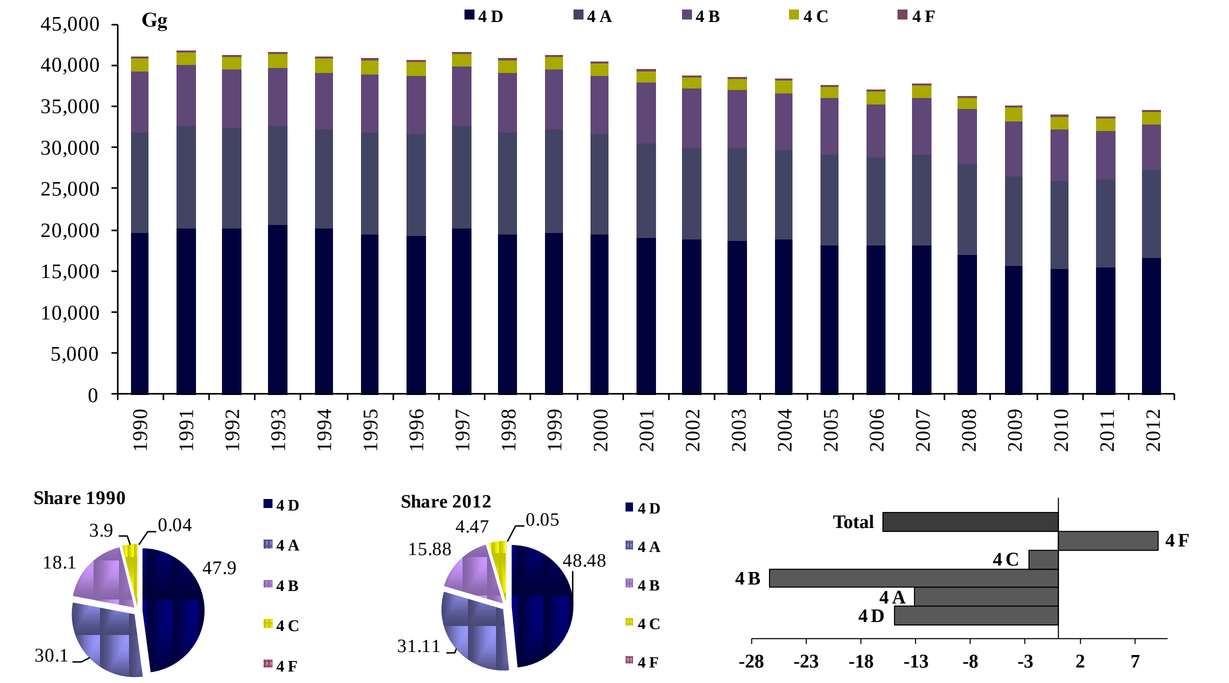

Figure 2.11 Trend of total emissions from the agriculture sector (1990-2012) (Gg CO_2 eq.)

2.3.5 LULUCF

Emissions from the LULUCF sector are reported in Table 2.5 and Figure 2.12.

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
						Gg CO_2 eq.					
Total emissions	**-3,609**	**-23,700**	**-16,974**	**-29,543**	**-30,206**	**-5,738**	**-25,817**	**-27,683**	**-31,119**	**-19,139**	**-18,556**
Forest Land	-18,061	-32,477	-26,746	-36,097	-35,815	-18,797	-32,143	-34,955	-36,433	-28,600	-29,526
Cropland	2,241	1,756	2,057	1,481	1,269	1,316	1,279	1,369	1,357	4,308	4,256
Grassland	5,215	-980	825	-2,609	-3,350	4,052	-2,652	-1,847	-3,807	-2,615	-1,060
Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
Settlements	6,996	8,001	6,890	7,682	7,690	7,692	7,698	7,750	7,763	7,768	7,774
Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 2.5 Total emissions from the LULUCF sector by source/sink (1990-2012) (Gg CO_2 eq.)

Total removals, in CO_2 equivalent, in the LULUCF sector, show an increase of 414.2% from the base year to 2012. CO_2 accounts for 93.8% of total emissions and removals of the sector. The key driver for the rise in removals is the increase of carbon stock changes from forest land (the area reported under forest land remaining forest land has increased by 20.4%). The trend is remarkable influenced by the annual area burned by fires.
Further details for LULUCF emissions and removals can be found in the specific chapter.

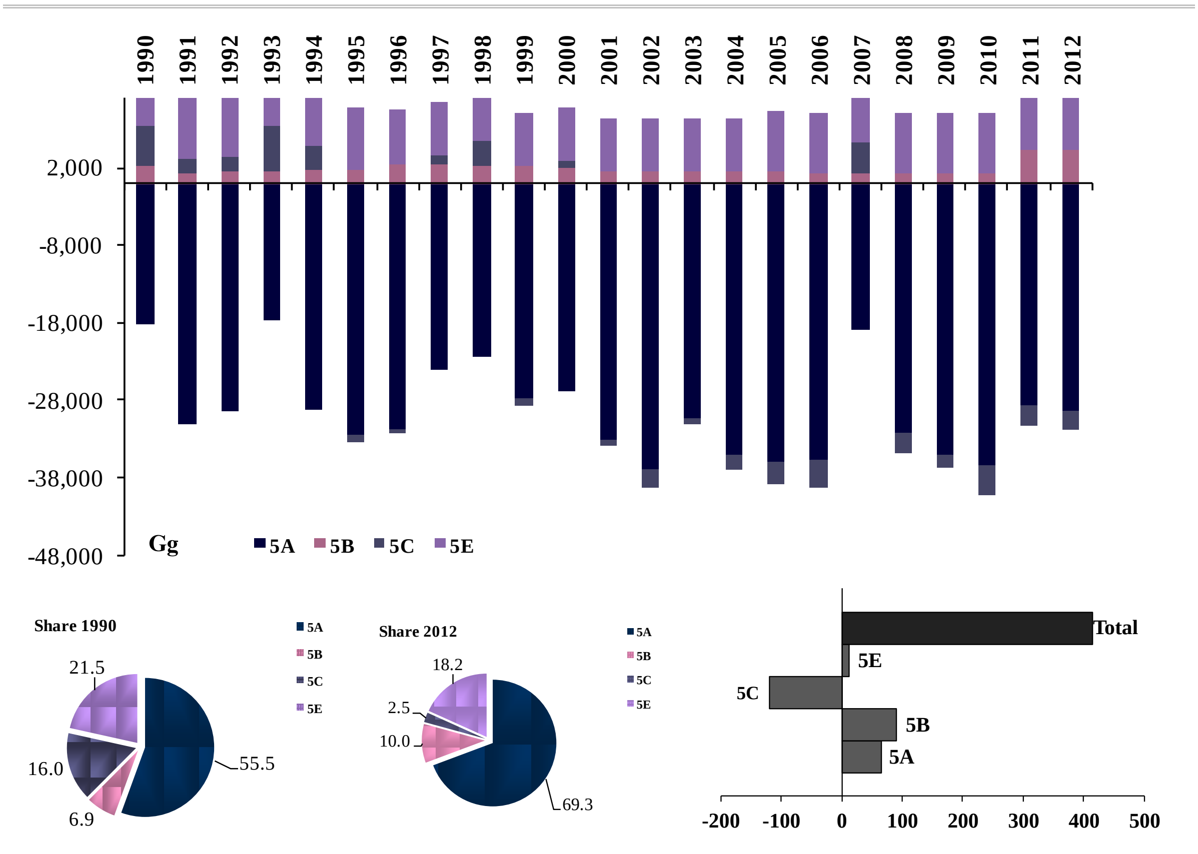

Figure 2.12 Trend of total emissions and removals from the LULUCF sector (1990-2012) (Gg CO_2 eq.)

2.3.6 Waste

Emissions from the waste sector account for 3.5% of total national greenhouse gas emissions, excluding LULUCF.
Emissions from the waste sector are shown in Table 2.6 and Figure 2.13.

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
	Gg CO_2 eq.										
Total emissions	**19,665**	**20,445**	**22,929**	**20,454**	**19,818**	**19,147**	**18,331**	**18,229**	**17,728**	**16,691**	**16,214**
Solid Waste Disposal on Land	15,254	15,909	18,357	15,514	14,851	14,194	13,364	13,237	12,767	11,770	11,303
Waste-water Handling	3,821	3,995	4,292	4,629	4,645	4,663	4,682	4,669	4,712	4,667	4,661
Waste Incineration	590	541	277	306	318	285	280	319	244	248	245
Other	0	0	2	4	4	5	4	4	5	5	6

Table 2.6 Total emissions from the waste sector by source (1990-2012) (Gg CO_2 eq.)

Total emissions, in CO_2 equivalent, decreased by 17.5% from 1990 to 2012. The trend is mainly driven by the decrease in emissions from solid waste disposal on land (-25.9%), accounting for 69.7% of the total. Considering emissions by gas, the most important greenhouse gas is CH_4 which accounts for 86.9% of the total and shows a decrease of 18.5% from 1990 to 2012. N_2O levels have increased by 4.8% while CO_2 decreased by 66.5%; these gases account for 12.1% and 1.0%, respectively.
Further details can be found in the specific chapter.

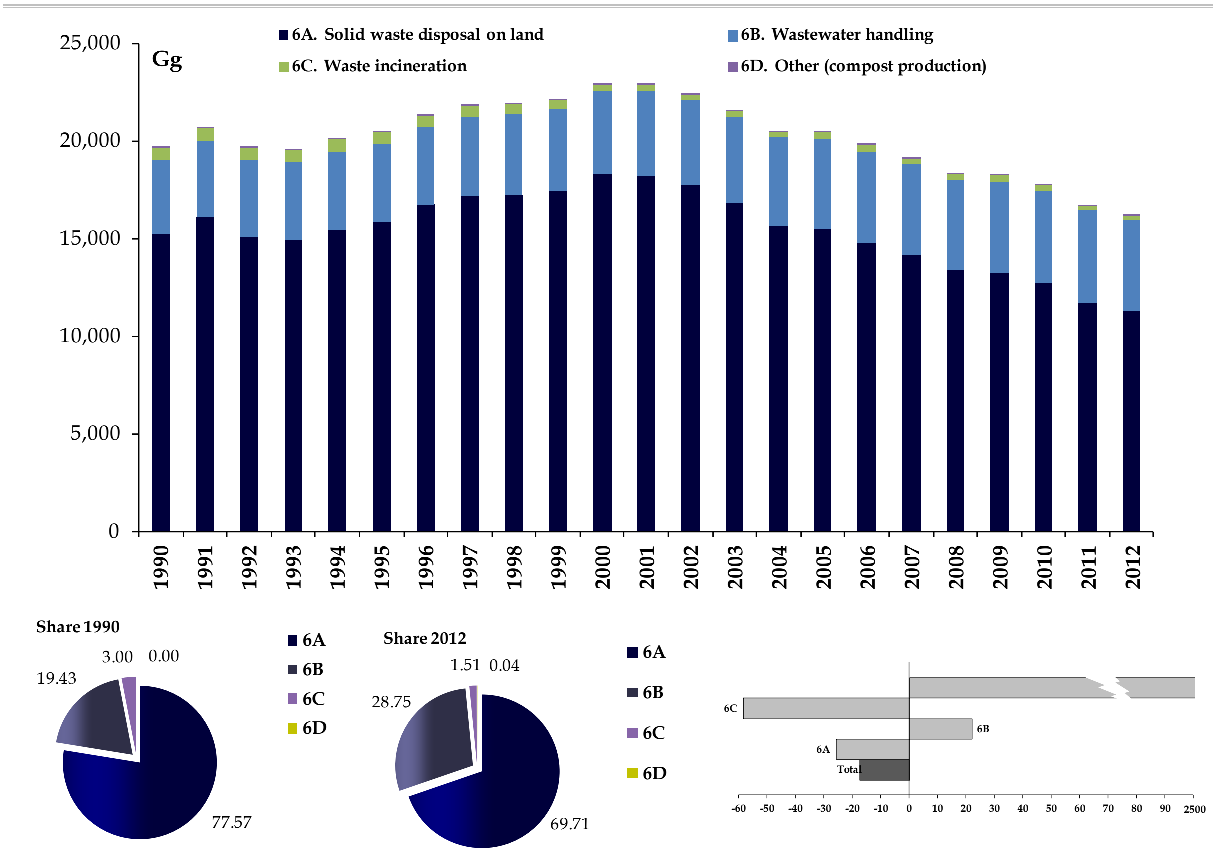

Figure 2.13 Trend of total emissions from the waste sector (1990-2012) (Gg CO_2 eq.)

2.4 Description and interpretation of emission trends for indirect greenhouse gases and SO_2

Emission trends of NO_X, CO, NMVOC and SO_2 from 1990 to 2012 are presented in Table 2.7 and Figure 2.14.

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
						Gg					
NO_X	2,068	1,910	1,453	1,229	1,171	1,157	1,058	990	965	947	882
CO	8,870	7,408	5,730	3,585	3,236	4,731	3,093	2,921	2,724	2,885	3,447
NMVOC	1,998	1,975	1,555	1,220	1,176	1,191	1,074	1,006	951	940	907
SO_2	1,805	1,327	756	407	384	346	286	235	215	196	182

Table 2.7 Total emissions for indirect greenhouse gases and SO_2 (1990-2012) (Gg)

All gases show a significant reduction in 2012 as compared to 1990 levels. The highest reduction is observed for SO_2 (- 89.9%), CO levels have reduced by 61.1%, while NO_X and NMVOC show a decrease by 57.4% and 54.6%, respectively. A detailed description of the trend by gas and sector as well as the main reduction plans can be found in the Italian National Programme for the progressive reduction of the annual national emissions of SO_2, NO_X, NMVOC and NH_3, as requested by the Directive 2001/81/EC.
The most relevant reductions occurred as a consequence of the Directive 75/716/EC, and successive ones related to the transport sector, and of other European Directives which established maximum levels for sulphur content in liquid fuels and introduced emission standards for combustion installations. As a consequence, in the combustion processes, oil with high sulphur content and coal have been substituted with oil with low sulphur content and natural gas.

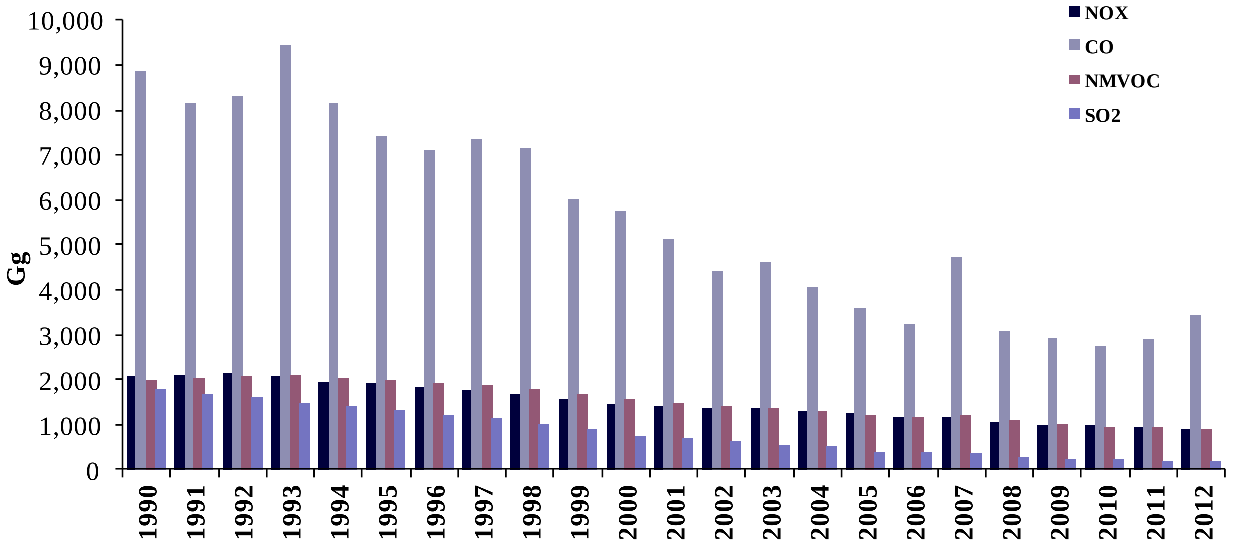

Figure 2.14 Trend of total emissions for indirect greenhouse gases and SO_2 (1990-2012) (Gg)

It should be noted that these figures differ from the national totals reported under the *United Nations Economic Commission for Europe* (UNECE) *Convention on Long Range Transboundary Air Pollution* (CLRTAP). Differences are to be attributed to the different accounting of emissions from the civil aviation sector and from fires. In the national totals under CLRTAP, in fact, emissions from aviation are calculated considering all LTO cycles, both domestic and international, excluding entirely the cruise phase. For fires, on the other hand, national figures under the UNFCCC include emissions from fires from forest, grassland and cropland whereas they are not considered in the national total for CLRTAP.

Emission trends of NO_X, CO, NMVOC and SO_2 from 1990 to 2012 communicated under UNECE CLRTAP are presented in Table 2.8.

Differences in percentage terms between figures of the two Conventions are illustrated in Table 2.9.

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
						Gg					
NO_X	2,025	1,896	1,424	1,214	1,157	1,107	1,036	965	946	922	844
CO	6,970	6,970	4,657	3,156	2,892	2,673	2,553	2,262	2,326	2,267	2,113
NMVOC	1,924	1,959	1,514	1,204	1,164	1,111	1,053	981	936	916	855
SO_2	1,799	1,326	753	405	382	339	284	232	214	194	177

Table 2.8 Total emissions for indirect greenhouse gases and SO_2 (1990-2012) (Gg) under UNECE CLRTAP

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
						%					
NO_X	2.1%	0.8%	2.0%	1.3%	1.2%	4.6%	2.1%	2.6%	2.0%	2.7%	4.5%
CO	27.3%	6.3%	23.0%	13.6%	11.9%	77.0%	21.1%	29.1%	17.1%	27.3%	63.2%
NMVOC	3.9%	0.9%	2.7%	1.3%	1.1%	7.2%	1.9%	2.6%	1.6%	2.6%	6.0%
SO_2	0.3%	0.1%	0.5%	0.4%	0.4%	1.9%	0.7%	1.0%	0.7%	1.1%	2.4%

Table 2.9 Percentage differences between total emissions for indirect greenhouse gases and SO_2 under the UNFCCC and UNECE CLRTAP Conventions (1990-2012).

3 ENERGY [CRF sector 1]

3.1 Sector overview

For the pollutants and sources discussed in this section, emissions result from the combustion of fuel. The pollutants estimated are: carbon dioxide (CO_2), NO_x as nitrogen dioxide, nitrous oxide (N_2O), methane (CH_4), non methane volatile organic compounds (NMVOC), carbon monoxide (CO), and sulphur dioxide (SO_2). The sources covered are:

- Electricity (power plants and Industrial producers);
- Refineries (Combustion);
- Chemical and petrochemical industries (Combustion);
- Construction industries (roof tiles, bricks);
- Other industries (metal works factories, food, textiles, others);
- Road Transport;
- Coastal Shipping;
- Railways;
- Aircraft;
- Domestic;
- Commercial;
- Public Service;
- Fishing and Agriculture.

The national emission inventory is prepared using energy consumption information available from national statistics and an estimate of the actual use of the fuels. The latter information is available at sectoral level in many publications but the evaluation of emissions of methane and nitrous oxide is needed. Those emissions are related to the actual physical conditions of the combustion process and to environmental conditions.
The continuous monitoring of GHG emissions in Italy is not regular especially in some sectors; hence, information is not often available on actual emissions over a specific period from an individual emission source. Therefore, the majority of emissions are estimated from different information such as fuel consumption, distance travelled or some other statistical data related to emissions.
Estimates for a particular source sector are calculated by applying an emission factor to an appropriate statistic. That is:

Total Emission = Emission Factor x Activity Statistic

Emission factors are typically derived from measurements on a number of representative sources and the resulting factor applied to the whole country.
For some categories, emissions data are available at individual site. Hence, emissions for a specific category can be calculated as the sum of the emissions from these point sources. That is:

Emission = Σ Point Source Emissions

However, it is necessary to carry out an estimate of the fuel consumption associated with these point sources, so that emissions from non-point sources can be estimated from fuel consumption data without double counting. In general, point source approach is applied to specific point sources (e.g. power stations, cement kilns, refineries). Most non-industrial sources are estimated using emission factors.
For most of the combustion source categories, emissions are estimated from fuel consumption data reported in the National Energy Balance (BEN) and from an emission factor appropriate to the type of combustion. However, the industrial category covers a range of sources and types, so the inventory disaggregates this category into a number of sub-categories, namely:

- Other Industry;
- Other Industry Off-road (see paragraph 3.6);

- Iron & Steel (Combustion, Blast Furnaces, Sinter Plant);
- Petrochemical industries (Combustion);
- Other combustion with contact industries: glass and tiles;
- Other industries (Metal works factories, food, textiles, others);
- Ammonia Feedstock (natural gas only);
- Ammonia (Combustion) (natural gas only);
- Cement (Combustion);
- Lime Production (non-decarbonising).

Thus, the estimate from fuel consumption emission factors refers to stationary combustion in boilers and heaters. The other categories are estimated by more complex methods discussed in the relevant sections. However, for these processes, where emissions arise from fuel combustion for energy production, these are reported under IPCC Table 1A. The fuel consumption of Other Industry is estimated so that the total fuel consumption of these sources is consistent with the national energy balance.

According to the IPCC 1996 Revised Guidelines (IPCC, 1997), electricity generation by companies primarily for their own use is auto-generation, and the emissions produced should be reported under the industry concerned. However, most national energy statistics (including Italy) report emissions from electricity generation as a separate category. The Italian inventory makes an overall calculation and then attempts to report as far as possible according to the IPCC methodology:

- auto-generators are reported in the relevant industrial sectors of section "1.A.2 Manufacturing Industries and Construction", including sector "1.A.2.f Other";
- refineries auto-generation is included in section 1.A.1.b;
- iron and steel auto-generation is included in section 1.A.1.c.

These reports are based on TERNA estimates of fuel used for steam generation connected with electricity production (TERNA, several years).

Emissions from waste incineration facilities with energy recovery are reported under category 1.A.4.a (Combustion activity, commercial/institutional sector), for the fossil and biomass fraction of waste incinerated in the other fuel and biomass sub categories respectively, whereas emissions from other types of waste incineration facilities are reported under category 6.C (Waste incineration). In fact, energy recovered by these plants is mainly used for district heating of commercial buildings. In particular, for 2012, more than 95% of the total amount of waste incinerated is treated in plants with energy recovery system. To estimate CO_2 emissions, considering the total amount of waste incinerated in plants with energy recovery, carbon content is calculated, as described in paragraph 8.4.2, in the waste chapter; the value is considered constant for the whole time series. Different emission factors for municipal, industrial and oils, hospital waste, and sewage sludge are applied, as reported in the waste chapter, Tables 8.24-8.28. Waste amount is then converted in energy content applying an emission factor equal to 9.2 GJ/t of waste. In 2012, the resulting average emission factor is equal to 111.4 kg CO_2/GJ.
Emissions from landfill gas recovered are used for heating and power in commercial facilities and reported under 1.A.4.a in biomass. Biogas recovered from the anaerobic digester of animal waste is used for utilities in the agriculture sector and relative emissions are reported under 1.A.4.c in biomass.
In consideration of the increasing of the share of waste used to produce electricity, we plan to revise the allocation of these emissions under category 1.A.1.a.

Emission trends
In 2012, the energy sector accounts for 95.3% of CO_2 emissions, 19.2% of CH_4 and 16.8% of N_2O. In terms of CO_2 equivalent, the energy sector shares 82.6% of total national greenhouse gas emissions excluding LULUCF.
Emission trends of greenhouse gases from the energy sector are reported in Table 3.1.

Table 3.1 GHG emission trends in the energy sector 1990-2012 (Mt CO_2 eq.)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
	Mt CO_2 eq.										
Energy	417.7	431.1	449.7	471.9	466.7	458.1	448.9	404.9	414.9	403.6	379.9
CO_2	404.1	417.0	436.2	459.4	454.8	446.2	437.2	393.5	403.2	392.0	368.5
CH_4	9.0	8.7	8.1	7.2	6.6	6.5	6.6	6.4	6.7	6.7	6.7
N_2O	4.6	5.4	5.4	5.3	5.3	5.3	5.2	4.9	4.9	4.9	4.7

Source: ISPRA elaborations

The emission trend is generally driven by the economic indicators as already shown in chapter 2.
From 2004, GHG emissions from the sector are decreasing as a result of the policies adopted at European and national level to implement the production of energy from renewable sources. From the same year, a further shift from petrol products to natural gas in producing energy has been observed as a consequence of the starting of the EU greenhouse gas Emission Trading Scheme (EU ETS) in January, 1st 2005. From 2009, a further drop of the sectoral emissions is due to the economic recession. In Table 3.2, the electricity production distinguished by source for the whole time series is reported on the basis of data supplied by the national grid operator (ENEL, several years; TERNA, several years).

Table 3.2 Production of electricity by sources 1990-2012 (GWh)

Source	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
	GWh										
Hydroelectric	35,079	41,907	50,900	42,927	43,425	38,481	47,227	53,443	54,407	47,757	43,854
Thermoelectric	178,590	196,123	220,455	253,073	262,165	265,764	261,328	226,638	231,248	228,507	217,561
- solid fuels	32,042	24,122	26,272	43,606	44,207	44,112	43,074	39,745	39,734	44,726	46,755
- natural gas	39,082	46,442	97,607	149,259	158,079	172,646	172,697	147,270	152,737	144,539	129,058
- derivated gases	3,552	3,443	4,252	5,837	6,251	5,645	5,543	3,701	4,731	5,442	5,000
- oil products	102,718	120,783	85,878	35,846	33,830	22,865	19,195	15,878	9,908	8,474	9,409
- other fuels	1,196	1,333	6,446	18,525	19,797	20,495	20,820	20,044	24,138	25,326	27,340
Geothermic	3,222	3,436	4,705	5,325	5,527	5,569	5,520	5,342	5,376	5,654	5,592
Eolic and Photovoltaic	0	14	569	2,347	2,973	4,073	5,054	7,219	11,032	20,652	32,269
Total	**216,891**	**241,480**	**276,629**	**303,672**	**314,090**	**313,888**	**319,130**	**292,642**	**302,062**	**302,570**	**299,276**

Source: TERNA

More in general the share of the total energy consumption by primary sources in the period 1990- 2012, reported in Table 3.3, shows an evident change from oil products to natural gas while the consumption of solid fuels and electricity maintain their share constant.

Table 3.3 Total energy consumptions by primary sources 1990-2012 (%)

Sources	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
	%										
renewable	0.7	0.9	1.1	2.0	2.2	2.6	2.9	3.7	4.3	4.7	5.1
solid fuels	9.6	7.9	6.9	8.6	8.7	8.9	8.8	7.3	8.0	9.0	9.4
natural gas	23.7	25.7	31.4	36.0	35.5	36.0	36.4	35.4	36.2	34.6	34.8
crude oil	56.2	54.9	49.5	43.1	43.4	42.4	41.4	40.6	38.5	37.5	35.3
primary electricity	9.8	10.5	11.1	10.3	10.1	10.0	10.6	13.0	13.1	14.1	15.3

Source: Ministry of Economic Development

Recalculations

In 2014 submission, recalculations regarded different sub-sectors.
For the whole energy sector, natural gas CO_2 emission factors have been updated for 2011 because of additional information collected on the energy conversion factor of imported fuels.
The whole time series of road transport emissions has been recalculated because of the update of activity data and parameters used to estimate emissions; in particular the update of emission factors for natural gas fuel consumption for the whole time series and the update of gasoline fuel consumption from 2008 to avoid double counting of the bioethanol fuel previously considered in the statistic of gasoline fuel consumption. Recalculation affected mainly CH_4 and N_2O emissions. Detailed information is reported in paragraph 3.5.3.

Waste fuel consumption for commercial heating activity data has been updated from 2010 because the update of activity data for industrial waste.
With regard to fugitive emissions, minor updates of activity data regarded 2005, 2010 and 2011.
Other minor changes in activity data occurred for 2011, including the update of the number of movements for shipping activities.

Recalculations affected the whole time series 1990-2011 for all gases. The following table shows the percentage differences between the 2014 and 2013 submissions for the total energy sector and by gas. Recalculation resulted for the energy sector in a reduction of GHG emissions in the base year of 0.005% and 0.20% in 2011 mainly due to the update of road transport natural gas emission factors for the whole time series and the update of waste fuel consumption activity data in 2010.

Table 3.4 Emission recalculations in the energy sector 1990-2010 (%)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
											%											
Energy	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	***-0.02***	***-0.02***	***-0.06***	***-0.08***	***-0.09***	***-0.20***
CO_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.05	-0.07	-0.08	-0.18
CH_4	0.01	0.04	0.03	0.03	0.00	0.04	0.05	0.05	0.05	0.05	0.04	0.04	0.03	0.03	0.02	-0.11	-0.55	-0.69	-0.70	-0.91	-0.73	-0.99
N_2O	-0.46	0.00	0.00	0.00	-0.08	-0.03	-0.05	-0.06	-0.09	-0.12	-0.03	-0.04	-0.04	-0.05	-0.05	0.18	-1.01	-1.07	-0.06	0.03	-0.18	-0.71

Source: ISPRA elaborations

Key categories

Key category analysis, for the years 1990 and 2012, identified 12 categories at level or trend assessment with Approach 1 and Approach 2 in the energy related emissions.
In the case of the energy sector in Italy, a sector by sector analysis instead of a source by source analysis will better illustrate the accuracy and reliability of the emission data, given the interconnection between the underlying data of most key categories.
In the following box, the relevant key categories are listed, making reference to the section of the text where they are quoted.

Key-categories identification in the energy sector with the IPCC Approach 1 and Approach 2 for 2011

KEY CATEGORIES	**without LULUCF**	**with LULUCF**	**Relevant paragraphs**	**Notes**
1. CO_2 stationary combustion liquid fuels	L,T	L,T	3.3, 3.4 and 3.6	Table 3.8-3.11
2. CO_2 stationary combustion solid fuels	L,T	L,T	3.3, 3.4 and 3.6	Table 3.8-3.11
3. CO_2 stationary combustion gaseous fuels	L,T	L,T	3.3, 3.4 and 3.6	Table 3.8-3.11
4. CO_2 mobile combustion: Road Vehicles	L,T	L,T	3.5 and 3.5.3	Tables 3.21-3.29
5. N_2O stationary combustion	L,T2	L	3.3, 3.4 and 3.6	Table 3.8-3.11
6. CO_2 mobile combustion: Waterborne Navigation	L1	L1	3.5.4	Table 3.28
7. CH_4 fugitive emissions from Oil and Gas Operations	L,T	L1,T	3.9	Table 3.40
8. CO_2 fugitive emissions from Oil and Gas Operations	L1,T2	L1	3.9	Table 3.40
9. CO_2 stationary combustion other fuels	L1,T1	L1,T1	3.3, 3.4 and 3.6	Table 3.8-3.11
10. CH_4 stationary combustion	T2	T2	3.3, 3.4 and 3.6	Table 3.8-3.11
11. CO_2 mobile combustion: aircraft	L1		3.5.1	Table 3.15-3.19
12. CH_4 mobile combustion: Road Vehicles	T2		3.5 and 3.5.3	Tables 3.21-3.29

With reference to the box, six key categories (n. 1, 2, 3, 5, 9 and 10) are linked to stationary combustion and to the same set of energy data: the energy sector CRF Table 1.A.1, the industrial sector, Table 1.A.2 and the civil sector Tables 1.A.4a and 1.A.4b. Four out of six key categories refer to CO_2 emissions. All these sectors refer to the national energy balance (MSE, several years [a]) for the basic energy data and the distribution among various subsectors, even if more accurate data for the electricity production sector can be found in TERNA publications (TERNA, several years). Evolution of energy consumptions/emissions is linked to the

activity data of each sector; see paragraph 3.3, 3.4 and 3.6 and Annex 2 for the detailed analysis of those sectors.
Electricity production is the most "dynamic" sector and the energy emissions trend, for CO_2, N_2O and CH_4, is mainly driven by the thermoelectric production, see Tables A2.1 and A2.4 for more details.
In the following table key category emissions are summarized. From 1990 to 2012, an increase in use of natural gas instead of fuel oil and gas oil in stationary combustion plants is observed; it results in a decrease of CO_2 emissions from combustion of liquid fuels and an increase of emissions from gaseous fuels.

Table 3.5 Stationary combustion, GHG emissions in 1990 and 2012

	1990	**2012**
CO_2 stationary combustion liquid fuels, Gg	153,467	51,805
CO_2 stationary combustion solid fuels, Gg	58,993	61,976
CO_2 stationary combustion gaseous fuels, Gg	85,066	142,425
CO2 stationary combustion other fuels, Gg	887	4,900
CH4 stationary combustion, Mg	784	1,465
N2O stationary combustion, Mg	3,533	3,641

Source: ISPRA elaborations

Another group of key categories (n. 4, 6, 11 and 12) referred to the transport sector, with basic total energy consumption reported in the national energy balance and then subdivided in the different subsectors with activity data taken from various statistical sources; see paragraph 3.5, transport, for an accurate analysis of these key sources. This sector also shows a remarkable increase in emissions, in particular CO_2 from air transport and road transport, as can be seen in Table 3.19 and Table 3.29, respectively. In the last years CO_2 emissions from road transport started to decrease as a consequence of the economical crisis and the reduction of the average fuel consumption per kilometre of the new vehicles. The trend of N_2O and CH_4 emissions is linked to technological changes occurred in the period.

Finally, the last two key categories (n.7, 8) refer to oil and gas operations. For this sector basic overall production data are reported in the national balance but emissions are calculated with more accurate data published or delivered to ISPRA by the relevant operators, see paragraph 3.9.

Most of the categories described are also key categories for the years 1990 and 2012 taking into account LULUCF emissions and removals.

3.2 Methodology description

Emissions are calculated by the equation:

$$E(p,s,f) = A(s,f) \times e(p,s,f)$$

where
$E(p,s,f)$ = Emission of pollutant *p* from source *s* from fuel *f* (kg)
$A(s,f)$ = Consumption of fuel *f* by source *s* (TJ-t)
$e(p,s,f)$ = Emission factor of pollutant *p* from source *s* from fuel *f* (kg/TJ-kg/t)

The fuels covered are listed in Table A2.2 in Annex 2, though not all fuels occur in all sources. Sector specific tables specify the emission factors used.

Emission factors are expressed in terms of kg pollutant/ TJ based on the net calorific value of the fuel.

The carbon factors used are based on national sources and are appropriate for Italy. Most of the emission factors have been crosschecked with the results of specific studies that evaluate the carbon content of the imported/produced fossil fuels at national level. A comparison of the current national factors with the IPCC

ones has been carried out; the results suggest quite limited variations in liquid fuels and some differences in natural gas, explained by basic hydrocarbon composition, and in solid fuels.
Monitoring of the carbon content of the fuels nationally used is an ongoing activity at ISPRA. The principle is to analyse regularly the chemical composition of the used fuel or relevant activity statistics, to estimate the carbon content and the emission factor. National emission factors are reported in Table 3.12 and Table 3.21. The specific procedure followed for each primary fuel (natural gas, oil, coal) is reported in Annex 6.

In response to the review process of the Initial report of the Kyoto Protocol, N_2O and CH_4 stationary combustion emission factors were revised, in the 2006 submission, for the whole time series taking into account default IPCC (IPCC, 1997; IPCC, 2000) and CORINAIR emission factors (EMEP/CORINAIR, 2007).

The emission factors should apply for all years provided there is no change in the carbon content of fuel over time. There are exceptions to this rule:

- transportation fuels have shown a significant variation around the year 2000 due to the reformulation of gasoline and diesel to comply with the EU directive, see Table 3.21;
- the most important imported fuels, natural gas, fuel oil and coal show variations of carbon content from year to year, due to changes in the origin of imported fuel supply; a methodology has been set up to evaluate annually the carbon content of the average fuel used in Italy, see Annex 6 for details:
- derived gases produced in refineries, as petcoke, refinery gas and synthesis gas from heavy residual fuel, in iron and steel integrated plants, as coke oven gas, blast furnaces gas and oxygen converter gas, and in chemical and petrochemical plants have been calculated from 2005 on the basis of the analysis of information collected by the plants in the framework of EU ETS, see Annex 6 for details.

The activity statistics used to calculate emissions are fuel consumptions provided annually by the Ministry of Economic Development (MSE) in the National Energy Balance (MSE, several years [a]), by TERNA (TERNA, several years) for the power sector and some additional data sources to characterise the technologies used at sectoral level, quoted in the relevant sections.
Activity data collected in the framework of the EU ETS scheme do not cover the overall energy sector, whereas the official statistics available at national level, such as the National Energy Balance (BEN) and the energy production and consumption statistics supplied by TERNA, provide the complete basic data needed for the emission inventory.

Italian energy statistics are mainly based on the National Energy Balance. The report is reliable, by international standards, and it may be useful to summarize its main features:

- it is a balance, every year professional people carry out the exercise balancing final consumption data with import-export information;
- the balance is made on the energy value of energy carriers, taking into account transformations that may occur in the energy industries (refineries, coke plants, electricity production);
- data are collected regularly by the Ministry of Economic Development, on a monthly basis, from industrial subjects;
- oil products, natural gas and electricity used by industry, civil or transport sectors are taxed with excise duties linked to the physical quantities of the energy carriers; excise duties are differentiated in products and final consumption sectors (i.e. diesel oil for industrial use pays duties lower than for transportation use and higher than for electricity production; even bunker fuels have a specific registration paper that state that they are sold without excise duties);
- concerning energy consumption information, this scheme produces highly reliable data: BEN is based on registered quantities of energy consumption and not on estimates; uncertainties may be present in the effective final destination of the product but total quantities are reliable;
- coal is an exception to this rule, it is not subject to excise duties; consumption information is estimated; anyway, it is nearly all imported and a limited number of operators use it and the Ministry of Economic Development monitors all of them on a monthly basis.

The energy balances of fuels used in Italy, published by the Ministry of Economic Development (MSE, several years [a]), compare total supply based on production, exports, imports, stock changes and known losses with the total demand; the difference between total supply and demand is reported as 'statistical difference'. In Annex 5, 2012 data are reported, while the full time series is available on website: http://dgerm.sviluppoeconomico.gov.it/dgerm/ben.asp.

Additionally to fossil fuel, the National Energy Balance reports commercial wood and straw combustion estimates for energy use, biodiesel and biogas. The estimate of GHG emissions are based on these data and on other estimates (ENEA, several years) for non commercial wood use. Carbon dioxide emissions from biomass combustion are not included in the national total as suggested in the IPCC Guidelines (IPCC, 1997) but emissions of other GHGs and other pollutants are included. CORINAIR methodology (EMEP/CORINAIR, 2007) includes emissions from the combustion of wood in the industrial and domestic sectors as well as the combustion of biomass in agriculture.

The inventory includes also emissions from the combustion of lubricants based on data collected from waste oil recyclers and quoted in the BEN; from 2002 onwards, this estimate is included in the column “Refinery feedstock”, row “Productions”, see Annex 5, Table A5.1- National energy balance, year 2012, Primary fuels. From 2001 onwards, it has been necessary to use also these quantities to calculate emissions in the reference approach, so as to minimize differences with sectoral approach. From 2001, the energy balances prepared by MSE include those quantities in the input while estimating final consumption; this procedure summarizes a complex stock change reporting by operators.

3.3 Energy industries

A detailed description of the methodology used to estimate greenhouse gas emissions from electricity production under 1.A.1.a, 1.A.1.b and 1.A.1.c is reported in Annex 2. Basic data, methodology and emission factors used to estimate emissions are derived from the same sources. In the following sub-paragraphs additional information on the specific categories are supplied.

3.3.1 Public Electricity and Heat Production

3.3.1.1 Source category description

This paragraph refers to the main electricity producers that produce electricity for the national grid. From 1998 onwards, the expansion of the industrial cogeneration of electricity and the split of the national monopoly have transformed many industrial producers into “independent producers”, regularly supplying the national grid. These producers account in 2012 for 94.6% of all electricity produced with combustion processes in Italy (TERNA, several years).
No data on consumption / emissions from heat production is reported in this section. In Italy, only limited data do exist about producers working for district heating grids; most of the cogenerated heat is produced and used on the same site by industrial operators. Therefore data on heat production is not reported here but in Table1.A(a)s2 for industry and Table1.A(a)s4 for district heating. In TERNA yearly publication, heat cogenerated while producing electricity is reported separately. Unfortunately, no details are reported on the final use of cogenerated heat, so it can be used in the inventory preparation just to cross check the total fuel amount with other sources as EU ETS or the consumption of fuels in the industry reported in BEN.
In the biomass subcategory wood and charcoal consumption and relevant emissions are reported; CO_2 emission factor is shown in Table 3.12.
Other fuels subcategory includes minor amounts of other liquid, solid and gaseous fuel consumptions such as industrial wastes, as plastics, rubber, and solvents, and synthesis gas from heavy residual; CO_2 emission factor equal to 94.0 kg/GJ have been used for these fuels.

3.3.1.2 *Methodological issues*

The data source on fuel consumption is the annual report "Statistical data on electricity production and power plants in Italy" ("Dati statistici sugli impianti e la produzione di energia elettrica in Italia"), edited from 1999 by the Italian Independent System Operator (TERNA, several years). The reports refer to the total of producers and the estimate of the part belonging to public electricity production is made by the inventory team on the basis of detailed electricity production statistics by industrial operators. Data on total electricity production for the year 2012 are reported in Annex 2. For the time series, see previous NIR reports. The emission factors used are listed in Table 3.12.
Another source of information is the National Energy Balance (MSE, several years [a]), which contains data on the total electricity producing sector. The data of the National Energy Balance (BEN) are also used to address the statistical survey of international organizations, IEA and Eurostat. Both BEN and TERNA publications could be used for the inventory preparation, as they are part of the national statistical system and published regularly.
A detailed analysis of both sources is reported in Annex 2; TERNA data appears to be more suitable for inventory preparation. From year 2005 onwards a valuable source of information is given by the reports prepared for each industrial installation subject to EU ETS scheme. These reports are prepared by independent qualified verifiers and concern the CO_2 emissions, emission factors and activity data, including fuel used. ISPRA receives copy of the reports from the competent authority (Ministry of Environment) and has been able to extract the information relative to electricity production. The information available is very useful but not fully covering the electricity production sector or the public electricity production. The EU ETS does not include all installations, only those above 20 MWe, it is made on a point source basis so the data include electricity and heat production while the corresponding data from TERNA, concerning only the fuel used for electricity production, are commercially sensitive, confidential and they are not available to the inventory team. Anyway the comparison of data collected by TERNA with those submitted to the EU ETS allows identifying possible discrepancies in the different datasets and thus providing the Ministry of Economic Development experts with useful suggestions to improve the energy balance.

To estimate CO_2 emissions, and also N_2O and CH_4 emissions, a rather complex calculation sheet is used (APAT, 2003[a]). The data sheet summarizes all plants existing in Italy divided by technology, about 60 typologies, and type of fuel used; the calculation sheet is a model of the national power system. The model is aimed at estimating the emissions of pollutants different from CO_2 that are technology dependent. For each year, a run estimates the fuel consumed by each plant type, the pollutant emissions and GHG emissions. The model has many possible outputs, some of which are built up in order to reproduce the data available from statistical source. The model is revised every year to mirror the changes occurred in the power plants. Moreover, the model is also able to estimate the energy/emissions data related to the electricity produced and used on site by the main industrial producers. These data are reported in the other energy industries, Tables 1.A.1.b and 1.A1.c, and in the industrial sector section, Tables 1.A.2. More detailed information is supplied in Annex 2.
In Table 3.6, fuel consumptions and emissions of 1.A.1.a category are reported for the time series. Table 3.6 shows a decrease in fuel consumption and overall decrease in GHG emissions. However, an increase is observed in CH_4 and N_2O emissions due to the increase in use of natural gas and biomass.

Table 3.6 Public electricity and heat production: Energy data (TJ) and GHG emissions, 1990-2012

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Fuel consumption (TJ)	1,428,137	1,468,278	1,668,305	1,799,929	1,822,784	1,838,270	1,727,715	1,482,944	1,425,570	1,417,296	1,374,916
GHG (Gg CO2 eq)	107,544	109,875	115,531	119,656	120,784	120,298	113,490	97,268	93,144	91,800	91,083
CO_2 (Gg)	107,136	109,477	115,159	119,219	120,346	119,875	113,080	96,887	92,792	91,397	90,666
CH_4 (Gg)	3.9	4.1	3.9	4.4	4.5	4.3	4.2	3.9	3.6	4.1	4.1
N_2O (Gg)	1.1	1.0	0.9	1.1	1.1	1.1	1.0	1.0	0.9	1.0	1.1

Source: ISPRA elaborations

As the main data source refers to the whole electricity production sector, the uncertainty and time-series consistency, source-specific QA/QC and verification, recalculations and planned improvements are all addressed in Annex 2.

3.3.2 Refineries

3.3.2.1 Source category description

This subsector covers the energy emissions from the national refineries (15 plants), including the energy used to generate electricity for internal use and exported to the national grid by power plants that directly use off-gases or other residues of the refineries. These power plants are generally owned by other companies but are located inside the refinery premises or just sideway. In 2012 the power plants included in this source category have generated 9.0% of all electricity produced with combustion processes in Italy.
The energy consumption and emissions are reported in CRF Table 1.A.1.b. Parts of refinery losses, flares, are reported in CRF Table 1.B.2.a and c, using IPCC emission factors.

3.3.2.2 Methodological issues

The consumption data used for refineries come from BEN (MSE, several years [a]); the same data are also reported by Unione Petrolifera, the industrial category association (UP, several years). From 2005 onwards, also the EU ETS "verifier's reports" cover almost the entire sector, for energy consumptions, combustion emissions and process emissions. Other sources of information are the yearly reporting obligations for the large combustion plants under European Directive (LCP) and the E-PRTR Regulation; both data collections include most of refineries but not all the emission sources.
The available data in BEN specify the quantities of refinery gas, petroleum coke and other liquid fuels. They are reported in Annex 5, Table A5.6.
For the part of the energy and related emissions due to the power plants the source is TERNA, refer to Annex 2 for further details. The quota of total energy consumption from electricity production included in source category 1.A.1.b is estimated by the electricity production model on the basis of fuels used and plant location.
All the fuel used in boilers and processes, the refinery "losses" and the reported losses of crude oil and other fuels (that are mostly due to statistical discrepancies) are considered to calculate emissions. Fuel lost in the distribution network is accounted for here and not in the individual end use sector. From 2002 particular attention has been paid to avoid double counting of CO_2 emissions checking if the refinery reports of emissions already include losses in their energy balances. IPCC Tier 2 emission factors and national emission factors are used as reported in Table 3.12.
From 2008, TERNA modified the detailed table of fuel consumption and related energy produced introducing a more complete list of fuels. Aim of the change was to revise the consumption values of waste fuels which are very important for estimating the contribution of renewable to electricity production and consequently greenhouse gases.
In Table 3.7, a sample calculation for the year 2012 is reported, with energy and emission data.

Table 3.7 Refineries, CO_2 emission calculation, year 2012

	Consumption, TJ				CO_2 emissions, Gg			
REFINERIES	Petroleum coke	Ref. gas	Liquid fuels	Natural gas	Petroleum coke	Ref. gas	Liquid fuels	Natural gas
energy			127,902	62,297			10,430	3,547
furnaces	33,395	85,855	49,836		3,133	4,895	3,741	
TOTAL				359,285				25,746

Source: ISPRA elaborations

From 2005, the weighted average of CO_2 emission factor reported by operators in the framework of the EU ETS scheme is used for petroleum coke, refinery gas and synthesis gas from heavy residual fuels. The trend of the implied emission factor is driven by the mix of the fuels used in the sector. The main fuel used are refinery gases, fuel oil and petroleum coke, which have very different emission factors, and every year their amount used changes resulting in a annual variation of the IEF. The increase in the last years, with respect to the nineties, of the consumption of fuels with higher carbon content, as petroleum coke and synthesis gas obtained from heavy residual fuels, explain the general growth of the IEF for liquid fuel reported in the CRF for this sector.

In the following box, liquid fuel consumptions of 1.A.1.b category disaggregated by fuel are reported for the time series.

Liquid fuel consumptions in petroleum refining (TJ), 1990-2012

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Refinery gas	119,176.49	138,163.39	118,501.19	129,837.27	123,326.99	128,222.25	135,899.85	121,301.95	133,527.54	117,850.16	100,867.39
Naphta	526.34	868.59	4,444.06	2,449.30	1,209.59	1,468.16	1,324.65	1,856.01	1,220.05	1,092.02	783.24
Pet coke	29,120.50	28,652.73	40,594.48	49,868.02	43,443.52	45,978.59	40,890.45	40,716.82	42,796.26	45,396.60	40,652.80
Synthesis gas	-	-	36,400.63	64,977.21	81,043.69	83,763.28	79,328.26	57,320.53	78,575.14	63,010.74	66,232.40
Fuel oil	87,501.74	101,429.68	86,684.53	76,084.42	70,253.09	73,194.25	89,736.28	97,245.12	81,913.47	88,617.83	86,463.15
LPG	2,025.05	1,979.02	3,253.47	2,593.24	2,409.14	1,580.71	1,933.00	1,979.02	1,794.93	1,242.64	1,058.55
Gasoil	2,558.92	2,071.07	7,259.21	11,317.67	298.74	42.68	290.37	666.09	879.47	1,046.00	930.52
Gasoline	3,426.68	4,520.79	303.34	958.13	263.59	878.64	303.34	259.41	-	-	-
Total	244,335.72	277,685.28	297,440.90	338,085.26	322,248.36	335,128.56	349,706.21	321,344.95	340,706.86	318,255.99	296,988.05

3.3.2.3 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions from refineries is estimated to be about 4.2% in annual emissions; a higher uncertainty, equal to 50.1%, is calculated for CH_4 and N_2O emissions because of the uncertainty levels attributed to the related emission factors.

Montecarlo analysis has been carried out to estimate uncertainty of CO_2 emissions from stationary combustion of solid, liquid and gaseous fuels emissions, resulting in 5.1%, 3.3% and 5.8%, respectively. Normal distributions have been assumed for all the parameters. A summary of the results is reported in Annex 1

In Table 3.8 GHG emissions from the sector in the years 1990, 1995, 2000, 2005-2012 are reported.

Table 3.8 Refineries, GHG emission time series

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
CO_2 emissions, Mt	16.3	18.6	22.4	27.1	26.2	27.2	28.1	25.3	28.0	26.9	25.7
CH_4 emissions, Gg	0.46	0.53	0.59	0.67	0.67	0.70	0.75	0.70	0.74	0.71	0.69
N_2O emissions, Gg	0.49	0.56	0.60	0.68	0.65	0.67	0.71	0.65	0.70	0.65	0.61
Refinery, total, Mt CO_2 eq	16.5	18.8	22.6	27.3	26.4	27.4	28.3	25.5	28.3	27.1	26.0

Source: ISPRA elaborations

An upward trend in emission levels is observed from 1990 to 2008 explained by the increasing quantities of crude oil processed and the complexity of process used to produce more environmentally friendly transportation fuels. Liquid fuel consumptions have reached a plateau in 2008 and they are now in a downward trend that is expected to continue, due to the reduced quantities of crude oil processed and electricity produced and to the gradual substitution with natural gas fuel consumption. In 2009 a drop is noted due to the effects of the economic recession that in 2010 and 2011 has partially recovered. A further drop is observed in 2012 where a plant closed.

3.3.2.4 Source-specific QA/QC and verification

Basic data to estimate emissions have been reported by national energy balance and the national grid administrator. Data collected under other reporting obligations that include refineries (EU ETS, LCP and E-PRTR databases) have been used to cross-check the energy balance data, fuels used and emission factors. Differences and problems have been analysed in details and solved together with Ministry of Economic Development experts, who are in charge of preparing the National Energy Balance.

3.3.2.5 Source-specific recalculations

In 2014 submission, negligible recalculations occurred for this category due to the update of natural gas CO_2 emission factor for 2011.

3.3.2.6 Source-specific planned improvements

No specific improvements are planned for the next submission.

3.3.3 Manufacture of Solid Fuels and Other Energy Industries

3.3.3.1 Source category description

In Italy, all the iron and steel plants are integrated, therefore there is no separated reporting for the different part of the process. A few coke and “manufactured gas” producing plants were operating in the early nineties and they have been reported here. Only one small manufactured gas producing plant is still in operation from 2002.
In this section, emissions from power plants, which use coal gases, are also reported. In particular, we refer to the electricity generated in the iron and steel plant sites (using coal gases and other fuels). In 2012 the power plants included in this source category have generated about 3% of all electricity produced with combustion processes in Italy.

3.3.3.2 Methodological issues

Fuel consumption data for the sector are reported in the BEN (MSE, several years [a]). Fuels used to produce energy are also reported with more detail as for fuel disaggregation level by TERNA (TERNA, several years). From 2005 onwards, also the EU ETS “verifier’s reports” cover almost the entire sector, for energy consumptions, combustion emissions and process emissions. Other sources of information are the yearly reporting obligations for the large combustion plants under European Directive (LCP) and for facilities under the E-PRTR Regulation; both reporting obligations include most of the iron and steel integrated plants and the only coke producing plant but not all the emission sources. A carbon balance is done, as suggested by the IPCC good practice guidance, to avoid over or under estimation from the sector. In Annex 3 further details on carbon balances of solid fuels and derived gases used are reported.
The high-implied emission factor for solid fuels is due to the large use of derived steel gases and in particular blast furnace gas to produce energy. These gases have been assimilated to the renewable sources and incentives are still provided for their use.
Other fuels are used in co-combustion with coal gases to produce electricity and they are reported by TERNA, see Annex 2. From 2008, natural gas and fuel oil consumptions reported in the CRF for this sector, are those communicated by the operators of the plants included in the sector in the framework of the EU ETS scheme. The consumptions of these fuels, especially for natural gas, are higher than those reported for the previous years. Fuel consumption reported in the sector is subtracted from the total fuel consumption to produce energy, guaranteeing that over and under estimation are avoided.
CH_4 emissions from coke ovens are estimated on the basis of production data to take in account additional volatile emissions due to the specific process. Average emission factors are calculated on the basis of information communicated by the four plants under the EPRTR registry.

3.3.3.3 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions from integrated iron and steel plants is estimated to be about 4.2% in annual emissions; a higher uncertainty, equal to 50.1%, is calculated for CH_4 and N_2O emissions on account of the uncertainty levels attributed to the related emission factors.
Montecarlo analysis has been carried out to estimate uncertainty of CO_2 emissions from stationary combustion of solid, liquid and gaseous fuels emissions, resulting in 5.1%, 3.3% and 5.8%, respectively. Normal distributions have been assumed for all the parameters. A summary of the results is reported in Annex 1.
In Table 3.9 GHG emissions from the sector in the years 1990, 1995, 2000, 2005-2012 are reported.

Table 3.9 Manufacture of solid fuels, GHG emission time series

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
CO_2 emissions, Mt	13.0	11.8	14.4	13.5	14.4	13.7	15.0	9.0	11.7	12.3	9.2
CH_4 emissions, Gg	4.9	3.8	2.3	1.2	1.0	0.7	0.7	0.6	0.7	0.7	0.7
N_2O emissions, Gg	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total, Mt CO_2 eq	13.2	11.9	14.5	13.6	14.5	13.8	15.0	9.1	11.8	12.3	9.3

Source: ISPRA elaborations

The trend of CO_2 and N_2O emissions is driven by the production trends combined with an increase in energy consumption required by more energy intensive products. In 2009 a strong reduction of emissions is observed due to the effects of the economic recession that in 2010 and 2011 has partially recovered. In 2012 a further drop occurred for the economic crisis.

The trend of CH_4 emissions is driven by the coke production trend, decreased from 6.4 Mt in 1990 to 4.5Mt in 2000 and by the renewal of the production plants. In particular the strong reduction of CH_4 emissions in the last years is the result of the renewal of the coke production plants in Taranto, started in 2005, and the implementation of best available technologies to reduce volatile organic compounds. In 2009, as well as in 2012, national coke production has reduced of about 40% with respect to the previous year, determining a loss in efficiency of the production plants and an increase of emissions by product unit (IEF) for that year.

3.3.3.4 Source-specific QA/QC and verification

Basic data to estimate emissions have been reported by national energy balance and the national grid administrator. Data collected under other reporting obligations that include integrated iron and steel plants, such as EU ETS Directive, LCP and E-PRTR databases, have been used to cross-check the energy balance data, fuels used and emission factors. Differences and problems have been analysed in details and solved together with Ministry of Economic Development experts, which are in charge to prepare the National Energy Balance. In particular, in the national PRTR register the integrated plants report every year the CO_2 emitted at each stage of the process, coke production, sinter production and iron and steel production, which result from separate carbon balances calculated in each phase of the production process. Moreover, total CO_2 emissions reported in the E-PRTR by the operators are equal to those reported under the EU ETS scheme.

The detailed analysis and comparison of the different data reported improved the allocation of fuel consumption and CO_2 emissions between 1.A.1.c and 1.A.2.a sectors. From the 2010 submission, in fact, coking coal losses for transformation process and related emissions have been reallocated under 1.A.1.c instead of 1.A.2.a.

3.3.3.5 Source-specific recalculations

In the 2014 submission, recalculations occurred for this category due to the update of natural gas CO_2 emission factor for 2011, resulting in negligible differences with the previous submission.

3.3.3.6 Source-specific planned improvements

No specific improvements are planned for the next submission.

3.4 Manufacturing industries and construction

3.4.1 Sector overview

Included in this category are emissions which originate from energy use in the manufacturing industries included in category 1.A.2. Where emissions are released simultaneously from the production process and from combustion, as in the cement, lime and glass industry, these are estimated separately and included in category 2.A. All greenhouse gases as well as CO, NOx, NMVOC and SO_2 emissions are estimated.

In 2012, energy use in industry account for 14.4% of total national CO_2 emissions, 0.4% of CH_4, 4.6% of N_2O. In term of CO_2 equivalent, manufacturing industry share 12.5% of total national greenhouse gas emissions.

Six key categories have been identified for this sector in 2012, as for the energy industries, for level and trend assessment, using both the IPCC Approach 1 and Approach 2:

CO_2 Stationary combustion liquid fuels (L, T);
CO_2 Stationary combustion solid fuels (L, T);
CO_2 Stationary combustion gaseous fuels (L, T);
CO_2 Stationary combustion other fuels (L1, T1);
N_2O Stationary combustion (L, T2)
CH_4 Stationary combustion (T2).

All these categories are also key category including the LULUCF estimates in the key category assessment.

In the following Table 3.10, GHG emissions connected to the use of fossil fuels, process emissions excluded, are reported for the years 1990, 1995 and 2000-2012. Industrial emissions show oscillations, related to economic cycles.

Table 3.10 Manufacturing industry, GHG emission time series

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
CO_2 emissions, Gg	85,276	85,037	82,245	78,551	77,490	74,222	70,905	54,580	60,015	59,852	53,656
CH_4 emissions, Gg	6.82	7.02	5.72	6.28	6.24	6.53	6.24	4.18	5.51	6.89	8.14
N_2O emissions, Gg	4.93	4.52	4.66	5.02	5.05	4.98	4.64	3.98	4.01	3.96	3.53
Industry, total, Gg CO_2 eq	86,948	86,586	83,811	80,239	79,187	75,903	72,473	55,903	61,374	61,226	54,922

Source: ISPRA elaborations

In Table 3.11 emissions are reported by pollutant for all the subsectors included in the sector.
A general trend of reduction in emissions is observed from 1990 to 2008; some sub sectors reduced sharply (steel, chemical), other sub sectors (pulp and paper, food) increased their emissions. In 2009 an overall reduction of emissions for all the sectors is noted due to the effects of the economic recession. In 2010 and 2011 production levels has restored for the iron and steel and pulp and paper sectors while the other sectors still continue to suffer from the economical crisis.

Table 3.11 Trend in greenhouse gas emissions from the manufacturing industry sector, 1990-2012

GAS/SUBSOURCE	1990	1995	2000	2005	2008	2009	2010	2011	2012
CO_2 (Gg)									
1.A.2.a Iron and Steel	17,917	18,647	13,329	14,621	13,588	8,698	14,094	16,382	15,420
1.A.2.b Non-Ferrous Metals	738	907	1,252	1,167	1,096	1,021	1,130	1,111	1,060
1.A.2.c Chemicals	19,203	17,280	12,250	10,835	9,285	7,384	7,777	6,954	6,893
1.A.2.d Pulp, Paper and Print	3,076	4,163	4,223	4,563	4,289	3,803	4,578	4,425	4,292
1.A.2.e Food	3,853	5,062	6,238	6,441	5,568	4,661	4,397	4,266	3,508
1.A.2.f Other	40,489	38,978	44,954	40,924	37,079	29,014	28,038	26,714	22,483
CH_4 (Mg)									
1.A.2.a Iron and Steel	3,795	4,226	3,093	3,304	3,521	1,892	2,880	3,254	3,313
1.A.2.b Non-Ferrous Metals	13	16	27	24	22	20	21	21	20
1.A.2.c Chemicals	798	677	318	340	231	177	198	173	170
1.A.2.d Pulp, Paper and Print	77	94	91	104	115	77	85	81	78
1.A.2.e Food	105	127	175	410	455	464	819	1,912	3,328
1.A.2.f Other	2,031	1,880	2,019	2,094	1,900	1,550	1,504	1,452	1,232
N_2O (Mg)									
1.A.2.a Iron and Steel	362	370	302	330	295	191	292	335	304
1.A.2.b Non-Ferrous Metals	13	16	25	23	21	19	21	21	20
1.A.2.c Chemicals	346	285	159	152	125	94	109	94	95
1.A.2.d Pulp, Paper and Print	64	82	81	89	84	70	82	79	77
1.A.2.e Food	52	53	76	91	81	61	57	78	87
1.A.2.f Other	4,093	3,712	4,020	4,335	4,032	3,547	3,448	3,359	2,952

Source: ISPRA elaborations

3.4.2 Source category description

The category 1.A.2 comprises six sources: 1.A.2.a Iron and Steel, 1.A.2.b Non-Ferrous Metals, 1.A.2.c Chemicals, 1.A.2.d Pulp, Paper and Print, 1.A.2.e Food, 1.A.2.f Other.

Iron and steel

The main processes involved in iron and steel production are those related to sinter and blast furnace plants, to basic oxygen and electric furnaces and to rolling mills.

Most of emissions are connected to the integrated steel plants, while for the other plants, the main energy source is electricity (accounted for in 1.A.1.a) and the direct use of fossil fuels is limited to heating – re heating of steel in the intermediate part of the process.

There were four integrated steel plants in 1990 that from 2005 are reduced to two, with another plant that still has a limited production of pig iron. Nevertheless, the steel production in integrated plants has not changed significantly in the 1990-2008 period due to an expansion in capacity of the two operating plants. The maximum production was around 11 Mt/y in 1990, 1995 and in 2005-2008, with lower values in other years and the lowest of 6 Mt in 2009.

It has to be underlined that the integrated steel plants include also the cogeneration of heat and electricity using the recovered “coal gases” from various steps of the process, including steel furnace gas, BOF gas and coke oven gas. All emissions due to the “coal gases” used to produce electricity are included in the electricity grid operator yearly reports and are accounted in the category 1.A.1.c. No detailed info is available for the heat produced, so the emissions are included in source category 1.A.2.a.

With the aim to avoid double counting process-related emissions from the iron and steel subcategory are reported in the industrial processes sector. More in detail CH_4 process emissions for pig iron and steel production are already allocated to the industrial processes sector as well as fugitive CH_4 emissions from coke production are reported under fugitive emissions while CH4 emissions from the combustion of fuels are allocated to the energy sector.

Non-Ferrous Metals

In Italy there is a production of primary aluminium (232 Gg in 1990 and 99 Gg in 2012) and of secondary aluminium (350 Gg in 1990 and 619 in 2012). These productions however use electricity as the primary energy source so the emissions due to the direct use of fossil fuels are limited. At present in Italy, there is only one primary aluminium production plants.

The sub sector comprises also the production of other non-ferrous metals, both primary and secondary copper, lead, zinc and others; but also those productions have a limited share of emissions. The bulk of emissions are due to foundries that prepare mechanical pieces for the engineering industry or the market, using all kinds of alloys, including aluminium, steel and iron.

Chemicals

CO_2, CH_4 and N_2O emissions from chemical and petrochemical plants are included in this sector.

In Italy there are petrochemical plants integrated with a nearby refinery and stand alone plants that get the inputs from the market. Main products are Ethylene, Propylene, Styrene.

In particular, ethylene and propylene are produced in petrochemical industry by steam cracking. Ethylene is used to manufacture ethylene oxide, styrene monomer and polyethylene. Propylene is used to manufacture polypropylene but also acetone and phenol. Styrene, also known as vinyl benzene, is produced on industrial scale by catalytic dehydrogenation of ethyl benzene. Styrene is used in the rubber and plastic industry to manufacture through polymerisation processes such products as polystyrene, ABS, SBR rubber, SBR latex. Except for ethylene oxide production, which has stopped since 2002, the other productions of the above mentioned chemicals still occur in Italy. Activity data are stable from 1990 to 2012, with limited yearly variations.

Chemical industry includes non organic chemicals as chlorine/soda, sulphuric acid, nitric acid, ammonia. A limited production of fertilizers is also present in Italy. From 1990 to 2012 the production has been greatly reduced, with less than half of the 1990 production still occurring in 2012.

This source category does include some emissions from the cogeneration of electricity. Due to the transformation of some of those plants in power plants directly connected to the grid (and so reported in category 1.A.1.a) the percentage of the category 1.A.2.c CO_2 emissions due to electricity generation has reduced from 1990 to 2012.

Pulp, Paper and Print

Emissions from the manufacturing of paper are included in this source category. In Italy the manufacture of virgin paper pulp is rather limited, with a production feeding less than 5% of the paper produced in 2012. Most of the pulp was imported in 1990, while in 2012 half of the pulp used is produced locally from recycled paper. The paper production is expanding and activity data (total paper produced) was 6.3 Mt in 1990 and 8.6 Mt in 2012. The printing industry represents a minor part of the source category emissions.

This source category includes also the emissions from the cogeneration of electricity. Due to the transformation of some of those plants in power plants directly connected to the grid (and so reported in category 1.A.1.a), the percentage of the category 1.A.2.d CO_2 emissions due to electricity generation has strongly reduced from 1990 to 2012.

Food

Emissions from the food production are included in this source category. In Italy the industrial food production is expanding. A comprehensive activity data for this sector is not available; energy fuel consumption was estimated to be 60 PJ in 1990 and 82 PJ in 2012. Value added in constant money has increased of 0.6% per years from 1990 to 2003 and of 0.1% yearly from 2004 to 2012.

This source category also includes emissions from the cogeneration of electricity. Due to the transformation of those plants in power plants directly connected to the grid (and so reported in category 1.A.1.a) the percentage of the category 1.A.2.e CO_2 emissions due to electricity generation has reduced from 1990 to 2012.

Other

This sector comprises emissions from many different industrial subsectors, some of which are quite significant in Italy in terms of both value added and export capacity.

In particular, engineering sectors (vehicles and machines manufacturing) is the main industrial sub sector in terms of value added and revenues from export and textiles was the second subsector up to year 2000.

Another sub sector, construction materials, is also included here and it is also quite significant in terms of emissions due to the energy intensity of the processes involved. Construction materials subsector includes the production of cement, lime, bricks, tiles and glass. It comprises thousands of small and medium size enterprises, with only a few large operators, mainly connected to cement production. Some of the production is also exported. The description of the process used to produce cement, lime and glass is reported in chapter 4, industrial processes.
The fabrication of bricks is a rather standard practice in most countries and does not need additional description; fossil source is mainly natural gas. A peculiar national circumstance is the fabrication of tiles, in which are involved many specialised "industrial districts" where many different independent small size enterprises are able to manufacture world level products for both quality and style, exported everywhere. Generally speaking, the processes implemented are efficient with reference to the average European level and use mostly natural gas as the main fossil source since the year 2000.
The remaining "other industries" include furniture and other various "made in Italy" products that produce not negligible amounts of emissions.
The activity data of industries oriented to so different markets are, of course, peculiar to each subsector and it is difficult to identify a common trend. The productions of cement, lime and glass are the most relevant from the emissions point of view.
This short preface is needed to understand the reasons why this subsector is a key sector and accounts, in 2012, for 43.7% of total 1.A.2 CO_2 emissions, and 5.1% of total national emissions.
This source category includes also emissions from the cogeneration of electricity. Due to the transformation of some of those plants in power plants directly connected to the grid (and so reported in category 1.A.1.a) the percentage of the category 1.A.2.f CO_2 emissions due to electricity generation has reduced in the last years.

3.4.3 Methodological issues

Energy consumption for this sector is reported in the BEN (see Annex 5, Tables A5.9 and A5.10). The data comprise specification of consumption for 13 sub-sectors and more than 25 fuels. These very detailed data, combined with industrial production data, allow for a good estimation of all the fuel used by most industrial sectors, with the details required by CRF format. With reference to coal used in the integrated steel production plants the quantities reported in BEN are not used as such but a procedure has been elaborated to estimate the carbon emissions linked to steel production and those attributable to the coal gases recovered for electricity generation, as already mentioned in paragraph 3.4.1. The detailed calculation procedure is described in Annex 3. Moreover, a part of the fuel input is considered in the estimation of process emissions, see chapter 4 for further details.
The balance of fuel (total consumption minus industrial processes consumption) is considered in the emission estimate; the emission factors used are listed in Table 3.12. The procedure used to estimate the national emission factors is described in Annex 6. These factors account for the fraction of carbon-oxidised equal to 0.98 for solid fuels, 0.99 for liquid fuels and 0.995 for natural gas, as suggested by the 1996 IPCC guidelines (IPCC, 1997).
Starting from 2005, for petroleum coke, synthesis gas from heavy residual and from 2007 for residual gases from chemical processes the oxidation factors have been modified based on the data reported by operators under the EU ETS scheme. See Annex 6 for further details.
During the revision of the aviation sector, for jet gasoline and jet kerosene, a fraction of carbon oxidised equal to 1 has been applied, as reported in the 2006 IPCC guidelines (IPCC, 2006), for the whole time series, on the basis of expert judgement.

Table 3.12 Emission Factors for Power, Industry and Civil sector

	t CO_2 / TJ	t CO_2 / t	t CO_2 / toe
Liquid fuels			
Crude oil	72.549	3.035	3.035
Jet gasoline	70.000	3.075	2.929
Jet kerosene	71.500	3.111	2.992
Petroleum Coke, 2012 average	93.802	3.221	3.925
Gasoil	73.274	3.127	3.066
Orimulsion	77.733	2.177	3.252
Synthesis gas from heavy residual, 2012 average	98.825	0.870	4.135
Residual gases from chemical processes 2012	51.309	2.504	2.147
Gaseous fuels, national data			
Natural gas, 2012 average	56.934	1.951 (sm^3)	2.382
Solid fuels			
Steam coal, 2012 average	91.885	2.315	3.844
"sub-bituminous" coal	96.234	2.557	4.026
Lignite	99.106	1.037	4.147
Coke	108.161	3.168	4.525
Biomass			
Solid Biomass		(1.124)	(4.495)
Derived Gases, national data			
Refinery Gas, 2012 average	57.015	2.702 (sm^3)	2.386
Coke Gas, 2012 average	43.329	0.775 (sm^3)	1.813
Oxygen converter Gas, 2012 average	197.208	1.225 (sm^3)	8.251
Blast furnace, 2012 average	251.544	0.888 (sm^3)	10.525
Fossil fuels, national data			
Fuel oil, 2012 average	75.426	3.110	3.156
Coking coal	95.702	2.963	4.004
Other fuels			
Municipal solid waste	47.877	0.718	2.003

Source: ISPRA elaborations

Other sources of information are the yearly survey performed for the E-PRTR, since 2003, and the EU ETS; both surveys include main industrial operators, but not all emission sources. In particular from 2005 onwards the detailed reports by operators subject to EU ETS constitute a valuable source of data, as already said above with reference to oxidation factors and average emission factors.
In general, in the industrial sector, the ETS data source is used for cross checking BEN data. Energy/emissions data from EU ETS survey of industrial sectors should be normally lower than the corresponding BEN data because only part of the installations / sources of a certain industrial sub sector are subject to EU ETS. In case of missing sources or lower figures in the BEN than ETS, at fuel sector level, a verification procedure is carried out.
Since 2007 data, ISPRA verifies actual data from both sources and communicates potential discrepancies to MSE. Thus a verification procedure is started that can eventually modify BEN data. However, we underline that EU ETS data do not include all industrial installations and cannot be used directly to estimate sectoral emissions for a series of reasons that will be analyzed in the following, sector by sector.

Iron and steel
For this sector, all main installations are included in EU ETS, but not all sources of emission. Only part of the processes of integrated steel making is subject to EU ETS, in particular the manufacturing process after the production of row steel was excluded up to 2007 and only the lamination processes have been included from 2008 onwards.
Moreover, the recovered coal gases used to produce electricity and steam are not included. So the EU ETS data is only of limited use for this subsector and the procedure set up starting from the total carbon input to the steel making process, is still the most comprehensive one to estimate the emissions to be reported in 1.A.2.a, see Annex 3 for further details.

Of course, data available from EU ETS are used for cross-checking the BEN data, with an aim to improve the consistency of the data set.
These plants are also reported in E-PRTR, but not all sources are included.
The low implied emission factors and annual variations in the average CO_2 emission factor for solid fuel are due to the fact that both activity data and emissions reported under this category include the results of the carbon balance (see Annex 3 for further details). The implied emission factor for 2012 is equal to 72.0 t/TJ and the trend is quite stable with figures around 60-65 t/TJ. CH_4 implied emission factor is equal to 21.0 kg/TJ in 2012 and it is higher than the default emission factors because of the specificities of the in-process combustion activities. The sintering process is a pre-treatment step in the production of iron in which metal ores, coke and other materials are roasted under burners, involving the mixing of combustion products and/or the fuel with the product or raw materials (EMEP/EEA, 2009). Apart from combustion emissions, the heating of plant feedstock and product can lead to substantial CH_4 emissions which are to be accounted for in the combustion process. According to the Good Practice Guidance these emissions are reported in the energy sector.

Non-Ferrous Metals
These plants are mostly excluded from EU ETS; some aluminium producing plants will be included from 2013, but only for CO_2 and PFCs emissions by production process. These plants are also in general not considered in E-PRTR survey, because they do not reach the emission ceilings for mandatory reporting. In this context emissions from the production processes are generally reported.

Chemicals
The use of EU ETS data for this subsector is rather complex because generally chemical plants are excluded from EU ETS while petrochemical plants are included. All plants reports under the E-PRTR. In this case, the latter data set is used for cross checking BEN data. As mentioned in paragraph 3.4.1, also a small amount of emissions connected to the production of electricity for the onsite use is reported in source 1.A.2.c, basic data are taken from TERNA reports and the relative subsector amount is estimated with a model.
In this category, biomass refers to the steam wood fuel consumption as available in the BEN while other fuel includes the consumption of residual gases from chemical processes. Relevant CO_2 emission factors are reported in Table 3.12 above. For CH_4, the emission factor is equal to 3 kg/TJ, which is the value reported in the IPCC guidelines for fuel oil; for N_2O, the upper level of the EF for fuel oil specified in the 2006 IPCC guidelines, equal to 2 kg/TJ, has been chosen.

Pulp, Paper and Print
Most of the operators in the paper and pulp sector are included in EU ETS, while only a few of the printing installations are included. The problem for the EU ETS data source for this subsector is that the data are reported on a point source basis, including the production of electricity, but these data are not subject to verification and appear not reliable. On the other hand, the inventory team has no access to the detailed, plant by plant, database of electricity producing plants so the emissions reported in the ETS survey cannot be divided between those belonging to table 1.A.1.a and table 1.A.2.d.
From 2010 submission CH_4 and N_2O emissions from biomass fuel consumption in the sector, have been added to the inventory on the basis of the biomass fuel consumption reported in the annual environmental report by the industrial association (ASSOCARTA, several years) and to the EU ETS. Statistics on biomass fuel consumption appears from 1998. According to the information supplied by the industrial association of the sector, ASSOCARTA, a few plants started to use biomass from 1998. The use of biomass has an increasing trend till 2008 while from 2009 the use of biomass sharply reduced. From 2008 information is directly reported by the production plants in the framework of the EU ETS. For the years from 1990 to 1997 the use of biomass for energy purposes in the pulp and paper industry has been assumed not occurring. Biomass fuel consumption includes especially black liquor but also industrial sludge and biogas from industrial organic wastes. CO_2 emission factor is equal to 110.3 t/TJ.

Food
Emissions from the food production are included in this source category. A comprehensive activity data for this sector is not available; the subsector comprises many small and medium size enterprises, with thousands of different products. Limited info on this sector can be found in ETS survey, the sector is not included in the scope of ETS.

Biomass includes fuel consumption of steam wood and biogas from food industrial residual. The CH_4 implied emission factor time series is driven by the mix of these fuels. In this sector emissions are prevalently from biogas from food industrial residual, with an EF of CH_4 equal to 153 kg/TJ, while in the other manufacturing industries biomass refers to wood and similar with an EF of CH_4 equal to 30 kg/TJ.
Biogas from food industrial residual has a N_2O EF, equal to 3 kg/TJ, while wood and similar have an EF equal to 4 kg/TJ.

Other
This sector comprises emissions from many different industrial subsectors, some of which are subject to EU ETS and some not. Construction material subsector is energy intensive and it is subject to EU ETS. In the national energy database (BEN), the data for construction material are reported separately and they can be cross cheeked with ETS survey. However, in the construction material subsector, there are many small and medium size enterprises, so the operators subject to ETS are only a part of the total.
Biomass includes wood fuel consumption and other non conventional fuels especially used in the construction material subsector. CH_4 emission factor is equal to 27.4 kg/TJ and refers to the use of these non conventional fuels for the cement production (EMEP/EEA, 2009).

3.4.4 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions for this category is estimated to be about 4% in annual emissions; a higher uncertainty is calculated for CH_4 and N_2O emissions on account of the uncertainty levels attributed to the related emission factors and the difference in emission factors between the industrial subsectors, sources 1.a.2.a-f.
Montecarlo analysis has been carried out to estimate uncertainty of CO_2 emissions from stationary combustion of solid, liquid and gaseous fuels emissions, resulting in 5.1%, 3.3% and 5.8%, respectively. Normal distributions have been assumed for all the parameters. A summary of the results is reported in Annex 1.
Estimates of fuel consumption for industrial use in 2012 are reported in Annex 5, Tables A5.9 and A5.10. Time series of the industrial energy consumption data are contained in the BEN time series and in the CRFs and are reported in the following table.

Table 3.13 Fuel consumptions for Manufacturing Industry sector, 1990-2012 (TJ)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
1.A.2 Manufacturing Industries and Construction	**1,265,428**	**1,308,830**	**1,305,976**	**1,258,635**	**1,240,363**	**1,186,848**	**1,114,333**	**869,818**	**948,361**	**963,542**	**857,208**
a. Iron and Steel	271,413	273,216	231,016	250,701	245,646	240,587	225,891	147,637	220,112	250,336	229,112
b. Non-Ferrous Metals	12,067	15,145	20,609	19,950	20,010	19,545	18,371	17,184	19,200	19,066	18,195
c. Chemicals	290,074	269,682	203,069	180,188	176,096	172,116	154,054	123,562	133,950	121,289	119,179
d. Pulp, Paper and Print	50,520	70,371	74,175	79,633	79,610	91,069	73,674	65,142	79,014	77,383	74,881
e. Food Processing, Beverages and Tobacco	62,141	85,138	103,552	108,371	94,999	91,438	92,042	79,102	78,415	83,781	82,410
f. Other	579,213	595,277	673,555	619,793	624,002	572,093	550,300	437,192	417,670	411,687	333,431

Source: ISPRA elaborations

Emission levels observed from 1990 to 2000 are nearly constant with some oscillations, linked to the economic cycles. After year 2000 the general trend is downward, with oscillations due to the economic cycles, see Table 3.11 above. The underlining reason for the reduced emissions is the reduced industrial output, and the increase in energy efficiency.

3.4.5 Source-specific QA/QC and verification

Basic data to estimate emissions have been reported by national energy balance and the national grid administrator. Data collected by other surveys that include EU-ETS and E-PRTR surveys have been used to cross – check the energy balance data, fuels used and EFs. Differences and problems have been analysed in details and solved together with MSE experts.
The energy data used to estimate emissions reported in table 1.A.2 have two different levels of accuracy:

- in general they are quite reliable and their uncertainty is the same of the BEN; as reported in Annex 4 the BEN survey covers 100% of import, export and production of energy; the total industrial consumption estimate is obtained subtracting from the total the known energy quantities (obtained by specialized surveys) used in electricity production, refineries and the civil sector.
- the energy consumption at sub sectoral level (sources 1.A.2.a-f) is estimated by MSE on the basis of sample surveys, actual production and economic data; therefore the internal distribution on energy consumption has not the some grade of accuracy of the total data.

3.4.6 Source-specific recalculations

Recalculations occurred for this category due to the update CO_2 emission factors in2011 for natural gas. Moreover the amount of biogas fuel consumption in the food industry for 2011 has been updated as well as lime and ceramic production data for 2011 resulting in the decrease of CH_4 and N_2O emissions for that year. The recalculation of the 1.A.2 subsector resulted in a decrease equal to -11.0% and -0.42% for CH_4 and N_2O emissions respectively.

3.4.7 Source-specific planned improvements

No specific improvements are planned for the next submission.

3.5 Transport

This sector shows an increase in emissions over time, reflecting the trend observed in fuel consumption for road transportation. The mobility demand and, particularly, the road transportation share have increased in the period from 1990 to 2012, although since 2007 emissions from the sector begin to decrease. Emissions show an increase of about 2.9 % from 1990 to 2012, and this results from an increase of about 24.9% from 1990 to 2007 and from a decrease of about -17.6% from 2007 to 2012, being equal to -9.7% the decrease in last year.
The time series of CO_2, CH_4 and N_2O emissions, in Mt CO_2 equivalent, is reported in Table 3.14; figures comprise all the emissions reported in table 1.A.(a)s3 of the CRF.
Emission estimates are discussed below for each sub sector.
The trend of N_2O emissions is related to the evolution of the technologies in the road transport sector and the distribution between the different fuels consumption.
Methane emission trend is due to the combined effect of technological improvements that limit VOCs from tail pipe and evaporative emissions (for cars) and the expansion of two-wheelers fleet. It has to be underlined that in Italy there is a remarkable fleet of motorbikes and mopeds (about 10.6 million vehicles in 2012) that use gasoline and although it has been increasing since 1990, during the last year it shows a slight decrease, of about -0.3%. Only a small part of this fleet complies with strict VOC emissions controls.

Table 3.14 GHG emissions for the transport sector (Mt CO_2 eq.)

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
CO_2	Mt	101.3	111.4	120.1	125.8	127.1	127.2	122.1	117.6	117.1	116.1	104.8
CH_4	Mt	0.8	0.9	0.7	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2
N_2O	Mt	1.0	1.7	1.6	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.0
Total, Mt CO_2 eq.	**Mt**	**103.1**	**114.1**	**122.4**	**127.4**	**128.7**	**128.7**	**123.5**	**119.0**	**118.4**	**117.4**	**106.1**

Source: ISPRA elaborations

CO_2 from road vehicles and CO_2 from waterborne navigation are key categories both in 1990 and in 2012, while CO_2 from aircraft is a key category in 2012.

3.5.1 Aviation

3.5.1.1 Source category description

The IPCC methodology requires the estimation of emissions for category 1.A.3.a.i International Aviation and 1.A.3.a.ii Domestic Aviation, including figures both for the cruise phase of the flight and the landing and take-off cycles (LTO). Emissions from international aviation are reported as a memo item, and are not included in national totals.
Civil aviation contributes mainly in rising CO_2 emissions. CH_4 and N_2O emissions also occur and are estimated in this category but their contribution is insignificant.
In 2012 total GHG emissions from this source category were about 2.1% of the national total emissions from transport, and about 0.5% of the GHG national total; in terms of CO_2 only, the share is 0.6%.
From 1990 to 2012, GHG emissions from the sector increased by 34% due to the expansion of the aviation transport mode. Therefore, emission fluctuations over time are mostly dictated by the growth rates in the number of flights.
Aviation is a key category with respect to CO_2 emissions in level with Tier1 for 2012, without considering LULUCF.

3.5.1.2 Methodological issues

According to the IPCC Guidelines and Good Practice Guidance (IPCC, 1997; IPCC, 2006; IPCC, 2000) and the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2007), a national technique has been developed and applied to estimate emissions.
The current method estimates emissions from the following assumptions and information.
Activity data comprise both fuel consumptions and aircraft movements, which are available in different level of aggregation and derive from different sources as specified here below:

- Total inland deliveries of aviation gasoline and jet fuel are provided in the national energy balance (MSE, several years [a]), see Annex 5 Table A5.10. This figure is the best approximation of aviation fuel consumption, for international and domestic use, but it is reported as a total and not split between domestic and international;
- Data on annual arrivals and departures of domestic and international landing and take-off cycles at Italian airports are reported by different sources: National Institute of Statistics in the statistics yearbooks (ISTAT, several years [a]), Ministry of Transport in the national transport statistics yearbooks (MIT, several years) and the Italian civil aviation in the national aviation statistics yearbooks (ENAC/MIT, several years).

As for emission and consumption factors, figures are derived by the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2007), both for LTO cycles and cruise phases, taking into account national specificities. These specificities derive from the results of a national study which, taking into account detailed information on the Italian air fleet and the origin-destination flights for the year 1999, calculated national values for both domestic and international flights (Romano et al., 1999; ANPA, 2001; Trozzi et al., 2002 [a]) on the basis of the default emission and consumption factors reported in the EMEP/CORINAIR guidebook. National average emissions and consumption factors were therefore estimated for LTO cycles and cruise both for domestic and international flights from 1990 to 1999. At present, the study has been updated for the years 2005, 2006 and 2007 in order to consider most recent trends in civil aviation both in terms of modelling between domestic and international flights and technological progress of the fleet (TECHNE, 2009). Based on the results, national average emissions and consumption factors were updated from 2000.

Specifically, for the years referred to in the surveys, the current method estimates emissions from the number of aircraft movements broken down by aircraft and engine type (derived from ICAO database if not specified) at each of the principal Italian airports; information of whether the flight is international or domestic and the relevant distance travelled has also been considered.

For those years, a Tier 3 method has been applied (IPCC, 2006). In fact, figures on the number of flights, destination, aircraft fleet and engines has been provided by the local airport authorities, national airlines (Alitalia, AirOne) and European Civil Aviation (EUROCONTROL), covering about 80% of the national official statistics on aircraft movements for the relevant years. Data on 'Times in mode' have also been supplied by the four principal airports and estimates for the other minor airports have been carried out on the basis of previous sectoral studies at local level. Consumption and emission factors are those derived from the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2007). Based on sample information, estimates have been carried out at national level for the related years considering the official statistics of the aviation sector (ENAC/MIT, several years).

In general, to carry out national estimates of greenhouse gases and other pollutants in the Italian inventory for LTO cycles, both domestic and international, consumptions and emissions are calculated for the complete time series using the average consumption and emission factors multiplied by the total number of flights. The same method is used to estimate emissions for domestic cruise; on the other hand, for international cruise, consumptions are derived by difference from the total fuel consumption reported in the national energy balance and the estimated values as described above and emissions are therefore calculated.
The fuel split between national and international fuel use in aviation is then supplied to the Ministry of the Economical Development to be included in the official international submission of energy statistics to the IEA in the framework of the Joint Questionnaire OECD/Eurostat/IEA compilation together with other energy data.

Data on domestic and international aircraft movements from 1990 to 2012 are shown in Table 3.15 where domestic flights are those entirely within Italy. Emission factors are reported in Table 3.16 and Table 3.17. Total fuel consumptions, both domestic and international, are reported by LTO and cruise in Table 3.18.
Emissions from military aircrafts are also estimated and reported under category 1.A.5 Other.
The methodology to estimate military aviation emissions is simpler than the one described for civil aviation since LTO data are not available in this case.
As for activity data, total consumption for military aviation is published in the petrochemical bulletin (MSE, several years [b]) by fuel.
Emission factors are those provided in the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2007). Therefore, emissions are calculated by multiplying military fuel consumption data for the EMEP/CORINAIR default emission factors shown in Table 3.17.

Table 3.15 Aircraft Movement Data (LTO cycles)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Domestic flights	186,446	199,585	319,963	311,218	324,779	346,724	331,004	312,257	329,145	331,561	311,490
International flights	139,733	184,233	303,747	363,140	385,159	420,021	403,436	378,888	387,466	393,701	389,342

Source: ISTAT, several years [a]; ENAC/MIT, several years

Table 3.16 CO_2 and SO_2 emission factors for Aviation (kg/t) 1990-2012

	CO_2 [a]	SO_2
Aviation jet fuel	849	1.0
Aviation gasoline	839	1.0

a Emission factor as kg carbon/t.

Table 3.17 Non-CO_2 emission factors for Aviation (2012)

	Units	CH_4	N_2O	NO_x	CO	NMVOC	Fuel
Domestic LTO	kg/LTO	0.189	0.040	5.313	6.939	1.698	461.7
International LTO	kg/LTO	0.306	0.048	5.702	8.524	2.758	553.3
Domestic Cruise	kg/Mg fuel	-	0.087	13.747	1.898	0.471	-
International Cruise	kg/Mg fuel	-	0.087	11.544	1.170	0.418	-
Aircraft Military [a]	kg/Mg fuel	0.4	0.2	15.8	126	3.6	-

a EMEP/CORINAIR, 2007

Table 3.18 Aviation jet fuel consumptions for domestic and international flights (Gg)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
					Gg						
Domestic LTO	121	129	198	150	153	160	153	144	152	153	144
International LTO	123	162	250	195	212	232	223	210	214	218	215
Domestic cruise	387	414	642	544	567	605	578	545	575	579	544
International cruise	1,215	1,662	2,327	2,733	2,948	3,120	3,019	2,673	2,820	2,908	2,779

Source: ISPRA elaborations

3.5.1.3 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions from aviation is estimated to be about 4% in annual emissions; a higher uncertainty is calculated for CH_4 and N_2O emissions on account of the uncertainty levels attributed to the related emission factors.

Time series of domestic emissions from the aviation sector is reported in Table 3.19.
An upward trend in emission levels is observed from 1990 to 2012 which is explained by the increasing number of LTO cycles.
Nevertheless, the propagation of more modern aircrafts in the fleet slows down the trend in the most recent years. There has also been a decrease in the number of flights in the last years.

Table 3.19 GHG emissions from domestic aviation

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
CO_2	*Gg*	1,613	1,709	2,649	2,204	2,291	2,428	2,301	2,197	2,319	2,299	2,167
CH_4	*Mg*	32	33	63	112	98	72	66	66	70	65	62
N_2O	*Mg*	45	48	74	62	64	68	64	61	65	64	61

Source: ISPRA elaborations

3.5.1.4 Source-specific QA/QC and verification

Data used for estimating emissions from the aviation sector derive from different sources: local airport authorities, national airlines operators, EUROCONTROL and official statistics by different Ministries and national authorities.
Specifically, the outcome of the estimation method derived from the 2009 research, applied at national and airport level, was shared with national experts in the framework of an ad hoc working group on air emissions instituted by the National Aviation Authority (ENAC). The group, chaired by ISPRA, meets regularly at least once a year and includes participants from ENAC, Ministry of Environment, Land and Sea, Ministry of Transport, national airlines and local airport authorities. The results reflect differences between airports, aircrafts used and times in mode spent for each operation. There is also an on going collaboration and data exchange with regional environmental agencies on this issue.

3.5.1.5 Source-specific recalculations

No recalculations were performed in this last submission.

3.5.1.6 Source-specific planned improvements

Improvements for the next submissions are planned on account of the investigation of data provided by ISTAT by aircraft type and origin destination and the possibility to built a specific database. The updating of relevant emission factors will be implemented consequently.

3.5.2 Railways

The electricity used by the railways for electric traction is supplied from the public distribution system, so the emissions arising from its generation are reported under category 1.A.1.a Public Electricity.
Emissions from diesel trains are reported under the IPCC category 1.A.3.c Railways. Estimates are based on the gas oil consumption for railways reported in BEN (MSE, several years [a]).
Carbon dioxide and sulphur dioxide emissions are calculated on fuel based emission factors using fuel consumption data from BEN. Emissions of CO, NMVOC, NO_x, N_2O and methane are based on the EMEP/CORINAIR methodology (EMEP/CORINAIR, 2007). The emission factors shown in Table 3.20 are aggregate factors so that all factors are reported on the common basis of fuel consumption.

Table 3.20 Emission factors for railway (kg/t)

	CO_2	CH_4	N_2O	NO_x *kg/t*	CO	NMVOC	SO_2
Diesel trains	3,138	0.18	1.24	39.6	10.7	4.65	0.015

Source: EMEP/CORINAIR, 2007

GHG emissions from railways accounted in 2012 for about 0.05% of the total transport sector emissions. In this submission no recalculation affected this category. No specific improvements are planned for the next submission.

3.5.3 Road Transport

3.5.3.1 Source category description

This section addresses the estimation of emissions related to category 1.A.3.b Road transportation.
In 2012, total GHG emissions from this category were about 92.6% of the total national emissions from transport, 25.8% of the energy sector and about 21.3% of the GHG national total.
From 1990 to 2012, GHG emissions from the sector increased by 3.3%; this trend has a twofold explanation: on one side a strong increase starting from 1990 until 2007 (26.3%), due to the increase of vehicle fleet, total mileage and consequently fuel consumptions and on the other side, in the last years, from 2007 onwards, a decrease in fuel consumption and emissions basically due to the economic crisis (starting from 2007, the mean annual decrease is about -3.9%; from 2007 to 2011, the mean annual decrease is about -2.3%, but during the last year a decrease is observed of about -10.2%).

CO_2 emissions from road transport are a key category in 2012 with Approach 1 and Approach 2 at level and trend assessment, with and without LULUCF. In 1990 CO_2 emissions are key category at level assessment, with Approach 1 and Approach 2, with and without LULUCF. N_2O emissions have been not identified as key category, while CH_4 emissions, differently from 2011, in 2012 are key category with Approach 2 at trend assessment without LULUCF.

Emissions from road transport are calculated either from a combination of total fuel consumption data and fuel properties or from a combination of drive related emission factors and road traffic data.
Non CO_2 emissions from biomass fuel consumption are included and reported: as regards biodiesel, under diesel fuel category; as regards bioethanol, under gasoline fuel category. Biomass fuel refers prevalently to the use of biodiesel which is mixed with diesel fuel and to the use of bioethanol by the passenger cars subsector E85 with reference to a blend consisting of 85% bioethanol and 15% gasoline by volume.
Whereas CO_2 emissions are calculated only on the basis of the amount of carbon in the fuel, and they could be easily take off by the total fuel CO_2 emissions, CH_4 and N_2O emissions depend from the technology of vehicles and could not be calculated without more detailed information regarding the type and technology of vehicles and the associated biofuel consumption.

3.5.3.2 Methodological issues

According to the IPCC Guidelines and Good Practice Guidance (IPCC, 1997; IPCC, 2000; IPCC, 2006) and the EMEP/EEA air pollutant emission inventory guidebook 2013 (EMEP/EEA, 2013), a national methodology has been developed and applied to estimate emissions.
The model COPERT 4 (EMISIA SA, 2012) has been used to estimate emissions for the whole time series. In 2014 submission, the version 10.0 has been used, the same as in 2013, being the last published update of the software, so the update of the historical series related exclusively to the inclusion of new data and information in the analysis.
Methodologies are described in the following, distinguishing emissions calculated from fuel consumption and traffic data.

3.5.3.2.1 Fuel-based emissions

Emissions of carbon dioxide and sulphur dioxide from road transport are calculated from the consumption of gasoline, diesel, liquefied petroleum gas (LPG) and natural gas and the carbon - sulphur content of the fuels consumed. Consumption data for the fuel consumed by road transport in Italy are taken from the BEN (MSE, several years [a]), see Annex 5, Tables A5.9 and A5.10, in physical units (rows “III - Road transportation” and “VI - Public Service”, subtracting the quantities for military use in diesel oil and off-road uses in petrol).

Emissions of CO_2, expressed as kg carbon per tonne of fuel, are based on the H/C and O/C ratios of the fuel. The increase in fuel consumption due to air conditioning use implies that extra CO_2 emissions in g/km are calculated as a function of temperature and relative humidity; nevertheless because of CO_2 emissions depend on total statistical fuel consumption, there is not impact on the CO_2 officially reported but instead on other pollutants.
Emissions of SO_2 are based on the sulphur content of the fuel, on the assumption that all the sulphur in the fuel is transformed completely into SO_2. As regards heavy metals (exhaust emissions of lead have been dropped because of the introduction of unleaded gasoline) apparent fuel metal contents are used in the emissions calculation which are indeed values taking into account also of lubricant content and engine wear (EMEP/EEA, 2013).
Values of the fuel-based emission factors for CO_2 from consumption of petrol and diesel fuels are shown in Table 3.21. These factors account for the fraction of carbon oxidised for liquid fuels equal to 0.99, as suggested by the 1996 IPCC guidelines (IPCC, 1997). From the nineties, different directives regulating the fuel quality in Europe have been implemented (Directive 93/12/EC, Directive 98/70/EC, Directive 2003/17/EC and Directive 2009/30/EC), in parallel with the evolution of vehicle fleet technologies; this resulted in remarkable differences in the characteristic of the fuels, including the content of carbon, hydrogen and oxygenates, parameters needed to derive the CO_2 emission factors. A specific survey was conducted to characterize the national fuel used in 2000-2001 and a similar survey was completed this year but the results will be used for the next submission. Regarding 1990-1999, a study has been done to evaluate the use of the default emission factors reported in the IPCC Guidelines 1996 in consideration of the available information on national fuels. Emission factors from the Guidelines have been considered representative for diesel and GPL while for gasoline a country specific emission factor has been calculated taking into account the IPCC default values and the specific energy content of the national fuels. For further details see the relevant paragraph in Annex 6.

Values for SO_2 vary annually as the sulphur-content of fuels change and are calculated every year for gasoline and gas oil and officially communicated to the European Commission in the framework of European Directives on fuel quality; these figures are also published by the refineries industrial association (UP, several years). Directive 2003/17/EC introduced for 2005 new limit for S content in the fuels, both gasoline and diesel, 50% lower than the previous ones.

Table 3.21 Fuel-Based Emission Factors for Road Transport

National emission factors	Mg CO_2 / TJ	Mg CO_2 / Mg
Mtbe	73.121	-
Gasoline, 1990-'99, interpolated emission factor	71.034	3.121
Gasoline, test data, 2000-12[b]	71.145	3.109
Gas oil, 1990-'99, IPCC OECD[a]	73.274	3.127
Gas oil, engines, test data, 2000-12[b]	73.153	3.138
LPG, 1990-'99, IPCC[a] Europe	64.350	3.000
LPG, test data, 2000-12[b]	64.936	2.994
Natural gas (dry) 1990	55.328	-
Natural gas (dry) 2012	56.934	-

a Revised 1996 IPCC Guidelines for National GHG Inventories, Reference Manual, ch1, tables 1-36 to 1-42
b Emission factor in kg carbon/tonne, based on ISPRA (APAT, 2003 [b])

Emissions of CO_2 and SO_2 can be broken down by vehicle type based on estimated fuel consumption factors and traffic data in a manner similar to the traffic-based emissions described below for other pollutants. The actual inventory used fuel consumption factors expressed as grams of fuel per kilometre for each vehicle type and average speed calculated from the emission functions and speed-coefficients provided by the model COPERT 4 (EMISIA SA, 2012). The updated version 10.0 of the model COPERT 4 has been used for the whole time series of the 2014 submission. As reported more in detail in the following, the updated version of the model, used for 2013 and 2014 submissions, considers, compared to the version 9.0, used for 2012 submission, a new subsector classification for gasoline and diesel passenger cars, updated emission factors for diesel passenger cars Euro 5 and 6, emissions update for mopeds, methane update for gasoline passenger cars, a new subsector for Compressed Natural Gas (CNG) for passenger cars (Katsis P., Mellios G., Ntziachristos L., 2012).

Mileage and fuel consumptions calculated from COPERT functions are shown in Table 3.22 for each vehicle, fuel and road type in Italy in 2012.

Table 3.22 Average fuel consumption and mileage for main vehicle category and road type, year 2012

SNAP CODE	Sub sector	Type of fuel	Mg of fuel consumed	Mileage, km_kVeh
070101	PC Hway	cng	175,614	3,224,685
070101	PC Hway	diesel	3,353,451	64,441,655
070101	PC Hway	gasoline	1,579,534	31,609,580
070101	PC Hway	lpg	440,122	6,519,488
070102	PC rur	cng	205,730	4,299,580
070102	PC rur	diesel	5,039,112	111,372,922
070102	PC rur	gasoline	2,461,517	55,014,406
070102	PC rur	lpg	400,108	8,692,651
070103	PC urb	cng	232,870	3,224,685
070103	PC urb	diesel	1,984,883	29,319,351
070103	PC urb	gasoline	2,989,552	35,533,331
070103	PC urb	lpg	512,769	6,519,488
070201	LDV Hway	diesel	1,234,859	12,096,188
070201	LDV Hway	gasoline	31,972	450,697
070202	LDV rur	diesel	1,996,425	33,264,518
070202	LDV rur	gasoline	89,921	1,239,417

SNAP CODE	Sub sector	Type of fuel	Mg of fuel consumed	Mileage, km_kVeh
070203	LDV urb	diesel	1,638,793	15,120,235
070203	LDV urb	gasoline	94,246	563,371
070301	HDV Hway	diesel	3,372,651	17,830,086
070301	HDV Hway	gasoline	49	331
070302	CNG Buses rur	cng	2,845	9,686
070302	HDV rur	diesel	2,291,986	11,856,817
070302	HDV rur	gasoline	143	993
070303	CNG Buses urb	cng	35,702	87,175
070303	HDV urb	diesel	1,251,662	4,067,470
070303	HDV urb	gasoline	65	331
070400	mopeds	gasoline	186,007	9,885,959
070501	Moto Hway	gasoline	53,308	1,427,192
070502	Moto rur	gasoline	279,433	9,990,345
070503	Moto urb	gasoline	509,240	17,126,305
Total				**494,788,937**

Source: ISPRA elaborations

Notes: PC, passenger cars ; LDV, light duty vehicles ; HDV, heavy duty vehicles and buses; Moto, motorcycles; Hway, highway speed traffic; rur, rural speed traffic; urb, urban speed traffic; biodiesel included in diesel; bioethanol included in gasoline

3.5.3.2.1.a The fuel balance process

A normalisation procedure is applied to ensure that the breakdown of fuel consumption by each vehicle type calculated on the basis of the fuel consumption factors once added up matches the BEN figures for total fuel consumption in Italy (adjusted for off-road consumption).

In COPERT a simulation process is started up having the target to equalize calculated and statistical consumptions, separately for fuel (gasoline including bioethanol, diesel including biodiesel, LPG and CNG) at national level, with the aim to obtain final estimates the most accurate as possible.

Once all data and input parameters have been inserted and all options have been set reflecting the peculiar situation of the Country, emissions and consumptions are calculated by the model in the detail of the vehicle category legislation standard; then the aggregated consumption values so calculated are compared with the input statistical national aggregated values (deriving basicly from the National Energy Balance, as described above) and a percentage deviation is calculated.

On the basis of the obtained deviation value, a process of refinement of the estimates is performed by acting on control variables such as speeds and mileages. These variables values are changed according to the constraints on the national average variability ranges (identified on the basis of the official data and information on the fleet peculiarities, described in this chapter). As a result of sequential refinements on input data in the detail of vehicle category legislation standard, the estimation process is repeated until the reachment of the deviation value 0.00% as minimum target, assumed as goodness of fit to the “true” BEN statistical value.

The results of the fuel balance process for the year 2012 in Italy are shown in the following table.

Table 3.23 Fuel balance results for Italy, year 2012

Fuel	Statistical (t)	Calculated (t)	Deviation (%)
Gasoline (fossil & bio)	8,274,986.00	8,274,986.00	0.00%
Diesel (fossil & bio)	22,163,822.00	22,163,822.46	0.00%
LPG	1,353,000.00	1,352,999.53	0.00%
CNG	652,761.00	652,761.36	0.00%

3.5.3.2.2 Traffic-based emissions

Emissions of NMVOC, NO_X, CO, CH_4 and N_2O are calculated from emission factors expressed in grams per kilometre and road traffic statistics estimated by ISPRA on the basis of data released from: Ministry of Transport (MIT, several years), the Automobile Club of Italy (ACI, several years), the National Association of Cycle-Motorcycle Accessories (ANCMA, several years), the National Institute of Statistics (ISTAT), the National Association of concessionaries of motorways and tunnels (AISCAT).
The emission factors are based on experimental measurements of emissions from in-service vehicles of different types driven under test cycles with different average speeds calculated from the emission functions and speed-coefficients provided by COPERT 4 (EMISIA SA, 2012). This source provides emission functions and coefficients relating emission factors (in g/km) to average speed for each vehicle type and Euro emission standard derived by fitting experimental measurements to polynomial functions. These functions were then used to calculate emission factor values for each vehicle type and Euro emission standard at each of the average speeds of the road and area types. In addition N_2O emission factors differ according to the fuel sulphur level (EMEP/EEA, 2013).

The road traffic data used are vehicle kilometre estimates for the different vehicle types and different road classifications in the national road network. These data have to be further broken down by composition of each vehicle fleet in terms of the fraction of vehicles on the road powered by different fuels and in terms of the fraction of vehicles on the road relating to the different emission regulations which applied when the vehicle was first registered. These are related to the age profile of the vehicle fleet.

It is beyond the scope of this paper to illustrate in details the COPERT 4 methodology: in brief, the emissions from motor vehicles fall into three different types calculated as hot exhaust emissions, cold-start emissions, and evaporative emissions for NMVOC; in addition not exhaust emissions for PM deriving from road vehicle tyre and brake wear are contemplated.
Hot exhaust emissions are emissions from the vehicle exhaust when the engine has warmed up to its normal operating temperature. Emissions depend on the type of vehicle, type of fuel the engine runs on, the driving profile of the vehicle on a journey and the emission regulations applied when the vehicle was first registered as this defines the type of technology the vehicle is equipped with.
For a particular vehicle, the drive cycle over a journey is the key factor which determines the amount of pollutant emitted.
Key parameters affecting emissions are acceleration, deceleration, steady speed and idling characteristics of the journey, as well as other factors affecting load on the engine such as road gradient and vehicle weight. However, studies have shown that for modelling vehicle emissions over a road network at national scale, it is sufficient to calculate emissions from emission factors in g/km related to the average speed of the vehicle in the drive cycle (EEA, 2007). Emission factors for average speeds on the road network are then combined with the national road traffic data.

Emissions are calculated from vehicles of the following types:

- Gasoline passenger cars;
- Diesel passenger cars;
- LPG passenger cars;
- CNG passenger cars;
- E85 passenger cars;
- Hybrid Gasoline passenger cars;
- Gasoline Light Goods Vehicles (Gross Vehicle Weight (GVW) <= 3.5 tonnes);
- Diesel Light Goods Vehicles (Gross Vehicle Weight (GVW) <= 3.5 tonnes);
- Rigid-axle Heavy Goods Vehicles (GVW > 3.5 tonnes);
- Articulated Heavy Goods Vehicles (GVW > 3.5 tonnes);
- Diesel Buses and coaches;
- CNG Buses;
- Mopeds and motorcycles.

As regards CNG fuel, a detailed classification for passenger cars has been introduced for the Italian fleet for the whole time series, reflecting the classification scheme of gasoline passenger cars (subsectors: Natural Gas <1.4l; Natural Gas 1.4 – 2.0l; Natural Gas >2.0l). Emissions deriving from these categories have been estimated for each subsector and legislation standard on the basis of MIT and ACI detailed fleet data and parameters derived from the comparison between Copert CNG passenger cars aggregated subsector and the three different engine capacity classes (<1.4l; 1.4 – 2.0l; >2.0l) of Copert gasoline cars.

Basic data derive from different sources.
Detailed data on the national fleet composition are found in the yearly report from ACI (ACI, several years), used from 1990 to 2006, except for mopeds for which ANCMA (National Association of Cycle-Motorcycle Accessories) data were used for the whole time series. The National Association of Cycle-Motorcycle Accessories (ANCMA, several years) supplies useful information on mopeds fleet composition and mileages.
Starting from 2013 submission, specific fleet composition data were provided by the MIT for all vehicle categories from 2007 onwards. The Ministry of Transport in the national transport yearbook (MIT, several years) reports passenger cars mileages time series. Furthermore in 2014 MIT supplies updated information relating the reallocation of not defined vehicles categories (data used for the updating of the time series from 2007 to 2012). MIT data have been used relating to: the passenger cars (the new categories of "E85" and "Hybrid Gasoline" passenger cars are introduced from 2007 onwards, the detailed "Gasoline < 0.8 l" passenger cars subsector is introduced for 2012 and "Diesel<1.4 l" subsector from 2007 onwards, in addition to the gasoline, diesel, LPG, CNG traditional ones); the diesel and gasoline light commercial vehicles; the breakdown of the heavy duty trucks, buses and coaches fleet according to the different weight classes and fuels (diesel for HDT and coaches; diesel and CNG for buses); the motorcycles fleet in the detail of subsector and legislation standard of both 2-stroke and 4-stroke categories (this kind of information has been used for the updating of the years 2005 – 2011).
The National Institute of Statistics carries out annually a survey on heavy goods vehicles, including annual mileages (ISTAT, several years [b]).
The National Association of concessionaries of motorways and tunnels produces monthly statistics on highway mileages by light and heavy vehicles (AISCAT, several years).
The National General Confederation of Transport and Logistics (CONFETRA, several years) and the national Central Committee of road transporters (Giordano, 2007) supplied useful information and statistics about heavy goods vehicles fleet composition and mileages.

In the following Tables 3.24, 3.25, 3.26 and 3.27 detailed data on the relevant vehicle mileages in the circulating fleet are reported, subdivided according to the main emission regulations.

Table 3.24 Passenger Cars technological evolution: circulating fleet calculated as stock data multiplied by effective mileage (%)

	1990	1995	2000	2005	2010	2011	2012
PRE ECE, pre-1972	0.05	0.03	0.01	0.01	0.004	0.004	0.005
ECE 15/00-01, 1972-1977	0.11	0.04	0.01	0.005	0.003	0.002	0.003
ECE 15/02-03, 1978-1986	0.32	0.15	0.03	0.01	0.01	0.005	0.01
ECE 15/04, 1987-1992	0.53	0.57	0.28	0.10	0.04	0.04	0.04
PC Euro 1 - 91/441/EEC, from 1/1/93	0.001	0.22	0.28	0.19	0.06	0.04	0.05
PC Euro 2 - 94/12/EEC, from 1/1/97	-	-	0.38	0.35	0.22	0.19	0.20
PC Euro 3 - 98/69/EC Stage2000, from 1/1/2001	-	-	-	0.26	0.21	0.17	0.16
PC Euro 4 - 98/69/EC Stage2005, from 1/1/2006	-	-	-	0.09	0.42	0.44	0.42
PC Euro 5 - EC 715/2007, from 1/1/2011	-	-	-	-	0.04	0.11	0.13
PC Euro 6 - EC 715/2007, from 9/1/2015	-	-	-	-	-	0.0000001	0.0002
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00
a. Gasoline cars technological evolution							
	1990	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**
Conventional, pre-1993	1.00	0.92	0.35	0.06	0.01	0.01	0.01
PC Euro 1 - 91/441/EEC, from 1/1/93	-	0.08	0.10	0.03	0.01	0.01	0.01
PC Euro 2 - 94/12/EEC, from 1/1/97	-	-	0.55	0.25	0.10	0.07	0.05

PC Euro 3 - 98/69/EC Stage2000, from 1/1/2001	-	-	-	0.53	0.26	0.23	0.25
PC Euro 4 - 98/69/EC Stage2005, from 1/1/2006	-	-	-	0.13	0.55	0.52	0.48
PC Euro 5 - EC 715/2007, from 1/1/2011	-	-	-	-	0.07	0.15	0.21
PC Euro 6 - EC 715/2007, from 9/1/2015	-	-	-	-	0.0001	0.0002	0.001
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00
b. Diesel cars technological evolution							
	1990	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**
Conventional, pre-1993	1.00	0.90	0.71	0.47	0.04	0.03	0.02
PC Euro 1 - 91/441/EEC, from 1/1/93	-	0.10	0.20	0.26	0.03	0.03	0.02
PC Euro 2 - 94/12/EEC, from 1/1/97	-	-	0.09	0.19	0.08	0.11	0.08
PC Euro 3 - 98/69/EC Stage2000, from 1/1/2001	-	-	-	0.06	0.08	0.10	0.09
PC Euro 4 - 98/69/EC Stage2005, from 1/1/2006	-	-	-	0.01	0.75	0.66	0.62
PC Euro 5 - EC 715/2007, from 1/1/2011	-	-	-	-	0.03	0.07	0.16
PC Euro 6 - EC 715/2007, from 9/1/2015	-	-	-	-	-	-	0.0001
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00
c. Lpg cars technological evolution							
	1990	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**
Conventional, pre-1993	1.00	0.89	0.54	0.29	0.02	0.02	0.01
PC Euro 1 - 91/441/EEC, from 1/1/93	-	0.11	0.24	0.21	0.03	0.02	0.01
PC Euro 2 - 94/12/EEC, from 1/1/97	-	-	0.22	0.26	0.17	0.13	0.08
PC Euro 3 - 98/69/EC Stage2000, from 1/1/2001	-	-	-	0.20	0.12	0.12	0.11
PC Euro 4 - 98/69/EC Stage2005, from 1/1/2006	-	-	-	0.05	0.57	0.56	0.55
PC Euro 5 - EC 715/2007, from 1/1/2011	-	-	-	-	0.09	0.15	0.23
PC Euro 6 - EC 715/2007, from 9/1/2015	-	-	-	-	-	-	0.00001
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00
d. CNG cars technological evolution							
			2008	**2009**	**2010**	**2011**	**2012**
PC Euro 4 - 98/69/EC Stage2005, from 1/1/2006			1.00	1.00	0.88	0.68	0.54
PC Euro 5 - EC 715/2007, from 1/1/2011			-	-	0.12	0.32	0.46
PC Euro 6 - EC 715/2007, from 9/1/2015			-	-	-	-	-
Total			1.00	1.00	1.00	1.00	1.00
e. E85 cars technological evolution (from 2008 onwards)							
		2007	**2008**	**2009**	**2010**	**2011**	**2012**
PC Euro 4 - 98/69/EC Stage2005, from 1/1/2006		1.00	1.00	0.65	0.54	0.43	0.35
PC Euro 5 - EC 715/2007, from 1/1/2011		-	-	0.35	0.46	0.57	0.64
PC Euro 6 - EC 715/2007, from 9/1/2015		-	-	-	-	-	0.01
Total		1.00	1.00	1.00	1.00	1.00	1.00
f. Hybrid Gasoline cars technological evolution (from 2007 onwards)							

Source: ISPRA elaborations on ACI and MIT data

Table 3.25 Light Duty Vehicles technological evolution: circulating fleet calculated as stock data multiplied by effective mileage (%)

	1990	1995	2000	2005	2010	2011	2012
Conventional, pre 10/1/94	1.00	0.93	0.60	0.38	0.08	0.07	0.07
LD Euro 1 - 93/59/EEC, from 10/1/94	-	0.07	0.24	0.19	0.11	0.09	0.09
LD Euro 2 - 96/69/EEC, from 10/1/98	-	-	0.16	0.15	0.30	0.26	0.21
LD Euro 3 - 98/69/EC Stage2000, from 1/1/2002	-	-	-	0.28	0.26	0.22	0.22
LD Euro 4 - 98/69/EC Stage2005, from 1/1/2007	-	-	-	0.01	0.25	0.26	0.27

	1990	1995	2000	2005	2010	2011	2012
LD Euro 5 - 2008 Standards 715/2007/EC, from 1/1/2012	-	-	-	-	0.004	0.11	0.14
LD Euro 6	-	-	-	-	-	-	-
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00
a. Gasoline Light Duty Vehicles technological evolution							

	1990	1995	2000	2005	2010	2011	2012
Conventional, pre 10/1/94	1.00	0.93	0.60	0.26	0.08	0.07	0.04
LD Euro 1 - 93/59/EEC, from 10/1/94	-	0.07	0.22	0.12	0.07	0.04	0.04
LD Euro 2 - 96/69/EEC, from 10/1/98	-	-	0.19	0.19	0.23	0.21	0.19
LD Euro 3 - 98/69/EC Stage2000, from 1/1/2002	-	-	-	0.41	0.33	0.33	0.34
LD Euro 4 - 98/69/EC Stage2005, from 1/1/2007	-	-	-	0.01	0.28	0.31	0.33
LD Euro 5 - 2008 Standards 715/2007/EC, from 1/1/2012	-	-	-	-	0.01	0.03	0.07
LD Euro 6	-	-	-	-	0.0000003	0.0000004	0.00001
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00
b. Diesel Light Duty Vehicles technological evolution							

Source: ISPRA elaborations on ACI and MIT data

Table 3.26 Heavy Duty Trucks and Buses technological evolution: circulating fleet calculated as stock data multiplied by effective mileage (%)

	1990	1995	2000	2005	2010	2011	2012
Conventional, pre 10/1/93	1.00	0.90	0.67	0.39	0.19	0.18	0.12
HD Euro I - 91/542/EEC Stage I, from 10/1/93	-	0.10	0.10	0.06	0.05	0.05	0.05
HD Euro II - 91/542/EEC Stage II, from 10/1/96	-	-	0.22	0.27	0.22	0.21	0.21
HD Euro III - 2000 Standards, 99/96/EC, from 10/1/2001	-	-	-	0.28	0.35	0.33	0.35
HD Euro IV - 2005 Standards, 99/96/EC, from 10/1/2006	-	-	-	-	0.06	0.06	0.06
HD Euro V - 2008 Standards, 99/96/EC, from 10/1/2009	-	-	-	-	0.14	0.17	0.21
HD Euro VI – EC 595/2009, from 12/31/2013	-	-	-	-	-	-	0.00002
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00
a. Heavy Duty Trucks technological evolution							

	1990	1995	2000	2005	2010	2011	2012
Conventional, pre 10/1/93	1.00	0.93	0.65	0.34	0.16	0.13	0.08
HD Euro I - 91/542/EEC Stage I, from 10/1/93	-	0.07	0.07	0.08	0.06	0.05	0.05
HD Euro II - 91/542/EEC Stage II, from 10/1/96	-	-	0.28	0.32	0.29	0.28	0.28
HD Euro III - 2000 Standards, 99/96/EC, from 10/1/2001	-	-	-	0.26	0.30	0.30	0.31
HD Euro IV - 2005 Standards, 99/96/EC, from 10/1/2006	-	-	-	-	0.10	0.10	0.11
HD Euro V - 2008 Standards, 99/96/EC, from 10/1/2009	-	-	-	-	0.09	0.13	0.17
HD Euro VI – EC 595/2009, from 12/31/2013	-	-	-	-	-	-	0.00
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00
b. Diesel Buses technological evolution							

	1990	1995	2000	2005	2010	2011	2012
Urban CNG Buses Euro I - 91/542/EEC Stage I, from 10/1/93	1.00	1.00	0.10	0.01	0.00	0.00	0.00
Urban CNG Buses Euro II - 91/542/EEC	-	-	0.90	0.22	0.10	0.09	0.08

	1990	1995	2000	2005	2010	2011	2012
Stage II, from 10/1/96							
Urban CNG Buses Euro III - 2000 Standards, 99/96/EC, from 10/1/2001; Urban CNG Buses Euro IV - 2005 Standards, 99/96/EC, from 10/1/2006	-	-	-	0.76	0.10	0.10	0.09
Euro V - 2008 Standards, 99/96/EC, from 10/1/2009; EEV (Enhanced environmentally friendly vehicle; ref. 2001/27/EC and 1999/96/EC line C, optional limit emission values)	-	-	-	-	0.80	0.81	0.83
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00
c. CNG Buses technological evolution							

Source: ISPRA elaborations on ACI and MIT data

Table 3.27 Mopeds and motorcycles technological evolution: circulating fleet calculated as stock data multiplied by effective mileage (%)

	1990	1995	2000	2005	2010	2011	2012
Conventional, pre 6/17/1999	1.00	1.00	0.86	0.43	0.22	0.20	0.15
Euro I, 97/24/EC, from6/17/1999	-	-	0.14	0.33	0.26	0.25	0.26
Euro II, 2002/51/EC, 2003/77/EC, from7/1/2004 (for mopeds: 97/24/EC, from6/17/2002)	-	-	-	0.20	0.29	0.29	0.30
EuroIII, 2002/51/EC, 2003/77/EC, from1/1/2007 (for mopeds not defined yet)	-	-	-	0.04	0.23	0.25	0.29
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Source:ISPRA elaborations on ACI, ANCMA and MIT data

Average emission factors are calculated for average speeds by three driving modes: urban, rural and motorway, combined with the vehicle kilometres travelled and vehicle categories.

ISPRA estimates total annual vehicle kilometres for the road network in Italy by vehicle type, see Table 3.28, based on data from various sources:

- Ministry of Transport (MIT, several years) for rural roads and on other motorways; the latter estimates are based on traffic counts from the rotating census and core census surveys of ANAS;
- highway industrial association for fee-motorway (AISCAT, several years);
- local authorities for built-up areas (urban).

Table 3.28 Evolution of fleet consistency and mileage

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
All passenger vehicles, total mileage (10^9 veh-km/y)	308	365	397	422	445	436	420	410	406	411	364
Car fleet (10^6)	27	30	33	35	35	36	37	37	37	38	38
Moto, total mileage (10^9 veh-km/y)	31	39	45	40	38	40	41	38	39	39	38
Moto fleet (10^6)	7	7	9	10	10	10	10	11	11	11	11
Goods transport, total mileage (10^9 veh-km/y)	68	75	89	99	97	103	102	101	104	100	93
Truck fleet (10^6), including LDV	2	3	3	4	4	5	5	5	5	5	5

Source: ISPRA elaborations

Notes: The passenger vehicles include passenger cars and buses; the moto fleet includes mopeds and motorcycles; in the goods transport light commercial vehicles and heavy duty trucks are included.

When a vehicle engine is cold, it emits at a higher rate than when it has warmed up to its designed operating temperature. This is particularly true for gasoline engines and the effect is even more severe for cars fitted with three-way catalysts, as the catalyst does not function properly until the catalyst is also warmed up. Emission factors have been derived for cars and LGVs from tests performed with the engine starting cold and warmed up. The difference between the two measurements can be regarded as an additional cold-start penalty paid on each trip a vehicle is started with the engine (and catalyst) cold.

Evaporative emissions of gasoline fuel vapour from the tank and fuel delivery system in vehicles constitute a significant fraction of total NMVOC and methane emissions from road transport. Nevertheless the contribution of evaporative emissions to total NMVOC emissions decreased significantly since the introduction of carbon canisters. Breathing losses through the tank vent and fuel permeations and leakages are considered the most important sources of evaporative emissions. The estimation of evaporative emissions takes into account three different mechanisms: diurnal emissions (depending on daily temperature variations), running losses (during the vehicles use) and hot soak emissions (following the vehicles use). The process of fuelling of vehicles is not considered here. The procedure for estimating evaporative emissions of NMVOCs takes account of gasoline volatility, the absolute ambient temperature and temperature changes, the characteristics of vehicles design; the driving pattern is also significant for hot soak emissions and running losses (EMEP/EEA, 2013).

3.5.3.3 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions from road transport is estimated to be about 4% in annual emissions; a higher uncertainty is calculated for CH_4 and N_2O emissions because of the uncertainty levels attributed to the related emission factors.

Montecarlo analysis has been carried out by EMISIA[1] on behalf of the Joint Research Centre (Kouridis et al., 2010) in the framework of the study “Uncertainty estimates and guidance for road transport emission calculations” for 2005 emissions; a summary of main results of study are reported in Annex 1. The study shows an uncertainty assessment, at Italian level, for road transport emissions on the basis of 2005 input parameters of the COPERT 4 model (v. 7.0).

The following Table 3.29 summarizes the time series of GHG emissions in CO_2 equivalent from road transport, highlighting the evolution of this source, characterized by an upward trend in CO_2 emission levels from 1990 to 2007, which is explained by the increasing of the fleet, total mileages, and fuel consumptions and by a decreasing trend from 2007 onwards, due, on one side, to the economical crisis, and on another side, to the propagation of the number of vehicles with low fuel consumption per kilometre. In 2012, with respect to 2007, a reduction in total mileages, especially for gasoline passenger cars and light duty vehicles, fuel consumptions and consequently CO_2 emissions has been noted.

CH_4 and N_2O emission trends are consequence of the penetration of new technologies according to the main emission regulations. Specifically CH_4 and more in general VOC emissions have reduced along the time

[1] EMISIA: www.emisia.com

series due to the introduction of VOC abatement devices on vehicles, in agreement with the legislation emission limits, and the rate of penetration of the new vehicles into the national fleet.
The time series of both N_2O emissions and implied emission factors are prevalently driven by the fleet composition and the penetration rate of the new vehicles/technologies. Moreover, in the COPERT4 model, N_2O emission factors depend also on the sulphur content of the fuel. In particular, significant drops of emissions and implied emission factors are observed in 1999-2000 and in 2004-2005 which are explained by the different fuel specifications in those years due to the application of the relevant European Directives on fuel quality. The sulphur content (%wt) in gasoline was 0.04 and 0.007 respectively in 1999 and 2000 and 0.0055 and 0.0025 respectively in 2004 and 2005 and changed from 0.0226 in 2004 to 0.0038 in 2005 for diesel oil.

Table 3.29 GHG emissions from road transport (Gg CO_2 equivalent)

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
CO_2	**Gg**	93,387	103,552	110,377	117,029	118,263	118,718	113,700	109,638	108,262	108,095	97,038
CH_4	**Gg CO_2 eq**	792	883	667	394	351	306	280	250	236	222	198
N_2O	**Gg CO_2 eq**	879	1,627	1,514	1,079	1,086	1,078	1,048	1,015	1,006	1,019	921
Total	**Gg CO_2 eq**	**95,058**	**106,062**	**112,558**	**118,503**	**119,700**	**120,102**	**115,028**	**110,903**	**109,504**	**109,337**	**98,157**

Source: ISPRA elaborations

3.5.3.4 Source-specific QA/QC and verification

Data used for estimating emissions from the road transport sector derive from different sources, including official statistics providers and industrial associations.
A specific procedure undertaken for improving the inventory in the sector regards the establishment of a national expert panel in road transport which involves, on a voluntary basis, different institutions, local agencies and industrial associations cooperating for improving activity data and emission factors accuracy. In this group, emission estimates are presented annually, and new methodologies are shared and discussed. Reports and data of the meetings can be found at the following address: http://groupware.sinanet.isprambiente.it/expert_panel/library.
Besides, time series resulting from the recalculation due to the application of COPERT 4 have been discussed with national experts in the framework of an ad hoc working group on air emissions inventories. The group is chaired by ISPRA and includes participants from the local authorities responsible for the preparation of local inventories, sectoral experts, the Ministry of Environment, Land and Sea, and air quality model experts. Recalculations are comparable with those resulting from application of the new model at local level. Top-down and bottom-up approaches have been compared with the aim to identify the major problems and future possible improvements in the methodology to be addressed.

3.5.3.5 Source-specific recalculations

In 2014 submission the historical series has been revised according to new data and information availability.

In 2014 recalculations are mainly due to: the reallocation of not defined vehicles categories as regards Ministry of Transport fleet data from 2007 onwards; the updating of annual fuel consumptions from 2008 onwards, descending from the introduction in the analysys of ETBE ("Etil-T-Butil-Etere") and bioethanol, jointly with the introduction in the classification of the passenger cars subsector "E85"; the revision and correction of parameters related to natural gas passenger cars user defined categories for the whole time series; the correction of VOC hot emission factors for urban CNG buses EEV; the update of fuel consumption factors for gasoline 0.8 – 1.4 l passenger cars according to the presence of city cars having engine <1.2 l; the update of heavy metals apparent fuel content factors; a global revision of bugs in the database; a general fuel balancing aimed at the reduction of mileage of old vehicles in favour of the recent ones, producing a significant effect on gasoline vehicles, in particular on mopeds and motorcycles and so, as regards greenhouse gases, on CH_4, as a consequence of the general effect on VOC.

The most recent update of the software is COPERT 4, version 10.0 (EMISIA SA, 2012). This is a user-friendly version that upgraded the methodology and the software, and it has been used to estimate emissions since 2013 submission determining a recalculation of emission estimates, producing changes mainly regarding, among greenhouse gases, methane and nitrous oxide emission estimated values, with respect to the previous submissions.
The updating to version COPERT 4 version 10.0 introduces important elements such as a new subsector classification of gasoline and diesel passenger cars, updated emission factors of Euro 5 and Euro 6 diesel passenger cars, updated emission factors for mopeds, updated methane emission factors for gasoline passenger cars, a new CNG subsector for passenger cars.
The updating of the tool also includes a CO_2 correction option for gasoline and diesel passenger cars (update currently not yet used) and a new E85 subsector for passenger cars.
In addition to the changes introduced by the previous submission related to the different classification used for input fleet data (MIT instead of ACI data) and to the introduction of CNG passenger cars categories (subsectors: Natural Gas <1.4l; Natural Gas 1.4 – 2.0l; Natural Gas >2.0l), in 2014 submission the passenger cars subsectors “Gasoline <0.8 l” (information available only for 2012), “Diesel <1,4 l”, “E85”, “Hybrid Gasoline” (data available from 2007 onwards), have been introduced.

As regards evaporative emissions, an update in both the methodology and the emission factors has been implemented in the version 10.0 of the software, used from 2013. Compared to the previous versions of the model, the effect of (activated carbon) degradation, an updated parking table (extending over several days), a trip distribution (prior to parking), updated permeation factors, and other minor updates and corrections have been introduced.

Differences between the 2014 and previous submission in the total road transport GHG emissions, account for -0.02% in 1990 and -0.4% in 2011. In 1990 carbon dioxide values are the same and in 2011 show a difference of -0.3%. As regards methane discrepancies vary from 0.1% in 1990 to -18.0% in 2011; emissions of nitrous oxide show a decrease of about -2.4% both in 1990 and in 2011.

3.5.3.6 Source-specific planned improvements

Improvements for the next submission will be connected to the possible new availability of data and information regarding activity data, calculation factors and parameters, new developments of the methodology and the update of the software.

3.5.4 Navigation

3.5.4.1 Source category description

This source category includes all emissions from fuels delivered to water-borne navigation.
Mainly CO_2 emissions derive from this category, whereas CH_4 and N_2O emissions are less important.
Emissions from navigation constituted 4.7% of the total GHG in the transport sector in 2012 and about 1% of the national total. Considering CO_2 only, emissions from navigation are 1.3% out of the national CO_2 emissions. GHG emissions decreased by 9.9% from 1990 to 2012, because of the reduction in fuel consumed in harbour and navigation activities although the increase in the number of movements.
Navigation is a key category with respect to CO_2 emissions in level with Tier1.

3.5.4.2 Methodological issues

Emissions of the Italian inventory from the navigation sector are carried out according to the IPCC Guidelines and Good Practice Guidance (IPCC, 1997; IPCC, 2000) and the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2007). In particular, a national methodology has been developed following the EMEP/CORINAIR Guidebook which provides details to estimate emissions from domestic navigation, specifying recreational craft, ocean-going ships by cruise and harbour activities; emissions from international navigation are also estimated and included as memo item but not included in national totals (EMEP/CORINAIR, 2007). Inland, coastal and deep-sea fishing are estimated and reported under 1.A.4.c.

The methodology developed to estimate emissions is based on the following assumptions and information. Activity data comprise both fuel consumptions and ship movements, which are available in different level of aggregation and derive from different sources as specified here below:

- Total deliveries of fuel oil, gas oil and marine diesel oil to marine transport are given in national energy balance (MSE, several years [a]) but the split between domestic and international is not provided;
- Naval fuel consumption for inland waterways, ferries connecting mainland to islands and leisure boats, is also reported in the national energy balance as it is the fuel for shipping (MSE, several years [a]);
- Data on annual arrivals and departures of domestic and international shipping calling at Italian harbours are reported by the National Institute of Statistics in the statistics yearbooks (ISTAT, several years [a]) and Ministry of Transport in the national transport statistics yearbooks (MIT, several years).

As for emission and consumption factors, figures are derived by the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2007), both for recreational and harbour activities and national cruise, taking into account national specificities. These specificities derive from the results of a national study which, taking into account detailed information on the Italian marine fleet and the origin-destination movement matrix for the year 1997, calculated national values (ANPA, 2001; Trozzi et al., 2002 [b])) on the basis of the default emission and consumption factors reported in the EMEP/CORINAIR guidebook.

National average emissions and consumption factors were therefore estimated for harbour and cruise activities both for domestic and international shipping from 1990 to 1999. In 2009 submission, as in the case of aviation, the study was updated for the years 2004, 2005 and 2006 in order to consider most recent trends in the maritime sector both in terms of modelling between domestic and international consumptions and improvements of operational activities in harbour (TECHNE, 2009). On the basis of the results, national average emissions and consumption factors were updated from 2000.
Specifically, for the years referred to in the surveys, the current method estimates emissions from the number of ships movements broken down by ship type at each of the principal Italian ports, considering the information of whether the ship movement is international or domestic, the average tonnage and the relevant distance travelled.
For those years, in fact, figures on the number of arrivals, destination, and fleet composition have been provided by the local port authorities and by the National Institute of Statistics (ISTAT, 2009), covering about 90% of the official national statistics on ship movements for the relevant years. Consumption and emission factors are those derived from the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2007) and refer to the specified Tier 3 ship movement methodology that takes into account origin-destination ship movements matrices as well as technical information on the ships, as engine size, gross tonnage of ships and operational times in harbours. On the basis of sample information, estimates have been carried out at national level for the relevant years considering the official statistics of the maritime sector.
In general, to carry out national estimates of greenhouse gases and other pollutants in the Italian inventory for harbour and domestic cruise activities, consumptions and emissions are calculated for the complete time series using the average consumption and emission factors multiplied by the total number of movements. On the other hand, for international cruise, consumptions are derived by difference from the total fuel consumption reported in the national energy balance and the estimated values as described above and emissions are therefore calculated.
The fuel split between national and international fuel use in maritime transportation is then supplied to the Ministry of the Economical Development to be included in the official international submission of energy statistics to the IEA in the framework of the Joint Questionnaire OECD/Eurostat/IEA compilation together with other energy data. A discrepancy with the international bunkers reported to the IEA still remains, especially for the nineties, because the time series of the energy statistics to the IEA are not updated

3.5.4.3 *Uncertainty and time-series consistency*

The combined uncertainty in CO_2 emissions from maritime is estimated to be about 4% in annual emissions; a higher uncertainty is calculated for CH_4 and N_2O emissions on account of the uncertainty levels attributed to the related emission factors.

Estimates of fuel consumption for domestic use, in the national harbours or for travel within two Italian destinations, and bunker fuels used for international travels are reported in Table 3.30. Time series of domestic GHG emissions for waterborne navigation are also shown in the same table.

An upward trend in emission levels is observed from 1990 to 2000, explained by the increasing number of ship movements. Nevertheless, the operational improvements in harbour activities and a reduction in ship domestic movements inverted the tendency in the last years.

Table 3.30 Marine fuel consumptions in domestic navigation and international bunkers (Gg) and GHG emissions from domestic navigation (Gg CO_2 eq.)

	1990	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Gasoline for recreational craft (Gg)	182	210	213	199	199	199	189	179	169	149	99
Diesel oil for inland waterways (Gg)	20	23	20	25	24	23	22	22	18	22	25
Fuels used in domestic cruise navigation (Gg)	778	706	811	740	709	673	670	650	725	678	709
Fuel in harbours (dom+int ships) (Gg)	748	693	818	759	727	690	687	667	744	696	727
Fuel in international Bunkers (Gg)	1,398	1,286	1,333	2,203	2,369	2,468	2,685	2,309	2,219	2,288	1,798
CO_2 (Gg)	5,420	5,117	5,842	5,403	5,204	4,970	4,914	4,762	5,195	4,844	4,890
CH4 (Gg CO2 eq.)	29	32	32	29	28	27	25	24	24	21	17
N2O (Gg CO2 eq.)	39	37	43	40	38	36	36	35	39	36	37

Source: ISPRA elaborations

3.5.4.4 *Source-specific QA/QC and verification*

Basic data to estimate emissions are reconstructed starting from information on ship movements and fleet composition coming from different sources. Data collected in the framework of the national study from the local port authorities, carried out in 2009 (TECHNE, 2009), were compared with the official statistics supplied by ISTAT, which are collected from maritime operators with a yearly survey and communicated at international level to EUROSTAT. Differences and problems were analysed in details and solved together with ISTAT experts. Different sources of data are usually used and compared during the compilation of the annual inventory.

Besides, time series resulting from the recalculation have been presented to the national experts in the framework of an ad hoc working group on air emissions inventories. The group is chaired by ISPRA and includes participants from the local authorities responsible for the preparation of local inventories, sectoral experts, the Ministry of Environment, Land and Sea, and air quality model experts. Top-down and bottom-up approaches have been compared with the aim to identify the potential problems and future improvements to be addressed. There is also an ongoing collaboration and data exchange with regional environmental agencies on this issue.

3.5.4.5 Source-specific recalculations

In 2014 submission, a verification of activity data from different sources was undertaken. The update of the number of ship movements for 2010 and 2011 resulted in an update of fuel consumption for both domestic and international navigation.
The recalculations affected CO_2, CH_4 and N_2O emissions and accounted for variations of +0.02% and -0.59% of GHG emissions respectively in 2010 and 2011, with respect to the previous submission.

3.5.4.6 Source-specific planned improvements

Further improvements will regard a verification of activity data on ship movements and emission estimates with regional environmental agencies, especially with those more affected by maritime pollution.

3.5.5 Other transportation

3.5.5.1 Source category description

This source category includes all emissions from fuels delivered to the transportation by pipelines and storage of natural gas.
Mainly CO_2 emissions derive from this category, as well as the other relevant pollutants typical of a combustion process, such as SO_X, NO_X, CO and PM. Also CH_4 and N_2O emissions are estimated and included in the inventory.
This category is not a key category.

3.5.5.2 Methodological issues

Emissions from pipeline compressors are carried out according to the IPCC Guidelines and are estimated on the basis of natural gas fuel consumption used for the compressors and the relevant emission factors. The amount of fuel consumption is estimated on the basis of data supplied for the whole time series by the national operators of natural gas distribution (SNAM, several years; STOGIT, several years) and refers to the fuel consumption for the gas storage and transportation; this consumption is part of the fuel consumption reported in the national energy balance in the consumption and losses sheet (MSE, several years). Emission factors are those reported in the EMEP/EEA Guidebook for gas turbines (EMEP/CORINAIR, 2007), except for CO_2 for natural gas which is the country specific value used for the whole energy sector reported in Table 3.12. Emissions communicated by the national operators in their environmental reports are also taken into account to estimate air pollutants.

3.5.5.3 Uncertainty and time-series consistency

The combined uncertainty is estimated to be about 6% in annual emissions; a higher uncertainty is calculated for CH_4 and N_2O emissions on account of the uncertainty levels attributed to the related emission factors.
Fluctuations and time series are driven both by the general trend of total natural gas fuel consumed (and transported) and by the annual fluctuation of the storage activities, which are driven by the price fluctuation of the natural gas.
Natural gas fuel consumption for pipeline compressors increased from 7,359 TJ in 1990 to 12,436 TJ in 2012 with a peak of 19,098 TJ in 2010. GHG emissions follow the same trend of fuel consumption.

3.5.5.4 Source-specific QA/QC and verification

Basic data to estimate emissions are reconstructed starting from information on fuel consumptions coming from different sources. Fuel consumptions reported by the national operators for this activity are compared with the amount of natural gas internal consumption and losses reported in the energy balance. Starting from the length of pipelines, the average energy consumptions by kilometre are calculated and used for verification of data collected by the operators. Energy consumptions and emissions by kilometre calculated on the basis of data supplied by the main national operator (SNAM, several years) are used to estimate the figures for the other operators when their annual data are not available.

3.5.5.5 Source-specific recalculations

No recalculations were performed in this submission.

3.5.5.6 Source-specific planned improvements

No further improvements are planned.

3.6 Other sectors

3.6.1 Sector overview

In this paragraph sectoral emissions are reported, which originate from energy use in the civil sector included in category 1.A.4. Commercial, institutional, residential, agriculture/fisheries, and emissions from military mobile activities which are also included in category 1.A.5. All greenhouse gases as well as CO, NOx, NMVOC and SO_2 emissions are estimated.
In 2012, energy use in other sectors account for 21.2% of CO_2 emissions, 3.4% of CH_4, 7.3%of N_2O emissions. In term of CO_2 equivalent, other sectors share 18.6% of total national greenhouse gas emissions and 22.5% of total GHG emissions of the energy sector.

The trends of greenhouse gas emissions are summarised in Table 3.31. Emissions are reported in Gg for CO_2, and in Mg for CH_4 and N_2O. An increase in emissions is observed from 1990 to 2000, due to increase in activity data (numbers and size of building with heating); a sharp increase can be observed in 2005 due to exceptionally cold weather conditions. CH_4 and N_2O emissions increase in the period due to the growing use of woody biomass and biogas for heating.

Table 3.31 Trend in greenhouse gas emissions from the other sectors, 1990-2012

GAS/SUBSOURCE	1990	1995	2000	2005	2008	2009	2010	2011	2012
CO_2 (Gg)									
1.A.4.a Commercial/ Institutional	16,144	17,197	20,407	26,137	27,783	28,399	30,585	27,799	27,729
1.A.4.b Residential	52,118	50,103	50,159	57,339	49,741	51,014	52,786	47,838	47,268
1.A.4.c Agriculture/ Forestry/ Fisheries	8,372	8,747	8,030	8,371	7,593	7,679	7,261	7,120	6,814
1.A.5 Other (Not elsewhere specified)	1,046	1,440	806	1,198	738	844	627	495	326
CH_4 (Mg)									
1.A.4.a Commercial/ Institutional	1,129	1,390	2,301	3,435	4,052	4,148	4,369	4,549	4,517
1.A.4.b Residential	18,854	26,177	28,000	31,033	37,809	40,264	44,410	44,711	50,567
1.A.4.c Agriculture/ Forestry/ Fisheries	1,269	947	2,449	2,616	3,662	3,964	2,557	2,780	1,076
1.A.5 Other (Not elsewhere specified)	173	223	126	160	74	73	65	52	28
N_2O (Mg)									
1.A.4.a Commercial/ Institutional	427	500	697	981	1,082	1,123	1,219	1,199	1,170
1.A.4.b Residential	1,854	2,081	2,162	2,399	2,547	2,667	2,865	2,798	3,036

GAS/SUBSOURCE	1990	1995	2000	2005	2008	2009	2010	2011	2012
1.A.4.c Agriculture/ Forestry/ Fisheries	2,520	2,756	2,687	2,772	2,591	2,630	2,450	2,415	2,246
1.A.5 Other (Not elsewhere specified)	225	215	135	291	199	239	131	98	92

Source: ISPRA elaborations

Six key categories have been identified for this sector for 2012, as for the energy and manufacturing industries, for level and trend assessment, using both the IPCC Approach 1 and Approach 2:

CO_2 Stationary combustion liquid fuels (L, T);
CO_2 Stationary combustion solid fuels (L, T);
CO_2 Stationary combustion gaseous fuels (L, T);
CO_2 Stationary combustion other fuels (L1, T1);
N_2O Stationary combustion (L, T2);
CH_4 Stationary combustion (T2).

All these categories are also key category including the LULUCF estimates in the key category assessment; see paragraph 3.1 for further details.
CH_4 and N_2O for stationary combustion are key categories especially for the increasing use of woody biomass for heating.

3.6.2 Source category description

The CRF Table 1.A(a)s4 comprises four sources: 1.A.4.a. Commercial/ Institutional, 1.A.4.b. Residential, 1.A.4.c. Agriculture/ Forestry/ Fisheries and 1.A.5 Other (Not elsewhere specified).
The estimation procedure follows that of the basic combustion data sheet. Emissions are estimated from the energy consumption data and the emission factor illustrated in Table 3.12.
Emissions from off-road sources are estimated and they are reported under the relevant sectors, i.e. Other Industry, Residential, Agriculture and Other Transport. The methodology of these estimates is discussed in the next paragraph 3.6.3 *Others.*

Commercial/ Institutional
Emissions from this sector arise from the energy used directly in the institutional, service and commercial buildings, mainly for heating. Additionally this category includes all emissions due to the non-renewable part of wastes used in electricity generation.
In the other fuel sub category, the amount of fossil waste burnt in incinerators with energy recovery is reported. Biomass refers to the consumption of biomass waste, biogas recovered for energy purposes from landfill and sludge treatments and wood and steam wood; from 2002 to 2005 minor amounts of biodiesel fuel consumption are also included. In Table 8.12 in the waste sector chapter the amount of waste and biogas fuel consumptions for 2012 are reported.
In 2012, this sector has a share of 6.1% of total GHG national emissions.

Residential
Emissions from this sector arise from the energy used directly in residential buildings, mainly for heating. The sector includes emission from off-road household and gardening machinery.
Biomass refers to wood and steam wood fuel consumption; from 2002 to 2005 it also includes minor amount of biodiesel fuel consumptions.
In 2012, this sector has a share of 10.8% of total GHG national emissions.

Agriculture/ Forestry/ Fisheries
This subsector include all emissions due to the direct fossil fuel use in agriculture, mainly to produce mechanical energy, the fuel use in fisheries and for the machinery used in the forestry sector.
Biomass refers to the consumption of wood fuel and biogas recovered for energy purposes from the storage of animal manure and agriculture residuals.
In 2012, this sector has a share of 1.7% of total GHG national emissions.

Others
Emissions from military aircraft and naval vessels are reported under 1A.5.b Mobile.
The methods of estimation are discussed in paragraphs 3.5.1 and 3.5.4 for aviation and maritime respectively.
In 2012, this sector has a share of 0.1% of total GHG national emissions.

3.6.3 Methodological issues

For this sector, energy consumptions are reported in the BEN (see Annex 5, Tables A5.9 and A5.10, in physical units, row "DOMESTIC AND COMMERCIAL USES", subtracting the quantities for military use in diesel oil and off-road uses in petrol). The BEN does separate energy consumption between civil and agriculture-fisheries, but it does not distinguish between Commercial – Institutional and Residential.
The total consumption of each fuel is therefore subdivided between commercial and residential on the basis of the estimations reported by ENEA in its annual energy report (ENEA, several years).
Emissions from 1.A.4.b Residential and 1.A.4.c Agriculture/Forestry/Fishing are disaggregated into those arising from stationary combustion and those from off-road vehicles and other machinery. The estimation of emissions from off-road sources is discussed in this paragraph in the following. Emissions from fishing vessels are estimated from fuel consumption data (MSE, several years [a]). Emission factors are shown in Table 3.12.
In the solid fuel sub category, the following fuels are included: steam coal, coke oven coke and gas work gas. Since eighties there has been a sharp reduction in the use of these fuels due to air quality national legislation (in 1990 they accounted for about 1.1 % of total energy consumption of 1.A.4 category) and a further decrease is observed between 1997 and 1998 in consequence of the banning of coal used in residential heating in urban areas.
CH_4 emission factors used are those reported in the 1996 CORINAIR handbook, vol.1, for coal, equal to 200 kg/TJ (EMEP/CORINAIR, 1996), and in the EMEP/CORINAIR Guidebook for coke oven coke, equal to 15 kg/TJ which is the maximum value of emission factor for solid fuels without specification, and gas work gas, equal to 5 kg/TJ assuming the maximum value for natural gas (EMEP/CORINAIR, 2007).
For liquid fuel, the average emission factors are driven by the mix of fuel consumptions used in heating boilers, prevalently LPG, but also gasoil and fuel oil which was used especially in the past.
For these fuels we use the respective CH_4 emission factors: LPG 1 kg/TJ, fuel oil 3 kg/TJ and gasoil 7 kg/TJ.
Regarding natural gas, the country specific CH_4 emission factor is equal to 2.5 kg/TJ.
All these emission factors have been calculated on the basis of the default and range emission factors published in the Guidebook EMEP/CORINAIR taking into account country specific circumstances by means of the type of boilers where these fuels are burnt. In the following box the default emission factors reported in the Guidebook EMEP/CORINAIR are shown.

Liquid fuel CH_4 default emission factor(kg/TJ) (EMEP/CORINAIR, 2007)

Fuel	Default EF	Range	National EF
LPG	-	1 - 2.5	1
Gasoil	0.6	0.1 - 8	7
Fuel oil	1.6	0.1 - 10	3
Natural gas	1.2	0.3 - 4	2.5

Average implied emission factors for other fuels, fossil waste, vary on an annual basis as a consequence of the mix of wastes used in incinerators, such as urban wastes, industrial, hospital, and oil wastes. In 2012 CO_2, CH_4 and N_2O average emission factors were equal to 111.4 kg/GJ, 6.4 kg/TJ and 10.7 kg/TJ respectively.
Regarding biomass fuel consumption in the following box CO_2, CH_4 and N_2O emission factors used in the national inventory for the different type of fuels are reported.

Biomass CH_4 and N_2O emission factor for 2012 (kg/TJ)

Fuel	CH_4	N_2O
Wood	320	14
Biogas	153	3
Waste	6	11
Biodiesel	12	2

Others

In this paragraph, the methodology used to estimate emissions from a range of portable or mobile equipment powered by reciprocating diesel or petrol driven engines is summarized. They include agricultural equipment such as tractors and combined harvesters; construction equipment such as bulldozers and excavators; domestic lawn mowers; aircraft support equipment; and industrial machines such as portable generators and compressors. In the CORINAIR inventory, they are grouped into four main categories (EMEP/CORINAIR, 2007):

- domestic house & garden
- agricultural power units (includes forestry)
- industrial off-road (includes construction and quarrying)
- aircraft support.

Those categories are mapped to the appropriate IPCC classes: Aircraft support is mapped to Other Transport and the other categories map to the off-road vehicle subcategories of Residential, Agriculture and Manufacturing Industries and Construction.

Estimates are calculated using a modification of the methodology given in EMEP/CORINAIR (EMEP/CORINAIR, 2007). This involves the estimation of emissions from around seventy classes of off-road source using the following equation for each class:

$$Ej = Nj \cdot Hj \cdot Pj \cdot Lj \cdot Wj \cdot (1 + Yj \cdot aj /2) \cdot ej$$

where

Ej = Emission of pollutant from class j (kg/y)
Nj = Population of class j
Hj = Annual usage of class j (hours/year)
Pj = Average power rating of class j (kW)
Lj = Load factor of class j (-)
Yj = Lifetime of class j (years)
Wj = Engine design factor of class j (-)
aj = Age factor of class j (y^{-1})
ej = Emission factor of class j (kg/kWh)

For gasoline engine sources, evaporative NMVOC emissions are also estimated as:

$$Evj = Nj \cdot Hj \cdot evj$$

where

Evj = Evaporative emission from class j kg
evj = Evaporative emission factor for class j kg/h

Population data have been revised based on a survey of machinery sales (Frustaci, 1999). Machinery lifetime is estimated on the European averages, see EMEP/CORINAIR (EMEP/CORINAIR, 2007), the annual usage data were taken either from industry or published data (EEA, 2000). The emission factors used came mostly from EMEP/CORINAIR and from Samaras (EEA, 2000). The load factors were taken from Samaras (EEA, 2000).

It was possible to calculate fuel consumptions for each class based on fuel consumption factors given in EMEP/CORINAIR (EMEP/CORINAIR, 2007). Comparison with known fuel consumption for certain groups of classes (e.g. agriculture and construction) suggested that the population method overestimated fuel consumption by factors of 2-3, especially for industrial vehicles.

Estimates were derived for fuel consumptions for the years 1990-2012 for each of the main categories:

A. Agricultural power units: Data on gas oil consumption were taken from ENEA (ENEA, several years). The consumption of gasoline was estimated using the population method for 1995 without correction. Time series is reconstructed in relation to the fuel used in agriculture.
B. Industrial off-road: The construction component of the gas oil consumption was calculated from the Ministry of Production Activities data (MSE, several years [a]) on buildings and constructions. The industrial component of gas oil was estimated from the population approach for 1995. Time series is reconstructed in relation to the fuel use in industry.
C. Domestic house & garden: gasoline and diesel oil consumption were estimated from the EMEP/CORINAIR population approach for 1995. Time series is reconstructed in relation to the fuel use in agriculture.

Emissions from off-road sources are particularly uncertain. The revisions in the population data produced higher fuel consumption estimates. The gasoline consumptions increased markedly but they are still only a tiny proportion of total gasoline sales.

3.6.4 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions in "Other sectors" is estimated to be about 4% in annual emissions; a higher uncertainty is calculated for CH_4 and N_2O emissions on account of the uncertainty levels attributed to the related emission factors.
Montecarlo analysis has been carried out to estimate uncertainty of CO_2 emissions from stationary combustion of solid, liquid and gaseous fuels emissions, resulting in 5.1%, 3.3% and 5.8%, respectively. Normal distributions have been assumed for all the parameters. A summary of the results is reported in Annex 1.

Estimates of fuel consumption used by other sectors in 2012 are reported in Annex 5, Tables A5.9 and A5.10, in physical units, row "DOMESTIC AND COMMERCIAL USES". Time series of the other sectors energy consumption data are contained in the BEN time series and reported in Table 3.32.

Table 3.32 Trend in fuel consumption for the other sector, 1990-2012 (TJ)

	1990	1995	2000	2005	2008	2009	2010	2011	2012
					TJ				
1.A.4a.Commercial Institutional	267,848	295,625	357,283	460,231	483,547	497,408	535,848	497,643	496,847
1.A.4b. Residential	882,091	901,054	919,788	1,067,011	945,107	974,853	1,022,123	945,087	954,659
1.A.4c.AgricultureForestry Fisheries	114,964	121,138	117,029	123,208	115,832	118,109	108,465	107,864	98,880
1.A.5 Other	14,830	20,800	11,587	16,935	10,411	11,898	8,995	7,110	4,594

Source: ISPRA elaborations

In the following Table 3.33, total GHG emissions connected to the use of fossil fuels and waste derived fuels are reported for the whole time series. Total emissions from the sector are reported in Gg for CO_2, and in Mg for CH_4 and N_2O. An increase in emissions is observed from 1990 to 2000, due to increase in activity data (numbers and size of building with heating); a sharp increase can be observed in 2005 due to exceptionally cold weather conditions. CH_4 and N_2O emissions increase in the period due to the growing use of woody biomass for heating.

Table 3.33 Other sectors, GHG emission time series 1990-2011

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
CO_2 (Gg)	77,681	77,487	79,402	93,045	86,968	81,855	85,855	87,937	91,259	83,252	82,138
CH_4 (Mg)	21,425	28,736	32,876	37,244	38,595	43,670	45,598	48,449	51,401	52,092	56,188
N_2O (Mg)	5,025	5,552	5,682	6,443	6,323	6,375	6,419	6,659	6,665	6,511	6,545
GHG (Gg CO_2 eq)	79,688	79,812	81,854	95,824	89,739	84,749	88,802	91,018	94,404	86,364	85,346

Source: ISPRA elaborations

In Table 3.34, other sectors emissions are summarized according to key categories. From 1990 to 2012, an increase in use of natural gas instead of fuel oil and gas oil in stationary combustion plants is observed; it results in a decrease of CO_2 emissions from combustion of liquid fuels and an increase of emissions from gaseous fuels. CH_4 and N_2O emissions increase in the period due to the crescent use of woody biomass for heating.

Table 3.34 Other sectors, GHG emissions in 1990 and 2012

		1990	2012
CO_2 stationary combustion liquid fuels	Gg	39,817	16,394
CO_2 stationary combustion solid fuels	Gg	920	12
CO_2 stationary combustion gaseous fuels	Gg	36,418	61,843
CO_2 stationary combustion other fuels	Gg	526	3,888
CH_4 stationary combustion	Mg	21,425	56,188
N_2O stationary combustion	Mg	5,025	6,545

Source: ISPRA elaborations

3.6.5 Source-specific QA/QC and verification

Basic data to estimate emissions are reported by national energy balance and the national grid administrator (for the waste used to generate electricity).
The energy data used to estimate emissions reported in table 1.A.2 have different levels of accuracy:

- the overall sum of residential and institutional/service/commercial energy consumption is quite reliable and their uncertainty is the same of the BEN; the quantities of fuels used for those economic sector are routinely reported by main suppliers and the data are well documented.
- the energy consumption for agriculture and fisheries is also routinely reported by energy statistics and the underlying data are quite reliable because the energy use for those sector has special taxation regimes and they are accounted for separately.
- The energy use for military and off roads is instead partly reported and partly estimated with models, as described in paragraph 3.6.3 others.

3.6.6 Source-specific recalculations

CO_2 emission factors have been updated for 2011 for natural gas. Energy recovery from waste reported in the commercial heating has been updated from 2010 as a consequence of the activity data update; further details are reported in the waste chapter.
The recalculation affected only slightly emissions with differences equal to -0.4% in 2011 for CO_2, -0.02 for CH_4 and -0.25 for N_2O emissions with respect to the previous submission.

3.6.7 Source-specific planned improvements

No specific improvements are planned for the next submission.

3.7 International bunkers

The methodology used to estimate the quantity of fuels used from international bunkers in aviation and maritime navigation has been illustrated in the relevant transport paragraphs, 3.5.1 and 3.5.4.
The methodology implements the IPCC guidelines according to the available statistical data.

3.8 Feedstock and non-energy use of fuels

3.8.1 Source category description

In Table 3.35 and 3.36 detailed data on petrochemical and other non-energy use for the year 2012 are given. The tables refer to all products produced starting from fossil fuels, solid, gas or liquid, and used for "non energy" purposes. A national methodology is used for the reporting and estimation of avoided emissions.

3.8.2 Methodological issues

Data are based on a detailed yearly report available by Ministry of Economic development (MSE, several years [b]). The report summarizes answers from a detailed questionnaire that all operators in Italy fill out monthly. The data are more detailed than those normally available are by international statistics and refer to:

- input to plants (gross input);
- quantities of fuels returned to the market (with possibility to estimate the net input);
- fuels used internally for combustion;
- quantities stored in products.

National energy balances include only the input and output quantities from the petrochemical plants; so in the petrochemical transformation process the output quantity could be greater than the input quantity, in particular for light products as LPG, gasoline and refinery gas, due to chemical reactions. Therefore it is possible to have negative values for some products (mainly gasoline, refinery gas, fuel oil). For this matter, for the reporting on CRF tables, these fuels have been added to naphtha.
The quantities of fuels stored in products, in percentage on net and gross petrochemical input, are estimated with these data, see Table 3.36 for details by product and Table 3.35 for the overall figure. Specifically, the amount of quantity stored in products for each fuel is calculated as the difference between input (petrochemical input) and output (returns to refinery and internal consumption and losses); carbon stored is therefore calculated from the amounts of fuels stored (in tonnes) multiplied by the emission factors (tC/t) reported in Table 3.36.
Non-energy products quantity amount stored from refineries are reported in the BEN and the carbon stored is estimated with emission factors reported in Table 3.37. For lubricants the net carbon stored results from the difference between the amount of lubricants and the amount of recovered lubricant oils.
In response to previous review recommendation, in the CRF tables the "gross" fuel input amount is reported so that the fractions of carbon oxidized could be derived. As these fractions are derived from actual measurements they do not correspond to any default values and may vary over time.
As can be seen from the value reported for the year 2012, there is a sizeable difference of the estimated quantities of fuel stored in product if reference is made to "net" or "gross" input. Moreover the estimation of quantities stored in products are quite different from those reported in the Revised 1996 IPCC Guidelines for National GHG Inventories, Reference Manual, ch1, tables 1-5 (IPCC, 1997).

An attempt was made to estimate the quantities stored in products using IPCC percentage values (tables 1-5 of the IPCC Guidelines) and the amount of fuels reported as "petrochemical input" in Table 3.36. The resulting estimate of about 4,792 Gg of products, for the year 2012, is almost 50% bigger than the quantities reported, 3,174 Gg.

Table 3.35 Other non-energy uses, year 2011

Breakdown of total petrochemical flow

	Petrochemical Input	Returns to refinery/market	Internal consumption / losses	Quantity stored in products
ALL ENERGY CARRIERS, Gg	7,528	2,508	1,846	3,174
% of total input		33.3%	24.5%	42.2%
% of net input			36.8%	63.2%

Source: ISPRA elaborations

Table 3.36 Petrochemical, detailed data from MSE, year 2011 (MSE, detailed petrochemical breakdown)

FUEL TYPE	Petroch. Input	Returns to refinery/ market	Internal consumption / losses	Quantity stored in products	% on gross input	% on net input	Emission factor (IPCC)
	Gg	Gg	Gg	Gg			t C / t
LPG	523	519	10	-6			0.8137
Refinery gas	42	34	719	-711			0.8549
Virgin naphtha	4,008	0	0	4,008			0.8703
Gasoline	707	1,144	6	-443			0.8467
Kerosene	617	506	0	111			0.8485
Gas oil	339	152	0	187			0.8569
Fuel oil	321	93	215	13			0.8678
Petroleum coke	0	0	0	0			0.9550
Others (feedstock)	124	60	49	15			0.8368
Losses			0	0			0.8368
Natural gas	847	0	847	0			0.7537
total	7,528	2,508	1,846	3,174	42%	63%	

Source: ISPRA elaborations

Table 3.37 Other non-energy uses, year 2011, MSE several years [a]

NON ENERGY FROM REFINERIES	Quantity stored in products	Energy content IPCC '96	Emission factor	Total energy content, IPCC values
	Gg		t C / t	TJ
Bitumen + tar	2,748	40.19	0.8841	110.4
lubricants	1,208	40.19	0.8038	48.5
recovered lubricant oils	168	40.19	0.8038	6.8
paraffin	81	40.19	0.8368	3.3
others (benzene, others)	968	40.19	0.8368	38.9
Totals	5,173			207.9

Source: ISPRA elaborations

At national level, this methodology seems the most precise according to the available data. The European Project "Non Energy use-CO_2 emissions" ENV4-CT98-0776 has analysed our methodology performing a mass balance between input fuels and output products in a sample year. The results of the project confirm the reliability of the reported data (Patel and Tosato, 1997).

With reference to the data of Table 3. 37, non-energy products are mainly outputs of refineries. The estimate refers to quantities produced that are reported by manufacturers and summarized by BEN. The data should not be controversial.

Minor differences in the overall energy content of these products occur if the calculation is based on national data or IPCC default values.

3.8.3 Uncertainty and time-series consistency

In Annex 4 the time series for comparison between reference and sectoral approach are reported showing percentage differences in a limited range.

3.8.4 Source-specific QA/QC and verification

Basic data to estimate emissions are directly reported to ISPRA by MSE. The energy data used to estimate emissions have a high level of accuracy because they summarize the results of a 100% legally binding monthly survey of all the concerned operators.

3.8.5 Source-specific recalculations

Recalculations have been performed from 2009 to 2011 to update some activity data and emission factors.
In particular, waste activity data have been updated from 2009 to 2011, international bunkers activity data for gasoil and fuel oil for 2010 and 2011, solid biomass for 2011.
Besides CO_2 emission factor for natural gas has been updated for 2011.

3.8.6 Source-specific planned improvements

No specific improvements are planned for the next submission.

3.9 Fugitive emissions from solid fuels, oil and natural gas

3.9.1 Source category description

Fugitive emissions of GHG arise during the stages of fuel production, from extraction of fossil fuels to their final use. Emissions are mainly due to leaks or other irregular releases of gases from the production and transformation of solid fuels, the production of oil and gas, the transmission and distribution of gas and from oil refining.
Solid fuels category implies mainly methane emissions, while oil and natural gas categories include carbon dioxide and nitrous oxide too.
In 2012, GHG emissions from this source category account for 1.9% out of the total emissions in the energy sector. Trends in fugitive emissions are summarised in Table 3.44.

The results of key category analysis are shown in the following box.

Key-category identification in the fugitive sector with the IPCC Approach 1 and Approach 2

Year		**IPCC category**	**without LULUCF**	**with LULUCF**
2012	CH_4	Fugitive emissions from oil and gas operations	L, T	L1,T
	CO_2	Fugitive emissions from oil and gas operations	L1, T2	L1
1990	CH_4	Fugitive emissions from oil and gas operations	L	L
	CO_2	Fugitive emissions from oil and gas operations	L	L1

Excluding LULUCF, methane emissions from oil and gas operations are a key category according to the level and trend assessment with Approach 1 and Approach 2, while CO_2 emissions are key category only for the level with Approach 1 and trend with Approach 2. Considering LULUCF methane emissions are key category for level with Approach 1 and trend assessment with Approach 1 and Approach 2, while CO_2 emissions are key category only for the level with Approach 1.
As concerns the level for the year 1990, CH_4 emissions from oil and gas operations are key categories, either including or excluding LULUCF emissions and removals following both the Approaches, while and CO_2 emissions are key categories only for Approach 1.

Fugitive CH_4 and CO_2 emissions reported in 1.B.1 refer to coal mining for only two mines with very low production in the last ten years. One mine is underground and produces coal and the other one, a surface mine, produces lignite. The underground mine stopped the extraction activities between 1994 and 1999, whereas the surface mine stopped the activity in 2001. CH_4 emissions from solid fuel transformation refer to fugitive emission from coke production in the iron and steel industry, which is also decreasing in the last years. N_2O emissions from 1.B.1 are not occurring.

Fugitive CO_2 emissions reported in 1.B.2 refer prevalently to fugitive emissions in refineries during petroleum production processes, e.g. fluid catalytic cracking and sulphur recovery plants and flaring, but include also emissions from the exploration, production, transport and distribution of oil and natural gas.
CH_4 emissions reported in 1.B.2 refer mainly to the production of oil and natural gas and to the transmission in pipelines and distribution of natural gas, while N_2O emissions refer to flaring in the production of oil and natural gas and in refineries and emission from exploration.

For the completeness of the related CRF tables, in particular 1.B.2, the rationale behind the reporting is explained below.
N_2O emissions in refining and storage are reported under flaring in refineries. According to Tier 1 and default EFs from the GPG 2000, CO_2 and CH_4 emissions from venting in gas production are included in fugitive emissions from gas production and reported under gas production. CO_2 and CH_4 emissions from other leakage are accounted for in the sectors where they occur.
A summary of the completeness of $CO_{2,}$ CH_4 and N_2O fugitive emissions is shown in the following Table 3.38.

Table 3.38 Completeness of CO_2, CH_4 and N_2O fugitive emissions

1.B. 2.a. Oil		
iv. Refining/storage	N_2O	Included in 1.B.2.d flaring in refineries
1.B.2.b. Natural Gas		
v. Other leakage	$CO_{2,}CH_4$	Included in 1.A.1/1.A.2/1.A.4
1.B.2.c. Venting		
ii. Gas	$CO_{2,}CH_4$	Included in 1.B.2.b.ii production

3.9.2 Methodological issues

CH_4 emissions from coal mining have been estimated on the basis of activity data published on the National Energy Balance (MSE, several years [a]) and emission factors provided by the IPCC guidelines (IPCC, 1997). Mining and post mining emissions have been calculated. As concerns CO_2 emissions the calculations have been carried out considering the species profile in coal mine gas by literature data (EMEP/CORINAIR, 2007). The coal gas composition considered is 80% of CH_4 and 6% of CO_2 by volume (Williams, 1993).

CH_4 emissions from coke production have been estimated on the basis of activity data published in the national statistical yearbooks (ISTAT, several years [a]) and emission factors reported in the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2007).

Fugitive emissions from oil refining are estimated starting from the total crude oil losses as reported in the National Energy Balance. Emissions have been reported in the Refining/Storage category (1.B.2.a.iv); they occur prevalently from processes in refineries.
Fugitive emissions from oil transport have been calculated according with the amount of transported oil (MIT, several years) and emission factors published on the IPCC Good practice Guidance (IPCC, 2000).
Most of the crude oil is imported in Italy by shipment and delivered at the refineries by pipelines as offshore national production of crude oil. Table 3.39 provides the length of pipelines for oil and the amount of oil products transported since 1990.

Table 3.39 Length of pipelines for oil transport (km) and amount of transported oil products (Gg)

	1990	1995	2000	2005	2010	2011	2012*
Length of pipelines (km)	4,140	4,235	4,346	4,328	4,291	4,290	4,290
Amount transported (Gg)	94,600	102,274	116,803	133,024	128,854	116,720	114,540

Source: MIT
***provisional values**

Emissions in refineries have been estimated on the basis of activity data published in the National Energy Balance (MSE, several years [a]) or supplied by oil and gas industry association (UP, several years) and operators especially in the framework of the European Emissions Trading Scheme (EU-ETS), and emission factors published on the IPCC Good Practice Guidance (IPCC, 2000).
Fugitive CO_2 emissions in refineries are mainly due to catalytic cracking production processes, sulphur recovery plants, flaring and emissions by other production processes including transport of crude oil and oil products. Emissions are calculated on the basis of the total crude oil losses reported in the National Energy Balance. These emissions are then distributed among the different processes on the basis of average emission factors agreed and verified with the association of industrial operators (UP) and yearly updated, from 2000, on the basis of data supplied by the plants in the framework of the European Emissions Trading Scheme. In particular in the EU-ETS context, refineries report CO_2 emissions for flaring and for processes separately.

In Table 3.40, the time series of crude oil losses published in the BEN and crude oil processed in Italian refineries are shown.

Table 3.40 Refineries activities and losses

	1990	1995	2000	2005	2010	2011	2012
Crude Oil losses (Mg)	1,004	937	757	576	664	658	626
Crude oil processing (Gg)	93,711	91,014	98,003	106,542	94,944	90,705	85,278

Source: MSE, UP

CO_2, CH_4, and N_2O fugitive emissions from oil and natural gas exploration have been calculated according with the number of exploration wells (MSE, several years [c]) and emission factors published on the IPCC Good practice Guidance (IPCC, 2000). Emissions factors for drilling, testing and servicing have been used for productive wells, while only emissions factor for drilling has been used for non productive wells.
CH_4 emissions from the production of oil and natural gas have been calculated according with activity data published on National Energy Balance (MSE, several years [a]), data by oil and gas industry association (UP, several years), data supplied by operators, and emission factors published on the IPCC Good practice Guidance (IPCC, 2000). CH_4 emission factors for the whole time series have been calculated taking into account this information. For CO_2, the IPCC default emission factor has not been modified, as no specific information is available. N_2O emissions from flaring in oil and gas production have been estimated on the basis of activity production data and emission factors reported in the IPCC GPG (IPCC, 2000). As regards the decline of CH_4 IEF for natural gas production and processing, gas companies stated that along the time there has been an increasing awareness to reduce GHG emissions and new emergency management systems have been implemented periodically in order to reduce emissions from venting. Moreover, with the updating of management systems, more accurate methods to estimate vented gas have been adopted by the main gas company at regular intervals.
In Table 3.41, the time series of national production of oil and gas are reported. Natural gas production should further reduce in the next years.

Table 3.41 National production of oil and natural gas

	1990	1995	2000	2005	2010	2011	2012
Oil (Gg)	4,668	5,236	4,586	6,111	5,106	5,309	5,396
Natural gas (Mm^3)	17,296	20,383	16,766	11,962	8,265	8,339	8,511

Source: MSE

CH_4 and CO_2 emissions from the transmission in pipelines and distribution of natural gas have been estimated on the basis of activity data published by industry, the national authority, and information collected annually by the Italian gas operators.

Emission estimates take into account the information on: the amount of natural gas distributed (ENI, several years [a]; SNAM, several years); length of pipelines, distinct by low, medium and high pressure and by type, cast iron, grey cast iron, steel or polyethylene pipelines (AEEG, several years); natural gas losses reported in the national energy balance (MSE, several years [a]); methane emissions reported by operators in their environmental reports (ENI, several years [b]; EDISON, several years; SNAM, several years). CO_2 emissions have been calculated considering CO_2 content in the leaked natural gas.
The average natural gas chemical composition has been calculated from the composition of natural gas produced and imported. Main parameters of mixed natural gas, as calorific value, molecular weight, and density, have been calculated as well. Data on chemical composition and calorific value are supplied by the main national gas providers for domestic natural gas and for each country of origin.
Table 3.42 shows average data for national pipelines natural gas.

Table 3.42 Average composition for pipelines natural gas and main parameters

	1990	1995	2000	2005	2010	2011	2012
HCV (kcal/m$_3$)	9,156	9,193	9,221	9,267	9,331	9,287	9,304
NCV (kcal/m$_3$)	8,255	8,290	8,325	8,360	8,418	8,376	8,393
Molecular weight	17.03	17.19	17.37	17.44	17.46	17.26	17.41
Density (kg/Sm$_3$)	0.72	0.73	0.74	0.74	0.74	0.73	0.74
CH_4 (molar %)	94.30	93.36	92.22	91.93	92.03	93.08	92.16
NMVOC (molar %)	3.45	4.09	4.84	5.35	5.74	5.00	5.48
CO_2 (molar %)	0.22	0.20	0.18	0.49	0.75	0.68	0.61
Other no carbon gas (molar %)	2.03	2.34	2.76	2.24	1.48	1.24	1.75
CH_4 (weight %)	88.83	87.14	85.16	84.53	84.52	86.52	84.89
NMVOC (weight %)	7.33	8.62	10.00	10.73	11.27	9.79	10.81
CO_2 (weight %)	0.57	0.51	0.47	1.23	1.89	1.73	1.54
Other no carbon gas (weight %)	3.27	3.74	4.37	3.51	2.30	1.95	2.76

More in details, emissions are estimated separately for the different phases: transmission in primary pipelines and distribution in low, medium, and high pressure network, losses in pumping stations and in reducing pressure stations (including venting and other accidental losses) with their relevant emission factors, considering also information regarding the length of the pipelines and their type.
Emissions from low pressure distribution include also the distribution of gas at industrial plants and in residential and commercial sector; data on gas distribution are only available at an aggregate level thus not allowing a separate reporting.
In addition, emissions from the use of natural gas in housing are estimated and included. Emissions calculated are compared and balanced with emissions reported by the main distribution operators.
Finally the emission estimates for the different phases are summed and reported in the most appropriate category (transmission/distribution).

Table 3.43 provides the trend of natural gas distribution network length for each pipeline material and the average CH_4 emission factor.

Table 3.43 Length of low and medium pressure distribution network (km) and network emission factors for CH_4

Material	1990	1995	2000	2005	2010	2011	2012
Steel and cast iron (km)	102,061	131,271	141,848	154,886	198,706	197,369	199,637
Grey cast iron (km)	24,164	23,229	21,314	15,080	4,658	4,519	4,414
Polyethylene (km)	775	7,300	12,550	31,530	49,663	51,053	52,335
Total (km)	**127,000**	**161,800**	**175,712**	**201,496**	**253,027**	**252,940**	**256,386**
CH_4 Emission Factors (kg/km)	**1,958**	**1,417**	**1,227**	**995**	**715**	**707**	**672**

More details on the methodology used and on the basic information collected from operators are reported in a technical paper (Contaldi, 1999).

3.9.3 *Uncertainty and time-series consistency*

The uncertainty in CH_4, N_2O and CO_2 emissions from oil and gas operations is estimated to be 25% as a combination of 3% and 25% for activity data and emission factors, respectively.
The uncertainty in methane emissions from coal mining and handling is estimated to be 200% as combination of 3% and 200% for activity data and emission factors, respectively.
Montecarlo analysis was applied last year to estimate uncertainty of CH_4 emissions; the resulting figure was 17.2% for 2009. Normal distributions have been assumed for most of the parameters; at the same time, whenever assumptions or constraints on variables were known this information has been appropriately reflected on the choice of type and shape of distributions. A summary of the results is reported in Annex 1. No variation could be conceived on assumptions as concern probability distributions and standard deviations.

Fugitive emissions, in CO_2 equivalent, account for 1.9% out of the total emissions in the energy sector in 2012. Both CH_4 and CO_2 emissions show a reduction from 1990 to 2012 by 32.6% and 33.5%, respectively.
The decrease of CO_2 fugitive emissions is driven by the reduction in crude oil losses in refineries.
The trend of CH_4 and CO_2 fugitive emissions from solid fuels is related to the extraction of coal and lignite that in Italy is quite low. The decrease of CH_4 fugitive emissions from oil and natural gas is due to the reduction of losses for gas transportation and distribution, because of the gradual replacement of old grey cast iron pipelines with steel and polyethylene pipelines for low and medium pressure network.
As regards the flaring activity from oil and gas production, and flaring in refineries N_2O emissions, in CO_2 equivalent, account for 0.15% out of fugitive emissions, with a reduction from 1990 to 2012 by 8.9%.

Fugitive emissions since 1990 are reported in Table 3.44.

Table 3.44 Fugitive emissions from solid fuels and oil & gas in the period 1990-2012 (Gg CO_2 eq.)

	1990	1995	2000	2005	2010	2011	2012
			Gg CO_2 eq.				
CO_2							
Solid fuels	0.1	0.0	0.1	0.0	0.0	0.0	0.0
Oil and natural gas	3,344	3,178	2,588	2,117	2,322	2,315	2,223
CH_4							
Solid fuels	127	66	75	70	66	71	62
Oil and natural gas	7,298	6,817	6,349	5,647	5,117	5,008	4,943
N_2O							
Oil and natural gas	12	12	13	14	12	11	11
Total emissions	10,781	10,072	9,024	7,847	7,518	7,406	7,239

3.9.4 *Source-specific QA/QC and verification*

Different data sources are used for fugitive emissions estimates: official statistics by Economic Development Ministry (MSE, several years [a], [c]), by Transport of Infrastructure Ministry (MIT, several years); national authorities (AEEG, several years; ISTAT, several years), gas operators (ENI, several years [b]; EDISON, several years; SNAM, several years), and industrial association for oil and gas (UP, several years).

Concerning CO_2 fugitive emissions from refineries activities, the estimates are balanced with the amount of crude oil losses reported in the national Energy Balance (MSE, several years [a]).
CH_4 emissions from transmission and distribution of natural gas are verified considering emission factors reported in literature and detailed information supplied by the main operators (ENI, several years [b]; Riva, 1997).

3.9.5 Source-specific recalculations

In the 2014 submission, some recalculations affected emission estimates of the sector.
Recalculations involved years 2005, 2010, and 2011. In 2005 the recalculation accounted for a decrease by 0.27% of CO_2 eq. of fugitive emissions as compared to the previous submission, while for 2010 and 2011 the recalculations accounted for decrease between 0.001% and 0.005% as compared to the previous submission.

3.9.6 Source-specific planned improvements

No further improvements are planned for the next submission.

4 INDUSTRIAL PROCESSES [CRF sector 2]

4.1 Sector overview

By-products or fugitive emissions, which originate from industrial processes, are included in this category. Where emissions are released simultaneously from the production process and from combustion, as in the cement industry, these are estimated separately and included in category 1.A.2. All greenhouse gases as well as CO, NO_X, NMVOC and SO_2 emissions are estimated.

In 2012 industrial processes account for 4.40% of CO_2 emissions, 0.2% of CH_4, 0.84% of N_2O, 100% of PFCs, HFCs and SF_6. In terms of CO_2 equivalent, industrial processes share 6.1% of total national greenhouse gas emissions.
The trends of greenhouse gas emissions from the industrial processes sector are summarised in Table 4.1. Emissions are reported in Gg for CO_2, CH_4 and N_2O and in Gg of CO_2 equivalent for F-gases.
An increase in HFC emissions is observed from 1990 to 2012, while CO_2 emissions from chemical and metal industry reduced sharply in the period.

Table 4.1 Trend in greenhouse gas emissions from the industrial processes sector, 1990-2012 (Gg)

GAS/SUBSOURCE	1990	1995	2000	2005	2010	2011	2012
CO_2 (Gg)	28,434	26,038	24,571	27,186	20,563	20,086	16,996
2A. Mineral Products	21,303	20,976	21,455	23,481	17,553	17,003	13,968
2B. Chemical Industry	3,254	1,659	1,362	1,784	1,544	1,473	1,507
2C. Metal Production	3,878	3,403	1,754	1,922	1,465	1,610	1,520
CH_4 (Gg)	5.16	5.36	3.01	3.06	2.48	2.73	2.62
2B. Chemical Industry	2.45	2.65	0.40	0.33	0.31	0.27	0.26
2C. Metal Production	2.71	2.71	2.61	2.72	2.17	2.47	2.36
N_2O (Gg)							
2B. Chemical Industry	21.54	23.35	25.54	25.03	2.09	0.95	0.76
HFCs (Gg CO_2 eq.)	351	680	1,838	5,148	8,299	8,804	9,246
PFCs (Gg CO_2 eq.)	2,487	1,266	1,217	1,715	1,331	1,455	1,314
SF_6 (Gg CO_2 eq.)	333	601	493	465	373	351	356

Seven key categories have been identified for this sector, for level and trend assessment, using both the Approach 1 and Approach 2. The results are reported in the following box.

Key-category identification in the industrial processes sector with the IPCC Approach 1 and Approach 2 for 2012

KEY CATEGORIES			**without LULUCF**	**with LULUCF**
2F	HFC, PFC	Emissions from substitutes for ODS	L, T	L, T
2A	CO_2	Emissions from cement production	L, T	L1, T
2B	N_2O	Emissions from adipic acid	T	T
2C	CO_2	Emissions from iron and steel production	T1	T1
2B	CO_2	Emissions from ammonia production	T1	T1
2B	N_2O	Emissions from nitric acid production	T1	T1
2C	PFC	Aluminium production	T1	T1

HFC and PFC from substitutes for ODS are included in 2F; CO_2 emissions from cement are included in category 2A; N_2O emissions from adipic acid, nitric acid and CO_2 emissions from ammonia refer to 2B; CO_2 emissions from iron and steel production and PFC emissions from aluminium production are included in 2C. Methane emissions from the sector are not a key source.
All these categories are also key categories including the LULUCF estimates in the assessment, even if CO_2 emissions from cement production are not a key category for level assessment with the Approach 2.
In addition CO_2 emissions from limestone and dolomite use are a key category in the base year at level assessment with the Approach 1 including and excluding LULUCF; CO_2 emissions from lime production are a key category in the base year at level assessment with the Approach 1 only including LULUCF.

4.2 Mineral Products (2A)

4.2.1 Source category description

In this sector CO_2 emissions from the following processes are estimated and reported: cement production, lime production, limestone and dolomite use, soda ash production. Asphalt roofing and road paving with asphalt activities are also included in this sector but they contribute only with NMVOC emissions; CO_2 emissions from decarbonising in glass production have been estimated and reported in “Other”.

Cement

Cement production (2A1) is the main source of CO_2 emissions in this sector. As already mentioned, it is a key source both at level and trend assessment with the Approach 1 and accounts for 2.60% of the total national emissions.

During the last 15 years, in Italy, changes in cement production sector have occurred, leading to a more stable structure. The oldest plants were closed, wet processes were abandoned in favour of dry processes so as to improve the implementation of more modern and efficient technologies. The effects of the global recession period have led at national level only to two plants closedown. Since 2011 Italy has become the second cement producer country in the EU 27 and the reduction of clinker production has been confirmed in 2012. Actually, 28 companies (80 plants of which: 56 full cycle and 24 grinding plants; i.e. in 2012 only one full cycle plant was converted to a grinding plant and a grinding plant was closed compared to 2011) operate in this sector: multinational companies and small and medium size enterprises (operating at national or only at local level) are present in the country. As for the localization of the operating plants: 46% is in northern Italy, 16% is in the central regions of the country and 38% is in the southern regions and in the islands. There are 80 active sintering rotary kilns which belong to the “dry” or of “semidry” types. In 2012 the larger size cement plants (i.e. 15 facilities with cement production capacity exceeding 600 kt/y) contributed with 40.2% to the national cement production. In Italy different types of cement are produced; as for 2012 AITEC, the national cement association, has characterised the national production as follows: 71.5% is CEM II (Portland composite cement); 13.1% is CEM IV (pozzolanic cement); 9.5% is CEM I (ordinary Portland Cement) and 4.9% is CEM III (blastfurnace cement). Clinker production has been decreasing since 2007 (about 10% in 2008 compared to 2007; about 19% in 2009 compared to 2008; about 4.7% in 2011 compared to 2010 and about 20% in 2012 compared to 2011) and clinker demand in cement production was about 75% also in 2012 (production of clinker out of production of cement). As CO_2 emissions and cement/clinker production are strictly related, a decrease in the CO_2 emissions from cement production has been observed in the same way which depends also by operating conditions at the Italian cement facilities.

Lime

CO_2 emissions occur also from processes where lime is produced and account for 0.53% of the total national emissions. Lime production can also occur, beside lime industry, in different industrial sectors such as iron and steel making, pulp and paper production, soda ash production, sugar production; lime can also be used in a number of processes concerning wastewater treatment, agriculture and the neutralization of acidic emissions in the industrial flue gases. In particular the other relevant lime productions accounted for in Italy are those occurring in the iron and steel making process and in the sugar production process.
Lime is basically produced by calcination of limestone (calcium carbonate) or dolomite (calcium/magnesium carbonate) at 900°C. The process leads to quicklime and CO_2 emissions according to the following reaction:

$$CaCO_3 + MgCO_3 + heat \rightarrow CaO + MgO + 2CO_2$$

CO_2 is released because of the process reaction itself and also because of combustion to provide energy to the process. CaO and MgO are called quicklime. Quicklime, together with water, give another product of the lime industry which is called calcium hydroxide $Ca(OH)_2$.
CO_2 emissions estimation is related to lime production in mineral industry and it also includes the production of lime to feed other industrial processes (e.g. iron and steel making facilities).
The number of lime producing facilities has been relevantly changing through the years: 85 operating plants in 1990, 46 plants in 2003, 35 plants in 2010 and 35 in 2012 (figures for 2010 and 2012 are based on the number of facilities reporting under the EU-ETS). Moreover, 46% of the plants is in the southern regions and

in the islands, 39% is in the northern regions and 15% in the central regions. The number of operating kilns has also decreased significantly through the years (about 171 in 1990, 75 in 2003). During the nineties, lime industry invested in technology implementation to replace the old kilns with regenerative and high efficiency kilns, rotary kilns are no longer used. Concerning fuel consumptions, 80% of the national lime industry uses natural gas, 20% uses coke.

Limestone and dolomite use (brick and tiles; fine ceramics; paper industry and power plants)
CO_2 emissions are also related to the use of limestone and dolomite in different industrial processes, and they account for 0.28% of the total national emissions. Limestone or dolomite can be added in different steps of the production process to obtain the desired product features (i.e. colour, porosity). Sometimes carbonates in limestone and dolomite may have to be calcined ("dead burned") in order to be added to the manufacturing process. Limestone and dolomite are also used in paper production process and in the treatment of power plants flue gases. A steep decrease in the production processes and the relevant use of limestone can be observed between 2007 and 2009; use of limestone has been decreasing more gradually since 2009; the overall decrease being mainly driven by the use of limestone and dolomite in the brick and tiles sector.

Glass production
Glass industry in Italy can be characterised with regard to four glass product types: flat glass, container glass, borosilicate and lead/crystal glass. Flat glass is produced in facilities mainly located in the North; container glass is produced in facilities located all over the country; glass fibres and wool are produced in the North. About 80 companies carry out activities related to glass industry in Italy, 30 companies carry out glass production processes in about 54 production units.
With regard to glass chemical composition, the national glass production consists of 95% soda-lime glass, 4% borosilicate glass and 1% lead/crystal glass.

The main steps of the production process in glass industry are the following:
- raw materials storage and batch formulation;
- melting of the formulated batch at temperature ranging from 1400°C to 1600°C, in different furnaces according to the type of glass product;
- forming into glass products at specific temperature ranges;
- annealing of glass products to prevent weak glass due to stress.

The formulated batch is generally melted in continuous furnaces, whose size and features are related to the types of glass production. In Italy 80% of the glass industry production is carried out using natural gas as fuel, other fossil fuels consumption is limited to low sulphur content oil. Emissions are basically released by the high temperature melting step and depend on the type of glass product, raw materials and furnaces involved in the production process. Main pollutants are: dust, NO_x, SO_x, CO_2; occasionally and depending on the specific production process, heavy metals, fluorides and chlorides gases could be released. CO_2 emissions are mainly related to the decarbonisation of carbonates used in the process (soda ash, limestone, dolomite) during the melting phase, accounting for 0.14% of the total national emissions. The use of scrap glass (recycled cullets) in the production processes has been increasing in Italy since 1998 thus contributing to the reduction of emissions from decarbonation and from the melting phase. In the following box, values of the rate of glass recycling from 1998 are reported.

Rate of glass recycling

GLASS PRODUCTION	**1998**	**2000**	**2005**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Rate of glass recycling (%)	38.8	46.9	57.2	59.6	64.3	65.4	68.4	69.9	70.9

Soda Ash production and use
In Italy only one facility operates soda ash production via Solvay process. Solvay process allows producing soda ash through the conversion of sodium chloride into sodium carbonate using calcium carbonate and ammonia. CO_2 is released and calcium chloride is the waste.
Up to the second half of year 2000 in the unit for the production of peroxidates there was one sodium carbonate line and a sodium perborate line which was then converted to sodium carbonate production. Soda ash is also used in glass production processes. CO_2 emissions from soda ash production account for 0.06% of the total national emissions.

Asphalt roofing and road paving with asphalt
In Italy 14 facilities have been producing bitumen roofing membranes and about 87 facilities operate in the production and laying of asphalt mix products for road paving. SITEB, the Italian asphalt and road association is the relevant source of information for these two source categories. NMVOC emissions have been estimated for these two source categories along the whole time series.

4.2.2 Methodological issues

IPCC Guidelines and Good Practice Guidance are used to estimate emissions from this sector (IPCC, 1997; IPCC, 2000; IPCC, 2006).
Activity data are supplied in the national statistical yearbooks (ISTAT, several years) and by industries. Emission factors are those provided by the IPCC Guidelines (IPCC, 1997; IPCC, 2000; IPCC, 2006), by the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2007) or by other international Guidebooks (USEPA, 1997).

Cement
CO_2 emissions from cement production are estimated using the IPCC Tier 2 approach. Activity data comprise data on clinker production provided by the national Institute of Statistics (ISTAT, several years). Emission factors are estimated on the basis of information provided by the Italian Cement Association (AITEC, several years) and by cement facilities in the framework of the European pollutant emission register (EPER, now E-PRTR) and the European emissions trading scheme. In this latter context, all cement production plants reported fuel consumption, raw materials and emissions, split between combustion process and decarbonising process and complying with a clinker kiln input method. Basically, CO_2 emissions time series is related to clinker production time series. Specifically, main decreases in the national production of cement industry, which well reflects the economical trend, can be observed for the years 1993-1994; an increase in production can be observed from 1996 to 2001 and from 2003 to 2007, while a significant decrease in the production is observed for 2008 and 2009 due to the effects of the international economic crisis. Practically, the same variations can be observed in CO_2 emissions trend. In order to enhance the transparency of the inventory, in Figure 4.1clinker production time series together with CO_2 emissions time series is shown.

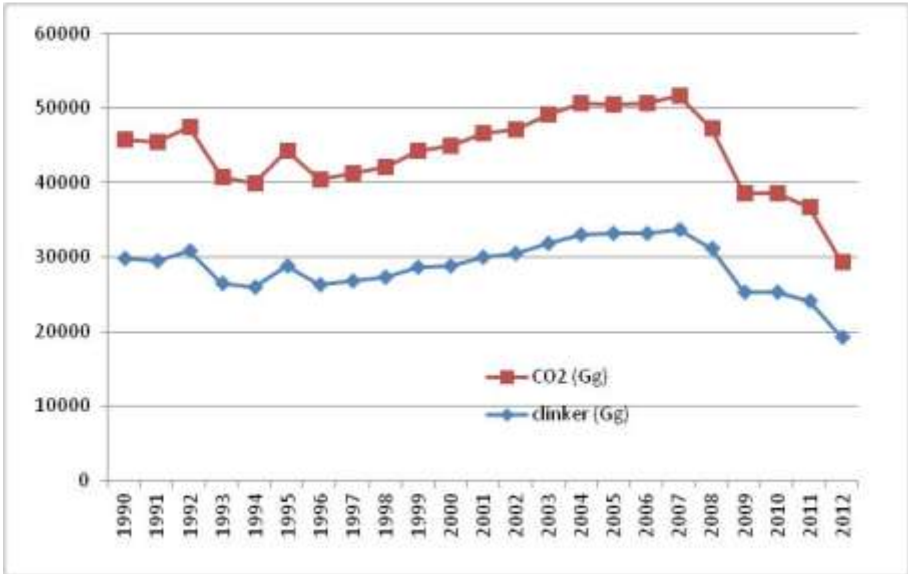

Figure 4.1 Trend of clinker production and CO_2 emissions 1990-2012 (Gg)

From 1990 to 2003 the resulting emission factor for cement production was equal to 540 kg CO_2/t clinker, based on the average CaO content in the clinker and taking into account the contribute of carbonates and additives. In lack of specific data from the plants, this value was suggested to the operators by AITEC (AITEC, 2004) on the basis of a tool provided by the World Business Council for Sustainable Development, available on website at the address http://www.ghgprotocol.org/standard/tools.htm. The WBCSD tool relies

on a methodology fully compliant with IPCC guidelines for the emissions estimation from this source category and allows for developing a country specific emission factor, facility specific information being already considered in the calculations.
From 2004, emission factors are based on the data reported within the frame of the EPER/EPRTR and of the European Emissions Trading scheme. The EF resulted in 518 kg CO_2/t clinker in 2008, in 528 kg CO_2/t clinker in 2009 (EF value for this year has been checked and revised in the present submission) and in 523 kg CO_2/t in 2011 based on the average CaO content in the clinker and taking into account the contribute of carbonates and additives, as reported in Figure 4.2. The average emission factor varies year per year as a consequence of the different operating circumstances (e.g. quality of the raw materials and operating conditions) at the 54 clinker facilities.

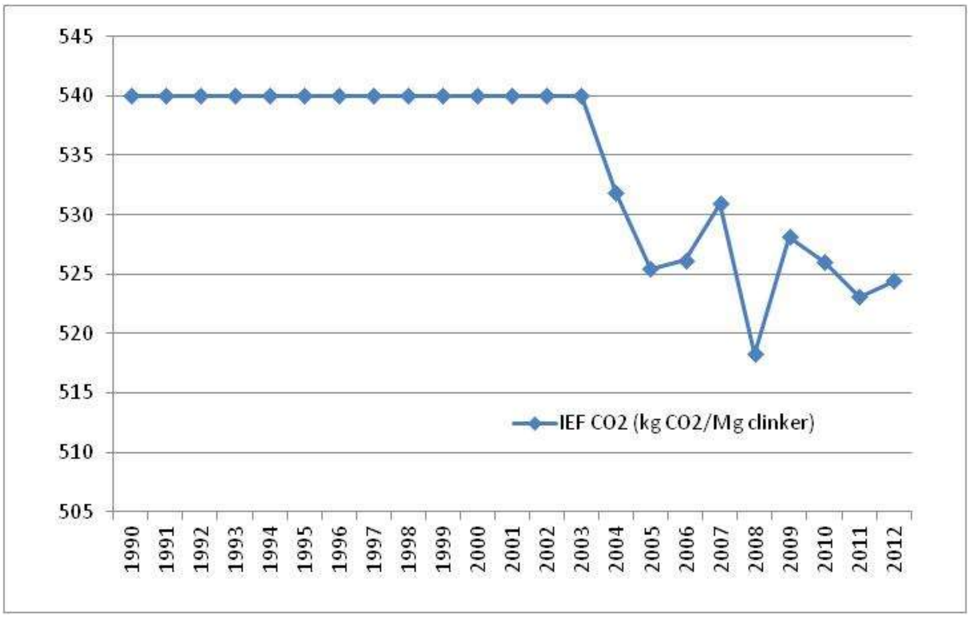

Figure 4.2 CO_2 IEF from decarbonation in clinker production, 1990-2012

As recommended by the ERT in the last review process (UNFCCC, 2012), the inventory team has further explored the fluctuation of the IEF for CO_2 from clinker production with the following findings over the years from 2005 to 2011:

- in 2005 73% of the clinker facilities had an IEF in the range 520÷544.99 (kg CO_2/t clinker) and 34.6% has IEF in the range 520÷529.99 (kg CO_2/t clinker);
- in 2006 81% of clinker facilities has an IEF in the range 515÷544.99 (kg CO_2/t clinker) and 54.2% has 515÷534.99 (kg CO_2/t clinker);
- in 2007 79.6% of clinker facilities an IEF in the range 515÷544.99 (kg CO_2/t clinker) and 48% has 525÷539.99 (kg CO_2/t clinker);
- in 2008 77% of clinker facilities an IEF in the range 505÷534.99 (kg CO_2/t clinker) and 39.6% has 510÷524.99 (kg CO_2/t clinker);
- in 2009 82.6% of clinker facilities an IEF in the range 520÷544.99 (kg CO_2/t clinker) and 59.6% has 525÷539.99 (kg CO_2/t clinker);
- in 2010 88.4% of clinker facilities an IEF in the range 515÷539.99 (kg CO_2/t clinker) and 50% has 520÷534.99 (kg CO_2/t clinker);
- in 2011 90% of clinker facilities an IEF in the range 510÷539.99 (kg CO_2/t clinker) and 64.7% has 510÷529.99 (kg CO_2/t clinker) and 33.3% are in the range 520÷529.99 (kg CO_2/t clinker).

The information related to activity data and emissions for the clinker facilities reporting to the national ETS system have been processed. The same analysis, performed on information referred to year 2003, shows that 88% of clinker facilities has an IEF in the range 535÷549.99 (kg CO_2/t clinker) and 75% are in the range 540÷544.99 (kg CO_2/t clinker) in line with the IEF value (540 kg CO_2/t clinker) reported for that year.

In addition to this, AITEC has been reporting the overall consumption of natural raw materials by the national cement industry and also the replacement of natural raw material (either in the raw meal for the clinker manufacture or in the ground mix for the different cement types) with alternative materials in the Italian cement facilities, so:

- Specific consumption of natural raw materials has been varying for the last years;
- The rate of replacement of natural raw materials has been varying for the last years.

In 2012 approximately 6.8% of natural raw material was replaced by about 2.3 Mt non raw materials (1 Mt non hazardous wastes and 1.3 Mt secondary raw material) (AITEC, 2012). Most of the alternative materials consist of already decarbonised materials. The use of decarbonised material in amounts varying year by year in clinker kilns contribute explaining the fluctuations in the trend of the CO_2 IEF from decarbonisation.

In the following box the amounts of natural raw material consumption for the years 2009-2012 have been reported together with the amounts of secondary raw materials and the replacement rates in the same years.

Replacement of natural raw materials by secondary raw materials at the Italian cement facilities

RAW MATERIALS DEMAND	2009	2010	2011	2012
Natural raw materials (Mt)	43.6	43.4	40.4	34.2
Secondary raw materials (Mt)	1.9	1.8	1.9	2.3
Natural raw material/ clinker (t/t)	1.726	1.719	1.681	1.780
Replacement of natural raw material (%)	4.0	4.3	4.3	6.8

(source: AITEC, 2012)

Finally, regarding industry data verification, the available activity data for the cement/clinker production in Italy are consistent to the information supplied by the Italian cement industry association, to the data reported under the national PRTR and also to the data collected in the frame of the national ETS. Emission data reported under the different obligations are in accordance for all the facilities.
In the following box the number of clinker facilities reporting under EPRTR and ETS are shown together with the corresponding reported productions.

Clinker facilities	2005	2006	2007	2008	2009	2010	2011	2012
Reporting to the national PRTR (n)	52	53	53	54	53	50	50	51
Reporting under the national ETS (n)	52	53	54	54	52	52	51	51
number of clinker manufacturers in Italy (AITEC)	59	59	60	60	58	58	57	56
PRTR/AITEC (%)	88	90	88	90	91	86	88	91
ETS/AITEC (%)	88	90	90	90	90	90	89	91

In the framework of the EU-ETS as well as the EPRTR registry, 51 plants out of 56 reported in 2012 their data representing more than 98% of total national clinker production. Under the EU-ETS, cement plants communicate emissions and activity data split between energy and processes phases and specifying the amount of carbonates and additives which are constituents of the raw meal complying with a “clinker kiln input” approach; both activity data and emissions are independently verified and certified as requested by the EU-ETS directive.

Lime

CO_2 emissions from lime have been estimated on the basis of production activity data supplied by ISTAT (ISTAT, several years up to 2008) and by operators in the frame of the ETS reporting obligations from 2009. CO_2 emissions from lime production and use in other industrial processes (e.g. iron and steel production, sugar mills) have been considered too. Emission factors have been estimated on the basis of detailed information supplied by lime facilities in the framework of the European emission trading scheme and checked with the national lime industrial association (CAGEMA, 2005). Specifically, the value of the emission factor from 1990-1999 has been derived as the average of the 2000-2003 figures provided by the operators in the framework of the ETS. From 2005, information available in the frame of the ETS reporting obligation has made activity data (including fuels and raw materials such as carbonates and additives, in compliance with a "lime kiln input" approach) available for the Italian lime industry at facility level together with CO_2 emissions data (combustion and process emissions). Both activity data and CO_2 emissions are certified and independently verified as requested by the EU-ETS legislation. The CO_2 implied emission factor varies year by year because of the natural raw material fed to the kilns at facility level (different CaO and MgO contents affect the resulting IEF). In the following box, CaO and MgO contents for the years 2008-2012 are reported; these figures refer only to the production plants, excluding autoproduction.

CaO and MgO oxides content for lime production (%)

LIME PRODUCTION	**2008**	**2009**	**2010**	**2011**	**2012**
CaO content (%)	89.64	96.88	96.68	96.23	93.03
MgO content (%)	10.36	3.12	3.32	3.77	6.97

Limestone and dolomite

CO_2 emissions from limestone and dolomite use are related to the use of limestone and dolomite in bricks, tiles and ceramic production, paper production and also in the treatment of flue gases from power plants. In general about 86% of the total limestone and dolomite is used in the production processes of bricks and tiles; about 6.9% is used for the fine ceramic material; 6.9% is used in the treatment of flue gases in the power plants and about 0.1% is used in the paper industry. CO_2 emissions have been estimated for the whole time series; the overall CO_2 emission time series is mainly driven by the CO_2 emissions from the use of limestone and dolomites in the bricks and tiles sector (the same percentages are observed in the distribution of CO_2 emissions among the contributing sectors as for the limestone and dolomite used amounts). In the CRFs the total amount of limestone and dolomite used in these processes is reported as activity data and it has been estimated on the basis of the average content of $CaCO_3$ in the different productions and consumptions. Detailed production , consumption, activity data and emission factors have been supplied in the framework of the European emissions trading scheme and relevant data are annually provided by the Italian bricks and tiles industrial association and by the Italian ceramic industrial associations (ANDIL, 2000; ANDIL, several years; ASSOPIASTRELLE, several years; ASSOPIASTRELLE, 2004, Confindustria Ceramica, several years). The activity data for 2011 have been updated in the present submission.

Glass

CO_2 emissions from glass production have been estimated taking into account activity data (ISTAT, several years) and emission factors estimated on the basis of information supplied by 53 facilities in the framework of the European emissions trading scheme. Based on this approach, CO_2 emissions from the decarbonation, which already take into account the national circumstances concerning the use of cullets (recycled scrap glass which does not cause CO_2 emissions) in the production processes, have been estimated.

Soda ash

CO_2 emissions from soda ash production have been estimated on account of information available about the Solvay process (Solvay, 2003), whereas those from soda ash use are included in glass production.

Asphalt roofing and road paving

NMVOC emissions from the manufacturing of asphalt roofing materials have been estimated based on the total surface of bitumen roofing membranes (Federchimica, several years; Siteb, several years) and default emission factors (EMEP/CORINAIR, 2007; EMEP/EEA, 2009).

NMVOC emissions from road paving operations have been estimated based on the amount of asphalt mix produced for each year (ISTAT, several years; Siteb, several years) and the emission factors also derived from data supplied by Siteb (EPA, 2000; Siteb, several years).

4.2.3 Uncertainty and time-series consistency

The uncertainty in CO_2 emissions from cement, lime, limestone and dolomite use and glass production is estimated to be equal to 10.4% from each activity, resulting from 3% and 10% for activity data and emission

factor, respectively. Official statistics of activity data for these categories are quite reliable when compared to the activity data reported by facilities under different data collections, thus leading to the considered uncertainty level for the activity data. The uncertainty level for emission factors is equal to the maximum level reported in the IPCC Good Practice Guidance (IPCC, 2000) for the cement production; this is a conservative estimation because the range of values of the emission factors of the Italian cement plants would lead to a lower uncertainty level.
Montecarlo analysis has been applied to estimate uncertainty of CO_2 emissions from cement for 2009. The resulting figure is equal to 10.0%. Normal distributions have been assumed for the parameters and information deriving from the ETS has been considered in defining the shape of the distributions. A summary of the results is reported in Annex 1.

In Tables 4.2 and 4.3, the production of mineral products and CO_2 emission trend is reported.

Table 4.2 Production of mineral products, 1990 – 2012 (Gg)

ACTIVITY DATA	1990	1995	2000	2005	2010	2011	2012
				(Gg)			
Cement production (decarbonizing)	29,786	28,778	29,816	33,122	25,239	24,057	19,204
Glass (decarbonising)	3,779	4,259	4,930	5,328	5,063	5,188	4,879
Lime (decarbonizing)	2,583	2,873	2,760	3,344	2,789	2,970	2,906
Limestone and dolomite use	5,773	5,283	5,132	6,076	3,513	3,366	2,436
Soda ash production and use	610	1,070	1,000	915	620	726	824

Table 4.3 CO_2 emissions from mineral products, 1990 – 2012 (Gg)

CO_2 EMISSIONS	1990	1995	2000	2005	2010	2011	2012
				(Gg)			
Cement production (decarbonizing)	16,084	15,540	16,101	17,403	13,276	12,583	10,071
Glass (decarbonizing)	453	511	611	768	559	584	547
Lime (decarbonizing)	2,042	2,279	2,185	2,361	1,969	2,092	2,038
Limestone and dolomite use	2,540	2,325	2,258	2,674	1,546	1,481	1,072
Soda ash production and use	183	321	300	275	203	263	240

Emission trends are generally related to the production level, which has been decreasing for the last years (except for lime and soda ash productions mainly because of the economic recession.

4.2.4 Source-specific QA/QC and verification

CO_2 emissions have been checked with the relevant industrial associations.
Both activity data and average emission factors are also compared every year with data reported in the national EPER/E-PRTR registry and in the European emissions trading scheme.
Under the EU-ETS, operators are requested to report activity data and CO_2 emissions as information verified and certified by auditors who check for consistency to the reporting criteria.
Activity data and emissions reported under EU-ETS and EPER/EPRTR are compared to the information provided by the industrial associations. In particular, comparisons have been carried out for cement, lime, limestone and dolomite, and glass sectors. The general outcome of this verification step shows consistency among the information collected under different legislative framework and the information provided by the relevant industrial associations. Additional QA/QC was performed on the inventory of CO_2 emissions from the decarbonation process in the national cement industry: resulting suggestions to focus on raw materials fed to clinker kilns (Aether ltd, 2013) were considered and the description of the fluctuation of the CO_2 implied emission factor has been improved in the present NIR accordingly.

4.2.5 Source-specific recalculations

Recalculations occurred as, in the current submission, CO_2 emissions in 2011 from production has been revised due to the update of 2011 activity data. Consequently, for CO_2 emissions, recalculations for the mineral industry result in +1% increase in 2011, mainly due to the update of activity data of lime production for the same year.

Recalculations (%) in CO_2 emissions time series for the lime sector,2011

GAS/SUBSOURCE	2011
CO_2	
2A.2. Lime Production	+1

4.2.6 Source-specific planned improvements

Further investigations concerning the replacement of natural raw material in clinker manufacture and in lime production are planned.

4.3 Chemical industry (2B)

4.3.1 Source category description

CO_2, CH_4 and N_2O emissions from chemical productions are estimated and included in this sector.

Adipic acid

Adipic acid production is a multistep process which starts with the oxidation of cyclohexanol using nitric acid and Cu catalysts according to the following reaction:

$$C_6H_{11}OH+2HNO_3 \rightarrow HOOC(CH_2)_4COOH+N_2O+2H_2O+energy$$

Adipic acid is then used to produce nylon or is fed to other production processes. Together with adipic acid, N_2O is produced and CO_2 is one of the by-products (Radici Chimica, 1993).
Emissions data from adipic acid production are provided and referenced by one plant, which is the only producer in Italy (Radici Chimica, several years). Specifically for N_2O, adipic acid is a key source at trend assessment, both with Approach 1 and Approach 2. These emissions account for 16% of total N_2O emissions in 2005, 2.4% in 2008; 1.8% in 2010 and 0.43% in 2011; the notable decrease in share is due to the fact that the technology to reduce N_2O emissions has become fully operational at the existing producing facility since 2007.

N_2O emissions have relevantly decreased thanks to the implementation of a catalytic abatement system (pilot scale plant). The use of thermally stable catalysts in the pilot plant has allowed the treatment of highly N_2O concentrated flue gas from the adipic acid production plant, reducing the volume of treated gas and the size of the pilot plant itself. The abatement system is generally run together with the adipic acid production process. In 2004 this system was tested for one month resulting in complete decomposition of N_2O; in 2005 the catalytic process was started only at the end of the year because of technical changes in the system; in 2006 the abatement system had been operating continuously for 9 months (3 months were needed for maintenance and technical changes) leading to the decomposition of 92% (efficiency of the abatement system while in operation) of N_2O emissions. Since 2007 the operating time has been about 11 months (about one month was needed for maintenance operations) and the N_2O emissions abatement system while in operation has reached an efficiency exceeding 98% (Radici Chimica, several years). In 2011 further emissions reduction was achieved thanks to technical improvements implemented in the production process during 2010:

1. the number of scheduled outages of the adipic acid production process is reduced (from about 1/month to 2/year);
2. the abatement system is set to reach the operating level more quickly than in the previous years.

These two achievements allow reducing the significance of N_2O peak emissions related to the start&stop phases. Moreover an emission monitoring and recording system was implemented in compliance with Decision 2007/589/EC (Radici Chimica, 2013).
Also CO_2 emissions are estimated from this source.

Ammonia production
In Italy only one facility had been producing ammonia since 2009 as a consequence of the resizing of the production at national level after the crisis of the largest fertilizer producer, Enichem Agricoltura, and as a consequence of the international financial crisis in the last years. Two facilities had been producing ammonia in Italy up to 2008, in 2009 one plant stopped the production and the plant reconversion is currently under negotiation. Ammonia is obtained after processing in ammonia converters a "synthesis gas" which contains hydrogen and nitrogen. CO_2 is also contained in the synthesis gas, but it is removed in the decarbonising step within the ammonia production process. Part of CO_2 is recovered as a by-product and part is released to atmosphere. Recovered CO_2 can either be used as input for different production processes (e.g. urea or calcium nitrate lines; liquefaction of CO_2 plant) on site or can be sold to technical gas manufacturers. The results of the investigation concerning the recovered CO_2 were accounted for in the previous submissions: operators provided the information used to revise both the emissions and the EF time series (YARA, several years). CO_2 emissions from ammonia production are also a key source, at trend assessment with the Approach 1.

Nitric acid
In early nineties seven facilities manufactured nitric acid, but since 2003 the production has been carried on only in three plants. In 2008 another plant stopped nitric acid production and the reconversion of the plant is currently under negotiation, so since 2009 nitric acid production has been carried out in only two plants. Nitric acid is produced from ammonia by catalytic oxidation (with air) of NH_3 to NO_2 and subsequent reaction with water. Currently the reactions involved take place in low and medium pressure processes.
N_2O emissions from nitric acid production are key source for trend assessment with Approach 1, although they also show a relevant decrease in emissions from 1990 due to a reduction in production. Moreover, as far as YARA facility is concerned, the decrease in N_2O emissions is also related to the implementation of catalytic N_2O decomposition in the oxidation reactors (YARA De-N_2O patented technology, based on the use of CeO_2 catalyst; YARA, several years) while the improvements in the monitoring system of N_2O emissions at the other facility has been affecting N_2O emissions estimation timeseries for the very last years.

Carbon black
Three facilities have been carrying out this production which consists basically on cracking of feedstock oil (a mixture of PAH) at 1200 – 1900 °C. Together with black carbon, tail gas is a by product of the process. Tail gas is a mixture of CO, H_2, H_2O, NO_x, SO_x and H_2S; it is generally burnt to reduce the emissions to air and to recover energy to be used in the production process.
CO_2 emissions from carbon black production have been estimated on the basis of information supplied directly by the Italian production plants also in the framework of the EU ETS for the last years.

Ethylene, Ethylene oxide, Propylene, Styrene
Ethylene, ethylene oxide, propylene and styrene productions belong to the organic chemical processes. In particular, ethylene is produced in petrochemical industry by steam cracking to manufacture ethylene oxide, styrene monomer and polyethylenes. Ethylene oxide is obtained via oxidation of ethylene and it is largely used as precursor of ethylene glycol and in the manufacture of surfactants and detergents. Propylene is obtained by cracking of oil and it is used to manufacture polypropylene but also acetone and phenol. Styrene, also known as vinyl benzene, is produced on industrial scale by catalytic dehydrogenation of ethyl benzene. Styrene is used in the rubber and plastic industry to manufacture through polymerisation processes such products as polystyrene, ABS, SBR rubber, SBR latex. Except for ethylene oxide production, which has stopped in 2002, the other productions of the above mentioned chemicals still occur in Italy.
As far as ethylene, ethylene oxide and propylene are concerned, Syndial Spa (ex Enichem) and Polimeri Europa (Syndial, several years; Polimeri Europa, several years) were the main producers in Italy up to 2006.

Since 2007 Polimeri Europa has become the main producer for those products, while it has been the main producer of styrene since 2002.

Titanium dioxide

CO_2 emissions from dioxide titanium production have been estimated on the basis of information supplied directly by the Italian maker. TiO_2 is the most used white pigment especially for paint and plastic industries. In Italy there is only one facility where this production occurs and titanium dioxide is produced through the "sulphate process". The "sulphate process" involves the use of sulphuric acid to concentrate the input raw mineral in terms of titanium dioxide content, then selective precipitation and calcination allow getting the final product.

Caprolactame production

Caprolactame is a monomer used in the industrial production of nylon-6. It can be obtained by catalytic oxidation of toluene and cycloexane. The process releases N_2O.
N_2O emissions from caprolactame production have been estimated and reported and are related to only one producing plant, which closed in 2003.

Calcium carbide production

Calcium carbide production process takes place in electric furnaces, CaO and coke are fed to the furnace and the product is obtained according to the following reaction:

$CaO+3C \rightarrow CaC_2+CO$

CARBITALIA S.p.A. is the only facility which can operate calcium carbide production in Italy (CARBITALIA S.p.A., 2009). It produced calcium carbide up to 1995, when it stopped the production because of the increasing price of electricity. The plant still exists and it is maintained, but since 1995 it has just been supplying calcium carbide bought abroad.

4.3.2 Methodological issues

Adipic acid

Italian production figures and emission estimates for adipic acid have been provided by the process operator (Radici Chimica, several years) for the whole time series. Emissions estimates provided by the operator are based on the IPCC default EF, so the values provided and the estimates in the Italian emissions inventory are, basically, the result of the same methodology. More specifically, N_2O emissions from adipic acid production (category 2B3) have been estimated using the default IPCC emission factor equal to 0.30 kg N_2O/kg adipic acid produced, from 1990 to 2003.
Since 2004 the operator has started to study how to introduce an abatement system; although emission estimates provided by the operator have still been based on the IPCC default emission factor (0.30 kgN_2O/kg adipic acid produced), the operating hours of the abatement system and the abatement rates have also been included in the estimation process. The abatement system is generally run together with the adipic acid production process. In 2004, the N_2O catalytic decomposition abatement technology has been tested so that the value of emission factor has been reduced taking into account the efficiency and the time, one month, that the technology operated. From the end of 2005 the abatement technology is fully operational; the average emission factor in 2006 is equal to 0.05 kg N_2O/kg adipic acid produced and the abatement system had been operating continuously for 9 months; since 2007 the average emission factor has been 0.03 kg N_2O/kg adipic acid produced and the operating time of the abatement system has been 11 months. Technical improvements in operating the production process and the abatement system have allowed achieving significant reduction in N_2O emissions since 2009 (Radici Chimica, 2013): in 2010 the average emission factor was 0.019 kg N_2O/kg adipic acid produced while in 2011 the average EF is 0.005 kg N_2O/kg adipic acid produced with the abatement rate exceeding 98%.
Thus, both for the period 1990-2005 and from 2006 onwards the estimates are provided according to the IPCC Good Practice Guidance (default EF has been used when no abatement system was operational; abatement rates have been considered in estimating emission values since 2006). The operator reports also under EPER/E-PRTR both adipic acid production and the N_2O emissions related to this production; adipic

production and N_2O emissions have been also reported by the operator to the national competent authority for the ETS (the facility was included in the ETS system in 2013) together with additional information such as abatement rates and operating times. Since 2011 the implementation of a new monitoring system has enabled also the reporting o better quality data in terms of nitrogen and nitrous oxides emissions. Based on information from the national PRTR and ETS, EFs are calculated for the plant, the resulting value is checked and verified by the formula included in the following box (based on the IPCC default EFs for adipic acid production, abatement rate and operating time of the abatement technology at the facility). In the formula the average emission factor is calculated subtracting from the default EF (0.300 kgN_2O /kg adipic acid produced) the default EF multiplied by the abatement technology rate and by the operating time factor, parameters and resulting EF values are indicated for the years 2005 to 2012.
The EFs submitted for the adipic acid production in the CRF and the EFs calculated for the plant in the following box are practically the same.

N_2O emission factors submitted vs calculations based on efficiency and utilization details

Parameter/Year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
EFp (IPCC default)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
A	0.925	0.9212	0.965	0.986	0.986	0.986	0.986	0.986
T	0.14	0.8825	0.93	0.91	0.91	0.952	0.999	1.002
EFs (average EF)	0.26	0.056	0.031	0.031	0.031	0.019	0.005	0.004

Values resulting according to the following formula

$$(1-A*T)*EFp = EFs$$

Where:
A= Abatement rate provided by the operator
EFp= N_2O Emission Factor for Adipic Acid production (kg N_2O /kg adipic acid prod)
T = operating time of the abatement system/ operating time of the adipic acid production line
EFs = N_2O actually released Emission Factor submitted (kg N_2O released/kg adipic acid prod)

CO_2 emissions from this source have been estimated according to the information communicated by the operator.

Ammonia

Ammonia production data are published in the international industrial statistical yearbooks (UN, several years), national statistical yearbooks (ISTAT, several years) and from 2002 they have been checked with information reported in the national EPER/E-PRTR registry. The number of ammonia facilities in Italy is known along the whole timeseries so it is possible to make sure that the national emissions estimation from this source is consistent to the sum of emissions from the ammonia facilities. Since 2009 only one facility has been producing ammonia in Italy and reporting data to the national PRTR. Recovered CO_2 has been investigated with the cooperation of the operators and the resulting information has been used to revise the whole CO_2 emission time series and the emission factors as reported in the last submissions. The analysis has allowed understanding that CO_2 emissions recovered from ammonia production are used to produce urea and technical gases. According to IPCC Guidelines this CO_2 recovered should be accounted for emission and included in the estimate. The resulting average CO_2 emission factors were found to be higher than the IPCC defaults. In particular, for the years 1990-2001, CO_2 emission factor has been calculated on the basis of information reported by the production plants for 2002 and 2003 in the framework of the national EPER/E-PRTR registry and considering also the amounts of CO_2 recovered since the beginning of the recovery operations. CO_2 reported to the national EPER/E-PRTR registry has been used for the previous years in consideration that, as communicated by the operators, no modifications to the production plants have occurred along the period (YARA, 2007). Since 2002, the average emission factors result also from data reported by the plants in the national EPER/E-PRTR and they account for the recovered CO_2 data too. The following box shows the time series for the average CO_2 emission factor.

Ammonia production, time series for the average CO_2 EF (t CO_2/t ammonia production)

AMMONIA PRODUCTION	**1990-2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
EF (t CO_2/t ammonia production)	1.90	1.90	1.93	1.94	1.93	1.92	1.90	1.86	1.96	1.90	1.82	1.76

Natural gas is used as feedstock in the ammonia production plants and the amount of fuel used is included in the energy balance under the no energy final consumption sector (see Annex 5), therefore double counting does not occur.

Nitric acid

With regard to nitric acid production (2B2), production figures at national level are published in the national statistical yearbooks (ISTAT, several years), while at plant level they have been collected from industry (Norsk Hydro, several years; YARA, several years; Radici Chimica, several years). The number of nitric acid facilities in Italy is known along the whole timeseries so it is possible to make sure that the national emissions estimation from this source is consistent to the sum of emissions from the ammonia facilities. In 1990 there were seven production plants in Italy; three of them closed between 1992 and 1995, and another one closed in 2004, one more closedown in 2008 has left two plants still operating.

The N_2O average emission factors are calculated from 1990 on the basis of the emission factors provided by the existing production plants in the national EPER/E-PRTR registry, applied for the whole time series, and default IPCC emission factors for low and medium pressure plants attributed to the plants, now closed, where it was not possible to collect detailed information. Thus, N_2O emissions are estimated at plant level also considering the operating unit level, if necessary. Activity data have been collected at plant level for the whole time series. Unit specific default IPCC EFs have been used for plants closed in the nineties because it was not possible to collect more detailed information. For the other plants, data supplied in the framework of the EPER/EPRTR registry have been used from 2001 onwards, while for the years 1990-2000 EFs at unit level have been calculated as an average of 2001-2004 data provided by operators in the EPER/EPRTR register. The implied emission factor varies year by year depending on the operating circumstances at the production facilities, the values for the emission factor are shown in the following box for the years from 2007 onwards.

Nitric acid production, time series for the average N_2O EF (t N_2O/t nitric acid production) since 2007

NITRIC ACID PRODUCTION	1990	2007	2008	2009	2010	2011	2012
EF (Mg N_2O/Mg nitric acid production)	6.49	7.07	2.29	2.94	1.21	1.32	1.10

Relevant reductions in N_2O emissions have been observed since 2008. Specifically, in 2008 the implementation of catalyst N_2O abatement technology in one of the major production plants (i.e. in one unit of that plant) has led to a significant decrease in total N_2O emissions from nitric acid production, consequently a relevant reduction in the IEF can be observed too (YARA, several years): the implied emission factor for 2008 is in fact 2.29 kg N_2O/Mg nitric acid production (the abatement rate in one plant was 82% so far); in 2010 the implied emission factor is 1.21 kg N_2O/Mg nitric acid production; the relevant decrease is due to the installation of the abatement technology in the other unit of the same producing facility (YARA, 2011) and to the technical improvements implemented in 2011 as far as monitoring of emissions is concerned at the second nitric acid facility (Radici Chimica, 2013). Sampling circumstances at the facility may affect the reported N2O emission values: sampling in times very close to catalyst exhaustion generally leads to higher N2O concentration in the processes flue gases, this seems to have occurred for N2O emissions in 2011 according to the operator (Radici Chimica, personal communication 2014).

Caprolactame

N_2O emissions from caprolactame have been estimated on the basis of information supplied by the only plant present in Italy, production activity data published by ISTAT (ISTAT, several years) and production and emission data reported in the national EPER/E-PRTR registry. The average emission factor is equal to 0.3 kg N_2O/Mg caprolactame production. The plant closed in 2003.

Carbon Black

CO_2 and CH_4 emissions from carbon black production process have been estimated on the basis of information supplied by the Italian production plants in the framework of the national EPER/E-PRTR registry and the European emissions trading scheme. In 1996 a change in the production technology in the existing plants caused a reduction of CH_4, NMVOC, NO_x, SO_x and PM_{10} emissions. In the present submission update values for the emission factors for this source category have been considered for the years 2010 and 2011 due to the performance of additional QA/QC procedures. The following box include the values of the IEF for CO_2 (t CO_2/t carbon black production) from 2005 to 2012.

Carbon black production, time series for the average CO_2 EF (t CO_2/t carbon black production)

CARBON BLACK PRODUCTION	2005	2006	2007	2008	2009	2010	2011	2012
EF (t CO_2/t Carbon black production)	2.55	2.56	2.51	2.59	2.49	2.48	2.45	2.46

<u>Calcium carbide</u>

CO_2 emissions from calcium carbide production process have been estimated on the basis of the activity data provided by the sole Italian producer and referred to the years from 1990 to 1995 when the production stopped. The default IPCC CO_2 emission factor (IPCC, 2006) has been used to estimate the emissions.

4.3.3 Uncertainty and time-series consistency

The uncertainty in N_2O emissions from adipic and nitric acid and caprolactame production and in CO_2 emissions from ammonia and for other chemical production is estimated by 10.4%, for each activity, as combination of uncertainties related to activity data (3%) and emission factors (10%). Uncertainty level for activity data is an expert judgement, taking into account the basic source of information, while the uncertainty level for emission factors is equal to the level reported in the IPCC Good Practice Guidance (IPCC, 2000) for the adipic and nitric acid N_2O emissions and for CO_2 emissions from other industrial processes.

In Tables 4.4 and 4.5, the production of chemical industry, including non-key sources, and CO_2, CH_4 and N_2O emission trends are reported.

In general, total emission trends for all the chemical productions have been affected by fluctuations in productions along the timeseries (and by reductions in productions over the years 2007-2009, except for adipic acid and titanium dioxide activity data), whenever abatement technologies (e.g. nitric acid since 2008) or closures of plants cannot be regarded to as the specific causes for the decreasing emissions. In 2012 an increase in ammonia production determined an increase in CO_2emissions estimates compared to 2011 estimates.

Table 4.4 Production of chemical industry, 1990 – 2012 (Gg)

ACTIVITY DATA	1990	1995	2000	2005	2010	2011	2012
				(Gg)			
Adipic acid	49	64	71	75	85	83	79
Ammonia	1,455	592	414	607	505	476	576
Calcium carbide	12	7	-	-	-	-	-
Caprolactame	120	120	111	-	-	-	-
Carbon black	184	208	221	214	205	217	179
Ethylene	1,466	1,807	1,771	1,721	1,551	1,254	1166
Ethylene oxide	61	54	13	-	-	-	-
Nitric acid	1,037	588	556	572	417	437	431
Propylene	774	693	690	1.037	880	716	673
Styrene	365	484	613	520	524	477	518
Titanium dioxide	58	69	72	60	70	69	51

Table 4.5 CO_2, CH_4 and N_2O emissions from chemical industry, 1990 – 2012 (Gg)

EMISSIONS	1990	1995	2000	2005	2010	2011	2012
<u>CO_2</u> (Gg)							
Ammonia	2,764.50	1,124.80	786.18	1,171.94	959.37	868.24	1,012.57
Calcium carbide	13.08	7.09	-	-	-	-	-

EMISSIONS	1990	1995	2000	2005	2010	2011	2012
Carbon black	422.05	477.48	508.83	548.22	510.38	531.45	440.05
Titanium dioxide	52.80	48.11	64.70	62.01	72.39	71.37	52.84
Adipic acid	1.33	1.72	1.93	1.50	1.76	1.70	1.62
CH_4 (Gg)							
Carbon black	1.84	2.08	0.11	0.10	0.10	0.10	0.1
Ethylene	0.12	0.15	0.15	0.15	0.13	0.11	0.09
Propylene	0.07	0.06	0.06	0.09	0.07	0.06	0.06
Styrene	0.01	NA	NA	NA	NA	NA	NA
Ethylene oxide	0.42	0.37	0.09	-	-	-	-
N_2O (Gg)							
Nitric acid	6.73	4.22	4.09	5.44	0.51	0.58	0.48
Adipic acid	14.77	19.09	21.42	19.59	1.58	0.38	0.28
Caprolactame	0.04	0.04	0.03	-	-	-	-

4.3.4 Source-specific QA/QC and verification

Emissions from adipic acid, nitric acid, ammonia and other chemical industry production have been checked with the relevant process operators and with data reported to the national EPER/E-PRTR registry. Emissions and activity data for adipic acid, nitric acid and ammonia productions have also been checked against the relevant information reported by operator to the national competent authority for the ETS, the resulting consistency of both emissions and activity data for those sectors is the outcome of this control. Additional QA/QC was performed on the inventory of CO_2 and CH_4 emissions from the production of carbon black (Aether ltd, 2013) thus leading to the improvements of the emissions estimate in the current submission.

4.3.5 Source-specific recalculations

Recalculations occurred in the estimates of CO_2, CH_4 and N_2O emissions from the Chemical industry in the current submission as the result of additional QA/QC operations. Detailed information per gas and sectors are reported in the box below.
Specifically recalcutions concerning CO2 emissions are due to the update of:

- emission factor for ammonia production in 2011;
- emission factors for carbon black production in 2010 and 2011
- activity data for Titanium dioxide production in 2011
- emission factor for Adipic acid production in 2011.

As for CH_4 emissions recalculations are due to the update of emission factors for carbon black production in 2010 and 2011

As for N_2O emissions, recalculations are due to the update of emission factors for Nitric acid and Adipic acid productions in 2011

Recalculations (%) in CO_2, CH_4 and N_2O emissions time series for the Chemical industry in 2010 and 2011

GAS/SUBSOURCE	2010	2011
CO_2		
2.B.1. Ammonia Production		+3
2.B.5. Carbon black	-19	-23
2.B.5. Titanium dioxide		+35
2.B.3. Adipic acid		-0.02
CH_4		

GAS/SUBSOURCE	2010	2011
2.B.5. Carbon black	-19	-23
N_2O		
2.B.2. Nitric acid		+0.02
2.B.3. Adipic acid		+0.01

4.3.6 Source-specific planned improvements

A detailed balance of the natural gas reported in the Energy Balance, as no energy fuel consumption, and the fuel used for the production processes in the petrochemical sector is planned.

4.4 Metal production (2C)

4.4.1 Source category description

The sub-sector metal production comprises four sources: iron and steel production, ferroalloys production, aluminium production and magnesium foundries; CO_2 emissions from iron and steel production and PFC emissions from aluminium production are key sources at trend assessment, using Approach 1.

In 2012, the share of CO_2 emissions from metal production accounts for 0.39% of the national total CO_2 emissions, and 8.95% of the total CO_2 from industrial processes.
The share of CH_4 emissions is, in 2012, equal to 0.14% of the national total CH_4 emissions while N_2O emissions do not occur.
The share of F-gas emissions from metal production out of the national total F-gas levels was 52.8% in the base-year and has decreased to 0.34% (0.01% of the national total greenhouse gas emissions) in the year 2012.

Iron and steel
The main processes involved in iron and steel production are those related to sinter and blast furnace plants, to basic oxygen and electric furnaces.
The sintering process is a pre-treatment step in the production of iron where fine particles of metal ores are agglomerated. Agglomeration of the fine particles is necessary to increase the passageway for the gases during the blast furnace process and to improve physical features of the blast furnace burden. Coke and a mixture of sinter, lump ore and fluxes are introduced into the blast furnace. In the furnace the iron ore is increasingly reduced and liquid iron and slag are collected at the bottom of the furnace, from where they are tapped. The combustion of coke provides both the carbon monoxide (CO) needed for the reduction of iron oxide into iron and the additional heat needed to melt the iron and impurities.
The resulting material, pig iron (and also scrap), is transformed into steel in subsequent furnaces which may be a basic oxygen furnace (BOF) or electric arc furnace (EAF).
Oxygen steelmaking allows the oxidation of undesirable impurities contained in the metallic feedstock by blowing pure oxygen. The main elements thus converted into oxides are carbon, silicon, manganese, phosphorus and sulphur.
In an electric arc furnace steel is produced from polluted scrap. The scrap is mainly produced by cars shredding and does not have a constant quality.
The iron and steel cycle is closed by rolling mills with production of long products, flat products and pipes.

In 1990, there were four integrated iron and steel plants in Italy. In 2012, there are only three of the above mentioned plants, one of which lacks sintering facilities. Oxygen steel production represents about 34% of the total production and the arc furnace steel the remaining 66% (FEDERACCIAI, several years).
Currently, long products represent about 40% of steel production in Italy, flat products about 50% and pipes the remaining 10%. In 2012 long production has been equal to 11.8 Tg with a decrease of 8% over the

previous year and still below 29% compared to 2008; flat production has been equal to 14.5 Tg with an increase of 1% on the previous year and an increase of 4% compared to 2008 level. Almost the whole flat production derives from one only integrated iron and steel plant, while in steel plants equipped with electric ovens, almost all located in the northern regions, long products are produced (e.g. carbon steel, stainless steels) and seamless pipes (only one plant) (FEDERACCIAI, several years).
CO_2 emissions from steel production refer to carbonates used in basic oxygen furnaces and crude iron and electrodes in electric arc furnaces. CO_2 emissions from pig iron production refer to carbonates used in sinter and pig iron production. CO_2 emissions from iron and steel production due to the fuel consumption in combustion processes are estimated and reported in the energy sector (1A2a) to avoid double counting.
CH_4 emissions from steel production refer to blast furnace charging, basic oxygen furnace, electric furnaces and rolling mills. CH_4 emissions from coke production are fugitive emissions during solid fuel transformation and have been reported under 1B1b category while CH_4 emissions from the combustion of fuels are allocated in the energy sector.

Ferroalloys
Ferroalloy is the term used to describe concentrated alloys of iron and one or more metals such as silicon, manganese, chromium, molybdenum, vanadium and tungsten. Usually alloy formation occurs in electric arc furnaces (EAF) and CO_2 emissions occur during oxidation of carbon still present in coke and because of consumption of the graphite electrodes.
In early nineties there were 13 plants producing various kinds of ferroalloys: FeCr, FeMn, FeSi, SiMn, Si-metal and other particular alloys, but since 2001 the production has been carried on only in one plant (ISPESL, 2005). The last remaining plant in Italy produces mainly ferro-manganese and silicon-manganese alloys.

Aluminium
From primary aluminium production CO_2 and PFCs (CF_4 and C_2F_6) are emitted. PFCs are formed during a phenomenon known as the ‘anode effect’, when alumina levels are low.
In 1990 primary aluminium production in Italy was carried out in 5 sites where different technologies were implemented:

- Fusina: Point Fed Prebake and Side Work Prebake (up to 1995);
- Portovesme: Point Fed Prebake and Side Work Prebake (up to 1990);
- Bolzano: Vertical Stud Soderberg;
- Fusina 2 and Porto Marghera: Side Work Prebake.

Since then the implemented technology has been upgraded from Side Work Prebake to Point Fed Prebake; while three old plants stopped the operations in 1991 (Bolzano) and in 1992 (Fusina 2 and Porto Marghera). Since 2000 Alcoa has replaced ENIRISORSE in operating the plants.
Up to 2010, two primary aluminium production plants, which use a prebake technology with point feeding, characterised by low emissions, have operated. Only one plant, located in Portovesme, was operating; in 2012, this plant produced 99.5 kt of primary aluminium and stopped the production at the end of the year. In 1990, primary aluminium production was 232 kt.

Magnesium foundries
In the magnesium foundries, SF_6 is used as a cover gas to prevent oxidation of molten magnesium. In Italy there is only one plant, located in the north, which started its activity in September 1995. Since the end of 2007, SF_6 has been replaced by HFC125, due to the enforcement of fluorinated gases regulation (EC, 2006) which, however, allows for the use of SF_6 in annual amounts less than 1 Mg. HFC125 emissions are reported in the category 2G and, in 2010, were equal to 605 kg. Since 2011 HFC125 has been replaced by HFC134a (3,220 kg in 2012); these emissions are reported in the category 2G too.

4.4.2 Methodological issues

CO_2 and CH_4 emissions from the sector have been estimated on the basis of activity data published in the national statistical yearbooks (ISTAT, several years), data reported in the framework of the national EPER/E-PRTR registry and the European Emissions Trading Scheme, and supplied by industry (FEDERACCIAI, several years; ALCOA, several years). Emission factors reported in the EMEP/EEA

Guidebook (EMEP/EEA, 2009), in sectoral studies (APAT, 2003; CTN/ACE, 2000) or supplied directly by industry (FEDERACCIAI, 2004; ALCOA, 2004; Italghisa, 2011) have been used.

Iron and steel

CO_2 emissions from iron and steel production refer to the carbonates used in sinter plants, in blast furnaces and in steel making plants to remove impurities; they are also related to the steel and pig iron scraps, and graphite electrodes consumed in electric arc furnaces.
Basic information for this sector derives from different sources in the period 1990-2012.
Activity data are supplied by official statistics published in the national statistics yearbook (ISTAT, several years) and by the sectoral industrial association (FEDERACCIAI, several years).
For the integrated plants, emission and production data have been communicated by the two largest plants for the years 1990-1995 in the framework of the CORINAIR emission inventory, distinguished by sinter, blast furnace and BOF, and by combustion and processes emissions. From 2000, CO_2 emissions and production data have been supplied by all the plants in the framework of the ETS scheme, for the years 2000-2004 disaggregated for sinter, blast furnace and BOF plants, from 2005 specifying carbonates and fuels consumption and related CO_2 emissions. For 2002-2012 data have also been supplied by all the integrated iron and steel plants in the framework of the European EPER/E-PRTR registry not distinguished for combustion and processes. Qualitative information and documentation available on the plants allowed reconstructing their history including closures or modifications of part of the plants; additional qualitative information regarding the plants collected and checked for other environmental issues or directly asked to the plant permitted to individuate the main driving of the emission trends for pig iron and steel productions.
Time series of carbonates used in basic oxygen furnaces have been reconstructed on the basis of the above mentioned information resulting in no emissions in the last years. Indeed, as regards the largest Italian producer of pig iron and steel, lime production has increased significantly from 2000 to 2008 by about 250,000 over 410,000 tonnes and the amount introduced in basic oxygen furnaces was, in 2004, about 490,000 tonnes (ILVA, 2006). In 2009 lime production, for the same plant, is equal to 216,000 tonnes but also steel production has sharply decreased; in 2010 lime production is 306,930 Mg and in 2012 is equal to 386,136 Mg. Emissions from lime production in steel making industries are reported in 1A2 Manufacturing Industries and Construction category.
Concerning the electric arc furnaces, additional information on the consumption of scraps, pig iron, graphite and electrodes and their average carbon content has been supplied together with the steel production by industry for a typical plant in 2004 (FEDERACCIAI, 2004) and checked with other sectoral study (APAT, 2003). On the basis of these figures an average emission factor has been calculated.
On account of the amount of carbonates estimated in sinter plants, average emission factor was equal in 1990 to 0.15 t CO_2/t pig iron production, while in 2012 it reduced to 0.07 t CO_2/t pig iron production. The reduction is driven by the increase in the use of lime instead of carbonates in sinter and blast furnaces in the Italian plants. Emissions are reported under pig iron because they are emitted as CO_2 in the blast furnaces producing pig iron.
CO_2 average emission factor in basic oxygen furnaces results in 1990 equal to 0.079 t CO_2/t steel production, while from 2003 is null.
CO_2 average emission factor in electric arc furnaces, equal to 0.035 t CO_2/t steel production, has been calculated on the basis of equation 3.6B of the IPCC Good Practice Guidance (IPCC, 2000) taking into account the pig iron and graphite electrodes used in the furnace and the amount of carbon stored in the final product. The same emission factor has been used for the whole time series.
Implied emission factors for steel production reduced from 0.053 to 0.023 t CO_2/t steel production, from 1990 to 2012, due to the reduction in the basic oxygen furnaces.
CO2 emissions due to the consumption of coke, coal or other reducing agents used in the iron and steel industry have been accounted for as fuel consumption and reported in the energy sector, including fuel consumption of derived gases; in Annex 3, the energy and carbon balance in the iron and steel sector, with detailed explanation, is reported.
During the last in country review, Italy reported on the results of a survey which found that there is no accurate information by which to disaggregate the emissions between energy and process. Coke is the only irreplaceable material in the blast furnace as it has several roles:

- the combustion of coke produces carbon monoxide which is responsible for the reduction of iron ores;
- the combustion of coke generates the heat needed to melt the iron ore;

- coke mechanically supports the charge allowing the crossing of the reducing gas;
- coke allows the process of carburation of liquid iron by lowering its melting point.

These are intrinsic properties of the coke and can not be separated one from the other, all the coke when burning simultaneously produces energy in the form of heat and CO as a reducing agent.
As any arbitrary disaggregation would not reflect the real situation, the ERT agreed that leaving the total emissions from the use of coke in the iron and steel industry in the energy sector is appropriate. Ultimately, carbon plays the dual role of fuel and reductant and it is very important not to double-count the carbon from the consumption of coke or other reducing agents if this is already accounted for as fuelconsumption in the energy sector. For this reason a balance is made between the coal used for coke production and the quantities of derived fuels used in various sectors. The iron and steel sector gets the resulting quantities of energy and carbon after subtraction of what is used for electricity generation, non energy purposes and other industrial sectors (Annex 3).
The amount of carbon stored in steel produced in integrated plants has been considered and subtracted from the carbon balance (see Annex 3). The amount of carbon contained in steel has been estimated on the basis of EN standard and, from 2005, with emission trading data. Carbon stored is equal to 48,511 tonnes in 1990 and equal to 62,466 Mg in 2012.
CH_4 emissions from steel production have been estimated on the basis of emission factors derived from the specific IPPC BREF Report (IPPC, 2001 available at http://eippcb.jrc.es), sectoral study (APAT, 2003) and the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2007) and refer to blast furnace, basic oxygen furnace, electric furnaces and rolling mills.

Ferroalloys
CO_2 emissions from ferroalloys have been estimated on the basis of activity data published in the national statistical yearbooks (ISTAT, several years) until 2001. Time series of ferroalloys activity data have been reconstructed from 2002 on the basis of statistical information (ISTAT, 2003), personal communication (Italghisa, 2011) and on the basis of production data communicated to E-PRTR register and to ETS from the only plant of ferroalloys in Italy. The comparison between E-PRTR and ETS data revealed some differences: further investigation led to a direct contact with the plant and to rectify the incorrect activity data.
The average emission factor has been calculated according to the IPCC Guidelines (IPCC, 2006) taking into consideration the different types of ferroalloys produced. The splitting up of national production in different types of ferroalloys was obtained from U.S. Geological Survey until 2001 (USGS, several years). Since 2002 only one plant of ferroalloys is located in Italy and different types of production are reconstructed on the basis of information listed above. This information is reported in the following box.

Splitting up of ferroalloys national production and IPCC 2006 emission factors

Ferroalloy	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**IPCC 2006 EF** kg/t
FeCr	0.30	0.26	-					1,300
FeMn	0.24	0.10	0.28	0.50	0.40	0.60	0.36	1,500
FeSi	0.02	-	-					4,800
SiMn	0.32	0.53	0.62	0.50	0.60	0.40	0.64	1,400
Si-Metal	0.06	0.05	0.03					5,000
Other	0.07	0.06	0.07					5,000

Implied emission factor for ferroalloys has been reduced from 1.90 to 1.44 t CO_2/t ferroalloys production, from 1990 to 2012 as a consequence of the sharp reduction in ferroalloys production, which is characterized by high emission factors (ferro-silicon and silicon-metal alloys). The simultaneous reduction of total production (from about 200 kt to 50 kt) has resulted in CO_2 emissions decreasing from 395 Gg in 1990 to 70 Gg in 2012.

Aluminium production
PFC emissions from aluminium production have been estimated using both Tier 1 and Tier 2 IPCC methodologies. The Tier 1 has been used to calculate PFC emissions from 1990 to 1999, while Tier 2 has been used since 2000; the use of different methods along the period is due to the lack of detailed data for the years previous to 2000. Although a number of attempts have been tried over the last years by the inventory team to retrieve the 1990-1999 historical operating data, it is not possible to retrieve the information: Alcoa

can not provide operating data for the period from 1990 to 1999 as the plants were managed by a different company not operating anymore. Thus the decision to use both tiers, which was supported by previous review processes, confirming the transparency, accuracy and conservativeness of this approach.
PFC emissions, specifically CF_4 and C_2F_6, have been calculated on the basis of information provided by national statistics (ENIRISORSE, several years; ASSOMET, several years) and the national primary aluminium producer (ALCOA, several years), with reference to the documents drawn up by the International Aluminium Institute (IAI, 2003; IAI 2006) and the IPCC Good Practice Guidance (IPCC, 2000).
Tier 1 method has been used to calculate PFC emissions related to the entire period 1990-1999. The emission factors for CF_4 and C_2F_6 were provided by the main national producer (ALCOA, 2004) based on the IAI document (IAI, 2003).
The Tier 1 method used by ALCOA is based on the IAI methodology, which collected anode effect data from 1990 up to 2000, accounting also for reductions in specific emission for all technology categories (specific factors for Point Fed Prebake cells have been considered to estimate emissions).
In 1990 at the five production sites the following technologies were implemented:

- Fusina: Point Fed Prebake (16% of the cells) and Side Work Prebake (84% of the cells);
- Portovesme: Point Fed Prebake (84% of the cells) and Side Work Prebake (16% of the cells);
- Bolzano: Vertical Stud Soderberg (100% of the cells)
- Fusina 2 and Porto Marghera: Side Work Prebake (100% of the cells).

The EFs for PFCs were then calculated by ALCOA as weighted arithmetic mean values of EFs for the different technologies (IAI, 2003), the weights representing the implemented technologies.
In the following tables (Tables 4.6, 4.7) the emission factors and the default parameters used are reported; site specific values are confidential but they have been supplied to the inventory team and taken into account in the estimation process.

Table 4.6 Historical default Tetrafluoromethane (CF_4) emission values by reduction technology type (IAI, 2003)

	Technology specific emissions (kg CF_4 / t Al)		
	1990 - 1993	**1994 - 1997**	**1998 – 1999**
Point Fed Prebake	0.3	0.1	0.08
Side Work Prebake	1.4	1.4	1.4
Vertical Stud Søderberg	0.6	0.5	0.4

Table 4.7 Multiplier factor for calculation of Hexafluoroethane (C_2F_6) by technology type (IAI, 2003)

	Technology multiplier factor
Center Work Prebake	0.17
Point Fed Prebake	0.17
Side Work Prebake	0.24
Vertical Stud Søderberg	0.06

PFC emissions for the period from the year 2000 are estimated by the IPCC Tier 2 method, based on default technology specific slope factors and facility specific anode effect minutes. Site-specific values (CF_4 and C_2F_6 emissions) and default coefficients (slope coefficients for CF_4 and C_2F_6) were provided by the main national producer (ALCOA, several years). Moreover, from 2005 certificated emission values and parameters, including anode effects, have been communicated under EU-ETS (ALCOA, 2010).
In Table 4.8 slope coefficients used for CF_4 and C_2F_6 are reported. ALCOA uses these values suggested by International Aluminium Institute (IAI, 2006), in accordance to the coefficients reported in the IPCC 2006 Guidelines (IPCC, 2006).

Table 4.8 CF_4 and C_2F_6 Slope Coefficients (IAI, 2006)

Type of Cell	**CF_4**	**C_2F_6**
	Slope Factor (kg PFC/tAl/AE-minutes/cell day)	
Center Work Prebake	0.143	0.0173

Anode Effects (minutes/cell day)

	2000	2005	2006	2007	2008	2009	2010	2011	2012
Primary Aluminium Plant	0.96	0.87	0.74	1.00	0.55	0.81	0.60	0.53	0.31

CO_2 emissions from aluminium production have been also estimated on the basis of activity data provided by industrial association (ENIRISORSE, several years; ASSOMET, several years) and default emission factor reported by industry (ALCOA, 2004) and by the IPCC Guidelines (IPCC, 1997) which refer to the prebaked anode process.
Emission factor has been assumed equal to 1.55 t CO_2/t primary aluminum production for the years 1990-2001, on the basis of data provided by the producer for 2002; this value is also consistent with the emission factors contained in the IPCC Guidelines and in the Aluminium Sector Greenhouse Gas Protocol. Since 2002 the emission factor has been calculated on account of information from the relevant plant supplied to the national EPER/EPRTR registry (emissions and productions). Therefore, thanks to the availability of this additional information, CO_2 emission estimations have been carried out by the operator since 2002 according to the criteria defined by the International Aluminium Institute (IAI) and are given by the following three components:

- Electrolysis Emissions from Prebake Anode
- Pitch Volatile Matter Oxidation from Pitch Coking
- Bake Furnace Packing Material

This detailed information is not available for previous years (1990-2001) so the Tier 2 approach can not be extended to those years and Tier 1 has to be used. Although a number of attempts have been tried for the last years by the inventory team to retrieve the same information related to 1990-2001, those data cannot be retrieved. Therefore the Tier1+Tier2 approach allows ensuring the quality of the estimates and also the consistency of the CO_2 emissions time series depending on the quality of the available information.

In the following tables (Tables 4.9, 4.10) the emission factors and the default parameters used are reported; site specific values are confidential but they have been supplied to the inventory team.

Table 4.9 Coefficients used for estimation of CO_2 from aluminium production process with the Tier 2 methodology by plant

	Baked Anode Properties		
	Sulphur	**Ash**	**Impurities**
	Weight %	*Weight %*	*Weight %*
Portovesme	ssv*	ssv	DV** = 0.4
Fusina	DV = 1.6	ssv	DV = 0.4

* site specific value
** default value

Table 4.10 Coefficients used for estimation of CO_2 from aluminium production process with the Tier 2 methodology by plant

	Pitch content in green anodes	Hydrogen content in pitch	Recovered tar	Packing coke consumption	Sulphur content of packing coke	Ash content of packing coke
	Weight %	*Weight %*	*kg/t BAP*	*t Pcc/ t BAP*	*Weight %*	*Weight %*
Portovesme	ssv*	ssv	DV** = 0	DV = 0.05	DV = 3	DV = 5
Fusina	ssv	DV = 4.45	DV = 0	DV = 0.05	DV = 3	DV = 5

* site specific value
** default value

<u>*Magnesium foundries*</u>
For SF_6 used in magnesium foundries, according to the IPCC Guidelines (IPCC, 1997), emissions are estimated from consumption data made available by the company (Magnesium products of Italy, several years), assuming that all SF_6 used is emitted. In 2007, SF_6 has been used partially, replaced in November by HFC125, due to the enforcement of fluorinated gases regulation (EC, 2006). This regulation allows for the use of SF_6 in annual amounts less than 850 kg starting from 1 January 2008; for this reason SF_6 was still reported together with HFC 125 emissions for the years 2008, 2009 while for 2010 only HFC125 was

reported. Since 2011 HFC134a has replaced HFC125. HFC 125 emissions, as well as HFC134a, have been reported in the CRF category 2G Other.

4.4.3 Uncertainty and time-series consistency

The combined uncertainty in PFC emissions from primary aluminium production is estimated to be about 11% in annual emissions, 5% and 10% concerning respectively activity data and emission factors; the uncertainty for SF_6 emissions from magnesium foundries is estimated to be about 7%, 5% for both activity data and emission factors. The uncertainty in CO_2 emissions from the sector is estimated to be 10.4%, for each activity, while for CH_4 emissions about 50%.
In Table 4.11 emission trends of CO_2, CH_4 and F-gases from metal production are reported. The decreasing of CO_2 emissions from iron and steel sector is driven by the use of lime instead of limestone and dolomite to remove impurities in pig iron and steel while CO_2 emissions from aluminium and ferroalloys are driven by the production levels.
In Table 4.12 the emission trend of F-gases per compound from metal production is given. PFC emissions from aluminium production decreased because of the closure of three old plants in 1991 and 1992 and the update of technology for the two plants still operating. The decreasing of SF_6 consumption in the magnesium foundry from 2003 is due to the abandonment of recycling plant and the optimisation of mixing parameters.

Table 4.11 CO_2, CH_4 and F-gas emissions from metal production, 1990 – 2012 (Gg)

EMISSIONS	1990	1995	2000	2005	2010	2011	2012
CO_2 (Gg)							
Iron and steel	3,124	2,897	1,230	1,533	1,139	1,297	1,291
Aluminium production	359	276	295	299	250	240	159
Ferroalloys	395	230	229	89	77	74	70
CH_4 (Gg)							
Pig iron	2.13	2.10	2.02	2.06	1.54	1.77	1.70
Steel	0.58	0.60	0.60	0.67	0.63	0.70	0.67
PFC (Gg CO_2 eq.)							
Aluminium production	1,673	298	198	182	85	81	33
SF_6 (Gg)							
Magnesium foundries	-	-	0.0072	0.0035	0.0007	-	-
HFC125 - 2G Other (Gg)							
Magnesium foundries	-	-	-	-	0.0006	-	-
HFC134a - 2G Other (Gg)							
Magnesium foundries	-	-	-	-	-	0.0030	0.0032

Table 4.12 Actual F-gas emissions per compound from metal production in Gg CO_2 equivalent, 1990 – 2012

COMPOUND	1990	1995	2000	2005	2010	2011	2012
Gg CO_2 eq.							
CF_4 (PFC-14)	1,289.2	235.8	169.2	155.5	72.7	69.5	28.3
C_2F_6 (PFC-16)	384.1	61.7	29.0	26.6	12.4	11.9	4.8
Total PFC emissions from aluminium production	*1,673.4*	*297.5*	*198.2*	*182.1*	*85.2*	*81.4*	*33.1*
Total SF_6 emissions from magnesium foundries	-	-	*172.1*	*84.7*	*17.5*	-	-
HFC-125 in Magnesium foundries	-	-	-	-	*1.7*	-	-
HFC-134a in Magnesium foundries	-	-	-	-	-	*3.9*	*4.2*
Total F-gas emissions from metal production	1,673.4	297.5	370.3	266.8	104.3	85.3	37.3

In response to the 2010 review process (UNFCCC, 2010) a more robust Tier 1 comparison has been evaluated in order to strengthen the conservativeness of combined Tier 1 and Tier 2 approaches.

In particular, as suggested by previous review processes, several comparisons were analyzed, using Tier 1 and Tier 2 approach, and under Tier 1 approach using different emission factors available from the following references (IAI, 2003; IAI, 2006; IPCC 2000):

1. 2003 International Aluminium Institute document, supplied by ALCOA to calculate emissions from 1990 to 1999 and actually used by the Party;
2. the updated 2006 International Aluminium Institute document, which agree with new 2006 IPCC Guidelines;
3. 2000 IPCC Good Practice Guidance.

In Tables 4.13 and 4.14 CF_4 and C_2F_6 default emission factors (Tier 1) and slope coefficient data (Tier 2) by technology are reported, distinguished for different reference sources.

Table 4.13 Default CF_4 and C_2F_6 Emission Factors

	CF_4 (kg/t)				C_2F_6 (kg/t)			
Plant Technology	**IAI 2003**	**IAI 2006**	**GPG 2000**	**GL 2006**	**IAI 2003**	**IAI 2006**	**GPG 2000**	**GL 2006**
CWPB	0.4	0.4	0.31	0.4	0.17	0.04	0.04	0.04
PFPB	0.3*	-	-	-	0.17*	-	-	-
SWPB	1.4	1.6	1.7	1.6	0.24	0.4	0.17	0.4
VSS	0.6	0.8	0.61	0.8	0.06	0.04	0.061	0.04
HSS	0.7	0.4	0.6	0.4	0.09	0.03	0.06	0.03

*****This value refer to period 1990 – 1993 (see Table 4.6)

Table 4.14 Default CF_4 and C_2F_6 Slope Coefficients

	CF_4 (kg PFC / t Al / AE minutes/cell day)				C_2F_6 (kg PFC / t Al / AE minutes/cell day)			
Plant Technology	**IAI 2003**	**IAI 2006**	**GPG 2000**	**GL 2006**	**IAI 2003**	**IAI 2006**	**GPG 2000**	**GL 2006**
CWPB	0.14	0.143	0.14	0.143	0.018	0.0173	0.018	0.0173
PFPB	-	-	-	-	-	-	-	-
SWPB	0.29	0.272	0.29	0.272	0.029	0.0685	0.029	0.0685
VSS	0.067	0.092	0.068	0.092	0.003	0.0049	0.003	0.0049
HSS	0.18	0.099	0.18	0.099	0.018	0.0084	0.018	0.0084

Worthy of remark is that, lacking specific plant data, IAI 2003 is the only document including emission factors for Point Fed Prebake technology, which is the technology implemented at the only remaining production site since 1990. Moreover, as reported in this document, IAI proposed lowest accuracy default method departs from the IPCC default method. In the IPCC default method a single specific emission value is specified for each of four reduction technology categories: Center Work Prebake, Side Work Prebake, Vertical Stud Søderberg and Horizontal Stud Søderberg. The IPCC expert working panel mostly based these default factors on 1990 average IAI anode effect data and the average technology specific slope factors. IAI survey data collected since the publication of the original IPCC default values shows substantial reductions over the period 1990 to 2000 in specific emissions in all technology categories. In addition it has been shown that among the overall category of Center Work Prebake cells, the more modern Point Fed Prebake cells have made progress at a faster rate than for the older bar broken Center Work Prebake cells. Thus the original category has been broken into two separate types.
This is one of the most important reasons that convinced Italy to use IAI 2003 default emission factors over the period 1990-1999, as indicated also by ALCOA, instead of IPCC Good Practice Guidance default emission factors. As reported in a recent publication supplied by ECOFYS (ECOFYS, 2009), currently all new aluminium plants are designed according to Point Fed Prebake technology and the first improvement in the primary aluminium industry advancement is to replace current technologies with PFPB. Other technologies, Vertical Stud Søderberg, Center Work Prebake and Side Work Prebake are expected to be gradually replaced by PFPB. Only 20% of the existing plants had not yet been upgraded to PFPB in EU27.

Moreover, the mean implied emission factor value for CF_4 over the period 2000-2012 is 0.12 (kg/t), comprised between 0.3 and 0.1 kg/t indicated in IAI 2003 for PFPB technology (see Table 4.6).

Figures 4.2 and 4.3 report the comparison in CF_4 emissions time series following Tier 1 and Tier 1 + Tier 2: in each diagram the emissions time series out of different source for EFs are compared.

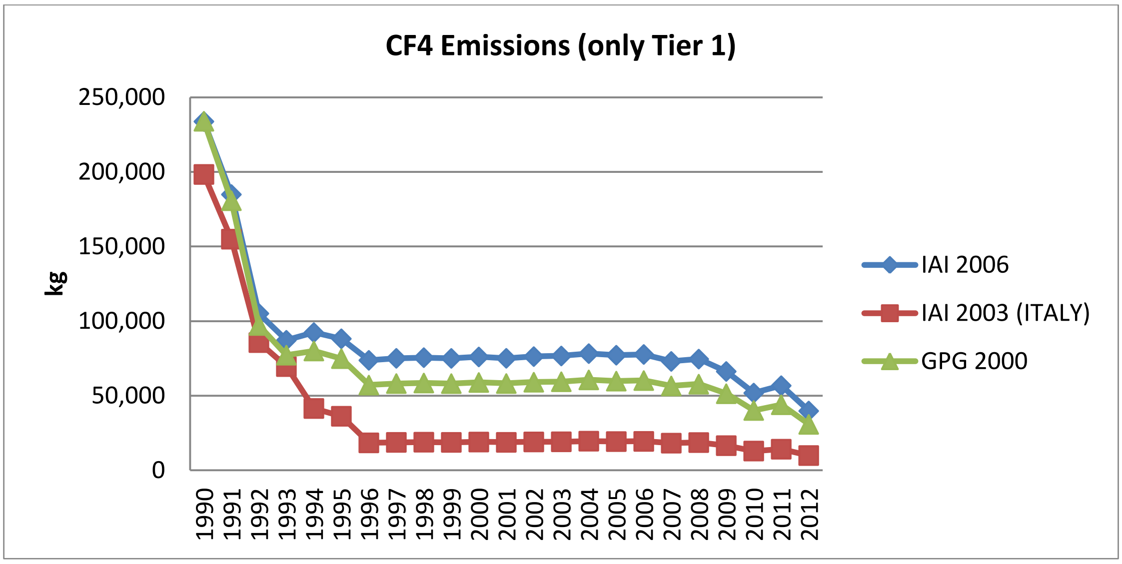

Figure 4.2 CF_4 emissions (only Tier 1)

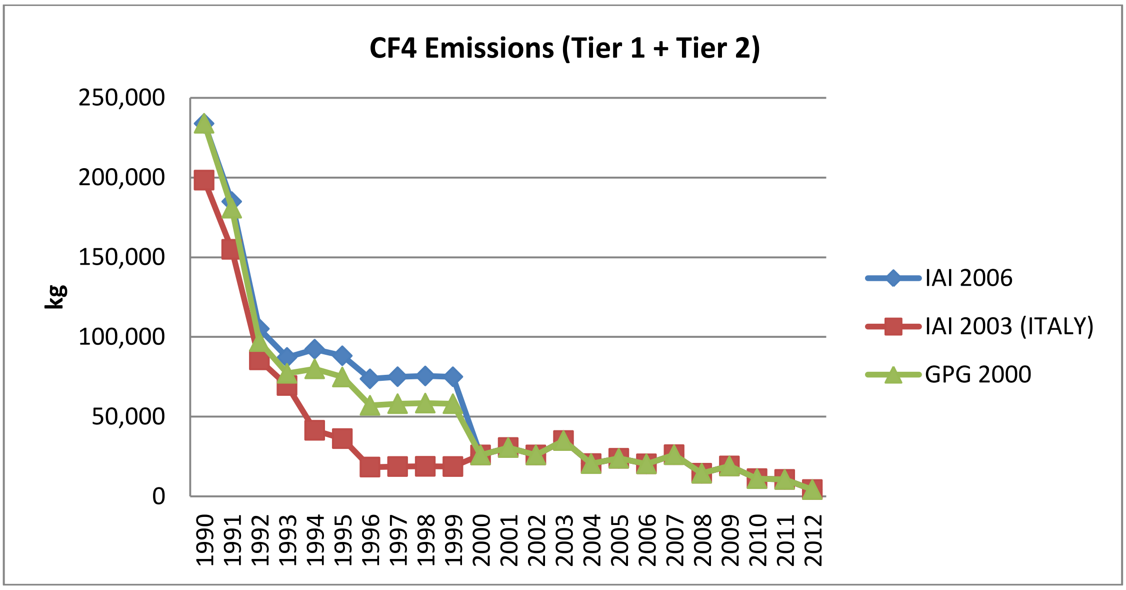

Figure 4.3 CF_4 emissions (Tier 1+Tier 2)

As for consistency, the Tier 1 + Tier 2 approach in estimating emissions is more reliable in producing the time series because it allows to use site specific data provided by the operator from 2000 onwards (and the use of the best available data is a good practice). Moreover, emission factor values reported in the IPCC Good Practice Guidance or in the 2006 IAI document (mean implied emission factor is 0.12 kg/t) lead to higher values for the emissions time series than those calculated out of emission factor values in 2003 IAI document (0.08 kg/t supplied by ALCOA and used by the Party), which means that national estimates can be considered conservative for the period. So for 1990 the use of EFs from IAI 2003, red line, results in CF_4 emission levels lower than those estimated by using the other EF references. This comparison was already done during the compilation of the 2006 submission and the Initial Report, which resulted in the establishment of the assigned amount.
Tier1 (1990-1999) and Tier 2 (2000-2012) time series are also better linked using IAI 2003 EFs (see Figure 4.3) because of the minor gap from 1999 to 2000 since the mean implied emission factor value for CF_4 over

the period 2000-2012 is 0.12 (kg/t), comprised between 0.3 and 0.1 kg/t indicated in IAI 2003 for PFPB technology (see Table 4.6).
For this reason, the use of the combined Tier1+Tier2 approach, in this case, is conservative.

4.4.4 Source-specific QA/QC and verification

Emissions from the sector are checked with the relevant process operators. In this framework, primary aluminium production supplied by national statistics (ENIRISORSE, several years; ASSOMET, several years) and the only national producer ALCOA (ALCOA, several years), in addition with data reported in a site-specific study (Sotacarbo, 2004), have been checked. Moreover, emissions from magnesium foundries are annually compared with those reported in the national EPER/E-PRTR registry while for the iron and steel sector emissions reported in the national EPER/E-PRTR registry and for the Emissions Trading Scheme are compared and checked. Emissions from primary aluminium production have been also checked with data reported under EU-ETS.

4.4.5 Source-specific recalculations

Minor recalculations occurred for PFC emissions in the years 2005 – 2009, due to update of activity data and for CO2 emissions from aluminium production in 2010 – 2011 because of corrections in the activity data

4.4.6 Source-specific planned improvements

Reductants used in EAF and the average emission factor of CO_2 from electric arc furnaces have been checked with ETS data and the T2 methodology will be applied in the next submission.

4.5 Other production (2D)

4.5.1 Source category description

Only indirect gases and SO_2 emissions occur from these sources.
In this sector, non-energy emissions from pulp and paper as well as food and drink production, especially wine and bread, are reported. CO_2 from food and drink production (e.g. CO_2 added to water or beverages) can be of biogenic or non-biogenic origin but only information on CO_2 emissions of non-biogenic origin should be reported in the CRF.
According to the information provided by industrial associations, CO_2 emissions do not occur, but only NMVOC emissions originate from these activities.
CO_2 emissions from food and beverages do not occur since they originated from sources of carbon that are part of a closed cycle.
As regards the pulp and paper production, NO_X and NMVOC emissions as well as SO_2 are estimated. NOx and SOx emissions have been referred to the paper and pulp production from acid sulphite and neutral sulphite semichemical processes up to 2009, activity data and emissions were provided by the two Italian production plants: in 2008 the bleached sulphite pulp production has stopped while in 2009 the neutral sulphite semi-chemical pulp process has closed (reconversion of the plant is currently under negotiation). NMVOC emissions are related to chipboard production and have been estimated and reported also for 2011.

4.6 Production of halocarbons and SF_6 (2E)

4.6.1 Source category description

The sub-sector production of halocarbons and SF_6 consists of two sources, “By-product emissions” and “Fugitive emissions”, identified as non-key sources. The production of halocarbons and SF_6 took place in

two facilities in Italy up to 2008 (Spinetta Marengo and Porto Marghera). Since the very beginning of 2005 the plant in Spinetta Marengo has not been producing SF_6 any longer. In the first quarter of 2008 the production plant at Porto Marghera has stopped its activity, since then there is only one facility in Italy where halocarbons productions have been carried out.
Within by-product emissions, HFC23 emissions are released from HCFC22 manufacture, CF_4 emissions are released from SF_6 and HCFC22/TFM productions, whereas C_2F_6 and HFC143a emissions are released from the production of C_3F_6 (and also CFC115) and HFC134a, respectively. Production of CFC115 was carried out only in one facility and stopped in 1998. Since the very beginning of 2005 Spinetta Marengo plant has not been producing SF_6 any longer.
Production of HFC125, HFC134a, HFC227ea and SF_6 lead to fugitive emissions of the same gases. In particular, production of HFC227ea only occurred in 1999.
A focus on by-product emissions from this sector has led to revise emission estimates for the whole time series. The share of F-gas emissions from the production of halocarbons and SF_6 in the national total of F-gases was 40.5% in the base-year (1990), and 10.8% in 2012. The share in the national total greenhouse gas emissions was 0.25% in the base-year and 0.26% in 2012..

4.6.2 Methodological issues

For both source categories ”By-product emissions” and “Fugitive emissions”, the IPCC Tier 2 method is used, based on plant-level data. The communication is supplied annually by the only national producer, and includes productions, emissions, import and export data for each gas (Solvay, several years). In particular, the operator of the only producing facility has been reporting CF_4 emissions to the national PRTR register for four years since 2007; in the Revised 1996 IPCC Guidelines and in the IPCC Good Practice Guidance, no methodology is reported. CF_4 emissions represent additional by product emissions together with HFC23 emissions (those being well referenced instead). The operator supplied all the relevant information for a better understanding of the activities taking place at the site of Spinetta Marengo and to help the inventory team to allocate CF_4 emissions from HCFC22 production properly. The industrial site of Spinetta Merengo hosts not only Solvay but also other Companies and is in the scope of EPRTR, IPPC permitting procedure and Seveso European Legislation. At the facility the monitoring system has 27 devices to perform gas chromatography analysis and about 540 monitoring points at the site. The resulting monitoring data flow, which regard other pollutants, is sent via web to the regional agency for the environmental protection (ARPA Piemonte).
In particular the operator explained that HCFC22 production has been carried out in Spinetta Marengo since ‘50s and up to 1990 part of HCFC22 was probably also sold as a marketable product. Since 1990 practically all the HCFC22 produced has been the input for the TFM (tetrafluoroethylene monomer) production process (by pyrolisis of HCFC22 at 600 °C), the TFM has been then used to produce TFE (tetrafluoroethylene, C_2F_4) and PTFE (polytetrafluoroethylene), HFP (hexafluoropropylene) and the other different fluoropolymers and fluoroelastomers. All the fluorinated flue gases from the different production lines are collected and treated in a centralized abatement unit (thermal oxidation system), specifically designed for the Spinetta Marengo plant, working at a temperature of 1400 °C with a residence time of the gases minor of 2 seconds. The abatement unit is run continuously and allows reducing F-gas emissions not depending on the operating level of the main production process. In the treated flue gases CF_4 is still present (65% of CF_4 released to air pass through the abatement system untreated for thermodynamic reasons; 35% of CF_4 released to air is formed during the reactions occurring in the abatement unit). Estimations of CF_4 emissions released to air have been then reported to the national PRTR since 2007. The operator has provided the time series for the activity data from 2002 to 2010 (HCFC22 and TFM), since the activity data for the years before 2002 are not retrievable (the property of the facility has changed over the years before 2002 and the administrative systems and softwares have also been changed many times); in order to complete the activity data time series for the period 1990-2001 a linear increasing production level was assumed from 1990 to 2002. The ratio relating TFM production to HCFC22 production in 2002 has been taken also over the years 2001 back to 1990 to estimate the TFM productions. CF_4 emission factor for 2007 was set constant in order to estimate the CF_4 time series over the years from 1990 to 2006. CF_4 emissions time series have been then included in the estimates under the CRF category 2E1 (By-product emissions).
In order to provide detailed information on the methodology applied for this category,CF_4 emissions estimation from HCFC22 can be summarised as follows:

1) For the years 2007-2010 by-product CF_4 emissions from HCFC22 production has been supplied by the operator (through the national PRTR). Based on data reported to the national PRTR since 2007 and the activity data concerning HCFC production, the TFM/HCFC22 ratio along the timeseries, the EF for by-product CF_4 emission has been calculated.
2) CF_4 EF (by-product emissions from HCFC22 production) for 2007 has been set as default value for the period 1990-2006 in order to estimate by-product CF_4 emissions consistently along the whole time series.
3) Activity data for the facilities are available for the years 2002-2010, so the missing activity data were estimated based on the HCFC22 production capacity of the facility in 1990 and 2002 HCFC22 production figure assuming a linear increasing production level whithin the years. The TFM/HCFC22 ratio for 2002 was assumed as a default ratio to estimate TFM production consistently from 1990 and 2002.
4) By product CF_4 emissions were estimated by applying the EF derived in point 2) to the TFM production levels along the years 1990-2002.

HFC23 is a by product of the HCFC22 production process, the HFC23/HCFC22 rate is about 3%. The abatement system, as previously mentioned, allows for treating all the fluorinated flue gases, vented gases originated in the processes at the facilty before being released to air. Since 1989 the abatement system has allowed to reduce HFC23 released to air, up to 1996 HFC23 emissions had been about 30 t/y. In 1996 the abatement system was improved with a second operating unit, since 1996 the abatement rate has been 99.99% thus reducing drastically HFC23 emissions close to zero. The operator communicated that for a HCFC22 production of 30,000 tons, HFC23 theroical residual emissions are less than 100 kg; a monitoring analysis has measured about 10 kg of HFC 23 in one year (Spinetta Marengo, 2011). HFC23 emissionshave been estimated, in responce to the problem identified by the EU during the European Union 2013 GHG inventory check review and included in the estimates under CRF category 2E1 (By-product emissions; Solvay Solexis, 2011).

4.6.3 Uncertainty and time-series consistency

The uncertainty in F-gas emissions from production of halocarbons and SF_6 is estimated to be about 11% in annual emissions.

HFC23 emissions from HCFC22 had been drastically reduced since 1996 due to the installation of a second thermal oxidation system in the facility located in Spinetta Marengo (the only facility currently producing HCFC22 in Italy). Productions and emissions from 1990 to 1995 are constant as supplied by industry; from 1996, untreated leaks have been collected and sent to the thermal oxidation system, thus allowing reduction of emissions under 100 kg (E.F. 3.3 g of HFC23/t of HCFC22). CF_4 by-product emissions in HCFC22 production process have been fully investigated, information supplied by the operator has allowed estimating emissions for the whole time series.

This information about productions and emissions is yearly directly updated by the producer, and it is also reported in the framework of the national PRTR register, confirming that the technology is fully operating.

PFC (C_2F_6) by-product emissions and SF_6 fugitive emissions were constant from 1990 to 1995 (4 t/y for C_2F_6 emissions; 5 t/y for SF_6 emissions) and from 1996 to 1998 (1 t/y for C_2F_6 emissions; 2 t/y for SF_6 emissions) and have eventually reduced to zero since 1999 due to the stop of the CFC115 production in one facility and the upgrade of the thermal oxidation system mentioned above in the other facility. Besides, SF_6 production has stopped since the 1st of January 2005.

Regarding fugitive emissions, emissions of HFC125 and HFC134a have been cut in 1999 thanks to a rationalisation in the new production facility located in Porto Marghera, whereas HFC143 released as by-products from the production of HFC134a has been recovered and commercialised. The relavant productions in Italy which originate these fugitive emissions stopped in the first quarter of 2008.

In Table 4.15 an overview of the emissions from production of halocarbons and SF_6 is given for the 1990-2011 period, per compound.

Table 4.15 Actual emissions of F-gases per compound from production of halocarbons and SF_6 in Gg CO_2 equivalent, 1990 – 2012

COMPOUND	1990	1995	2000	2005	2010	2011	2012
Gg CO_2 eq.							
HFC 23	351.0	351.0	1.0	1.0	0.8	0.9	0.8
HFC 143a	-	22.8	3.8	4.2	-	-	-
CF_4	776.6	873.1	872.1	1,361.1	1,144.0	1,265.6	1,183.0
PFC C2÷C3 (C_2F_6)	36.8	36.8	-	-	-	-	-
Total F-gas by product emissions	*1,164*	*1,284*	*877*	*1,366*	*1,145*	*1,266*	*1,184*
HFC 125	-	28.0	2.8	3.4	-	-	-
HFC 134a	-	39.0	15.6	12.6	-	-	-
HFC 227ea	-	-	-	-	-	-	-
SF_6	119.5	119.5	-	-	-	-	-
Total F-gas fugitive emissions	*119.5*	*186.5*	*18.4*	*16.0*	-	-	-
Total F-gas emissions from production of halocarbons and SF_6	1,284	1,470	895	1,382	1,145	1,266	1,184

4.6.4 Source-specific QA/QC and verification

Emissions from production of halocarbons and SF_6 have been checked with data reported to the national EPER/E-PRTR registry. Additional CF_4 emissions have been then accounted for along the whole time series for category 2E.

4.6.5 Source-specific recalculations

Recalculations have been occurred for HFC 23 from HCFC 22 production for the years 1996 – 2011. To be conservative, an emission factor of 3.3 g of HFC23/t of HCFC22 has been considered, even if the plant operator has always communicated zero emission from the thermal afterburner and a monitoring analysys has measured about 10 kg of HFC 23 in one year (the results of this monitoring analysis are not available form the Company)

4.6.6 Source-specific planned improvements

No further improvements are planned.

4.7 Consumption of halocarbons and SF_6 (2F)

4.7.1 Source category description

The sub-sector consumption of halocarbons and SF_6 consists of three sources, “HFC, PFC emissions from ODS substitutes”, key category at level and trend assessment, both Tier 1 and 2 approaches, “PFC, HFC, SF_6 emissions from semiconductor manufacturing”, “SF_6 emissions from electrical equipment”, that are non-key categories.
Potential emissions are also reported in this section.
The share of F-gas emissions from the consumption of halocarbons and SF_6 in the national total of F-gases was 6.73% in the base-year 1990, and 88.8% in 2012; the share in the national total greenhouse gas emissions was 0.04% in the base-year, and 2.11% in 2012.

4.7.2 Methodological issues

The methods used to calculate F-gas emissions from the consumption of halocarbons and SF_6 are presented in the following box:

Sub-sources of F-gas emissions and calculation methods

Source category	Sub-source	Calculation method
HFC, PFC emissions from ODS substitutes	Refrigeration and air conditioning equipment (2F1)	IPCC Tier 2a
	Foam blowing (2F2)	IPCC Tier 2a
	Fire extinguishers (2F3)	IPCC Tier 2a
	Aerosols/metered dose inhalers (2F4)	IPCC Tier 2a
PFC, HFC, SF_6 emissions from semiconductor manufacturing (2F6)		IPCC Tier 2a
SF_6 emissions from electrical equipment (2F7)		IPCC Tier 2a

Total emissions have been calculated as the sum of manufacturing emissions, use emissions and disposal emissions. The estimates are based on single gas consumptions data supplied by the only national refrigerants producer (Solvay, several years) and by industry and not on equipment consumption estimates.
Beacause of the approach followed, and thus lack of data on quantity of each gas disposed, emissions from disposal are included into the emissions during the product's life for the whole time series, except for SF_6 emissions from electrical equipments, which disposal emissions are supplied by the ANIE Federation representing the electrotechnical and electronic companies operating in Italy (ANIE, several years).
Basic data have been supplied by industry: specifically, for the mobile air conditioning equipment the national motor company and the agent's union of foreign motor-cars vehicles have provided the yearly consumptions (FIAT, several years; IVECO, several years; UNRAE, several years; CNH, several years); for the other refrigeration and air conditioning equipment the producers supply detailed table of consumption data by gas (Solvay, several years); pharmaceutical industry has provided aerosols/metered dose inhaler data (Sanofi Aventis, several years; Boehringer Ingelheim, several years; Chiesi Farmaceutici, several years; GSK, several years; Lusofarmaco, several years; Menarini, several years; Istituto De Angeli, several years); the semiconductor manufacturing industry has supplied consumption and emission data for three national plants (ST Microelectronics, several years; MICRON, several years; Numonyx, several years); finally, for the sub-source fire extinguishers, the European Association for Responsible Use of HFCs in Fire Fighting was contacted (ASSURE, 2005), as well as the Consortium of fire protection systems (Clean Gas, 2001).
In the following box, the sources of activity data and emissions factors are summarized.

CRF Category	Category	Substance	Activity Data References	Emission Factors References
2.II.A.F.1.1	Domestic Refrigeration	HFC 134a	Solvay	Expert Judgement
2.II.A.F.1.2	Commercial Refrigeration	HFC 23 HFC 125 HFC 134a HFC 143a	Solvay	Expert Judgement
2.II.A.F.1.5	Stationary Air Conditioning	HFC 32 HFC 125 HFC 134a	Solvay	Expert Judgement
2.II.A.F.1.6	Mobile Air Conditioning	HFC 134a	FIAT, IVECO, UNRAE, CNH	IPCC GPG
2.II.A.F.2.1	Hard foam	HFC 245fa	Solvay	IPCC GPG
2.II.A.F.2.2	Soft foam	HFC 134a	Solvay	IPCC GPG
2.II.A.F.4.1	Metered Dose Inhalers	HFC 134a	Menarini, Chiesi, Sanofi Aventis, GSK, Lusofarmaco, Istituto De Angeli, Boehringer	Chiesi

2.F.3	Fire Extinguishers	HFC 227ea	Clean Gas	ASSURE
2.F.7	Semiconductor Manufacturing	HFC 23	ST Microelectronics, Micron, Numonyx	ST Microelectronics, Micron, Numonyx
		HFC 134a		
		CF_4		
		C_2F_6		
		C_3F_8		
		C_4F_8		
		SF_6		
2.F.8	Electrical Equipment	SF_6	ANIE, Energy Distrubution Industry	ANIE

For the sub-source category Stationary Refrigeration, emissions are estimated for Domestic Refrigeration, Commercial Refrigeration and Stationary Air Conditioning. Industrial Refrigeration and Transport Refrigeration estimations are included in Commercial Refrigeration because no detailed information is available to split consumptions and emissions in the different sectors.
Solvay, which is the only national refrigerants producer, has supplied gas consumptions data with the indication of the relevant use sector, as reported in the following box.

Refrigerant	**Final Use**	**Equipment typology**
R 404	Refrigeration	Large Commercial Refrigeration Equipments
R 507	Refrigeration	Large Commercial Refrigeration Equipments
R 407c	Air Conditioning	Chillers
R 410a	Air Conditioning	Chillers
HFC 23	Refrigeration	Small Commercial Refrigeration Equipments
HFC 134a (pure)	Refrigeration	Domestic Refrigeration Equipments

Appropriate losses rates have been applied for each gas, taking into account the equipment where refrigerants are generally used, as suggested by a pool of experts during a specific meeting held at the Ministry of the Environment, Land and Sea (ISPRA-MATTM, 2013), in order to assess F-gas emissions from refrigeration and air conditioning, with a focus on commercial refrigeration. These experts represent the following national associations of refrigeration and air conditioning:

- COAER-ANIMA (Air Conditioning) - Association of Manufacturers of aerodynamic equipment and systems under the Federation of National Associations of Mechanical and Engineering similar (ANIMA), which is the sectoral industrial association within Confindustria (Confederation of Italian Industry) representing companies in this sector.
- ASSOFOODTEC-ANIMA (Commercial Refrigeration) - Association of Italian manufacturers of machinery, plant, equipment for the production, processing and preservation of food, under the ANIMA Federation.
- AICARR – Italian Association of Air Conditioning, Heating and Refrigeration.
- CECED (Domestic Refrigeration) - It represents the manufacturers of the Domestic and Professional Appliance sector in Italy; CECED is a member of ANIE Federation (The National Federation of Italian Electrotechnical, Electronics and ICT Companies) and Confindustria.

On the basis of their knowledge, the appropriate emission factors are reported in the following box, distinguished in two different periods of the time series.

	1990-1999		**2000-2012**	
	Leakage rate (%)		**Leakage rate (%)**	
Equipment	Manufacturing	Product life	Manufacturing	Product life
Small Commercial Refrigeration	0.5%	5.0%	0.5%	5.0%
Chillers	3.0%	5.0%	0.5%	2.0%
Large Commercial Refrigeration	3.0%	15.0%	0.5%	12.0%
Domestic Refrigeration	3.0%	0.7%	0.5%	0.7%

For what concern the other sources of emissions of substitutes for ozone depleting substances, the following emission factors have been used, for the whole time series.

	Leakage rate (%)	
	Manufacturing	Product life
Mobile Air Conditioning – new vehicles	4%	10%
Mobile Air Conditioning – retrofit vehicles	8%	20%
Metered Dose Inhalers	1.95%	100%
Foam	10%	5%
Fire Protection	0%	5%

The Regulation n. 842/2006 of the European Parliament and of the Coucil of 17 May 2006 on certain fluorinated greenhouse gases (EC, 2006), has been transposed into a national decree in 2012, by the Decree of the President of the Republic 27 January 2012, n. 43 (DPR 43/2012). In particular, the article 3(6) of the Regulation n. 842/2006 has been transposed in the art. 16 of the national Decree, where is stated that every year by the 31 May, the operator of the refrigeration, air conditioning and heat pump equipment, as well as fire protection systems, which contain more than 3 kg of fluorinated greenhouse gases, must submit to ISPRA data on emissions referred to those applications.
ISPRA has developed a specific website, where each operator requests username and password and compiles the Declaration.
The year 2012 has been the first year of the data collection, and actually ISPRA is opening the new 2014 collection (data collected will refer to the year 2013). Data are still of course not complete, and consequently not comparable with inventory data, but a preliminary analysis has been done, resulting in product life factor for the commercial appliances much far lower compare to product life factors reported in the IPCC GPG and Guidelies, as enhanced in the following box.

	National DB			**IPCC GPG**		**IPCC Revised GL96**	
Charge class (kg)	**Total charge (kg)**	**Total annual release (kg)**	**Product life factor (%)**	**Charge class (kg)***	**IPCC GPG Product life factor (%)***	**Charge class (kg)****	**Product life factor (%)****
3 - 6	2,518	54	2.14	0.2 - 6	1 - 10	NA	NA
6 - 50	28,863	725	2.51	NA	NA	10 - 230	17% (3% if improved valves and fittings are used)
> 50 kg	271,442	2,170	0.80	50 - 2000	10 - 30		
Total	*302,823*	*2,949*	*0.97*				

* IPCC Good Practice Guidance - Industrial Processes, Chapter 3 table 3.22
** Revised 1996 IPCC Guidelines: Workbook - Industrial Processes table 2-29

As regard SF_6 emissions from electrical equipment, these have been estimated according to the IPCC Tier 2a approach. Concerning manufacturing and installation emissions, since 1995 the methodology used is largely in accordance with the IPCC Tier 3b methodology.In 1997, the ANIE Federation has began a statistical survey within their associated companies, in accordance with ISPRA, in order to monitorate yearly SF_6 used in electrical equipment > 1kV, and thus SF_6 manufacturing emissions (ANIE, 2001). ANIE Federation is the Confindustria member representing the electrotechnical and electronic companies operating in Italy. ANIE has developed data sheets for their associated companies in accordance with the methodology drawn up by CAPIEL, the Coordinating Committee for the Associations of Manufacturers of Switchgear and Controlgear equipments in the European Union: the CAPIEL inventory methodology covers all sorts of use of SF_6 in the electrical sector, from the SF_6 purchase till the end of life of the equipment and covers all aspects of the required data (CAPIEL, 2002). It is based on a Mass Balance Methodology, as given by IPCC Tier 3b, comparing the input and output on a yearly basis. In the Figure 4.4 the summary sheet used for manufacturing inventory, referred to the year 2011, is reported (ANIE, several years).

INVENTORY'S CATEGORIES					**Year 2012 (Kg)**
1. Purchased amount	1.1 In Italy		Weight of SF_6 contained in the tanks		37,798
	1.2 Abroad		Weight of SF_6 contained in the tanks		117,744
				TOTAL 1.	**155,542**
2. Amount contained in the equipment at the terms of sale	2.1 In Italy	2.1.1 ENEL	Weight of SF_6 contained in the equipments and in the tanks		26,846
		2.1.2 Energy industry and railways	Weight of SF_6 contained in the equipments and in the tanks		16,569
		2.1.3 Others (Industry, Tertiary, Private, ecc.)	Weight of SF_6 contained in the equipments and in the tanks		15,636
	2.2 Abroad		Weight of SF_6 contained in the equipments and in the tanks		88,978
				TOTAL 2.	**148,029**
3. Amount contained in the equipment returned to the manufacturer			Weight of SF_6 contained in the equipments and in the tanks	**TOTAL 3.**	**794**
4. a) Destroyed amount			Weight of SF_6 in the equipments sent to authorized disposal treatment		2,983
4. b) Amount returned to the manufacturer			Weight of SF_6 returned to manufacturer for authorized recycling		302
				TOTAL 4.	**3,285**
5. Annual stock changes				**TOTAL 5.**	**2,894**
SF_6 emissions from manufacturing	**Balance input-output (1+3-5)-(2+4)**				**2,128**

Figure 4.4 SF_6 inventory at manufacturing level (ANIE, reporting year 2012)

From 1990 to 1994 emissions have been estimated on the basis of leakage rate during manufacturing and installation and the amount of SF_6 contained in the equipments sold to the end users, because, for this period, only data referred to point 1 and point 2 of the Figure 4.4, are available from ANIE. The loss rates during manufacturing and installation of the equipments, used to estimate the SF_6 emissions, are reported in the Table 4.16. Leakage rates have been derived from ANIE Federation expert judgement.

Table 4.16 Leakage rates used to estimate SF_6 emissions from manufacturing and installation from 1990 to 1994

	1990	**1991**	**1992**	**1993**	**1994**
Manufacturing	0.060	0.060	0.060	0.060	0.060
Installation	0.060	0.055	0.050	0.045	0.040

In Table 4.17, SF_6 emissions from manufacturing (which include installation), use and disposal are reported. Emissons from manufacturing were about 14 tons in 1995, whereas in 2011 are only2.13 tons, starting from 110 tons of SF_6 purchased in 1995 and on the other hand 155 tons of SF_6 purcahsed in 2012. Emissions trend from manufacturing is strongly decreasing thanks to the diligence of the companies involved, which have taken voluntary actions to reduce emissions as much as technically possible. Probable fluctuations within the time series in manufacturing emissions are basically due to yearly variation of the stocked quantity of SF_6.

Table 4.17 SF_6 emissions from manufacturing, use and disposal

SF_6 EMISSIONS	1990	1995	2000	2005	2010	2011	2012
tons							
Manufacuring	8.470	14.657	5.637	3.562	3.185	1.554	2.128
Use	0.460	4.886	6.469	9.592	10.302	10.865	10.704
Disposal	0.000	0.623	0.464	0.199	0.059	0.065	0.024
Total	**8.930**	**20.165**	**12.571**	**13.353**	**13.546**	**12.484**	**12.856**

SF_6 use emissions are those from Closed Pressure Systems, including hight voltage equipment that requires refilling with gas during its lifetime. Equipment use emissions are estimating by multiplying the quantity of SF_6 yearly accumulated by a use emission factor. The quantity of SF_6 accumulated is estimated using SF_6 annual sales activity data (ANIE, several years), multiplied for the factor 0.8, which take into account the percentage of the total sales referred to Closed Pressure Systems. Moreover, equipment use emissions are the sum of three components:

- emissions from ENEL (the former electricicy monopoly);
- emissions from electricity utilities and the national railways company;
- emissions from industries and other private operators.

Since 1994, refilling data of SF_6 used in high voltage gas-insulated transmission lines have been supplied by the main energy distribution companies (in the past included in ENEL) checked with data reported under the national PRTR register (EDIPOWER, several years; ENDESA, 2004; ENDESA, several years [a] and [b]; ENEL, several years; TERNA, several years).
The leakage rate used to estimate the SF_6 use emissions is assumed equal to 0.01 from 1990 to 2009 and 0.005 from 2010, based on national expert judgment (AIET, 2007).

Finally, SF_6 disposal emissions from electrical equipments are estimating by multiplying the quantity of SF_6 contained in retired equipments by the fraction of SF_6 left in the equipment at the end of its life, assumed to be constant and equal to 0.15 from 1990 to 1995, and linearly decreasing until to 2010 value 0.03, as reported in Table 4.18. Since 1995, activity data (point 3 of the Figure 4.4) are directly supplied by ANIE (ANIE, several years), whereas from 1990 to 1994 the total amount of SF_6 accumulated in the equipments is multiplied by a disposal rate which is equal to zero in that period. Leakage disposal rate and disposal rate derived from personal communication.

Table 4.18 Disposal rates and leakage rate at disposal used to estimate SF_6 emissions from disposal, 1990-2012

	1990	1991	1992	1993	1994	1995	2000	2005	2010	2011	2012
Disposal rate	0	0	0	0	0	0	0.01	0.02	0.03	0.03	0.03
Leakage rate at disposal	0.15	0.15	0.15	0.15	0.15	0.15	0.11	0.07	0.03	0.03	0.03

As for fluctuation in emissions within the years, Figure 4.5 is reported for a better understanding.
As regard the years from 1995 to 2000, please consider that the total SF_6 emission values result by the sum of emissions from "manufacturing", "operating" and "retiring" and that concerning the trends of these contributions the following facts should be pointed out:
1) emissions from manufacturing reach a peak in 1997;
2) emissions from operating reach a peak in 1997;
3) emissions from retiring reach a peak in 1997 although the relevant contributions to total SF_6 emissions are those from manufacturing and operating.
Data between 1995 an 2000 are consistent and come from the SF_6 mass balance.
In Figure 4.5 the time series for SF_6 purchased amounts and of the three contributions to SF_6 emissions from electrical equipments are illustrated.
It could be noted that the trend of the amounts of SF_6 estimated for "manufacturing" is driven by the trend of purchased SF_6.

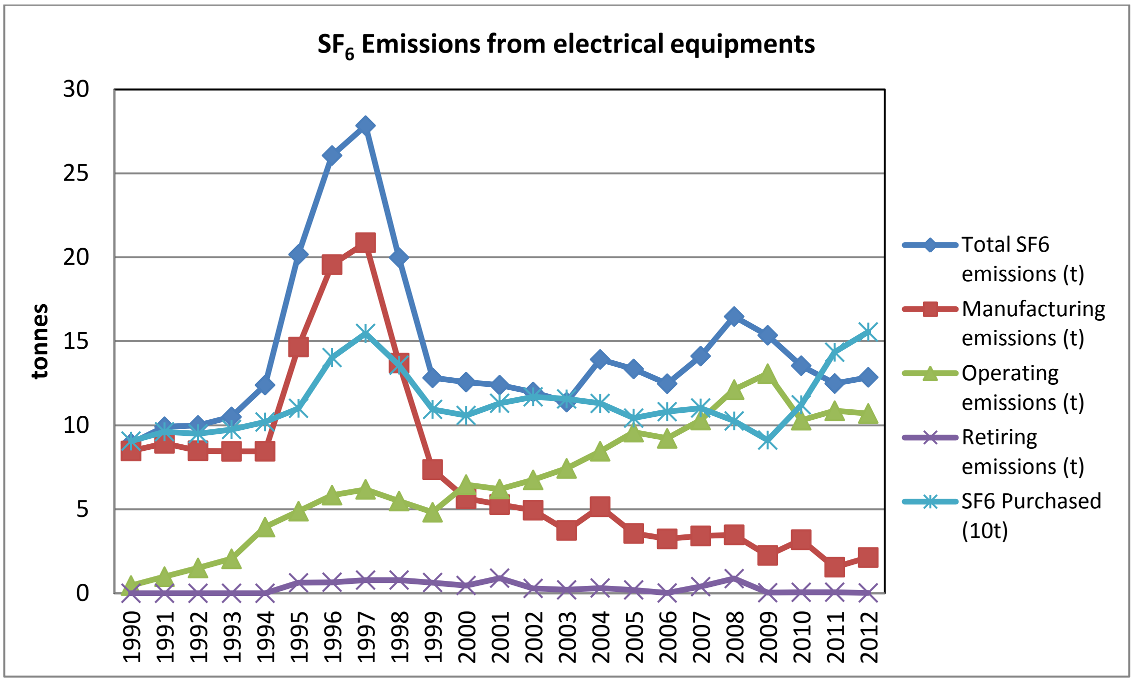

Figure 4.5 Time series for SF_6 purchased amounts and emissions from electrical equipments

Finally, the IPCC Tier 1a method has been used to calculate potential emissions, using production, import, export and destruction data provided by the national producer (Solvay, several years; ST Microelectronics, several years; MICRON, several years, Numonyx, several years). Since 2007, in compliance with article 6 of the fluorinated gases European regulation (EC, 2006), producers, importers and exporters have communicated to the Ministry of the Environment and to the Commission the required data; unfortunately, only few companies (6 for 2007, 9 for 2008, 8 for 2009, 10 for 2010, 12 for 2011 and 17 for 2012) have reported data and we expect that more information will be available in the next years (Euro Gardian srl, several years; Green Chemicals srl, several years; General Gas, several years; Mariel, several years; Safety Hi Tech, several years; Solvay Fluor Italia, several years; Tazzetti, several years; Sinteco, several years; Synthesis Chimica, several years; Trench Italia, several years; Coferc, 2008; Wilhelmsen Ships Service spa, several years; Alstom Grid, 2011; Sirap Insulation srl, 2011; Bulk H24, 2012; Cartesio, 2012; Linde Gas, 2012; Settala Gas, 2012). For the above mentioned companies data available since 2007 related to import, export and blends have been considered to revise the potential emissions time series since 2007. As regard PFC potential emissions, since no production occurs in Italy, export has been assumed as not occurring, whereas import corresponds to consumption of PFCs by semiconductor manufacturers that use these substances.

4.7.3 Uncertainty and time-series consistency

The combined uncertainty in F-gas emissions for HFC, PFC emissions from ozone depletion substances (ODS) substitutes and PFC, HFC, SF_6 emissions from semiconductor manufacturing is estimated to be about 58% in annual emissions, 30% and 50% concerning respectively activity data and emission factors; the uncertainty in SF_6 emissions from electrical equipment is estimated to be about 11% in annual emissions, 5% and 10% concerning respectively activity data and emission factors.

In Table 4.19 an overview of the emissions from consumption of halocarbons and SF_6 is given for the 1990-2012 period, per compound.
HFC emissions from refrigeration and air conditioning equipment increased from 1994 driven by the increase of their consumptions, especially HFC134a consumption for mobile air conditioning. HFC emissions from ODS substitutes started in 1996 and they have been increasing since then, especially HFC134a from foam blowing and aerosols. Emissions from semiconductor manufacturing are driven by the consumption data provided by the producers, three companies are currently operating in Italy: ST

Microelectronics (since 1995); Micron (since 1998) and Numonyx (since 2008). SF_6 emissions from electrical equipment increased from 1995 to 1997 and decreased in the following years; from 2004 emissions are enough stable: they are driven by emissions from manufacturing due to the amount of fluid filled in the new manufacturing products while emissions from stocks are slightly increasing.

Table 4.19 Actual F-gas emissions per compound from the consumption of halocarbons and SF_6 in Gg CO_2 equivalent, 1990-2012.COMPOUND (Gg CO_2 eq.)	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**
Total HFC emissions from Domestic Refrigeration	*0.0*	*0.0*	*40.3*	*78.2*	*119.3*	*127.9*	*136.6*
HFC 134a	0.0	0.0	40.3	78.2	119.3	127.9	136.6
Total HFC emissions from Commercial Refrigeration	*0.0*	*14.7*	*639.2*	*2,816.4*	*4,952.4*	*5,311.4*	*5,654.2*
HFC 23	0.0	4.4	27.0	63.5	96.4	101.0	103.9
HFC 125	0.0	4.1	236.6	1061.7	1871.9	2008.4	2139.4
HFC 134a	0.0	0.1	8.0	36.6	64.8	69.6	74.1
HFC 143a	0.0	6.1	367.7	1654.7	2919.3	3132.4	3336.8
Total HFC emissions from Stationary Air Conditioning	*0.0*	*0.0*	*90.4*	*460.3*	*947.3*	*1,047.6*	*1,147.8*
HFC 32	0.0	0.0	10.9	56.4	118.3	131.8	145.6
HFC 125	0.0	0.0	49.4	255.2	534.2	594.3	655.7
HFC 134a	0.0	0.0	30.1	148.8	294.8	321.5	346.6
Other HFC emissions from ODS substitutes	*0.0*	*224.3*	*1,039.4*	*1,764.8*	*2,268.7*	*2,304.2*	*2,297.3*
HFC 134a emissions from MAC	0.0	224.3	847.2	1,077.1	1,219.4	1,228.4	1,227.5
HFC 134a emissions from foam blowing	0.0	0.0	64.2	234.1	278.0	277.3	275.6
HFC 245fa emissions from foam blowing	0.0	0.0	0.0	133.5	217.7	235.2	253.1
HFC 227ea emissions from fire extinguishers	0.0	0.0	19.6	79.9	160.3	174.0	187.1
HFC 134a emissions from aerosols/metered dose inhalers	0.0	0.0	108.4	240.2	393.4	389.3	354.1
Total HFC emissions from ODS substitutes	***0.0***	***239.0***	***1,809.4***	***5,119.8***	***8,287.8***	***8,791.1***	***9,236.0***
PFC, HFC, SF_6 *emissions from semiconductor manufacturing*	*0.0*	*59.0*	*173.2*	*240.4*	*142.2*	*169.0*	*151.6*
HFC 23	0.0	0.0	5.1	7.0	8.5	8.4	5.3
HFC 134a	0.0	0.0	0.1	0.0	0.0	0.0	0.0
CF_4	0.0	24.4	64.8	96.8	58.5	64.5	66.0
C_2F_6	0.0	34.6	82.0	62.8	20.7	23.2	19.9
C_3F_8	0.0	0.0	0.0	3.5	0.0	0.1	0.0
C_4F_8	0.0	0.0	0.4	8.7	22.4	19.7	12.1
SF_6	0.0	0.0	20.9	61.5	32.1	53.0	48.5
SF_6 emissions from electrical equipment	213.4	482.0	300.4	319.1	323.8	298.4	307.3
Total F-gas emissions from consumption of halocarbons and SF_6	**213.4**	**780.0**	**2,283.0**	**5,679.3**	**8,753.7**	**9,258.4**	**9,694.9**

In Table 4.20 an overview of the potential emissions is given for the 1990-2012 period, per compound. In some years import data for HFC compounds are equal to zero while exports are greater than production data because of stocks availability thus leading to negative values for HFC compounds: in fact, the formula suggested by the UNFCCC guidelines to calculate potential emissions does not consider stock variations.

Table 4.20 Potential F-gas emissions per compound from the consumption of halocarbons and SF_6 in Gg CO_2 equivalent, 1990 – 2012.

COMPOUND	1990	1995	2000	2005	2010	2011	2012
Gg CO_2 eq.							
HFC 23	0.0	0.0	0.0	0.0	16.4	87.8	-87.8
HFC 32	0.0	0.0	10.4	31.9	224.2	67.2	117.9
HFC 125	0.0	148.4	268.8	1,131.2	1,492.2	314.5	1,050.7
HFC 134a	0.0	1,739.4	2,107.3	5,575.7	939.4	2,022.9	2,436.8
HFC 143a	0.0	11.4	68.4	801.8	2,289.9	111.0	1,030.3
HFC 152a	0.0	0.0	0.0	0.0	-37.4	211.7	242.8
HFC 227ea	0.0	0.0	72.5	0.0	2,580.5	7.5	97.2
HFC245fa	0.0	0.0	0.0	760.0	924.7	961.6	1,000.1
Total HFC potential emissions	*0.0*	*1,899.2*	*2,527.4*	*8,300.6*	*8,429.9*	*3,784.3*	*5,888.1*
CF_4	0.0	0.0	55.8	148.9	30.6	-51.9	2,092.3
C_2F_6	0.0	0.0	65.5	111.4	-169.5	-141.1	1,825.0
C_3F_8	0.0	0.0	0.0	17.9	-186.2	170.7	2,380.4
C_4F_8	0.0	0.0	0.5	29.0	4,396.5	1,683.3	2,174.1
Total PFC potential emissions	*0.0*	*0.0*	*121.8*	*307.2*	*4,071.4*	*1,661.0*	*8,471.8*
SF_6	*3,752.3*	*3,675.8*	*3,919.6*	*1,541.8*	*2,666.8*	*2,729.5*	*2,814.1*
Total F-gas potential emissions (Gg CO_2 equivalent)	**3,752.3**	**5,575.0**	**6,568.8**	**10,149.6**	**15,168.0**	**8,174.8**	**17,174.0**

4.7.4 Source-specific QA/QC and verification

This source category is covered by the general QA/QC procedures. Where information is available, emissions from production and consumption of halocarbons and SF_6 have been checked with data reported to the national EPER/E-PRTR registry.
Refrigeration and air conditioning category has been analyzed with experts of the national associations, in the framework of a revision of the sector as a consequence of the in country review process, hosted by ISPRA from the 30th of September to 5th of October 2013.
Information from the National Database of the refrigeration, air conditioning and fire protection systems, established by the article 16 of DPR 43/2012, has been analyzed.

4.7.5 Source-specific recalculations

In response to the in country review process (ISPRA, 30 September – 5 October 2013), emissions from Domestic refrigeration, which since the 2013 Submission have included commercial, transport, industrial refrigeration and stationary air conditioning emissions, have been reported separately in the sub-sources Domestic, Commercial Refrigeration and Stationary Air Conditioning.
Emission factors of domestic refrigeration appliances, small and large commercial refrigeration appliances and air conditioning systems have been revised, on the basis of national expert judgement, as reported above. Recalculations of the sub-sector are reported in the following Table 4.21.
Minor recalculations occurred in Potential emissions time series since 2007 due to update of data reported by operators under the fluorinated gases European Regulation.

Table 4.21 Comparison between previous and recalculated F-gas emissions from the consumption of halocarbons and SF_6 per gas (%) 1990-2012.

COMPOUND	1990	1995	2000	2005	2010	2011
Total HFC emissions from refrigeration and air conditioning equipment	-	*3.70%*	*-8.43%*	*-5.41%*	*-5.81%*	*-6.12%*
HFC 134a emissions from foam blowing	-	-	-	-	-	-
HFC 245fa 2F2 emissions from foam blowing	-	-	-	-	-	-
HFC 227ea emissions from fire extinguishers	-	-	-	-	-	-
HFC 134a emissions from aerosols/metered dose inhalers	-	-	-	-	-	-
Total HFC emissions from ODS substitutes	-	*3.70%*	*-7.61%*	*-4.72%*	*-5.11%*	*-5.41%*
HFC 23	-	-	-	-	-	-
HFC 134a	-	-	-	-	-	-
CF_4	-	-	-	-	-	-
C_2F_6	-	-	-	-	-	-
C_3F_8	-	-	-	-	-	-
C_4F_8	-	-	-	-	-	-
SF_6	-	-	-	-	-	-
Total PFC, HFC, SF_6 emissions from semiconductor manufacturing	-	-	-	-	-	-
SF_6 emissions from electrical equipment	-	-	-	-	-	-
Total F-gas emissions from consumption of halocarbons and SF_6	-	1.10%	-6.12%	-4.28%	-4.85%	-5.15%

4.7.6 Source-specific planned improvements

Improvements in the refrigeration and air conditioning sub-category are expected from the collection of emission data as requested by the article 16 of the Decree of the President of the Republic 27 January 2012, n. 43 which receipt the article 3(6) of the EC Fluorinated Gas Regulation.
Further investigation is planned to evaluate disposal emissions, also checking data reported in the National Database. A top down approach to cross check emission estimates is also in program.

5 SOLVENT AND OTHER PRODUCT USE [CRF sector 3]

5.1 Sector overview

In this sector all non-combustion emissions from other industrial sectors than the manufacturing and energy industry are reported. The indirect CO_2 emissions, related to Non-Methane Volatile Organic Compound (NMVOC) emissions from solvent use in paint application, degreasing and dry cleaning, chemical products manufacturing or processing and other use, are estimated.
N_2O emissions are also estimated. These emissions arise from the use of N_2O in medical applications, such as anaesthesia, and in the food industry, where N_2O is used as a propelling agent in aerosol cans, specifically those for whipped cream. Emissions from the use of N_2O in explosives are also included.

In 2012, solvent use is responsible for about 0.3% of the total CO_2 and 1.9% of the total N_2O emissions (excluding LULUCF). The share of the sector out of the of the total CO_2 equivalent emissions (excluding LULUCF), in 2012, is about 0.3%.
The sector represents the main source of anthropogenic NMVOC national emissions, contributing to 41.9% of total NMVOC emissions.

Table 5.1 Trend in NMVOC, CO_2 and N_2O emissions from the solvent use sector, 1990 – 2012 (Gg)

GAS/SUBSOURCE	1990	1995	2000	2005	2010	2011	2012
NMVOC (Gg)							
3A. Paint application	270.67	252.49	226.00	214.13	156.37	174.43	163.11
3B. Degreasing and dry cleaning	56.66	34.12	26.40	23.10	20.28	19.76	19.26
3C. Chemical products	77.25	85.98	82.67	60.45	60.17	60.03	58.56
3D. Other	199.59	182.84	156.60	179.65	157.97	149.47	138.91
CO_2 (Gg)							
3A. Paint application	843.66	787.02	704.45	667.44	487.41	543.68	508.42
3B. Degreasing and dry cleaning	176.62	106.34	82.27	72.01	63.20	61.59	60.03
3D. Other	622.12	569.92	488.12	559.96	492.40	465.90	432.99
N_2O (Gg)							
3D. Other (use of N_2O for anaesthesia, aerosol cans and explosives)	2.62	2.49	3.31	2.66	2.02	1.86	1.66

CO_2 emissions from the sector are a key category, in 2012, for trend assessment calculated with Approach 2, because of the high level of uncertainty in the estimates and a reduction of emissions in the years. This source is not a key category if including the LULUCF sector in the uncertainty analysis. Results are reported in the following box. As for the base year, these emissions were a key category for the level assessment, according to Approach 2, even when considering the LULUCF sector.

Key-source identification in the solvent and other product use sector with the IPCC Approach 1 and Approach 2 approaches (without LULUCF) for 2012

3	CO_2	Solvent and other product use	Key (T2)

5.2 Source category description

In accordance with the indications of the IPCC Guidelines (IPCC, 1997), the carbon contained in oil-based solvents, or released from these products, is considered both as NMVOC and CO_2 emissions as final oxidation of NMVOC. Emissions from the following sub-sectors are estimated: solvent use in paint application (3A), degreasing and dry cleaning (3B), manufacture and processing of chemical products (3C), other solvent use, such as printing industry, glues application, use of domestic products (3D).
CO_2 emissions are estimated and included in this sector, as they are not already accounted for in the energy and industrial processes sectors.

N_2O emissions from the use of N_2O for anaesthesia, aerosol cans and explosives (3D) are also estimated. Emissions of N_2O from fire extinguishers do not occur.

5.3 Methodological issues

Emissions of NMVOC from solvent use have been estimated according to the methodology reported in the EMEP/CORINAIR guidebook, applying both national and international emission factors (Vetrella, 1994; EMEP/CORINAIR, 2007). Country specific emission factors provided by several accredited sources have been used extensively, together with data from the national EPER Registry; in particular, for paint application (Offredi, several years; FIAT, several years), solvent use in dry cleaning (ENEA/USLRMA, 1995), solvent use in textile finishing and in the tanning industries (TECHNE, 1998; Regione Toscana, 2001; Regione Campania, 2005; GIADA 2006). Basic information from industry on percentage reduction of solvent content in paints and other products has been applied to EMEP/CORINAIR emission factors in order to evaluate the reduction in emissions during the considered period.

Emissions from domestic solvent use have been calculated using a detailed methodology, based on VOC content per type of consumer product.
As regards household and car care products, information on VOC content and activity data has been supplied by the Sectoral Association of the Italian Federation of the Chemical Industry (Assocasa, several years) and by the Italian Association of Aerosol Producers (AIA, several years [a] and [b]). As regards cosmetics and toiletries, basic data have been supplied by the Italian Association of Aerosol Producers too (AIA, several years [a] and [b]) and by the national Institute of Statistics and industrial associations (ISTAT, several years [a], [b], [c] and [d]; UNIPRO, several years); emission factors time series have been reconstructed on the basis of the information provided by the European Commission (EC, 2002). The conversion of NMVOC emissions into CO_2 emissions has been carried out considering that carbon content is equal to 85% as indicated by the European Environmental Agency for the CORINAIR project (EEA, 1997), except for CO_2 emissions from the 3C sub-sector which are not calculated to avoid double-counting. These emissions are, in fact, already accounted for in sectors 1A2c and 2B.

Emissions of N_2O have been estimated taking into account information available by industrial associations. Specifically, the manufacturers and distributors association of N_2O products has supplied data on the use of N_2O for anaesthesia from 1994 (Assogastecnici, several years). For previous years, data have been estimated by the number of surgical beds published by national statistics (ISTAT, several years [a]).
Moreover, the Italian Association of Aerosol Producers (AIA, several years [a] and [b]) has provided data on the annual production of aerosol cans. It is assumed that all N_2O used will eventually be released to the atmosphere, therefore the emission factor for anaesthesia is equal to 1 Mg N_2O/Mg product use, while the emission factor used for aerosol cans is 0.025 Mg N_2O/Mg product use, because the N_2O content in aerosol cans is assumed to be 2.5% on average (Co.Da.P., 2005).
For the estimation of N_2O emissions from explosives, data on the annual consumption of explosives have been obtained by a specific study on the sector (Folchi and Zordan, 2004); as stated in the document, this figure is believed to be constant for all the time series with a variation within a range of 30%. As for the emission factor, the estimated N_2O emissions represent the theoretically maximum emittable amount; in fact, no figures are available on the amount of N_2O emissions actually emitted upon detonations and the value of 3,400 Mg N_2O/Mg explosive use is provided by a German reference (Benndford, 1999) which corresponds to the assumption of 68 g N_2O per kg ammonium nitrate.
N_2O emissions have been calculated multiplying activity data, total quantity of N_2O used for anaesthesia, total aerosol cans and explosives, by the related emission factors.

5.4 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions from solvent use is estimated equal to 58% due to an uncertainty by 30% and 50% in activity data and emission factors, respectively. For N_2O emissions, the uncertainty is estimated equal to 51% due to an uncertainty in activity data of N_2O use of 50% and 10% in the emission factor.

The European Directives (EC, 1999; EC, 2004) regarding NMVOC emission reduction in this sector entered into force, in Italy, in January 2004 and in March 2006, establishing a reduction of the solvent content in products. Figure 5.1 shows NMVOC emission trend from 1991 to 2012, by sub-sector, with respect to 1990.
The decrease in NMVOC emission levels from 1990 to 2012 is about 37%, mainly to be attributed to the reduction of emissions in paint application, application of glue and adhesives and domestic solvent use; specifically, the reduction of emissions from paint application for domestic use, which drop by about 40% from 1990, is due to the implementation of Italian Legislative Decree 161/2006.

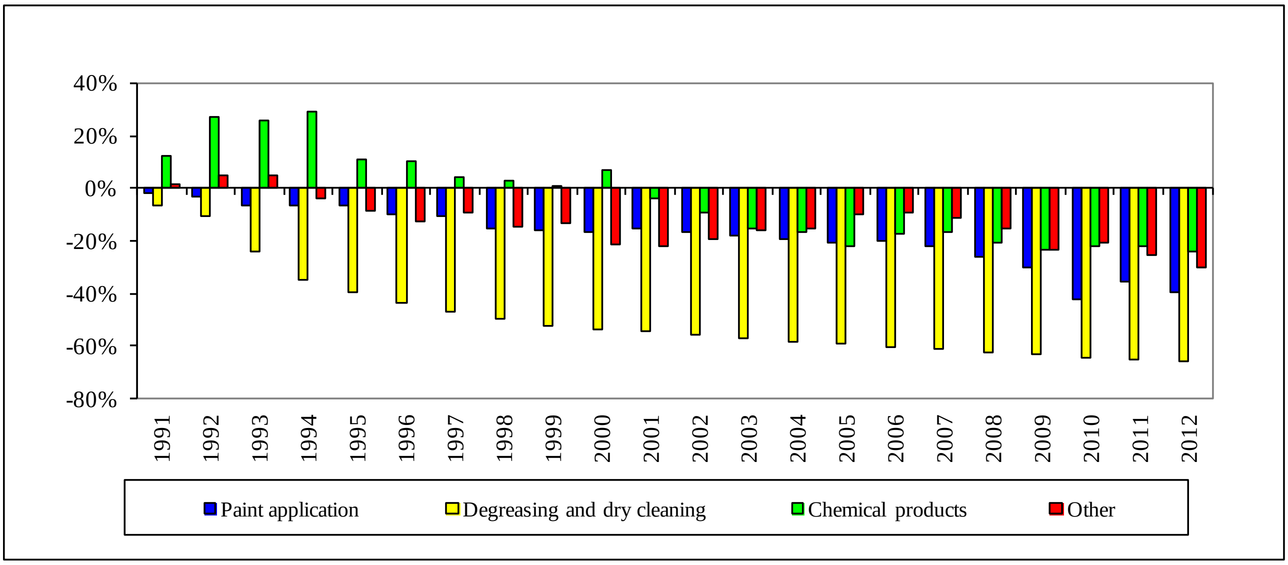

Figure 5.1 Trend of NMVOC emissions from 1991 to 2012 as compared to 1990

N_2O emissions remain almost at the same levels from 1990 onwards although, from 2000, a reduction is detected, due to a decrease in the anaesthetic use of N_2O that has been replaced by halogen gas.

5.5 Source-specific QA/QC and verification

Data production and consumption time series for some activities (paint application in constructions and buildings, polyester processing, polyurethane processing, pharmaceutical products, paints manufacturing, glues manufacturing, textile finishing, leather tanning, fat edible and non edible oil extraction, application of glues and adhesives) are checked with data acquired by the National Statistics Institute (ISTAT, several years [a], [b] and [c]), the Sectoral Association of the Italian Federation of the Chemical Industry (AVISA, several years) and the Food and Agriculture Organization of the United Nations (FAO, several years). For specific categories, emission factors and emissions are also shared with the relevant industrial associations; this is particularly the case of paint application for wood, some chemical processes and anaesthesia and aerosol cans.
In the framework of the MeditAIRaneo project, ISPRA commissioned to Techne Consulting S.r.l. a survey to collect national information on emission factors in the solvent sector. The results, published in the report "*Rassegna dei fattori di emissione nazionali ed internazionali relativamente al settore solventi*" (TECHNE, 2004), have been used to verify and validate the emission estimates. ISPRA commissioned to Techne Consulting S.r.l. another survey to compare emission factors with the last update published in the EMEP/EEA guidebook (EMEP/EEA, 2009). The results are reported in "*Fattori di emissione per l'utilizzo di solventi*" (TECHNE, 2008) and have been used to update emission factors for polyurethane and polystyrene foam processing activities.
In addition, for paint application, data communicated from the industries in the framework of the EU Directive 2004/42, implemented by the Italian Legislative Decree 161/2006, on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products have been used as a verification of emission estimates. These data refer to the composition of the total amount of paints and varnishes (water and solvent contents) in different

subcategories for interior and exterior use and the total amount of products used for vehicle refinishing and they are available from the year 2007.
Additional verifications of the emissions from the sector occurred in 2012, on account of the bilateral independent review between Italy and Spain and the revision of national estimates and projections in the context of the National emission ceilings Directive for the EU Member States and the Gothenburg Protocol of the Convention on Long-Range Transboundary Air Pollution (CLRTAP).
In the context of the bilateral review, national emissions from the solvent sector were revised by the Spanish team.The analysis by category has not highlighted the need of major methodological revisions of the sector; an additional source of emissions has been added affecting only NMVOC emissions. A change of NMVOC emission factors for the last years in two chemical categories was the result of the other review process.

5.6 Source-specific recalculations

In Table 5.2 the comparison of CO_2 and NMVOC emissions between the actual and last year submission is reported only for those years where recalculations actually occurred.

Recalculations are observed in other use of solvents, due to an updating of ink consumption in printing industry from 2006, fat, edible and non edible oil extraction in 2010 and 2011 and the import and export of cosmetics in 2011. Minor changes occurred in chemical products considering a variation in import-export data of paints.

Table 5.2 Differences in CO_2 and NMVOC emissions between the updated time series and the 2012 submission

	CO_2/NMVOC	NMVOC
	3D. Other	3C. Chemical products
2006	-1.56%	
2007	-0.86%	
2008	-1.19%	
2009	-2.34%	
2010	-1.45%	0.38%
2011	-1.76%	0.20%

5.7 Source-specific planned improvements

No further improvements are planned.

6 AGRICULTURE [CRF sector 4]

6.1 Sector overview

In this chapter information on the estimation of greenhouse gas (GHG) emissions from the Agriculture sector, as reported under the IPCC Category 4 in the Common Reporting Format (CRF), is given. Emissions from enteric fermentation (4A), manure management (4B), rice cultivation (4C), agriculture soils (4D) and field burning of agriculture residues (4F) are included in this sector. Methane (CH_4) and nitrous oxide (N_2O) emissions are estimated and reported. Savannas areas (4E) are not present in Italy. Emissions from other sources (4G) have not been estimated. CO_2 and F-gas emissions do not occur.
To provide update information on the characteristics of the agriculture sector in Italy, figures from the Agricultural Census 2010 are reported. In Italy, there are 1.6 millions of agricultural holdings with a Utilized Agricultural Area (UAA) of 12.9 million hectares, +0.9% more than Farm Structure Survey 2007 (FSS 2007). Looking at the data from the last four censuses (see box below), the number of agricultural holdings and the agricultural area have decreased, in particular, between 2000 and 2010, the reduction of agricultural holdings is equal to 32% (775,390 units). At national level, the average size of the agricultural holdings varied from 5.5 hectares in 2000 to 7.9 hectares in 2010. Census data confirm the findings of the FSS, according to which the average size of the agricultural holdings varied from 7.4 hectares in 2005 to 7.6 hectares in 2007. However, more than 50% of agricultural holdings have an area of less than 2 hectares of UAA. The distribution of agricultural holdings by type confirms a typical family conduction system, which characterized the Italian agriculture. Direct conduction of holdings by farmers is around 1.5 million (95.4% of total agricultural holdings with UAA) which hold 11 million hectares of UAA (82.8% of total)[2] (EUROSTAT, 2007[a], [b], 2012; ISTAT, 2008[a]).
Updated figures of the agriculture sector such as added value, employment, productivity are available (INEA, 2012).

Agricultural holding characteristics from Agricultural Censuses

Agricultural holding characteristics	1982	1990	2000	2010
Number of agricultural holdings	3,133,118	2,848,136	2,396,274	1,620,884
Utilized agricultural area - hectares	15,832,613	15,025,954	13,181,859	12,856,048
Total agricultural area - hectares	22,397,833	21,628,355	18,766,895	17,081,099
Average size of the agricultural holdings	5.1	5.3	5.5	7.9

6.1.1 Emission trends

Emission trends per gas

In 2012, 7.5% of the Italian GHG emissions, excluding emissions and removals from LULUCF, (7.9% in 1990) originated from the agriculture sector, which is the second source of emissions, after the energy sector which accounts for 82.6%. For the agriculture sector, the trend of GHGs from 1990 to 2012 shows a decrease of 16.02% due to the reduction of the activity data, such as the number of animals and cultivated surface/crop production, and the recovery of biogas (see Figure 6.1). CH_4 and N_2O emissions have decreased by 19.7% and 13.3%, respectively (see Table 6.1). In 2012, the agriculture sector has been the second source for CH_4, after the waste sector, sharing 40% of national CH_4 levels. As for N_2O, agriculture is the dominant source, accounting for 73% of national N_2O emissions.

Table 6.1 GHG emissions and trend from 1990 to 2012 for the agriculture sector (Gg CO_2 eq.)

	1990	1995	2000	2005	2010	2011	2012
				Gg CO_2 eq.			
CH_4	17,334	17,320	16,932	15,552	14,880	14,431	13,918
N_2O	23,495	23,281	23,286	21,890	18,903	19,141	20,371
Total	**40,830**	**40,602**	**40,218**	**37,442**	**33,783**	**33,572**	**34,289**

[2] Agricultural Census data are available at the link http://dati-censimentoagricoltura.istat.it/

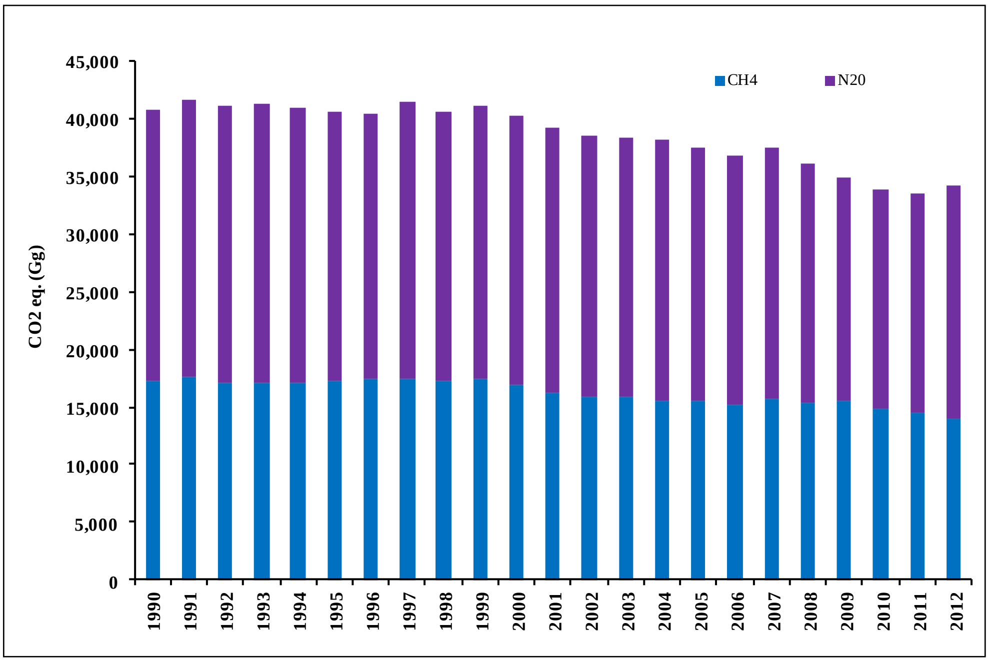

Figure 6.1 Trend of GHG emissions for the agriculture sector from 1990 to 2012 (Gg CO_2 eq.)

Emission trends per sector
Total GHG emissions and trends by sub category from 1990 to 2012 are presented in Table 6.2 (expressed in Gg. CO_2 eq.). CH_4 emissions from enteric fermentation (4A) and N_2O emissions from direct agriculture soils (4D) are the most relevant categories. In 2012, their individual share in national GHG emissions excluding LULUCF was 2.3% and 3.6%, respectively.

Table 6.2 Total GHG emissions from 1990 to 2012 for the agriculture sector (Gg CO_2 eq.)

Year	GHG emissions (Gg CO_2 eq.) by sub category					
	4A	4B	4C	4D	4F	TOTAL
1990	12,278	7,401	1,576	19,557	17	**40,829.7**
1995	12,348	7,080	1,671	19,487	17	**40,601.8**
2000	12,246	7,152	1,391	19,411	17	**40,217.6**
2001	11,423	7,357	1,390	19,099	16	**39,284.4**
2002	11,107	7,128	1,439	18,893	18	**38,585.3**
2003	11,134	7,087	1,470	18,715	16	**38,422.2**
2004	10,908	6,880	1,534	18,774	20	**38,115.1**
2005	10,914	6,868	1,472	18,169	18	**37,442.0**
2006	10,699	6,638	1,475	18,014	18	**36,844.7**
2007	11,099	6,842	1,516	18,033	18	**37,507.8**
2008	10,996	6,744	1,386	16,947	19	**36,091.3**
2009	11,007	6,693	1,565	15,569	18	**34,851.7**
2010	10,732	6,275	1,565	15,193	18	**33,783.0**
2011	10,753	5,828	1,550	15,423	18	**33,572.0**
2012	10,667	5,446	1,533	16,624	19	**34,289.4**

6.1.2 Key categories

In 2012, N_2O emissions from agricultural soils, both direct and indirect emissions, CH_4 emissions from enteric fermentation, CH_4 and N_2O emissions from manure management, N_2O emissions from animal production were ranked among the top-10 level key sources with the Approach 2, including the uncertainty (L2). CH_4 and N_2O from manure management emissions are ranked among the top-10 trend key sources with Approach 2, including the uncertainty (T2). In the following box, key and non-key categories from the agriculture sector are shown, with a level and/or trend assessment (*IPCC Approach 1 and Approach 2*), excluding and including the LULUCF sector in the analysis.

Key-source identification in the agriculture sector with the IPCC Approach 1 and Approach 2 for 2012

			excluding LULUCF	*including LULUCF*
4A	CH_4	Emissions from enteric fermentation	Key (L)	Key (L)
4B	CH_4	Emissions from manure management	Key (L2, T)	Key (L2, T)
4B	N_2O	Emissions from manure management	Key (L, T2)	Key (L, T2)
4D1	N_2O	Direct soil emissions	Key (L, T2)	Key (L)
4D2	N_2O	Emissions from animal production	Key (L2)	Key (L2)
4D3	N_2O	Indirect soil emissions	Key (L)	Key (L)
4C	CH_4	Rice cultivation	Non-key	Non-key
4F	CH_4	Emissions from field burning of agriculture residues	Non-key	Non-key
4F	N_2O	Emissions from field burning of agriculture residues	Non-key	Non-key

6.1.3 Activities

Emission factors used for the preparation of the national inventory reflect the characteristics of the Italian agriculture sector. Information from national research studies is considered. Activity data are mainly collected from the National Institute of Statistics (ISTAT, *Istituto Nazionale di Statistica*). Every year, national and international references, and personal communications used for the preparation of the agriculture inventory are kept in the *National References Database*.

Improvements for the Agriculture sector are described in the Italian Quality Assurance/Quality Control plan (ISPRA, several years [a]). Moreover, an internal report describes the procedure for preparing the agriculture UNFCCC/CLRTAP national emission inventory, and projections (Cóndor, 2013).

In the last years, results from different research projects have improved the quality of the agriculture national inventory (MeditAIRaneo project and Convention signed between ISPRA and the Ministry for the Environment, Land and Sea; CRPA, 2006[a], CRPA, 2006[b]). Furthermore, suggestions from the inventory review processes have been considered (UNFCCC, 2009; UNFCCC, 2010[a]; UNFCCC, 2010[b], UNFCCC, 2012; UNFCCC, 2013; ISPRA, several years [a]). Methodologies for the preparation of agriculture national inventory under the Convention on Long-Range Transboundary Air Pollution (CLRTAP) and the United Nations Framework Convention on Climate Change (UNFCCC) are consistent. Synergies among international conventions and European directives while preparing the agriculture inventory are implemented (Cóndor and De Lauretis, 2007; Cóndor *et al*., 2008[b]; Cóndor and De Lauretis, 2009).

The national agriculture UNFCCC/CLRTAP emission inventory is used, every 5 years, to prepare a more disaggregated inventory by region and province as requested by CLRTAP (Cóndor *et al*., 2008[c]). A database with the time series for all sectors and pollutants is available (ISPRA, 2008; ISPRA, 2009; ISPRA, several years [b]). Methodologies used for the inventory, emission scenarios and projections are similar (MATTM, 2007; MATTM, 2009; MATTM, 2013).

6.1.4 Agricultural statistics

The Italian National Statistical System (SISTAN[3]) revises every year the National Statistical Plan that covers three years and includes, among others, the system of agricultural statistics. In this framework, the Agriculture, Forestry and Fishing Quality Panel has been established under coordination of the Agriculture service of ISTAT where those who produce and use agricultural statistics (mainly public institutions) meet every year in order to monitor and improve national statistics. ISTAT plays a major role in the agricultural sector collecting comprehensive data through different surveys (Greco and Martino, 2001):

- Structural surveys (Farm Structure Survey, survey on economic results of the farm, survey on the production means);

[3] SISTAN, *Sistema Statistico Nazionale* (http://www.sistan.it/)

- Conjunctural surveys[4] (survey on the area and production of the cultivation, livestock number, milk production, slaughter, etc.);
- General Agricultural Census[5], carried out every 10 years (1990, 2000, 2010).

Detailed information on the agriculture sector is found every two years in the Farm Structure Survey, FSS[6] (ISTAT, 2008[a]; ISTAT, 2007[a]; ISTAT, 2006[a]). ISTAT has provided quality reports of the FSS 2005 and FSS 2007 (ISTAT, 2008[b]; ISTAT, 2007[d]) and a report on the assessment of the quality of the agricultural census data (ISTAT, 2013). The main agricultural statistics used for the agriculture emission inventory are available on-line. Detailed information is provided in the following box:

Main activity data sources used for the Agriculture emission inventory

Agricultural statistics	Time series	Web site
Livestock number	Table 6.3; 6.4; 6.7	http://agri.istat.it/jsp/Introduzione.jsp
Milk production	Table 6.3	http://agri.istat.it/jsp/Introduzione.jsp
Fertilizers	Table 6.24	http://agri.istat.it/jsp/Introduzione.jsp
Crops production/surface	Table 6.25; 6.26; 6.30; 6.32	http://agri.istat.it/jsp/Introduzione.jsp

Differences in the some animal populations are found between FAOSTAT and national statistics. FAO publishes figures of the *x-1* year on 1st January of the *x* year. Each year ISPRA verifies the official statistics directly contacting the experts responsible for each agricultural survey (number of animals, agricultural surface/production, fertilizers, etc). Agricultural statistics reported by ISTAT are also those published in the European statistics database[7] (EUROSTAT). Whenever outliers are identified, ISTAT and category associations are contacted. Slight differences in the livestock number (cattle and other swine) are found between conjunctural surveys (used for emissions estimation) and Agricultural census for the year 2010; while for the other categories the differences are more significant[8] (ISTAT, 2012). The verification of statistics is part of the QA/QC procedures implemented. The livestock data represents the number of animals present on the farm at any given time of the year (conventionally 1st of June or 1st of December). Therefore livestock figures do not represent the number of animals produced annually; for animal populations that are alive for only part of a complete year, the annual average population is estimated on the basis of “places” instead of the days of life and the number of cycles.

6.2 Enteric fermentation (4A)

6.2.1 Source category description

Methane is produced as a by-product of enteric fermentation, which is a digestive process where carbohydrates are degraded by microorganisms into simple molecules.
Methane emissions from enteric fermentation are a major key category, in terms of level assessment, for Approach 1 and Approach 2. All livestock categories have been estimated except camels and llamas, which are not present in Italy. Methane emissions from poultry do not occur, and emissions from rabbits are estimated and included in “Other” as suggested by the IPCC guidelines.
In 2012, CH_4 emissions from this category were 507.98 Gg which represents 76.6% of CH_4 emissions for the agriculture sector (70.8% in 1990) and 30.7% for national CH_4 emissions excluding LULUCF (28.1% in 1990). Methane emissions from this source consist mainly of cattle emissions: dairy cattle (215.93 Gg) and non-dairy cattle (186.43 Gg). These two sub-categories represented 42.5% (42.7% in 1990) and 36.7% (39.9% in 1990), respectively, of total enteric fermentation emissions.

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[4] http://agri.istat.it/
[5] http://censagr.istat.it/; http://dati-censimentoagricoltura.istat.it/
[6] Indagine sulla struttura e produzione delle aziende agricole (SPA), survey carried out every two years in agricultural farms.
[7] http://epp.eurostat.ec.europa.eu/portal/page/portal/agriculture/data/database
[8] The number of heads of conjunctural surveys of the sows, sheep, goats, mules and asses, broilers, hens categories is on average 15% higher than the census, whereas for other poultry the difference is 30% and for horses and rabbits is more than double.

6.2.2 Methodological issues

Methane emissions from enteric fermentation are estimated by defining an emission factor for each livestock category, which is multiplied by the population of the same category. Data for each livestock category are collected from ISTAT (several years [a], [b], [c], [f], [g]; ISTAT, 1991; 2007[a], [b]). Livestock categories provided by ISTAT are classified according to the type of production, slaughter or breeding, and the age of animals. In the following box, livestock categories and source of information are provided. Parameters for the livestock categories are shown in Table 6.19. In order to have a consistent time series, it was necessary to reconstruct the number of animals for some categories. The reconstruction used information available from other official sources such as FAO and UNAITALIA (FAO, several years; UNAITALIA, several years).

Activity data for the different livestock categories

Livestock category	Source
Cattle	ISTAT
Buffalo	ISTAT
Sheep	ISTAT
Goats	ISTAT
Horses	ISTAT/FAO(a)
Mules and asses	ISTAT/FAO(a)
Swine	ISTAT
Poultry	ISTAT/UNAITALIA (b)
Rabbits	ISTAT(c)

(a) Reconstruction of a consistent time series; (b) For 1990 data from the census and reconstruction for broilers, hens and other poultry based on meat production (UNAITALIA, several years); (c) For 1990 data from the census and reconstruction based on a production index (ISTAT, 2007[b]; ISTAT, several years [k])

Dairy cattle

Methane emissions from enteric fermentation for dairy cattle are estimated using a Tier 2 approach, as suggested in the Good Practice Guidance (IPCC, 2000). Feeding characteristics are described in a national publication (CRPA, 2004[a]) and have been discussed in a specific working group in the framework of the MeditAIRaneo project (CRPA, 2006[a]; CRPA, 2005). Parameters used for the calculation of the emission factor are shown in the following box:

Parameters for the calculation of dairy cattle emission factors from enteric fermentation

Parameter	Value	Reference	IPCC 2006(*)
Average weight (kg)	602.7	CRPA, 2006[a]	600
Coefficient NE_m (dairy cattle)	0.335	NRC, 2001; IPCC, 2000	0.386
Pasture (%)	5	CRPA, 2006[a]; ISTAT, 2003	0(**)
Weight gain (kg day^{-1})	0.051	CRPA, 2006[a]; CRPA, 2004[b]	0
Milk fat content (%)	3.59-3.75	ISTAT, several years [a], [b], [d], [e], [h]	
Hours of work per day	0	CRPA, 2006[a]	0
Portion of cows giving birth	0.97-0.89	AIA, several years	0.9
Milk production (kg $head^{-1}$ day^{-1})	11.5-17.6	CRPA, 2006[a]; OSSLATTE/ISMEA, 2003; ISTAT, several years [a], [b], [c], [d], [e], [f], [h]; OSSLATTE, 2001	16.4
Digestibility of feed (%)	65	CRPA, 2006[a]; CRPA, 2005	70
Methane conversion rate (%)	6	CRPA, 2006[a]	6.5
MJ/kg methane	55.65	IPCC, 2000	55.65

(*) Data for estimating tier 1 enteric fermentation CH_4 emission factors for dairy cows (Western Europe); (**) Stall fed (feeding situation)

Milk production national statistics were analysed (Cóndor *et al*., 2005). Milk used for dairy production and milk used for calf feeding contributes to total milk production. This last value was reconstructed with national and ISTAT publications (ISTAT, several years [h]). For calculating milk production (kg $head^{-1}$ d^{-1}), total production is divided by the number of animals and by 365 days, as suggested by the IPCC (IPCC, 2000). Therefore, lactating and non-lactating periods are included in the estimation of the CH_4 dairy cattle EF (CRPA, 2006[a]). In Table 6.3, the time series of the dairy cattle population, fat content in milk, portion of cows giving birth and milk production are shown. Further information on parameters used for dairy cattle estimations is reported in Annex 7.1.

In Table 6.6, the time series of the dairy cattle emission factors (EF) is presented. In 2012, the CH_4 dairy cattle EF was 116.3 kg CH_4 head^{-1} year^{-1} with an average milk production of 6,429 kg head^{-1} year^{-1} (17.6 kg head^{-1} day^{-1}). IPCC report a default EF of 117 kg CH_4 head^{-1} year^{-1} with a milk production of 6,000 kg head^{-1} year^{-1} (IPCC, 2006).

Table 6.3 Parameters used for the estimation of the CH_4 emission factor for dairy cattle

Year	Dairy cattle (head)	Fat content in milk (%)	Portion of cows giving birth	Milk production yield (kg head^{-1} d^{-1})
1990	2,641,755	3.59	0.97	11.5
1995	2,079,783	3.64	0.95	14.8
2000	2,065,000	3.65	0.93	15.1
2001	2,077,618	3.65	0.91	14.9
2002	1,910,948	3.67	0.91	16.2
2003	1,913,424	3.67	0.91	16.2
2004	1,838,330	3.71	0.90	16.8
2005	1,842,004	3.71	0.91	17.2
2006	1,821,370	3.69	0.90	17.4
2007	1,838,783	3.71	0.90	17.3
2008	1,830,711	3.72	0.90	17.7
2009	1,878,421	3.67	0.90	17.4
2010	1,746,140	3.72	0.90	18.7
2011	1,754,981	3.73	0.90	18.5
2012	1,857,004	3.75	0.89	17.6

Non-dairy cattle

For non-dairy cattle, CH_4 emissions from enteric fermentation are estimated with a Tier 2 approach (IPCC, 2000). The estimation of the EF uses country-specific data, disaggregated livestock categories (see Table 6.4), and is based on dry matter intake (kg head^{-1} day^{-1}) calculated as percentage of live weight (CRPA, 2000; INRA, 1988; NRC, 1984; NRC, 1988; Borgioli, 1981; Holter and Young, 1992; Sauvant, 1995). Dry matter intake is converted into gross energy (MJ head^{-1} day^{-1}) using 18.45 MJ/kg dry matter (IPCC, 2000). Emission factors for each category are calculated with equation 4.14 from IPCC (IPCC, 2000). In Table 6.5, parameters used for the estimation of non-dairy cattle EF are shown. Since the 2006 submission, average weights were updated with information from the Nitrogen Balance Inter-regional Project (CRPA, 2006[a]; Regione Emilia Romagna, 2004). For reporting purposes, some animal categories are aggregated, such as the non-dairy and the swine categories. The non-dairy cattle category is composed of the different sub-categories as shown in Table 6.4. For this reason, the gross energy intake, CH_4 conversion factor and EFs for this category are calculated as a weighted average.

Table 6.4 Non-dairy cattle population (heads) classified by type of production and age

Year	<1 year		1-2 years Males		1-2 years Females		>2 years Males	>2 years Females			TOTAL
	for slaughter	others	breeding	for slaughter	breeding	for slaughter	all	breeding	for slaughter	others	
	(heads)										
1990	300,000	2,127,959	72,461	708,329	749,111	186,060	128,958	467,216	57,654	312,649	**5,110,397**
1995	458,936	1,796,034	27,871	783,300	684,881	154,548	155,116	430,564	40,198	657,856	**5,189,304**
2000	408,000	1,783,000	27,521	641,479	736,000	160,000	93,000	500,000	51,000	588,000	**4,988,000**
2001	496,264	1,498,068	25,528	595,029	709,941	181,550	75,365	591,000	46,000	442,525	**4,661,270**
2002	409,970	1,617,127	26,194	610,550	647,656	176,481	65,948	541,233	59,582	444,408	**4,599,149**
2003	412,682	1,594,994	27,598	643,277	673,246	158,094	78,890	520,237	48,873	433,388	**4,591,279**
2004	445,231	1,509,387	28,458	663,316	648,308	149,053	71,762	460,765	38,385	451,606	**4,466,271**
2005	500,049	1,418,545	26,424	615,921	588,660	181,971	102,081	466,566	37,971	471,733	**4,409,921**
2006	540,223	1,407,401	26,091	608,152	584,680	182,719	78,328	395,066	54,022	419,083	**4,295,765**
2007	519,034	1,410,357	26,852	625,902	593,369	189,704	79,936	498,091	59,961	440,845	**4,444,051**
2008	502,391	1,401,501	26,908	627,186	630,194	196,936	74,059	469,074	48,075	372,051	**4,348,375**
2009	494,463	1,313,146	25,191	587,167	617,494	183,420	83,087	478,782	67,781	373,865	**4,224,396**
2010	507,452	1,228,696	23,913	557,386	597,733	212,983	70,284	445,370	70,411	372,089	**4,086,317**
2011	509,904	1,272,903	23,461	546,847	600,769	222,859	70,018	433,336	72,430	390,017	**4,142,544**
2012	441,975	1,081,177	21,231	494,860	671,688	177,308	76,035	485,930	54,694	380,708	**3,885,606**

Table 6.5 Main parameters used for non-dairy cattle CH_4 emission factor estimations

	<1 year	1-2 years Males		1-2 years Females		>2 years Males	>2 years Females		
Parameters	Others (*)	breeding	for slaughter	breeding	for slaughter	all	breeding	for slaughter	Others
Average weight (kg)	236	557	557	405	444	700	540	540	557
Percentage weight ingested	2.1	1.9	2.1	2.1	2.1	2.4	2.1	2.1	1.9
Dry matter intake (kg head $^{-1}$ day^{-1})	4.8	10.7	11.6	8.5	9.3	17.1	11.5	11.5	10.6
Gross Energy (MJ head^{-1}day^{-1})	89.4	197.3	214.8	156.9	171.2	315.5	212.2	212.2	195.3
CH_4 conversion (%)	4	4.5	4	6	4	6	6	6	6

(*) It has been considered that calves for slaughter of <1 year do not emit CH_4 emissions, as they are milk fed. Therefore, the average weight for the category "others" of <1 year takes into account fattening male cattle, fattening heifer and heifer for replacement.

National characteristics of Italian breeding are reflected in EFs, and they are also related to the age classification of animals and dry matter intake. In Table 6.6, Implied Emission Factors (IEF) for non-dairy cattle are shown. In 2012, the non dairy-cattle EF was 48 kg CH_4 head^{-1} year^{-1} as IPCC 1996 Guidelines default EF (IPCC, 1997) while IPCC 2006 Guidelines default EF is 57 kg CH_4 head^{-1} year^{-1} (IPCC, 2006). The inter-annual decrease 2005/2006 of the IEF for non-dairy cattle is related to the reduction in the number of animals for some categories and an increase in the number of the '*less than 1 year for the slaughter*' category (no emissions) (see Table 6.4). This last category (calves) has not been considered when estimating methane emissions as they are milk fed. However relevant parameters for this category, used for estimating N_2O emissions from manure management, are the following:

- Average body weight: 157 kg;
- Nitrogen excretion: 75.7 kg N/head/year;
- Average milk period: 4-6 months;
- Average weight at slaughter: less than 300 kg.

Buffalo

Data collected in the framework of the MeditAIRaneo project allowed for the implementation of the Tier2 approach for the buffalo category (IPCC, 2000). Two different country-specific CH_4 EFs, for cow buffalo and other buffaloes, were developed. Detailed description of the methodology is reported in Cóndor *et al*. (Cóndor *et al*., 2008[a]). In 2012, the cow buffalo CH_4 EF was 72 kg CH_4 $head^{-1}$ $year^{-1}$ and for other buffaloes the value was 56 kg CH_4 $head^{-1}$ $year^{-1}$. The CRF IEF is an average value for the two categories (65.7 kg CH_4 $head^{-1}$ $year^{-1}$). Parameters used for the Tier 2 approach are shown in the following boxes.

Parameters for the calculation of CH_4 cow buffalo emission factors from enteric fermentation

Parameters	Value	Reference
Average body weight (kg)	630	Infascelli, 2003; Consorzio per la tutela del formaggio mozzarella di bufala campana, 2002
Coefficient NE_m, cattle/buffalo (lactating)	0.335	IPCC, 2000
Pasture (%)	2.90	ISTAT, 2003; Zicarelli, 2001; expert judgement
Weight gain (kg day^{-1})	0.055	Estimations
Milk fat content (%)	7.73-7.92	ISTAT, several years [a], [b], [d], [e], [h]
Hours of work per day	0	Our estimation
Proportion of calving cows	0.89-0.84	Barile, 2005; De Rosa and Trabalzi, 2004
Milk production (kg $head^{-1}$ day^{-1})	1.9-2.9	OSSLATTE/ISMEA, 2003; ;OSSLATTE, 2001; ISTAT, several years [a], [b], [c] [d], [e], [f], [h]
Digestibility of feed (%)	65	Infascelli, 2003; Masucci *et al*., 1997, 1999
Methane conversion rate (%)	6	CRPA, 2006[a]
MJ/kg methane	55.65	IPCC, 2000

Parameters for the calculation of other buffalo emission factors from enteric fermentation

Parameter	Calves (3 months-1 year)	Sub-adult buffaloes (1-3 years)
Average body weight (kg)	130	405
Dry matter intake (% of body weight $head^{-1}$ day^{-1})	3.0	2.5
Dry matter intake (kg $head^{-1}$ day^{-1})	3.9	10.1
Gross Energy (MJ $head^{-1}$ day^{-1})	71.68	186.58
CH4 conversion (%)	6	6
CH_4 emission factor (kg $head^{-1}$ $year^{-1}$)	21.16 (*)	73.42

(*) original CH_4 emission factor was 28.208 kg CH_4 $head^{-1}$ $year^{-1}$; a correction factor of 9/12 has been applied in order to consider the time between 3 months and 1 year, therefore the final emission factor was 21.16 kg CH_4 $head^{-1}$ $year^{-1}$.

Rabbits

Methane emissions from rabbits have been estimated using a country-specific EF suggested by the Research Centre on Animal Production (CRPA). Daily dry matter intake for brood-rabbits and other rabbits are 0.13 kg day^{-1} and 0.11 kg day^{-1}, respectively. Besides, a value of 0.6% has been assumed as CH_4 conversion rate (CRPA, 2004[c]).

Other livestock categories

A Tier 1 approach, with IPCC default EFs, is used to estimate CH_4 emissions from swine, sheep, goats, horses, mules and asses (IPCC, 1997). In Table 6.6, EFs for all livestock categories (dairy cattle, non-dairy cattle, buffalo, swine, sheep, goats, horses, mules and asses, and rabbits) are presented. In Table 6.7, time series of the number of animals are shown.

Table 6.6 Average CH_4 emission factors for enteric fermentation (kg CH_4 head^{-1} year^{-1})

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sheep	Goats	Horses	Mules and asses	Sows	Other swine	Rabbits
	average CH_4 EF (kg CH_4 head^{-1} year^{-1})									
1990	94.5	45.6	62.9	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1995	106.0	47.4	64.4	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2000	107.0	47.0	66.8	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2001	106.3	46.7	69.7	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2002	110.8	46.5	68.0	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2003	110.8	46.6	67.6	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2004	113.2	46.3	69.7	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2005	114.7	46.4	72.3	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2006	115.0	44.7	70.9	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2007	114.9	46.1	68.3	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2008	116.5	45.5	66.8	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2009	114.8	46.3	65.0	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2010	119.9	45.9	64.7	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2011	119.1	45.6	65.6	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2012	116.3	48.0	65.7	8.0	5.0	18.0	10.0	1.5	1.5	0.08

Table 6.7 Time series of number of animals from 1990 to 2012 (heads)

Year	Buffalo	Sheep	Goats	Horses	Mules and asses	Sows	Other swine	Rabbits	Poultry
	(heads)								
1990	94,500	8,739,253	1,258,962	287,847	83,853	650,919	7,755,602	14,893,771	173,341,562
1995	148,404	10,667,971	1,372,937	314,778	37,844	689,846	7,370,830	17,110,587	184,202,416
2000	192,000	11,089,000	1,375,000	280,000	33,000	708,000	7,599,000	17,873,993	176,722,211
2001	193,774	8,311,383	1,024,769	285,000	33,000	697,491	8,068,771	18,494,839	209,187,654
2002	185,438	8,138,309	987,844	277,819	28,913	751,159	8,415,099	18,852,530	205,566,136
2003	222,268	7,950,981	960,994	282,936	28,507	736,637	8,420,087	18,866,643	196,511,409
2004	210,195	8,106,043	977,984	277,767	28,932	724,891	8,247,181	19,654,694	191,315,963
2005	205,093	7,954,167	945,895	278,471	30,254	721,843	8,478,427	20,504,282	188,595,022
2006	230,633	8,227,185	955,316	287,123	31,013	771,751	8,509,352	20,238,089	177,274,561
2007	293,947	8,236,668	920,085	315,725	34,557	753,721	8,519,214	20,964,928	188,871,886
2008	307,149	8,175,196	957,248	332,496	36,239	756,345	8,496,102	19,515,455	197,298,265
2009	344,007	8,012,651	960,950	343,519	40,608	745,508	8,411,572	17,689,669	199,924,644
2010	365,086	7,900,016	982,918	373,324	46,475	717,366	8,603,753	17,957,421	198,346,719
2011	354,402	7,942,641	959,915	373,327	50,966	708,770	8,642,011	17,549,225	200,718,160
2012	348,861	7,015,729	891,604	395,913	59,865	621,446	8,040,080	17,821,915	198,767,734

6.2.3 Uncertainty and time-series consistency

Uncertainty related to CH_4 emissions from enteric fermentation was 28% for annual emissions, resulting from the combination of 20% of uncertainty for both activity data and emission factors.
In the 2011 submission, Montecarlo analysis was also applied to estimate uncertainty of this category for 2009; an asymetrical probability density distribution resulted from the analysis, showing uncertainties values equal to -21.8% and 31.7%. Different distributions have been assumed for the parameters; assumptions or constraints on variables have been appropriately reflected on the choice of type and shape of distributions. A summary of the results is reported in Annex 1.

In 2012, CH_4 emissions from enteric fermentation were 13.1% (507.98 Gg) lower than in 1990 (584.69 Gg). Between 1990 and 2012 cattle livestock has decreased by 25.9% (from 7,752,152 to 5,742,610 heads). Dairy cattle and non-dairy cattle have decreased by 29.7% (from 2,641,755 to 1,857,004) and 24.0% (from

5,110,397 to 3,885,606), respectively. The reduction in number of cattle is the main driving force for the reduction in CH_4 emissions, particularly as emissions per head from cattle are 10 times greater than emissions per head of sheep or goat. In 2012, cattle contribute with 79.2% to total CH_4 emissions from enteric fermentation. In Table 6.8, emission trends from the enteric fermentation category are shown. Emissions from swine, as reported in the CRF submission 2014, are represented by 'other swine' and 'sow' (12.99 Gg).

Table 6.8 Trend of CH_4 emissions from enteric fermentation (Gg)

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sheep	Goats	Horses	Mules and asses	Sows	Other swine	Rabbits	TOTAL
	(Gg)										
1990	249.75	233.00	5.95	69.91	6.29	5.18	0.84	0.98	11.63	1.16	**584.69**
1995	220.53	246.22	9.55	85.34	6.86	5.67	0.38	1.03	11.06	1.33	**587.98**
2000	221.03	234.48	12.83	88.71	6.88	5.04	0.33	1.06	11.40	1.39	**583.14**
2001	220.87	217.91	13.51	66.49	5.12	5.13	0.33	1.05	12.10	1.44	**543.96**
2002	211.81	213.95	12.61	65.11	4.94	5.00	0.29	1.13	12.62	1.46	**528.92**
2003	212.01	214.17	15.02	63.61	4.80	5.09	0.29	1.10	12.63	1.47	**530.19**
2004	208.15	206.60	14.64	64.85	4.89	5.00	0.29	1.09	12.37	1.53	**519.41**
2005	211.19	204.65	14.82	63.63	4.73	5.01	0.30	1.08	12.72	1.59	**519.73**
2006	209.46	192.10	16.36	65.82	4.78	5.17	0.31	1.16	12.76	1.57	**509.48**
2007	211.36	205.03	20.06	65.89	4.60	5.68	0.35	1.13	12.78	1.63	**528.51**
2008	213.21	197.94	20.52	65.40	4.79	5.98	0.36	1.13	12.74	1.52	**523.60**
2009	215.64	195.53	22.37	64.10	4.80	6.18	0.41	1.12	12.62	1.37	**524.14**
2010	209.29	187.46	23.62	63.20	4.91	6.72	0.46	1.08	12.91	1.39	**511.05**
2011	209.05	188.81	23.25	63.54	4.80	6.72	0.51	1.06	12.96	1.36	**512.07**
2012	215.93	186.43	22.93	56.13	4.46	7.13	0.60	0.93	12.06	1.38	**507.98**

6.2.4 Source-specific QA/QC and verification

Since 2006 submission, results from the MeditAIRaneo project focusing on the assessment of critical points of the enteric fermentation category have been incorporated (CRPA, 2006[a]; Valli *et al*., 2004). Information related to the 2010 Agricultural census have been analysed and verified. Slight differences in the livestock number (cattle and other swine) are found between conjunctural surveys (used for emissions estimation) and Agricultural census for the year 2010; while for the other categories the differences are more significant[9] (ISTAT, 2012).

6.2.5 Source-specific recalculations

CH_4 emissions have been recalculated for 2011 due to the update of the milk production and fat content for dairy cattle and the number of animals for the rabbits category.

6.2.6 Source-specific planned improvements

In the framework of the collaboration between ISPRA and ISTAT (Agriculture Service) we expect to continuously update and improve activity data. Every year agricultural statistics from other sources are also updated (UNAITALIA, several years; AIA, several years).

[9] The number of heads of conjunctural surveys of the sows, sheep, goats, mules and asses, broilers, hens categories is on average 15% higher than the census, whereas for other poultry the difference is 30% and for horses and rabbits is more than double.

6.3 Manure management (4B)

6.3.1 Source category description

In 2012, CH_4 emissions from manure management were 81.13 Gg, which represents 12.2% of CH_4 emissions for the agriculture sector (20.0% in 1990) and 4.9% of national CH_4 emissions (7.9% in 1990). CH_4 emissions from swine were 31.89 Gg and from cattle were 25.50 Gg. These two sub-categories represented 39% and 31%, respectively, of total CH_4 manure management emissions.
In 2012, N_2O emissions from manure management were 12.07 Gg, which represents 18.4% of total N_2O emissions for the agriculture sector (16.7% in 1990) and 13.5% of national N_2O emissions (10.5% in 1990). In 2012, N_2O emissions from this source mainly consist of the solid storage source (10.79 Gg), accounting for 89.4% of the N_2O manure management source.
Since 2006 submission, parameters related to the estimation of CH_4 and N_2O emissions have been updated: average weight, production of slurry and solid manure and the nitrogen excretion rates. The source for updating these parameters was the Nitrogen Balance Inter-regional Project and other national studies (references are provided in this section).
N_2O emissions from manure management are key sources at level, following Approach 1 and Approach 2, and at trend assessment with Approach 2. CH_4 emissions from manure management are key sources at level following Approach 2 and at trend assessment with Approach 1and Approach 2.

6.3.2 Methodological issues

The IPCC Tier 2 approach is used for estimating methane EFs for manure management of cattle, buffalo and swine. For estimating slurry and solid manure EFs and the specific conversion factor, a detailed methodology (*Method 1*) was applied at a regional basis for cattle and buffalo categories. Then, a simplified methodology, for estimating EF time series, was followed (*Method 2*). Livestock population activity data is collected from ISTAT (see Table 6.3; Table 6.4; Table 6.7).

Methane emissions (cattle and buffalo)
Method 1: Regional basis
Methane emission estimations for manure management are drawn up on a regional basis and depend on specific manure management practices and environmental conditions (Safley *et al*., 1992; Steed and Hashimoto, 1995; Husted, 1994). The following factors are used: average regional monthly temperatures (UCEA, 2011), amount of slurry and solid manure produced per livestock category (CRPA, 2006[a]; Regione Emilia Romagna, 2004) and management techniques for the application of slurry and solid manure for agricultural purposes in Italy (CRPA, 1993).
For cattle and buffalo, the estimation of the EF starts with the calculation of the *methane emission rate* (g CH_4 m^{-3} day^{-1}), which is obtained from an equation for slurry (Husted, 1994) and solid manure (Husted, 1993). Then, the *methane emission rate* is transformed to g m^{-3} $month^{-1}$.
Equations are presented below (CRPA, 2006[a]; CRPA, 1997[a]).

For slurry:

$$CH_4 \text{ (g m}^{-3}\text{ day}^{-1}) = e^{(0.68+0.12) * t (°C) \text{ (average regional monthly temperature)}} \quad \textit{Eq. 6.1}$$

For solid manure:

$$CH_4 \text{ (g m}^{-3}\text{ day}^{-1}) = e^{(-2.3+0.1) * t (°C) \text{ (monthly storage temperature)}} \quad \textit{Eq. 6.2}$$

The monthly storage temperature from the solid manure is estimated with the following equation (Husted, 1994):

$$T \text{ solid manure storage} = 6{,}7086e^{0.1014t (°C) \text{ (average regional monthly temperature)}}$$

For temperatures below 10°C emissions are considered negligible.

The volume of slurry and solid manure produced per livestock category was obtained (m^3 $head^{-1}$) with the average production of slurry and solid manure per livestock category per day (m^3 $head^{-1}$ day^{-1}) and the days of storage of slurry and solid manure. These days are related to the temporal application dynamics of slurry and solid manure under Italian conditions (CRPA, 1997[a]). On the other hand, the production of solid manure and slurry were estimated assuming a distribution of housing systems in Italy; an assessment of the abovementioned distribution has been carried out on the basis of the 2010 Agricultural Census to validate and verify the used distribution of housing system which has been deduced by reaserches at national level (CRPA, 2006[a]; Bonazzi *et al*., 2005; APAT, 2004[a]; APAT, 2004[b]). Emission factors for slurry and solid manure (g CH_4 $head^{-1}$ $month^{-1}$) are calculated for each month, and were obtained with the *methane emission rates* (Eq. 6.1 and 6.2), and the volume of slurry and solid manure produced. The annual EF for each livestock category is the sum of slurry and solid manure EFs (kg CH_4 $head^{-1}$ $year^{-1}$). In order to correlate CH_4 emission production and volatile solid (VS) production, a *specific conversion factor* was estimated. Later, this '*conversion factor'* is used for the simplified methodology (*Method 2*). The *specific conversion factor* values for slurry and solid manure are 15.32 g CH_4/kg VS and 4.80 g CH_4/kg VS, respectively.

Method 2: National basis

A simplified methodology (*Method 2*) for estimating methane EFs from manure management was used for the whole time series. Slurry and solid manure EFs (kg CH_4 $head^{-1}$ $year^{-1}$) were calculated with Equations 6.3 and 6.4, respectively. These equations include the *specific conversion factor,* estimated on a regional basis. The production of volatile solids (kg $head^{-1}day^{-1}$) was estimated with the slurry and solid manure production, and factors proposed by Husted: 47g VS/kg (slurry) and 142 g VS/kg (solid manure). The daily VS excreted, estimated for slurry and solid manure, are summed and used for calculating the methane producing potential (Bo).

In Table 6.9, EF estimations are shown.

EF slurry = 15.32 gCH_4/Kg VS • VS production slurry (kg VS $head^{-1}$ day-^{1}) • 365 days *Eq. 6.3*

EF manure = 4.80 gCH_4/Kg VS • VS production solid manure (kg VS $head^{-1}$ day-^{1}) • 365 days *Eq. 6.4*

Table 6.9 Methane manure management EFs for cattle and buffalo in 2012 (kg CH_4 $head^{-1}$ yr^{-1})

Livestock category	Slurry (kg CH_4 $head^{-1}$ yr^{-1})	Solid manure (kg CH_4 $head^{-1}$ yr^{-1})	CH_4 manure management EF (kg CH_4 $head^{-1}$ yr^{-1})
Calf	6.22	0.00	**6.22**
Cattle	5.38	3.70	**9.08**
Female cattle	2.88	4.25	**7.13**
Other dairy cattle	4.01	6.65	**10.66**
Dairy cattle	5.64	9.41	**15.04**
Cow buffalo	4.93	10.32	**15.25**
Other buffaloes	3.12	3.17	**6.30**

Since 2006 submission, the average production of slurry and solid manure per livestock category per day (m^3 $head^{-1}$ day^{-1}) has been updated with results from the Nitrogen Balance Inter-regional Project (Regione Emilia Romagna, 2004). Based on the type and distribution of housing systems for the different animal categories, and the average weight of animals, a time series of slurry and solid manure production was obtained.

In Table 6.10 the disaggregated manure management EFs for cattle and buffalo are shown. See also Table 6.13 for the average EFs of main categories (dairy, non-dairy, buffalo and swine).

Table 6.10 Methane manure management EFs for cattle and buffalo (kg CH_4 $head^{-1}$ yr^{-1})

Year	Calf	Cattle	Female cattle	Other dairy cattle	Dairy cattle	Cow buffalo	Other buffaloes
	(kg CH_4 $head^{-1}$ yr^{-1})						
1990	6.22	8.11	6.71	10.66	15.04	15.25	6.34
1995	6.22	8.56	6.71	10.66	15.04	15.25	6.33

Year	Calf	Cattle	Female cattle	Other dairy cattle	Dairy cattle	Cow buffalo	Other buffaloes
	(kg CH_4 head^{-1} yr^{-1})						
2000	6.22	8.27	6.80	10.66	15.04	15.25	6.31
2001	6.22	8.48	7.07	10.66	15.04	15.25	6.31
2002	6.22	8.23	6.99	10.66	15.04	15.25	6.30
2003	6.22	8.38	6.94	10.66	15.04	15.25	6.30
2004	6.22	8.34	6.98	10.66	15.04	15.25	6.30
2005	6.22	8.61	6.95	10.66	15.04	15.25	6.30
2006	6.22	8.52	6.87	10.66	15.04	15.25	6.29
2007	6.22	8.56	7.05	10.66	15.04	15.25	6.29
2008	6.22	8.58	6.99	10.66	15.04	15.25	6.29
2009	6.22	8.75	7.03	10.66	15.04	15.25	6.29
2010	6.22	8.81	7.04	10.66	15.04	15.25	6.30
2011	6.22	8.80	6.96	10.66	15.04	15.25	6.30
2012	6.22	9.08	7.13	10.66	15.04	15.25	6.30

Since 2006 submission, a reduction of CH_4 emissions has been introduced in the manure management category (4B) in order to consider the biogas production. A national census on biogas production/technology can be found in CRPA and CRPA/AIEL (CRPA, 2008; CRPA/AIEL 2008). Biogas production data are collected every year by the National Electric Network (TERNA, several years). For further information on biogas activity data see Annex 7.2.
Reductions of CH_4 emissions related to biogas recovery are assumed for cattle and swine livestock categories, and distributed according to the contribution of emissions from each category. This reduction is evident in the IEF reported in the CRF. In 2012, the CRF IEFs, for dairy cattle and non-dairy cattle, were 6.57 kg CH_4 head^{-1} year^{-1} and 3.42 kg CH_4 head^{-1} year^{-1}, respectively. IPCC default EFs for cool temperature are 14 kg CH_4 head^{-1}year^{-1} and 6 kg CH_4 head^{-1}year^{-1}, respectively (IPCC, 1997).
The IEF for non-dairy cattle and buffalo represents a weighted average. The non-dairy cattle IEF includes: calf, cattle, female cattle and other dairy cattle. The buffalo category includes: cow buffalo and other buffaloes categories. In the following box, EFs and IEFs are shown. Differences, as mentioned before, are related to the amount of CH_4 reductions from biogas recovery. Moreover, interannual decrease of the non-dairy IEFs reflects the strong increase of biogas recovery. In the following box the default EFs of the IPCC 2006 Guidelines are also reported.

Livestock category	EF (kg CH_4 head^{-1} yr^{-1})	IEF(*) (kg CH_4 head^{-1} yr^{-1})	IPCC 1996 default EF (kg CH_4 head^{-1} yr^{-1})	IPCC 2006 default EF (kg CH_4 head^{-1} yr^{-1})
Dairy cattle	15.04	6.57	14	27
Non-dairy cattle	7.85	3.42	6	8
Buffalo	11.74	11.74	3	5

(*) IEF as reported in the CRF submission 2014

Emissions from the biogas combustion for energy production are estimated and reported in the energy sector in the 1.A.4.c category, agriculture, forestry and fisheries, biomass fuel.

For reporting purposes, the CH_4 producing potential (Bo) is estimated with Equation 4.17 from IPCC (IPCC, 2000). The average methane conversion factors (MCF), for each manure management system (classified by climate), was estimated with data coming from the Agriculture Census from 1990 and 2000 and the FSS 2005 (ISTAT, 2007[a]). An assessment of the abovementioned MCFs has been carried out on the basis of the data coming from the FSS 2007 (ISTAT, 2008[a]) and the 2010 Agriculture Census (ISTAT, 2012), resulting in very slight differences comparing to the used average methane conversion factors. Average MCFs were not used for estimating manure management EF, but they are useful to verify the EF accuracy. In the following box, estimated country-specific VS and Bo parameters, and IPCC default values are shown (IPCC, 2000). Differences are mainly attributed to country-specific characteristics.

Livestock category	VS country-specific (*) (kg dm $head^{-1}$ yr^{-1})	VS IPCC default (kg DM $head^{-1}$ yr^{-1})	Bo country-specific (*) (CH_4 m^3/kg VS)	Bo IPCC default (CH_4 m^3/kg VS)
Dairy cattle	6.37	5.08	0.14	0.24
Non-dairy cattle	2.92	2.65	0.13	0.17
Buffalo	5.04	2.68	0.13	0.10
Swine	0.34	0.50	0.46	0.45

(*) IEF as reported in the CRF submission 2014

Methane emissions (swine)

For the estimation of CH_4 emissions for swine, a country-specific *methane emission rate* was experimentally determined by the Research Centre on Animal Production (CRPA, 1996). The estimation of the EF considers: the storage systems for slurry (tank and lagoons), type of breeding and seasonal production of biogas.

Different parameters were considered, such as the livestock population, average weight for fattening swine and sows, and *methane emission rate*. Methane emission rates used are 41 normal litre CH_4/100 kg live weight/day for fattening swine, and 47 normal litre CH_4/100 kg live weight/day for sows including piglets (CRPA, 1997[a]), based on experimental measuments on covered storage systems. Then, a reduction of 8% is applied to these factors to take in account the proportion of animal waste allocated to uncovered storage systems, which are the most common ones (CRPA, 1997 [a]; CRPA, 2006[b]), considering that the uncovered systems are emitting less than the covered ones since the temperatures are lower. Characteristics of swine breeding and EFs are shown in Table 6.11; the emission factors reflect the share of covered/uncovered storage systems. In the 2006 submission, parameters such as: average weight of sows, production of slurry (t $year^{-1}$ per t live weight) and volatile solid content in the slurry (g SV/kg slurry w.b.) were updated. The slurry production considered the different swine categories (classified by weight and housing characteristics). Volatile solid content were determined experimentally from 598 measurements carried out by CRPA (CRPA, 2006[a]).

In 2012, the EF from sow was 22.17 kg CH_4 $head^{-1}year^{-1}$, and for the other swine category was 8.94 kg CH_4 $head^{-1}$ $year^{-1}$ (average swine EF is 8.44 kg CH_4 $head^{-1}year^{-1}$). In Table 6.13 the time series of EFs for the swine category (sow and other swine) are shown. The CRF IEF reported is 3.68 kg CH_4 $head^{-1}$ $year^{-1}$. IPCC 1996 Guidelines default EF for cool temperature is 3 kg CH_4 $head^{-1}year^{-1}$ (IPCC, 1997) while IPCC 2006 Guidelines default EF is 7 kg CH_4 $head^{-1}year^{-1}$ for market swine and 11 kg CH_4 $head^{-1}year^{-1}$ for breeding swine respectively (IPCC, 2006). The difference between the EF and the IEF is due to the reduction in CH_4 because of biogas recovery. For reporting purposes, the VS daily excretion and Bo is estimated and is useful to verify the EF accuracy. The VS daily excretion was estimated for each sub-category with the following parameters: animal number, production of slurry (t/y/t live weight) and the volatile solids content in the slurry (g VS/kg slurry w.b.). Methane producing potential (Bo) used Equation 4.17 from the IPCC (IPCC, 2000).

Table 6.11 Methane manure management parameters and emission factors for swine in 2012

Livestock category	Average weight (kg)	Breed live weight (t)	Methane emission rate with 8% emission reduction (Nl CH_4/100 kg live weight)	Emission factor (kg CH_4 $head^{-1}$ yr^{-1})
Other swine	**90**	**597,067**	**13,768**	**8.94**
20-50 kg	35	53,398	13,768	3.48
50-80 kg	65	82,205	13,768	6.46
80-110 kg	95	141,184	13,768	9.44
110 kg and more	135	313,728	13,768	13.41
Boar	200	6,552	13,768	19.86
Sow	**172.1**	**121,020**	**15,783**	**22.17**
Piglets	10	14,069	*15,783*	*1.14*
Sow	172.1	106,951	*15,783*	*19.60*
			TOTAL	**8.44**

The fundamental characteristic of Italian swine production is the high live weight of the animals slaughtered as related to age; the optimum weight for slaughtering to obtain meat suitable for producing the typical cured meats is between 155 and 170 kg of live weight. Such a high live weight must be reached in no less than nine months of age. Other characteristics are the feeding situation, to obtain high quality meat, and the concentration of Italian pig production, limited to a small area (*Lombardia, Emilia-Romagna, Piemonte* and *Veneto*), representing 75% of national swine resources (Mordenti *et al*., 1997). These peculiarities of swine production influence the methane EF for manure management as well as nitrogen excretion factors used for the estimation of N_2O emissions.

Other livestock categories

Methane EFs used for calculating the other livestock categories are those proposed by the IPCC 1996 Guidelines. Since the yearly average temperature in Italy is 13 °C, EFs are characteristic of the "cold" climatic region (IPCC, 1997). A study carried out at national level by CRPA (CRPA, 1997[a]) assessed the specific IPCC default EFs to estimate emissions from this category, and an average figure was calculated for each animal category considering that the manure of some animals occur in Italian provinces where average temperatures are higher than 15° C (temperate). In Table 6.12 the distribution of animals in temperate zone is shown. In Table A.7.3 in the Annex, percentages of animals in temperate zone based on data from the FSS 2005, provided by ISTAT, and the average temperature at provincial level are shown. In order to verify the used animal distribution, the 2010 Agriculture Census (ISTAT, 2012) has been used to infer the percentages of animals in temperate zone. Comparing the assessed percentage with the used distribution slight differences have to be noted, except for other swine, other equines and hens categories (decrease of 30%, 30% and an increase by 27%, respectively); a higher deviation is resulting for the other poultry and broilers categories.

Table 6.12 Distribution of animals in temperate zone

Animals in temperate zone based on data from the FSS 2005 (ISTAT)	Total	N animals	% animals	Based on temperature non weighted by % animals	
				N animals	% animals
Non-dairy cattle	4,409,921	552,951	12.54%	285,415	6.47%
Dairy cattle	1,842,004	140,747	7.64%	55,975	3.04%
Buffalo	205,093	83,864	40.89%	121	0.06%
Other swine	8,478,427	208,355	2.46%	76,427	0.90%
Sows	721,843	21,948	3.04%	14,775	2.05%
Sheep	7,954,167	2,046,930	25.73%	1,273,110	16.01%
Goats	945,895	380,826	40.26%	129,030	13.64%
Horses	278,471	38,047	13.66%	16,695	6.00%
Mules and asses	30,254	6,040	19.97%	2,153	7.12%
Broilers	97,532,025	1,560,813	1.60%	1,269,593	1.30%
hen	52,692,584	3,971,390	7.54%	2,534,710	4.81%
other poultry	38,370,412	567,236	1.48%	555,050	1.45%
Rabbits	20,504,282	1,378,261	6.72%	477,474	2.33%

In Table 6.13, the average methane EFs for cattle, buffalo and swine categories are shown for the whole time series.

For the other categories, the EFs are as follows:

- rabbits, 0.080 kg CH_4 $head^{-1}$ $year^{-1}$
- sheep, 0.22 kg CH_4 $head^{-1}$ $year^{-1}$
- goats, 0.145 kg CH_4 $head^{-1}$ $year^{-1}$
- horses, 1.48 kg CH_4 $head^{-1}$ $year^{-1}$

- mules and asses, 0.84 kg CH_4 head^{-1} year^{-1}
- hens, 0.082 kg CH_4 head^{-1} year^{-1}
- broilers, 0.079 kg CH_4 head^{-1} year^{-1}
- other poultry, 0.079 kg CH_4 head^{-1} year^{-1}
- fur animals, 0.68 kg CH_4 head^{-1} year^{-1}

Table 6.13 Average methane EF for manure management (kg CH^4 head^{-1} year^{-1})

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sows	Other swine
	(kg CH_4 head^{-1} year^{-1})				
1990	15.04	7.47	12.17	22.14	8.54
1995	15.04	7.82	11.95	21.96	8.52
2000	15.04	7.67	11.71	21.97	8.43
2001	15.04	7.72	13.74	22.20	8.55
2002	15.04	7.66	14.07	22.27	8.21
2003	15.04	7.69	12.98	22.19	8.20
2004	15.04	7.73	12.87	22.22	8.27
2005	15.04	7.78	12.29	22.30	8.35
2006	15.04	7.67	11.96	22.16	8.35
2007	15.04	7.77	11.97	22.21	8.33
2008	15.04	7.70	11.75	22.14	8.32
2009	15.04	7.75	12.03	22.17	8.40
2010	15.04	7.75	12.30	22.34	8.36
2011	15.04	7.70	12.27	22.40	8.40
2012	15.04	7.85	11.74	22.17	8.94

(*) These are the EFs used for estimating CH_4 emissions from manure management. CH_4 reductions are not included.

Nitrous oxide emissions

As suggested in the IPCC (IPCC, 2000) N_2O emissions were estimated with equation 4.18 from IPCC. Different parameters were used for the estimation: number of livestock species, country-specific nitrogen excretion rates per livestock category, the fraction of total annual excretion per livestock category related to a manure management system and EFs for manure management systems (IPCC, 1997).
Liquid system, solid storage and other management systems (chicken-dung drying process system) are considered according to their significance and major distribution in Italy. For these management systems, the following EFs are used: 0.001 kg N_2O-N/kg N excreted, 0.02 kg N_2O-N/kg N excreted and 0.02 kg N_2O-N/kg N excreted, respectively (CRPA, 2000; CRPA, 1997[b]). The chicken-dung drying process system is considered since 1995, since it has become increasingly common (CRPA, 2000; CRPA, 1997[b]).

When estimating emissions from manure management, the amount related to manure excreted while grazing is subtracted and reported in ‘Agricultural soils’ under soil emissions - animal production (see Table 6.14). In the 2006 submission, different parameters such as the nitrogen excretion rates (CRPA, 2006[a]; GU, 2006; Xiccato *et al.*, 2005), the slurry and solid manure production, and the average weight (CRPA, 2006[a]; GU, 2006; Regione Emilia Romagna, 2004) were updated. In Table 6.14, nitrogen excretion rates used for the estimation of N_2O are shown. The nitrogen excretion rate for swine is 12.54 kg head^{-1} yr^{-1}. This last parameter is a weighted average: sow (28.13 kg head^{-1} yr^{-1}) and other swine (13.74 kg head^{-1} yr^{-1}).

Table 6.14 Average weight and nitrogen excretion rates in 2012

Livestock category	Average weight (kg)	N excreted Housing (kg head^{-1} yr^{-1})	N excreted Grazing (kg head^{-1} yr^{-1})	TOTAL Nitrogen excreted (kg head^{-1} yr^{-1})
Non-dairy cattle	388	50.16	1.46	**51.62**

Livestock category	Average weight (kg)	N excreted Housing (kg head^{-1} yr^{-1})	N excreted Grazing (kg head^{-1} yr^{-1})	TOTAL Nitrogen excreted (kg head^{-1} yr^{-1})
Dairy cattle	603	110.20	5.80	**116.00**
Buffalo	505	88.33	2.64	**90.97**
Other swine	90	13.74	-	**13.74**
Sow	172	28.13	-	**28.13**
Sheep	48	1.62	14.58	**16.20**
Goat	47	1.62	14.58	**16.20**
Horses	550	20.00	30.00	**50.00**
Mules and asses	300	20.00	30.00	**50.00**
Poultry	1.7	0.51	-	**0.51**
Rabbit	1.6	1.02	-	**1.02**
Fur animals	1	4.10	-	**4.10**

Since 2006 submission, with results obtained from the Nitrogen Balance Inter-regional Project, country-specific annual nitrogen excretion rates have been incorporated. This project involved *Emilia Romagna*, *Lombardia*, *Piemonte* and *Veneto* regions, where animal breeding is concentrated. The nitrogen balance methodology was followed, as suggested by the IPCC. As a result, estimations of nitrogen excretion rates[10] and net nitrogen arriving to the field[11] were obtained. In order to get reliable information on feed consumption and characteristics, and composition of the feed ratio, the project considered territorial and dimensional representativeness of Italian breeding. Final annual nitrogen excretion rates used for the UNFCCC/CLRTAP agriculture national inventory are reported in a report from CRPA (CRPA, 2006[a]).
In Table 6.15, nitrogen excretion rates for the main livestock categories are shown for the whole time series. For the other livestock categories nitrogen excretion is the same for the whole time series, as shown in Table 6.14.

For the dairy cattle category, the same nitrogen excretion rate is applied for the whole time series. This figure is the result of the Nitrogen Balance Inter-regional Project. Further explanation on the efforts to improve the modelling of nitrogen excretion is given in the following section 6.3.6.

Table 6.15 Nitrogen excretion rates for main livestock categories (kg N head^{-1} yr^{-1})

Year	Dairy cattle	Non-dairy cattle	Buffalo	Other swine	Sows
	(kg N head^{-1} yr^{-1})				
1990	116.0	50.00	93.94	13.13	28.10
1995	116.0	49.86	92.42	13.10	27.86
2000	116.0	50.08	90.76	12.96	27.87
2001	116.0	50.69	105.23	13.14	28.17
2002	116.0	50.39	107.58	12.61	28.27
2003	116.0	50.53	99.82	12.60	28.16
2004	116.0	50.04	99.01	12.72	28.20
2005	116.0	49.76	94.91	12.84	28.30
2006	116.0	48.52	92.59	12.84	28.12
2007	116.0	49.84	92.61	12.81	28.18

[10] Nitrogen excretion = N consumed – N retained
[11] Net nitrogen to field= (N consumed – N retained) – N volatilized

Year	Dairy cattle	Non-dairy cattle	Buffalo	Other swine	Sows
	(kg N head^{-1} yr^{-1})				
2008	116.0	49.76	91.05	12.79	28.09
2009	116.0	50.19	93.04	12.92	28.13
2010	116.0	49.83	94.96	12.85	28.36
2011	116.0	49.46	94.80	12.92	28.44
2012	116.0	51.62	90.97	13.74	28.13

Since 2006 submission, new average weight data have been used for UNFCCC/CLRTAP agriculture national inventory. For verification purpose, a time series reported by ISTAT in the yearbooks (animal weight before slaughter) was collected (CRPA, 2006[a]). For the specific case of sheep and goats, a detailed analysis was applied with information coming from the National Association for Sheep Farming (ASSONAPA, 2006). In order to estimate the average weight for sheep and goats, breed distribution in Italy and consistency for each breed were considered (CRPA, 2006[a]; PROINCARNE, 2005). Slurry and solid manure production parameters were updated in the 2006 submission. These parameters consider characteristics from Italian breeding, for slurry and solid manure effluents, housing systems and the distribution for the different animal categories (CRPA, 2006[a]; Bonazzi *et al*., 2005; APAT, 2004[a]; APAT, 2004[b]).

6.3.3 Uncertainty and time-series consistency

Uncertainty of CH_4 and N_2O emissions from manure management has been estimated equal to 102%, as a combination of 20% and 100% for activity data and emission factors, respectively.
In the 2012 submission, Montecarlo analysis was also applied to estimate uncertainty of these two categories. The resulting figures were 22.96% and 10.19% for CH_4 and N_2O emissions from manure management, respectively. Normal and lognormal distributions have been assumed for the parameters; at the same time, whenever assumptions or constraints on variables were known this information has been appropriately reflected on the range of distribution values. A summary of the results is reported in Annex 1.

In 2012, livestock CH_4 emissions from manure management were 51% (81.13 Gg CH_4) lower than in 1990 (165.08 Gg CH_4). From 1990 to 2012, dairy and non-dairy cattle livestock population decreased by 69% and 65%, respectively, while swine decreased by 53%. The reduction of manure management emissions has mainly driven down by the number of cattle and, in the last years, the increasing amount of biogas recovered for energy production. Cattle CH_4 emissions contribute with 31% (in 1990 with 47%) to total CH_4 manure management emissions and swine with 39% (41% in 1990).
In Table 6.16, CH_4 emission trends from manure management are shown. These emissions considered the reduction of CH_4 because of biogas recovery.

Table 6.16 Trend in CH_4 emissions from manure management (Gg)

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sows	Other swine	Sheep	Goats	Horses	Mules and asses	Poultry	Rabbits	Fur animals	TOTAL
							Gg						
1990	39.74	38.18	1.15	14.41	53.78	1.90	0.18	0.43	0.07	13.82	1.19	0.22	**165.08**
1995	30.85	40.01	1.77	14.94	49.85	2.32	0.20	0.47	0.03	14.67	1.36	0.15	**156.63**
2000	30.80	37.92	2.25	15.42	51.14	2.41	0.20	0.41	0.03	14.09	1.42	0.16	**156.25**
2001	30.78	35.43	2.66	15.25	54.51	1.81	0.15	0.42	0.03	16.68	1.47	0.16	**159.35**
2002	28.17	34.54	2.61	16.40	53.46	1.77	0.14	0.41	0.02	16.39	1.50	0.17	**155.59**
2003	28.11	34.47	2.89	15.96	53.97	1.73	0.14	0.42	0.02	15.68	1.50	0.16	**155.05**
2004	26.73	33.38	2.70	15.57	52.58	1.76	0.14	0.41	0.02	15.27	1.57	0.15	**150.29**
2005	26.44	32.74	2.52	15.36	53.87	1.73	0.14	0.41	0.03	15.05	1.63	0.14	**150.07**
2006	25.21	30.31	2.76	15.73	52.04	1.79	0.14	0.42	0.03	14.15	1.61	0.12	**144.32**
2007	25.05	31.28	3.52	15.16	51.26	1.79	0.13	0.47	0.03	15.07	1.67	0.11	**145.54**
2008	24.11	29.32	3.61	14.66	49.56	1.78	0.14	0.49	0.03	15.74	1.56	0.10	**141.09**

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sows	Other swine	Sheep	Goats	Horses	Mules and asses	Poultry	Rabbits	Fur animals	TOTAL
							Gg						
2009	23.79	27.57	4.14	13.91	47.60	1.74	0.14	0.51	0.03	15.95	1.41	0.10	**136.89**
2010	19.61	23.63	4.49	11.96	42.86	1.72	0.14	0.55	0.04	15.82	1.43	0.09	**122.34**
2011	15.26	18.45	4.35	9.18	33.49	1.73	0.14	0.55	0.04	16.01	1.40	0.11	**100.71**
2012	12.19	13.31	4.09	6.01	25.88	1.53	0.13	0.59	0.05	15.82	1.42	0.11	**81.13**

In Table 6.17, N_2O emissions from liquid systems, solid storage and ‘other’ sources are shown.

Table 6.17 Trend in N_2O emissions due to manure management, (Gg)

Year	Liquid system	Solid storage	Other	TOTAL
		(Gg)		
1990	0.62	12.07	-	**12.69**
1995	0.57	11.57	0.09	**12.23**
2000	0.54	11.39	0.56	**12.49**
2001	0.54	11.62	0.78	**12.94**
2002	0.52	11.09	0.84	**12.45**
2003	0.52	10.95	0.89	**12.36**
2004	0.51	10.62	0.89	**12.01**
2005	0.51	10.51	0.97	**11.99**
2006	0.50	10.19	0.95	**11.64**
2007	0.51	10.75	0.94	**12.21**
2008	0.51	10.73	0.96	**12.20**
2009	0.51	10.83	0.98	**12.32**
2010	0.49	10.49	0.97	**11.95**
2011	0.50	10.50	0.98	**11.98**
2012	0.49	10.79	0.79	**12.07**

In 2012, N_2O emissions from manure management were 5% (12.07 Gg N_2O) lower than in 1990 (12.69 Gg N_2O). The major contribution is given by the ‘solid storage system’ with 89% (in 1990 with 95%).

6.3.4 Source-specific QA/QC and verification

In order to verify the data related to the distribution of housing systems used to estimate the production of solid manure and slurry, an assessment of the abovementioned distribution has been carried out on the basis of the 2010 Agricultural Census. Similarly the MCFs have been assessed on the basis of the data of the FSS 2007 (ISTAT, 2008[a]) and the 2010 Agriculture Census (ISTAT, 2012) to verify the average methane conversion factors used in the estimation process, resulting in very slight differences.Further verification has been carried out to evaluate the animal distribution used in the estimation process; the 2010 Agriculture Census (ISTAT, 2012) has been used to infer the percentages of animals in temperate zone, resulting in slight differences, except for other swine, other equines and hens categories (decrease of 30%, 30% and an increase by 27%, respectively); an higher deviation is resulting for the other poultry and broilers categories.

6.3.5 Source-specific recalculations

CH_4 and N_2O emissions have been recalculated for the whole time series due to the uploading of the fur animals category. In 2011 CH_4 emissions have been recalculated due to the updating of the number of animals for rabbits.

6.3.6 Source-specific planned improvements

In Table 6.18, future improvements in agreement with the QA/QC plan are presented.

Table 6.18 Improvements for manure management category according to the QA/QC plan

Category/sub category	Parameter	Year of submission 2015	2016	Activities
Dairy cattle	N excretion		√	Further efforts on theoretical assessment of N excretion data will be done based on N balance methodology (Gruber and Poesch, 2006).
Livestock categories	Housing systems	√		A query on the housing systems of different livestock categories has been introduced in the Farm and structure survey 2005. Validation of the results has been carried out, in collaboration with the CRPA experts, taking into account also information collected from the 2010 Agricultural Census. An evaluation of the possible update to be introduced in the estimation process is currently ongoing.
Livestock categories	Slurry and solid manure storage facilities	√		A query related to storage facilities for slurry and solid manure of different livestock categories has been introduced in the Farm and structure survey 2007. Validation of the results has to be carried out, taking into account also information collected from the 2010 Agricultural Census.
Livestock categories	Production methods	√		Different queries have been incorporated in a specific section of the 2010 Agricultural Census. Detailed information on grazing, housing, storage systems and land spreading information has been collected and will be considered in the next submission.
Livestock categories	Average temperature		√	The average annual temperatures used in the assessment of the manure management CH_4 emission factors will be verified on the basis of the available information (i.e. updated data from SCIA[12]).

For the dairy cattle category, the suggestions by the review process (UNFCCC, 2009) have been taken into consideration. Nitrogen excretion in Italy has been evaluated through a Nitrogen Balance Inter-regional Project (nitrogen balance in animal farms), funded by the Regional Governments of the most livestock-intensive Italian Regions. The N-balance methodology has been applied in real case farms, monitoring their normal feeding practice, without specific diet adaptation. In the project, the most relevant dairy cattle production systems in Italy have been considered. Contrary to what is normally found in European milk production systems, poor correlation between the N excretion and milk production has been found. Probably there are two reasons for explaining the absence of correlation: a) extreme heterogeneity in the protein content of the forage and in the use of the feed; b) the non optimisation of the protein diet of less productive cattle (De Roest and Speroni, 2005; CRPA, 2010). Further efforts on theoretical assessment of nitrogen excretion data will be done based on nitrogen balance methodology (Gruber and Pötsch, 2006). An ad-hoc agro-environmental indicator group coordinated by the Ministry of Agriculture is working to determine gross nitrogen balances; the revision of N coefficients will be considered accordingly.
Parameters used for this submission are shown in Table 6.19.

[12] SCIA is the national system for the collection, elaboration and dissemination of climatological data, by ISPRA, in the framework of the national environmental information system, in collaboration with the relevant institutions: http://www.scia.isprambiente.it/scia_eng.asp

Table 6.19 Parameters used for the different livestock categories in 2014 submission (Year 2012)

Livestock category			Average weight (kg)	N excretion (kg N $head^{-1}$ yr^{-1})
DAIRY CATTLE			603	116
NON- DAIRY CATTLE				
Less than 1 year (*)			205(**)	24.2 (**)
From 1 year - less than 2 years				
	Male	for reproduction	557	66.8
		for slaughter	557	66.8
	Female	for breeding	405	67.6
		for slaughter	444	53.3
From 2 years and more				
	Male	for reproduction	700	84.0
		for slaughter and work	700	84.0
	Female	Breeding heifer	540	90.2
		Slaughter heifer	540	64.8
		Other dairy cattle	557	54.1
BUFFALO	Cow buffalo		630	116
	Other buffaloes		313	52.2
OTHER SWINE	Weight less than 20 kg		10	
	From 20 kg weight and under 50 kg		35	5.3
	From 50 kg and more			
		Boar	200	30.5
		For slaughter		
		from 50 to 80 kg	65	9.9
		from 80 to 110 kg	95	14.5
		from 110 kg and more	135	20.6
SOW			172.1	28.1 (**)
SHEEP	Sheep		51	16.2
	Other sheep		21	16.2
GOAT	Goat		54	16.2
	Other goat		15	16.2
EQUINE	Horses		550	50.0
	Mules and asses		300	50.0
POULTRY	Broilers		1.2	0.36
	Hen		1.8	0.66
	Other poultry		3.3	0.83
RABBIT	Female rabbits		4	2.5
	Other rabbit		1.3	0.8
FUR ANIMALS			1.0	4.1

(*) Categories included in less than 1 year are: calf, fattening male cattle, fattening heifer and heifer for replacement;
(**) values are variable for the time series.

6.4 Rice cultivation (4C)

6.4.1 Source category description

For the rice cultivation category, only CH_4 emissions are estimated, other GHGs do not occur; N_2O from fertilisation during cultivation was estimated and reported in "Agricultural soils" under direct soil emissions - synthetic fertilizers. Methane emissions from rice cultivation have not been identified as a key source. In 2012, CH_4 emissions from rice cultivation were 73.0 Gg, which represent 11.0 % of CH_4 emissions for the agriculture sector (9.1% in 1990) and 4.4% for national CH_4 emissions (3.6% in 1990).
In Italy, CH_4 emissions from rice cultivation are estimated only for an irrigated regime, other categories suggested by IPCC (rainfed, deep water and "other") are not present. Methane emissions, reported in the CRF, represent two water regimes: single aeration (16.3 Gg) and multiple aeration (56.7 Gg).
In response to UNFCCC review processes from 2004 and 2005 (UNFCCC, 2005; UNFCCC, 2004) and in consultation with an expert in CH_4 emissions and rice cultivation (Wassmann, 2005), a detailed methodology was developed. New activity data and parameters are used for the estimation of CH_4 emissions (Cóndor *et al*., 2007[a]). For this purpose, an expert group on rice cultivation together with the C.R.A. – Experimental Institute of Cereal Research – Rice Research Section of Vercelli was established. Different national experts from the rice cultivation sector were also contacted[13].
The quality of the Italian rice emission inventory was verified with the Denitrification Decomposition model (DNDC). Initial results have found a high correspondence between the EFs used for the Italian inventory and those simulated with DNDC model (Leip and Bocchi, 2007).

6.4.2 Methodological issues

For the estimation of CH_4 emissions from rice cultivation a detailed methodology was implemented following the IPCC guidelines (IPCC, 2006). We have considered country-specific circumstances. Parameters such as an adjusted integrated emission factor (kg CH_4 $m^{-2}day^{-1}$), cultivation period of rice (days) and annual harvested area (ha) cultivated under specific conditions are considered. Information of the cultivated surface is collected 100% from rice farmers. Every year, data are collected on time by the National Rice Institute (ENR, several years [b]). Activity data information is shown in the following box.

Parameters used for the calculation of CH_4 emissions from rice cultivation

Parameters	Reference
Cultivated surface with "dry-seeded" technique (%)	ENR, several years [a]
Cultivated surface – national (ha)	ISTAT, several years [a],[b],[j]; ENR, several years [b]
Cultivated surface by rice varieties (ha)	ENR, several years [b]
Cultivation period of rice varieties (days)	ENR, 2011
Methane emission factor (kg CH_4 m^{-2} d^{-1})	Leip *et al*., 2002; Schutz *et al*., 1989[a], [b]
Crop production (t yr^{-1})	ISTAT, several years [a],[b],[j]
Yield (t ha^{-1})	Estimations based on cultivated surface and crop production data
Straw incorporation (%)	Expert judgement (Tinarelli, 2005; Lupotto *et al*., 2005)
Agronomic practices (%)	ISTAT, 2006[b]; Tinarelli, 2005; Lupotto *et al*., 2005; Zavattaro et. al, 2004; Baldoni & Giardini, 1989; Tinarelli, 1973; 1986
Scaling factors (SFw, SFp, SFo)	IPCC, 2006; Yan et. al, 2005

Rice cultivation practice
In Italy, rice is sown from mid-April to the end of May and harvested from mid-September to the end of October; the only practised system is the controlled flooding system, with variations in water regimes (Regione Emilia Romagna, 2005; Mannini, 2004; Tossato and Regis, 2002). In Table 6.20, water regimes descriptions for the most common agronomic practices in Italy are presented. Water regime trends have been

[13]Stefano Bocchi, Crop Science Department (University of Milan); Aldo Ferrero, Department of Agronomy, Forestry and Land Management (University of Turin); Antonino Spanu, Department of agronomic science and agriculture genetics (University of Sassari).

estimated in collaboration with expert judgement expertise (Tinarelli, 2005; Lupotto *et al*., 2005) and available statistics (ENR, several years [b]).
Normally, the aeration periods are very variable in number and time, depending on different circumstances, as for example, the type of herbicide, which is used (Baldoni and Giardini, 1989). Another water regime system, present in southern Italy, is the sprinkler irrigation, which exists only on experimental plots and could contribute to the diffusion of rice cultivation in areas where water availability is a limiting factor (Spanu et al., 2004; Spanu and Pruneddu, 1996).

Table 6.20 Water regimes in Italy and classification according to IPCC guidelines

Type of seeding	April	May	June	July	August	September -October	Description
Wet-seeded "classic"	15-30 April Flooding and wet-seeded (*)	10 may	Herbicide treatment	Fertilizer application (1/3), soil is saturated but not flooded. Panicle formation	Final aeration	Harvest	2 aeration periods during rice cultivation, as minimum, not including the final aeration IPCC classification: Intermittently flooded – multiple aeration
		1ºaeration - AR	2º aeration-AA		3º final aeration		
Wet-seeded "red rice control"	15 April Flooding and wet-seeded (*)	First application of herbicides, the soil is dry. Approximately, on 15 may flooding and after some days seeding	At the end of June, fertilization treatment	Fertilizer application (1/3), soil is saturated but not flooded. Panicle formation	Final aeration	Harvest	2 aeration periods during rice cultivation, as minimum, not including the final aeration. In some cases, between April and May, even 3 aeration periods are practised. IPCC classification: Intermittently flooded – multiple aeration
		1° aeration – AC Approx. after 10 days 2° aeration - AR	3ºaeration - AA		Final aeration		
Dry-seeded with delay flooding	15 April Dry-seeded	Approximately, on 15 may flooding	Herbicide treatment	Fertilizer application (1/3), soil is saturated but not flooded. Panicle formation		Harvest	1 aeration period during rice cultivation, as minimum, not including the final aeration. IPCC classification: Intermittently flooded – single aeration
			1° aeration-AA		2º final aeration		

(*) the first fertilization (2/3) during the initial part of the rice cultivation, generally on July there is a second period for the fertilization (1/3), normally there is no aeration during the second fertilization period. Aeration periods mostly last between 5-15 days and are classified as follows: AC=aeration to control red rice; AR=drained, aeration in order to promote rice rooting; AA=drained, tillering aeration.

In general, rice seeds are mechanically broadcasted in flooded fields. However, in Italy for the last 15 years, the seeds are also drilled to dry soil in rows. The rice which has been planted in dry soil is generally managed as a dry crop until it reaches the 3-4 leaf stage. After this period, the rice is flooded and grows in continuous submersion, as in the conventional system (Ferrero and Nguyen, 2004; Russo, 1994).
During the cultivation period, water is commonly kept at a depth of 4-8 cm, and drained away 2-3 times during the season to improve crop rooting, to reduce algae growth and to allow application of herbicides. Rice fields are drained at the end of August to allow harvesting, once in a year (Ferrero and Nguyen, 2004; Baldoni and Giardini, 1989; Tinarelli, 1973; 1986).
Nitrogen is generally the most limiting plant nutrient in rice production and is subject to losses because of the reduction processes (denitrification) and leaching. Sufficient nitrogen should be applied pre-plant or pre-flood to assure that rice plant needs no additional nitrogen until panicle initiation or panicle differentiation stage. When additional nitrogen is required, it should be top-dressed at either of these plant stages or whenever nitrogen deficiency symptoms appear. The above-mentioned applications are usually used in two or three periods; the first period is always before sowing, that is on dry soil, while the others occur during the growing season (Russo, 2001; Russo, 1993; Russo *et al*., 1990; Baldoni and Giardini, 1989).

In Italy, another type of fertilization practise is the incorporation of straw. The incorporation period can vary according to weather conditions, but probably mainly incorporated approximately one month before flooding (Russo, 1988; Russo 1976). Rice straw are often burned in the field, otherwise incorporated into the soil or buried. For other agronomic practice, a national publication has been considered for understanding fertilizer and crop residues management (Zavattaro *et al*., 2004).

Methane emission factor

An analysis on recent and past literature, for the CH_4 daily EF (kg CH_4 m^{-2} d^{-1}) was done. Different scientific publications related to the CH_4 daily EF measurements in Italian rice fields were revised (Marik *et al*., 2002; Leip *et al*., 2002; Dan *et al*., 2001; Butterbach-Bahl *et al*., 1997; Schutz et al., 1989[a], [b]; Holzapfel-Pschorn & Seiler, 1986). Other publications indirectly related with CH_4 production were also considered (Kruger *et al*., 2005; Weber *et al*., 2001; Dannenberg & Conrad, 1999; Roy *et al*., 1997). Butterbach-Bahl *et al*. have presented interesting results associated to the difference in EFs of two cultivation periods (1990 and 1991). In these consecutive years, fields planted with rice cultivar Lido showed a level of CH_4 emissions 24-31% lower than fields planted with cultivar Roma. Marik *et al*. have published detailed information on agronomic practices (fertilized fields) related to measurements of CH_4 emission factor for years 1998 and 1999; values are similar to those presented in previous publications (Schutz et al., 1989[a], [b]; Holzapfel-Pschorn & Seiler, 1986). Leip *et al*. have published specific CH_4 EF for the so called dry-seeded with delay flooding, as shown in Table 6.21. The dry–seeded technique could bring interesting benefits in emission reduction, since lower emission rates compared with normal agronomic practices were determined experimentally.

The estimation of CH_4 emissions for the rice cultivation category considers an irrigated regime, which includes intermittently flooded with single aeration and multiple aeration regimes. The CH_4 emission factor is adjusted with the following parameters: daily integrated emission factor for continuously flooded fields without organic fertilizers, scaling factor to account for the differences in water regime in the rice growing season (*SFw*), scaling factor to account for the differences in water regime in the preseason status (*SFp*) and scaling factor which varies for both types and amount of amendment applied (*SFo*). Scaling factor parameters have been updated according to literature (Yan *et al*., 2005) and the IPCC 2006 Guidelines (IPCC, 2006).
Assumptions of agronomic practices, and parameters used for CH_4 emission estimations are shown in Table 6.20 and Table 6.21, respectively.
Total CH_4 emissions for rice cultivation in 2012 were 73.0 Gg.

Table 6.21 Parameters used for estimating CH_4 emissions from rice cultivation in 2012

Rice cultivation water regimes: Intermittently flooded	**Single aeration**	**Multiple aeration**	**Multiple aeration**
Type of seeding	Dry-seeded	Wet-seeded (*classic*)	Wet-seeded (*red rice control*)
Surface (ha)	66,069	76,029	92,924
Daily EF (g CH_4 m^{-2} d^{-1})	0.20	0.28	0.28
SF_w	0.60	0.52	0.52
SF_p	0.68	0.68	0.68
SF_o	2.2	2.2	2.2
Adjusted daily EF (g CH_4 m^{-2} d^{-1})	0.18	0.22	0.22
Days of cultivation (days)	138	156	156
Seasonal EF (g CH_4 m^{-2} yr^{-1})	24.72	33.54	33.54
Methane emissions (Gg)	**16.34**	**25.50**	**31.16**

6.4.3 Uncertainty and time-series consistency

Uncertainty of emissions from rice cultivation has been estimated equal to 20% as a combination of 3% and 20% for activity data and emissions factor, respectively.
Lack of experimental data and knowledgement about the occurrence and duration of drainage periods in Italy is the major cause of uncertainty. Moreover, it is not easy to quantify the surface where the traditional or the different number of aerations is practiced, which depends on the degree and the type of infestation, and the positive or negative results of the herbicide treatment application (Spanu, 2006).
In 2012, CH_4 emissions from rice cultivation were 2.7% (73.0 Gg CH_4) lower than in 1990 (75.06 Gg CH_4). In Italy, the driving force of CH_4 emissions from rice cultivation is the harvest area and the percentage of single aerated surface (lower CH_4 emission factor). From 1990-2012, the harvest area has increased by 9%, from 215,442 ha year^{-1} (1990) to 235,052 ha year^{-1} (2012). The percentage of single aerated surface has increased from 1% (1990) to 28.1% (2012). In Table 6.22, CH_4 emissions from rice cultivation and harvested area are shown.

Table 6.22 Harvest area and CH_4 emissions from the rice cultivation sector

Year	Harvested area ($10^9 m^2 yr^{-1}$)	CH_4 emissions (Gg) 2014 submission
1990	2.15	75.06
1991	2.06	71.64
1992	2.16	74.39
1993	2.32	78.00
1994	2.36	79.98
1995	2.39	79.56
1996	2.38	78.37
1997	2.33	77.82
1998	2.23	73.50
1999	2.21	72.00
2000	2.20	66.26
2001	2.18	66.19
2002	2.19	68.52
2003	2.20	70.00
2004	2.30	73.04
2005	2.24	70.11
2006	2.29	70.23
2007	2.33	72.18
2008	2.24	65.99
2009	2.38	74.51
2010	2.48	74.54
2011	2.47	73.80
2012	2.35	73.00

6.4.4 Source-specific QA/QC and verification

Systematic quality control activities have been carried out in order to ensure completeness and consistency in time series and correctness in the sum of sub-categories. Data entries have been checked several times during the compilation of the inventory. Several QA activities are carried out in the different phases of the inventory process. In particular the applied methodology has been presented and discussed during several national workshop and expert meeting, collecting findings and comments to be incorporated in the estimation process. All the agriculture categories have been embedded in the overall QA/QC-system of the Italian GHG inventory.

6.4.5 Source-specific recalculations

No recalculations are observed.

6.4.6 Source-specific planned improvements

In Table 6.23, improvements according to the QA/QC plan are shown.

Table 6.23 Improvements for the rice cultivation category according to the QA/QC plan

Category/sub category	Parameter	Year of submission 2015	Activities
Activity data	Days of cultivation and cultivars	√	Information on days of cultivation for new varieties will be collected.
Rice	Emission factor	√	The Joint Research Centre Institute for Environment and Sustainability - Climate Change Unit, in charge of measuring rice paddy fields in Italy, has been contacted to obtain data related to measurements carried out in the latest years. The use of updated information on EFs is under evaluation.

Provincial estimations on the basis of the relation between emissions and temperature would result in further possible improvements, even if enhancement would be limited since the largest Italian rice production is in the Po valley, where monthly temperatures of the rice paddies are similar. In 1990, *Piemonte* and *Lombardia* regions represented 95% of the national surface area of rice cultivation, while in 2012 they represented 93% (ENR, several years [b]; Confalonieri and Bocchi, 2005).

6.5 Agriculture soils (4D)

6.5.1 Source category description

In 2012, N_2O emissions from agricultural soils were 53.63 Gg, representing 81.6% of N_2O emissions for the agriculture sector (83.2% in 1990) and 59.9% for national N_2O emissions (52.2% in 1990). N_2O emissions from this source consist of direct soil (25.97 Gg), animal production (4.60 Gg) and indirect soil (23.06 Gg) emissions.
Direct and indirect N_2O emissions from agricultural soils are key sources at level assessment, both with Approach 1 and Approach 2. Animal Production is a key source at level assessment with Approach 2, taking into account the uncertainty. Direct soil emissions have been identified as a key source at trend assessment with Approach 2, taking into account the uncertainty.
In Italy, agricultural soil emissions are estimated for direct and indirect soils and animal production. For direct soil emissions the following sources are estimated: synthetic fertilizers, animal waste applied to soil, N-fixing crops, crop residues, cultivation of histosols and sewage sludge applied to soils. For indirect soil emissions, atmospheric deposition and nitrogen leaching and run-off are estimated. Nitrous oxide emissions from animal production are calculated together with the manure management category on the basis of nitrogen excretion, and reported in agricultural soils under "Animal Production".
ISPRA is in charge of collecting, elaborating and reporting the UNFCCC/CLRTAP agriculture national emission inventory (APAT, 2005), thus, consistency among methodologies and parameters is verified. Since 2006 submission, the UNFCCC/CLRTAP inventory has updated country-specific nitrogen excretion rates and EFs. The nitrogen balance coming from the CLRTAP emission inventory feeds the UNFCCC inventory, specifically for the estimation of $FRAC_{GASM}$ and $FRAC_{GASF}$ parameters, used for calculating F_{AM} and F_{SN}. Following recommendations from the UNFCCC ERT, direct and indirect N_2O emissions from the use of sewage sludge in agricultural soils have been estimated (UNFCCC, 2010[b]).

6.5.2 Methodological issues

Methodologies used for estimating N_2O emissions from “Agricultural soils” follow the IPCC approach. Emission factors suggested by the IPCC (IPCC, 1997) and by the Research Centre on Animal Production (CRPA, 2000; CRPA, 1997[b]) are used. Activity data used for estimations are shown in the following box.

Data used for estimating agricultural soil emissions

Data	Reference
Fertilizer distributed (t/yr)	ISTAT, several years [a], [b], [i]
Nitrogen content (%)	ISTAT, several years [a], [b], [i]
N excretion rates (kg $head^{-1}$ yr^{-1})	CRPA, 2006[a]; GU, 2006; Xiccato *et al*., 2005
Cultivated surface (ha yr^{-1})	ISTAT, several years [a], [b], [j]
Annual crop production (t yr^{-1})	ISTAT, several years [a], [b], [j]
N fixed by type of species (kg N ha^{-1})	Erdamn,1959 in Giardini, 1983
Residue/crop product ratio by crop type	CESTAAT, 1988
Crop residue production (t dry matter $ha^{-1}yr^{-1}$)	CRPA/CNR, 1992
Dry matter content by crop type	CRPA/CNR, 1992
Protein content in dry matter by crop type	CESTAAT, 1988
Livestock data	ISTAT, several years [a], [b], [g]

In Table 6.25 and Table 6.26, time series of cultivated surface and crop production used for the preparation of the inventory are shown. In Table 6.24 the time series of the nitrogen content from fertilizers are shown.
For estimating N_2O direct soil emissions, the IPCC approach is followed, and some modifications were included because of country-specific peculiarities (IPCC, 2000; IPCC, 1997). N_2O-N emissions are estimated from the amount of synthetic fertilizers (F_{SN}), animal waste applied to soil (F_{AM}), N-fixing crops (F_{BN}), crop residues (F_{CR}), cultivation of histosols (F_{OS}) and sewage sludge applied to soils (F_{SEWAGE}). Then default IPCC emission factors (IPCC, 2000) are applied. Afterwards, N_2O-N emissions are converted to N_2O emissions, multiplying by the 44/28 coefficient. Animal Production emissions are estimated according to the methodology described in section 6.3.2 for manure management. Indirect emissions are estimated as suggested by IPCC (IPCC, 1997). As requested in a previous review process (UNFCCC, 2005) a review of the $FRAC_{LEACH}$ parameter was done. Italy verified that the IPCC default is similar to the country-specific reference value reported from the main regional basin authority - Po Valley (ADBPO, 2001; ADBPO, 1994).

Direct emissions

Synthetic fertilizers (F_{SN})
The total use of synthetic fertilizer (expressed in t N $year^{-1}$) is estimated for each type of fertilizer (see Table 6.24). The calculation of synthetic fertilizer use (F_{SN}) is obtained by multiplying the total use of fertilizer by (1- $FRAC_{GASF}$). $FRAC_{GASF}$ parameter is estimated for the whole time series, following the IPCC definition, where the total $N\text{-}NH_3$ and N-NOx emissions from fertilizers are divided by the total nitrogen content of fertilizers. N_2O emissions from synthetic fertilizers are obtained multiplying F_{SN} by the emission factor, 0.0125 kg $N\text{-}N_2O$/kg N (IPCC, 1997). In 2008 submission, a specification for “Other nitrogenous fertilizers” was introduced (ENEA, 2006). This improvement was introduced since 1998, because activity data is available from that year.
The time series of nitrogen content of fertilizers is shown in Table 6.30. In 2012, the total use of synthetic fertilizers was 683,566 t N, while F_{SN} parameter was 613,437 t N (see Table 6.27).

Table 6.24 Total use of synthetic fertilizer in 2012 (t N yr^{-1})

Type of fertilizers	Fertilizers distributed (t yr^{-1})	Nitrogen content (%)	Nitrogen content of synthetic fertilizers (t N yr^{-1})
Ammonium sulphate	125,544	21.70%	27,246
Calcium cyanamide	22,225	19.83%	4,408
Nitrate (*)	382,958	27.05%	103,606
Urea	751,235	45.92%	344,981

Type of fertilizers	Fertilizers distributed ($t\ yr^{-1}$)	Nitrogen content (%)	Nitrogen content of synthetic fertilizers ($t\ N\ yr^{-1}$)
Other nitric nitrogen	134,775	30.83%	4,122
Other ammoniacal nitrogen	-	-	13,517
Other amidic nitrogenous	-	-	23,906
Phosphate nitrogen	285,796	17.94%	51,277
Potassium nitrogen	98,059	17.05%	16,720
NPK nitrogen	573,112	13.11%	75,142
Organic mineral	227,038	8.21%	18,641
TOTAL	**2,600,741**		**683,566**

(*) includes ammonim nitrate < 27% and ammonium nitrate > 27% and calcium nitrate

Animal waste applied to soil (F_{AM})

The manure nitrogen corrected for NH_3 and NO_x emissions, excluding manure produced during grazing (kg N yr^{-1}), is calculated with the IPCC methodology (IPCC, 1997). It uses country-specific nitrogen excretion rates (CRPA, 2006[a]; GU, 2006; Xiccato *et al.*, 2005). A country-specific $FRAC_{GASM}$ parameter is estimated and used for the calculation of the animal waste applied to soil. The $FRAC_{GASM}$(direct) and $FRAC_{GASM}$(indirect) parameters are reported in Table 6.27. The estimation has followed the IPCC definition; therefore, NH_3 and NOx emissions from animal manure are divided by the total nitrogen excreted. The F_{AM} (t yr^{-1}) value is estimated by summing the F_{AM} for each livestock category; then emissions are calculated with emission factor 0.0125 kg N-N_2O/kgN (IPCC, 1997). In 2012, F_{AM} parameter was 437,133 t N.

N-fixing crops (F_{BN})

Nitrogen input from N-fixing crops (F_{BN}, kg N yr^{-1}) is calculated with a country-specific methodology. Peculiarities that are present in Italy were considered: N-fixing crops and legumes forage. F_{BN} is calculated with two parameters: cultivated surface and nitrogen fixed per hectare (Erdamn 1959 in Giardini, 1983). Emissions are calculated using the default emission factor 0.0125 kg N-N_2O/kgN (IPCC, 1997). In Table 6.25, cultivated surface from N-fixing species (ha yr^{-1}) and N fixed by each species (kg N ha^{-1} yr^{-1}) are shown. In 2012 F_{BN} parameter was 139,623 t N (see Table 6.27).

Table 6.25. Cultivated surface (ha) and nitrogen fixed by each variety (kg N ha^{-1} yr^{-1})

	N fixed	1990	1995	2000	2008	2009	2010	2011	2012
	(kg N $ha^{-1}yr^{-1}$)	(ha)							
Bean,freshseed	40	29,096	23,943	23,448	21,041	20,108	19,027	20,292	17,256
Bean,dryseed	40	23,002	14,462	11,046	5,972	6,290	7,001	6,235	6,154
Broadbean,freshseed	40	16,564	14,180	11,998	9,547	8,563	8,487	7,440	6,515
Broadbean,dryseed	40	104,045	63,257	47,841	54,310	49,784	52,108	43,477	46,130
Pea,freshseed	50	28,192	21,582	11,403	12,854	15,295	8,691	24,026	15,283
Pea,dryseed	72	10,127	6,625	4,498	10,690	10,751	11,692	10,770	9,861
Chickpea	40	4,624	3,023	3,996	5,265	5,929	6,813	5,830	7,928
Lentil	40	1,048	1,038	1,016	1,821	1,868	2,458	2,156	2,629
Tare	80	5,768	6,532	6,500	6,500	6,500	6,500	6,500	6,500
Lupin	40	3,303	3,070	3,000	3,000	3,000	3,000	3,000	3,000
Soyabean	58	521,169	195,191	256,647	107,795	134,704	159,511	165,955	152,993
Alfalfa	194	987,000	823,834	810,866	712,674	720,382	745,128	728,034	599,031
Clovergrass	103	224,087	125,009	114,844	98,601	100,484	102,691	101,819	86,976
TOTAL		**1,958,025**	**1,301,746**	**1,307,102**	**1,050,070**	**1,083,659**	**1,133,106**	**1,125,533**	**960,256**

Crop residues (F_{CR})

For the estimation of nitrogen input from crop residues (FCR), a country-specific methodology is used. The total amount of crop residues is estimated (t dry matter yr^{-1}) by using the following parameters: annual crop production (t yr^{-1}), residue/crop product ratio, and dry matter content by type of crop (%), while, when

cultivated surface (ha) is the available activity data, only the crop residue production (t dry matter ha-1 yr-1) parameter is used to assess total amount of crop residues.
The nitrogen content from cereals, legumes, tubers and roots and legumes forages crop residues (t N yr-1) is estimated by multiplying the total amount of crop residue as dry matter with the reincorporated fraction (1-$FRAC_{BURN}$, where $FRAC_{BURN}$ is the fraction of crop residue that is burned rather than left on field equal to 0.1 kg N/kg crop-N), and the nitrogen content for each crop type. The nitrogen content is obtained converting protein content in dry matter, dividing by factor 6.25. The F_{CR} parameter is obtained by adding the nitrogen content of cultivars crop residues. In 2012, F_{CR} parameter was 105,931 t N (see Table 6.27). Emissions are calculated with emission factor 0.0125 kg N-N_2O/kg N (IPCC, 1997).
The crop residues production is shown in Table 6.26. Furthermore, following the 2013 review's finding, detailed information related to the cultivated surfaces, crops production, residues production and parameters used for emissions estimates, for each type of crop, are shown in the Annex 7 (tables A.7.5-8).

Table 6.26 Cultivated surfaces, crops production and total residue production time series

Year	Cultivated surfaces(*) (ha)	Crops production(*) (t)	Total residue production (dry matter)
1990	2,128,674	82,247,958	20,719,032
1995	1,484,453	81,343,949	20,466,710
2000	1,491,308	82,090,948	20,685,330
2001	1,438,578	77,979,120	19,813,878
2002	1,350,329	82,289,945	20,647,499
2003	1,338,109	66,503,842	17,301,569
2004	1,314,187	81,403,175	21,351,753
2005	1,338,656	84,706,239	20,800,434
2006	1,352,385	71,186,530	19,239,493
2007	1,283,235	69,888,807	18,956,246
2008	1,222,418	68,515,647	19,428,127
2009	1,258,650	62,564,634	16,914,528
2010	1,309,260	63,456,159	17,330,750
2011	1,304,417	64,100,854	17,906,847
2012	1,122,625	53,951,586	16,090,448

(*)Cultivated surface and crop production are related to different crops.

Cultivation of histosols (F_{os})
In Italy, the area of organic soils cultivated annually (histosols) is estimated to be 24,690 hectares for the whole time series (FAOSTAT database [14]). This value is multiplied by 8 kg N-N_2O ha^{-1} yr^{-1}, as suggested by IPCC (IPCC, 2000). The data are consistent with figures used for estimation in the LULUCF sector. Additional information may be found in the paragraph *7.3.4 Methodological issues* of the LULUCF sector.

[14] http://faostat3.fao.org/faostat-gateway/go/to/download/G1/GV/E

Table 6.27 Parameters used for the estimation of direct and indirect N_2O emissions

Year	F_{SN} (t N)	F_{AM} (t N)	F_{BN} (t N)	F_{CR} (t N)	F_{SEWAGE} (t N)	$FRAC_{GASF}$	$FRAC_{GASM}$ (direct)	$FRAC_{GASM}$ (indirect) (*)
1990	691,723	474,783	254,654	147,541	4,057	0.087	0.319	0.328
1995	726,343	454,058	191,018	142,216	6,510	0.089	0.298	0.308
2000	715,366	458,298	189,545	144,372	8,763	0.089	0.286	0.296
2001	737,063	468,005	182,928	137,779	12,861	0.089	0.299	0.307
2002	745,286	453,998	177,529	142,457	12,271	0.090	0.297	0.305
2003	750,296	453,609	175,154	119,184	11,718	0.090	0.296	0.304
2004	765,064	440,666	172,532	143,172	6,444	0.091	0.293	0.302
2005	710,888	440,358	176,624	145,246	7,099	0.088	0.293	0.301
2006	713,369	430,967	175,243	128,431	6,222	0.092	0.290	0.299
2007	694,048	447,268	168,482	126,478	6,644	0.093	0.292	0.301
2008	595,641	445,992	160,637	126,286	7,073	0.097	0.291	0.300
2009	469,086	448,411	163,797	113,572	9,092	0.096	0.292	0.301
2010	449,972	435,544	170,136	115,822	8,032	0.094	0.291	0.300
2011	467,653	437,268	167,385	119,362	8,895	0.094	0.290	0.299
2012	613,437	437,133	139,623	105,931	10,291	0.103	0.295	0.304

(*) $FRAC_{GASM}$ (indirect) is reported in the Table4.Ds2 as "other fractions"

Sewage sludge applied to soils (F_{SEWAGE})
Direct and indirect N_2O emissions from the application of sewage sludge to agricultural soils were calculated using the tier 1 methodology described in the IPCC GPG (IPCC, 2000). Direct emissions were estimated by applying the relevant default IPCC equations, EFs and parameters (see Annex A7.3). From 1995 to 2009 activity data (amount of sewage sludge) and parameters (N content) were collected from the Ministry for the Environment, Land and Sea, which is in charge of collecting and reporting data under the EU Sewage Sludge Directive 86/278/EEC (MATTM, 2014). From 1990 to 1994 AD and parameters were reconstructed, description is available in the Waste Chapter. The amount of sewage N applied was calculated using the amount of sewage sludge (expressed in t dry matter) and the N content of sludge. Emission factor used was 0.0125 kg N-N_2O/kg N and the volatilization factor was 20% for N-NH_3+NOx emissions (IPCC, 1997).

Animal production
As mentioned in section 6.3.2, when estimating N_2O emissions from manure management, the amount related to manure excreted while grazing is subtracted and reported in "Agricultural soils" under animal production**.** In Table 6.14, nitrogen excretion rates (kg $head^{-1}yr^{-1}$) used for estimations are shown. N_2O emissions are estimated with the total nitrogen excreted from grazing (include all livestock categories), number of animals, and an EF of 0.02 kg N_2O-N/kg N excreted (IPCC, 1997).

Indirect emissions
For indirect emissions from agricultural soils the following parameters are estimated:

- Atmospheric deposition
- Nitrogen leaching and run-off

For estimating of N_2O emissions due to atmospheric deposition of NH_3 and NO_x the IPCC approach was followed (IPCC, 1997). Parameters used are: total use of synthetic fertilizer (t N yr^{-1}), $FRAC_{GASF}$ emission factor (see Table 6.27), total N excreted by livestock (kg $head^{-1}yr^{-1}$), $FRAC_{GASM}$ emission factor (see Table 6.27), total use of sewage sludge to agricultural soils (t N yr^{-1}), $FRAC_{SLUDGE}$ emission factor (the volatilization factor for N-NH_3+NOx emissions) and emission factor 0.01 kg N_2O-N per kg NH_3-N + NO_x-N emitted (IPCC, 2000; IPCC, 1997). The estimation of N_2O emissions due to nitrogen leaching and run-off has followed the IPCC approach (IPCC, 1997). Parameters used are: total use of synthetic fertilizer (t N yr^{-1}), total N excreted by livestock (kg $head^{-1}$ yr^{-1}), total use of sewage sludge to agricultural soils, $FRAC_{LEACH}$ emission factor 0.3 N/kg nitrogen of fertilizer or manure and the emission factor 0.025 Kg N_2O-N per kg nitrogen leaching/run-off (IPCC, 2000; IPCC, 1997). As mentioned before, the $FRAC_{LEACH}$ IPCC default value was compared with the country-specific $FRAC_{LEACH}$ parameter (ADBPO, 2001; ADBPO, 1994). Indirect emissions from sewage sludge applied to soils are included in the atmospheric deposition and N leaching estimations.

6.5.3 Uncertainty and time-series consistency

Uncertainty for N_2O emissions from agricultural soils (direct soil emissions, indirect soil emissions and animal production) has been estimated to be 102%, as combination of 20% and 100% for activity data and emission factor, respectively.
In the 2012 submission, Montecarlo analysis was also applied to estimate uncertainty of the two key categories *Direct N_2O emissions from agricultural soils* and *Indirect N_2O emissions from nitrogen used in agriculture*. The resulting figures were 21.34% and 21.67% for *Direct and Indirect* N_2O emissions, respectively. Normal and lognormal distributions have been assumed for the parameters; at the same time, whenever assumptions or constraints on variables were known this information has been appropriately reflected on the range of distribution values. A summary of the results is reported in Annex 1.

In Table 6.28, time series of N_2O emissions are reported.

Table 6.28 Nitrous oxide emission trends from Agricultural soils (Gg)

Year	Direct Soil Emissions	Animal Production	Indirect Soil emissions	TOTAL
	(Gg)			
1990	31.20	5.60	26.28	63.09
1995	30.17	6.44	26.25	62.86
2000	30.10	6.60	25.92	62.62
2001	30.53	5.18	25.90	61.61
2002	30.39	5.03	25.52	60.94
2003	29.97	4.93	25.47	60.37
2004	30.32	4.98	25.26	60.56
2005	29.39	4.90	24.33	58.61
2006	28.88	5.02	24.22	58.11
2007	28.65	5.06	24.45	58.17
2008	26.55	5.06	23.06	54.67
2009	23.96	5.02	21.24	50.22
2010	23.48	4.98	20.55	49.01
2011	23.89	5.00	20.86	49.75
2012	25.97	4.60	23.06	53.63

In 2012, N_2O emissions from agricultural soils were 15.0% (53.63 Gg N_2O) lower than in 1990 (63.09 Gg N_2O). Major contributions were given by direct soil (25.97 Gg) and indirect soil emissions (23.06 Gg). Indirect N_2O emissions from nitrogen leaching and run-off sub-category have the highest individual contribution with respect to total 4D N_2O emissions, equal to 33.5% (17.96 Gg N_2O). N_2O emissions from leaching and run-off are related to the nitrogen content in fertilizers and animal wastes, therefore, emissions are mainly linked to the use of N fertilizers and the animal number trends. In 2012, the second individual source with respect to total N_2O emissions was the direct emissions of synthetic fertilizers with 12.05 Gg (22.5%), followed by animal wastes applied to soils, with 8.59 Gg (16.0%). The time series of N_2O emissions from 4D is shown in Table 6.29. Between 1996 and 1997 there was a high increase in the use of nitrogen fertilizers in Italy, thus, emissions could be identified as outlier. Between 2007/2008 (-14%) and 2008/2009 (-21%) N fertiliser distribution has decreased. In 2010 the same trend was observed. According to the Italian Fertilizer Association (AIF) the use of fertilisers is determined by their cost and particularly by the price of agricultural products. In the last years, prices have decreased and, as a result, farmers need to save costs, consequently, less fertilisers is being used (Perelli, 2007; De Corso 2008).

Table 6.29 Nitrous oxide emission trends from Agricultural soils (Gg)

Year	Direct N_2O emissions						Animal Production	Indirect N_2O emissions	
	Synthetic fertilizer	Animal Wastes	N-fixing Crops	Crop Residue	Histosols	Sewage sludge		Atmospheric Deposition	Nitrogen Leaching and Run-off
	Gg						Gg	Gg	
1990	13.59	9.33	5.00	2.90	0.31	0.08	5.60	5.99	20.29

Year	Direct N_2O emissions						Animal Production	Indirect N_2O emissions	
	Synthetic fertilizer	Animal Wastes	N-fixing Crops	Crop Residue	Histosols	Sewage sludge		Atmospheric Deposition	Nitrogen Leaching and Run-off
	Gg						Gg	Gg	
1995	14.27	8.92	3.75	2.79	0.31	0.13	6.44	5.69	20.56
2000	14.05	9.00	3.72	2.84	0.31	0.17	6.60	5.50	20.42
2001	14.48	9.19	3.59	2.71	0.31	0.25	5.18	5.54	20.36
2002	14.64	8.92	3.49	2.80	0.31	0.24	5.03	5.40	20.12
2003	14.74	8.91	3.44	2.34	0.31	0.23	4.93	5.36	20.11
2004	15.03	8.66	3.39	2.81	0.31	0.13	4.98	5.25	20.01
2005	13.96	8.65	3.47	2.85	0.31	0.14	4.90	5.10	19.23
2006	14.01	8.47	3.44	2.52	0.31	0.12	5.02	5.06	19.15
2007	13.63	8.79	3.31	2.48	0.31	0.13	5.06	5.21	19.25
2008	11.70	8.76	3.16	2.48	0.31	0.14	5.06	5.08	17.98
2009	9.21	8.81	3.22	2.23	0.31	0.18	5.02	4.88	16.37
2010	8.84	8.56	3.34	2.28	0.31	0.16	4.98	4.71	15.84
2011	9.19	8.59	3.29	2.34	0.31	0.17	5.00	4.75	16.12
2012	12.05	8.59	2.74	2.08	0.31	0.20	4.60	5.09	17.96

6.5.4 Source-specific QA/QC and verification

Synthetic fertilizers and nitrogen content are compared with the international FAO agriculture database statistics (FAO, several years). In Table 6.30, national and FAO time series of total nitrogen applied are reported. Differences between national data and FAO database are related to the difference in data elaboration (ISTAT, 2004) and could be attributed to different factors. First, national data are more disaggregated by substance than FAO data and the national nitrogen content is considered for each substance, while FAO utilises default values. Besides, differences could also derive from different products classification. A join meeting, held in July 2011 with the FAO experts in charge of the fertiliser database, ISPRA verified that there are two FAO databases for fertilisers. In Table 6.30 the two databases are presented. Differences between FAO data and national statistics will be overcome as soon as the same classification is used.

Table 6.30 Total annual N content in fertilizer applied from 1990 to 2012

Year	National data (t N)	FAO database (Nitrous fertilizer consumption, Mt)	FAO new database (Nitrous fertilizer consumption, Mt)
1990	757,509	878,960	-
1991	837,402	906,720	-
1992	884,121	910,000	-
1993	945,290	917,900	-
1994	875,536	879,200	-
1995	797,500	875,000	-
1996	756,057	876,000	-
1997	856,945	855,000	-
1998	772,227	845,000	-
1999	788,243	868,000	-
2000	785,593	828,000	-
2001	808,964	773,161	-
2002	819,352	785,314	845,003
2003	824,649	Not available	846,812
2004	841,363	Not available	866,469
2005	779,846	Not available	800,697

Year	National data (t N)	FAO database (Nitrous fertilizer consumption, Mt)	FAO new database (Nitrous fertilizer consumption, Mt)
2006	785,265	Not available	798,807
2007	765,490	Not available	812,480
2008	659,922	Not available	670,261
2009	518,778	Not available	486,728
2010	496,637	Not available	498,605
2011	515,966	Not available	516,543
2012	683,566	Not available	Not available

For verification purposes, the $FRAC_{GASM}$(direct) parameter have been also estimated as a fraction of nitrogen recovered and stored that is emitted as N_NH_3-NOx. This value is equal to 0.392, for 1990, and to 0.359 in 2012.
Furthermore, average NH_3 emission factors for manure management from animal housing have been estimated, for each animal category, on the basis of animal housing collected by the 2010 Agricultural Census. Comparing the obtained values against the country specific parameters, used in the estimation process, slight deviations are resulting, mainly due to the different aggregation levels.

6.5.5 Source-specific recalculations

N_2O emissions have been recalculated for the whole time series due to the uploading of the fur animals category and due to the updating of the area of organic soils cultivated annually (histosols). In 2010 and 2011, activity data on sewage sludge have been updated. In 1999, 2000, 2005, 2007-2010 data on crops surface and production have been updated.

6.5.6 Source-specific planned improvements

In Table 6.31, planned improvements for this category are presented.

Table 6.31 Improvements for the agricultural soils category

Category/sub category	Parameter	Year of submission 2015	Activities
Activity data	Land spreading	√	Figures on land spreading collected in the framework of the 2010 Agricultural Census will be considered for the next annual submission.

A specific research on land spreading practices, (CRPA, 2009) will be analysed; its results will be validated and considered for future submissions.

6.6 Field burning of agriculture residues (4F)

6.6.1 Source category description

Methane and nitrous oxide emissions from field burning agriculture residues have not been identified as a key source. In 2012, CH_4 emissions from this source were 0.67 Gg, representing 0.10% of emissions for the agriculture sector. N_2O emissions were 0.015 Gg, representing 0.02% of emissions for the agriculture sector.

6.6.2 Methodological issues

IPCC methodology is used for estimating emissions from field burning of agriculture residues. Different IPCC parameters are considered, such as amount of residues produced, amount of dry residues, total biomass burned, and total carbon and nitrogen released (see the following box).

Data used for estimating field burning of agriculture residues emission

Data	Reference
Annual crop production	ISTAT, several years [a], [b], [j]
Removable residues/product ratio	CESTAAT, 1988
Fixed residues/removable residues ratio	ENEA, 1994
Fraction of dry matter in residues	IPCC, 1997; CRPA/CNR, 1992; CESTAAT, 1988; Borgioli, 1981
Fraction of the field where "fixed" residues are burned	ANPA-ONR, 2001; CESTAAT, 1988; IPCC, 1997
Fraction of residues oxidized during burning	IPCC, 1997
Fraction of carbon from the dry matter of residues	IPCC, 1997
Raw protein content from residues (dry matter fraction)	CESTAAT, 1988; Borgioli, 1981
IPCC Default Emission rates (CH_4, N_20)	IPCC, 1997

Activity data (annual crop production of cereals) used for estimating burning of agriculture residues are reported in the Table 6.32.
The same methodology is used to estimate emissions from burning of agriculture residues. Emissions from fixed residues and stubble, burnt on open fields, are reported in this category (4F) while emissions from removable residues burnt off-site, are reported under the waste sector (waste incineration - 6C category).

Table 6.32 Time series of activity data (t) used for 4F estimations

Year	Agricultural production						
	Wheat	Barley	Maize	Oats	Rye	Rice	Sorghum
	(t)						
1990	8,108,500	1,702,500	5,863,900	298,400	20,800	1,290,700	114,200
1995	7,946,081	1,387,069	8,454,164	301,322	19,780	1,320,851	214,802
2000	7,427,660	1,261,560	10,139,639	317,926	10,292	1,245,555	215,200
2001	6,413,329	1,125,720	10,556,185	310,087	8,588	1,272,952	213,992
2002	7,547,763	1,190,326	10,554,423	328,759	9,631	1,378,796	215,072
2003	6,229,454	1,020,838	8,702,289	306,425	6,941	1,448,212	158,217
2004	8,638,721	1,156,620	11,368,007	337,694	7,851	1,525,509	215,394
2005	7,717,129	1,214,054	10,427,930	429,153	7,876	1,444,818	184,915
2006	7,181,720	1,297,395	9,626,373	394,866	8,590	1,449,973	221,392
2007	7,170,181	1,225,282	9,809,265	361,148	8,954	1,540,097	193,243
2008	8,859,410	1,236,711	9,722,910	356,094	10,756	1,332,974	224,557
2009	6,534,748	1,049,200	8,142,974	314,421	12,204	1,644,135	243,398
2010	6,849,858	944,257	8,495,946	288,880	13,926	1,564,377	275,572
2011	6,641,807	950,934	9,752,373	297,079	14,381	1,555,893	299,862
2012	7,654,248	940,234	7,888,668	292,357	16,083	1,594,476	157,808

The methodology for estimating emissions refers to fixed residues burnt. The same steps are followed to calculate emissions from removable residues burnt reported in 6C. Parameters taken into consideration are the following:

a) Amount of "fixed" residues (t), estimated with annual crop production, removable residues/product ratio, and "fixed" residue/removable residues ratio.
b) Amount of dry residues in "fixed" residue (t dry matter), calculated with amount of fixed residues and fraction of dry matter.
c) Amount of "fixed" dry residues oxidized (t dry matter), assessed with amount of dry residues in the "fixed" residues, fraction of the field where "fixed" residues are burned, and fraction of residues oxidized during burning.
d) Amount of carbon from stubble burning release in air (t C), calculated with the amount of "fixed" dry residue oxidized and the fraction of carbon from the dry matter of residues.
e) C-CH_4 from stubble burning (t C-CH_4), calculated with the amount of carbon from stubble burning release in air and default emissions rate for C-CH_4, equal to 0.005 (IPCC, 1997).

In 2012, final CH_4 emissions from on field burning of agriculture residues (0.67 Gg CH_4) have been estimated multiplying the C-CH_4 value (0.506 Gg C-CH_4) by the coefficient 16/12.
In Table 6.33, parameters used for estimating of CH_4 emissions from on field burning of agriculture residues are shown.

Table 6.33 Parameters used for the estimation of CH_4 emissions from agriculture residues in 2012

Crop	Annual crop production (t 1000)	Amount of "fixed" burnable residues (t 1000)	Amount of dry residue in the "fixed" residues (t 1000 dry matter)	Amount of "fixed" dry residues oxidized (t 1000 dry matter)	Amount of carbon from stubble burning (t 1000 C)	C-CH_4 from stubble burning (t C-CH_4)
Wheat	7,654	1,320	1,126	99	48	239
Rye	16	3	2	0	0	0
Barley	940	188	161	15	5	27
Oats	292	51	44	4	2	8
Rice	1,594	267	200	108	45	224
Maize	7,889	789	329	0	0	0
Sorghum	158	55	46	4	2	8
TOTAL	**18,544**	**2,674**	**1,909**	**230**	**101**	**506**

For estimating N_2O emissions, the same amount of "fixed" dry residue oxidized described above were used; further parameters are:

a) Amount of nitrogen from stubble burning release in air (t N), calculated with the amount of "fixed" dry residue oxidized and the fraction of nitrogen from the dry matter of residues. The fraction of nitrogen has been calculated considering raw protein content from residues (dry matter fraction) divided by 6.25.
b) N-N_2O from stubble burning (t N-N_2O), calculated with the amount of nitrogen from stubble burning release in air and the default emissions rate for N- N_2O, equal to 0.007 (IPCC, 1997).

In 2012, final N_2O emissions from on field burning of agriculture residues (0.015 Gg N_2O) are estimated by multiplying the N-N_2O value (0.009 Gg N) with the coefficient 44/28.
In Table 6.34 are shown the parameters for the estimation of N_2O emissions from field burning of agriculture residues.

Table 6.34 Parameters used for the estimation of nitrous oxide from agriculture residues in 2012

Crop	Amount of "fixed" dry residue oxidized (t 1000 dry matter)	Raw protein content from residues (dry matter fraction)	Fraction of nitrogen from the dry matter of residues	Amount of nitrogen from stubble burning (t 1000 N)	N-N_2O from stubble burning (t N-N_2O)
Wheat	99	0.030	0.005	0.473	3.3
Rye	0	0.036	0.006	0.001	0.01
Barley	15	0.037	0.006	0.086	0.6

Crop	Amount of "fixed" dry residue oxidized (t 1000 dry matter)	Raw protein content from residues (dry matter fraction)	Fraction of nitrogen from the dry matter of residues	Amount of nitrogen from stubble burning (t 1000 N)	N-N_2O from stubble burning (t N-N_2O)
Oats	4	0.040	0.006	0.025	0.2
Rice	108	0.041	0.007	0.710	5.0
Maize	0		0.007	0.000	0
Sorghum	4	0.037	0.006	0.024	0.2
TOTAL	**230**			**1.320**	**9.2**

6.6.3 Uncertainty and time-series consistency

Uncertainties for CH_4 and N_2O emissions from field burning of agriculture residues are estimated to be 54% as a result of 50% and 20% for activity data and emission factor, respectively.
In 2012, CH_4 emissions from field burning of agriculture residues were 0.67 Gg emissions of CH_4 and 0.015 Gg emissions of N_2O emissions (see Table 6.35). Variation in emissions trend is related to cereal production trends.

Table 6.35 CH_4 and N_2O emission trends from field burning of agriculture residues (Gg)

Year	CH_4 (Gg)	N_2O (Gg)
1990	0.623	0.013
1995	0.616	0.013
2000	0.617	0.013
2001	0.574	0.012
2002	0.644	0.014
2003	0.591	0.013
2004	0.716	0.015
2005	0.666	0.014
2006	0.649	0.014
2007	0.660	0.014
2008	0.694	0.015
2009	0.648	0.014
2010	0.643	0.014
2011	0.635	0.014
2012	0.675	0.015

6.6.4 Source-specific QA/QC and verification

In response to the review process (UNFCCC, 2007) and in order to verify the national assumption, which considered that 10% of the cultivated surface (cereals) is burned in Italy, a specific elaboration of data has been carried out by ISTAT, in the framework of FSS in 2003. The information, provided by ISTAT, related to the regional practises of field burning (cereals) has confirmed the abomentioned assumption (ISTAT, 2007[c]).

6.6.5 Source-specific recalculations

No recalculations are observed.

6.6.6 Source-specific planned improvements

No specific improvements are planned.

7 Land Use, Land Use Change and Forestry [CRF sector 5]

7.1 Sector overview

CO_2 emissions and removals occur as a result of changes in land-use and from forestry. The sector is responsible for 18.6 Mt of CO_2 eq. removals from the atmosphere in 2012.
The 2003 IPCC Good Practice Guidance for LULUCF has been entirely applied for all the categories of this sector as detailed data were available from national statistics and from research at national and regional level, whereas for category 5A (Forest Land) estimates were supplied by a growth model, applied to national forestry inventory data, with country specific emission factors.
CO_2 emissions from forest fires have been considered in the calculation of the net carbon stocks reported in 5A.
Greenhouse gas removals and emissions in the main categories of the LULUCF sector in 2012 are shown in Figure 7.1.

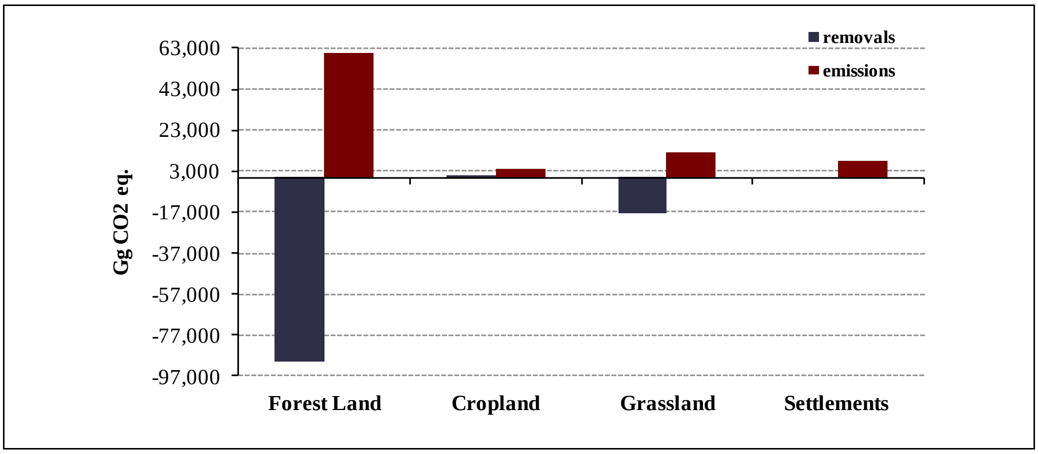

Figure 7.1 Greenhouse gas removals and emissions in LULUCF sector in 2012 [Gg CO_2 eq.]

In Table 7.1 emissions and removals time series is reported.

Table 7.1 Trend in greenhouse gas emissions from the LULUCF sector in the period 1990-2012

GHG Gas Source and Sink Categories	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
CO_2	**-5,443**	**-24,215**	**-18,020**	**-29,989**	**-30,577**	**-7,719**	**-26,397**	**-28,385**	**-31,567**	**-19,794**	**-19,864**
A. Forest Land	-18,943	-32,660	-27,233	-36,281	-35,954	-19,706	-32,314	-35,156	-36,536	-28,785	-30,062
B. Cropland	2,175	1,659	2,017	1,443	1,231	1,271	1,240	1,330	1,319	4,275	4,228
C. Grassland	4,329	-1,214	306	-2,833	-3,543	3,024	-3,021	-2,310	-4,113	-3,053	-3,053
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
E. Settlements	6,996	8,001	6,890	7,682	7,690	7,692	7,698	7,750	7,763	7,768	7,774
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CH_4	**1487.99**	**343.47**	**841.68**	**337.78**	**271.85**	**1612.42**	**424.25**	**517.09**	**313.18**	**485.61**	**1,046**
A. Forest Land	877.43	182.30	484.38	183.32	138.46	904.83	170.26	199.33	102.91	184.25	534.41
B. Cropland	4.85	1.40	2.82	1.31	1.18	5.56	1.81	1.95	1.04	2.20	4.14
C. Grassland	605.70	159.77	354.48	153.16	132.21	702.02	252.18	315.80	209.22	299.16	507.59
D. Wetlands	0	0	0	0	0	0	0	0	0	0	0
E. Settlements	0	0	0	0	0	0	0	0	0	0	0
F. Other Land	0	0	0	0	0	0	0	0	0	0	0
G. Other	0	0	0	0	0	0	0	0	0	0	0
N_2O	**346.46**	**171.15**	**204.43**	**108.92**	**98.94**	**368.89**	**155.04**	**184.76**	**134.44**	**169.80**	**262**
A. Forest Land	4.07	0.85	2.25	0.85	0.64	4.20	0.79	0.92	0.48	0.85	2.48
B. Cropland	61.37	96.18	37.72	37.02	36.96	38.99	37.25	37.32	36.89	30.15	23.77
C. Grassland	281.01	74.13	164.46	71.06	61.34	325.70	117.00	146.52	97.07	138.79	235.49
D. Wetlands	0	0	0	0	0	0	0	0	0	0	0
E. Settlements	0	0	0	0	0	0	0	0	0	0	0
F. Other Land	0	0	0	0	0	0	0	0	0	0	0
G. Other	0	0	0	0	0	0	0	0	0	0	0
LULUCF (*Gg CO_2 equivalent*)	**-3,609**	**-23,700**	**-16,974**	**-29,543**	**-30,206**	**-5,738**	**-25,817**	**-27,683**	**-31,119**	**-19,139**	**-18,556**

CO_2 emissions and removals in LULUCF sector, in the period 1990-2012, are shown in Figure 7.2.

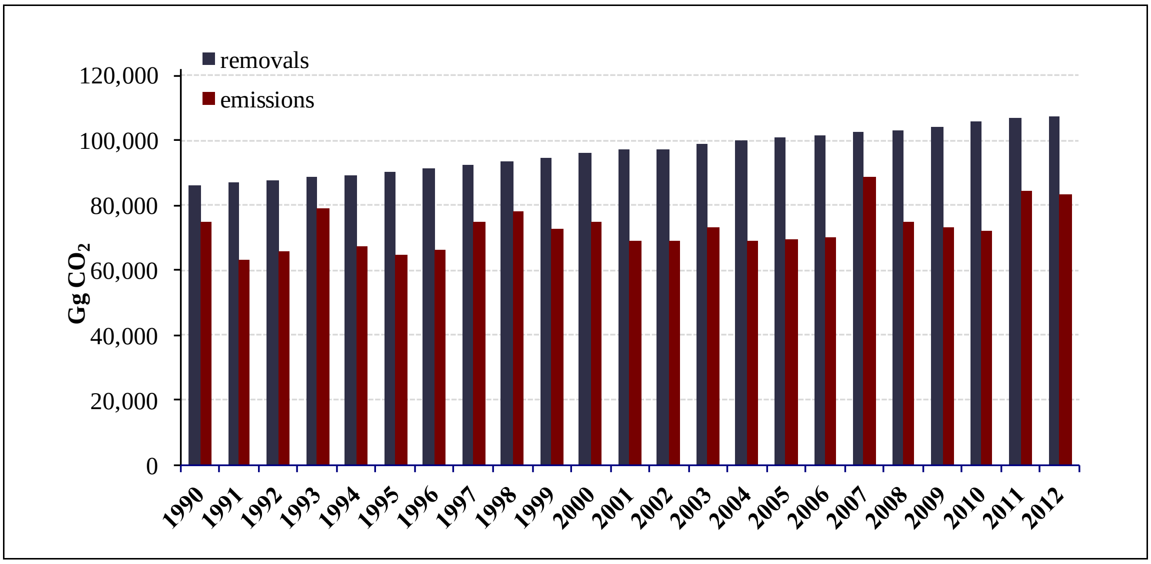

Figure 7.2 CO_2 removals and emissions in LULUCF sector in the period 1990-2012 [Gg CO_2]

The outcome of the key category analysis for 2011, according to level and/or trend assessment (*IPCC Approach 1 and Approach 2*), is listed in Table 7.2. CO_2 emissions and removals from forest land remaining forest land, land converted to forest land, cropland remaining cropland, land converted to grassland and land converted to settlements have been identified as key categories, both in level and in trend assessment. CO_2 emissions and removals from land converted to cropland have resulted key categories with Approach 2 concerning trend assessment. CO_2 emissions and removals from grassland remaining grassland have resulted key categories concerning trend assessment, either with Approach 1 and Approach 2. Concerning CH_4 or N_2O emissions, no categories have resulted as a key source.

Table 7.2 Key categories identification in the LULUCF sector

	gas	*categories*	2012
5.A.1	CO_2	Forest land remaining forest land	key (L, T)
5.A.2	CO_2	Land converted to forest land	key (L, T)
5.B.1	CO_2	Cropland remaining cropland	key (L, T)
5.C.1	CO_2	Grassland remaining Grassland	key (L, T)
5.C.2	CO_2	Land converted to Grassland	key (L, T)
5.E.2	CO_2	Land converted to Settlements	key (L, T)
5.D	CO_2	Wetlands	Non-key
5.E.1	CO_2	Settlements remaining Settlements	Non-key
5(V).A1	CH_4	Forest land remaining forest land	Non-key
5(V).A1	N_2O	Forest land remaining forest land	Non-key
5.B.2	CO_2	Land converted to cropland	Non key
5.B.2	N_2O	Land converted to cropland	Non-key

An updated methodology to assess land uses and land use changes has been used, on the basis of the IUTI[15] data, related to 1990, 2000 and 2008. For 2012, land use and land use changes data were assessed through the survey, carried out in the framework of the III NFI, on an IUTI's subgrid (i.e. 301,300 points, covering the entire country). Time series related to the areas to be included into the different IPCC categories have been assembled using IUTI data, and the data assessed by the national forest inventories (1985, 2005,2012).

[15] Detailed information on IUTI is reported in Annex 10

(i.e. National Forest Service, Ministry of Agricultural, Food and Forestry Policies (MIPAAF), Forest Monitoring and Planning Research Unit (CRA-MPF)).
Due to the technical characteristics of the IUTI assessment (i.e. classification of orthophotos for 1990, 2000 and 2008), it was technically impossible to have a clear distinction among some subcategories in *cropland* and *grassland* categories (i.e. annual pastures versus grazing land). Therefore it has been decided to aggregate the *cropland* and *grassland* categories, as detected by IUTI, and then disaggregate them into the different subcategories, using as proxies the national statistics (ISTAT, [b], [c]) related to annual crops and perennial woody crops. Annual figures for areas in transition between different land uses have been derived by a hierarchy of basic assumptions (informed by expert judgement) of known patterns of land-use changes in Italy as well as the need for the total national area to remain constant. A task force has been established among national experts and, in this context, an expert judgment has been made on the basis of known patterns of land-use changes in Italy, also considering local studies and research on land uses transitions.
More in details the following assumptions have been used: growth in forest land area as detected by the National Forest Inventories is used as the basis. The rule then assumes that new forest land area can only come from grassland; new cropland area can only come from grassland area, as new grassland area can only come from cropland area. Concerning settlements, initial land use may be forest land, cropland, grassland or other land (see Table 7.28, 7.31); in addition a conservative approach was applied, assuming that the total deforested area is converted into settlements. Land transition to wetlands is from cropland and grassland categories. These rules have been set up also on the basis of the relevant normative (i.e. concerning deforestation activities, in Italy land use changes from forest to other land use categories are allowed in very limited circumstances (railways, highways constructions or other public utility projects), as stated in art. 4.2 of the Law Decree n. 227 of 2001; land use changes due to wildfires are not allowed by national legislation (Law Decree 21 November 2000, n. 353, art.10.1)).
On the basis of the land uses classification, the land use matrices, for each year of the period 1990–2012, have been assembled for the categories forest lands, croplands, grasslands, wetlands and settlement.
In order to determine the lands converting to other land use categories in 20 years, land use change matrices have also been prepared, taking into account the area in conversion over a period of 20 years.
Following previous ERT's recommendation, Italy has decided to use the IPCC default land use transition period of 20 years, in the estimation process of carbon stock changes in mineral soils related to land use changes. In particular the 20-years transition period has been applied to estimate carbon stock changes from the following land use changes:

LULUCF

- Land converted to Forest land
- Land converted to Cropland
- Land converted to Grassland
- Land converted to Settlements
- Land converted to Wetlands

KP-LULUCF

- Art. 3.3 - Afforestation/Reforestation
- Art. 3.3 – Deforestation

The relevant equations of IPCC GPG for LULUCF (i.e. eq. 3.2.32, eq. 3.3.3, eq. 3.4.8) have been applied; once a land has converted to a land use category, the annual changes in carbon stocks in mineral soils have been reported for 20 years subsequent the conversion. For the Land converted to Settlements and Art. 3.3 – Deforestation, the 20-years transition period has been applied to determine the area in conversion, while the related CO_2 emissions are assumed to happening in the year following the conversion, taking into account the nature of final land use category (Settlements) and assuming that soils organic matter content of previous land use category is lost in the conversion year. Soil Organic Content (SOC) reference value, for Settlements category, has been assumed to be zero.
In the following Table 7.3, the land use matrices for each year of the period 1990–20112 are reported.

Table 7.3 Land use change matrices for the years 1990-2012

		1990						total 1989
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1989	Forest	**7,511**				0.72		*7,512*
	Grassland	78.68	**8,891**	0.00	0.00	1.73		*8,971*
	Cropland		0	**10,841**	0.00	25		*10,866*
	Wetland				**510**			*510*
	Settlements					**1,616**		*1,616*
	Other Land					0.00	**658**	*658*
	total 1990	*7,590*	*8,891*	*10,841*	*510*	*1,644*	*658*	30,134

20 years matrix		1990						total 1971
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1971	Forest	**6,901**				14.4		*6,916*
	Grassland	689	**8,566**	136	0.00	33		*9,423*
	Cropland		325	**10,704**	0.00	174		*11,203*
	Wetland				**510**			*510*
	Settlements					**1,423**		*1,423*
	Other Land					0.00	**658**	*658*
	Total 1990	*7,590*	*8,891*	*10,841*	*510*	*1,644*	*658*	30,134
	Land converted to:	689	325	136	0	221	0	

		1991						total 1990
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1990	Forest	**7,589**				0.72		*7,590*
	Grassland	78.68	**8,768**	16.77	0.47	26.70		*8,891*
	Cropland		0	**10,841**	0.00	0		*10,841*
	Wetland				**510**			*510*
	Settlements					**1,644**		*1,644*
	Other Land					0.18	**658**	*658*
	total 1991	*7,668*	*8,768*	*10,857*	*511*	*1,672*	*658*	30,134

20 years matrix		1991						total 1972
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1972	Forest	**6,932**				14.4		*6,947*
	Grassland	736	**8,450**	153	0.47	59		*9,398*
	Cropland		318	**10,704**	0.00	169		*11,192*
	Wetland				**510**			*510*
	Settlements					**1,429**		*1,429*
	Other Land					0.18	**658**	*658*
	Total 1991	*7,668*	*8,768*	*10,857*	*511*	*1,672*	*658*	30,134
	Land converted to:	736	318	153	0	243	0	

		1992						total 1991
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1991	Forest	**7,667**				0.72		*7,668*
	Grassland	78.68	**8,646**	16.77	0.47	26.70		*8,768*
	Cropland		0	**10,857**	0.00	0		*10,857*
	Wetland				**511**			*511*
	Settlements					**1,672**		*1,672*
	Other Land					0.18	**658**	*658*
	total 1992	*7,746*	*8,646*	*10,874*	*511*	*1,699*	*658*	30,134

20 years matrix		1992						total 1973
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1973	Forest	**6,963**				14.4		*6,978*
	Grassland	782	**8,334**	170	0.95	86		*9,373*
	Cropland		312	**10,704**	0.00	164		*11,181*
	Wetland				**510**			*510*
	Settlements					**1,434**		*1,434*
	Other Land					0.36	**658**	*658*
	Total 1992	*7,746*	*8,646*	*10,874*	*511*	*1,699*	*658*	30,134
	Land converted to:	782	312	170	1	265	0	

		1993						total 1992
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1992	Forest	**7,745**				0.72		*7,746*
	Grassland	78.68	**8,523**	16.77	0.47	26.70		*8,646*
	Cropland		0	**10,874**	0.00	0		*10,874*
	Wetland				**511**			*511*
	Settlements					**1,699**		*1,699*
	Other Land					0.18	**658**	*658*
	total 1993	*7,824*	*8,523*	*10,891*	*511*	*1,727*	*658*	30,134

20 years matrix		1993						total 1974
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1974	Forest	**6,994**				14.4		*7,009*
	Grassland	829	**8,218**	186	1.42	113		*9,348*
	Cropland		305	**10,704**	0.00	159		*11,169*
	Wetland				**510**			*510*
	Settlements					**1,440**		*1,440*
	Other Land					0.54	**658**	*658*
	Total 1993	*7,824*	*8,523*	*10,891*	*511*	*1,727*	*658*	30,134
	Land converted to:	829	305	186	1	287	0	

		1994						total 1993
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1993	Forest	**7,823**				0.72		*7,824*
	Grassland	78.68	**8,400**	16.77	0.47	26.70		*8,523*
	Cropland		0	**10,891**	0.00	0		*10,891*
	Wetland				**511**			*511*
	Settlements					**1,727**		*1,727*
	Other Land					0.18	**658**	*658*
	total 1994	*7,902*	*8,400*	*10,908*	*512*	*1,754*	*658*	30,134

20 years matrix		1994						total 1975
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1975	Forest	**7,025**				14.4		*7,040*
	Grassland	876	**8,101**	203	1.89	139		*9,322*
	Cropland		299	**10,704**	0.00	155		*11,158*
	Wetland				**510**			*510*
	Settlements					**1,445**		*1,445*
	Other Land					0.72	**658**	*658*
	Total 1994	*7,902*	*8,400*	*10,908*	*512*	*1,754*	*658*	30,134
	Land converted to:	876	299	203	2	309	0	

		1995						total 1994
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1994	Forest	**7,901**				0.72		*7,902*
	Grassland	78.68	**8,278**	16.77	0.47	26.70		*8,400*
	Cropland		0	**10,908**	0.00	0		*10,908*
	Wetland				**512**			*512*
	Settlements					**1,754**		*1,754*
	Other Land					0.18	**657**	*658*
	total 1995	*7,980*	*8,278*	*10,924*	*512*	*1,782*	*657*	30,134

20 years matrix		1995						total 1976
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1976	Forest	**7,056**				14.4		*7,071*
	Grassland	923	**7,985**	220	2.37	166		*9,297*
	Cropland		292	**10,704**	0.00	150		*11,147*
	Wetland				**510**			*510*
	Settlements					**1,451**		*1,451*
	Other Land					0.90	**657**	*658*
	Total 1995	*7,980*	*8,278*	*10,924*	*512*	*1,782*	*657*	30,134
	Land converted to:	923	292	220	2	331	0	

		1996						total 1995
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1995	Forest	**7,979**				0.72		*7,980*
	Grassland	78.68	**8,199**	0	0.00	0.00		*8,278*
	Cropland		60.32	**10,837**	0.47	26.70		*10,924*
	Wetland				**512**			*512*
	Settlements					**1,782**		*1,782*
	Other Land					0.18	**657**	*657*
	total 1996	*8,058*	*8,259*	*10,837*	*513*	*1,810*	*657*	30,134

20 years matrix		1996						total 1977
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1977	Forest	**7,068**				14.4		*7,083*
	Grassland	989	**7,907**	193	2.37	161		*9,252*
	Cropland		353	**10,644**	0.47	176		*11,174*
	Wetland				**510**			*510*
	Settlements					**1,456**		*1,456*
	Other Land					1.08	**657**	*658*
	Total 1996	*8,058*	*8,259*	*10,837*	*513*	*1,810*	*657*	30,134
	Land converted to:	989	353	193	3	353	0	

		1997						total 1995
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1996	Forest	**8,057**				0.72		*8,058*
	Grassland	78.68	**8,181**	0	0.00	0.00		*8,259*
	Cropland		60.32	**10,749**	0.47	26.70		*10,837*
	Wetland				**513**			*513*
	Settlements					**1,810**		*1,810*
	Other Land					0.18	**657**	*657*
	total 1996	*8,136*	*8,241*	*10,749*	*513*	*1,837*	*657*	30,134

20 years matrix		1997						total 1978
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1978	Forest	**7,759**				14.4		*7,773*
	Grassland	1,055	**7,878**	166	2.37	157		*9,258*
	Cropland		413	**9,604**	0.95	203		*10,221*
	Wetland				**514**			*514*
	Settlements					**1,710**		*1,710*
	Other Land					1.26	**655**	*657*
	Total 1997	*8,814*	*8,292*	*9,769*	*518*	*2,086*	*655*	30,134
	Land converted to:	1,055	413	166	3	375	0	

		1998						total 1997
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1997	Forest	8,135				0.72		8,136
	Grassland	78.68	8,162	0	0.00	0.00		8,241
	Cropland		60.32	10,662	0.47	26.70		10,749
	Wetland				513			513
	Settlements					1,837		1,837
	Other Land					0.18	657	657
total 1998		8,213	8,223	10,662	514	1,865	657	30,134

		1999						total 1998
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1998	Forest	8,213				0.72		8,213
	Grassland	78.68	8,144	0	0.00	0.00		8,223
	Cropland		60.32	10,574	0.47	26.70		10,662
	Wetland				514			514
	Settlements					1,865		1,865
	Other Land					0.18	657	657
total 1999		8,291	8,204	10,574	514	1,892	657	30,134

		2000						total 1999
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1999	Forest	8,291				0.72		8,291
	Grassland	78.68	8,126	0	0.00	0.00		8,204
	Cropland		60.32	10,487	0.47	26.70		10,574
	Wetland				514			514
	Settlements					1,892		1,892
	Other Land					0.18	656	657
total 2000		8,369	8,186	10,487	515	1,920	656	30,134

		2001						total 2000
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
2000	Forest	8,369				0.72		8,369
	Grassland	78.68	8,107	0	0.00	0.00		8,186
	Cropland		94.48	10,365	0.47	26.70		10,487
	Wetland				515			515
	Settlements					1,920		1,920
	Other Land					0.18	656	656
total 2001		8,447	8,202	10,365	515	1,948	656	30,134

		2002						total 2001
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
2001	Forest	8,447				0.72		8,447
	Grassland	78.68	8,123	0	0.00	0.00		8,202
	Cropland		94.48	10,244	0.47	26.70		10,365
	Wetland				515			515
	Settlements					1,948		1,948
	Other Land					0.18	656	656
total 2002		8,525	8,218	10,244	516	1,975	656	30,134

		2003						total 2002
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
2002	Forest	8,525				0.72		8,525
	Grassland	78.68	8,139	0	0.00	0.00		8,218
	Cropland		94.48	10,122	0.47	26.70		10,244
	Wetland				516			516
	Settlements					1,975		1,975
	Other Land					0.18	656	656
total 2003		8,603	8,233	10,122	516	2,003	656	30,134

		2004						total 2003
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
2003	Forest	8,603				0.72		8,603
	Grassland	78.68	8,155	0	0.00	0.00		8,233
	Cropland		94.48	10,000	0.47	26.70		10,122
	Wetland				516			516
	Settlements					2,003		2,003
	Other Land					0.18	656	656
total 2004		8,681	8,249	10,000	517	2,030	656	30,134

		2005						total 2004
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
2004	Forest	8,678				3.69		8,681
	Grassland	81.65	8,168	0	0.00	0.00		8,249
	Cropland		97.46	9,879	0.47	23.73		10,000
	Wetland				517			517
	Settlements					2,030		2,030
	Other Land					0.18	656	656
total 2005		8,759	8,265	9,879	517	2,058	656	30,134

		2006						total 2005
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
2005	Forest	8,756				3.69		8,759
	Grassland	58.31	8,207	0	0.00	0.00		8,265
	Cropland		84.89	9,769	0.47	23.73		9,879
	Wetland				517			517
	Settlements					2,058		2,058
	Other Land					0.18	655	656
total 2006		8,814	8,292	9,769	518	2,086	655	30,134

20 years matrix		1998						total 1979
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1979	Forest	7,093				14.4		7,107
	Grassland	1,121	7,749	138	2.37	152		9,163
	Cropland		473	10,524	1	230		11,228
	Wetland				510			510
	Settlements					1,467		1,467
	Other Land					1.44	657	658
Total 1998		8,213	8,223	10,662	514	1,865	657	30,134
Land converted to:		1,121	473	138	4	398	0	

20 years matrix		1999						total 1980
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1980	Forest	7,105				14.4		7,119
	Grassland	1,187	7,671	111	2.37	147		9,118
	Cropland		534	10,463	1.89	257		11,256
	Wetland				510			510
	Settlements					1,473		1,473
	Other Land					1.62	657	658
Total 1999		8,291	8,204	10,574	514	1,892	657	30,134
Land converted to:		1,187	534	111	4	420	0	

20 years matrix		2000						total 1981
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1981	Forest	7,117				14.4		7,131
	Grassland	1,252	7,592	84	2.37	142		9,073
	Cropland		594	10,403	2.37	283		11,283
	Wetland				510			510
	Settlements					1,478		1,478
	Other Land					1.80	656	658
Total 2000		8,369	8,186	10,487	515	1,920	656	30,134
Land converted to:		1,252	594	84	5	442	0	

20 years matrix		2001						total 1982
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1982	Forest	7,131				14.4		7,145
	Grassland	1,317	7,572	84	2.37	142		9,117
	Cropland		630	10,281	2.84	305		11,219
	Wetland				510			510
	Settlements					1,484		1,484
	Other Land					1.98	656	658
Total 2001		8,447	8,202	10,365	515	1,948	656	30,134
Land converted to:		1,317	630	84	5	464	0	

20 years matrix		2002						total 1983
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1983	Forest	7,144				14.4		7,159
	Grassland	1,381	7,552	84	2.37	142		9,161
	Cropland		666	10,160	3.32	327		11,156
	Wetland				510			510
	Settlements					1,489		1,489
	Other Land					2.17	656	658
Total 2002		8,525	8,218	10,244	516	1,975	656	30,134
Land converted to:		1,381	666	84	6	486	0	

20 years matrix		2003						total 1984
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1984	Forest	7,158				14.4		7,173
	Grassland	1,445	7,531	84	2.37	142		9,205
	Cropland		702	10,038	3.79	349		11,093
	Wetland				510			510
	Settlements					1,495		1,495
	Other Land					2.35	656	658
Total 2003		8,603	8,233	10,122	516	2,003	656	30,134
Land converted to:		1,445	702	84	6	508	0	

20 years matrix		2004						total 1985
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1985	Forest	7,172				14.4		7,186
	Grassland	1,509	7,511	84	2.37	142		9,249
	Cropland		738	9,916	4.26	371		11,030
	Wetland				510			510
	Settlements					1,500		1,500
	Other Land					2.53	656	658
Total 2004		8,681	8,249	10,000	517	2,030	656	30,134
Land converted to:		1,509	738	84	7	530	0	

20 years matrix		2005						total 1986
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1986	Forest	7,183				17.4		7,200
	Grassland	1,577	7,488	84	2.37	142		9,293
	Cropland		777	9,795	4.74	390		10,966
	Wetland				510			510
	Settlements					1,506		1,506
	Other Land					2.71	656	658
Total 2005		8,759	8,265	9,879	517	2,058	656	30,134
Land converted to:		1,577	777	84	7	552	0	

20 years matrix		2006						total 1987
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
1987	Forest	7,258				20.4		7,278
	Grassland	1,556	7,430	84	2.37	140		9,213
	Cropland		862	9,686	5.21	388		10,941
	Wetland				510			510
	Settlements					1,534		1,534
	Other Land					2.89	655	658
Total 2006		8,814	8,292	9,769	518	2,086	655	30,134
Land converted to:		1,556	862	84	8	552	0	

	2007						total 2006
2006	Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
Forest	**8,810**				3.69		*8,814*
Grassland	58.31	**8,233**	0	0.00	0.00		*8,292*
Cropland		84.89	**9,660**	0.47	23.73		*9,769*
Wetland				**518**			*518*
Settlements					**2,086**		*2,086*
Other Land					0.18	**655**	*655*
total 2007	*8,868*	*8,318*	*9,660*	*518*	*2,113*	*655*	30,134

	2008						total 2007
2007	Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
Forest	**8,865**				3.69		*8,868*
Grassland	58.31	**8,260**	0	0.00	0.00		*8,318*
Cropland		84.89	**9,551**	0.47	23.73		*9,660*
Wetland				**518**			*518*
Settlements					**2,113**		*2,113*
Other Land					0.18	**655**	*655*
total 2008	*8,923*	*8,345*	*9,551*	*519*	*2,141*	*655*	30,134

	2009						total 2008
2008	Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
Forest	**8,919**				3.69		*8,923*
Grassland	58.31	**8,286**	0	0.00	0.00		*8,345*
Cropland		172.46	**9,355**	0.00	23.91		*9,551*
Wetland				**519**			*519*
Settlements					**2,141**		*2,141*
Other Land					0.00	**655**	*655*
total 2009	*8,978*	*8,459*	*9,355*	*519*	*2,169*	*655*	30,134

	2010						total 2009
2009	Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
Forest	**8,974**				3.69		*8,978*
Grassland	58.31	**8,401**	0	0.00	0.00		*8,459*
Cropland		172.46	**9,159**	0.00	23.91		*9,355*
Wetland				**519**			*519*
Settlements					**2,169**		*2,169*
Other Land					0.00	**655**	*655*
total 2010	*9,032*	*8,573*	*9,159*	*519*	*2,196*	*655*	30,134

	2011						total 2010
2010	Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
Forest	**9,029**				3.69		*9,032*
Grassland	58.31	**8,515**	0.00	0.00	0.00		*8,573*
Cropland		231	**8,903**	0.00	24		*9,159*
Wetland				**519**			*519*
Settlements					**2,196**		*2,196*
Other Land					0.00	**655**	*655*
total 2011	*9,087*	*8,746*	*8,903*	*519*	*2,224*	*655*	30,134

	2012						total 2010
2011	Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
Forest	**9,083**				3.69		*9,087*
Grassland	58.31	**8,688**	0.00	0.00	0.00		*8,746*
Cropland		231	**8,648**	0.00	24		*8,903*
Wetland				**519**			*519*
Settlements					**2,224**		*2,224*
Other Land					0.00	**655**	*655*
total 2011	*9,142*	*8,919*	*8,648*	*519*	*2,251*	*655*	30,134

20 years matrix	2007						total 1988
1988	Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
Forest	**7,333**				23.4		*7,356*
Grassland	1,536	**7,371**	84	2.37	139		*9,132*
Cropland		947	**9,577**	5.68	387		*10,916*
Wetland				**510**			*510*
Settlements					**1,561**		*1,561*
Other Land					3.07	**655**	*658*
Total 2007	*8,868*	*8,318*	*9,660*	*518*	*2,113*	*655*	30,134
Land converted to:	1,536	947	84	8	552	0	

20 years matrix	2008						total 1989
1989	Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
Forest	**7,408**				26.3		*7,434*
Grassland	1,516	**7,313**	84	2.37	137		*9,052*
Cropland		1,032	**9,467**	6.16	386		*10,891*
Wetland				**510**			*510*
Settlements					**1,589**		*1,589*
Other Land					3.25	**655**	*658*
Total 2008	*8,923*	*8,345*	*9,551*	*519*	*2,141*	*655*	30,134
Land converted to:	1,516	1,032	84	9	552	0	

20 years matrix	2009						total 1990
1990	Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
Forest	**7,483**				29.3		*7,512*
Grassland	1,495	**7,255**	84	2.37	135		*8,971*
Cropland		1,204	**9,271**	6.16	384		*10,866*
Wetland				**510**			*510*
Settlements					**1,616**		*1,616*
Other Land					3.25	**655**	*658*
Total 2009	*8,978*	*8,459*	*9,355*	*519*	*2,169*	*655*	30,134
Land converted to:	1,495	1,204	84	9	552	0	

20 years matrix	2010						total 1991
1991	Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
Forest	**7,558**				32.3		*7,590*
Grassland	1,475	**7,196**	84	2.37	134		*8,891*
Cropland		1,377	**9,075**	6.16	383		*10,841*
Wetland				**510**			*510*
Settlements					**1,644**		*1,644*
Other Land					3.25	**655**	*658*
Total 2010	*9,032*	*8,573*	*9,159*	*519*	*2,196*	*655*	30,134
Land converted to:	1,475	1,377	84	9	552	0	

20 years matrix	2011						total 1992
1992	Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
Forest	**7,633**				35.3		*7,668*
Grassland	1,454	**7,138**	67	1.89	107		*8,768*
Cropland		1,608	**8,836**	6.2	407		*10,857*
Wetland				**511**			*511*
Settlements					**1,672**		*1,672*
Other Land					3.07	**655**	*658*
Total 2011	*9,087*	*8,746*	*8,903*	*519*	*2,224*	*655*	30,134
Land converted to:	1,454	1,608	67	8	552	0	

20 years matrix	2012						total 1992
1993	Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	
Forest	**7,707**				38.2		*7,746*
Grassland	1,434	**7,080**	50	1.42	80		*8,646*
Cropland		1,839	**8,598**	6.16	431		*10,874*
Wetland				**511**			*511*
Settlements					**1,699**		*1,699*
Other Land					2.89	**655**	*658*
Total 2011	*9,142*	*8,919*	*8,648*	*519*	*2,251*	*655*	30,134
Land converted to:	1,434	1,839	50	8	552	0	

7.2 Forest Land (5A)

7.2.1 Description

Under this category, CO_2 emissions from living biomass, dead organic matter and soils, from forest land remaining forest land and from land converted to forest land have been reported.
Forest land removals share, in 2012, 68.9% of total CO_2 eq. LULUCF emissions and removals; in particular, the living biomass removals represent 94.6%, while the removals from dead organic matter and soils stand for 2.6% and 2.8% of total 2012 forest land CO_2 removals, respectively, also taking into account that, for forest land remaining forest land, soils pool has been not reported, providing in the relevant paragraph information to demonstrate that this pool is not a source.
CO_2 removals from forest land remaining forest land have been identified as key category (sinks) in level and in trend assessment either with Approach 1 and Approach 2. CO_2 emissions and removals from land converted to forest land have resulted key categories in level and in trend assessment. Concerning CH_4 or N_2O emissions, neither forest land nor land converting to forest land have resulted as a key source.

7.2.2 *Information on approaches used for representing land areas and on land-use databases used for the inventory preparation*

Coherently with the previous submission, forest definition adopted by Italy in the framework of application of elected 3.4 activity, under Kyoto Protocol, has been fully implemented also in the LULUCF sector of the inventory under the Convention, in order to maintain coherence and congruity between the two forest-related reporting. The forest definition has been set up, and included in the determination of Italy's assigned amount under Article 7, paragraph 4, of the Kyoto Protocol, and the election of the art. 3.3 and 3.4 activities, by a national expert panel set up under the coordination of Ministry of Environment and in cooperation with the Ministry of Agriculture, Food and Forest Policies. The abovementioned panel involves, on a voluntary basis, the relevant national experts, including the forest inventory experts (http://www.sian.it/inventarioforestale/jsp/home_en.jsp), members of the FAO-FRA Italian panel (http://www.fao.org/docrep/013/al537E/al537E.pdf) and other national researchers. The national expert panel has considered the Kyoto Protocol rules and requirements, related to reporting and accounting of art. 3.3 and 3.4 activities, and agreed the national forest definition. In the same context, national circumstances (e.g. forest composition, forestry management practices, agroforestry practices, etc.) were examined and it was decided to classify shrubland in the grassland category because they do not fulfil national forest definition; in the current submission, following a key finding in the 2013 review process, the plantations, previously classified in the cropland category, have been included in forest.

For the land use conversion, land use change matrices have been used; as abovementioned, LUC matrices for each year of the period 1990–2012 have been assembled on the basis of the IUTI[16] data, related to 1990, 2000 and 2008, and the results of the NFI (related to 2012). Annual figures for areas in transition between different land uses have been derived by a hierarchy of basic assumptions (informed by expert judgement) of known patterns of land-use changes in Italy as well as the need for the total national area to remain constant.

Forest land area detected by the National Forest Inventories (NFI) has been used as basis to assess the Growth in forest land area. It was assumed that new forest land area can only come from grassland.

The Italian Ministry of Agriculture and Forests (MAF) and the Experimental Institute for Forest Management (ISAFA) carried out the first National Forest Inventory in 1985. As a result of the first NFI based on a regular sampling grid of 3 km by 3 km, the global Italian extent of forest resources was about 8.7 million hectares (MAF/ISAFA, 1988). A second national forest inventory (INFC2005), using a grid of 1 km by 1 km, had been launched in 2001. A first inventory phase, consisting in interpretation of orthophotos, was followed by a ground survey, in order to assess the forest use, and to detect the main attributes of Italian forests. The final result, regarding forest surfaces, has been used (Tabacchi et al., 2007). The third national forest inventory (INFC2015), using the same sampling design of the II NFI, has been carried out in 2013, concluding the first phase, interpretation of orthophotos, in October 2013. The abovementioned data, referring to forest area estimates, have been used in the estimation process.

7.2.3 *Land-use definitions and the classification systems used and their correspondence to the LULUCF categories*

The forest definition adopted by Italy in the framework of the Kyoto Protocol has been adopted; this definition is in line with the definitions of the Food and Agriculture Organization of the United Nations, therefore the following threshold values for tree crown cover, land area and tree height are applied:

a. a minimum area of land of 0.5 hectares;
b. tree crown cover of 10 per cent;
c. minimum tree height of 5 meters.

7.2.4 *Methodological issues*

Forest Land remaining Forest Land

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[16] Detailed information on IUTI is reported in Annex 10

All the data concerning the growing stock and the related carbon are assessed by the For-est model, estimating the evolution in time of the Italian forest carbon pools, according to the GPG classification and definition: living biomass, both aboveground and belowground, dead organic matter, including dead wood and litter, and soils as soil organic matter. Additional information on the methodological aspects may be found in Federici et al., 2008; some specific parameters (i.e. biomass expansion factors, wood basic densities for aboveground biomass estimate, root/shoot ratios) used in the estimation process are the same reported in the above-mentioned article; in other cases (i.e. dead wood or litter pools) different coefficients have been used to deduce the carbon stock changes in the pools, on the basis of the results of the II National Forestry Inventory and the national forest definition. Details are reported in the following relevant sections. The model has been applied at regional scale (NUTS2) because of availability of forest-related statistical data: model input data for the forest area, per region and inventory typologies, were the Italian forest inventories (NFI1985, INFC2005), while the results of the first phase of the INFC2015 were used in forest area assessment.

The inventory typologies, classified in 4 main categories, are:

- Stands*: norway spruce, silver fir, larches, mountain pines, mediterranean pines, other conifers, European beech, turkey oak, other oaks, other broadleaves*.
- Coppices: *European beech, sweet chestnut, hornbeams, other oaks, turkey oak, evergreen oaks, other broadleaves, conifers*.
- Plantations: *eucalyptuses coppices, other broadleaves coppices, poplar stands, other broadleaves stands, conifers stands, others*.
- Protective Forests: *rupicolous forest, riparian forests, shrublands*

To estimate the growing stock of Italian forest, from 1990 to 2012, the following methodology was applied:

1. the initial growing stock volume is the 1985 growing stock data (MAF/ISAFA, 1988);
2. starting from 1985, for each year, the current increment per hectare [m^3 ha^{-1}] is computed with the derivative Richards function[17], for each forest typology by the Italian yield tables collection;
3. starting from 1986, for each year the growing stock per hectare [m^3 ha^{-1}] is computed, from the previous year growing stock volume, with the addition of the calculated increment ("y" value of the derivative Richards) for the current year and subtraction of the losses due to harvest, mortality and fire for the current year. Mortality and rate of drain and grazing are applied, as percentage, directly to the growing stock amount of the previous year.

The relationship can be summarized as follows:

$$v_i = \frac{V_{i-1} + I_i - H_i - F_i - M_i - D_i}{A_i}$$

where:

$$I_i = f(v_{i-1}) \cdot A_{i-1}$$

in which the current increment is estimated year by year applying the derivative Richards function and

[17] In the followed approach the Richards function is fitted through the data of growing stock [m^3] and increment [m^3 y^{-1}] obtained by the data of the national forestry inventory and yield tables collection.

$$y = a \cdot \left(1 \pm e^{\beta - kt}\right)^{-\frac{1}{\nu}}$$ (Richards function)

The independent variable represents the growing stock of the stand, while the dependent variable y is the correspondent increment computed with the Richards function - first derivative.

$$\frac{dy}{dt} = \frac{k}{\nu} \cdot y \cdot \left[1 - \left(\frac{y}{a}\right)^{\nu}\right] + y_0$$ (Richards function - first derivative)

where the general constrain for the parameters are the following:

$a,k > 0 \quad -1 \leq \nu \leq \infty$ and $\nu \neq 0$

The constant y_0 is derived from the data of age and volume reported in the yield tables: more precisely y_0 has the value of the volume for the age 1. After choosing the function, it is fitted to the measurements by non-linear regression. The minimization of the deviation is performed by the least squares method. The model performances were evaluated against the data by validation statistics according to Jabssen and Heuberger (1995).

v_i is the volume per hectare of growing stock for the current year

V_{i-1} is the total previous year growing stock volume

I_i is the total current increment of growing stock for the current year

H_i is the total amount of harvested growing stock for the current year

F_i is the total amount of burned growing stock for the current year

Mi is the annual rate of mortality

D is the annual rate of drain and grazing for the protective forest

A_i is the total area referred to a specific forest typology for the current year

v_{i-1} is the previous year growing stock volume per hectare

A_{i-1} is the total area referred to a specific forest typology for the previous year

f is the Richards function reported above

The average rate of mortality, the fraction of standing biomass per year, used for the calculation was 0.0116, concerning the evergreen forest, and 0.0117, for deciduous forest, according to the GPG (IPCC, 2003).
The rate of draining and grazing, applied to protective forest, has been set as 3% following an expert judgement (Federici et al., 2008) because of total absence of referable data.
Total commercial harvested wood, for construction and energy purposes, has been published by ISTAT (disaggregated at NUTS2 level, in sectoral statistics (ISTAT, several years [a]) or at NUTS1 level for coppices and high forests in national statistics (ISTAT, several years [c])); nevertheless as data on biomass removed in commercial harvest, particularly concerning fuelwood consumption, have been judged underestimated (APAT - ARPA Lombardia, 2007, UNECE – FAO, Timber Committee, 2008, Corona et al., 2007). Consequently the time series has been recalculated, applying a correction factor, on regional basis, to the entire time series of commercial harvested wood. The correction factor[18], was inferred with the outcome of a specific survey conducted in the framework of the NFI, carrying out a regional assessment of the harvested biomass; the computed figures have been subtracted, as losses, from growing stock volume, as mentioned above.
Carbon amount released by forest fires has been included in the overall assessment of carbon stocks change.. Moreover, not having data on forest typologies of burned areas, the total value of burned forest area coming from national statistics has been subdivided and assigned to forest typologies based on their respective weight on total national forest area. Finally, the amount of burned growing stock has been calculated multiplying average growing stock per hectare of forest typology for the assigned burned area. Assessed value has been subtracted to total growing stock of respective typology, as aforesaid.
In Figure 7.3, losses of carbon due to harvest and forest fires, referred to forest land category and reported as percentage on total aboveground carbon, are shown.

[18] A correction factor for each Italian region (21) has been pointed out. The mean value is 1.57, obtained as ratio of data from official statistics and INFC survey data. The variance is equal to 0.82.

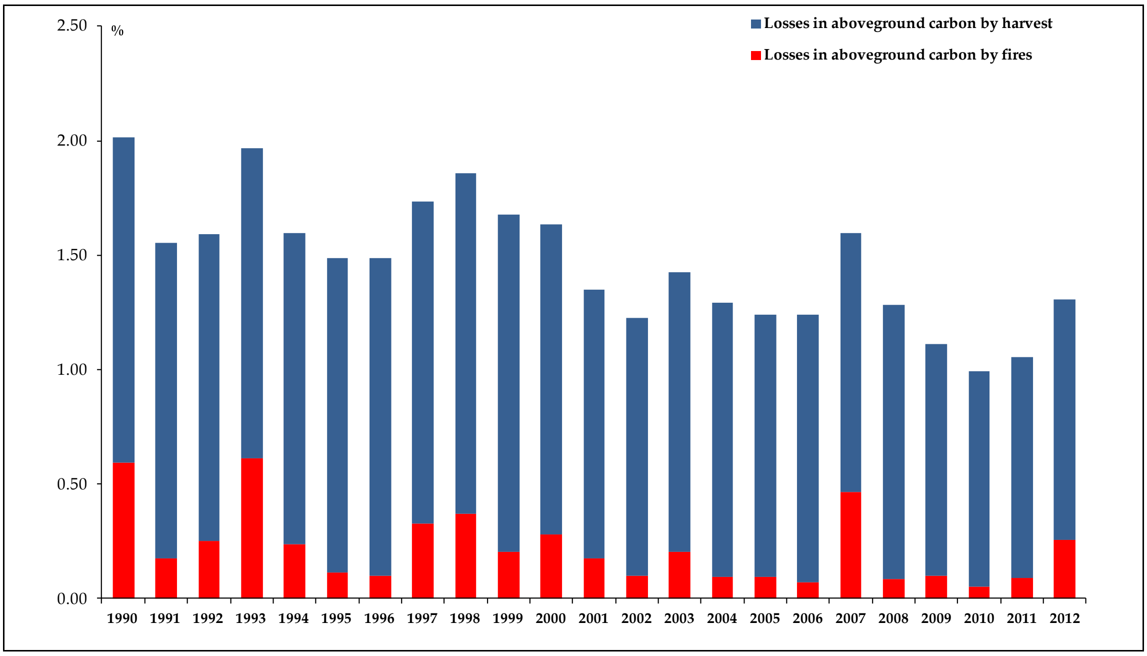

Figure 7.3 Losses by harvest and fires in relation to aboveground carbon

CO_2 emissions due to wildfires in forest land remaining forest land are included in CRF Table 5.A.1, carbon stocks change in living biomass - decrease. Non CO_2 emissions from fires have been estimated and reported in CRF table 5(V); details on the methodology used to estimate emissions are reported in the paragraph 7.12.2.

Once the growing stock is estimated, the amount of aboveground tree biomass (dry matter), belowground biomass (dry matter) and dead mass (dry matter), can be assessed, from 1990 to 2012. In the following, the default value of carbon fraction of dry matter (0.5 t d.m.) has been applied to obtain carbon amount from biomass.

The net carbon stock change of living biomass has been calculated according to the GPG for LULUCF (IPCC, 2003), from the aboveground tree biomass and belowground biomass:

$$\Delta C_{\text{Living biomass}} = \Delta C_{\text{Aboveground biomass}} + \Delta C_{\text{Belowground biomass}}$$

where the total amount of carbon has been obtained from the biomass (d.m.), multiplying by the conversion factor carbon content/dry matter.

With regard to the aboveground biomass:

1. starting from the 1985 growing stock data, reported in the NFI, the amount of aboveground woody tree biomass (d.m) [t] was calculated, for every forest typology, through the relation:

$$\text{Aboveground tree biomass (d.m.)} = GS \cdot BEF \cdot WBD \cdot A$$

   where:
   GS = volume of growing stock (MAF/ISAFA, 1988) [m^3 ha-[1]]
   BEF = Biomass Expansion Factors which expands growing stock volume to volume of aboveground woody biomass (ISAFA, 2004)
   WBD = Wood Basic Density for conversions from fresh volume to dry weight (d.m) [t m^{-3}] (Giordano, 1980)
   A = forest area occupied by specific typology [ha] (MAF/ISAFA, 1988)

   The BEF were derived for each forest typology and wood basic density (WBD) values were different for the main tree species:
2. starting from 1985, for each year, current increment per hectare [m^3 ha-[1] y^{-1}] is computed with the derivative Richards function, for every specific forest typology by the Italian yield tables collection;
3. starting from 1986, for each year growing stock per hectare [m^3 ha^{-1}] is computed, from the previous year growing stock volume, adding the calculated increment ("y" value of the derivative Richards)

for the current year and subtracting losses due to harvest, mortality and fire for the current year, as described above.

Re-applying the relation:

$$\text{Aboveground tree biomass} = GS \cdot BEF \cdot WBD \cdot A$$

it is possible to obtain the aboveground woody tree biomass (d.m.) [t] for each forest typology, for each year, starting from the 1986.

In Table 7.4 biomass expansion factors for the conversions of volume to aboveground tree biomass and wood basic densities are reported.

Table 7.4 Biomass Expansion Factors and Wood Basic Densities

	Inventory typology	BEF *aboveground biomass / growing stock*	WBD *Dry weigth t/ fresh volume*
stands	norway spruce	1.29	0.38
	silver fir	1.34	0.38
	larches	1.22	0.56
	mountain pines	1.33	0.47
	mediterranean pines	1.53	0.53
	other conifers	1.37	0.43
	european beech	1.36	0.61
	turkey oak	1.45	0.69
	other oaks	1.42	0.67
	other broadleaves	1.47	0.53
coppices	european beech	1.36	0.61
	sweet chestnut	1.33	0.49
	hornbeams	1.28	0.66
	other oaks	1.39	0.65
	turkey oak	1.23	0.69
	evergreen oaks	1.45	0.72
	other broadleaves	1.53	0.53
	conifers	1.38	0.43
plantations	eucalyptuses coppices	1.33	0.54
	other broadleaves coppices	1.45	0.53
	poplars stands	1.24	0.29
	other broadleaves stands	1.53	0.53
	conifers stands	1.41	0.43
	others	1.46	0.48
protective	rupicolous forest	1.44	0.52
	riparian forest	1.39	0.41

Belowground biomass was estimated applying a Root/Shoot ratio to the aboveground biomass. The belowground biomass is computed, as:

$$\text{Belowground biomass (d.m.)} = GS \cdot BEF \cdot WBD \cdot R \cdot A$$

where:

GS = volume of growing stock [$m^3\ ha^{-1}$]

R = Root/Shoot ratio which converts growing stock biomass in belowground biomass

BEF = Biomass Expansion Factors which expands growing stock volume to volume of aboveground woody biomass (ISAFA, 2004)

WBD = Wood Basic Density [t d.m. m^{-3}]

A = forest area occupied by specific typology [ha]

Also in this case, the Root/shoot ratios and WBDs were derived for each forest typology, on the basis of different studies conducted at the national and local level in different years and contexts; the derived

Root/Shoot ratios have been then included in the JRC-AFOLU database[19]. Description of the database is detailed in Somogyi et al., 2008. The relevant projects taken into account to derive Root/Shoot ratios used in the estimation process are the European projects CANIF[20] (*CArbon and NItrogen cycling in Forest ecosystems*), CARBODATA[21] (*Carbon Balance Estimates and Resource Management - Support with Data from Project Networks Implemented at European Continental Scale*), CARBOINVENT[22] (*Multi-source inventory methods for quantifying carbon stocks and stock changes in European forests*) and COST[23] Action E21- Contribution of forests and forestry to mitigate greenhouse effects.
In Table 7.5 root/shoot ratio and wood basic densities are reported.

Table 7.5 Root/Shoot ratio and Wood Basic Densities

	Inventory typology	**R** *Root/shoot ratio*	**WBD** *Dry weigth t/ fresh volume*
stands	norway spruce	0.29	0.38
	silver fir	0.28	0.38
	Larches	0.29	0.56
	mountain pines	0.36	0.47
	mediterranean pines	0.33	0.53
	other conifers	0.29	0.43
	european beech	0.20	0.61
	turkey oak	0.24	0.69
	other oaks	0.20	0.67
	other broadleaves	0.24	0.53
coppices	european beech	0.20	0.61
	sweet chestnut	0.28	0.49
	Hornbeams	0.26	0.66
	other oaks	0.20	0.65
	turkey oak	0.24	0.69
	evergreen oaks	1.00	0.72
	other broadleaves	0.24	0.53
	Conifers	0.29	0.43
Plantations	eucalyptuses coppices	0.43	0.54
	other broadleaves coppices	0.24	0.53
	poplars stands	0.21	0.29
	other broadleaves stands	0.24	0.53
	conifers stands	0.29	0.43
protective	rupicolous forest	0.42	0.52
	riparian forest	0.23	0.41

The dead organic matter carbon pool is defined, in the GPG, as the sum of the dead wood and the litter.

$$\Delta C_{\text{Dead Organic Matter}} = \Delta C_{\text{dead mass}} + \Delta C_{\text{litter}}$$

[19] European Commission - Joint Research Centre, Institute for Environment and Sustainability, AFOLU DATA clearinghouse: Allometric Biomass and Carbon (ABC) factors database: http://afoludata.jrc.ec.europa.eu/index.php/public_area/data_and_tools

[20] CANIF - CArbon and NItrogen cycling in Forest ecosystems http://www.bgc-jena.mpg.de/bgc-processes/research/Schulze_Euro_CANIF.html; Scarascia Mugnozza G., Bauer G., Persson H., Matteucci G., Masci A. (2000). Tree biomass, growth and nutrient pools. In: Schulze E.-D. (edit.) Carbon and Nitrogen Cycling in European forest Ecosystems, Ecological Studies 142, Springer Verlag, Heidelberg. Pp. 49-62. ISBN 3-540-67239-7

[21] CARBODATA - Carbon Balance Estimates and Resource Management - Support with Data from Project Networks Implemented at European Continental Scale: http://afoludata.jrc.it/carbodat/proj_desc.html

[22] CARBOINVENT - Multi-source inventory methods for quantifying carbon stocks and stock changes in European forests; http://www.joanneum.at/carboinvent/

[23] COST Action E21 - Contribution of forests and forestry to mitigate greenhouse effects: http://www.cost.eu/domains_actions/fps/Actions/E21; http://www.afs-journal.org/index.php?option=com_article&access=standard&Itemid=129&url=/articles/forest/pdf/2005/08/F62800f.pdf

The total amount of carbon for dead organic matter has been obtained from the dead organic matter (d.m.), multiplying by the conversion factor carbon content / dry matter.
The dead wood mass has been estimated using coefficients calculated from outcomes of a survey conducted by the Italian national forest inventory, in 2008 and 2009, which specifically intended to investigate the carbon storage of forests. Samples of dead-wood were collected across the country from the plots of the national forest inventory network, and their basic densities measured in order to calculate conversion factors for estimating the dry weight of dead-wood (Di Cosmo et al., 2013). The values used, aggregated at regional level, may be found on the INFC website: http://www.sian.it/inventarioforestale/jsp/dati_carquant_tab.jsp. In Table 7.6 dead wood coefficients are reported.

Table 7.6 Dead-wood expansion factor

	Inventory typology	**dead wood (dry matter)** *t ha⁻¹*
stands	norway spruce	6.360
	silver fir	7.770
	Larches	3.830
	mountain pines	4.385
	mediterranean pines	2.670
	other conifers	4.290
	european beech	3.350
	turkey oak	1.770
	other oaks	1.690
	other broadleaves	3.990
coppices	european beech	3.350
	sweet chestnut	12.990
	Hornbeams	2.730
	other oaks	1.690
	turkey oak	1.770
	evergreen oaks	1.370
	other broadleaves	2.690
	Conifers	4.290
plantations	eucalyptuses coppices	0.670
	other broadleaves coppices	0.670
	poplars stands	0.480
	other broadleaves stands	0.670
	conifers stands	3.040
protective	rupicolous forest	2.730
	riparian forest	4.790

The dead wood [t] is:

$$\text{Dead wood(d.m.)} = DC \cdot A$$

where:
DC = Dead wood expansion factor (dead wood - dry matter) [t ha^{-1}]
A = forest area occupied by specific typology [ha]

Carbon amount contained in litter pool has been estimated using the values of litter carbon content assessed by the Italian national forest inventory. The values used, aggregated at regional level, may be found on the INFC website: http://www.sian.it/inventarioforestale/jsp/dati_carquant_tab.jsp. The average value of litter organic carbon content, for Italy, is equal to 1.990 t C ha^{-1}.
Following the main finding of 2011 review process regarding soils pool, Italy has decided to apply the IPCC Tier1, assuming that, for forest land remaining forest land, the carbon stock in soil organic matter does not change, regardless of changes in forest management, types, and disturbance regimes; in other words it has to be assumed that the carbon stock in mineral soil remains constant so long as the land remains forest. Therefore carbon stock changes in soils pool, for forest land remaining forest land, have been not reported. Carbon stock changes in minerals soils, for *Forest land remaining Forest land* have been estimated and detailed in par. 10.3.1.2.

Land converted in Forest Land

The area of land converted to forest land is always coming from grassland. There is no occurrence for other conversion. Carbon stocks change due to grassland converting to forest land has been estimated and reported. The carbon stock change of living biomass has been calculated taking into account the increase and the decrease of carbon stock related to the areas in transition to forest land, using the same For-est model already used in *the forest land remaining forest land* sub-category: a description of the methodology used in the estimation process is provided in par. 7.2.4.

Net carbon stock change in dead organic matter and soil has been calculated as well. Following the main finding of 2011 review process, Italy has decided to use the IPCC default land use transition period of 20 years, to estimate carbon stock changes in mineral soils related to land converted in Forest Land. The relevant equations of IPCC GPG for LULUCF (i.e. eq. 3.2.32, eq. 3.3.3, eq. 3.4.8) have been applied; once a land has converted to a land use category, the annual changes in carbon stocks in mineral soils have been reported for 20 years subsequent the conversion. SOC reference value for grassland has been revised and set to 78.9 t C ha^{-1}, after a review of the latest papers reporting data on soil carbon in mountain meadows, pastures, set-aside lands as well as soil not disturbed since the agricultural abandonment, in Italy (Viaroli and Gardi 2004, CRPA 2009, IPLA 2007, ERSAF 2008, Del Gardo *et al* 2003, LaMantia *et al* 2007, Benedetti *et al* 2004, Masciandaro and Ceccanti 1999, Xiloyannis 2007). Concerning forest soils, the SOCs reported in the table 7.7 have been used; each SOC reported in the abovementioned table has been used for the years indicated in the first column of the table 7.8. A detailed description of the methodology used in the estimation process of soils pool, and consequently of the SOCs, is provided in par. 10.3.1.2, related to the KP-LULUCF.

Table 7.7 Soil Organic Content (SOC) values for *forest land remaining forest land*

years	**SOC** *t C ha^{-1}*
1985-1994	80.449
1995-1999	80.829
2000-2004	81.248
2005-2009	81.777
2010-2012	82.160

The total amount of carbon for dead organic matter has been obtained from the dead organic matter (d.m.), multiplying by the conversion factor carbon content/dry matter.

In Table 7.8 carbon stock changes due to conversion to forest land, for the living biomass, dead organic matter and soil pools, have been reported.

Table 7.8 Carbon stock changes in land converting to forest land

	Conversion Area	**Carbon stock change in living biomass**			**Net C stock change in dead organic matter**	**Net C stock change in mineral soils**
	20 years change	***Increase***	***Decrease***	***Net change***		
year	*kha*	*Gg C*				
1990	689	2,307.1	-1,551.7	755.4	31.4	72.0
1991	736	2,421.2	-1,342.1	1,079.1	33.1	78.6
1992	782	2,538.2	-1,479.1	1,059.1	34.8	85.2
1993	829	2,650.6	-1,840.2	810.4	36.4	91.7
1994	876	2,767.4	-1,676.4	1,091.0	38.0	98.3
1995	923	2,886.9	-1,685.0	1,201.9	39.6	106.4
1996	989	3,042.6	-1,731.0	1,311.6	42.0	116.0
1997	1,055	3,203.7	-2,191.8	1,011.9	44.2	125.7
1998	1,121	3,362.0	-2,393.3	968.7	46.5	135.4
1999	1,187	3,531.5	-2,350.3	1,181.2	48.7	145.0
2000	1,252	3,696.8	-2,489.3	1,207.5	50.8	156.4
2001	1,317	3,848.6	-2,312.7	1,535.9	52.9	167.5

year	Conversion Area *20 years change* *kha*	Carbon stock change in living biomass *Increase*	 *Decrease*	 *Net change*	Net C stock change in dead organic matter *Gg C*	Net C stock change in mineral soils
2002	1,381	4,003.5	-2,266.2	1,737.3	54.9	178.7
2003	1,445	4,158.0	-2,664.4	1,493.7	56.9	189.9
2004	1,509	4,313.3	-2,569.5	1,743.8	58.8	201.1
2005	1,577	4,474.9	-2,635.8	1,839.1	60.8	214.4
2006	1,556	4,423.7	-2,631.6	1,792.1	38.3	215.9
2007	1,536	4,349.9	-3,381.4	968.6	37.6	217.4
2008	1,516	4,278.4	-2,728.4	1,550.0	36.9	218.8
2009	1,495	4,207.3	-2,549.3	1,658.0	36.2	220.3
2010	1,475	4,140.3	-2,452.2	1,688.1	35.5	222.9
2011	1,454	4,074.3	-2,766.0	1,308.3	34.8	225.5
2012	1,434	4,083.9	-2,742.4	1,341.5	34.8	228.1

CO_2 emissions due to wildfires in land converting to forest land are included in CRF Table 5.A.2, carbon stocks change in living biomass - decrease. Non CO_2 emissions from fires have been estimated and reported in CRF table 5(V); details on the methodology used to estimate emissions are reported in the paragraph 7.12.2.

7.2.5 Uncertainty and time series consistency

Estimates of removals by forest land are based on application of the above-described model. To assess the overall uncertainty related to the years 1990–2012, Approach 1 of 2006 IPCC Guidelines (IPCC, 2006) has been followed. In Table 7.9, the values of carbon stocks in the five pools, for the 1985, and the abovementioned uncertainties are reported.

Table 7.9 Carbon stocks and uncertainties for year 1985 and current increment related uncertainty

Carbon stocks *t CO_2 eq. ha^{-1}*	*Aboveground biomass*	V_{AG}	137.8
	Belowground biomass	V_{BG}	31.5
	Dead mass	V_D	6.0
	Litter	V_L	10.0
Uncertainty	*Growing stock*	E_{NFI}	3.2%
	Current increment (Richards)[24]	E_{NFI}	51.6%
	Harvest[25]	E_H	30%
	Fire[26]	E_F	30%
	Drain and grazing	E_D	30%
	Mortality	E_M	30%
	BEF	E_{BEF1}	30%
	R	E_R	30%
	deadwood	E_{DEF}	4.6%
	Litter	E_L	10%
	Basic Density	E_{BD}	30%
	C Conversion Factor	E_{CF}	2%

[24] The current increment is estimated by the Richards function (first derivative); uncertainty has been assessed considering the standard error of the linear regression between the estimated values and the corresponding current increment values reported in the National Forest Inventory

[25] Good Practice Guidance default value (IPCC, 2003)

[26] Good Practice Guidance default value (IPCC, 2003)

The uncertainties related to the carbon pools and the overall uncertainty for 1985 has been computed and shown in Table 7.10.

Table 7.10 Uncertainties for the year 1985

Aboveground biomass	E_{AG}	42.59%
Belowground biomass	E_{BG}	42.59%
Dead mass	E_D	42.84%
Litter	E_L	43.75%
Overall uncertainty	$\mathbf{E_{1985}}$	**32.61%**

The overall uncertainty related to 1985 (the year of the first National Forest Inventory) has been propagated through the years, till 2012, following Approach 1.
The uncertainties related to the carbon pools and the overall uncertainty for 2012 are shown in Table 7.11.

Table 7.11 Uncertainties for the year 2012

Aboveground biomass	E_{AG}	42.66%
Belowground biomass	E_{BG}	42.66%
Dead mass	E_D	42.90%
Litter	E_L	43.81%
Overall uncertainty	**E**	**33.36%**

Following Approach 1 and the abovementioned methodology, the overall uncertainty in the estimates produced by the described model has been quantified; in Table 7.12 the uncertainties of the 1985-2012 period are reported.

Table 7.12 Overall uncertainties 1985 - 2012

1985	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
32.6%	32.8%	32.9%	33.1%	33.2%	33.2%	33.2%	33.3%	33.3%	33.3%	33.3%	33.4%

The overall uncertainty in the model estimates between 1990 and 2012 has been assessed with the following relation:

$$E_{1990-2012} = \frac{\sqrt{(E_{1990} \cdot V_{1990})^2 + (E_{2011} \cdot V_{2012})^2}}{|V_{1990} + V_{2012}|}$$

where the terms V stands for the growing stock [$m^3\ ha^{-1}\ CO_2\ eq$] while the uncertainties have been indicated with the letter E. The overall uncertainty related to the year 1990–2012 is equal to 23.5%.
A Montecarlo analysis has been carried out to assess uncertainty for Forest Land category (considering both Forest Land remaining Forest Land and Land converted to Forest Land), considering the different reporting pools (*aboveground, belowground, litter, deadwood and soils*), and the subcategories stands, coppices and rupicolous and riparian forests for the reporting year 2009, resulting equal to 49%. As for Land converted to Forest Land, an asymmetrical probability density distribution resulted from the analysis, showing uncertainties values equal to -147.6% and 192.3%. Normal distributions have been assumed for most of the parameters. A more detailed description of the results is reported in Annex 1.
The table reporting the uncertainties referring to all the categories (Forest Land, Cropland, Grassland, Wetlands, Settlements, Other Land) is shown in Annex 1.
A comparison between carbon in the aboveground, deadwood and litter pools, estimated with the described methodology, and the II NFI data (INFC2005) is reported in the Table 7.13.

Table 7.13 Comparison between estimated and INFC2005 aboveground carbon stock

	INFC2005	**For-est model**	*differences*	
	t C	*t C*	*t C*	*%*
aboveground	486,018,500	450,992,675	-35,025,825	**-7.21**
deadwood	17,008,023	16,886,305	-121,717	**-0.72**
litter	28,170,660	28,645,850	475,190	**1.69**

7.2.6 Category-specific QA/QC and verification

Systematic quality control activities have been carried out in order to ensure completeness and consistency in time series and correctness in the sum of sub-categories; where possible, activity data comparison among different sources (FAO database[27], ISTAT data[28]) has been made. Data entries have been checked several times during the compilation of the inventory; particular attention has been focussed on the categories showing significant changes between two years in succession. Land use matrices have been accurately checked and cross-checked to ensure that data were properly reported. An independent verification of reported data was done in the framework of the National Forestry Inventory, resulting in comparison of the model results versus data measured, relating to the year 2005 (Tabacchi et al., 2010). In Figure 7.4 outcome of the comparison is shown.

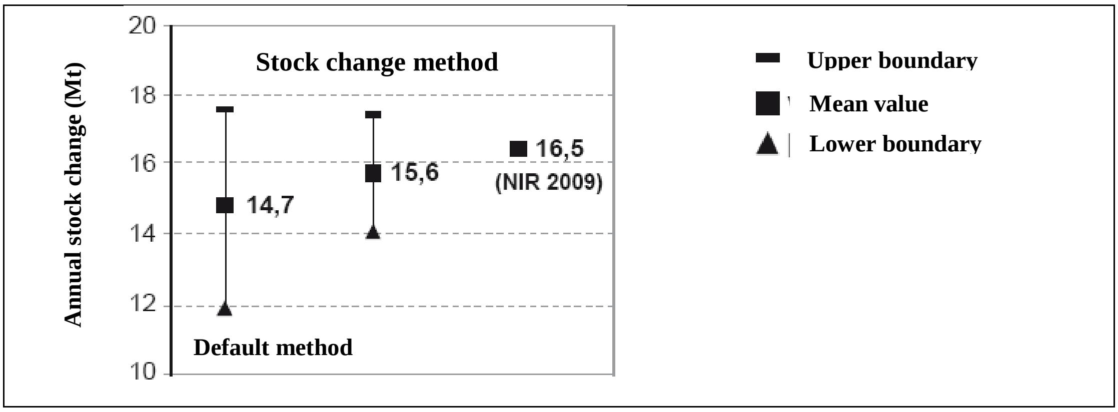

Figure 7.4 Comparison between carbon stock changes, for living biomass pool, by the National Inventory (NIR, 2009) and estimated data on the basis of INFC2005 measurements (modified from Tabacchi et al., 2010)

The II NFI classification system, and consequent categories list, has changed respect to the system (and inventory categories) used in the first forest inventory. A transition matrix, between the INFC2005 and first forest inventory classification systems, has planned to be elaborated. In the meanwhile a comparison among INFC2005 current increment data and For-est model current increment data is possible only for a not exhaustive number of inventory typologies. In the following Figure 7.5 the comparison has been reported.

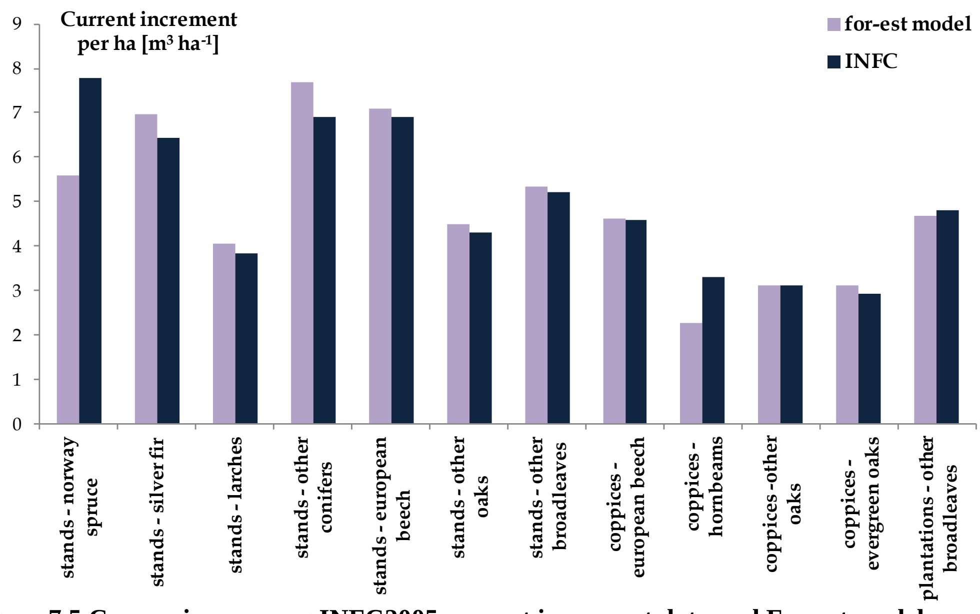

Figure 7.5 Comparison among INFC2005 current increment data and For-est model current increment data

[27] FAO, 2005. FAOSTAT, http://faostat.fao.org
[28] ISTAT, several years [a], [b], [c]

Regarding both soil and litter, a validation of the applied methodology has been done in Piemonte region, comparing results of a regional soil inventory with data obtained with the abovementioned methodology (Petrella and Piazzi, 2006). Results show a good agreement between the two dataset either in litter and soil. An interregional project, named INEMAR[29], developed to carry out atmospheric emission inventories at local scale, has added a module to estimate forest land emission and removals, following the abovementioned methodology. The module has been applied, at local scale with local data, in Lombardia region, for the different pools and for the year 1990, 2000, 2005, 2008. In Figure 7.6 carbon stocks, in the different pools, estimated by the National Inventory (ISPRA) and the correspondent values obtained in the INEMAR framework for the Lombardia region, have showed (ARPA Lombardia - Regione Lombardia, 2011 [a, b]).

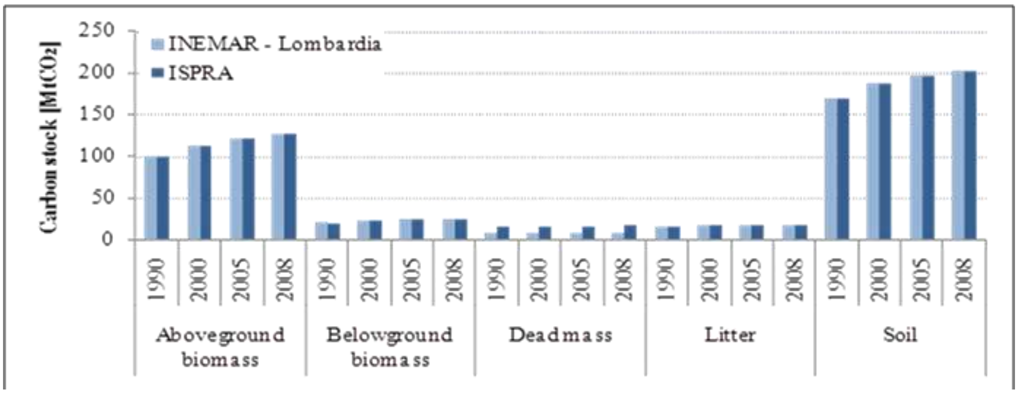

Figure 7.6 Carbon stocks estimates by the National Inventory (ISPRA) and the INEMAR project for Lombardia

In Table 7.14 carbon stocks, in the different pools, estimated by the National Inventory (ISPRA) and the correspondent values obtained in the INEMAR framework for the Lombardia region, are shown.

Table 7.14 Carbon stocks estimates by the National Inventory (ISPRA) and the INEMAR project for Lombardia

	INEMAR - Lombardia	**ISPRA**	**Differences**
	Gg CO_2	***Gg CO_2***	***%***
1990	311,370	319,203	-2.45
2000	345,886	353,326	-2.11
2005	367,537	375,275	-2.06
2008	379,742	387,673	-2.05

The same module, applied in Lombardia region, will be applied, at local scale with local data, in seven of the 20 Italian regions and the results will constitute a good validation of the used methodology.
An additional verification activity has been carried out, comparing the implied carbon stock change per area (IEF), related to the living biomass, with the IEFs reported by other Parties. The 2013 submission has been considered to deduce the different IEFs; in the figure 7.7 the comparison is showed, taking into account the IEFs for both the forest land remaining forest land (FL-FL) and land converting to forest land (L-FL) subcategories, for the living biomass.

[29] INEMAR: INventario EMissioni Aria: http://www.ambiente.regione.lombardia.it/inemar/e_inemarhome.htm

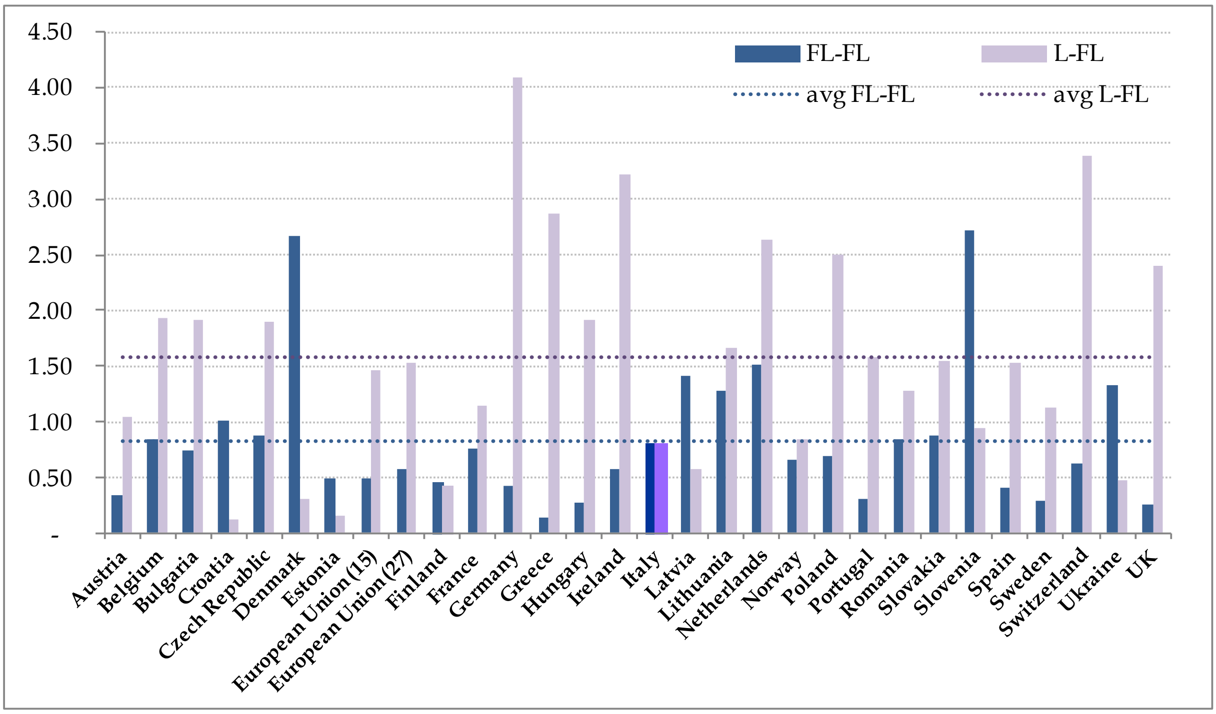

Figure 7.7 Implied carbon stock change per area for the living biomass

Further identification of critical issues and uncertainties in the estimations derived from the participation at workshops and pilot projects (MATT, 2002). Specifically, the European pilot project to harmonise the estimation and reporting of EU Member States, in 2003, led to a comparison among national approaches and problems related to the estimation methodology and basic data needed (JRC, 2004). The estimate methodology has been presented and discussed during several national workshops; findings and comments collected have been used in the refining estimation process.

7.2.7 Category-specific recalculations

Recalculations of emissions and removals have been carried out on the basis of the IPCC Good Practice Guidance for LULUCF (IPCC, 2003).

Deviations from the previous sectoral estimates are equal to an average[30] increase of 1.2%, concerning the whole forest land category; as well regards the different carbon pools, an increase of 3.1% and 3.0 in living biomass pool and in soils pool, respectively, are resulting, due to the activity data updating and errors' correction. An average[31] decrease of 56.6% respect the previous sectoral estimates is affecting the dead organic matter pool, resulting from the update in the litter coefficients used in the estimation process, following the inclusion of latest NFI's outcomes. In the Table 7.15 the comparison between the 2014 and 2013 submissions is reported.

Table 7.15 Comparison of the 2014 and 2013 submissions for the Forest land category

	1990	1995	2000	2005	2008	2009	2010	2011
2014 submission				*CO_2 eq. - Gg*				
Forest land	**-18,943**	**-32,660**	**-27,233**	**-36,281**	**-32,314**	**-35,156**	**-36,536**	**-28,785**
- *living biomass*	*-17,460*	*-31,052*	*-25,441*	*-34,276*	*-30,727*	*-33,563*	*-34,934*	*-27,173*
- *dom*	*-1,219*	*-1,219*	*-1,219*	*-1,219*	*-785*	*-785*	*-785*	*-785*
- *soils*	*-264*	*-390*	*-573*	*-786*	*-802*	*-808*	*-817*	*-827*
2013 submission								
Forest land	**-17,282**	**-32,369**	**-26,989**	**-36,388**	**-33,541**	**-36,641**	**-38,247**	**-29,544**
- *living biomass*	*-15,597*	*-30,301*	*-24,841*	*-33,858*	*-31,004*	*-34,025*	*-35,575*	*-27,017*
- *dom*	*-1,429*	*-1,699*	*-1,605*	*-1,769*	*-1,722*	*-1,782*	*-1,816*	*-1,658*
- *soils*	*-256*	*-369*	*-543*	*-760*	*-816*	*-834*	*-857*	*-869*

[30] Average value on the period 1990-2011
[31] Average value on the period 1990-2011

7.2.8 Category-specific planned improvements

The implementation of the III national forest inventory, which has already completed the first phase related to forest area assessment, is increasing the robustness of the data sources used in the estimation process. The third NFI, which has the same sampling design of the previous one, is a three-phase inventory. In particular the field surveys, related to the qualitative and quantitative attributes measurements, will allow using of IPCC carbon stock change method to estimate emissions and removals for forest land remaining forest land category. In addition a comparison between the two IPCC methods (carbon stock change versus gains-losses) could be undertaken; the comparison is a valuable verification exercise and is able to highlight any potential outlier which detaches the two estimates.

The 'National Registry for Carbon sinks', established by a Ministerial Decree on 1st April 2008, is part of National Greenhouse Gas Inventory System in Italy (ISPRA, 2011 [a]) and includes information on units of lands subject of activities under Article 3.3 and activities elected under Article 3.4 and related carbon stock changes. The National Registry for Carbon sinks is the instrument to estimate, in accordance with the COP/MOP decisions, the IPCC Good Practice Guidance on LULUCF and every relevant IPCC guidelines, the greenhouse gases emissions by sources and removals by sinks in forest land and related land-use changes and to account for the net removals in order to allow the Italian Registry to issue the relevant amount of RMUs. In 2009, a technical group, formed by experts from different institutions (ISPRA; Ministry of the Environment, Land and Sea; Ministry of Agriculture, Food and Forest Policies and University of Tuscia), set up the methodological plan of the activities necessary to implement the registry and defined the relative funding. Some of these activities (in particular IUTI, inventory of land use) has been completed, resulting in land use classification, for all national territory, for the years 1990, 2000 and 2008. After a process of validation and verification, the IUTI data has been used in the current submission. An update of the for-est model has been done; the II NFI (INFC2005) data related to the litter carbon content, collected in the framework of INFC2005 surveys, have been implemented in the model and land use and land use changes assessment has been carried out through the use of IUTI results.

For the LULUCF sector, following the election of 3.4 activities and on account of an in-depth analysis on the information needed to report LULUCF under the Kyoto Protocol, a Scientific Committee, *Comitato di Consultazione Scientifica del Registro dei Serbatoi di Carbonio Forestali*, constituted by the relevant national experts has been established by the Ministry for the Environment, Land and Sea in cooperation with the Ministry of Agriculture, Food and Forest Policies. In addition, in 2013, the joint project "ITALI" (*Integration of Territorial And Land Information*) has started its activities; the project, coordinated by the National Institute of Statistics and promoted by EUROSTAT[32], involves ISPRA, the Ministry of Agriculture, Food and Forest Policies, the National Forestry Service and the SIN (*Sistema Informativo Nazionale per lo sviluppo dell'agricoltura*) and is aimed to supply national statistics related to land use and land cover, harmonising and improving the current informative bases already available in the country.

An expert panel on forest fires has been set up, in order to obtain geographically referenced data on burned area; the overlapping of land use map and georeferenced data should assure the estimates of burned areas in the different land uses. The fraction of CO_2 emissions due to forest fires, now included in the estimate of the forest land remaining forest land, will be pointed out.

In addition to these expert panels, ISPRA participates in technical working groups, denominated *Circoli di qualità*, within the National Statistical System (Sistan). Concerning the LULUCF sector, this group, coordinated by the National Institute of Statistics, includes both producers and users of statistical information with the aim of improving and monitoring statistical information for the forest sector. These activities should improve the quality and details of basic data, as well as enable a more organized and timely communication.

[32] Eurostat is the statistical office of the European Union: http://epp.eurostat.ec.europa.eu/portal/page/portal/about_eurostat/introduction

7.3 Cropland (5B)

7.3.1 Description

Under this category, CO_2 emissions from living biomass, dead organic matter and soils, from cropland remaining cropland and from land converted in cropland have been reported.
Cropland removals share 9.4% of total CO_2 2011 LULUCF emissions and removals; in particular the living biomass removals represent 73.6%, while the emissions and removals from soils stand for 26.4% of total cropland CO_2 emissions and removals.
CO_2 emissions and removals from cropland remaining cropland have been identified as key category in level and in trend assessment either by Approach 1 and Approach 2. CO_2 emissions and removals from land converting to cropland have been not identified as key category. Concerning N_2O emissions, the category land converting to cropland has not resulted as a key source.

7.3.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Following 2013 ERT's finding, plantations, previously included into cropland category, have been allocated in forest land category. For the land use conversion, land use change matrices have been used; as abovementioned, LUC matrices for each year of the period 1990–2012 have been assembled on the basis of the IUTI data, related to 1990, 2000 and 2008, and the results of the NFI (related to 2012). Annual figures for areas in transition between different land uses have been derived by a hierarchy of basic assumptions (informed by expert judgement) of known patterns of land-use changes in Italy as well as the need for the total national area to remain constant. Concerning cropland category, it has been assumed that only transition from grassland to cropland occurs. In response to 2011 ERT's recommendation, Italy has decided to use the IPCC default land use transition period of 20 years, in the estimation process of carbon stock changes in mineral soils related to land converting to cropland; once a land has converted to a land use category, the annual changes in carbon stocks in mineral soils have been reported for 20 years subsequent the conversion.
Furthermore land use changes have been derived, by the way of land use change matrices, smoothing the amount of changes over a 5 year period, harmonizing the whole time series, resulting in a constant amount of C stock change in the 5 year period, following a previous review remark.

7.3.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Cropland areas have been assessed on the basis of IUTI assessment; due to the technical characteristics of the IUTI assessment (i.e. classification of orthophotos for 1990, 2000 and 2008), it was technically impossible to have a clear distinction among some subcategories in *cropland* and *grassland* categories (i.e. annual pastures versus grazing land). Therefore it has been decided to aggregate the *cropland* and *grassland* categories, as detected by IUTI, and then disaggregate them into the different subcategories, using as proxies the national statistics (ISTAT, [b], [c]) related to annual crops and perennial woody crops. National statistics on cropland areas have been used, in order to derive the land in conversion from grassland to cropland, by the way of land use change matrices, following the assumption that transition into cropland category occurs only from grassland category.

7.3.4 Methodological issues

Cropland includes all annual and perennial crops; the change in biomass has been estimated only for perennial crops, since, for annual crops, the increase in biomass stocks in a single year is assumed equal to biomass losses from harvest and mortality in that same year. Activity data for cropland remaining cropland have been subdivided into annual and perennial crops. Carbon stock changes due to annual conversion from one cropland subcategory to another (i.e. annual crops to perennial woody crops) have not been assessed, coherently with the IPCC GPG for LULUCF.

Perennial – woody crops

Concerning woody crops, estimates of carbon stocks changes are applied to aboveground biomass only, according to the GPG (IPCC, 2003). To assess change in carbon in cropland biomass, the Tier 1 based on highly aggregated area estimates for generic perennial woody crops, has been used. The carbon stock change in living biomass has been estimated on the basis of carbon gains and losses, computed applying a value of biomass C stock at maturity. The default factors of aboveground biomass carbon stock at harvest, harvest/maturity cycle, biomass accumulation rate, biomass carbon loss, for the temperate climatic region, are not very representative of the Mediterranean area, where the most common woody crops are crops like olive groves or vineyards that have different harvest/maturity cycles. Therefore, in the absence of country specific values, and following the suggestion of Joint Research Centre (JRC[33]) experts, in the framework of European Union QA/QC checks of the Member States' inventories for the preparation of EU greenhouse gas inventory, an average value of 10 t C ha^{-1} (carbon stock at maturity), deduced by the values adopted in Spain, has been chosen (JRC, 2013). A cycle of 20 years has been considered.

Net changes in cropland C stocks obtained are equal to -189 Gg C for 1990, and -840 Gg C for 2012, as far as living biomass pool is concerned. In Table 7.16 change in carbon stock in living biomass are reported.

Table 7.16 Change in carbon stock in living biomass

	Area	**Gains (Area <30yrs)**		**Losses**		**net change in C stock**
year	*kha*	*kha*	*GgC*	*kha*	*GgC*	*GgC*
1990	2,698	70	35	-22	-224	-189
1991	2,701	58	29	0	0	29
1992	2,704	49	25	0	0	25
1993	2,707	40	20	0	0	20
1994	2,710	32	16	0	0	16
1995	2,712	23	11	0	0	11
1996	2,691	14	7	-21	-212	-206
1997	2,670	14	7	-21	-213	-206
1998	2,648	14	7	-21	-213	-206
1999	2,627	14	7	-21	-213	-206
2000	2,606	14	7	-21	-213	-206
2001	2,600	14	7	-6	-57	-50
2002	2,594	14	7	-6	-57	-50
2003	2,589	14	7	-6	-57	-50
2004	2,583	14	7	-6	-57	-50
2005	2,577	14	7	-6	-57	-50
2006	2,578	14	7	0	0	7
2007	2,579	14	7	0	0	7
2008	2,579	15	8	0	0	8
2009	2,577	16	8	-2	-25	-17
2010	2,574	16	8	-2	-25	-17
2011	2,490	16	8	-85	-846	-838
2012	2,405	13	7	-85	-846	-840

According to the LULUCF GPG (IPCC, 2003), the change in soil C stocks (Equation 3.3.4) is the result of a change in practices or management between the two time periods and concentration of soil carbon is only driven by the change in practice or management. It wasn't possible to point out different sets of relative stock change factors [F_{LU} (land use), F_{MG} (management), F_I (input factor)] for the period 1990-2012 under investigation; therefore, as no management changes can be documented, resulting change in carbon stock has been reported as zero.

CO_2 emissions from cultivated organic soils (CRPA, 1997) in cropland remaining cropland have been estimated, using default emission factor for warm temperate, reported in Table 3.3.5 of IPCC GPG; the IPCC

[33] European Commission's Joint Research Centre (JRC) - Institute for Environment and Sustainability (IES): http://ies.jrc.ec.europa.eu/

default EF for cultivated organic soils is equal to 10 t C ha^{-1} y^{-1}. The area of organic soils has been updated on the basis of the data reported in the FAOSTAT[34] database; these FAOSTAT assessement have been carried out through the stratification of different global datasets:

- the area covered by organic soils have been defined by extracting the Histosols classes from the *Harmonized World Soil Database*[35]
- the cultivated area has been identified from the global land cover dataset, GLC2000[36], using the three “cropland” classes.

CO_2 emissions from urea application have been estimated, and reported in the following Table 7.17; it has to be noticed that CRF Reporter doesn’t allow reporting such a contribution to overall emissions, and therefore these emissions are not included in the current submission.

Table 7.17 CO_2 emissions from urea application

	amount of urea *Mg*	EF *t* C^{-1}	C emissions *Gg C*	CO_2 emissions *Gg C*
1990	633,873	0.20	127	465
1991	708,148	0.20	142	519
1992	731,357	0.20	146	536
1993	848,043	0.20	170	622
1994	802,345	0.20	160	588
1995	698,251	0.20	140	512
1996	598,943	0.20	120	439
1997	716,463	0.20	143	525
1998	717,711	0.20	144	526
1999	751,223	0.20	150	551
2000	716,412	0.20	143	525
2001	735,310	0.20	147	539
2002	763,930	0.20	153	560
2003	770,412	0.20	154	565
2004	785,515	0.20	157	576
2005	691,255	0.20	138	507
2006	735,487	0.20	147	539
2007	732,213	0.20	146	537
2008	679,390	0.20	136	498
2009	506,694	0.20	101	372
2010	456,951	0.20	91	335
2011	478,306	0.20	96	351
2012	751,235	0.20	150	551

Land converted to Cropland

In accordance with the GPG methodology, estimates of carbon stock change in living biomass have been provided. Italy uses the IPCC default land use transition period of 20 years, to estimate carbon stock changes in mineral soils related to land converted to cropland; once a land has converted to cropland, the annual changes in carbon stocks in mineral soils have been reported for 20 years subsequent the conversion.

N_2O emissions arising from the conversion of land to cropland have been also estimated, and reported in Table 5(III) - N_2O emissions from disturbance associated with land-use conversion to cropland.

The carbon stocks change, for land converted to cropland, is equal to the carbon stocks change due to the removal of biomass from the initial land use plus the carbon stocks from one year of growth in cropland

[34] FAOSTAT database: http://faostat3.fao.org/faostat-gateway/go/to/download/G1/GV/E

[35] FAO/IIASA/ISRIC/ISSCAS/JRC, 2012. Harmonized World Soil Database (version 1.2). FAO, Rome, Italy and IIASA, Laxenburg, Austria.

[36] EC-JRC. 2003. Global Land Cover 2000 database. Available at http://bioval.jrc.ec.europa.eu/products/glc2000/glc2000.php

following the conversion. The Tier 1 has been followed, assuming that the amount of biomass is cleared and some type of cropland system is planted soon thereafter. At Tier 1, carbon stocks in biomass immediately after the conversion are assumed to be zero.

The average area of land undergoing a transition from non cropland, only grassland as far as Italy is concerned, to cropland, during each year, from 1990 to 2012, has been estimated through the construction of the land use change matrices, one for each year. The GPG equation 3.3.8 (IPCC, 2003) has been used to estimate the change in carbon stocks resulting from the land use change. The carbon stocks change per area for land converted to cropland is assumed, following the Tier1, equal to loss in carbon stocks in biomass immediately before conversion to cropland.

For the Italian territory, only conversion from grassland to cropland has occurred; therefore the default estimates for standing biomass grassland, as dry matter, reported in Table 3.4.2 of GPG (IPCC, 2003) for warm temperate – dry have been used, equal to 1.6 t d.m. ha^{-1}. Changes in carbon stocks from one year of cropland growth have been obtained by the default biomass carbon stocks reported in Table 3.3.8, for temperate region. In accordance to national expert judgement, it has been assumed that the final crop type, for the areas of transition land, is annual cropland; this assumption has been made on the basis of known patterns of land-use changes in Italy.

As pointed out in the land use matrices reported above, in Table 7.3, conversion of lands into cropland has taken place only in a few years during the period 1990-2012. C emissions [Gg C] due to change in carbon stocks in living biomass in land converted to cropland are reported in Table 7.18.

Table 7.18 Change in carbon stock in living biomass in land converted to cropland

	Conversion Area		Δ**C** $_{\text{converted land}}$
	annual change	*20 years change*	
year	*kha*	*kha*	*Gg C*
1990	0	136	0
1991	16.8	153	21.8
1992	16.8	170	21.8
1993	16.8	186	21.8
1994	16.8	203	21.8
1995	16.8	220	21.8
1996	0	193	0
1997	0	166	0
1998	0	138	0
1999	0	111	0
2000	0	84	0
2001	0	84	0
2002	0	84	0
2003	0	84	0
2004	0	84	0
2005	0	84	0
2006	0	84	0
2007	0	84	0
2008	0	84	0
2009	0	84	0
2010	0	84	0
2011	0	67	0
2012	0	50	0

Changes in carbon stocks in mineral soils in land converted to cropland have been estimated following land use changes, resulting in a change of the total soil carbon content, with a land use transition period of 20 years. Initial land use soil carbon stock [$SOC_{(0-T)}$] and soil carbon stock in the inventory year [SOC_0] for the cropland area have been estimated from the reference carbon stocks.

SOC reference value for cropland has been set to 56.7 tC/ha on the basis of reviewed references. This value has been drawn up by analysing a collection of the latest papers reporting data on soil carbon under the most common agricultural practices in Italy, including woody cropland cultivations such as vineyards and olive orchards (Triberti *et al* 2008, Ceccanti *et al* 2008, Monaco *et al* 2008, Martiniello 2007, Lugato and Berti

2008, Francaviglia et al., 2006, IPLA 2007, ERSAF 2008, Del Gardo *et al* 2003, Puglisi *et al*, 2008, Lagomarsino *et al* 2009, Perucci *et al* 2008).
Whenever the soil carbon stock was not reported in the papers, it has been calculated at the default depth of 30 cm from the soil carbon content, the bulk density, and the stoniness according to the following formula (Batjes 1996):

$$T_d = \sum_{i=1}^{K} \rho_i \cdot P_i \cdot D_i \cdot (1 - S_i)$$

where

T_d is the overall soil carbon stock (gcm^{-2}) and, for each K layer of the soil profile, ρ_i is the soil bulk density (gcm^{-3}), P_i is the soil carbon content (gCg^{-1}), D_i is the layer thickness (cm), S_i is the fraction of gravel > 2mm.
If not available in the papers, soil bulk density has been calculated on the basis of the soil organic matter and texture (Adam 1973):

$$\rho = \frac{100}{\left(\frac{X}{\rho_0}\right) + \left(\frac{100 - X}{\rho_m}\right)}$$

where

ρ, soil bulk density (gcm^{-3}); X, percent by weight of organic matter; ρ_0, average bulk density of organic matter (0.224 gcm^{-3}) and ρ_m, bulk density of the mineral matter usually estimated at 1.33 gcm^{-3} or determined on the "mineral bulk density chart" (Rawls and Brakensiek, 1985).
Since soil carbon stocks are derived from experimental measurements under some representative cropland management systems, the effect of the practices is intended to be included into the values and consequently no stock change factors (F_{LU}, F_{MG}, F_I) have been applied on the soil carbon stock. Each soil carbon stock was assigned to the geographical area where the relative soil carbon content has been measured and the overall values have been averaged by means of weights resulting from the proportional relevance of the investigated area (ha) over the entire Italian territory.
The annual change in carbon stocks in mineral soils has been, at last, assessed as described in the equation 3.3.3 of the GPG (IPCC, 2003). C emissions [Gg C] due to change in carbon stocks in soils in land converted to cropland are reported in Table 7.19.

Table 7.19 Change in carbon stock in soil in land converted to cropland

	Conversion Area		**Carbon stock**
	annual change	*20 years change*	
year	*kha*	*kha*	*Gg C*
1990	0	136	-145.6
1991	16.8	153	-163.6
1992	16.8	170	-181.5
1993	16.8	186	-199.5
1994	16.8	203	-217.4
1995	16.8	220	-235.3
1996	0	193	-206.2
1997	0	166	-177.1
1998	0	138	-147.9
1999	0	111	-118.8
2000	0	84	-89.7
2001	0	84	-89.7
2002	0	84	-89.7
2003	0	84	-89.7
2004	0	84	-89.7
2005	0	84	-89.7
2006	0	84	-89.7
2007	0	84	-89.7
2008	0	84	-89.7

2009	0	84	-89.7
2010	0	84	-89.7
2011	0	67	-71.8
2012	0	50	-53.8

7.3.5 Uncertainty and time series consistency

Uncertainty estimates for the period 1990–2012 have been assessed following Approach 1 of 2006 IPCC Guidelines (IPCC, 2006). The table reporting the uncertainties referring to the category cropland is shown in Annex 1. Input uncertainties deal with activity data and emission factors have been assessed on the basis of the information provided in the IPCC Good Practice Guidance for LULUCF (IPCC, 2003).
A Montecarlo analysis has been carried out to assess uncertainty for Cropland category (considering both Cropland remaining Cropland and Land converted to Cropland). For Cropland remaining Cropland, an asymmetrical probability density distribution resulted from the analysis, showing uncertainties values equal to -108.5% and 210.2%, taking into account all the carbon pools estimated. As for Land converted to Cropland, an asymmetrical probability density distribution resulted from the analysis, showing uncertainties values equal to -408.2% and 178.5%. Normal distributions have been assumed for most of the parameters. A more detailed description of the results is reported in Annex 1.

7.3.6 Category-specific QA/QC and verification

Systematic quality control activities have been carried out in order to ensure completeness and consistency in time series and correctness in the sum of sub-categories; where possible, activity data comparison among different sources (FAO database[37], ISTAT data[38]) has been made. Data entries have been checked several times during the compilation of the inventory; particular attention has been focussed on the categories showing significant changes between two years in succession. Land use matrices have been accurately checked and cross-checked to ensure that data were properly reported. Several QA activities are carried out in the different phases of the inventory process. In particular the applied methodologies have been presented and discussed during several national workshop and expert meeting, collecting findings and comments to be incorporated in the estimation process. All the LULUCF categories have been embedded in the overall QA/QC-system of the Italian GHG inventory.

7.3.7 Category-specific recalculations

Recalculations of emissions and removals have been carried out on the basis of LULUCF Good Practice Guidance (IPCC, 2003). The comparison with the previous sectoral estimates results in remarkable deviation, as may be noted from the 2014 and 2013 data reported in the Table 7.20. The significant deviation is mainly due to the exclusion of plantations from cropland category and the subsequent allocation in the forest land category. Additional causes for the noted deviation are related to update of activity data related to organic soils and to the change in change in the data source used to assess land use and land use changes. Differences from the previous sectoral estimates are equal to an average[39] increase of 129.2%, concerning the 2011.

[37] FAO, 2005. FAOSTAT, http://faostat.fao.org
[38] ISTAT, several years [a], [b], [c]
[39] Average value on the period 1990-2011

Table 7.20 Comparison of the 2014 and 2013 submissions for the Cropland category

	1990	1995	2000	2005	2008	2009	2010	2011
2014 submission				*CO_2 eq. - Gg*				
Cropland	**2,132**	**1,647**	**1,990**	**1,418**	**1,206**	**1,296**	**1,296**	**4,243**
- *living biomass*	*693*	*-122*	*756*	*184*	*-28*	*62*	*62*	*3,074*
- *dom*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
- *soils*	*1,439*	*1,768*	*1,234*	*1,234*	*1,234*	*1,234*	*1,234*	*1,168*
2013 submission								
Cropland	**-1,155**	**697**	**-605**	**-1,001**	**-1,082**	**-1,185**	**-1,208**	**3,300**
- *living biomass*	*-2,244*	*-411*	*-1,174*	*-1,569*	*-1,489*	*-1,537*	*-1,505*	*2,930*
- *dom*	*-53*	*-44*	*-44*	*-45*	*-41*	*-42*	*-42*	*-32*
- *soils*	*1,142*	*1,151*	*613*	*613*	*449*	*394*	*339*	*402*

7.3.8 Category-specific planned improvements

Additional research will be carried out to collect more country-specific data on woody crops. Improvements will concern the implementation of the estimate of carbon change in cropland biomass at a higher disaggregated level, with the subdivision of the activity data in the main categories of woody cropland (orchards, citrus trees, vineyards, olive groves) and the application of different biomass accumulation rates and harvest/maturity cycles for the various categories.
In addition, in 2013, the joint project “ITALI” (*Integration of Territorial And Land Information*) has started its activities; the project, coordinated by the National Institute of Statistics and promoted by EUROSTAT[40], involves ISPRA, the Ministry of Agriculture, Food and Forest Policies, the National Forestry Service and the SIN (*Sistema Informativo Nazionale per lo sviluppo dell’agricoltura*) and is aimed to supply national statistics related to land use and land cover, harmonising and improving the current informative bases already available in the country.

7.4 Grassland (5C)

7.4.1 Description

Under this category, CO_2 emissions from living biomass, dead organic matter and soils, from grassland remaining grassland and from land converted in grassland have been reported.
Grassland category is responsible for 3,053 Gg of CO_2 removals in 2012, sharing 6.8% of absolute CO_2 LULUCF emissions and removals; in particular the living biomass emissions represent 2.6%, while the removals from dead organic matter pool share for 1.5% and removals from soils stand for 96.0% of absolute total grassland CO_2 emissions and removals.
CO_2 emissions and removals from grassland remaining grassland and from land converting to grassland have resulted as key category, concerning trend analysis, either by Approach 1 and Approach 2.

7.4.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Coherently with the forest definition adopted by Italy in the framework of application of elected 3.4 activities, under Kyoto Protocol, shrublands have been reported into the grassland category, as they don’t fulfil the national forest definition. For the land use conversion, land use change matrices have been used; as abovementioned, LUC matrices for each year of the period 1990–2012 have been assembled on the basis of the IUTI data, related to 1990, 2000 and 2008, and the results of the III NFI (related to 2012). Annual figures

[40] Eurostat is the statistical office of the European Union: http://epp.eurostat.ec.europa.eu/portal/page/portal/about_eurostat/introduction

for areas in transition between different land uses have been derived by a hierarchy of basic assumptions (informed by expert judgment) of known patterns of land-use changes in Italy as well as the need for the total national area to remain constant. Concerning grassland category, it has been assumed that only transition from cropland to grassland occurs. Italy uses the IPCC default land use transition period of 20 years, in the estimation process of carbon stock changes in mineral soils related to land converting to grassland; once a land has converted to a land use category, the annual changes in carbon stocks in mineral soils have been reported for 20 years subsequent the conversion.
Furthermore land use changes have been derived, by the way of land use change matrices, smoothing the amount of changes over a 5 year period, harmonizing the whole time series, resulting in a constant amount of C stock change in the 5 year period, following a previous review remark.

7.4.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Grassland areas have been assessed on the basis of IUTI assessment; due to the technical characteristics of the IUTI assessment (i.e. classification of orthophotos for 1990, 2000 and 2008), it was technically impossible to have a clear distinction among some subcategories in *cropland* and *grassland* categories (i.e. annual pastures versus grazing land). Therefore it has been decided to aggregate the *cropland* and *grassland* categories, as detected by IUTI, and then disaggregate them into the different subcategories, using as proxies the national statistics (ISTAT, [b], [c]) related to grazing lands, forage crops, permanent pastures, and lands once used for agriculture purposes, but in fact set-aside since 1970. The subcategory “shrublands” has been added; shrublands areas have been derived from national forest inventories (IFN, IFNC2005 and the ongoing INFC2015), through linear interpolations for the periods 1985-2005, 2005-2012. National statistics on cropland areas have been used, in order to derive the land in conversion from cropland to grassland, by the way of LUC matrix, following the assumption that transition into cropland category occurs only from grassland category.

7.4.4 Methodological issues

Grassland remaining Grassland
Grassland includes all grazing land and other wood land that do not fulfil the forest definition (as shrublands); the change in biomass has been estimated only for subcategory “other wooded land”, since, for grazing land, the increase in biomass stocks in a single year is assumed equal to biomass losses from harvest and mortality in that same year. Activity data for grassland remaining grassland have been subdivided into grazing land and other wooded land.

Grazing land
To assess change in carbon in grassland biomass, the Tier 1 has been used; therefore no change in carbon stocks in the living biomass pool has been assumed; in accordance with the GPG no data regarding the dead organic matter pool have been provided, since not enough information is available.
According to the LULUCF GPG (IPCC, 2003), the estimation method is based on changes in soil C stocks over a finite period following changes in management that impact soil C (Equation 3.4.8). Soil C concentration for grassland systems is driven by the change in practice or management, reflecting in different specific climate, soil and management combination, applied for the respective time points. It wasn’t possible to point out different sets of relative stock change factors [F_{LU} (land use), F_{MG} (management), F_I (input factor)] for the period 1990-2012 under investigation; therefore, as no management changes can be documented, resulting change in carbon stock has been reported as zero.
No CO_2 emissions from organic soils or from application of carbonate containing lime have occurred.

Other wooded land
Regarding shrublands, growing stock and the related carbon are assessed by the For-est model, estimating the evolution in time of the different pools and applied at regional scale (NUTS2). A detailed description of the model is reported in the paragraph 7.2.4.
The aboveground biomass was calculated, for shrublands, through the relation:

$$\text{Aboveground tree biomass (d.m.)} = GS \cdot BEF \cdot WBD \cdot A$$

where:
GS = volume of growing stock (MAF/ISAFA, 1988) [m^3 ha^{-1}]
BEF = Biomass Expansion Factors which expands growing stock volume to volume of aboveground woody biomass (ISAFA, 2004)
WBD = Wood Basic Density for conversions from fresh volume to dry weight (d.m.) [t m^{-3}] (Giordano, 1980)
A = area occupied by specific typology [ha] (MAF/ISAFA, 1988)

In Table 7.21 biomass expansion factors for the conversions of volume to aboveground tree biomass and wood basic densities are reported.

Table 7.21 Biomass Expansion Factors and Wood Basic Densities for shrublands

Inventory typology	BEF *aboveground biomass / growing stock*	WBD *Dry weigth t/ fresh volume*
shrublands	1.49	0.63

Belowground biomass was estimated applying a Root/Shoot ratio to the aboveground biomass. The belowground biomass is computed, as:

$$\text{Belowground biomass (d.m.)} = GS \cdot BEF \cdot WBD \cdot R \cdot A$$

where:
GS = volume of growing stock [m^3 ha^{-1}]
BEF = Biomass Expansion Factors which expands growing stock volume to volume of aboveground woody biomass (ISAFA, 2004)
R = Root/Shoot ratio which converts growing stock biomass in belowground biomass
WBD = Wood Basic Density [t d.m. m^{-3}]
A = area occupied by specific typology [ha]
The Root/shoot ratio and WBD were estimated on the basis of different studies conducted at the national and local level in different years and contexts, and then included in the JRC-AFOLU database[41]. Further details are reported in par. 7.2.4.
In Table 7.22 Root/shoot ratio for the conversion of growing stock biomass in belowground biomass and wood basic density for shrubland are reported.

Table 7.22 Root/Shoot ratio and Wood Basic Densities for shrubland

Inventory typology	R *Root/shoot ratio*	WBD *Dry weigth t/ fresh volume*
Shrublands	0.62	0.63

Dead wood mass has been estimated using coefficients calculated from outcomes of a survey conducted by the Italian national forest inventory (Di Cosmo et al., 2013). The values used, aggregated at regional level, may be found on the INFC website: http://www.sian.it/inventarioforestale/jsp/dati_carquant_tab.jsp.
In Table 7.23 Dead wood coefficients are reported.
The dead wood [t] is:

$$\text{Dead wood (d.m.)} = DC \cdot A$$

where:
DC = Dead-wood expansion factor (dead/live ratio – dry matter) [t ha^{-1}]
A = forest area occupied by specific typology [ha]

[41] European Commission - Joint Research Centre, Institute for Environment and Sustainability, AFOLU DATA clearinghouse: Allometric Biomass and Carbon (ABC) factors database: http://afoludata.jrc.ec.europa.eu/index.php/public_area/data_and_tools

Table 7.23 Dead-wood expansion factor [live/dead ratio]

Inventory typology	dead wood (dry matter) *t ha⁻¹*
Shrublands	1.510

Carbon amount contained in litter pool has been estimated using the values of litter carbon content assessed by the Italian national forest inventory. The values used, aggregated at regional level, may be found on the INFC website: http://www.sian.it/inventarioforestale/jsp/dati_carquant_tab.jsp. The average value of litter organic carbon content, for Italy, is equal to 1.990 t C ha^{-1}.
As for soils pool, following the ERT recommendation, Italy has decided to apply the IPCC Tier1, assuming that, the carbon stock in soil organic matter, for shrubland, does not change. Therefore carbon stock changes in soils pool, for grassland remaining grassland, have been not reported.
In Table 7.24, other wooded land areas and net changes in carbon stock, for the different required pools, are reported, for the period 1990-2012.

Table 7.24 Change in carbon stock in living biomass, dead organic matter and soil organic matter in other wooded land

	Area	Living biomass			Dead organic matter	Soil organic matter
		Increase	*Decrease*	*Net Change*		
	kha			*Gg C*		
1990	1,555	2,466	-2,584	-118.25	32.19	0
1991	1,571	2,503	-2,355	148.13	32.19	0
1992	1,586	2,543	-2,486	57.35	32.19	0
1993	1,602	2,593	-2,851	-258.42	32.19	0
1994	1,618	2,630	-2,506	124.55	32.19	0
1995	1,634	2,660	-2,294	366.49	32.19	0
1996	1,650	2,691	-2,327	363.67	32.19	0
1997	1,666	2,726	-2,513	213.00	32.19	0
1998	1,682	2,764	-2,686	78.31	32.19	0
1999	1,698	2,795	-2,453	342.24	32.19	0
2000	1,713	2,830	-2,619	210.50	32.19	0
2001	1,729	2,860	-2,504	356.61	32.19	0
2002	1,745	2,889	-2,461	427.71	32.19	0
2003	1,761	2,919	-2,557	361.40	32.19	0
2004	1,777	2,947	-2,507	439.61	32.19	0
2005	1,793	2,974	-2,510	464.00	32.19	0
2006	1,804	3,000	-2,502	498.28	26.50	0
2007	1,816	3,030	-3,057	-26.92	26.50	0
2008	1,827	3,046	-2,586	459.81	26.50	0
2009	1,839	3,064	-2,660	403.54	26.50	0
2010	1,850	3,079	-2,622	457.10	26.50	0
2011	1,862	3,100	-2,851	249.34	26.50	0
2012	1,873	3,118	-2,713	404.94	26.50	0

Land converted to Grassland
The assessment of emissions and removals of carbon due to conversion of other land uses to grassland requires estimates of the carbon stocks prior to and following conversion and the estimates of land converted during the period over which the conversion has an effect.
In accordance with the GPG methodology, estimates of carbon stock change in living biomass have been provided. Concerning soil carbon pool, Italy uses the IPCC default land use transition period of 20 years, to estimate carbon stock changes in mineral soils related to land converted to grassland; once a land has converted to grassland, the annual changes in carbon stocks in mineral soils have been reported for 20 years subsequent the conversion. As a result of conversion to grassland, it is assumed that the dominant vegetation

is removed entirely, after which some type of grass is planted or otherwise established; alternatively grassland can result from the abandonment of the preceding land use, and the area is taken over by grassland. The Tier 1 has been followed, assuming that carbon stocks in biomass immediately after the conversion are equal to 0 t C ha^{-1}.

The annual area of land undergoing a transition from non grassland to grassland during each year has been pointed out, from 1990 to 2012, for each initial and final land use, through the use of the land use change matrices, one for each year. The GPG equation 3.4.13 (IPCC, 2003) has been used to estimate the change in carbon stocks, resulting from the land use change. Concerning Italian territory, only conversion from cropland to grassland has occurred; therefore the default biomass carbon stocks present on land converted to grassland, as dry matter, as supplied by Table 3.4.9 of the GPG for warm temperate – dry, have been used, equal to 6.1 t d.m. ha^{-1}. Since, according to national expert judgement, it has been assumed that lands in conversion to grassland are mostly annual crops, carbon stocks in biomass immediately before conversion have been obtained by the default values reported in Table 3.3.8 of the GPG, for annual cropland.

As pointed out above in the land use matrices (see Table 7.3), the conversion of lands into grassland has taken place only in a few years during the period 1990-2012. C emissions [Gg C] due to change in carbon stocks in living biomass in land converted to grassland, are reported in Table 7.25.

Table 7.25 Change in carbon stock in living biomass in land converted to grassland

	Conversion Area		**C_{before}**	**ΔC_{growth}**	**ΔC**
	annual change	*20 years change*			
year	*kha*	*kha*	*t C ha^{-1}*	*t C ha^{-1}*	*Gg C*
1990	0	325	5	3.05	0
1991	0	318	5	3.05	0
1992	0	312	5	3.05	0
1993	0	305	5	3.05	0
1994	0	299	5	3.05	0
1995	0	292	5	3.05	0
1996	60	353	5	3.05	-118
1997	60	413	5	3.05	-118
1998	60	473	5	3.05	-118
1999	60	534	5	3.05	-118
2000	60	594	5	3.05	-118
2001	94	630	5	3.05	-184
2002	94	666	5	3.05	-184
2003	94	702	5	3.05	-184
2004	94	738	5	3.05	-184
2005	97	777	5	3.05	-190
2006	85	862	5	3.05	-166
2007	85	947	5	3.05	-166
2008	85	1,032	5	3.05	-166
2009	172	1,204	5	3.05	-336
2010	172	1,377	5	3.05	-336
2011	231	1,608	5	3.05	-451
2012	231	1,839	5	3.05	-451

Changes in carbon stocks in mineral soils in land converted to grassland have been estimated following land use changes, resulting in a change of the total soil carbon content, with a land use transition period of 20 years. Initial land use soil carbon stock [$SOC_{(0-T)}$] and soil carbon stock in the inventory year [SOC_0] for the grassland have been estimated from the reference carbon stocks.

SOC reference value for grassland has been revised and set to 78.9 tC ha^{-1} on the basis of reviewed references. It makes the current estimate consistent with the SOC stocks reported for grassland in temperate regions, 60-150 tC ha^{-1} (Gardi et al., 2007). This value has been drawn up by analysing a collection of the latest papers reporting data on soil carbon in mountain meadows, pastures, set-aside lands as well as soil not disturbed since the agricultural abandonment in Italy (Viaroli and Gardi 2004, CRPA 2009, IPLA 2007, ERSAF 2008, Del Gardo *et al* 2003, LaMantia *et al* 2007, Benedetti *et al* 2004, Masciandaro and Ceccanti 1999, Xiloyannis 2007).

Whenever the soil carbon stock was not reported in the papers, it has been calculated at the default depth of 30 cm from the soil carbon content, the bulk density, and the stoniness according to the following formula (Batjes 1996):

$$T_d = \sum_{i=1}^{K} \rho_i \cdot P_i \cdot D_i \cdot (1 - S_i)$$

where T_d is the overall soil carbon stock (gcm^{-2}) and, for each K layer of the soil profile, ρ_i is the soil bulk density (gcm^{-3}), P_i is the soil carbon content (gCg^{-1}), D_i is the layer thickness (cm), S_i is the fraction of gravel > 2mm. If not available in the papers, soil bulk density has been calculated on the basis of the soil organic matter and texture (Adam 1973):

$$\rho = \frac{100}{\left(\frac{X}{\rho_0}\right) + \left(\frac{100 - X}{\rho_m}\right)}$$

where ρ, soil bulk density (gcm^{-3}); *X*, percent by weight of organic matter; ρ_0, average bulk density of organic matter (0.224 gcm^{-3}) and ρ_m, bulk density of the mineral matter usually estimated at 1.33 gcm^{-3} or determined on the "mineral bulk density chart" (Rawls and Brakensiek, 1985).

Since soil carbon stocks are derived from experimental measurements under some representative cropland management systems, the effect of the practices is intended to be included into the values and consequently no stock change factors (F_{LU}, F_{MG}, F_I) have been applied on the soil carbon stock. Each soil carbon stock was assigned to the geographical area where the relative soil carbon content has been measured and the overall values have been averaged by means of weights resulting from the proportional relevance of the investigated area (ha) over the entire Italian territory.

The annual change in carbon stocks in mineral soils has been, at last, assessed as described in the equation 3.3.3 of the GPG. C emissions [Gg C] due to change in carbon stocks in soils in land converted to grassland, are reported in Table 7.26.

Table 7.26 Change in carbon stock in soils

	Conversion Area		**Carbon stock**
year	*annual change* *kha*	*20 years change* *kha*	*Gg C*
1990	0	325	348
1991	0	318	341
1992	0	312	334
1993	0	305	327
1994	0	299	320
1995	0	292	313
1996	60	353	377
1997	60	413	442
1998	60	473	506
1999	60	534	571
2000	60	594	635
2001	94	630	674
2002	94	666	712
2003	94	702	751
2004	94	738	789
2005	97	777	831
2006	85	862	922
2007	85	947	1,013
2008	85	1,032	1,104
2009	172	1,204	1,288
2010	172	1,377	1,473
2011	231	1,608	1,720
2012	231	1,839	1,720

7.4.5 Uncertainty and time series consistency

Uncertainty estimates for the period 1990–2012 have been assessed following Approach 1 of 2006 IPCC Guidelines (IPCC, 2006). The table reporting the uncertainties referring to the category grassland is shown in Annex 1. Input uncertainties deal with activity data and emission factors have been assessed on the basis of the information provided in the IPCC Good Practice Guidance for LULUCF (IPCC, 2003).
A Montecarlo analysis has been carried out to assess uncertainty for Grassland category (considering both Grassland remaining Grassland and Land converted to Grassland). For Grassland remaining Grassland, an asymmetrical probability density distribution resulted from the analysis, showing uncertainties values equal to -67.7% and 75.0%. An asymmetrical probability density distribution resulted from the analysis also for the subcategory Land converted to Grassland, showing uncertainties values equal to -119.3% and 194.5%. Normal distributions have been assumed for most of the parameters; whenever assumptions or constraints on variables were known this information has been appropriately reflected on the choice of type and shape of distributions. A more detailed description of the results is reported in Annex 1.

7.4.6 Category-specific QA/QC and verification

Systematic quality control activities have been carried out in order to ensure completeness and consistency in time series and correctness in the sum of sub-categories; where possible, activity data comparison among different sources (FAO database[42], ISTAT data[43]) has been made. Data entries have been checked several times during the compilation of the inventory; particular attention has been focussed on the categories showing significant changes between two years in succession. Land use matrices have been accurately checked and cross-checked to ensure that data were properly reported. Several QA activities are carried out in the different phases of the inventory process. In particular the applied methodologies have been presented and discussed during several national workshop and expert meeting, collecting findings and comments to be incorporated in the estimation process. All the LULUCF categories have been embedded in the overall QA/QC-system of the Italian GHG inventory.

7.4.7 Category-specific recalculations

Recalculations of emissions and removals have been carried out on the basis of LULUCF Good Practice Guidance (IPCC, 2003). The comparison with the previous sectoral estimates results in an average[44] increase of 9.1% in living biomass pool, in a decrease of 93.5% and 16.4% in dead organic matter and soils pool, respectively. The dead organic matter pool deviation is due to the update in the litter coefficients used in the estimation process, while the remaining deviations are resulting from the change in the data source used to assess land use and land use changes and errors' correction.

7.4.8 Category-specific planned improvements

Concerning land in transition to grassland, further investigation will be made to obtain additional information about different types of management activities on grassland, and the crop types of land converting to grassland, to obtain a more accurate estimate of the carbon stocks change.
In 2013, the joint project "ITALI" (*Integration of Territorial And Land Information*) has started its activities; the project, coordinated by the National Institute of Statistics and promoted by EUROSTAT[45], involves ISPRA, the Ministry of Agriculture, Food and Forest Policies, the National Forestry Service and the SIN (*Sistema Informativo Nazionale per lo sviluppo dell'agricoltura*) and is aimed to supply national statistics related to land use and land cover, harmonising and improving the current informative bases already available in the country.

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[42] FAO, 2005. FAOSTAT, http://faostat.fao.org
[43] ISTAT, several years [a], [b], [c]
[44] Average value on the period 1990-2011
[45] Eurostat is the statistical office of the European Union: http://epp.eurostat.ec.europa.eu/portal/page/portal/about_eurostat/introduction

7.5 Wetlands (5D)

7.5.1 Description

Under this category, activity data from wetlands remaining wetlands are reported.

7.5.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

For the land use conversion, land use change matrices have been used; as abovementioned, LUC matrices for each year of the period 1990–2012 have been assembled on the basis of the IUTI data, related to 1990, 2000 and 2008, and the results of the III NFI (related to 2012). Annual figures for areas in transition between different land uses have been derived by a hierarchy of basic assumptions (informed by expert judgement) of known patterns of land-use changes in Italy as well as the need for the total national area to remain constant.
Concerning land converted to wetland, during the period 1990-2012, cropland and grassland categories have been converted into wetlands area.

7.5.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Lands covered or saturated by water, for all or part of the year, have been included in this category (MAMB, 1992). No data were available on flooded lands, therefore reservoirs or water bodies regulated by human activities have not been considered.

7.5.4 Methodological issues

No estimates related to emissions of CO_2, CH_4 and N_2O from flooded lands have been supplied, as very few information on this source is available.

7.5.5 Category-specific planned improvements

Improvements will concern the acquirement of data about flooded lands and the implementation of the GPG method to estimate CO_2, CH_4 and N_2O emissions from flooded lands.

7.6 Settlements (5E)

7.6.1 Description

Under this category, activity data from settlements and from land converted to settlements are reported; CO_2 emissions, from living biomass and soil, from land converted in settlements have been also reported. In 2012, settlements emissions share 17.2% of absolute CO_2 LULUCF emissions and removals.
CO_2 emissions and removals from land converting to settlements have resulted as key category, concerning level and trend analysis, either by Approach 1 and Approach 2.

7.6.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

For the land use conversion, land use change matrices have been used; as abovementioned, LUC matrices for each year of the period 1990–2012 have been assembled on the basis of the IUTI data, related to 1990, 2000 and 2008, and the results of the III NFI (related to 2012). Annual figures for areas in transition between different land uses have been derived by a hierarchy of basic assumptions (informed by expert judgement) of known patterns of land-use changes in Italy as well as the need for the total national area to remain constant. The average area of land undergoing a transition from non-settlements to settlements during each year, from 1990 to 2012, has been estimated with the land use change matrices that have also permitted to specify the initial and final land use.
In response to ERT remark in the 2009 review, land use changes have been derived, by the way of LUC matrices, smoothing the amount of changes over a 5 year period, harmonizing the whole time series, resulting in a constant amount of C stock change in the 5 year period.

7.6.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

All artificial surfaces, transportation infrastructures (urban and rural), power lines and human settlements of any size, comprising also parks, have been included in this category.

7.6.4 Methodological issues

Settlements remaining Settlements
CO_2 estimates on the carbon stocks changes in living biomass, dead organic matter and soil for settlements remaining settlements haven't been submitted, due to the lack of information and data related to urban tree formations. Therefore only activity data have been reported.

Land converted to Settlements
The GPG equation 3.6.1 approach (IPCC, 2003) has been used to estimate the change in carbon stocks, resulting from the land use change. A 20-years transition period has been applied to determine the area in conversion to Settlements, while the related CO_2 emissions are assumed to happening in the year following the conversion, taking into account the nature of final land use category (Settlements) and assuming that soils organic matter content of previous land use category is lost in the conversion year. The annual change in carbon stocks, for land converted to settlements, is assumed equal to carbon stocks in living biomass immediately following conversion to settlements minus the carbon stocks in living biomass in land immediately before conversion to settlements, multiplied for the area of land annually converted. The default assumption, for Tier 1, is that carbon stocks in living biomass following conversion are equal to zero. As reported in Table 7.3, conversions from forest land, grassland and cropland and other land categories to settlements have occurred in the 1990-2012 period. Carbon stock changes related to forest land converted to settlements have been estimated, for each year and for each pool (living biomass, dead organic matter and soils), on the basis of forest land carbon stocks deduced from the model described in paragraph 7.2.4 and 10.3.1.2, concerning soils pool.
Concerning forest soils, the SOCs reported in the table 7.27 have been used; the time range reported in the first column of the abovementioned table provides the time references for the SOCs' use. A detailed description of the methodology used in the estimation process of soils pool, and consequently of the SOCs, is provided in par. 10.3.1.2, related to the KP-LULUCF.

Table 7.27 Soil Organic Content (SOC) values for *forest land remaining forest land*

years	**SOC** *t C ha^{-1}*
1985-1994	80.449
1995-1999	80.829
2000-2004	81.248
2005-2009	81.777
2010-2012	82.160

SOC reference value for grassland has been revised and set to 78.9 t C ha^{-1}, after a review of the latest papers reporting data on soil carbon in mountain meadows, pastures, set-aside lands as well as soil not disturbed since the agricultural abandonment, in Italy (Viaroli and Gardi 2004, CRPA 2009, IPLA 2007, ERSAF 2008, Del Gardo *et al* 2003, LaMantia *et al* 2007, Benedetti *et al* 2004, Masciandaro and Ceccanti 1999, Xiloyannis 2007). SOC reference value for cropland has been set to 56.7 tC/ha on the basis of reviewed references. This value has been drawn up by analysing a collection of the latest papers reporting data on soil carbon (Triberti *et al* 2008, Ceccanti *et al* 2008, Monaco *et al* 2008, Martiniello 2007, Lugato and Berti 2008, Francaviglia et al., 2006, IPLA 2007, ERSAF 2008, Del Gardo *et al* 2003, Puglisi *et al*, 2008, Lagomarsino *et al* 2009, Perucci *et al* 2008).
SOC reference value, for settlements category, has been assumed, using a conservative approach, to be zero.
In Table 7.28 C stocks [Gg C] related to change in carbon stocks in living biomass, dead organic matter and soils in forest land converted to settlements are reported.

Table 7.28 Change in carbon stocks in forest land converted to settlements

	Forest land to settlements				***Total Carbon***
Year	*Conversion Area*	*Living biomass*	*Dead organic matter*	*Soils*	***stock***
	kha	*Gg C*	*Gg C*	*Gg C*	*Gg C*
1990	0.72	-34.10	-3.14	-58.10	-95.34
1991	0.72	-34.42	-3.13	-58.10	-95.66
1992	0.72	-34.69	-3.13	-58.10	-95.93
1993	0.72	-34.70	-3.13	-58.10	-95.93
1994	0.72	-34.96	-3.13	-58.10	-96.20
1995	0.72	-35.30	-3.13	-58.38	-96.81
1996	0.72	-35.62	-3.12	-58.38	-97.13
1997	0.72	-35.78	-3.12	-58.38	-97.28
1998	0.72	-35.88	-3.12	-58.38	-97.38
1999	0.72	-36.11	-3.12	-58.38	-97.61
2000	0.72	-36.30	-3.12	-58.68	-98.10
2001	0.72	-36.62	-3.12	-58.68	-98.42
2002	0.72	-37.01	-3.11	-58.68	-98.80
2003	0.72	-37.26	-3.11	-58.68	-99.06
2004	0.72	-37.61	-3.11	-58.68	-99.40
2005	3.69	-194.19	-15.91	-302.13	-512.23
2006	3.69	-196.45	-15.90	-302.13	-514.47
2007	3.69	-196.95	-15.88	-302.13	-514.96
2008	3.69	-198.81	-15.87	-302.13	-516.80
2009	3.69	-200.89	-15.85	-302.13	-518.87
2010	3.69	-203.09	-15.84	-303.54	-522.47
2011	3.69	-204.47	-15.83	-303.54	-523.84
2012	3.69	-206.01	-15.81	-303.54	-525.37

Concerning grassland converted to settlements, change in carbon stocks has been computed only for soil pool, as, in Tier 1 approach, no change in carbon stocks in the grassland living biomass pool has been assumed. For what concerns cropland in transition to settlements, carbon stocks, for each year and for crops type (annual or perennial), have been estimated, using as default coefficients the factors shown in the following Table 7.29.

Table 7.29 Stock change factors for cropland

	Biomass carbon stock
	t C ha^{-1}
Annual cropland	5
Perennial woody cropland	10

In Table 7.30 C stocks [Gg C] related to change in carbon stocks in living biomass in cropland converted to settlements are reported.

Table 7.30 Change in carbon stocks in living biomass in cropland converted to settlements

Year	**Conversion Area** *kha*	**Carbon stock** *Gg C*
1990	25.15	-252
1991	0	0
1992	0	0
1993	0	0
1994	0	0
1995	0	0
1996	26.70	-267.01
1997	26.70	-267.01
1998	26.70	-267.01
1999	26.70	-267.01
2000	26.70	-267.01
2001	26.70	-267.01
2002	26.70	-267.01
2003	26.70	-267.01
2004	26.70	-267.01
2005	23.73	-237.29
2006	23.73	-237.29
2007	23.73	-237.29
2008	23.73	-237.29
2009	23.91	-239.09
2010	23.91	-239.09
2011	23.91	-239.09
2012	23.91	-239.09

Changes in soil carbon stocks from land converting to settlements have been also estimated. In Table 7.31 soil C stocks [Gg C] of cropland and grassland converted to settlements are reported.

Table 7.31 Change in carbon stocks in soil in cropland and grassland converted to settlements

	Cropland to settlements		**grassland to settlements**	
Year	*Conversion Area* *kha*	*Carbon stock* *Gg C*	*Conversion Area* *kha*	*Carbon stock* *Gg C*
1990	25.15	-1,426	1.73	-135
1991	0	0	26.70	-2,085
1992	0	0	26.70	-2,085
1993	0	0	26.70	-2,085
1994	0	0	26.70	-2,085
1995	0	0	26.70	-2,085
1996	26.70	-1,514	0	0
1997	26.70	-1,514	0	0
1998	26.70	-1,514	0	0
1999	26.70	-1,514	0	0
2000	26.70	-1,514	0	0
2001	26.70	-1,514	0	0
2002	26.70	-1,514	0	0
2003	26.70	-1,514	0	0
2004	26.70	-1,514	0	0
2005	23.73	-1,345	0	0
2006	23.73	-1,345	0	0
2007	23.73	-1,345	0	0
2008	23.73	-1,345	0	0
2009	23.91	-1,356	0	0
2010	23.91	-1,356	0	0
2011	23.91	-1,356	0	0
2012	23.91	-1,356	0	0

Concerning other land converted to settlements, change in carbon stocks has been not estimated, in line with the GPG (IPCC, 2003), as no change in carbon stocks in the other land has been assumed.

7.6.5 Uncertainty and time series consistency

Uncertainty estimates for the period 1990–2012 have been assessed following Approach 1 of 2006 IPCC Guidelines (IPCC, 2006). The table reporting the uncertainties referring to the category settlements is shown in Annex 1. Input uncertainties deal with activity data and emission factors have been assessed on the basis of the information provided in the IPCC Good Practice Guidance for LULUCF (IPCC, 2003).
A Montecarlo analysis has been carried out to assess uncertainty for Settlements category, resulting in an asymmetrical probability density distribution, with uncertainties values equal to -100.3% and 49.2%. Normal distributions have been assumed for most of the parameters; whenever assumptions or constraints on variables were known this information has been appropriately reflected on the choice of type and shape of distributions. A more detailed description of the results is reported in Annex 1.

7.6.6 Category-specific QA/QC and verification

Systematic quality control activities have been carried out in order to ensure completeness and consistency in time series and correctness in the sum of sub-categories; where possible, activity data comparison among different sources (FAO database[46], ISTAT data[47]) has been made. Data entries have been checked several times during the compilation of the inventory; particular attention has been focussed on the categories showing significant changes between two years in succession. Land use matrices have been accurately checked and cross-checked to ensure that data were properly reported. Several QA activities are carried out in the different phases of the inventory process. In particular the applied methodologies have been presented and discussed during several national workshop and expert meeting, collecting findings and comments to be incorporated in the estimation process. All the LULUCF categories have been embedded in the overall QA/QC-system of the Italian GHG inventory.

7.6.7 Category-specific recalculations

The comparison with previous submission results in average[48] increase of the emissions equal to 60.9% in settlements category, for the period 1990-2011, due to multiple reasons. Firstly the notable increase of land converted to settlements, resulting from the III NFI data (related to 2012); secondly the update in the litter coefficients used in the estimation process, while the remaining deviations are resulting from the change in the data source used to assess land use and land use changes and errors' correction.

7.6.8 Category -specific planned improvements

Urban tree formations will be probed for information, in order to estimate carbon stocks. In addition, in 2013, the joint project "ITALI" (*Integration of Territorial And Land Information*) has started its activities; the project, coordinated by the National Institute of Statistics and promoted by EUROSTAT[49], involves ISPRA, the Ministry of Agriculture, Food and Forest Policies, the National Forestry Service and the SIN (*Sistema Informativo Nazionale per lo sviluppo dell'agricoltura*) and is aimed to supply national statistics related to land use and land cover, harmonising and improving the current informative bases already available in the country.

[46] FAO, 2005. FAOSTAT, http://faostat.fao.org
[47] ISTAT, several years [a], [b], [c]
[48] Average value on the period 1990-2011
[49] Eurostat is the statistical office of the European Union: http://epp.eurostat.ec.europa.eu/portal/page/portal/about_eurostat/introduction

7.7 Other Land (5F)

Under this category, CO_2 emissions, from living biomass, dead organic matter and soils, from land converted in other land should be accounted for; no data is reported since the conversion to other land is not occurring.

7.8 Direct N_2O emissions from N fertilization (5(I))

N_2O emissions from N fertilization of cropland and grassland are reported in the agriculture sector; therefore only forest land should be included in this table; no data have been reported, since no fertilizers are applied to forest land.

7.9 N_2O emissions from drainage of soils (5(II))

As regards N_2O emissions from N drainage of forest or wetlands soils no data have been reported, since no drainage is applied to forest or wetlands soils.

7.10 N_2O emissions from disturbance associated with land-use conversion to Cropland (5(III))

7.10.1 Description

Under this category, N_2O emissions from disturbance of soils associated with land-use conversion to cropland are reported, according to the GPG (IPCC, 2003). N_2O emissions from cropland remaining cropland are included in the agriculture sector of the good practice guidance. The good practice guidance provides methodologies only for mineral soils.

7.10.2 Methodological issues

N_2O emissions from land use conversions are derived from mineralization of soil organic matter resulting from conversion of land to cropland. The average area of land undergoing a transition from non-cropland to cropland during each year, from 1990 to 2012, has been estimated with the land use change matrices; as mentioned above, only conversion from grassland to cropland has occurred in the Italian territory. The GPG equation 3.3.14 has been used to estimate the emissions of N_2O from mineral soils, resulting from the land use change.
Changes in carbon stocks in mineral soils in land converted to cropland have been estimated following land use changes, resulting in a change of the total soil carbon content. Assuming the GPG default values, 15 and 0.0125 kg N_2O-N/kg N for the C/N ratio and for calculating N_2O emissions from N in the soil respectively, N_2O emissions have been estimated.
In Table 7.32 N_2O emissions resulting from the disturbance associated with land-use conversion to cropland are reported.

Table 7.32 N_2O emissions from land-use conversion to cropland

	Conversion Area		**Carbon stock**	**$N_{net-min}$**	**N_2O $_{net-min}$ -N**	**N_2O emissions**
	annual change	*annual change*				
year	*kha*	*kha*	*Gg C*	*kt N*	*kt N_2O-N*	*Gg N_2O*
1990	0	136.15	145.64	9.7	0.121	0.191
1991	16.77	152.92	163.57	10.9	0.136	0.214
1992	16.77	169.69	181.51	12.1	0.151	0.238
1993	16.77	186.46	199.45	13.3	0.166	0.261
1994	16.77	203.23	217.39	14.5	0.181	0.285
1995	16.77	220.00	235.33	15.7	0.196	0.308

	Conversion Area		Carbon stock	$N_{net-min}$	N_2O $_{net-min}$ -N	N_2O emissions
	annual change	*annual change*				
year	*kha*	*kha*	*Gg C*	*kt N*	*kt N_2O-N*	*Gg N_2O*
1996	0	192.77	206.20	13.7	0.172	0.270
1997	0	165.54	177.07	11.8	0.148	0.232
1998	0	138.31	147.94	9.9	0.123	0.194
1999	0	111.08	118.82	7.9	0.099	0.156
2000	0	83.85	89.69	6.0	0.075	0.117
2001	0	83.85	89.69	6.0	0.075	0.117
2002	0	83.85	89.69	6.0	0.075	0.117
2003	0	83.85	89.69	6.0	0.075	0.117
2004	0	83.85	89.69	6.0	0.075	0.117
2005	0	83.85	89.69	6.0	0.075	0.117
2006	0	83.85	89.69	6.0	0.075	0.117
2007	0	83.85	89.69	6.0	0.075	0.117
2008	0	83.85	89.69	6.0	0.075	0.117
2009	0	83.85	89.69	6.0	0.075	0.117
2010	0	83.85	89.69	6.0	0.075	0.117
2011	0	67.08	71.75	4.8	0.060	0.094
2012	0	50.31	53.81	3.6	0.045	0.070

7.10.3 Category-specific recalculations

The comparison with previous submission results in average[50] increase of the emissions equal to 17.5%, in the period 1990-2011, due to the change of data source used to assess land use and land use changes.

7.11 Carbon emissions from agricultural lime application (5(IV))

7.11.1 Description

CO_2 emissions from application of carbonate containing lime and dolomite to agricultural soils have been estimated for the period 1998-2012, since data on agricultural lime application have been made available only for that period; moreover CO_2 emissions from agricultural dolomite application have been included in CO_2 emissions from limestone application, as national statistics on amount of lime applied don't allow to disaggregate the two components (limestone and dolomite). CO_2 emissions from agricultural lime application are reported in the Table5(IV) - CO_2 emissions from agricultural lime application.

7.11.2 Methodological issues

Tier 1 approach, assuming that the total amount of carbonate containing lime is applied annually to cropland soil, has been followed; an overall emission factor of 0.12 t C (t limestone or dolomite)$^{-1}$ has been used to estimate CO_2 emissions, without differentiating between variable compositions of lime material. The GPG equation 3.3.6 has been used to estimate CO_2 emissions, without disaggregation between calcic limestone and dolomite, as national statistics report an aggregate annual amount of lime.

[50] Average value on the period 1990-2011

7.11.3 Category-specific planned improvements

Improvements will concern the acquirement of data about annual amount of lime applied in the period 1990-1997; consideration will be focussed onto the acquisition of disaggregated data on calcic limestone and dolomite agricultural application.

7.12 Biomass Burning (5(V))

7.12.1 Description

Under this source category, CH_4 and N_2O emissions from forest fires are estimated, in accordance with the IPCC method, reporting areas for forest land remaining forest land and land converting to forestland subcategories. CO_2, CH_4 and N_2O emissions have been also estimated for cropland and grassland categories. Areas affected by fires encompassed in settlements category have been reported, but no emissions are estimated, assuming the carbon losses from the settlements areas affected by fires are irrelevant.
For the period 1990-2012, national statistics on areas affected by fire per region and forestry use, high forest (resinous, broadleaves, resinous and associated broadleaves) and coppice (simple, compound and degraded), are available (ISTAT, several years [a]). In addition, for the period 2008-2012, a detailed database, provided by the Italian National Forest Service (CFS - Ministry of Agriculture, Food and Forest Policies), has been used; the database collects data related to any fire event occurred in 15 administrative Italian regions[51] (the 5 autonomous regions are not included), reporting, for each fire event, the following information:

- *burned area [ha]*
- *forest typology (27 classes in line with the NFI nomenclature)*
- *scorch height [m]*
- *fire's type (crown, surface or ground fire)*

Data and information related to fire occurrences in the 5 remaining autonomous regions are collected at regional level, with different level of disaggregation and details (for example, in Sardinia region, the amount of biomass burned is reported instead of the scorch height).
Therefore the data used in the estimation process may be subdivided into the following groups with similar characteristics:

a. time series from 2008 on for the 15 Regions: data related to burned area, divided into different forest types, scorch height and fire's type;
b. time series from 2008 on for the 5 autonomous regions/provinces: data related to burned area;
c. time series from 1990 to 2007 for the 20 Italian regions: data related to burned area.

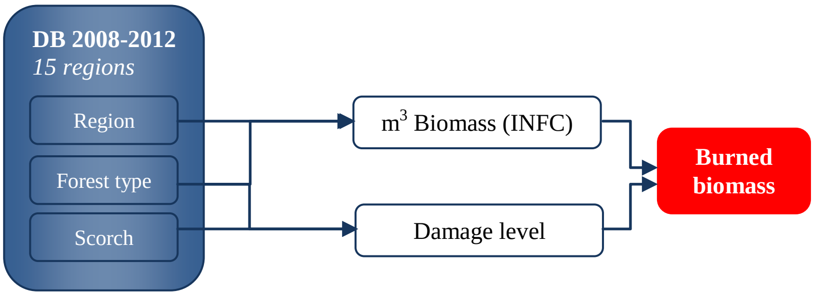
Statistics related to fires occurring in other land use categories (i.e. cropland, grassland and settlements) have been collected in the framework of *ad hoc* expert panel on fires has been set up, formed by experts from different institutions from ISPRA and Italian National Forest Service (Ministry of Agriculture, Food and Forest Policies), currently in charge for the official publication related to burned area (http://www3.corpoforestale.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/6358).
CO_2 emissions due to forest fires in forest land remaining forest land and land converting to forest land are included in Table 5.A.1 of the CRF, under carbon stock change in living biomass - losses.
Non CO_2 emissions from fires have been estimated and reported in CRF Table 5(V), while NO_x, CO and NMVOC emissions from fires have been reported in CRF Table 5. SO_2 emissions from fires are reported in 5G (Other - SO_2 from fires).

[51] The Italian territory is subdivided in 20 administrative regions, 5 of which are autonomous: Valle d'Aosta, Friuli Venezia Giulia, Sardegna, Sicilia and Trentino Alto Adige, the latest subdivided in two autonomous provinces (Trento and Bolzano).

7.12.2 *Methodological issues*

In Italy, in consideration of national legislation[52], forest fires do not result in changes in land use; therefore conversion of forest and grassland does not take place. Anyway CO_2 emissions due to forest fires in forest land remaining forest land and land converting to forest land are included in table 5.A.1 of the CRF, under carbon stock change in living biomass - decrease. The total biomass reduction due to forest fires, and subsequent emissions have been estimated following the methodology reported in paragraph 7.2.4.
On the basis of the different datasets available, in each year and group of regions, different approaches and assumptions have been followed to estimate non CO_2 emissions from forest fires.

a. The estimation of non CO_2 emissions from fires in the 15 regions has been carried out on the basis of the approach developed by Bovio (Bovio, 2007); the approach is aimed to assess forest fire damage and related biomass losses in Italy, taking into account two main elements: the fire intensity (assessed through the scorch height) and the forest typologies affected by fire. These two elements allow an assessment of the fraction of biomass burnt in a fire event. The estimation process has been carried out using the database containing around 24,000 records, related to any fire event fires on forest and other wooded land for the period 2008-2012, including information as the scorch height and the area per forest type.



In case of some data missing, record by record, a gap filling procedure has been adopted, using the following assumptions/data:

1. Scorch height data missing: the average damage level for the forest type/type of fire/region calculated over the 5 years data period (2008-2012) has been attributed to the record.
2. No volume is associated with the record – this is due to the probable misclassification of the forest type by the surveyors, which have attributed a forest type that is not present in the region, thus no data from NFI can be attributed. In this case the average burned volume per region and fire's type has been attributed to the record. In case of no specific indication on fire's type, then the average of the most severe fire's type, by region, calculated over the complete dataset (2008-2012) has been used (i.e. highest average among averages calculated per fire's type in the region)
3. Scorch height and volume missing: In case information on both issues is missing the highest average burned biomass calculated per fire's type in each region has been attributed to the record.

b. The emissions from fires for the 5 autonomous regions/provinces has been estimated on the basis of the average values assessed for the 15 regions from 2008 on, using the following procedure:

1. for each of the 15 regions (group a), the highest value of C released among the averages, calculated for the years from 2008 on, has been selected, per fire's type;
2. the 15 regions have been clustered into three group with similar climatic conditions and forest types (Northern, Center and Southern Italy);
3. the average values of carbon released for fire's type have been calculated for the three abovementioned clusters;
4. the 5 autonomous regions have been classified according the 3 cluster identified at step 2;
5. an average value of carbon released, computed at step 3, is associated to the 5 autonomous regions, according the belonging cluster;
6. the emissions from fires are estimated by multiplying average value of carbon released per the burned area of each autonomous region.

[52] Legge 21 novembre 2000, n. 353 - "Legge-quadro in materia di incendi boschivi" art. 10, comma 1 - http://www.camera.it/parlam/leggi/00353l.htm

c. The emissions from fires for the period 1990-2007 for the 20 Italian regions have been estimated on the basis of the maximum of average values computed among 2008 and 2012 (when the detailed database is available), taking into account the fire's type and each region. The selected value of released carbon is then multiplied by the burned area of the region in each year from 1990 to 2007.

CH_4, N_2O, CO and NO_x have been estimated following GPG approach (eq. 3.2.19), multiplying the amount of C released from 1990 to 2012, calculated as abovementioned, by the emission ratios from EMEP/EEA 2009 (table 3.3, chapt. 11.B).
In Table 7.33 CH_4 and N_2O emissions resulting from biomass burning in forest land category are reported.

Table 7.33 CH_4 and N_2O emissions from biomass burning in forest land category

	Forest land remaining forest land		***Land converting to forest land***	
	CH_4	**N_2O**	**CH_4**	**N_2O**
year	*Gg*	*Gg*	*Gg*	*Gg*
1990	37.992	0.012	3.790	0.001
1991	11.419	0.004	1.212	0.000
1992	16.388	0.005	1.842	0.001
1993	39.941	0.013	4.737	0.001
1994	15.995	0.005	1.995	0.001
1995	7.677	0.002	1.005	0.000
1996	6.964	0.002	0.975	0.000
1997	22.612	0.007	3.369	0.001
1998	25.592	0.008	4.044	0.001
1999	14.371	0.005	2.400	0.001
2000	19.614	0.006	3.452	0.001
2001	12.616	0.004	2.330	0.001
2002	7.147	0.002	1.381	0.000
2003	14.752	0.005	2.978	0.001
2004	6.857	0.002	1.443	0.000
2005	7.158	0.002	1.571	0.000
2006	5.429	0.002	1.164	0.000
2007	35.625	0.011	7.462	0.002
2008	6.731	0.002	1.377	0.000
2009	7.911	0.002	1.581	0.000
2010	4.100	0.001	0.800	0.000
2011	7.370	0.002	1.404	0.000
2012	21.456	0.007	3.992	0.001

In Table 7.34 CO_2, CH_4 and N_2O emissions resulting from biomass burning in cropland and grassland categories are reported.

Table 7.34 CO_2, CH_4 and N_2O emissions from biomass burning in cropland and grassland categories

		Cropland			***Grassland***	
	CO_2	**CH_4**	**N_2O**	**CO_2**	**CH_4**	**N_2O**
year	*Gg*	*Gg*	*Gg*	*Gg*	*Gg*	*Gg*
1990	42.363	0.231	0.007	5,287.879	28.843	0.906
1991	30.464	0.166	0.005	3,099.132	16.904	0.531
1992	26.740	0.146	0.005	3,032.878	16.543	0.520
1993	38.194	0.208	0.007	5,246.608	28.618	0.899
1994	39.009	0.213	0.007	4,115.077	22.446	0.705
1995	12.192	0.066	0.002	1,394.833	7.608	0.239
1996	16.462	0.090	0.003	1,744.483	9.515	0.299
1997	21.182	0.116	0.004	2,879.094	15.704	0.494
1998	36.080	0.197	0.006	4,316.517	23.545	0.740
1999	13.882	0.076	0.002	1,856.013	10.124	0.318
2000	24.661	0.135	0.004	3,094.648	16.880	0.531
2001	16.717	0.091	0.003	2,075.419	11.320	0.356

	Cropland			Grassland		
	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
year	*Gg*	*Gg*	*Gg*	*Gg*	*Gg*	*Gg*
2002	8.993	0.049	0.002	1,110.901	6.059	0.190
2003	20.870	0.114	0.004	2,528.480	13.792	0.433
2004	17.184	0.094	0.003	1,814.825	9.899	0.311
2005	11.412	0.062	0.002	1,337.110	7.293	0.229
2006	10.283	0.056	0.002	1,154.216	6.296	0.198
2007	48.579	0.265	0.008	6,128.734	33.429	1.051
2008	15.761	0.086	0.003	2,201.581	12.009	0.377
2009	17.050	0.093	0.003	2,757.017	15.038	0.473
2010	9.097	0.050	0.002	1,826.536	9.963	0.313
2011	19.212	0.105	0.003	2,611.683	14.246	0.448
2012	36.115	0.197	0.006	4,431.337	24.171	0.760

7.12.3 Category-specific planned improvements

An expert panel on forest fires has been set up, in order to obtain geographically referenced data on burned area. Activities planned in the framework of the National Registry for Forest Carbon Sinks should also provide data to improve estimate of emissions by biomass burning.

7.12.4 Uncertainty and time series consistency

Uncertainty estimates for the period 1990–2012 have been assessed following Approach 1 of 2006 IPCC Guidelines (IPCC, 2006). Input uncertainties deal with activity data and emission factors have been assessed on the basis of the information provided in the IPCC Good Practice Guidance for LULUCF (IPCC, 2003).

7.12.5 Category-specific QA/QC and verification

Systematic quality control activities have been carried out in order to ensure completeness and consistency in time series and correctness. Data entries have been checked several times during the compilation of the inventory. Several QA activities are carried out in the different phases of the inventory process. In particular the applied methodologies have been presented and discussed during several national workshop and expert meeting, collecting findings and comments to be incorporated in the estimation process. All the LULUCF categories have been embedded in the overall QA/QC-system of the Italian GHG inventory.

7.12.6 Category-specific recalculations

Remarkable deviations are resulting from the comparison with previous sectoral estimates, due to the implementation of the new methodology and to the use of updated activity data; in particular the comparison of emissions related to fires in forest land category results in average[53] increase of the emissions equal to 56.2% (79.2% for forest land remaining forest land and 45.8% for land converting to forest land). Concerning cropland category, an increase of the emissions equal to 2.6% has to be noted, while an increase of 31.5% for grassland category has to be observed.

7.12.7 Category-specific planned improvements

An expert panel on forest fires has been set up, in order to obtain geographically referenced data on burned area; the overlapping of land use map and georeferenced data should assure the estimates of burned areas in the different land uses. The fraction of CO_2 emissions due to forest fires, currently included in the estimate of the forest land remaining forest land, will be pointed out.

[53] Average value on the period 1990-2011

In addition an *ad hoc* expert panel on fires has been constituted by experts from different institutions from ISPRA and Ministry of Agriculture, Food and Forest Policies; the panel is currently working on harmonising the data, related to fires, collected at regional level (considering the 20 administrative regions, 5 of which are autonomous) which are now characterized with different level of disaggregation and details (burned area, with reference to various land uses, forest land category, with reference to different forest typologies, specific parameters related to fire’s type (crown or grazing fire), amount of burned biomass, etc.).

8 WASTE [CRF sector 6]

8.1 Sector overview

The waste sector comprises four source categories:

1 solid waste disposal on land (6A);
2 wastewater handling (6B);
3 waste incineration (6C);
4 other waste (6D).

The waste sector share of GHG emissions in the national greenhouse total is presently 3.52% (and was 3.79% in the base year 1990).

The trend in greenhouse gas emissions from the waste sector is summarised in Table 8.1. It clearly shows that methane emissions from solid waste disposal sites (landfills) are by far the largest source category within this sector.

Emissions from waste incineration facilities without energy recovery are reported under category 6C, whereas emissions from waste incineration facilities, which produce electricity or heat for energetic purposes, are reported under category 1A4a (according to the IPCC reporting guidelines).

Under 6D, CH_4 and NMVOC emissions from compost production and NO_x emissions from sludge spreading are reported.

Emissions from methane recovered, used for energy purposes, in landfills and wastewater treatment plants are estimated and reported under category 1A4a.

Table 8.1 Trend in greenhouse gas emissions from the waste sector 1990 – 2012 (Gg)

GAS/SUBSOURCE	1990	1995	2000	2005	2010	2011	2012
CO_2 (Gg)							
6C. Waste incineration	507.18	453.89	201.57	225.56	168.31	172.68	169.92
CH_4 (Gg)							
6A. Solid waste disposal on land	726.38	757.56	874.15	738.78	607.95	560.50	538.23
6B. Wastewater handling	94.76	105.62	112.73	129.67	130.12	129.80	129.78
6C. Waste incineration	2.09	2.41	2.32	2.56	2.43	2.42	2.42
6D. Other (compost production)	0.01	0.02	0.10	0.20	0.25	0.25	0.27
N_2O (Gg)							
6B. Wastewater handling	5.91	5.73	6.21	6.15	6.39	6.26	6.24
6C. Waste incineration	0.13	0.12	0.09	0.09	0.08	0.08	0.08

In the following box, key and non-key sources of the waste sector are presented based on level, trend or both. Methane emissions from landfills result as a key category at level and trend assessment calculated with Approach 1 and Approach 2; methane emission from wastewater handling is a key source at level assessment with Approach 1 and Approach 2 in 2012, only with Approach 2 in 1990 and at trend assessment taking into account uncertainty. When including the LULUCF sector in the key source analysis, methane emissions from landfills result as a key source at level and trend with Approach 1 and Approach 2 in 2012, whereas methane emission from wastewater handling is a key category at level assessment with Approach 1 and Approach 2 in 2012 and at trend assessment taking into account uncertainty.

Key-source identification in the waste sector with the IPCC Approach 1 and Approach 2 (without LULUCF) for 2012

6A	CH_4	Emissions from solid waste disposal sites	Key (L, T)
6B	CH_4	Emissions from wastewater handling	Key (L, T2)
6B	N_2O	Emissions from wastewater handling	Non-key
6C	CO_2	Emissions from waste incineration	Non-key
6C	CH_4	Emissions from waste incineration	Non-key
6C	N_2O	Emissions from waste incineration	Non-key
6D	CH_4	Emissions from other waste (compost production)	Non-key

8.2 Solid waste disposal on land (6A)

8.2.1 Source category description

The source category solid waste disposal on land is a key category for CH_4, both in terms of level and trend. The share of CH_4 emissions is presently 32.5% (and was about 34.9% in the base year 1990) of the CH_4 national total. For this source category, also NMVOC emissions are estimated; it has been assumed that non-methane volatile organic compounds are 1.3 weight per cent of VOC (Gaudioso et al., 1993): this assumption refers to US EPA data (US EPA, 1990).
Methane is emitted from the degradation of waste disposed of in municipal landfills, both managed and unmanaged.
The main parameters that influence the estimation of emissions from landfills are, apart from the amount of waste disposed into managed landfills, the waste composition, the fraction of methane in the landfill gas and the amount of landfill gas collected and treated. These parameters are strictly dependent on the waste management policies throughout the waste streams which start from waste generation, flow through collection and transportation, separation for resource recovery, treatment for volume reduction, stabilisation, recycling and energy recovery and terminate at landfill sites.
Urban waste disposal in landfill sites is still the main disposal practice: the percentage of waste disposed in landfills dropped from 91.1% in 1990 to 46.6% in 2012. This trend is strictly dependent on policies that have been taken in the last 20 years in waste management. In fact, at the same time, waste incineration as well as composting and mechanical and biological treatment have shown a remarkable rise due to the enforcement of legislation. Also recyclable waste collection, which at the beginning of nineties was a scarce practice and waste were mainly disposed in bulk in landfills or incineration plants, has been increasing: in 2012, the percentage of municipal solid waste separate collection is near 40%, still far from legislative targets (fixed 50% in 2009) but characterized by a strong growth in recent years.
In particular, in Italy the first legal provision concerning waste management was issued in 1982 (Decree of President of the Republic 10 September 1982, n.915), as a consequence of the transposition of some European Directives on waste (EC, 1975; EC, 1976; EC, 1978). In this decree, uncontrolled waste dumping as well as unmanaged landfills are forbidden, but the enforcement of these measures has been concluded only in 2000. Thus, from 2000 municipal solid wastes are disposed only into managed landfills.
For the year 2012, the non hazardous landfills in Italy disposed 11,664 kt of MSW and 2,292 kt of industrial wastes, as well as 214 kt of sludge from urban wastewater treatment plants.
Since 1999, the number of MSW landfills has decreased by more than 500 plants, despite the decrease of the amount of wastes disposed of is less pronounced. This because both uncontrolled landfills and small controlled landfills have been progressively closed, especially in the south of the country, where the use of modern and larger plants was opted in order to serve large territorial areas.
Concerning the composition of waste which is disposed in municipal landfills, this has been changed over the years, because of the modification of waste production due to changes in the life-style and not to a forceful policy on waste management.
The Landfill European Directive (EC, 1999) has been transposed into national decree only in 2003 by the Legislative Decree 13 January 2003, n. 36 and applied to the Italian landfills since July 2005, but the effectiveness of the policies will be significant in the future. Moreover, a following law decree (Law Decree 30 December 2008, n.208) moved to December 2009 the end of the temporary condition regarding waste acceptance criteria, thus the composition of waste accepted in landfills is expected to change hardly.
Finally, methane emissions are expected especially from non hazardous waste landfills due to biodegradability rate of the wastes disposed of; in the past, provisions by law forced only non hazardous waste landfills to have a collecting gas system. Investigation on industrial sludge disposed into landfills for hazardous waste is ongoing and relates to the 2010 activity data.

8.2.2 Methodological issues

Emission estimates from solid waste disposal on land have been carried out using the IPCC Tier 2 methodology, through the application of the First Order Decay Model (FOD).
Parameter values used in the landfill emissions model are:

1) total amount of waste disposed;
2) fraction of Degradable Organic Carbon (DOC);

3) fraction of DOC dissimilated (DOC_F);
4) fraction of methane in landfill gas (F);
5) oxidation factor (O_X);
6) methane correction factor (MCF);
7) methane generation rate constant (k);
8) landfill gas recovered (R).

It has been assumed that all the landfills, both managed and unmanaged, started operations in the same year, and have the same parameters, although characteristics of individual landfill sites can vary substantially.
Moreover, the share of waste disposed of into uncontrolled landfills has gradually decreased, as specified previously, and in the year 2000 it has been assumed equal to 0; nevertheless, emissions still have been occurring due to the waste disposed in the past years. The unmanaged sites have been considered "shallow" according to the IPCC classification.

Municipal solid waste
Basic data on waste production and landfills system are those provided by the national Waste Cadastre. The Waste Cadastre is formed by a national branch, hosted by ISPRA, and by regional and provincial branches. The basic information for the Cadastre is mainly represented by the data reported through the Uniform Statement Format (MUD), complemented by information provided by regional permits, provincial communications and by registrations in the national register of companies involved in waste management activities.
These figures have been elaborated and published by ISPRA yearly since 1999: the yearbooks report waste production data, as well as data concerning landfilling, incineration, composting and generally waste life-cycle data (ANPA-ONR, several years; ISPRA, several years).
For inventory purposes, a database of waste production, waste disposal in managed and unmanaged landfills and sludge disposal in landfills was created and it has been assumed that in Italy waste landfilling started in 1950.
The complete database from 1975 of waste production, waste disposal in managed and unmanaged landfills and sludge disposal in landfills is reconstructed on the basis of different sources (MATTM, several years; FEDERAMBIENTE, 1992; AUSITRA-Assoambiente, 1995; ANPA-ONR, 1999 [a], [b]; APAT, 2002; APAT-ONR, several years; ISPRA, several years), national legislation (Legislative Decree 5 February 1997, n.22), and regression models based on population (Colombari et al, 1998).
Since waste production data are not available before 1975, they have been reconstructed on the basis of proxy variables. Gross Domestic Product data have been collected from 1950 (ISTAT, several years [a]) and a correlation function between GDP and waste production has been derived from 1975; thus, the exponential equation has been applied from 1975 back to 1950.
Consequently the amount of waste disposed into landfills has been estimated, assuming that from 1975 backwards the percentage of waste landfilled is constant and equal to 80%; this percentage has been derived from the analysis of available data. As reported in the Figure 8.1, in the period 1973 – 1991 data are available for specific years (available data are reported in dark blue, whereas estimated data are reported in light blue). From 1973 to 1991 waste disposal has increased, because the most common practice in waste management; from early nineties, thanks to a change in national policies, waste disposal in landfill has started to decrease, in favour of other waste treatments.

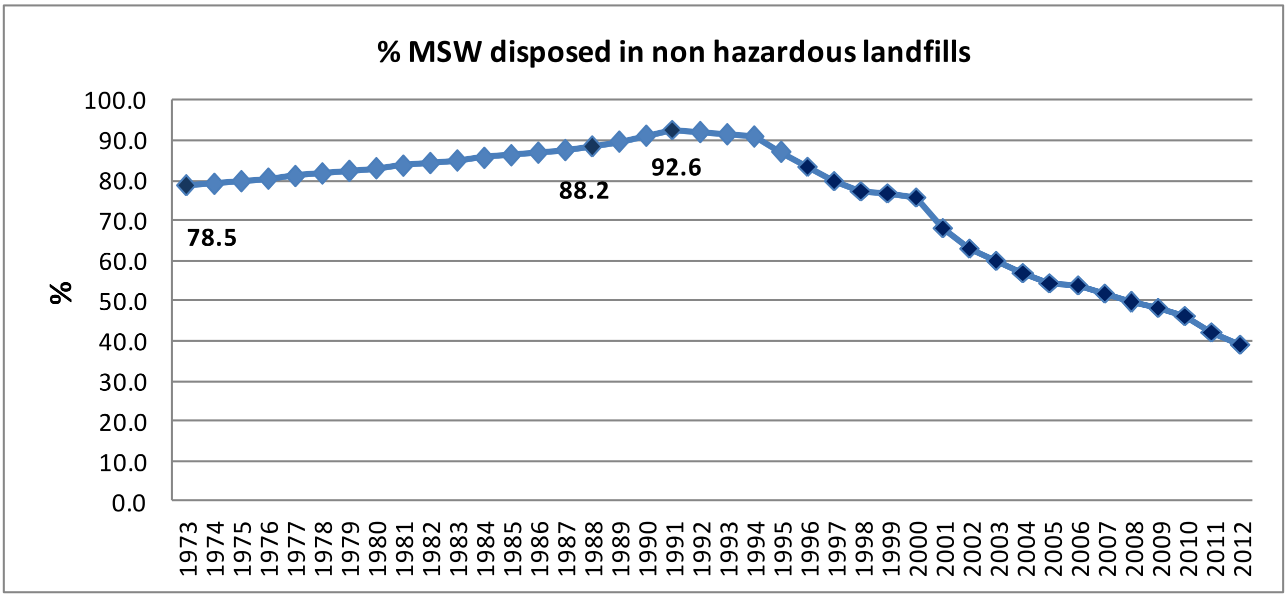


Figure 8.1 Percentage of MSW disposal on land (%)

In the following Table 8.2, the time series of MSW production and MSW disposed of into non hazardous landfills from 1990 is reported. The amount of waste disposed in managed landfills is yearly provided by the national Waste Cadastre since 1995. The time series has been reconstructed backwards on the basis of several studies reporting data available for 1973, 1988, 1991, 1994 (Tecneco, 1972; MATTM, several years). The amount of waste disposed in unmanaged landfills has been estimated as a percentage of the waste disposed in managed landfills. Different studies provided information about the percentage of waste in unmanaged sites for 1973, 1979, 1991 (Tecneco, 1972; ISTAT, 1984, MATTM, several years) and data in other years are extrapolated. These studies show that the share of waste disposed of into uncontrolled landfills has gradually decreased, from 72.8%, in 1973, to 53.4% in 1979 and 26.6% in 1991, which is a consequence of the progressive implementation of the national legislation. Since 2000 the percentage of waste in unmanaged landfills is equal to zero because of legal enforcement described in 8.2.1.

Industrial waste

Industrial wastes assimilated to municipal solid waste (AMSW) could be disposed of in non hazardous landfills. Composition of AMSW must be comparable to municipal solid waste composition.

From 2001, data on industrial waste disposed in municipal landfills are available from Waste Cadastre.

For previous years, assimilated municipal solid waste production has been reconstructed, and the same percentage of MSW disposed in landfill has been applied also to AMSW.

The complete database of AMSW production from 1975 to 2000 has been reconstructed starting from data available for the years 1988 (ISTAT, 1991) and 1991 (MATTM, several years) with a linear interpolation, and with a regression model based on Gross Domestic Product (Colombari et al, 1998). From 1975 back to 1950 AMSW production has been derived as a percentage of MSW production; this percentage has been set equal to 15%, which is approximately the value obtained from the only data available (MSW and AMSW production for the years 1988 and 1991).

In Table 8.2, the time series of AMSW and domestic sludge disposed of into non hazardous landfills from 1990 is reported.

Table 8.2 Trend of MSW production and MSW, AMSW and domestic sludge disposed in landfills, 1990 – 2012

ACTIVITY DATA	1990	1995	2000	2005	2010	2011	2012
MSW production (Gg)	22,231	25,780	28,959	31,664	32,479	31,386	29,962
MSW disposed in landfills for non hazardous waste (Gg)	17,432	22,459	21,917	17,226	15,015	13,206	11,664
Assimilated MSW disposed in landfills for non hazardous waste (Gg)	2,828	2,978	2,825	2,914	3,508	2,883	2,292
Sludge disposed in managed landfills for non hazardous waste (Gg)	2,454	1,531	1,326	544	301	292	214
Total Waste to managed landfills for non hazardous waste (Gg)	16,363	21,897	26,069	20,684	18,825	16,380	14,170
Total Waste to unmanaged landfills for non hazardous waste (Gg)	6,351	5,071	0	0	0	0	0
Total Waste to landfills for non hazardous waste (Gg)	22,714	26,968	26,069	20,684	18,825	16,380	14,170

Sludge from urban wastewater plants

Sludge from urban wastewater treatment plants has also been considered, because it can be disposed of at the same landfills as municipal solid waste and assimilated, once it meets specific requirements. The fraction of sludge disposed in landfill sites has been estimated to be 75% in 1990, decreasing to 8% in 2012.

On the basis of their characteristics, sludge from urban wastewater treatment plants is also used in agriculture, sludge spreading on land, and in compost production, or treated in incineration plants.

The percentage of each treatment (landfilling, soil spreading, composting, incinerating and stocking) has been reconstructed within the years starting from 1990: for that year, percentages have been set based on data on tonnes of sludge treated in a given way available from a survey conducted by the National Institute of Statistics on urban wastewater plants for the year 1993 (ISTAT, 1998 [a] and [b]; De Stefanis P. et al., 1998). From 1990 onwards each percentage has been varied on the basis of data available for specific years: in particular, data on sludge use in agriculture have been communicated by the Ministry for the Environment, Land and Sea concerning the reference time period from 1995 (MATTM, 2005; MATTM 2010; MATTM, 2014); data on sludge used in compost production are published from 1999, while data on sludge disposed into landfills are published from 2001 (APAT-ONR, several years; ISPRA, several years).

The total production of sludge from urban wastewater plants is communicated by the Ministry for the Environment, Land and Sea from 1995 (MATTM, 2005; MATTM 2010; MATTM, 2014) in the framework of the reporting commitments established by the European Sewage Sludge Directive (EC, 1986) transposed into the national Legislative Decree 27 January 1992, n. 99.

Moreover, sewage sludge production is available from different sources also for the years 1987, 1991 (MATTM, several years) and 1993 (ISTAT, 1998 [a] and [b]). Thus, for the missing years data have been extrapolated.

As for the waste production, also sludge production time series has been reconstructed from 1950. Starting from the number of wastewater treatment plants in Italy in 1950, 1960, 1970 and 1980 (ISTAT, 1987), the equivalent inhabitants have been derived.

To summarize, from 1987 both data on equivalent inhabitants and sludge production are available (published or estimated), thus it is possible to calculate a *per capita* sludge production: the parameter results equal on average to 80 kg inhab.$^{-1}$ yr^{-1}. Consequently, this value has been multiplied to equivalent inhabitants from 1987 back to 1950.
In Table 8.3, time series of sewage sludge production and landfilling is reported.

Table 8.3 Trend of total sewage sludge production and landfilling, 1990 – 2012

ACTIVITY DATA	1990	1995	2000	2005	2010	2011	2012
Total sewage sludge production (Gg)	3,272	2,437	3,402	4,299	3,359	3,407	2,616
Sewage sludge landfilled (Gg)	2,454	1,531	1,326	544	301	292	214
Percentage (%)	75.0	62.8	39.0	12.7	9.0	8.6	8.2

Waste composition
One of the most important parameter that influences the estimation of emissions from landfills is the waste composition.
An in-depth survey has been carried out, in order to diversify waste composition over the years.
On the basis of data available on waste composition (Tecneco, 1972; CNR, 1980; Ferrari, 1996), three slots (1950-1970; 1971-1990; 1991- 2005) have been individuated to which different waste composition has been assigned. Waste composition used from 2005 back to 1971 (CNR, 1980; Ferrari, 1996) has been better specified, on the basis of data available from those publications. In particular, screened waste (< 20mm) has been included in emissions estimation, because the 50% of it has been assumed as organic and thus rapidly biodegradable. This assumption has been strengthened by expert judgments and sectoral studies (Regione Piemonte, 2007; Regione Umbria, 2007).
Moreover, a fourth slot (2006-2011) has been individuated on the basis of the analysis of several regional waste composition and the analysis of waste disposed of into non hazardous landfills specified by the European Waste Catalogue (EWC) code for the year 2007, available from Waste Cadastre database (ISPRA, 2010). Data on waste composition refer to recent years and they are representative of the national territory, deriving from the North of Italy (Regione Piemonte, 2007; Regione Veneto, 2006; Regione Emilia Romagna, 2009), the Centre (Regione Umbria, 2007; Provincia di Roma, 2008) and the South (Regione Calabria, 2002; Regione Sicilia 2004). The new waste composition, adopted from 2006, includes compost residues which are disposed into landfills because their parameters are not in compliance with those set by the law: compost residues are reported under garden and park waste component, as they are considered moderately biodegradable. The moisture content and the organic carbon content are from national studies (Andreottola and Cossu, 1988; Muntoni and Polettini, 2002).

In Tables 8.4, 8.5, 8.6 and 8.7 waste composition of each national survey mentioned above and waste composition derived from the analysis of EWC code is reported, together with moisture content, organic carbon content and consequently degradable organic carbon both in waste type *i* and in bulk waste, DOC calculation is described in following paragraphs.
Waste types containing most of the DOC and thus involved in methane emissions are highlighted in bold type.
Since sludge is not included in waste composition, because it usually refers to waste production and not to waste landfilled, it has been added to each waste composition, recalculating the percentage of waste type.

Table 8.4 Waste composition and Degradable Organic Carbon calculation, 1950 - 1970

WASTE COMPONENT	Composition by weight (wet waste)	Moisture content	Organic carbon content (dry matter)	DOC_i (kgC/tMSW)
Organic	**32.7%**	**60%**	**48%**	**62.72**
Garden and park	**3.6%**	**50%**	**48%**	**8.71**
Paper, paperboard	**29.7%**	**9%**	**50%**	**135.09**
Plastic	2.9%	2%	70%	
Inert	26.9%			
Sludge	**4.2%**	**75%**	**48%**	**5.07**
DOC				**211.59**

Table 8.5 Waste composition and Degradable Organic Carbon calculation, 1971 – 1990

WASTE COMPONENT	Composition by weight (wet waste)	Moisture content	Organic carbon content (dry matter)	DOC_i (kgC/tMSW)
Organic	**33.3%**	**60%**	**48%**	**64.00**
Garden and park	**3.7%**	**50%**	**48%**	**8.89**
Paper, paperboard, textile and wood	**19.6%**	**9%**	**50%**	**89.26**
Plastic	6.3%	2%	70%	
Inert	6.2%			
Metal	2.6%			
Screened waste (< 2 cm)				
- organic	8.0%	**60%**	**48%**	**15.45**
- non organic	8.0%			
Sludge	**12.0%**	**75%**	**48%**	**14.44**
DOC				**192.04**

Table 8.6 Waste composition and Degradable Organic Carbon calculation, 1991 - 2005

WASTE COMPONENT	Composition by weight (wet waste)	Moisture content	Organic carbon content (dry matter)	DOC_i (kgC/tMSW)
Organic	**24.7%**	**60%**	**48%**	**47.37**
Garden and park	**4.2%**	**50%**	**48%**	**10.09**
Paper, paperboard	**25.5%**	**8%**	**44%**	**103.38**
Nappies	**2.7%**	**8%**	**44%**	**10.98**
Textiles	**4.8%**	**10%**	**55%**	**23.98**
Leather and rubbers	2.1%	2%	70%	
Light plastics	8.9%	2%	70%	
Rigid plastics	3.0%	2%	70%	
Inert and glasses	5.9%			
Metal	2.9%			
Bulky waste	0.5%			
Various	1.5%			
Screened waste (< 2 cm)				
- organic	**3.4%**	**60%**	**48%**	**6.60**
- non organic	3.4%			
Sludge	**6.3%**	**75%**	**48%**	**7.53**
DOC				**209.93**

Table 8.7 Waste composition and Degradable Organic Carbon calculation, 2006 – 2012

WASTE COMPONENT	Composition by weight (wet waste)	Moisture content	Organic carbon content (dry matter)	DOC_i (kgC/tMSW)
Organic	**21.9%**	**60%**	**48%**	**42.07**
Garden and park	**5.6%**	**50%**	**48%**	**13.53**
Wood	**1.6%**	**20%**	**50%**	**6.47**
Paper, paperboard, nappies	**23.9%**	**8%**	**44%**	**96.72**
Textiles and leather	**3.0%**	**10%**	**55%**	**14.86**
Plastics	11.8%	2%	70%	
Metals and Aluminium	2.3%			
Inert and glasses	6.4%			
Bulky waste	2.2%			
Various	6.5%			
Screened waste (< 2 cm)				
- organic	**5.4%**	**60%**	**48%**	**10.43**
- non organic	5.4%			
Sludge	**3.9%**	**75%**	**48%**	**4.68**
DOC				**188.76**

On the basis of the waste composition, waste stream have been categorized in three main types: rapidly biodegradable waste, moderately biodegradable waste and slowly biodegradable waste, as reported in Table 8.8. Methane emissions have been estimated separately for each mentioned biodegradability class and the results have been consequently added up.

Table 8.8 Waste biodegradability

Waste biodegradability	Rapidly biodegradable	Moderately biodegradable	Slowly biodegradable
Food	X		
Sewage sludge	X		
Screened waste (organic)	X		
Garden and park		X	
Paper, paperboard			X
Nappies			X
Textiles, leather			X
Wood			X

Degradable organic carbon (DOC) and Methane generation potential (L_0)

Degradable organic carbon (DOC) is the organic carbon in waste that is accessible to biochemical decomposition, and should be expressed as Gg C per Gg waste. The DOC in waste bulk is estimated based on the composition of waste and can be calculated from a weighted average of the degradable carbon content of various components of the waste stream. The following equation estimates DOC using default carbon content values.

$$DOC = \Sigma_i (DOC_i * W_i)$$

Where:

DOC = fraction of degradable organic carbon in bulk waste, kg C/kg of wet waste

DOC_i = fraction of degradable organic carbon in waste type *i*,

W_i = fraction of waste type *i* by waste category

Degradable organic carbon in waste type *i* can be calculated as following:

$$DOC_i = C_i * (1-u_i) * W_i$$

Where:
C_i = organic carbon content in dry waste type *i*, kg C/ kg of waste type *i*
u_i= moisture content in waste type *i*
W_i = fraction of waste type *i* by waste category

Once known the degradable organic carbon, the methane generation potential value (L_0) is calculated as following:

$$L_0 = MCF * DOC * DOC_F * F * 16/12$$

Where:
MCF = methane correction factor
DOC_F = fraction of DOC dissimilated
F = fraction of methane in landfill gas

Fraction of degradable organic carbon (DOC_F) is an estimate of the fraction of carbon that is ultimately degraded and released from landfill, and reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the landfill.
DOC_F value is dependent on many factors like temperature, moisture, pH, composition of waste: the default value 0.5 has been used.
The methane correction factor (MCF) accounts for that unmanaged SWDS (solid waste disposal sites) produce less CH_4 from a given amount of waste than managed SWDS, because a larger fraction of waste decomposes aerobically in the top layers of unmanaged SWDS. The MCF should be also interpreted as the ‘waste management correction factor’ because it reflects the management aspects.
The MCF value used for unmanaged landfill is the default IPCC value reported for uncategorised landfills: in fact, in Italy, before 2000 the existing unmanaged landfills were mostly shallow, because they resulted in uncontrolled waste dumping instead of real deep unmanaged landfills. On the basis of the qualitative information available regarding the national unmanaged landfills, the default IPCC value used has been considered the most appropriate to represent national circumstances also in consideration of the type of waste landfilled and the humidity degree of landfills. It is assumed that landfill gas is 50% VOC. The following Table 8.9 summarizes the methane generation potential values (L_0) generated, distinguished for managed and unmanaged landfills.

Table 8.9 Methane generation potential values by waste composition and landfill typology

L_0 ($m^3 CH_4$ $tMSW^{-1}$)	1950 - 1970	1971 - 1990	1991 - 2005	2006 - 2012
Rapidly biodegradable				
- Managed landfill	90.5	86.6	88.1	90.2
- Unmanaged landfill	54.3	52.0	52.9	54.1
Moderately biodegradable				
- Managed landfill	118.2	118.2	118.2	118.2
- Unmanaged landfill	70.9	70.9	70.9	70.9
Slowly biodegradable				
- Managed landfill	224.1	224.1	205.9	204.0
- Unmanaged landfill	134.5	134.5	123.5	122.4

Finally, oxidation factors have been assumed equal to 0.1 for managed landfills and 0 for unmanaged according to the IPCC Good Practice Guidance where 0.1 is suggested for well managed landfills.

Methane generation rate constant (k)

The methane generation rate constant *k* in the FOD method is related to the time necessary for DOC in waste to decay to half its initial mass (the 'half life' or t½).

The maximum value of *k* applicable to any single SWDS is determined by a large number of factors associated with the composition of the waste and the conditions at the site. The most rapid rates are associated with high moisture conditions and rapidly degradable material such as food waste. The slowest decay rates are associated with dry site conditions and slowly degradable waste such as wood or paper. Thus, for each rapidly, moderately and slowly biodegradable fraction, a different maximum methane generation rate constant has been assigned, as reported in Table 8.10. Different *k* values for rapidly, moderately and slowly biodegradable waste are applied to the different parts of the model.

The methane generation rate constant *k* values derive from national and international literature and reported by Italian national experts (Andreottola and Cossu, 1988; Ham, 1979); these figures are representative of average biogas production conditions with respect to the characteristics of national landfills and waste composition in terms of moisture, density and size.

Table 8.10 Half-life values and related methane generation rate constant

WASTE TYPE	Half life	Methane generation rate constant
Rapidly biodegradable	1 year	0.69
Moderately biodegradable	5 years	0.14
Slowly biodegradable	15 years	0.05

The average k is calculated on the basis of the waste composition, and assumes different values during different periods on account of the waste composition changes, as reported in Table 8.11.

Table 8.11 Average k values based on waste compositions

	1971 - 1990	1991 - 2005	2006 - 2030
k	0.463	0.362	0.363

Landfill gas recovered (R)

Landfill gas recovered data have been reconstructed on the basis of information on extraction plants (De Poli and Pasqualini, 1991; Acaia et al., 2004; Asja, 2003) and electricity production (TERNA, several years).

Only managed landfills have a gas collection system, and the methane extracted can be used for energy production or can be flared.

The amount of methane recovery in landfills has increased as a result of the implementation of the European Directive on the landfill of waste (EC, 1999); the amounts of methane recovered and flared have been estimated taking into account the amount of energy produced, the energy efficiency of the methane recovered, the captation efficiency and the efficiency in recovering methane for energy purposes assuming that the rest of methane captured is flared. The emissions from biogas recovered from landfills and used for energy purposes are reported in the energy sector in "1A4a biomass" category together with wood, the biomass fraction of incinerated waste and biogas from wastewater plants. In Table 8.12 consumptions and low calorific values are reported for the year 2012.

Table 8.12 1A4a biomass detailed activity data. Year 2012

Fuels		Consumption (Gg)	LCV (TJ/Gg)
Wood and similar	Wood	57.32	10.46
	Steam Wood	0.22	31.38
Incinerated waste (biomass)		2968.54	9.20
Biogas from landfills		356.61	50.04
Biogas from wastewater plants		19.33	50.04

The total CH_4 recovered is the sum of methane flared and methane used for energy purposes (see figure 8.2). The methane used for energy production is estimated starting from the electricity produced annually (E=GWh*3.6=TJ) by landfills (TERNA, several years) assuming an energy conversion efficiency equal to 0.3, typical efficiency value for engines that produce electricity from biogas (Colombo, 2001), and a LCV (Lower Calorific Value) equal to 50.038 TJ/Gg:

$$((E/0.3)/50.038)*1000= CH_4 \text{ Mg/year}$$

The LCV used for biogas derives from national experts and it is verified with energy and quantitative data about biogas production from waste supplied by TERNA (National Independent System Operator). For the years 1987, 1988, 1989 and 1990, the methane flared is supplied by the plants (De Poli and Pasqualini, 1991); from 1991 to 1997 the methane flared has been extrapolated from the previous years; finally, for the following years the methane flared has been estimated using information based on monitored data supplied by the main operators (Asja, 2003 and Acaia, 2004) regarding the efficiency in recovering methane for energy purposes with respect to the total methane collected. This efficiency value increased from 60% of the total, in 1998, to 70% since 2002. Total methane collected is estimated, in 2012, equal to 50% of the total methane produced.

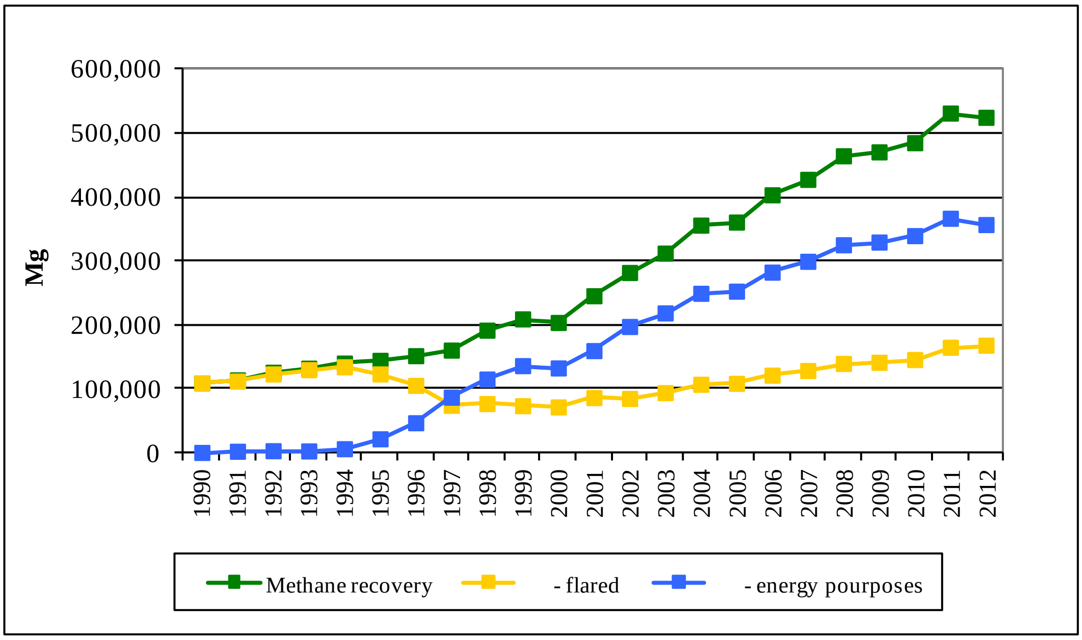


Figure 8.2 Methane recovery distinguished in flared amount and energy purposes (Mg)

CH_4 and NMVOC emission time series

The time series of CH_4 emissions is reported in Table 8.13; emissions from the amount used for energy purposes are estimated and reported under category 1A4a.

Whereas waste production continuously increases, from 2001 solid waste disposal on land has decreased as a consequence of waste management policies, although fluctuations in the amounts of industrial waste and sludge could influence this trend. At the same time, the increase in the methane-recovered percentage has led to a reduction in net emissions.

Further reduction is expected in the future because of the increasing in waste recycling.

Table 8.13 VOC produced, recovered and CH_4 and NMVOC net emissions, 1990 – 2012 (Gg)

EMISSIONS	1990	1995	2000	2005	2010	2011	2012
Managed Landfills							
VOC produced (Gg)	648.1	755.0	1,028.3	1,084.6	1,085.6	1,082.5	1,054.6
VOC recovered (Gg)	108.9	144.1	203.4	360.5	484.7	531.1	524.4

EMISSIONS	1990	1995	2000	2005	2010	2011	2012
VOC recovered (%)	16.8	19.1	19.8	33.2	44.6	49.1	49.7
CH_4 net emissions (Gg)	479.0	542.6	732.8	643.2	533.8	489.8	470.9
NMVOC net emissions (Gg)	6.3	7.1	9.7	8.5	7.0	6.5	6.2
Unmanaged Landfills							
VOC produced (Gg)	250.6	217.7	143.2	96.8	75.2	71.6	68.2
VOC recovered (Gg)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CH_4 net emissions (Gg)	247.3	214.9	141.4	95.6	74.2	70.7	67.3
NMVOC net emissions (Gg)	3.3	2.8	1.9	1.3	1.0	0.9	0.9

8.2.3 Uncertainty and time-series consistency

The uncertainty in CH_4 emissions from solid waste disposal sites has been estimated both by Approach 1 and Approach 2 of the IPCC guidelines.
Following Approach 1, the combined uncertainty is estimated to be 36.1%, 20% and 30% for activity data and emission factors, respectively, as suggested by the IPCC Good Practice Guidance (IPCC, 2000).
Applying Montecarlo analysis, the resulting uncertainty is estimated equal to 12.6% in 2009. Normal distributions have been assumed for most of the parameters; whenever assumptions or constraints on variables were known this information has been appropriately reflected on the choice of type and shape of distributions. A summary of the results is reported in Annex 1.

Emissions from landfills (Table 8.13) are influenced, apart from the amount of waste landfilled, also from waste composition, as for each biodegradability class different parameters are used in the model. The total amount of waste disposed into managed landfills increased until 2000 (in 2000 the landfilling of waste in unmanaged landfills has stopped too), then it decreased from 2000 to 2003, while from 2003 it is quite stable. In the last two years, due to the increasing in collection and recycling, but also to the economic crisis, the amount of waste disposed of in landfills is significantly decreased. We enhance that the total amount of waste disposed of is the sum of municipal solid wastes (which have decreased due to the enforcement of the legislation), sludge and industrial waste, which are subjected to fluctuation. As previously reported, four waste compositions have been used, changing from 1950 to 2012 as well as the percentage of rapidly, moderately and slowly biodegradable fraction. The combination of the amount of waste landfilled and the waste composition has led to an increase of methane production from 1990 to 2002 and stabilization from 2003 to 2012. At the same time, biogas recovery has increased from 1990 to 2012, but from 2000 the recovery rate is higher: in 2012 the methane recovered is about half of the methane produced.

8.2.4 Source-specific QA/QC and verification

The National Waste cadastre is managed by ISPRA and is formed by a national branch hosted by ISPRA and regional and provincial branches hosted by the Regional Agencies for the Protection of the Environment. So the system requires continuous and systematic knowledge exchange and QA/QC checks in order to ensure homogeneity of information concerning waste production and management throughout the entire Italian territory. At central level, ISPRA provides assessment criteria and procedures for data validation, through the definition of uniform standard procedures for all regional branches. The national branch, moreover, ensures spreading of the procedures and training of technicians in each regional branch. Data are validated by ISPRA detecting potential errors and data gaps, comparing among different data sources and asking for further explanation to the regional branches whenever needed. Moreover, ISPRA has started a number of sectoral studies with a view to define specific waste production coefficients related to each production process. So through the definition of such 'production factors' and the knowledge of statistical information on production, it is possible to estimate the amount of waste originated from each sector for the selected territorial grid cell and compare the results to the statistical data on waste production.

For general QC checks on emission estimates and related parameters, each inventory expert fills in, during the inventory compilation process, a format with a list of questions to be answered which helps the compiler avoid potential errors and is also useful to prove the appropriateness of the methodological choices.
Moreover, an in depth analysis of EWC codes of waste disposed of in landfills has been done for the year 2007, thanks to the complete database of Waste Cadastre kindly supplied by ISPRA Waste Office. This accurate analysis has permitted to verify the correctness of waste typology assumptions used for the estimations.
Finally, an important improvement in waste data collection has been implemented by ISPRA and the Regional Agencies for the Protection of the Environment, consequently the waste statistical report includes the urban waste data referred to last years allowing a timely reporting.

8.2.5 Source-specific recalculations

Recalculations in the sector have been done because the quantity of waste disposed in landfill has been updated since 2010 (ISPRA, several years) producing a recalculation for 2011.
In Table 8.14, municipal and industrial (assimilated to MSW) wastes disposed into non hazardous landfills are reported also for Submission 2013, with differences in percentage.

Table 8.14 MSW disposed into landfills time series, 1990 – 2012 (t), AMSW disposed into landfills time series, 1990 – 2012 (t), and differences in percentage between Submission 2014 and Submission 2013.

Year	Submission 2014			Submission 2013			Δ% MSW	Δ% AMSW	Δ% Total
	MSW to landfill (t)	AMSW to landfill (t)	Total waste (except sludge) to landfill (t)	MSW to landfill (t)	AMSW to landfill (t)	Total waste (except sludge) to landfill (t)			
1990	17,431,760	2,827,867	20,259,627	17,431,760	2,827,867	20,259,627	-	-	-
1995	22,458,880	2,977,672	25,436,552	22,458,880	2,977,672	25,436,552	-	-	-
2000	21,917,417	2,825,340	24,742,757	21,917,417	2,825,340	24,742,757	-	-	-
2005	17,225,728	2,913,697	20,139,425	17,225,728	2,913,697	20,139,425	-	-	-
2006	17,525,881	2,480,830	20,006,711	17,525,881	2,480,830	20,006,711	-	-	-
2007	16,911,545	2,776,637	19,688,182	16,911,545	2,776,637	19,688,182	-	-	-
2008	16,068,760	3,703,220	19,771,980	16,068,760	3,703,220	19,771,980	-	-	-
2009	15,537,822	3,180,904	18,718,726	15,537,822	3,180,904	18,718,726	-	-	-
2010	15,015,119	3,508,400	18,523,519	15,015,119	3,508,400	18,523,519	-	-	-
2011	13,205,749	2,882,686	16,088,435	15,644,147	3,468,979	19,113,126	-16%	-17%	-16%
2012	11,663,832	2,291,946	13,955,778						

The amount of VOC recovered has also been updated as reported in Table 8.15.
These updates have influenced methane and NMVOC emissions. In Table 8.15 differences in percentage between emissions from landfills reported in the updated time series and 2013 submission are presented.

Table 8.15 Differences in percentage between emissions from landfills reported in the updated time series and 2013 submission

EMISSIONS	1990	1995	2000	2005	2010	2011
Managed Landfills						
VOC produced (Gg)	-	-	-	-	-	-0.03%
VOC recovered (Gg)	-	-	-	-	-	8.26%
CH_4 net emissions (Gg)	-	-	-	-	-	-6.90%
NMVOC net emissions (Gg)	-	-	-	-	-	-6.90%
Unmanaged Landfills						

VOC produced (Gg)	-	-	-	-	-	-
VOC recovered (Gg)	-	-	-	-	-	-
CH_4 net emissions (Gg)	-	-	-	-	-	-
NMVOC net emissions (Gg)	-	-	-	-	-	-

8.2.6 Source-specific planned improvements

Currently, more recent data on the fraction of CH_4 in landfill gas and on the amount of landfill gas collected and treated are under investigation. A survey on industrial sludge disposed of into landfills for hazardous waste is ongoing and relates to 2010 activity data.

8.3 Wastewater handling (6B)

8.3.1 Source category description

Under source category 6B, CH_4 and N_2O are estimated both from domestic and commercial wastewater as well as from industrial wastewaters.
In Table 8.16 an emission reporting scheme is shown.

Table 8.16 Emissions reporting scheme

6.B.1 Industrial wastewater	
Wastewater	
Sludge	Emissions from sludge are reported in 6.B.1 Industrial wastewater/wastewater
6.B.2 Domestic and commercial wastewater	
6.B.2.1 Domestic and commercial wastewater	
Wastewater	N_2O emissions are reported in 6.B.2.2 Human sewage
Sludge	N_2O emissions are reported in 6.B.2.2 Human sewage
6.B.2.2 Human sewage	

The principal by-product of the anaerobic decomposition of the organic matter in wastewater is methane gas. Normally, CH_4 emissions are not encountered in untreated wastewater because even small amounts of oxygen tend to be toxic to the organisms responsible for the production of methane. Occasionally, however, as a result of anaerobic decay in accumulated bottom deposits, methane can be produced. Again, wastewater collected in closed underground sewers is not believed to be a significant source of CH_4 (IPCC, 2006).
In 2005, about 84% of population is served by sewer systems, whereas 74.8% of population is served by wastewater treatment plants (COVIRI, 2005).
In the framework of the Urban Wastewater Treatment Directive (UWWTD, 2011) regarding agglomerations ≥ 2,000 p.e. (population equivalent) and referred to reporting year 2007, Italy reported the following data: 3,246 agglomerations ≥ 2,000 p.e. and 97.8% of all agglomerations have a collecting system in place; 2,942 of these agglomerations (or 90.6% of the total generated load) have installations for secondary treatment in place, while 2,584 agglomerations (or 79.6% of the total generated load) have more stringent treatment installations in place. In unsewered areas, onsite systems, such as Imhoff tanks, are usually used.
On the contrary, in treatment plants, methane is produced from the anaerobic treatment process used to stabilised wastewater sludge.
The plant typology is usually distinguished in ‘primary’ (only physical-chemical unit operations such as sedimentation), ‘secondary’ (biological unit process) or ‘advanced’ treatments, defined as those additional treatments needed to remove suspended and dissolved substances remaining after conventional secondary treatment.
In Italy wastewater handling is managed mainly using a secondary treatment, with aerobic biological units: a wastewater treatment plant standard design consists of bar racks, grit chamber, primary sedimentation, aeration tanks (with return sludge), settling tank, chlorine contact chamber. The stabilization of sludge occurs

in aerobic or anaerobic reactors; where anaerobic digestion is used, the reactors are covered and provided of gas recovery.
As a consequence of these considerations, it is assumed that domestic and commercial wastewaters are treated 95% aerobically and 5% anaerobically. The bad management of aerobic process is assumed equal to 5% as a conservative estimation.
For high strength organic waste, such as some industrial wastewater, anaerobic process is recommended also for wastewater besides sludge treatment.
It is assumed that industrial wastewaters are treated 85% aerobically and 15% anaerobically (IRSA-CNR, 1998).
Emissions from methane recovered, used for energy purposes, in wastewater treatment plants are estimated and reported under category 1A4a, as reported in Table 8.12.
A percentage of 1.7% of domestic and commercial wastewater is currently treated in Imhoff tanks, where the digestion of sludge occurs anaerobically without gas recovery. Therefore, very few emissions from sludge disposal do occur.

8.3.2 Methodological issues

Regarding N_2O emissions from human sewage, the default approach suggested by the IPCC Guidelines (IPCC, 1997), and updated in the Good Practice Guidance (IPCC, 2000), based on population and *per capita* intake protein has been followed. Fraction of nitrogen protein ($Frac_{NPR}$) 0.16 kg N kg^{-1} protein and emission factor (EF_6) 0.01 kg N-N_2O kg^{-1} N produced have been used, whereas the time series of the protein intake is from the yearly FAO Food Balance (FAO, several years) and refers to the Italian value. The estimation procedure checks for consistency with sludge produced and sludge applications, as sludge applied to agriculture soils, sludge incinerated, sludge composting and sludge deposited in solid waste disposal. Sludge spreading is subtracted from human sewage and is not accounted for twice.
N_2O emissions from industrial wastewater have been estimated on the basis of the emission factors equal to 0.25 g N_2O/m^3 of wastewater production (EMEP/CORINAIR, 2007). The wastewater production is resulting from the model for the estimation of methane emissions from industrial wastewater.
The methane estimation concerning industrial wastewaters makes use of the IPCC method based on wastewater output and the respective degradable organic carbon for each major industrial wastewater source. Default emission factors of methane per Chemical Oxygen Demand (COD) equal to 0.25 kg CH_4 kg^{-1} COD, suggested in the IPCC Good Practice Guidance (IPCC, 2000), has been used for the whole time series.
As recommended by the IPCC Good Practice Guidance (IPCC, 2000) for key source categories, data have been collected for several industrial sectors (iron and steel, refineries, organic chemicals, food and beverage, paper and pulp, textiles and leather industry). The total amount of organic material, for each industry selected, has been calculated multiplying the annual production (t $year^{-1}$) by the amount of wastewater consumption per unit of product (m^3 t^{-1}) and by the degradable organic component (kg COD $(m^3)^{-1}$). Moreover, the fraction of industrial degradable organic component removed as sludge has been assumed equal to zero. The yearly industrial productions are reported in the national statistics (ISTAT, several years [a], [b] and [c]), whereas the wastewater consumption factors and the degradable organic component are either from Good Practice Guidance (IPCC, 2000) or from national references. National data have been used in the calculation of the total amount of both COD produced and wastewater output specified as follows: refineries (UP, several years), organic chemicals (FEDERCHIMICA, several years), beer (Assobirra, several years), wine, milk and sugar sectors (ANPA-ONR, 2001), pulp and paper sector (ANPA-FLORYS, 2001; Assocarta, several years), and leather sector (ANPA-FLORYS, 2000; UNIC, several years).

In Table 8.17 detailed references for 2012 are reported: for these national data, slightly differences within the years can occur.

Table 8.17 Wastewater generation and COD values, 2012.

	Wastewater generation (m^3/t)	References	COD (g/l)	References
Coke	1.5	IPCC, 2000	0.1	IPCC, 2000
Petroleum Refineries	UNIONE PETROLIFERA supplies Total COD generated per year			
Organic Chemicals	22.33	FEDERCHIMICA, several years	3	IPCC, 2000
Paints	5.5	IPCC, 2000	5.5	IPCC, 2000
Plastics and Resins	0.6	IPCC, 2000	3.7	IPCC, 2000
Soap and Detergents	3	IPCC, 2000	0.9	IPCC, 2000
Vegetables, Fruits and Juices	20	IPCC, 2000	5.2	IPCC, 2000
Sugar Refining	4	ANPA-ONR, 2001	2.5	ANPA-ONR, 2001
Vegetable Oils	3.1	IPCC, 2000	1.2	IPCC, 2000
Dairy Products	3.9	ANPA-ONR, 2001	2.7	ANPA-ONR, 2001
Wine and Vinegar	3.8	ANPA-ONR, 2001	0.2	ANPA-ONR, 2001
Beer and Malt	5	Assobirra, several years	2.9	IPCC, 2000
Alcohol Refining	24	IPCC, 2000	11.0	IPCC, 2000
Meat and Poultry	13	IPCC, 2000	4.1	IPCC, 2000
Fish Processing	13	same value of Meat and Poultry	2.5	IPCC, 2000
Paper	28	Assocarta, several years	0.1	ANPA-FLORYS, 2001; Assocarta, several years
Pulp	28	Assocarta, several years	0.1	ANPA-FLORYS, 2001; Assocarta, several years
Textiles (dyeing)	60	IPCC, 1995	1.0	IPCC, 2000
Textiles (bleaching)	350	IPCC, 1995	1.0	IPCC, 2000
Leather	0.1	UNIC, several years	4.5	UNIC, several years

CH_4 emissions from sludge generated by domestic and commercial wastewater treatment have been calculated using the IPCC default method on the basis of national information on anaerobic sludge treatment system (IPCC, 1997; IPCC 2000). All the anaerobic digestion systems are equipped with systems to collect the methane produced. The methane collected is partly flared and partly used for energy purposes. The total methane recovered is estimated on the basis of the methane production and the efficiency of captation. Where anaerobic digestion of sludge is used, the reactors are covered and provided of gas recovery and the efficiency of captation is equal to 100%; so the methane recovered and reported in the CRFs is equal to the methane production.

A recent survey by the National Institute of Statistics (ISTAT, 2004) has provided information on urban wastewater treatment plants in Italy for the year 1999: an investigation on previous references has been done and data on primary treatment plants using Imhoff tanks are also available for 1987 (ISTAT, 1991; ISTAT, 1993) and 1993 (ISTAT, 1998 [a] and [b]).

CH_4 emissions have been calculated on the basis of the equivalent inhabitants treated in Imhoff tanks, the organic load in biochemical oxygen demand per person equal to 60 g BOD_5 capita^{-1} d^{-1}, as defined by national legislation and expert estimations (Legislative Decree 11 May 1999, no.152; Masotti, 1996; Metcalf and Eddy, 1991), the fraction of BOD_5 that readily settles equal to 0.3 (ANPA, 2001; Masotti, 1996), and the IPCC emission factor default value of 0.6 g CH_4 g^{-1} BOD_5.

CH_4 emissions from wastewater have been estimated assuming that 5% of domestic and commercial wastewater is treated anaerobically. This assumption may correspond to the Italian situation where wastewater is treated in aerobic biological units with the possibility of bad management cases. Both in the case of the sludge and in the case of wastewater Equation 5.5 reported in the IPCC Good Practice Guidance (IPCC, 2000) has been used. The emission factor has been calculated using the Equation 5.7 (IPCC, 2000), whereas MCF has been assumed equal to 1 (0 – 1) and the default value B_0 = 0.6 kgCH_4/kg BOD.

In the case of sludge, most of the CH_4 produced (263,056 Mg in 2012) is recovered and not emitted because the anaerobic digestion of sludge takes place in reactors covered and provided with gas recovery system and

the efficiency of captation is equal to 100%. Only CH_4 produced in Imhoff tanks (7,060 Mg in 2012) is emitted.
In the case of wastewater, the lack of information has led to use the most conservative estimate considering MCF=1 again.

8.3.3 Uncertainty and time-series consistency

The combined uncertainty in CH_4 emissions from wastewater handling is estimated to be about 104% in annual emissions 100% and 30% for activity data and emission factor respectively, as derived by the IPCC Good Practice Guidance (IPCC, 2000). The uncertainty in N_2O emissions is 30% both for activity data and emission factor as suggested in the GPG (IPCC, 2000).

The amount of total industrial wastewater production is reported, for each sector, in Table 8.18; as previously noted only the 15% of industrial flows are treated anaerobically (IRSA-CNR, 1998).
CH_4 emission trend for industrial wastewater handling for different sectors is shown in Table 8.19, whereas the emission trend for N_2O emissions both from industrial wastewater handling and human sewage is shown in Table 8.20.
Concerning CH_4 emissions from industrial wastewater, neither wastewater flow nor average COD value change much over time, therefore emissions are stable and mainly related to the production data.
The CH_4 emission trend from wastewater and sludge generated by domestic and commercial wastewater treatment is reported in Table 8.21.

Table 8.18 Total industrial wastewater production by sector, 1990 – 2012 (1000 m^3)

Wastewater production (1000 m^3)	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**
Iron and steel	9,534	7,778	6,756	6,861	6,165	7,182	6,276
Oil refinery	NA	NA	NA	NA	NA	NA	NA
Organic chemicals	210,936	212,317	215,049	214,735	214,116	213,691	213,202
Food and beverage	179,120	177,383	182,736	185,657	186,260	182,550	182,944
Pulp and paper	377,167	402,952	387,285	366,025	232,691	264,243	264,528
Textile industry	108,460	103,047	101,572	75,492	64,363	57,846	49,828
Leather industry	23,623	25,002	27,216	18,315	14,250	14,512	13,566
Total	908,840	928,479	920,614	867,085	717,846	740,024	730,344

Table 8.19 CH_4 emissions from anaerobic industrial wastewater treatment, 1990 – 2012 (Gg)

CH_4 Emissions (Gg)	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**
Iron and steel	0.036	0.029	0.025	0.026	0.023	0.027	0.024
Oil refinery	5.850	5.625	4.250	4.750	4.750	4.750	4.750
Organic chemicals	23.794	23.911	24.173	24.177	24.069	23.999	23.892
Food and beverage	22.946	22.112	22.871	23.197	23.447	23.070	23.055
Pulp and paper	0.923	0.986	1.055	0.997	0.544	0.578	0.720
Textile industry	4.067	3.864	3.809	2.831	2.414	2.169	1.869
Leather industry	3.192	3.378	3.677	2.901	2.517	2.449	2.313
Total	60.81	59.91	59.86	58.88	57.76	57.04	56.62

Table 8.20 N_2O emissions from industrial wastewater handling and human sewage, 1990 – 2012 (Gg)

N_2O Emissions (Gg)	1990	1995	2000	2005	2010	2011	2012
Industrial Wastewater	0.227	0.232	0.230	0.217	0.179	0.185	0.183
Human Sewage	5.679	5.500	5.979	5.933	6.206	6.078	6.061
Total	5.91	5.73	6.21	6.15	6.39	6.26	6.24

Table 8.21 CH_4 emissions from sludge generated by domestic and commercial wastewater treatment, 1990 – 2012 (Gg)

Domestic and Commercial Wastewater	1990	1995	2000	2005	2010	2011	2012
Wastewater (5% treated anaerobically)							
Organic loading in wastewater (t $year^{-1}$)	49.80	63.75	74.03	105.63	108.92	109.54	110.17
CH_4 emissions (Gg)	29.88	38.25	44.42	63.38	65.35	65.73	66.10
Sludge (generated by Imhoff tanks)							
Eq. inhabitants treated in Imhoff tanks (10^3 millions)	1,033	1,893	2,144	1,880	1,776	1,785	1,791
Organic loading in sludge (t $year^{-1}$)	6.79	12.43	14.09	12.35	11.67	11.73	11.77
CH_4 emissions (Gg)	4.07	7.46	8.45	7.41	7.00	7.04	7.06

8.3.4 Source-specific QA/QC and verification

Where information is available, wastewater flows and COD concentrations are checked with those reported yearly by the industrial sectoral reports or technical documentation developed in the framework of the Integrated Pollution and Prevention Control (IPPC) Directive of the European Union (http://eippcb.jrc.es).
Moreover, in the framework of EPER/E-PRTR registry the methodology used to estimate emissions from wastewater handling can be used by the operators of wastewater treatment plants to check if their emission data exceed the reporting threshold values.
Finally, a Ph.D. thesis on GHG emissions from wastewater handling has been carried out at Environmental, Hydraulic, Infrastructures and Surveying Engineering Department (DIIAR) of Politecnico di Milano (Solini, 2010), where national methodology has been compared with that reported in 2006 IPCC Guidelines (IPCC, 2006) and with a methodology developed in the framework of a previous thesis Ph.D. for the estimation of emissions from wastewater treatment plants located in Regione Lombardia.

8.3.5 Source-specific recalculations

Recalculations in the sector have been done because the activity data about wastewater from food and beverage industry have been updated since 2008, pulp and paper industry have been updated since 2009. Methane emissions from industrial wastewater showed changes reported in Table 8.22.

Table 8.22 Differences in percentages between time series reported in the updated time series and 2013 submission

CH_4 emissions	1990	1995	2000	2005	2010	2011
Iron and steel	-	-	-	-	-	-
Oil refinery	-	-	-	-	-	-
Organic chemicals	-	-	-	-	-	-
Food and beverage	-	-	-	-	- 1.17	- 1.25
Pulp and paper	-	-	-	-	- 16.82	- 13.69
Textile industry	-	-	-	-	-	-
Leather industry	-	-	-	-	-	-
Total	-	-	-	-	- 0. 67	- 0.67

N_2O emissions from industrial wastewater have been recalculated because food and beverage data have been updated since 2008, pulp and paper data have been updated since 2009.. Regarding human sewage, negligible recalculation occurred in 2005 because of the correction of an error in the sludge nitrogenum content whereas changes in 2010 and 2011 have been due to the update of sludge activity data In Table 8.23, differences in percentage between new time series and 2013 submission are reported.

Table 8.23 Differences in percentages between time series reported in the updated time series and 2013 submission

N_2O Emissions (Gg)	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**
Industrial Wastewater	-	-	-	- -	0.01	0.02
Human Sewage	-	-	-	0.00	0.00	0.00

8.3.6 Source-specific planned improvements

Methane conversion factor from domestic and commercial wastewater will be investigated in the future. Moreover the served population equivalent figures supplied by the National Institute of Statistics will be verified with the results of the next national survey.

8.4 Waste incineration (6C)

8.4.1 Source category description

Existing incinerators in Italy are used for the disposal of municipal waste, together with some industrial waste, sanitary waste and sewage sludge for which the incineration plant has been authorized by the competent authority. Other incineration plants are used exclusively for industrial and sanitary waste, both hazardous and not, and for the combustion of waste oils, whereas there are few plants where residual waste from waste treatments, as well as sewage sludge, are treated. Since 2007, the activity of co-incineration in industrial plants, especially to produce wooden furniture, has increased significantly, resulting in an increase of the relevant emissions related to the proportion of waste burned.
Emissions from incineration of human bodies in crematoria have been estimated too.
As mentioned above, emissions from waste incineration facilities with energy recovery are reported under category 1A4a (Combustion activity, commercial/institutional sector, see Table 8.12) in the "Other fuel" and "Biomass" sub category for the fossil and biomass fraction of wastes, respectively, whereas emissions from other types of waste incineration facilities are reported under category 6C (Waste incineration). For 2012, more than 95% of the total amount of waste incinerated is treated in plants with energy recovery system.
A complete database of the incineration plants is now available, updated with the information reported in the yearly report on waste production and management published by ISPRA (APAT-ONR, several years; ISPRA, several years).
Emissions from removable residues from agricultural production are included in the IPCC category 6C: the total residues amount and carbon content have been estimated by both IPCC and national factors. The detailed methodology is reported in Chapter 6 (6.6.2).
CH_4 emissions from biogenic, plastic and other non-biogenic wastes have been calculated.

8.4.2 Methodological issues

Regarding GHG emissions from incinerators and crematoria, the methodology reported in the IPCC Good Practice Guidance (IPCC, 2000) has been applied, combined with that reported in the CORINAIR Guidebook (EMEP/CORINAIR, 2007; EMEP/EEA, 2009). A single emission factor for each pollutant has been used combined with plant specific waste activity data. Since 2010, NO_x, SO_2 and CO emission factors for urban waste incinerators have been updated on the basis of data provided by plants (ENEA-federAmbiente, 2012; De Stefanis P., 2012)

As regard incineration plants, emissions have been calculated for each type of waste: municipal, industrial, hospital, sewage sludge and waste oils.
A complete database of these plants has been built, on the basis of various sources available for the period of the entire time series, extrapolating data for the years for which no information was available (MATTM, several years; ANPA-ONR, 1999 [a] and [b]; APAT, 2002; APAT-ONR, several years; AUSITRA-Assoambiente, 1995; Morselli, 1998; FEDERAMBIENTE, 1998; FEDERAMBIENTE, 2001; AMA-Comune di Roma, 1996; ENI S.p.A., 2001; COOU, several years).
For each plant a lot of information is reported, among which the year of the construction and possible upgrade, the typology of combustion chamber and gas treatment section, if it is provided with energy recovery (thermal or electric), and the type and amount of waste incinerated (municipal, industrial, etc.).
Different procedures were used to estimate emission factors, according to the data available for each type of waste, except CH_4 emission factor that is derived from EMEP Corinair (EMEP/CORINAIR, 2007).

Specifically:

1 for municipal waste, emission data from a large sample of Italian incinerators were used (FEDERAMBIENTE, 1998; ENEA-federAmbiente, 2012);
2 for industrial waste and waste oil, emission factors have been estimated on the basis of the allowed levels authorized by the Ministerial Decree 19 November 1997, n. 503 of the Ministry of Environment;
3 for hospital waste, which is usually disposed of alongside municipal waste, the emission factors used for industrial waste were also applied;
4 for sewage sludge, in absence of specific data, reference was made to the emission limits prescribed by the Guidelines for the authorisation of existing plants issued on the Ministerial Decree 12 July 1990.

In Table 8.24, emission factors are reported in kg per tons of waste treated, for municipal, industrial, hospital waste, waste oils and sewage sludge.

Table 8.24 Waste incineration emission factors

POLLUTANT/WASTE TYPOLOGY	NMVOC (kg/t)	CO (kg/t)	CO_2 fossil (kg/t)	N_2O (kg/t)	NO_x (kg/t)	SO_2 (kg/t)	CH_4 (kg/t)
Municipal waste 1990 - 2009	0.46	0.07	289.26	0.1	1.15	0.39	0.06
Municipal waste since 2010	0.46	0.07	289.26	0.1	0.62	0.02	0.06
Hospital waste	7.4	0.075	1200	0.1	0.604	0.026	0.06
Sewage sludge	0.25	0.6	0	0.227	3	1.8	0.06
Waste oils	7.4	0.075	3000.59	0.1	2	1.28	0.06
Industrial waste	7.4	0.56	1200	0.1	2	1.28	0.06

Here below (Tables 8.25, 8.26, 8.27, 8.28), details about data and calculation of specific emission factors are reported. Emission factors have been estimated on the basis of a study conducted by ENEA (De Stefanis, 1999), based on emission data from a large sample of Italian incinerators (FEDERAMBIENTE, 1998; AMA-Comune di Roma, 1996), legal thresholds (Ministerial Decree 19 November 1997, n. 503 of the Ministry of Environment; Ministerial Decree 12 July 1990), the last study conducted by ENEA and federAmbiente (ENEA-federAmbiente, 2012) and expert judgements.
In details, CO_2 emission factor for municipal waste has been calculated considering a carbon content equal to 23%; moreover, on the basis of the IPCC Guidelines (IPCC, 1997) and referring to the average content analysis on a national scale (De Stefanis P., 2002), a distinction was made between CO_2 from fossil fuels (generally plastics) and CO_2 from renewable organic sources (paper, wood, other organic materials). Only emissions from fossil fuels, which are equivalent to 35% of the total, were included in the inventory. This fraction is not expected to change significantly because of the energy characteristics required for the waste incinerated.
CO_2 emission factor for industrial, oils and hospital waste has been derived as the average of values of investigated industrial plants. On the other hand, CO_2 emissions from the incineration of sewage sludge were

not included at all, while all emissions relating to the incineration of hospital and industrial waste were considered.
In Table 8.29 activity data are reported by type of waste.

Table 8.25 Municipal waste emission factors

MUNICIPAL WASTE	Average concentration values (mg/Nm^3)		Standard specific flue gas volume (Nm^3/KgMSW)		E.F. (g/Mg)	
	1990-2009	2010	1990-2009	2010	1990-2009	2010
SO_2	78.00	2.17	5	6.7	390	18
NO_x	230.00	97.08			1,150	621
CO	14.00	12.30			70	73
N_2O					100	100
CH_4					59.80	59.80
NMVOC					460.46	460.46
C content, % weight	23	23				
CO_2					826.5 (kg/Mg)	826.5(kg/Mg)

Table 8.26 Industrial waste and oils emission factors

INDUSTRIAL AND OIL WASTE	Average concentration values (mg/Nm^3)	Standard specific flue gas volume (Nm^3/KgMSW)	E.F. (g/t)
SO_2	160.00	8	1,280
NO_x	250.00		2,000
CO	70.00		560
N_2O			100
CH_4			59.80
NMVOC			7,400
CO_2			1,200 (kg/t)

Table 8.27 Hospital waste emission factors

HOSPITAL WASTE	Average concentration values (mg/Nm^3)	Standard specific flue gas volume (Nm^3/KgMSW)	E.F. (g/t)
SO_2	3.24	8	26
NO_x	75.45		604
CO	9.43		75
N_2O			100
CH_4			59.80
NMVOC			7,400
CO_2			1,200 (kg/t)

Table 8.28 Sewage sludge emission factors

SEWAGE SLUDGE	Average concentration values (mg/Nm^3)	Standard specific flue gas volume (Nm^3/KgMSW)	E.F. (g/t)
SO_2	300	6	1,800
NO_x	500		3,000
CO	100		600
N_2O			100
CH_4			59.80
NMVOC			251.16
CO_2			700 (kg/t)

Table 8.29 Amount of waste incinerated by type, 1990 – 2012 (Gg)

	1990	1995	2000	2005	2010	2011	2012
Total Waste incinerated	1,656	2,149	3,062	4,964	6,980	7,189	6,938
- with energy recovery	911	1,558	2,752	4,721	6,793	7,011	6,762
- without energy recovery	745	591	310	243	186	179	176
MSW incinerated	1,026	1,437	2,325	3,220	4,337	4,758	4,604
- with energy recovery	626	1,185	2,161	3,168	4,284	4,720	4,567
- without energy recovery	399	251	164	52	53	38	37
Industrial Waste incinerated							
Other waste	*473*	*536*	*604*	*1,602*	*2,502*	*2,282*	*2,187*
- with energy recovery	258	330	510	1,447	2,397	2,171	2,078
- without energy recovery	215	206	94	155	105	111	109
Hospital waste	*134*	*152*	*110*	*126*	*135*	*143*	*141*
- with energy recovery	25	41	77	106	113	119	117
- without energy recovery	109	111	34	21	23	24	24
Sludge	*20.72*	*23.18*	*21.50*	*15.60*	*5.98*	*6.33*	*6.23*
- with energy recovery	0.00	0.00	3.40	0.00	0.00	0.00	0.00
- without energy recovery	20.72	23.18	18.11	15.60	5.98	6.33	6.23
Waste oil	*2.66*	*1.41*	*0.82*	*0.67*	*0.18*	*0.18*	*0.05*
- with energy recovery	1.77	0.94	0.55	0.54	0.18	0.18	0.05
- without energy recovery	0.89	0.47	0.27	0.12	0.00	0.00	0.00

CH_4 and N_2O emissions from agriculture residues removed, collected and burnt ‘off-site’, as a way to reduce the amount of waste residues, are reported in the waste incineration sub-sector.
Removable residues from agriculture production are estimated for each crop type (cereal, green crop, permanent cultivation) taking into account the amount of crop produced, the ratio of removable residue in the crop, the dry matter content of removable residue, the ratio of removable residue burned, the fraction of residues oxidised in burning, the carbon and nitrogen content of the residues. Most of these wastes refer especially to the prunes of olives and wine, because of the typical national cultivation. Emissions due to stubble burning, which are emissions only from the agriculture residues burned on field, are reported in the agriculture sector, under 4.F. Under the waste sector the burning of removable agriculture residues that are collected and could be managed in different ways (disposed in landfills, used to produce compost or used to produce energy) is reported. Different percentages of the removable agriculture residue burnt for different residues are assumed, varying from 10% to 90%, according to national and international literature. Moreover, these removable wastes are assumed to be all burned in open air (e.g. on field) taking in consideration the higher available CO, NMVOC, PM, PAH and dioxins emission factors. The amount of these wastes treated differently is not supplied, but they are included in the respective sectors (landfill, composting, biogas production for energy purposes, etc.).
The methodology is the same used to calculate emissions from residues burned on fields, in the category 4F, described in details in Chapter 6.

On the basis of carbon and nitrogen content of the residues, CH_4 and N_2O emissions have been calculated, both accounting nearly for 100% of the whole emissions from waste incineration. CO_2 emissions have been calculated but not included in the inventory as biomass. All these parameters refer both to the IPCC Guidelines (IPCC, 1997) and country-specific values (CESTAAT, 1988; Borgioli, 1981).
The amount of biomass from pruning used for domestic heating is reported in the energy sector in the 1A4b category as biomass fuel.
As regard incineration of corpses in crematoria, activity data have been supplied by a specific branch of Federutility, which is the federation of energy and water companies (SEFIT, several years). Emission factors are from EMEP/EEA Air Pollutant Emission Inventory Guidebook (EMEP/EEA, 2009).

In Table 8.30 time series of cremation as well as annual deaths and crematoria in Italy are reported.

Table 8.30 Cremation time series (activity data), 1990 – 2012

	1990	1995	2000	2005	2010	2011	2012
Cremations (no. of corpses)	5,809	15,436	30,167	48,196	77,379	87,871	101,842
Deaths (no. of corpses)	543,700	555,203	560,241	567,304	587,488	593,404	612,883
Mortal remains (no.)	1,000	1,750	1,779	9,880	18,899	23,353	29,009
Cremation percentage	1.07	2.78	5.38	8.50	13.17	14.81	16.62
Crematoria (no.)	NA	31	35	43	53	56	58

The major emissions from crematoria are nitrogen oxides, carbon monoxide, sulphur dioxide, particulate matter, mercury, hydrogen fluoride (HF), hydrogen chloride (HCl), NMVOCs, other heavy metals, and some POPs. Here below emission factors used for GHG emissions estimate; all emission factors are from EMEP/EEA, 2009 except for CH_4 and N_2O, assumed equal to MSW emission factor because not available from 2009 Guidebook. CO_2 emissions have been not calculated for the inventory as human body is 'biomass'.

In Table 8.31 emission factors for cremation are reported.

Table 8.31 Cremation emission factors

POLLUTANT/WASTE TYPOLOGY	NMVOC (kg/body)	CO (kg/body)	N_2O (kg/t)	NO_x (kg/body)	SO_2 (kg/body)	CH_4 (kg/t)
Cremation	0.013	0.141	0.1	0.309	0.544	0.06

8.4.3 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions from waste incineration is estimated to be about 25.5%, 5% and 25% for activity data and emission factors respectively. For N_2O and CH_4 emissions, the combined uncertainty is estimated to be about 100.1% and 20.6%.

The time series of activity data, distinguished in Municipal Solid Waste and other (including cremation), is shown in Table 8.32; CO_2 emission trends for each type of waste category are reported in Table 8.33, both for plants without energy recovery, reported under 6C, and plants with energy recovery, reported under

1A4a. In Table 8.34 N_2O and CH_4 emissions are summarized, including those from open burning and cremation.

In the period 1990-2012, total CO_2 emissions have increased by 293%, but whereas emissions from plants with energy recovery have increased by nearly 639%, emissions from plants without energy recovery decreased by 66% (Table 8.32). While CO_2 emission trend reported in 6C is influenced by the amount of waste incinerated in plant without energy recovery, CH_4 and N_2O emission trend are related to the open burning, as already reported above.

Table 8.32 Waste incineration activity data, 1990 – 2012 (Gg)

Activity Data	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**
MSW Production (Gg)	22,231	25,780	28,959	31,664	32,479	31,386	29,962
MSW Incinerated (%)	4.6%	5.6%	8.0%	10.2%	13.4%	15.2%	15.4%
- in energy recovery plants	2.8%	4.6%	7.5%	10.0%	13.2%	15.0%	15.2%
MSW to incineration (Gg)	1,026	1,437	2,325	3,220	4,337	4,758	4,604
Industrial, Sanitary, Sewage Sludge and Waste Oil to incineration (Gg)	631	712	737	1,744	2,643	2,432	2,334
Cremation (no. of corpses)	5,809	15,436	30,167	48,196	77,379	87,871	101,842
Total Waste to incineration, excluding cremation (6C and 1A4a) (Gg)	1,656	2,149	3,062	4,964	6,980	7,189	6,938

Table 8.33 CO_2 emissions from waste incineration (without and with energy recovery), 1990 – 2012 (Gg)

CO_2 Emissions	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**
Incineration of domestic or municipal wastes (Gg)	115.47	72.64	47.30	15.02	15.31	10.92	10.74
Incineration of industrial wastes (except flaring) (Gg)	257.99	247.11	113.09	185.57	125.87	133.05	130.93
Incineration of hospital wastes (Gg)	131.07	132.73	40.36	24.61	27.12	28.71	28.25
Incineration of waste oil (Gg)	2.66	1.41	0.82	0.36	0.00	0.00	0.00
Incineration of corpses	NO	NO	NO	NO	NO	NO	NO
Waste incineration (6C) (Gg)	507	454	202	226	168	173	170
Waste incineration reported under 1A4a (Gg) – not biomass	526	791	1,331	2,781	4,251	4,074	3,888
Waste incineration reported under 1A4a (Gg) - biomass	337	637	1,161	1,702	2,301	2,536	2,453
Total waste incineration (Gg)	1,033	1,245	1,532	3,007	4,419	4,246	4,058

Table 8.34 N_2O and CH_4 emissions from waste incineration (cremation and open burning included), 1990 – 2012 (Gg)

GAS/SUBSOURCE	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**
N_2O (Gg)							
Waste incineration (6C)	0.13	0.12	0.09	0.09	0.08	0.08	0.08
MSW incineration reported under 1A4a – not biomass	0.05	0.08	0.13	0.27	0.40	0.39	0.37
MSW incineration reported under 1A4a – biomass	0.04	0.08	0.14	0.21	0.28	0.31	0.30

GAS/SUBSOURCE	1990	1995	2000	2005	2010	2011	2012
CH_4 (Gg)							
Waste incineration (6C)	2.09	2.41	2.32	2.56	2.43	2.42	2.42
MSW incineration reported under 1A4a – not biomass	0.03	0.05	0.08	0.16	0.24	0.23	0.22
MSW incineration reported under 1A4a – biomass	0.02	0.05	0.08	0.12	0.17	0.18	0.18

8.4.4 Source-specific QA/QC and verification

Several verification were carried out which led to some recalculations as described in the following paragraph 8.4.5.

8.4.5 Source-specific recalculations

As planned in the previous submissions a rearrangement of incinerators database has been made. During this process an in depth analysis about all incineration plants has been carried out with the target to eliminate double counting and to add eventual not counted plants.

Table 8.35 Differences in percentages between time series reported in the updated time series and 2013 submission

GAS/SUBSOURCE	1990	1995	2000	2005	2010	2011
CO_2 (Gg)						
Waste incineration (6C)	-	-	-	-	-24.03%	-26.37%
MSW incineration reported under 1A4a	-	-	-	-	2.13%	-7.54%
N_2O (Gg)						
Waste incineration (6C)	-	-	-	-	-5.6%	-8.0%
MSW incineration reported under 1A4a	-	-	-	-	1.79%	-6.25%
CH_4 (Gg)						
Waste incineration (6C)	-	-	-	-	-0.1%	-0.2%
MSW incineration reported under 1A4a	-	-	-	-	1.79%	-6.25%

The analysis regarding incineration plants has been conducted through verifications and comparisons with data reported in E-PRTR registry, Emissions Trading Scheme and updated data of waste amount and pollutants emissions (ENEA-federAmbiente, 2012). These investigations have led, in the previous submission, to the right allocation of some plants erroneously reported as incinerators whilst boilers and cement kiln facility already considered in the energy sector have been deleted. In the current submission, recalculations occurred since 2009 because of the update of plants activity data.
In 2009, recalculations in N_2O and CH_4 emissions also occurred because of fixing error in 2009 agriculture waste activity data.

8.4.6 Source-specific planned improvements

An assessment of the changes in GHG EFs across the time series with the aim of reflecting efficiency improvements or other changes with time is planned for the future.

8.5 Other waste (6D)

8.5.1 Source category description

Under this source category CH_4 emissions from compost production have been reported. The amount of waste treated in composting plants has shown a great increase from 1990 to 2012 (from 363,319 Mg to 9,329,725 Mg).

Information on input waste to composting plants are published yearly by ISPRA since 1996, including data for 1993 and 1994 (ANPA, 1998; APAT-ONR, several years; ISPRA, several years), while for 1987 and 1995 only data on compost production are available (MATTM, several years; AUSITRA-Assoambiente, 1995); on the basis of this information the whole time series has been reconstructed.

8.5.2 Methodological issues

The composting plants are classified in two different kinds: plants that treat a selected waste (food, market, garden waste, sewage sludge and other organic waste, mainly from the agro-food industry); and mechanical-biological treatment plants, where the unselected waste is treated to produce compost, refuse derived fuel (RDF), and a waste with selected characteristics suitable for landfilling or incinerating systems.
It is assumed that 100% of the input waste to the composting plants from selected waste is treated as compost, while in mechanical-biological treatment plants 30% of the input waste is treated as compost on the basis of national studies and references (Favoino and Cortellini, 2001; Favoino and Girò, 2001).
For these emissions, literature data (Hogg, 2001) have been used for the emission factor, 0.029 g CH_4 kg^{-1} treated waste, which is the same as the compost production emission factor. The paper referred to considers also national experimental measurements from the Scuola Agraria del Parco di Monza, and reports that methane emissions are expected to be zero where the facility is well operated.
NMVOC emissions have also been estimated: emission factor (51 g NMVOC kg^{-1} treated waste) is from international scientific literature too (Finn and Spencer, 1997).
In Table 8.36, activity data, CH_4 and NMVOC emissions are reported. Moreover, NO_x emissions from sludge spreading are reported.

Table 8.36 CH_4 and NMVOC emissions from compost production, 1990 – 2012 (Gg)

	1990	1995	2000	2005	2010	2011	2012
Waste treated in composting plants (t)							
CH_4 (Gg)							
Compost production (6D)	0.011	0.023	0.097	0.200	0.247	0.251	0.274
NMVOC (Gg)							
Compost production (6D)	0.018	0.040	0.168	0.346	0.429	0.434	0.474
NO_x (Gg)							
Sludge spreading (6D)	0.667	1.069	1.440	1.166	1.319	1.461	1.691

8.5.3 Uncertainty and time-series consistency

The uncertainty in CH_4 emissions from compost production is estimated to be about 100% in annual emissions, 10% and 100% concerning activity data and emission factors respectively.

8.5.4 Source-specific QA/QC and verification

This source category is covered by the general QA/QC procedures.

8.5.5 Source-specific recalculations

Negligible recalculations due to the 2010 compost activity data update.

8.5.6 Source-specific planned improvements

No specific activities are planned.

9 RECALCULATIONS AND IMPROVEMENTS

9.1 Explanations and justifications for recalculations

To meet the requirements of transparency, consistency, comparability, completeness and accuracy of the inventory, the entire time series from 1990 onwards is checked and revised every year during the annual compilation of the inventory. Measures to guarantee and improve these qualifications are undertaken and recalculations should be considered as a contribution to the overall improvement of the inventory.
Recalculations are elaborated on account of changes in the methodologies used to carry out emission estimates, changes due to different allocation of emissions as compared to previous submissions, changes due to error corrections and in consideration of new available information.
The complete revised CRFs from 1990 to 2011 have been submitted as well as the CRF for the year 2012 and recalculation tables of the CRF have been filled in. Explanatory information on the recalculations involving methodological changes between the 2013 and 2014 submissions are reported in Table 9.1.
The revisions that lead to relevant changes in GHG emissions are pointed out in the specific sectoral chapters and summarized in the following section 9.4.1.

9.2 Implications for emission levels

The time series reported in the 2013 submission and the actual one (2014 submission) are summarised in Table 9.2 by gas; differences in emission levels due to recalculations are also reported.
Improvements in the calculation of emission estimates have led to a recalculation of the entire time series of the national inventory. Considering total GHG emissions without LULUCF, estimates show an increase in comparison with the last year submission, equal to 0.01% for the base year and -0.45% for 2011. Considering the national total with the LULUCF sector, the base year has increased by 1.70% and the 2011 emission levels by 2.02%.
Detailed explanations of these recalculations are provided in the sectoral chapters.

For 2011, changes are mainly related to the LULUCF for the reallocation of Plantations subcategory from cropland to forest land, an updated land use classification, a new methodology applied to estimate emissions from fires, new litter coefficients used in forest land carbon stock changes estimates and activity data on organic soil have been updated. These recalculations affected all the GHG reported. Minor recalculations are related to the industrial sector, specifically for F-gases, where leakage rates in manufacturing and in use have been revised and emissions from domestic refrigeration have been reallocated in commercial refrigeration and stationary air conditioning. Other slight deviation, compared to the previous submission, involved the waste sector in relation to the update of waste incinerator fuel consumption for commercial sector.

Changes in the base year levels are related to the same rationales except for the waste sector were no changes occurred.

Table 9.1 Explanations of the main recalculations in the 2014 submission

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methodological descriptions compared to the NIR of the previous year	Please tick where this is also reflected in recalculations compared to the previous years' CRF	If ticked please provide a reference to the relevant section or pages in the NIR and if applicable some more detailed information such as the sub-category or gas concerned for which the description was changed.
Total (Net Emissions)			
1. Energy			
A. Fuel Combustion (Sectoral Approach)			
1. Energy Industries			
2. Manufacturing Industries and Construction			
3. Transport			
4. Other Sectors			
5. Other			
B. Fugitive Emissions from Fuels			
1. Solid Fuels			
2. Oil and Natural Gas			
2. Industrial Processes			
A. Mineral Products			
B. Chemical Industry			
C. Metal Production			
D. Other Production			
E. Production of Halocarbons and SF6			
F. Consumption of Halocarbons and SF6	√	√	See chapter 4 paragraph 7, 2F category. Emissions from Domestic Refrigeration have been reallocated in Commercial Refrigeration and Stationary Air Conditioning, and leakage rates in manufacturing and in use have been revised for the whole time series
G. Other			
3. Solvent and Other Product Use			
4. Agriculture			
A. Enteric Fermentation			
B. Manure Management			
C. Rice Cultivation			
D. Agricultural Soils			
E. Prescribed Burning of Savannas			
F. Field Burning of Agricultural Residues			
G. Other			
5. Land Use, Land-Use Change and Forestry			
A. Forest Land	√	√	Chapter 7 paragraph 2, 5A category. Plantations have been allocated in FL instead of CL. Methodology to estimate emissions from fires has been updated. Methodology to estimate litter coefficients has been changed.
B. Cropland	√	√	Chapter 7 paragraph 3, 5B category. Plantations have been allocated in FL instead of CL. Methodology to estimate emissions from fires has been updated. Methodology to estimate litter coefficients has been changed.
C. Grassland	√	√	Chapter 7 paragraph 4, 5C category. Methodology to estimate emissions from fires has been updated. Methodology to estimate litter coefficients has been changed.
D. Wetlands			
E. Settlements			
F. Other Land			
G. Other			
6. Waste			
A. Solid Waste Disposal on Land			
B. Waste-water			

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methodological descriptions compared to the NIR of the previous year	Please tick where this is also reflected in recalculations compared to the previous years' CRF	If ticked please provide a reference to the relevant section or pages in the NIR and if applicable some more detailed information such as the sub-category or gas concerned for which the description was changed.
Handling			
C. Waste Incineration			
D. Other			
7. Other (as specified in Summary 1.A)			
Memo Items:			
International Bunkers			
Aviation			
Marine			
Multilateral Operations			
CO2 Emissions from Biomass			
NIR Chapter	**DESCRIPTION**		**REFERENCE**
	Please tick where the latest NIR includes major changes in descriptions compared to the previous year NIR		**If ticked please provide some more detailed information for example reference to pages in the NIR**
Chapter 1.2 Institutional arrangements			
Chapter 1.6 QA/QC plan			

Table 9.2 Differences in time series between the 2014 and 2013 submissions due to recalculations

	subm	1990	1995	2000	2005	2008	2009	2010	2011
Net CO_2 emissions/removals (Gg CO_2-eq.)	**2013**	421,621	414,255	435,952	449,563	426,954	374,799	381,940	383,394
	2014	429,213	420,729	444,257	458,089	437,299	386,425	393,426	393,585
Differences		*1.80%*	*1.56%*	*1.91%*	*1.90%*	*2.42%*	*3.10%*	*3.01%*	*2.66%*
CO_2 emissions (without LULUCF) (Gg CO_2-eq.)	**2013**	434,656	444,944	462,278	488,078	463,922	415,089	425,499	414,239
	2014	434,656	444,944	462,278	488,078	463,696	414,810	424,993	413,379
Differences		*0.00%*	*0.00%*	*0.00%*	*0.00%*	*-0.05%*	*-0.07%*	*-0.12%*	*-0.21%*
CH_4 emissions (Gg CO_2-eq.)	**2013**	44,359	44,495	46,191	41,267	38,404	38,282	37,453	36,756
	2014	45,254	44,686	46,692	41,440	38,566	38,464	37,547	36,208
Differences		*2.02%*	*0.43%*	*1.08%*	*0.42%*	*0.42%*	*0.48%*	*0.25%*	*-1.49%*
CH_4 emissions (without LULUCF) (Gg CO_2-eq.)	**2013**	43,761	44,336	45,844	41,107	38,192	38,013	37,290	36,568
	2014	43,766	44,342	45,850	41,102	38,141	37,947	37,233	35,722
Differences		*0.01%*	*0.02%*	*0.01%*	*-0.01%*	*-0.13%*	*-0.17%*	*-0.15%*	*-2.31%*
N_2O emissions (Gg CO_2-eq.)	**2013**	37,680	38,569	39,627	37,751	29,700	28,154	27,132	26,939
	2014	37,808	38,670	39,765	37,863	29,841	28,311	27,264	27,059
Differences		*0.34%*	*0.26%*	*0.35%*	*0.30%*	*0.47%*	*0.56%*	*0.48%*	*0.44%*
N_2O emissions (without LULUCF) (Gg CO_2-eq.)	**2013**	37,396	38,422	39,483	37,668	29,615	28,053	27,076	26,873
	2014	37,462	38,499	39,561	37,754	29,686	28,126	27,129	26,889
Differences		*0.17%*	*0.20%*	*0.20%*	*0.23%*	*0.24%*	*0.26%*	*0.20%*	*0.06%*
HFCs (Gg CO_2-eq.)	**2013**	351	671	1,986	5,401	7,513	8,164	8,745	9,306
	2014	351	680	1,838	5,148	7,162	7,769	8,299	8,804
Differences		*0.00%*	*1.27%*	*-7.45%*	*-4.68%*	*-4.68%*	*-4.84%*	*-5.10%*	*-5.39%*
PFCs (Gg CO_2-eq.)	**2013**	2,487	1,266	1,217	1,715	1,501	1,063	1,331	1,455
	2014	2,487	1,266	1,217	1,715	1,501	1,063	1,331	1,455
Differences		*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*
SF_6 (Gg CO_2-eq.)	**2013**	333	601	493	465	436	398	373	351
	2014	333	601	493	465	436	398	373	351
Differences		*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*
Total (with LULUCF) (Gg CO_2-eq.)	**2013**	506,830	499,858	525,467	536,162	504,507	450,860	456,973	458,202
	2014	515,446	506,632	534,263	544,719	514,803	462,430	468,239	467,463
Differences		*1.70%*	*1.36%*	*1.67%*	*1.60%*	*2.04%*	*2.57%*	*2.47%*	*2.02%*
Total (without LULUCF) (Gg CO_2-eq.)	**2013**	518,984	530,241	551,301	574,433	541,177	490,780	500,314	488,792
	2014	519,055	530,333	551,237	574,262	540,620	490,113	499,359	486,601
Differences		*0.01%*	*0.02%*	*-0.01%*	*-0.03%*	*-0.10%*	*-0.14%*	*-0.19%*	*-0.45%*

9.3 Implications for emission trends, including time series consistency

Recalculations account for an improvement in the overall emission trend and consistency in time series.
In comparison with the time series submitted in 2013, emission levels of the base year, as total emissions in CO_2 equivalent without LULUCF, slightly changed (0.01%) due to the revisions previously described.
If considering emission levels with LULUCF, an increase by 1.7% is observed between the 2013 and 2014 total figures in CO_2 equivalent.

The trend 'base year- year 2011' does not show a significant change from the previous to this year submission.

Figure 9.1 shows the time series of the range of total national GHG emissions due to recalculations in the last years (submissions 2001-2013) and the 2014 emission estimates. Values of the coefficient of variation are also illustrated which show that the first years of the time series were mostly affected by recalculation in terms of variability whereas lower values are observed for the last years. In total, the graph shows that improvements in methodologies guarantee accurate estimates and minor changes from one year to another for the entire time series.

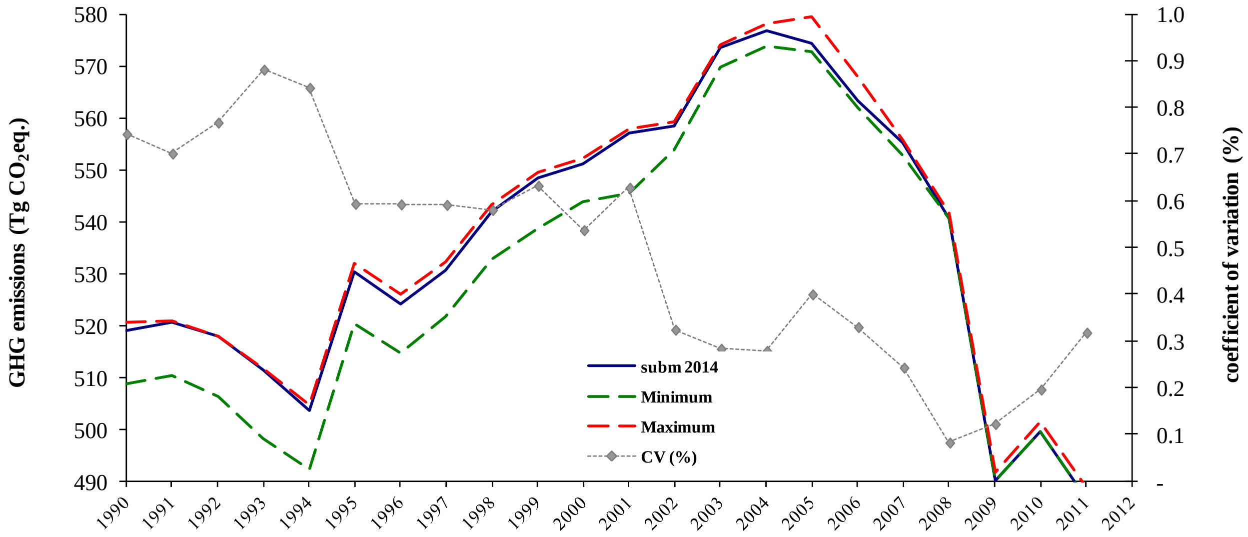


Figure 9.1 Range of national GHG emissions (Tg CO_2 eq.) in the 2001-2014 submissions and coefficient of variation (%)

9.4 Recalculations, response to the review process and planned improvements

This chapter summarises the recalculations and improvements made to the Italian GHG inventory since the last year submission.
In addition to a new year, the inventory is updated annually by a revision of the existing activity data and emission factors in order to include new information available; the update could also reflect the revision of methodologies. Revisions always apply to the whole time series.
The inventory may also be expanded by including categories not previously estimated if sufficient information on activity data and suitable emission factors have been identified and collected.

9.4.1 Recalculations

The key differences in emission estimates occurred since the last year submission are reported in Table 9.1 and Table 9.2.

Besides the usual updating of activity data, recalculations may be distinguished in methodological changes, source allocation and error corrections.
All sectors were involved in methodological changes. Specifically:

Energy. CO_2 emission factor have been updated for natural gas in 2011. Fugitive emissions have been revised on account of the update of activity data on gas distribution. A recalculation in the road transport sector affected CH_4 and N_2O for a revision of emission factors of natural gas fuelled vehicles and all gases for a reallocation of mileages among vehicles; there has also been an update of gas fuel consumption due to double counting of EBTE and bioethanol. In the maritime sector, ship movements were revised. There has been also a revision of biogas activity data in the food processing industry. Moreover, there has been an update of waste fuel consumption with energy recovery.

Industrial sector. Recalculations of CO_2 emissions occurred due to an update of activity data for lime production. In the chemical industry, recalculations occurred for the update of N_2O emission factor for nitric acidic, and N_2O and CO_2 emission factors for adipic acid production; production data for TiO_2 were also changed. For F-gases, recalculations affected HFC emissions from the production of halocarbons for a re-evaluation of the efficiency of the abatement technology and for emissions from the consumption of halocarbons from refrigeration and air conditioning equipment due to a revision of the leakage rates in manufacturing and in use and a reallocation of emissions from domestic refrigeration in commercial refrigeration and stationary air conditioning. Other recalculations occurred for the import-export data of these gases.

Solvent and other product use sector. Recalculations are observed due to the update of activity data on printing consumption, fat edible and non edible oil and cosmetics.

Agriculture. CH_4 emissions have been recalculated due to the update of milk production and fat content in milk for cattle and the revision of the number of animals. N_2O emissions were revised for the update of activity data on organic soils and sewage sludge applied to soils. CH_4 and N_2O emissions also changed for the inclusion of the fur animals category.

LULUCF. Recalculations affected emissions and removals from the sector estimates mainly for the update land use classification and the reallocation of plantations subcategory from cropland to forest land. A new methodology for emissions from fires was applied. Revised litter coefficients were used and there was an update of organic soils activity data.

Waste. Revision of emissions in this sector occurred only for the update of activity data on industrial wastewater, waste disposed of in landfills, compost and waste incinerator fuel consumption in the commercial sector.

9.4.2 Response to the UNFCCC review process

In 2013, the Italian GHG inventory was subject to the in-country review of the 2013 inventory submission.
A complete list of improvements following the UNFCCC review process is reported in Annex 12.

Improvements regarded the completeness and transparency of the information reported in the NIR.

More information on the methodology used to estimate emissions in the energy (carbon stored, iron and steel and fugitive), industrial processes (specifically, cement, iron and steel, and lime production, F-gases estimations), and agriculture sector (manure management and agricultural soils) has been added and the description of country specific methods and the rationale behind the choice of emission factors, activity data and other related parameters for different sector has been better detailed.
The main improvement for LULUCF sector was the update of land use classification and reallocation of plantations subcategory into forest land category.

9.4.3 Planned improvements (e.g., institutional arrangements, inventory preparation)

The main institutional and legal arrangements required under the Kyoto Protocol have been finalized. Main improvements are related to the finalization of activities defined in the framework of national registry for forest carbon sinks, specifically related to the land and land-use changes identification in accordance with paragraph 20 of the annex to decision 16/CMP.1. Time series related to the different IPCC categories areas have been assembled using IUTI data, and the data assessed by the national forest inventories (1985, 2005, 2012). Additional information is provided in Annex 10.

Specific improvements are identified in the relevant chapters and specified in the 2014 QA/QC plan; they can be summarized in the following.

For the energy and industrial sectors, the database where information collected in the framework of different EU legislation, Large Combustion Plant, E-PRTR and Emissions Trading, is annually updated and improved. The database has helped highlighting the main discrepancies in information and detecting potential errors leading to a better use of these data in the national inventory.
For the agriculture and waste sectors, improvements will be related to the availability of new information on emission factors, activity data as well as parameters necessary to carry out the estimates; specifically, for agriculture, improvements are expected for the grazing, housing, storage systems and land spreading information collected by 2010 Agricultural Census, while for waste sector the availability of additional information on waste composition.

For the LULUCF, the third NFI field surveys will allow using of IPCC carbon stock change method to estimate emissions and removals for forest land remaining forest land category. In addition a comparison between the two IPCC methods (carbon stock change vs gains-losses) could be undertaken; the comparison is a valuable verification exercise and is able to highlight any potential outlier which detaches the two estimates.

Additional studies will regard the comparison between local inventories and national inventory and exchange of information with the ‘local inventories’ national expert group.

Further analyses will concern the collection of statistical data and information to estimate uncertainty in specific sectors by implementing Approach 2 of the IPCC guidelines.

PART II: SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1

10 KP-LULUCF

10.1 General information

Under Article 3, paragraph 3, of the Kyoto Protocol (KP), Italy reports emissions and removals from afforestation (A), reforestation (R) and deforestation, and under Article 3, paragraph 4 emissions and removals from forest management (FM). The estimates for emissions and removals under Articles 3.3 and 3.4 are consistent with the IPCC GPG LULUCF 2003 and Decisions 15/CMP.1 and 16/CMP.1 of the KP.

10.1.1 Definition of forest and any other criteria

Forest is defined by Italy under the Kyoto Protocol reporting using the same definition applied by the Food and Agriculture Organization of the United Nations for its Global Forest Resource assessment (FAO FRA 2000). This definition is consistent with the definition given in Decision 16/CMP.1. Forest is a land with the following threshold values for tree crown cover, land area and tree height:

a. a minimum area of land of 0.5 hectares;
b. tree crown cover of 10 per cent;
c. minimum tree height of 5 meters.

Forest roads, cleared tracts, firebreaks and other open areas within the forest as well as protected forest areas are included in forest.
Following 2013 ERT's finding, plantations, previously not included in areas subject to art. 3.3 and 3.4 activities, have been classified as forest and reported in the appropriate Art. 3.3 and 3.4, categories.

10.1.2 Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

Italy has chosen to elect *Forest Management* (FM) as an activity under Article 3.4. In accordance with the Annex to Decision 16/CMP.1, credits from Forest Management are capped in the first commitment period. Following the Decision 8/CMP.2, the cap is equal to 2.78 Mt C (10.19 $MtCO_2$) per year, or to 13.9 Mt C (50.97 $MtCO_2$) for the whole commitment period.

10.1.3 Description of how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time

Afforestation and *reforestation* areas have been estimated on the basis of data of the three Italian National Forest Inventories (IFN1985, IFNC2005 and the on-going INFC2015). *Deforestation* data have been detected by the surveys carried out in the framework of the NFIs (with reference to the years 2005 and 2012); administrative records at NUT2 level collected by the National Institute of Statistics related to deforested area have been used for the period 1990-2005.
The definition of *forest management* is interpreted in using the broader approach as described in the GPG LULUCF 2003. All forests fulfilling the definition of forest, as given above, are considered as managed and are under forest management. The total Italian forest area is eligible under *forest management* activity, since the entire Italian forest area has to be considered managed forest lands.
Concerning *deforestation* activities, in Italy land use changes from forest to other land use categories are allowed in very limited circumstances, as stated in art. 4.2 of the Law Decree n. 227 of 2001.

10.1.4 Description of precedence conditions and/or hierarchy among Article 3.4 activities, and how they have been consistently applied in determining how land was classified

As Italy has elected only *forest management* under Article 3.4 activities, there is no need to build up a hierarchy between *forest management* and other Article 3.4 activities.

10.2 Land-related information

Italy implements the Reporting Method 1 for lands subject to Article 3.3 and Article 3.4 activities. The reporting area boundaries have been identified with the administrative boundaries of Italian regions (NUTS2 level). These areas include multiple units of land subject to *afforestation/reforestation* and *deforestation* and land areas subject to *forest management*. In the reporting, the same geographical boundaries were used for Article 3.3 and Article 3.4 activities. Approach 2 has been used for representing land areas.
Data for land use and land-use changes were obtained by the National Forest Inventories ((IFN1985, IFNC2005 and the on-going INFC2015). IFN1985 was accomplished by means of systematic sampling with a single phase of information gathering on the ground. The sampling points were identified in correspondence to the nodes of a grid with a mesh of 3 km superimposed on the official map of the State on a scale of 1:25.000. Each point therefore represents 900 ha, for a total of 33,500 points distributed within the national territory. IFNC2005 has a three-phase sampling design; the sampling units were 300,000 and were identified in correspondence to the nodes of a grid with a mesh of 1 km superimposed on the official map of the State. A first inventory phase, consisting in interpretation of 1m resolution orthophotos, dated from 2002 to 2003, was followed by ground surveys, in order to assess the forest use, and to detect the main qualitative attributes of Italian forests. The phase 3 has consisted in ground surveys to estimate the values of the main quantitative attributes of forest stands (i.e. volume of growing stock, tree density, annual growth, aboveground biomass, carbon stock, deadwood volume and biomass). A specific survey was dedicated to the soils pool, gaining data on soils carbon stock by 1,500 sampling areas selected in the IFNC2005 original grid. The third national forest inventory, IFNC2015, has the same three-phase sampling design of the previous NFI (INFC2005); the first phase of INFC2015 (interpretation of orhophotos) has been carried out in 2013, resulting in an assessment of forest land area.

10.2.1 Spatial assessment unit used for determining the area of the units of land under Article 3.3

The spatial assessment unit to determine the area of units of land under Article 3.3 is 0.5 ha, which is the same as the minimum area of forest.

10.2.2 Methodology used to develop the land transition matrix

The land transition matrix is shown in Table NIR-2 (Table 10.1). The same data sources are used for the UNFCCC greenhouse gas inventory and for the estimates of emissions and removals under Articles 3.3 and 3.4.
LUC matrices for each year of the period 1990–2012 have been assembled on the basis of the IUTI[54] data, related to 1990, 2000 and 2008. For 2012, land use and land use changes data were assessed through the survey, carried out in the framework of the III NFI, on an IUTI's subgrid (i.e. 301,300 points, covering the entire country). Annual figures for forest land area, and consequently for *afforestation/reforestation* areas, were estimated on the basis of the forest area increase as detected by the National Forest Inventories.
Deforestation data have been detected by the surveys carried out in the framework of the NFIs (with reference to the years 2005 and 2012); administrative records at NUT2 level collected by the National Institute of Statistics related to deforested area have been used for the period 1990-2005. Activities planned in the framework of the registry for carbon sinks are expected to refine these estimates, providing detailed information on the final land use of the deforested area; in the current submission, a conservative approach was applied hypothesising that the total deforested area is converted into settlements. In addition, it should be noted that land use changes due to wildfires are not allowed by national legislation (Law Decree 21 November 2000, n. 353, art.10.1).

[54] Detailed information on IUTI is reported in Annex 10

Table 10.1 Land transition matrices - Areas and changes in areas between the previous and the current inventory years (2008 – 2009 – 2010 – 2011 - 2012) [kha]

2008

	kha	Art 3.3 Aff. / Ref.	Art 3.3 Deforestation	Art. 3.4 FM	Other	*total (beginning of 2008)*
Art 3.3	Aff. / Ref.	**1,378.51**				*1,379*
Art 3.3	Deforestation		**21.92**			*22*
Art. 3.4	FM		3.69	**7,486.23**		*7,490*
	Other	*58.31*			**21,184.93**	*21,243*
	Total (end of 2008)	*1,437*	*25.61*	*7,486*	*21,185*	*30,134*

2009

	kha	Art 3.3 Aff. / Ref.	Art 3.3 Deforestation	Art. 3.4 FM	Other	*total (beginning of 2009)*
Art 3.3	Aff. / Ref.	**1,436.83**				*1,437*
Art 3.3	Deforestation		**25.61**			*26*
Art. 3.4	FM		3.69	**7,482.54**		*7,486*
	Other	*58.31*			**21,126.62**	*21,185*
	Total (end of 2009)	*1,495*	*29.31*	*7,483*	*21,127*	*30,134*

2010

	kha	Art 3.3 Aff. / Ref.	Art 3.3 Deforestation	Art. 3.4 FM	Other	*total (beginning of 2010)*
Art 3.3	Aff. / Ref.	**1,495.14**				*1,495*
Art 3.3	Deforestation		**29.31**			*29*
Art. 3.4	FM		3.69	**7,478.84**		*7,483*
	Other	*58.31*			**21,068.30**	*21,127*
	Total (end of 2010)	*1,553*	*33.00*	*7,479*	*21,068*	*30,134*

2011

	kha	Art 3.3 Aff. / Ref.	Art 3.3 Deforestation	Art. 3.4 FM	Other	*total (beginning of 2010)*
Art 3.3	Aff. / Ref.	**1,553.46**				*1,553*
Art 3.3	Deforestation		**33.00**			*33*
Art. 3.4	FM		3.69	**7,475.15**		*7,479*
	Other	*58.31*			**21,009.99**	*21,068*
	Total (end of 2011)	*1,612*	*36.70*	*7,475*	*21,010*	*30,134*

2012

	kha	Art 3.3 Aff. / Ref.	Art 3.3 Deforestation	Art. 3.4 FM	Other	*total (beginning of 2010)*
Art 3.3	Aff. / Ref.	**1,611.77**				*1,612*
Art 3.3	Deforestation		**36.70**			*37*
Art. 3.4	FM		3.69	**7,471.45**		*7,475*
	Other	*58.31*			**20,951.67**	*21,010*
	Total (end of 2012)	*1,670*	*40.39*	*7,471*	*20,952*	*30,134*

10.2.3 Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

The Italian regions have been used as the geographical units for reporting (Figure 10.1); boundaries of reporting areas have been identified with the administrative boundaries of Italian regions (NUTS2 level). ID-codes have been assigned following the denomination of the different regions.

Figure 10.1 Geographical locations of the reporting regions and their identification codes

10.3 Activity-specific information

10.3.1 Methods for carbon stock change and GHG emission and removal estimates

10.3.1.1 Description of the methodologies and the underlying assumptions used

Methods for estimating carbon stock changes in forests (for Article 3.3 *afforestation/reforestation* and Article 3.4 *forest management*) are the same as those used for the UNFCCC greenhouse gas inventory: details are given in par. 7.2.4. A growth model, For-est, is used to estimate the net change of carbon in the five reporting pools: aboveground and belowground biomass, dead wood and litter, and soils as soil organic matter. Additional information on the methodological aspects may be found in Federici et al., 2008; some specific parameters (i.e. biomass expansion factors, wood basic densities for aboveground biomass estimate, root/shoot ratios) used in the estimation process are the same reported in the above-mentioned article; in other cases (i.e. dead wood or litter pools) different coefficients have been used to deduce the carbon stock changes in the pools, on the basis of the results of the II National Forestry Inventory and the national forest definition. The model has been applied at regional scale (NUTS2) because of availability of forest-related statistical data: model input data for the forest area, per region and inventory typologies, were the Italian forest inventories (NFI1985, INFC2005), while the results of the first phase of the INFC2015 were used in forest area assessment.
Following the 2011 ERT's recommendation regarding soils pool, Italy has decided to apply the IPCC Tier1, assuming that, for land under Forest Management activities, the carbon stock in soil organic matter does not

change, regardless of changes in forest management, types, and disturbance regimes; in other words it has to be assumed that the carbon stock in mineral soil remains constant so long as the land remains forest. Therefore carbon stock changes in soils pool, for land subject to Forest Management, have not been reported, and transparent and verifiable information that the pool is not a net source for Italy is provided in par. 10.3.1.2.

Italy uses the IPCC default land use transition period of 20 years, to estimate carbon stock changes in soils pools for afforestation/reforestation activities under art. 3.3 of the Kyoto Protocol.

In the KP CRF tables changes in carbon stock are reported in terms of gains and losses, for aboveground and belowground biomass, and net carbon stock change for the remaining pools (dead wood, litter, soils).

Concerning carbon stock changes resulting from *deforestation* activities, for the current submission a conservative approach was applied, hypothesising that the total deforested area is converted into settlements. Activities planned in the framework of the registry for carbon sinks are expected to refine these estimates, providing detailed information on the final land use of the deforested area. In addition, it should be noted that land use changes due to wildfires are not allowed by national legislation (Law Decree 21 November 2000, n. 353, art.10, comma 1). Carbon stock changes related to the forest land areas, before deforestation activities, have been estimated, for each year and for each pool (living biomass, dead organic matter and soils), on the basis of forest land carbon stocks deduced from the model described in par. 7.2.4. The loss, in terms of carbon, due to deforested area is computed assuming that the total amount of carbon, existing in the different pools before deforestation, is lost.

GHG emissions from biomass burning were estimated with the same method as described in par. 7.12.2. CO_2 emissions due to forest fires in areas subject to art. 3.3 and art 3.4 activities have been included in corresponding tables: in particular, CO_2 emissions from biomass burning in land subject to art 3.3 activities are included in Table 5(KP-I)A.1.1, Losses (Aboveground and belowground pools), while CO_2 emissions from burnt areas under *forest management* are included in Table 5(KP-I)B.1, Forest Management, Losses (Aboveground and belowground pools).

10.3.1.2 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

Following the main finding of 2011 review process, Italy has decided not to account for the soil carbon stock changes from activities under Article 3.4, providing transparent and verifiable information to demonstrate that soils pool is not a source in Italy, as required by par. 21 of the annex to decision 16/CMP.1).

Art. 3.4 – Forest Management: demonstration that soils pool is not a source

Carbon stock changes in minerals soils, for *Forest land remaining Forest land* and for land under art. 3.4 (*Forest Management*) activities, have been estimated from the aboveground carbon amount with linear relations (SOC = f ($C_{Aboveground}$)), per forestry use – stands (resinous, broadleaves, mixed stands) and coppices, calculated on data collected within the European project Biosoil[55] (for soils) and a Life+ project FutMon[56] (*Further Development and Implementation of an EU-level Forest Monitoring System*), for the aboveground biomass. Soil carbon stocks of mineral soils were assessed down to 40 cm with layer-based sampling (0-10, 10-20, 20-40 cm) on 227 forest plots on a 15x18 km grid. Data have been calculated layer by layer by using measured data of layer depth and soil carbon concentration (704 values), bulk density (543 measured data, 163 estimated data in the field or using pedofunctions) and volume of coarse fragment (704 values estimated in the field). BioSoil assessed also OF and OH layer in which organic material is in various states of decomposition (down to humus). Those layers were included in the estimation of carbon stocks in mineral soils. In Table 10.2 the different relations used to obtain soil carbon amount per ha [t C ha^{-1}] from the aboveground carbon amount per ha [t C ha^{-1}] have been reported.

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[55] BioSoil project – http://www3.corpoforestale.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/487/UT/systemPrint; http://www.inbo.be/content/page.asp?pid=EN_MON_FSCC_condition_report

[56] FutMon: Life+ project for the "*Further Development and Implementation of an EU-level Forest Monitoring System*"; http://www.futmon.org; http://www3.corpoforestale.it/flex/cm/pages/ServeAttachment.php/L/IT/D/D.e54313ecaf7ae893e249/P/BLOB%3AID%3D397

Table 10.2 Relations soil - aboveground carbon per ha

	Inventory typology	**Relation soil – aboveground C per ha**	R^2	**Standard error**
stands	norway spruce	y = 0.2218x + 73.005	0.0713	40.14
	silver fir	y = 0.2218x + 73.005	0.0713	40.14
	larches	y = 0.2218x + 73.005	0.0713	40.14
	mountain pines	y = 0.2218x + 73.005	0.0713	40.14
	mediterranean pines	y = 0.2218x + 73.005	0.0713	40.14
	other conifers	y = 0.2218x + 73.005	0.0713	40.14
	european beech	y = 0.2502x + 79.115	0.0925	44.10
	turkey oak	y = 0.2502x + 79.115	0.0925	44.10
	other oaks	y = 0.2502x + 79.115	0.0925	44.10
	other broadleaves	y = 0.2502x + 79.115	0.0925	44.10
coppices	european beech	y = 0.2683x + 70.208	0.073	33.39
	sweet chestnut	y = 0.2683x + 70.208	0.073	33.39
	hornbeams	y = 0.2683x + 70.208	0.073	33.39
	other oaks	y = 0.2683x + 70.208	0.073	33.39
	turkey oak	y = 0.2683x + 70.208	0.073	33.39
	evergreen oaks	y = 0.2683x + 70.208	0.073	33.39
	other broadleaves	y = 0.2683x + 70.208	0.073	33.39
	conifers	y = 0.2218x + 73.005	0.0713	40.14
plantations	eucalyptuses coppices	y = 0.2683x + 70.208	0.073	33.39
	other broadleaves coppices	y = 0.2683x + 70.208	0.073	33.39
	poplars stands	y = 0.2502x + 79.115	0.0925	44.10
	other broadleaves stands	y = 0.2502x + 79.115	0.0925	44.10
	conifers stands	y = 0.2218x + 73.005	0.0713	40.14
protec tive	rupicolous forest	y = 0.3262x + 68.648	0.1338	38.96
	riparian forest	y = 0.3262x + 68.648	0.1338	38.96

Linear relationships resulted in different trends for the different forest inventory typologies. In the following Table 10.3 the Soil Organic Content (SOC) per hectare, inferred by the use of the linear relationships, is shown for the different inventory typologies and different years.

Table 10.3 Soil Organic Content (SOC) per hectare, for the different inventory typologies

	Inventory typology	1990 *t C ha⁻¹*	1995 *t C ha⁻¹*	2000 *t C ha⁻¹*	2005 *t C ha⁻¹*	2010 *t C ha⁻¹*	2012 *t C ha⁻¹*
stands	norway spruce	86.17	85.56	84.99	84.63	84.50	84.42
	silver fir	87.71	86.53	85.53	85.26	85.15	85.01
	larches	84.10	83.24	82.56	82.38	82.47	82.40
	mountain pines	84.33	85.09	85.78	86.86	87.84	88.20
	mediterranean pines	83.84	85.53	87.00	88.71	89.82	90.17
	other conifers	80.40	81.11	81.72	82.61	83.53	83.80
	european beech	99.85	99.52	99.38	99.71	99.97	100.09
	turkey oak	95.64	95.85	96.12	96.79	97.10	97.16
	other oaks	89.78	90.07	90.43	91.23	91.74	91.82
	other broadleaves	90.28	90.21	90.18	90.76	91.20	91.24
coppices	european beech	84.09	83.70	83.32	83.29	83.58	83.66
	sweet chestnut	85.00	88.24	90.86	93.63	96.44	97.50
	hornbeams	76.81	76.48	76.21	76.11	76.15	76.17
	other oaks	75.87	76.33	76.58	76.82	77.06	77.16
	turkey oak	79.78	79.27	78.82	78.57	78.49	78.48
	evergreen oaks	80.17	79.98	79.81	79.82	79.88	79.94
	other broadleaves	79.16	80.90	82.27	83.60	84.81	85.20
	conifers	80.46	80.96	81.37	82.00	82.70	82.96
plantations	eucalyptuses coppices	84.75	88.28	89.38	90.05	89.96	89.60
	other broadleaves coppices	85.68	88.80	90.09	90.78	91.26	91.37
	poplars stands	89.32	93.19	95.62	97.52	98.91	99.31
	other broadleaves stands	87.82	87.65	87.84	88.41	89.13	89.42
	conifers stands	83.11	84.95	87.40	90.73	94.35	95.86
protective	rupicolous forest	77.33	77.87	78.41	79.07	79.74	79.95
	riparian forest	84.62	84.08	83.66	83.42	83.58	83.58

Table 10.4 Carbon stock changes in mineral soils (Soil Organic Matter (SOM) pool)

Inventory typology	1990 *Gg C*	1995 *Gg C*	2000 *Gg C*	2005 *Gg C*	2010 *Gg C*	2012 *Gg C*
stands	1,926	2,314	2,165	2,493	2,001	1,773
coppices	3,475	3,830	3,623	3,758	3,139	3,010
rupicolous and riparian forests	567	649	623	655	480	459
plantations	244	206	187	185	118	103
Total	**6,212**	**6,999**	**6,599**	**7,091**	**5,737**	**5,345**

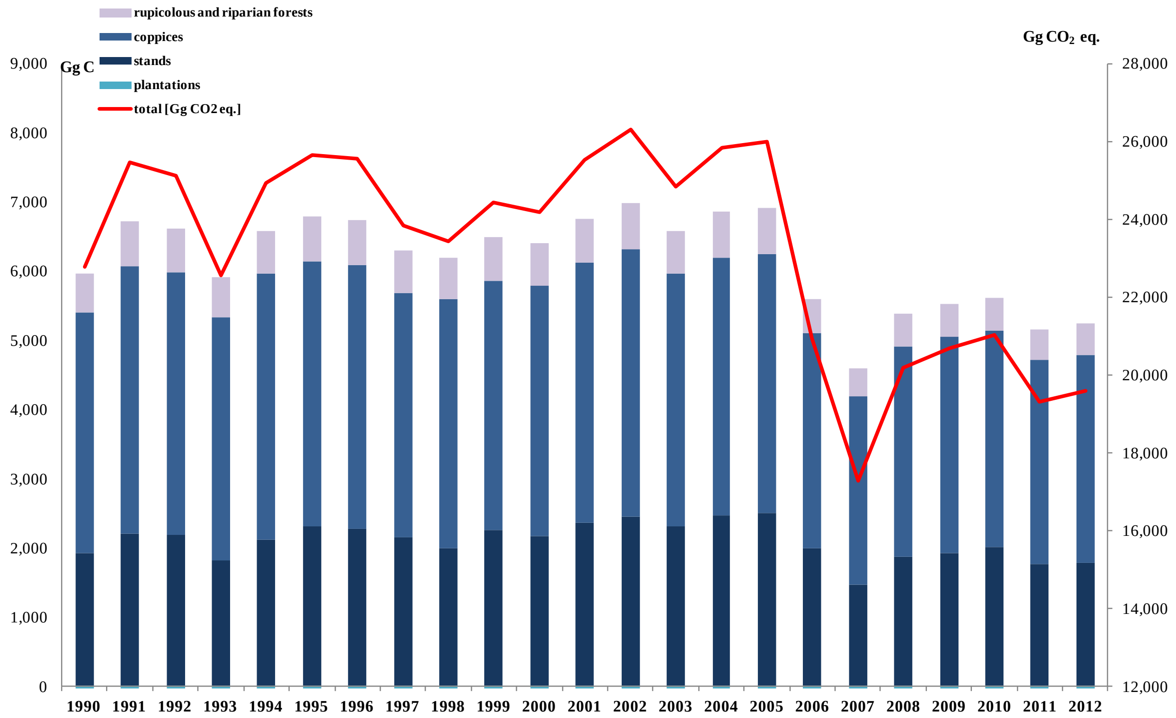


Figure 10.2 Carbon stock changes in mineral soils in the period 1990-2012 (SOM pool)

A comparison of the model results versus data measured in the framework of II NFI (INFC2005) may be carried out on the basis of the outcomes of the soil survey of INFC2005. In the following Table 10.5 estimated carbon stocks for SOM, for 2008, are provided:

Table 10.5 Comparison between estimated and INFC 2008 carbon stocks for SOM and litter

2008	INFC	For-est model	*differences*	
	t C= Mg	*t C= Mg*	*t C= Mg*	*%*
SOM	703,524,894	717,545,498	14,020,603	**-1.99**

Montecarlo analysis has been carried out for the CO_2 emissions and removals from Forest Land remaining Forest Land, considering the different reporting pools (aboveground, belowground, litter, deadwood and soils), and the subcategories stands, coppices and rupicolous and riparian forests for the reporting year 2009, resulting equal to 49%. In the following Table 10.6, the results of the uncertainty assessment for soils pool are reported:

Table 10.6 Montecarlo uncertainty assessment for soils pool

Uncertainties for the different subcategories, year 2010	
	soils
stands	44.65
coppices	67.35
rupicolous and riparian forests	58.52
total	**49.33**

Table 5(KP-I)A.1.3 Article 3.3 activities: Afforestation and Reforestation. Units of land otherwise subject to elected activities under Article 3.4 (information item)
According to the fact that all Italian forests are managed, the whole area subject to *afforestation/reforestation* should be reported here since otherwise subject to *forest management.*

Table 5(KP-I)A.2.1 Article 3.3 activities: Deforestation. Units of land otherwise subject to elected activities under Article 3.4 (information item)

Only *forest management* has been elected under Article 3.4. As *Deforestation* is a permanent loss of forest cover, any unit of land that has been deforested under Article 3.3 cannot also be subject to *forest management* under Article 3.4.

Table 5(KP-II)1. Direct N_2O emissions from N fertilization
No N fertilization is applied to Italian forests, so emissions are reported as not occurring.

Table 5(KP-II)2. N_2O emissions from drainage of soils
Reporting of these emissions is not mandatory so no estimates are made. There is no activity data on the extent of drainage under *forest management* areas but this is currently under investigation.

Table 5(KP-II)3. N_2O emissions from disturbance associated with land use conversion to cropland.
Deforestation to Cropland has not occurring in Italy, as total deforested area is in transition into settlements.

Table 5(KP-II)4. Carbon emissions from lime application
No lime is applied to Italian forests, so emissions are reported as not occurring. This is consistent with UNFCCC reporting, where all liming is assumed to occur in Cropland remaining Cropland.

10.3.1.3 Information on whether or not indirect and natural GHG emissions and removals have been factored out

Italy has not factored out removals from elevated carbon dioxide concentrations, indirect nitrogen deposition or the dynamic effects of age structure resulting from activities prior to 1 January 1990, considering also that GPG do not give methods for factoring out. For the first commitment period, the effect of indirect and natural removals will be considered through the cap under Article 3.4 credits from *forest management*. For Italy the cap is 2.78 Mt C per year.

10.3.1.4 Changes in data and methods since the previous submission (recalculations)

Recalculations of emissions and removals have been carried out on the basis of the IPCC Good Practice Guidance for LULUCF (IPCC, 2003).
Concerning the activities under art. 3.3 of the Kyoto Protocol, the main driver for the deviations from the previous sectoral estimates is the update of the coefficients used to estimate the carbon stock changes in the litter pool; the remaining deviations are resulting from updating of activity data (the new available data from the III NFI) and from the detection and correction of computation errors. With reference to the ARD activities, the 2014 submission results in an average decrease of 0.99%, for the Afforestation/Reforestation activities, and an average increase equal to 79.82% for Deforestation activities, respect the previous submission, mainly due to the updated deforestation areas resulting from the NFI's survey. Deviations are occurring, in the comparison of the current submission with the previous one for all pools: aboveground (average increase of 0.79% for AR activities and by 80.78% for D activities), belowground (average decrease of 2.16% for AR activities and increase by 80.78% for D activities), litter (average decrease of 167.9% for AR activities and increase by 77.35% for D activities), deadwood pool (average decrease of 64.43% for AR and increase by 76.79% for D activities) and soils (average increase of 9.11% for AR and by 80.64% for D activities) pools. In Table 10.7 deviations, related to the ARD activities, resulting from the comparison of the 2014 submission against the previous submission are reported.

Table 10.7 Deviations for ARD activities resulting from the comparison of the 2014 submission against 2013 submission

	1990-2008		1990-2009		1990-2010		1990-2011	
	AR	D	AR	D	AR	D	AR	D
pools	%	%	%	%	%	%	%	%
aboveground	1.78	80.72	-0.05	80.78	0.64	80.83	0.37	80.85
belowground	-5.28	80.52	-0.77	80.58	-0.42	80.63	-0.42	80.66
litter	-157.12	77.41	-171.26	77.35	-175.31	77.29	-149.40	77.25
deadwood	-65.67	76.79	-67.09	76.79	-60.53	76.79	-70.75	76.79
soils	11.58	80.63	9.26	80.64	6.50	80.64	3.68	80.64
total	**-0.30**	**79.80**	**-1.42**	**79.82**	**-1.24**	**79.85**	**-1.95**	**79.86**

With reference to forest management, the 2014 submission results in an average decrease of 1.39% respect the previous submission. Slight deviations are noticeable respect the previous submission for aboveground and belowground pool (average increase of 3.35% and 2.17%, respectively). Remarkable deviations affected the deadwood and litter pool resulting from the detection and correction of computation errors and from updating of activity data; in addition, for litter pool, the coefficients used in the estimation process have been updated. In Table 10.8 the deviations for Forest Management activities, resulting from the comparison of the 2014 submission against the previous submission are reported.

Table 10.8 Deviations for FM activities resulting from the comparison of the 2014 submission against 2013 submission

	2008	2009	2010	2011
pools	%	%	%	%
aboveground	1.79	3.50	4.75	4.40
belowground	6.83	4.20	-4.52	3.08
litter	-1,199.58	-1,249.36	-1,271.06	-1,094.93
deadwood	-991.12	-983.49	-975.42	-988.00
total	**-2.16**	**-0.90**	**-1.10**	**-0.99**

10.3.1.5 Uncertainty estimates

It was assumed that uncertainty estimates for forest land also apply for lands under FM (par. 7.2.5). The uncertainties related to the different pools are reported, for 2012, in Table 10.9.

Table 10.9 Uncertainties for the year 2012

Aboveground biomass	E_{AG}	42.66%
Belowground biomass	E_{BG}	42.66%
Dead mass	E_D	42.90%
Litter	E_L	43.81%
Overall uncertainty	E	33.36%

The uncertainties for Article 3.3 activities estimates are expected to be higher. It can be assumed that the given uncertainty analysis in table 10.2 covers the uncertainty of all gains and all losses in living tree biomass under FM and ARD. The Montecarlo analysis has been implemented for the LULUCF sector with particular focus on Forest land category. Detailed description can be found in Annex 1.

10.3.1.6 Information on other methodological issues

Italy has decided to account for the emissions and removals under Article 3 paragraphs 3 and 4 at the end of the commitment period. The inventory of land use (IUTI, see Annex 10) has been completed, resulting in land use classification, for all national territory, for the years 1990, 2000 and 2008 (Corona et al., 2012, Marchetti et al., 2012). Verification and validation activities have been undertaken and the resulting time series have been discussed with the institutions involved in the data providing (i.e. National Forest Service, Ministry of Agricultural, Food and Forestry Policies (MIPAAF), Forest Monitoring and Planning Research Unit (CRA-MPF)).

An in-depth verification process has been carried out to compare the implied carbon stock change per area (IEF), related to the aboveground and belowground pools, with the IEFs reported by other Parties. The 2013 submission has been considered to deduce the different IEFs; in the figures 10.3 and 10.4 the comparison is showed, taking into account the IEFs for both the AR and FM activities, for the aboveground and belowground pools.

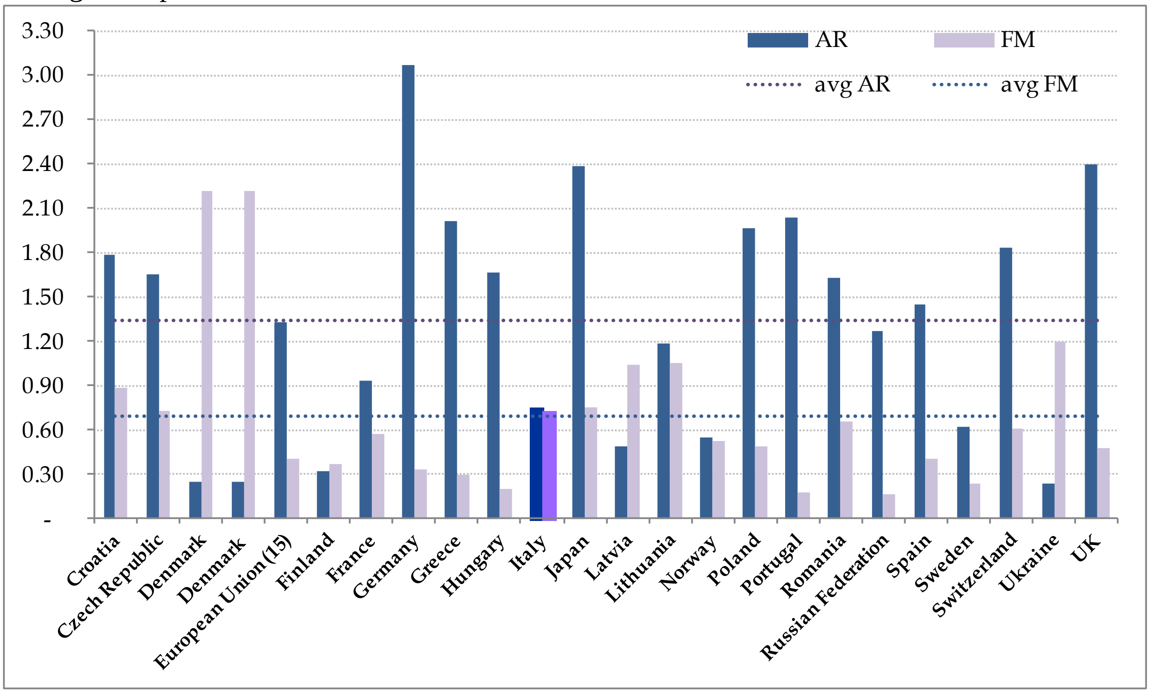


Figure 10.3 Implied carbon stock change per area related to the aboveground biomass

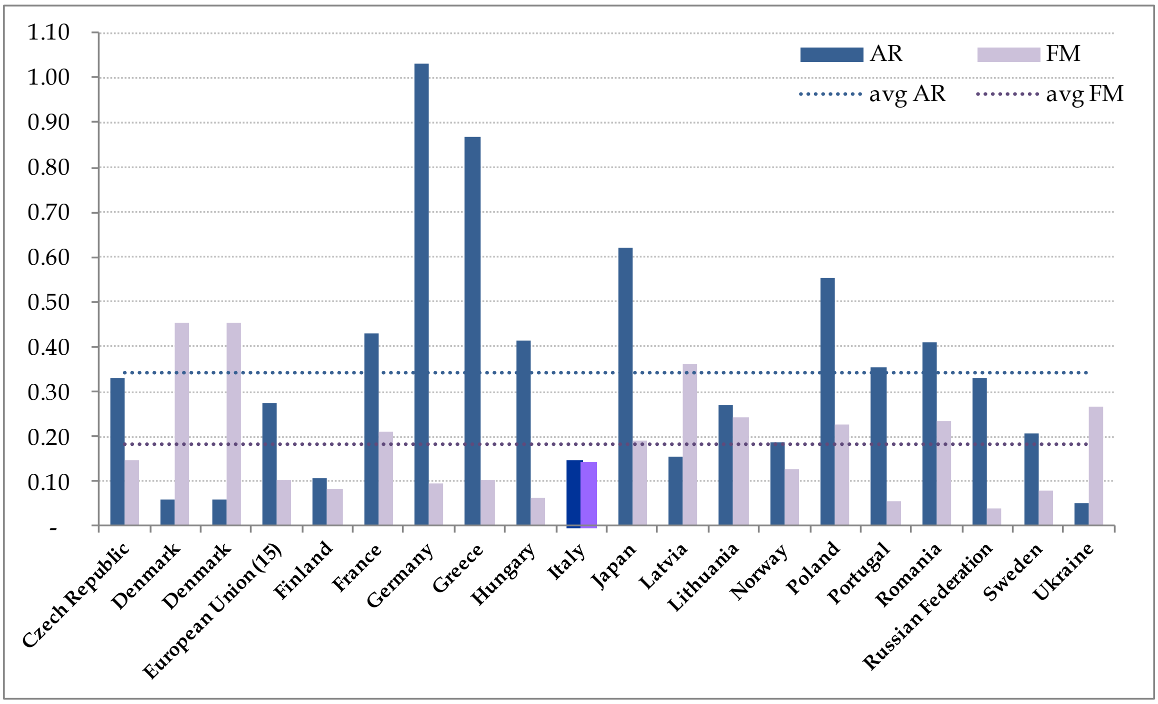


Figure 10.4 Implied carbon stock change per area related to the belowground biomass

10.3.1.7 The year of the onset of an activity, if after 2008

For the ARD activities (Art. 3.3) Italy reports all the area subject to these activities since 1990 (that has to be considered the starting year of the ARD activities). Furthermore, for each reporting year of the commitment

period, the area that annually is added to each of art. 3.3 activities has been reported in table NIR-2, for the relevant year.
Concerning Forest Management (Art. 3.4) Italy considers the entire national territory as managed, i.e. subject to human activities, consequently the entire national forest area is subject to human activities that, by-law, are aimed at sustainably manage the forest. Therefore, as described in par. 10.1.3, the whole set of human activities, implemented in forest, are part of the *forest management* activities under art. 3.4 and those activities were already in place before the starting of first commitment period of the Kyoto Protocol.

10.4 Article 3.3

Italy reports all emissions by sources and removals by sinks from the AR activities in the table 5(KP-I)A.1.1 - Afforestation/Reforestation: units of land not harvested. Italy has interpreted harvesting as clear cutting done on short rotation forests, coherently with statements reported in the par. 4.2.5.3.2 of IPCC GPG LULUCF 2003.

10.4.1 Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are direct human-induced

Changes in forest area were detected on the basis of national forest inventories data.
The following *afforestation/reforestation* activities that occurred or could have occurred on or after 1990 (Table 10.10) are included in the reporting of these activities:

- Planted or seeded croplands;
- Planted or seeded grasslands;
- Abandoned arable lands, which are naturally forested, through planting, seeding and/or the human-induced promotion of natural seed sources..

In Italy all land use categories (cropland, grazing land, forest) are to be considered managed; therefore any land use change occurs between managed lands and, consequently, is direct human-induced.
Afforested/reforested areas are to be considered legally bound by national legislation[57]. Usually these activities have resulted from a decision to change the land use by planting or seeding. Abandoned arable lands are left to forest naturally.
On the basis of the definitions provided in the Decision 16/CMP.1[58], natural afforestation and reforestation occurred on abandoned agricultural lands have to be included in the art. 3.3: a frequent forest management strategy, in Italy, consists, in fact, in the exploitation of natural re-growth caused, for instance, by the seed of adjacent trees. In addition the national legislation provides some references to the management strategy of abandoned lands: Law Decree n. 3267/1923 updated in 1999, (art.39 and art. 75), has planned afforestation and reforestation activities on areas for protection purposes (in particular hydro-geological purposes), explicitly forbidding clear cut or clearing on areas undergo under afforestation or reforestation activities (art. 51). Therefore the provision to avoid clear cut activities is a direct consequence of current legislation, as it provides strict constrains for different re-uses of agricultural lands. The same decree (art. 90 and 91) furthermore subsidized land owners to naturally regenerate forest on bare lands or on grasslands. Other (Law Decree 227/2001 Law 353/2000, Law 431/1985), even though focused on specific issues as forest fires and to the protection of nature and landscape are coherent with the previous decrees and complete the legislative framework on the issue; for example, for burnt areas no land use change is allowed and for forest areas, natural restoration of previous ecosystem occurs. In addition afforestation and reforestation activities are essentially linked to political decisions under the EEC Regulations 2080/92 and 1257/99 (art.10.1 and 31.1), therefore induced by man. In particular articles 10.1 and 31.1 of the EEC Regulations 1257/99 (Council Regulation (EC) No 1257/1999 of 17 May 1999 on support for rural development from the European

[57] In particular: Law Decree n. 227/2001; Law n. 353/2000; Law 1497/1939; Law Decree n. 3267/1923; 985, Law n. 431
[58] "Afforestation" is the direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources;
"Reforestation" is the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but that has been converted to non-forested land. For the first commitment period, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989.

Agricultural Guidance and Guarantee Fund (EAGGF)) refer directly to the provision of income for elderly farmers who decide to stop farming and to the support granted for the afforestation of agricultural land.

Table 10.10 Area estimates for 1990, 2008, 2009 2010 and cumulative for 1990-2008, 1990-2009, 1990-2010, 1990-2011 and 1990-2012 (kha) under Article 3.3 activities Afforestation/Reforestation.

Afforestation /Reforestation	**1990-2008**	**1990-2009**	**1990-2010**	**1990-2011**	**1990-2012**
			kha		
Abruzzo	60.1	62.7	65.3	67.9	70.5
Basilicata	46.4	48.4	50.5	52.6	54.8
Calabria	82.6	86.4	90.1	93.9	97.7
Campania	61.1	63.5	65.8	68.1	70.5
Emilia-Romagna	89.1	92.7	96.2	99.7	103.1
Friuli-Venezia Giulia	55.9	58.1	60.3	62.5	64.6
Lazio	90.0	94.0	98.1	102.2	106.3
Liguria	55.4	57.7	59.9	62.2	64.4
Lombardia	94.8	98.5	102.1	105.7	109.3
Marche	47.5	49.4	51.2	53.0	54.8
Molise	21.4	22.6	23.7	24.8	26.0
Piemonte	137.8	143.2	148.5	153.8	159.1
Puglia	24.9	26.1	27.3	28.5	29.7
Sardegna	81.7	84.9	88.1	91.2	94.4
Sicilia	46.8	49.0	51.2	53.5	55.7
Toscana	172.7	179.4	186.1	192.8	199.4
Trentino Alto Adige	124.3	128.9	133.4	137.9	142.3
Bolzano-Bozen	*57.1*	*58.6*	*60.0*	*61.3*	*62.6*
Trento	*67.2*	*70.3*	*73.4*	*76.6*	*79.8*
Umbria	60.1	62.7	65.2	67.7	70.3
Valle d'Aosta	17.1	17.7	18.4	19.1	19.8
Veneto	66.9	69.5	72.1	74.7	77.3
Italia	**1,436.8**	**1,495.1**	**1,553.5**	**1,611.8**	**1,670.1**

Concerning *deforestation* activities, as mentioned above, in Italy land use changes from forest to other land use categories are allowed in very limited circumstances, as stated in art. 4.2 of the Law Decree n. 227 of 2001. *Deforestation* data have been detected by the surveys carried out in the framework of the NFIs (with reference to the years 2005 and 2012); administrative records at NUT2 level collected by the National Institute of Statistics related to deforested area have been used for the period 1990-2005. Activities planned in the framework of the registry for carbon sinks are expected to refine these estimates, providing detailed information on the final land use of the deforested area; in the current submission, a conservative approach was applied hypothesising that the total deforested area is converted into settlements.

10.4.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

Extensive forest disturbances have been rare in Italy, except for wildfires. Land-use changes after damage do not occur; concerning wildfires, national legislation (Law n. 353 of 2000, art.10.1) doesn't allow any land use change after a fire event for 15 years.

Harvesting is regulated through regional rules, which establish procedures to follow in case of harvesting. Although different rules exist at regional level, a common denominator is the requirement of an explicit written communication with the localization and the extent of area to be harvested, existing forest typologies and forestry treatment. *Deforestation* is allowed only in very limited circumstances (i.e. in construction of railways the last years) and has to follow several administrative steps before being legally permitted. In addition, clear-cutting is a not allowed practice (Law Decree n. 227 of 2001, art. 6.2)

10.4.3 Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

Restocking is assumed for forest areas that have lost forest cover through harvesting or forest disturbance, unless there is *deforestation* as described above. As such, information on the size and location of forest areas that have lost forest cover is not explicitly collected on an annual basis.

10.5 Article 3.4

10.5.1 Information that demonstrates that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced

Forests in 1 January 1990 were under *forest management*, since Italy considers all forest land managed, and, therefore, human-induced.

10.5.2 Information relating to Forest Management

Italian forest resources are totally legally bound; the two main constraints, provided by the laws n. 3267 of 1923 and n. 431 of 1985, compel private and public owners to strictly respect limitations concerning the use of their forest resources. As a matter of fact, each exploitation of forest resources must not compromise their perpetuation and therefore, any change of land use, for hydro-geological, landscape and environmental protection in general (the same limitations apply also to burnt areas, following the law n. 353 on forest fires approved in 2000). Consequently unplanned cuttings are always forbidden and local prescriptions fix strict rules to be observed for forestry.

10.6 Other information

10.6.1 Key category analysis for Article 3.3 activities and any elected activities under Article 3.4

Key category analysis for KP-LULUCF was performed according to section 5.4 of the IPCC GPG for LULUCF (IPCC, 2003). CO_2 emissions and removals from *Afforestation/Reforestation* and *Deforestation* activities (art. 3.3) and from *Forest management* (art. 3.4) have been assessed as key categories in accordance with the IPCC good practice guidance for LULUCF section 5.4.4. The figures have been compared with Table 1.6 Key categories for the latest reported year (2012) based on level of emissions (including LULUCF).

Article 3.3 Afforestation and reforestation (CO_2): CO_2 emissions and removals from the associated UNFCCC subcategory *land converting to forest land* have been identified as key category, at level and trend assessment. Therefore AR is stated to be a key category.
Deforestation (CO_2): CO_2 emissions and removals from the associated UNFCCC subcategory *land converting to settlements* have been identified as key category, at level and trend assessment. Therefore D is stated to be a key category.

Article 3.4 Forest management (CO_2): The associated UNFCCC subcategory *Forest land remaining Forest land* is a key category in level and in trend assessment (Approach 1). The *forest management* category contribution is also greater than other categories in the UNFCCC key category.

10.7 Information relating to Article 6

Italy is not participating in any project under Article 6 (Joint Implementation).

11 Information on accounting of Kyoto units

11.1 Background information

The Standard Electronic Format report for 2013, containing the information required in paragraph 11 of the annex to decision 15/CMP.1 and adhering to the SEF guidelines, has been submitted to the UNFCCC Secretariat in electronic format (SEF_IT_2014_1_15-45-11 9-1-2014).
The report contains information on unit holdings in the Italian registry at the beginning and at the end of the reporting year as well as on transfers of units in 2013 to and from other Parties of the Kyoto Protocol. The contents of the report (Report R1) can also be found in Annex 8 of this document.

11.2 Summary of information reported in the SEF tables

At the beginning of 2013 the holdings in the Italian registry per unit type were as follow:

- a total of 2,378,523,048 AAUs: 1,638,291,168 in the party holding accounts, 1,970,000 in the entity holding accounts and 738,261,880 in the retirement account;
- a total of 10,711,761 ERUs: 15,815 in the party holding accounts, 5,134,484 in the entity holding accounts and 5,561,462 in the retirement account;
- a total of 57,300,900 CERs: 83,759 in the party holding accounts, 13,845,427 in the entity holding accounts and 43,371,714 in the retirement account;
- a total of 54,670 tCERs in the entity holding accounts.

At the end of 2013 the holdings in the Italian registry per unit type were as follow:

- a total of 2,280,271,071 AAUs: 1,540,039,191 in the party holding accounts, 1,970,000 in the entity holding accounts and 738,261,880in the retirement account;
- a total of 29,641,051 ERUs: 23,605,709 in the party holding accounts, 473,880 in the entity holding accounts and 5,561,462 in the retirement account;
- a total of 71,570,370 CERs: 22,999,923 in the party holding accounts, 5,194,483 in the entity holding accounts and 43,371,714 in the retirement account;
- a total of 116,900 tCERs in the entity holding accounts.

During 2013 the Italian registry received in all 41,426,870 units: 25,984,861 ERUs, 38,766,179 CERs and 62,230 tCERs.
Conversely, 129,808,507 units were externally transferred to other national registries: 98,251,977 AAUs, 7,055,571 ERUs and 24,500,959 CERs.
There were no transactions of any kind involving RMUs or lCERs.
At the end of 2013 no RMUs or l-CERs were held in the Italian registry and the total amount of units corresponded to 2,381,599,392 tonnes CO_2 eq. while Italy's assigned amount is 2,416,277,898 tonnes CO_2 eq.
Full details are available in the SEF tables reported in Annex 8.

11.3 Discrepancies and notifications

During the reported period (1st January 2013 - 31st December 2013) no discrepant transactions, no CDM notifications and no non-replacements occurred. No invalid units were present as at 31 December 2013.
Therefore the relevant reports (R2, R3, R4, R5) are empty and have not been included.

11.4 Publicly accessible information

Non-confidential information required by Decision 13/CMP.1 annex II.E paragraphs 44-48, is publicly accessible at the following link http://www.info-ets.isprambiente.it
All required information is provided with the following exceptions:

- paragraph 45(d)(e): account number, representative identifier name and contact information is deemed as confidential according to Annex III and VIII (Table III-I and VIII-I) of Commission Regulation (EU) No 389/2013;
- paragraph 46: no Article 6 (Joint Implementation) project is reported as conversion to an ERU under an Article 6 project did not occur in the specified period;
- paragraph 47(a)(d)(f): holding and transaction information is provided on an account type level, due to more detailed information being declared confidential by article 110 of Commission Regulation (EU) No 389/2013.

11.5 Calculation of the commitment period reserve (CPR)

The commitment period reserve for Italy is 2,174,650,108 tonnes of CO_2 equivalent (or assigned amount units). The CPR is based on the assigned amount and has not changed from the previous submission.

11.6 KP-LULUCF accounting

Italy has decided to account for Article 3.3 and 3.4 LULUCF activities at the end of the commitment period, therefore no information on KP-LULUCF accounting is included in the SEF tables.
In Table 11, information on accounting for the KP-LULUCF activities based on the reporting for the year 2008, 2009, 2010, 2011 and 2012 are given.

Table 11.1 Information table on accounting for activities under art. 3.3 and 3.4 of the Kyoto Protocol, for 2008, 2009, 2010, 2011 and 2012

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Net emissions/removals(1)						Accounting Parameters(7)	Accounting Quantity (8)
	2008	2009	2010	2011	2012	Total(6)		
A. Article 3.3 activities								
A.1. Afforestation and Reforestation								-34,052.83
A.1.1. Units of land not harvested since the beginning of the commitment period(2)	-6,352	-7,088	-7,708	-6,310	-6,594	-34,053		-34,052.83
A.1.2. Units of land harvested since the beginning of the commitment period(2)								
A.2. Deforestation	1,930	1,940	1,951	1,957	1,965	9,743		9,742.90
B. Article 3.4 activities								
B.1. Forest Management	-27,191	-29,779	-30,869	-23,564	-24,735	-136,139		-50,967
3.3 offset(3)							0	0
FM cap(4)							50,967	-50,967

(1) All values are reported in table 5(KP) of the CRF for the relevant inventory year as reported in the current submission and are automatically entered in this table.
(2) In accordance with paragraph 4 of the annex to decision 16/CMP.1, debits resulting from harvesting during the first commitment period following Afforestation and Reforestation since 1990 shall not be greater than credits accounted for on that unit of land.
(3) In accordance with paragraph 10 of the annex to decision 16/CMP.1, for the first commitment period, a Party included in Annex I that incurs a net source of emissions under the provisions of Article 3.3 may account for anthropogenic greenhouse gas emissions by sources and removals by sinks in areas under Forest Management under Article 3.4, up to a level that is equal to the net source of emissions under the provisions of Article 3.3, but not greater than 9.0 megatonnes of carbon times five, if the total anthropogenic

greenhouse gas emissions by sources and removals by sinks in the managed forest since 1990 is equal to, or larger than, the net source of emissions incurred under Article 3.3.
(4) In accordance with paragraph 11 of the annex to decision 16/CMP.1, for the first commitment period only, additions to and subtractions from the assigned amount of a Party resulting from Forest Management under Article 3.4, after the application of paragraph 10 of the annex to decision 16/CMP.1 and resulting from Forest Management project activities undertaken under Article 6, shall not exceed the value inscribed in the appendix of the annex to decision 16/CMP.1, times five.
(5) Net emissions and removals in the Party's base year, as established by decision 9/CP.2.
(6) Cumulative net emissions and removals for all years of the commitment period reported in the current submission.
(7) The values in the cells "3.3 offset" and "FM cap" are absolute values.
(8) The accounting quantity is the total quantity of units to be added to or subtracted from a Party's assigned amount for a particular activity in accordance with the provisions of Article 7.4 of the Kyoto Protocol.

12 Information on changes in national system

No changes with respect to last year submission occurred in the Italian National System.

13 Information on changes in national registry

13.1 Previous Review Recommendations

The SIAR Report for Italy from last year reported the following recommendations:

Ref Nr P2.4.2.1 (Recommendation Ref P1.4.1, P1.4.4)

Recommendation description
The assessor noted that some of the publicly available information dates from 12 April 2013. However, decision 13/CMP.1 Annex paragraph 45 requires that the information is up-to-date. The assessor recommends that the publicly available information be up to date (i.e. updated as close to real time as possible, but at least updated on a monthly basis).

RESPONSE
The delay in regularly publishing up-to-date information on accounts was due to unavailability of relevant reports. Since August 2013 the European Commission is providing daily reports and the information on the public website is updated every two weeks

Ref Nr P2.4.2.2 (Recommendation Ref P2.3.3, P2.3.10)

Recommendation description
The assessor notes that Italy is not fully reporting changes in the national registry related to change of test results and change of database structure. The assessor recommends that Italy provides this information related to the most current implemented version of the consolidated registry software.
Comment
The assessor notes that Italy provided this information in [RESPONSE]. However, additional analysis of the provided documentation reveals an incomplete test was performed and that an insufficient database structure was provided. Based on this information ***two additional recommendations*** have been added.

RESPONSE
See below, the following two recommendations

Ref Nr P2.4.2.3 (Recommendation Ref 2.3.3)

Recommendation description
The assessor recommends that following major changes, the party provide a data model which contains all DES required entities complete with descriptions in its annual NIR.

RESPONSE
The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. Since the successful certification of the registry on 1 June 2012, Iteration 4 of the registry, introduced in October 2012, added a limited number of new entities, none of them relating to DES entities.
A data model which more clearly showed the relevant entities "RECONCILIATIONS", "NOTIFICATIONS", "RESPONSES", "INTERNAL AUDIT LOG" and "MESSAGE LOG" has been provided to the Expert Review Team. As specified in the DES (Section VII. Data Logging Specifications/E. Message Archive), a copy of messages sent and received is stored in standalone files in one of two managed servers in the hosting environment. For that reason, the Message Archive is not shown in the model. The "MESSAGE LOG" object holds the location of the entire message, for each Message_ID.

Iteration 5 of the national registry released in January 2013 and Iteration 6 of the national registry released in June 2013 introduced changes in the structure of the database. Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. An updated diagram of the database structure is provided along with this submission as Annex A.

No change to the capacity of the national registry occurred during the reported period.

Ref Nr P2.4.2.4 (Recommendation Ref 2.3.10)

Recommendation description
The assessor strongly recommends that the Party test each release thoroughly against the DES as part of each major release cycle and provide the results of such tests in its annual NIR.

RESPONSE
The consolidated EU system of registries successfully completed a full certification procedure in June 2012. Notably, this procedure includes connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). This included a full Annex H test. All tests were executed successfully and led to successful certification on 1 June2012 (the certificate received from the UNFCCC has been provided to the Expert Review Team).
The October 2012 release (version 4) was only a minor iteration and changes were limited to EU ETS functionality and had no impact on Kyoto Protocol functions in the registry. The first test script provided reflects this.
However, each major release of the registry is subject to both regression testing and tests related to new functionalities. The tests for version 5 included thorough testing against the DES and were successfully carried out prior to the release to Production (the test report has been provided to the Expert Review Team).
Changes introduced in release 5 and the following version 6 of the national registry were limited and only affected EU ETS functionality. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission; the report is attached as Annex B.
Annex H testing was carried out in February 2014 and the successful test report is attached to this submission as Annex C.
Moreover, prior to each release, security tests are carried out by the registry developer, by the hosting organization (DIGIT) and by an independent security expert. Test reports for these tests are confidential, in line with standard security protocol, and cannot be disclosed. The scope of the security tests includes source code analysis, vulnerability tests (OWASP) and penetration tests.
Prior to specific release, load and stress tests are carried out by the hosting organization (DIGIT). The version following iteration 4 was tested with the following conclusions:

- Average Response times are correct and lot of them have decreased from previous version
- CPU used by the application is good
- CPU used on the Database is correct

13.2 Changes to National Registry

The following changes to the national registry of Italy have therefore occurred in 2013.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	No change of name or contact occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	An updated diagram of the database structure is attached as Annex A. Iteration 5 of the national registry released in January 2013 and Iteration 6 of the national registry released in June 2013 introduced changes in the structure of the database. Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. However, each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to the relevant major release of the version to Production (see Annex B). Annex H testing was carried out in February 2014 and the successful test report has been attached (see Annex C). No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No change of security measures occurred during the reporting period
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change to the list of publicly available information occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the registry internet address occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission; the report is attached as Annex B. Annex H testing was carried out in February 2014 and the successful test report has been attached (see Annex C).

Reporting Item	Description
The previous Annual Review recommendations	See paragraph 13.1 above

14 Information on minimization of adverse impacts in accordance with Article 3, paragraph 14

14.1 Overview

In the framework of the EU Burden Sharing Agreement, Italy has committed to reduce its GHG emissions by 6.5% below base-year levels (1990) over the first commitment period, 2008-2012. After the review of the initial report of Italy under the Kyoto Protocol (KP), the Kyoto objective was fixed in 483.255 $MtCO_2$ per year for each year of the "commitment period" (UNFCCC, 2007).
In this section Italy provides an overview of its commitments under Article 3.1, and specifically how it is striving to implement individually its commitment under Article 3 paragraph 14 of the KP. Under Article 3.14 of the KP:
"Each Party included in Annex I shall strive to implement the commitments mentioned in paragraph 1[59] above in such a way as to minimize adverse social, environmental and economic impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9[60], of the Convention. In line with relevant decisions of the Conference of the Parties on the implementation of those paragraphs, the Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, consider what actions are necessary to minimize the adverse effects of climate change and/or the impacts of response measures on Parties referred to in those paragraphs. Among the issues to be considered shall be the establishment of funding, insurance and transfer of technology.
For the preparation of this chapter ISPRA has collected information through the revision of peer review international articles on sustainable development (SD) of ex-ante/ex-post assessments related to activities on climate change mitigation, and through personal communication with people/institutions involved in project/programs/policy implementation of climate change activities. Moreover, experts from the Ministry for the Environment, Land and Sea (*Ministero dell'Ambiente e della Tutela del Territorio e del Mare*, MATTM) and the Directorate General for Development Co-operation (DGCS) from the Ministry of Foreign Affairs (*Ministero degli Affari Esteri*, MAE) were contacted. This chapter has been updated with new information according to the on-going activities at national and international level.
As the reporting obligation related to Article 3, paragraph 14 does not include an obligation to report on each specific mitigation policy. Italy briefly describes how EU is striving to minimize adverse impacts, because Italy is member of the European Union, thus incorporated into its European legal system to implement directives/policies; and individually how is striving to implement Article 3.14 with specific examples.
Two main parts are requested under Article 3.14 for reporting purposes: commitments to minimize adverse effects (section 14.2, 14.3) and priority actions (section 14.4, 14.5). Future improvements/research activities are expected for next submissions (section 14.6).

14.2 European Commitment under Art 3.14 of the Kyoto Protocol

The EU is well aware of the need to assess impacts, and has built up thorough procedures in line with obligations. This includes bilateral dialogues and different platforms that allow interacting with third countries, explain new policy initiatives and receive comments from third countries. Impacts on third countries are mostly indirect and can frequently neither be directly attributed to a specific EU policy, nor directly measured by the EU in developing countries. A wide-ranging impact assessment (IA) system

[59] **Kyoto Protocol, Art. 3 Par. 1 "**The Parties included in Annex I shall, individually or jointly, ensure that their aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amounts, calculated pursuant to their quantified emission limitation and reduction commitments inscribed in Annex B and in accordance with the provisions of this Article, with a view to reducing their overall emissions of such gases by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012."
[60] **UNFCCC, Art 4. Par 8.** "In the implementation of the commitments in this Article, the Parties shall give full consideration to what actions are necessary under the Convention, including actions related to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures, especially on: (a) Small island countries; (b) Countries with low-lying coastal areas; (c) Countries with arid and semi-arid areas, forested areas and areas liable to forest decay; (d) Countries with areas prone to natural disasters; (e) Countries with areas liable to drought and desertification; (f) Countries with areas of high urban atmospheric pollution; (g) Countries with areas with fragile ecosystems, including mountainous ecosystems; (h) Countries whose economies are highly dependent on income generated from the production, processing and export, and/or on consumption of fossil fuels and associated energy-intensive products; and (i) Landlocked and transit countries. Further, the Conference of the Parties may take actions, as appropriate, with respect to this paragraph." **UNFCCC Art 4. Par. 9**. "The Parties shall take full account of the specific needs and special situations of the least developed countries in their actions with regard to funding and transfer of technology."

accompanying all new policy initiatives has been established. This approach ensures that potential adverse social, environmental and economic impacts on various stakeholders are identified and minimized within the legislative process (European Commission, 2010).
At European level, IA is required for most important Commission initiatives, policy and programs and those which will have the most far-reaching impacts. In 2009, IA was adopted, replacing the previous Guidelines 2005 and also the 2006 update. In general, the IA evidence advantages and disadvantages of possible policy options by assessing their potential impacts. Among different issues, it should be assessed which are the likely social, environmental and economic impacts of those options (European Commission, 2009[a]). Since 2003 all IA of EU policies are listed and published online by subject (European Commission, 2014). Key questions on economic, social and environmental impacts in relation to third countries are listed in Table 14.1.

Table 14.1 Questions in relation to impacts on Third countries

Economic	Social	Environmental
• How does the policy initiative affect trade or investment flows between the EU and third countries? How does it affect EU trade policy and its international obligations, including in the WTO? • Does the option affect specific groups (foreign and domestic businesses and consumers) and if so in what way? • Does the policy initiative concern an area in which international standards, common regulatory approaches or international regulatory dialogues exist? • Does it affect EU foreign policy and EU development policy? • What are the impacts on third countries with which the EU has preferential trade arrangements? • Does it affect developing countries at different stages of development (least developed and other low-income and middle income countries) in a different manner? • Does the option impose adjustment costs on developing countries? • Does the option affect goods or services that are produced or consumed by developing countries?	• Does the option have a social impact on third countries that would be relevant for overarching EU policies, such as development policy? • Does it affect international obligations and commitments of the EU arising from e.g. the ACP-EU Partnership Agreement or the Millennium Development Goals? • Does it increase poverty in developing countries or have an impact on income of the poorest populations?	• Does the option affect the emission of greenhouse gases (e.g. carbon dioxide, methane etc) into the atmosphere? • Does the option affect the emission of ozone-depleting substances (CFCs, HCFCs etc)? • Does the option affect our ability to adapt to climate change? • Does the option have an impact on the environment in third countries that would be relevant for overarching EU policies, such as development policy?

Source: European Commission, 2010

A review of European response measures for two EU policies were chosen for further description because the IA identified potential impacts on thirds countries. These measures are the Directive 2009/28/EC on the promotion of the use of renewable energy, and the EU emission trading scheme for the inclusion of the aviation (see European Commission, 2009[b]; European Commission, 2010).

Directive on the promotion of the use of renewable energy
EU will reach a 20% share of energy from renewable sources in the overall energy consumption by 2020 (with individual targets for each Member State) and a 10% share of renewable energy specifically in the transport sector, which includes biofuels, biogas, hydrogen and electricity from renewables. IAs related to enhanced use in the EU showed that the cultivation of energy crops have positive (growing of EU demand for bioenergy generates new export revenues and employment opportunities for developing countries and boosts rural economies), and negative (biodiversity, soil and water resources and have positive/ negative effects on air pollutants) impacts. For this reason, Article 17 of the EU's Directive has created "sustainability criteria", applicable to all biofuels (biomass used in the transport sector) and bioliquids, which consider to establish a threshold for GHG emission reductions that have to be achieved from the use of biofuels; to exclude the use of biofuels from land with high biodiversity value (primary forest and wooded land, protected areas or highly biodiverse grasslands), and to exclude the use of biofuels from land with high C stocks, such as wetlands, peatlands or continuously forested areas. In this context, developing country representatives as well as other stakeholder were extensively consulted during the development of the sustainability criteria and preparation of the directive and the extensive consultation process has been documented. The Commission also reports on biofuels' potential indirect land use change effect and the positive and negative impact on social sustainability in the Union and in third countries, including the

availability of foodstuffs at affordable prices, in particular for people living in developing countries, and wider development issues. The first reports were submitted in 2012 (European Commission, 2010).

Inclusion of aviation in the EU emission trading scheme
In 2005 the Commission adopted a Communication entitled "Reducing the Climate Change Impact of Aviation", which evaluated the policy options available to this end and was accompanied by an IA. The assessment concluded that, in view of the likely strong future growth in air traffic emissions, further measures are urgently needed. Aircraft operators from developing countries will be affected to the extent they operate on routes covered by the scheme. As operators from third countries generally represent a limited share of emissions covered, the impact is also modest. On the other hand, to the extent that aviation's inclusion in the EU ETS creates additional demand for credits from JI and CDM projects, there will also be indirect positive effects as such projects imply additional investments in clean technologies in developing countries (European Commission, 2010).

Common Agricultural Policy
Furthermore, many developing countries and least developed countries (LDC) are based on the agricultural production, therefore, it will be important to understand how the *EU Common Agricultural Policy (CAP) Health Check*, together with the new targets on climate change and renewable energies will potentially influence developing countries. Some information on cereal intervention options on third parties have been identified (European Commission, 2008). Some studies on the impact of agricultural policies on developing countries are also available (Schmidhuber, 2009; Hallam, 2010). Brooks et al (2010) has recently presented DEVPEM[61] a companion to the OECD-country PEM[62] as a tool for policy evaluation in developing countries. Preliminary results for Malawi indicate that agricultural policies may have fundamentally different impacts on incomes in low income countries to those obtained in developed OECD countries.

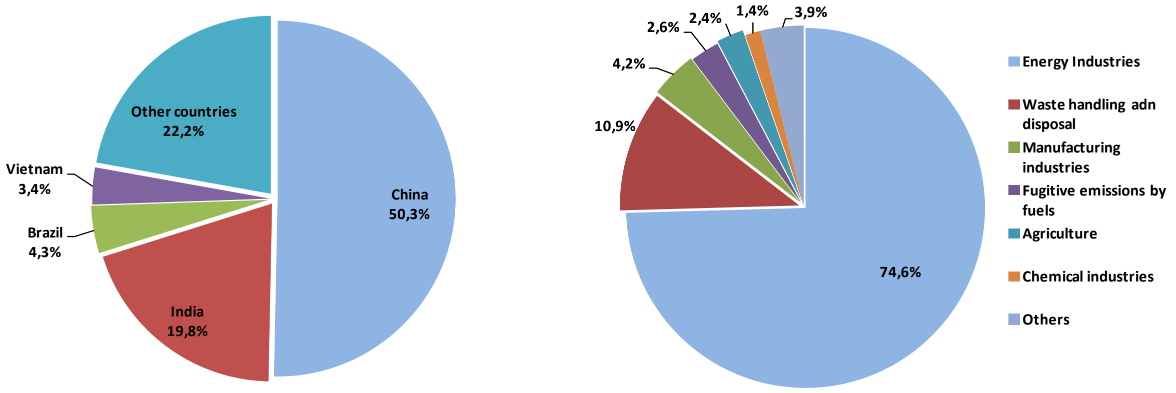
14.3 Italian commitment under Art 3.14 of the Kyoto Protocol

Article 3, paragraph 14 of the KP is related to Annex I Parties' way of implementing commitments under Article 3.1 of the KP. Therefore, it addresses the implementation of the quantified emission limitation and reduction objectives (QELROs) under Article 3.1, the implementation of LULUCF activities under Article 3 paragraphs 3 and 4, the use of Emission Reduction Units (ERUs) and Certified Emission Reductions (CERs) under Article 3 paragraphs 10, 11, and 12.
Italy is aware of the potential direct and indirect impact of measures/policies and tries to ensure that the implementation of national mitigation policies under the KP does not impact other parties. Minimizing adverse effects of policies/measures are described in Chapter 4.8 in the Sixth National Communication (MATTM, 2014). Information of activities under Article 3 paragraphs 3 and 4 of the KP is described in 'Chapter 10' KP-LULUCF' of this report.
National and sectoral Italian policies are expected to have no direct impacts in developing countries. Policies and measures in the Italian energy sector aim to increase energy efficiency and develop a low-carbon energy system but in the context of a global energy scenarios that do not foresee a decline in income for fossil fuel exporting countries (IEA, World Energy Outlook 2008).
Efforts to tackle adverse social, economic, and environmental impacts of mitigation actions are directly expected in the framework of the Kyoto Mechanisms. Hence, this chapter has concentrated efforts to analyze the Clean Development Mechanism and Joint Implementation in order to provide response to reporting requirements under Article 3.14 of KP.

Procedure for assessing sustainability at local and national level for CDM and JI
The Clean Development Mechanism (CDM), defined in Article 12 of the KP, allows a country with an emission-limitation commitment (Annex B Party) to implement an emission-reduction project in developing countries.
For this section, information was collected from the UNFCCC CDM Project Search Database (UNFCCC, 2014[a]). On 26 February 2014, the UNFCCC CDM Database reported a total of 7,445 registered project

[61] DEVPEM, Development Policy Evaluation Model
[62] PEM, Policy Evaluation Model examine the effects of agricultural policies in member countries

activities out of 7,803 projects. With data as of 31 January 2014, 84.2% of CDM projects were registered in Asia and the Pacific Region, 12.8% in Latin America and Caribbean, 2.4% in Africa, and 0.6% in Countries with economies in transition. The distribution of registered projects by scope activity was mainly: energy industries (74.6%), waste handling and disposal (10.9%) and manufacturing industries (4.2%). Registered projects by Host Party were mainly in China (50.3%), India (19.8%), Brazil (4.3%) and Vietnam (3.4%). The distribution of global CDM projects by Host country and scope is presented in Figure 14.1.



Source: UNFCCC (UNFCCC, 2014)

Figure 14.1 CDM projects by Host country and scope (as for 31/01/2014)

Italy as investor Party, contributes with 1.6% of world-wide CDM project portfolio. Italy is involved in more than 100 CDM projects at different stage, and is involved directly, as government, in 27 registered CDM (MATTM, 2011[a]). Up to now Italy is involved in 114 CDM registered projects (UNFCCC, 2014[a]), 7.5% more than the beginning of 2013. Projects by dimension are 56.1% large scale and 43.9% small-scale. Italy is the only proposer for 49.1% of the CDM projects. In Annex A8.2.4 a complete list of CDM projects is available. Italian CDM projects by Host country and scope are illustrated in tables 14.2 and 14.3 respectively.

Table 14.2 Italian CDM projects by Host country

Country	n°	%
China	49	43.8
India	11	9.8
Nepal	5	4.5
Uganda	5	4.5
Argentina	4	3.6
Brazil	4	3.6
Kenya	4	3.6
Republic of Moldova	4	3.6
Other	26	23.2
Totale	**112**	**100**

Table 14.3 Italian CDM projects by scope

Scope	n°	%
Energy industries (renewable - / non-renewable)	62.5	55.8
Afforestation and reforestation	15	13.4
Manufacturing industries	11	9.8
Waste handling and disposal	11	9.8
Fugitive emissions from production and consumption of halocarbons and sulphur hexafluoride	8	7.1
Other	4.5	4.0
Total	**112**	**100**

Parties should follow a project cycle to propose CDM projects (first designing phase and realization phase). During the first phase, among other activities, Parties participating in the CDM shall designate a national authority (DNA). Each Host Party has implemented a procedure for assessing CDM projects. The DNA evaluates project documentation against a set of pre-defined criteria, which tend to encompass social, environmental and economic aspects. For instance, India has SD criteria such as the social, economic, environmental and technological 'well-being'. Instead, China discriminated projects by priority area and by gas based-approach (Olsen and Fenhann, 2008; Boyd et al., 2009).

Most of the CDM projects (if large-scale) are subject to ex-ante assessments. For instance, environmental impact assessments (EIA) are required. In other cases, because of the size of the project, EIA are not necessary. Still some CDM projects have performed voluntary EIA. This is the case for the *Santa Rosa* Hydroelectric CDM project in Peru (Endesa Carbono, 2010). After, a second evaluation is performed by the DNA as described previously. For example, in the Peruvian DNA, the process follows the: submission of the project to the Ministry of competence on the activities, a site visit of the project done by the Ministry of Environment, and the conformation of an *ad hoc* committee that evaluate projects considering legal, social, environmental and economic criteria (MINAM, 2010). Thus, possible impacts of the CDM projects are mainly subject to local and national verification.

In some cases, an ex-post assessment could be also performed by the Designated Operational Entities (DOE), which validated CDM projects and certifies as appropriate and requests the Board to issue CERs. For some CDM projects, for instance, *Poechos I* Hydroelectric project (Peru), CERs are approve only if the project complies also with social and environmental conditions (Endesa Carbono, 2010). In addition, Italy agreed to accept in principle common guidelines for approval of large hydropower project activities. EU Member States have arrived at uniform guidelines on the application of Article 11b(6) of the Directive 2004/101/EC to ensure compliance (of such projects) with the international criteria and guidelines, including those contained in the World Commission on Dams 2000 Report. It aims to ensure that hydro projects are developed along the SD and the not damaging to the environment (exploring possible alternatives) and addressing such issues as gaining public acceptance, and fair and equitable treatment of stakeholders, including local and indigenous people (MATTM, 2010[a]).

Another feedback for participating to CDM project with SD characteristics comes from the carbon funds. For instance, Italy participates to the *BioCarbon Fund* (BCF), the *Community Development Carbon Fund* (CDCF) and the *Italian Carbon Fund* (ICF). The first two funds aim to finance projects with strong social impact at local level, that combine community development attributed with emission reductions and will significantly improve the life of the poor and their local environment (MATTM, 2010[a]). Italian CDM projects which are under the CDCF initiative are listed in Annex A8.2.4.

The Joint implementation (JI) is defined in Article 6 of the KP allowing a country with a limitation commitment (Annex B) to earn emission reduction units (ERUs) from an emission-reduction or emission removal project in another Annex B Party. Two procedures could be followed. 'Track 1' procedures apply when the Host Party and investors meets all of the eligibility requirements to transfer and/or acquire ERUs, and the project is additional to any that would otherwise occur. 'Track 2' applies when the Host Party fulfils with a limited set of eligibility requirements or there is not an institutional authority able to follow up the project cycle. In this case the project should go through the verification procedure under the Joint Implementation Supervisory Committee (JISC). The development of the project is divided in a design and implementation phases (MATTM 2011[b]). Parties involved in JI activities should designated focal point for approving projects, and prepared Guidelines and Procedures for approving Art.6 Projects, including the consideration of stakeholders' (MATTM, 2010[b]). By the time the JI database from IGES source shows only one large scale project (Track 1) with Italy involved. The task of the project is to reduce GHG emissions fuel switch (IGES, 2014).

Voluntary validation of sustainable development is taking place at international level for CDM and JI projects. The UNEP Risoe Centre database[63] highlights the Gold Standard (GS) and the Climate, Community and Biodiversity Alliance (CCB) for assessing SD on CDM project, and only GS for JI projects. The GS operates a certification scheme for premium quality carbon credits and promotes sustainable development (GS label). Indicators include air/water quality, soil condition, biodiversity, quality of employment, livelihood of the poor, access to affordable and clean energy services, etc (Gold Standard, 2011). After labelling, these projects are tracked in the UNFCCC/CDM Registry. The CCBA is a voluntary standard,

[63] http://uneprisoe.org/

which support the design and identification of land management activities that simultaneously minimize climate change, support sustainable development, and conserve biodiversity. Project design standards include: climate, community, and biodiversity indicators (CCBA, 2011). Up to 26 February 2014, the UNEP Risoe database reports 761 JI projects (track1+track2) from which 604 projects are registered (91.9% track 1+8.1% track 2). Up to 26 February 2014, the UNEP Risoe database reports 8,750 CDM projects with 7,426 registered from which 4 projects are validated with CCB, and 142 projects with GS.

Assessment of social, environmental, and economic effects of CDM and JI projects

The assessment of adverse social, environmental, and economic impacts contribution of CDM projects has been concentrated in the energy sector (or non-forestry CDM projects). Results from most relevant peer-review literature are available in this section.

Most common used methodologies for assessing sustainability are checklists and multicriteria assessments (Olsen 2007). For instance, Sirohi (2007) has qualitatively analyzed and discussed the Project Design Document (PDD) of 65 CDM projects covering all the types of CDM project activity in India. Results from this paper show that the benefits of the projects focusing on improving energy efficiency in industries, fossil fuel switching in industrial units and destruction of HFC-23 would remain largely "firm-specific" and are unlikely to have an impact on rural poverty. Boyd et al. (2009) have chosen randomly 10 CDM projects that capture diversity of project types and regions. Environment and development benefits (environment, economic, technology transfer, health, employment, education and other social) were assessed qualitatively. This review shows divergences and no causal relationship between project types and SD outcomes. Sutter and Parreño (2007) assessed CDM projects in terms of their contribution to employment generation, equal distribution of CDM returns, and improvement of local air quality. The multi-attribute assessment methodology (MATA-CDM) for non-forestry CDM projects was used for assessing 16 CDM projects registered at UNFCCC as of August 30, 2005. Results indicated that projects might contribute to one of the two CDM objectives (GHG emission reductions and SD in the Host country), but neither contributes strongly to both objectives. Uruguay's DNA has adopted this tool for approval of CDM projects. Nussbaumer (2009) has presented a SD assessment of 39 CDM projects. Label CDM projects ('Gold Standard' label and CDCF focuses) were compared to similar non-labelled CDM projects. Results show that labelled CDM activities tend to slightly outperform comparable projects, although not unequivocally. Nussbaumer selected criteria based on those from Sutter (2003) including social (stakeholder participation, improved service availability, equal distribution, capacity development), environmental (fossil energy resources, air quality, water quality, land resource) and economic (regional economy, microeconomic efficiency, employment generation, sustainable technology transfer) issues.

Some studies have also addressed the assessment of forestry CDM projects. Olsen and Fenhann (2008) have developed a taxonomy for sustainability assessment based on PDD text analysis. These authors concluded that the taxonomy can be supportive of DNAs to decide what the consequences should be, if a CDM project at the verification stage does not show signs of realizing its potential SD benefits. Palm et al (2009) developed a ranking process to assess sustainability of forest plantation projects in India. They concluded that successful implementation of forest-based project activities will require local participation and are likely to involve multiple forest products and environmental services demanded by the local community. For the first time a study has addressed the choice of an appropriate method for measuring strong sustainability. In a decision-aiding process, 10 UNFCCC/CDM afforestation/reforestation projects were evaluated through criteria that reflect global and local interests using a non-compensatory multicriteria method. Criteria for assessing SD included: social (land tenure, equitably share natural, skill development, ensure local participation), economic (employment, financial resource to local entities, financial forestry incentives) and environmental (use of native species, conservation and maintenance of soil/water resources, biodiversity conservation) issues. The multicriteria assessment allows sorting forestry projects in three ordered categories: synergistic, reasonably synergistic, and not synergistic. This means that those projects, which are synergistic comply with a higher number of criteria (Cóndor et al., 2010).

A recent report from the UNFCCC concluded that most studies of hydrofluorocarbon and nitrous oxide related projects yield the fewest SD benefits, but the studies differ in their assessment of other project types. It also reports that other studies suggest a trade-off between the goals of the CDM in favour of producing low-cost emission reductions at the expense of achieving SD benefits (UNFCCC, 2011[b]).

For this section we have accessed project databases (UNFCCC, Carbon Finance, UNEP Risoe Centre) and peer-reviewed articles (see Annex A8.2.4 for detailed information on CDM research studies). For non-forestry CDM projects, Nussbaumer (2009) have published results of SD assessment from Honduras and Peru (Hydroelectric), Nepal (Biogas), Argentina (landfill), Moldova (Biomas), India (small hydroelectric and

wind) and China (hydropower), and Sirohi (2007) for projects in India (biomass, F-gas, hydroelectric). For forestry CDM projects, Cóndor et al. (2010) has assessed 3 out from 13 CDM projects in which Italy is involved. 'The Moldova Soil Conservation' project was classified as a 'synergistic' project, while the 'Assisted Natural Regeneration of Degraded Lands' project in Albania and the 'Facilitating Reforestation for Guangxi Watershed Management' project in China were classified as 'reasonably synergistic'. The higher the assignment of the project, the better the performance respect to social, economic and environmental criteria including climate change, biodiversity and desertification issues.
Most articles found for JI are related with institutional arrangements (Evans et al., 2000; Streimikiene and Mikalauskiene, 2007; Firsova and Taplin, 2008) or the integration of JI with other mechanisms such as the white certificates (Oikonomou and van der Gaast, 2008). On peer-review article, no much information was found regarding JI and SD assessment. However, Cha et al. (2008) developed Environmental-Efficiency and Economic-Productivity indicators to choose an environmentally and economically-efficient CDM and JI project.

14.4 Funding, strengthening capacity and transfer of technology

According to Art 3.14 of the KP information on funding and transfer of technology need to be described, thus, brief information is provided in this section.
The flow of financial resources to developing countries and multilateral organisations from Italy is shown in Table 14.4 (OECD, 2014). Between 2006 and 2008 the Ministry of Foreign Affairs has contributed with around 30 million EUR in bilateral and multilateral cooperation with developing countries for climate change related activities. In order to contribute to the implementation of the commitment foreseen in the "Bonn Declaration", since 2002 the Ministry for the Environment, Land and Sea, has been authorized to finance bilateral and multilateral activities in developing countries for 55.1 million EUR/year as of 2008 (MATTM, 2009). A recent peer review report of the Development Assistance Committee (DAC) describes bilateral and multilateral cooperation funding activities in Italy. The Directorate General for Development Co-operation (DGCS) from the Ministry of Foreign Affairs in collaboration with other players in Italian Co-operation is in charge of implementing recommendations (OECD, 2009). The most important institutional actor is the Ministry for the Environment, Land and Sea, because of its contribution to implementing the Kyoto Protocol and other Rio conventions in developing countries.
The Ministry of Foreign Affairs defined the Programming Guidelines and Directions of Italian Development Co-operation 2011-2013, where priority areas are identified (MAE, 2010[c]): i) agriculture/food security; ii) human development, particularly referred to health and education/training; iii) governance and civil society; iv) support for endogenous development, inclusive and sustainable, the private sector, and v) environment, land and natural resources management, particularly referred to water and mitigation/adaptation to climate change. The aid effectiveness is a top priority for the Italian cooperation as described in the 'Aid Effectiveness Action Plan' (DGCS, 2009). The Ministry of Foreign Affairs has a database of environmental projects available online (DGCS, 2013). The ecosystem approach management is a strategy adopted by Italian cooperation. In the environment field, projects that have been monitored by the Central Technical Unit/DGCS - Ministry of Foreign Affairs, are subject to field visit and ex-post assessments in order to verify compliance in the framework of climate change activities (MAE, 2010[a]).

Table 14.4 Financial resources to developing countries and multilateral organisations from Italy

	Italy				
	2001-02	**2009**	**2010**	**2011**	**2012**
NET DISBURSEMENTS			**USD million**		
I. Official Development Assistance (ODA) (A + B)	**1 980**	**3 297**	**2 996**	**4 326**	**2 737**
ODA as % of GNI	**0,18**	**0,16**	**0,15**	**0,20**	**0,14**
A. Bilateral Official Development Assistance	724	875	759	1 703	624
of which: General budget support	- 1	9	5	1	6
Core support to national NGOs	64	-	15	-	1
Investment projects	- 107	37	- 34	310	- 17
Administrative costs	34	59	42	53	35
Other in-donor expenditures	10	5	5	526	272
of which: Refugees in donor countries	8	-	3	525	247
B. Contributions to Multilateral Institutions	1 255	2 423	2 237	2 623	2 113
of which: UN	198	205	170	150	188
EU	691	1 862	1 557	1 924	1 516
IDA	183	214	386	179	166
Regional Development Banks	61	24	6	206	105
II. Other Official Flows (OOF) net (C + D)	- 158	- 72	- 151	- 214	196
C. Bilateral Other Official Flows (1 + 2)	- 158	- 72	- 151	- 214	196
1. Official export credits	16	- 28	- 28	117	97
2. Equities and other bilateral assets	- 173	- 44	- 123	- 330	100
D. Multilateral Institutions	-	-	-	-	-
III. Grants by Private Voluntary Agencies	16	162	150	111	91
IV. Private Flows at Market Terms (long-term) (1 to 4)	-1 233	2 181	6 612	7 689	8 161
1. Direct investment	930	129	4 366	7 530	8 016
2. Private export credits	1 271	463	882	1 234	725
3. Bilateral portfolio investment	-3 434	1 590	1 365	-1 074	- 580
4. Securities of multilateral agencies	-	-	-	-	-
V. Total Resource Flows (long-term) (I to IV)	**605**	**5 569**	**9 608**	**11 912**	**11 186**
Total Resource Flows as a % of GNI	**0,05**	**0,27**	**0,47**	**0,55**	**0,56**

Source: OECD (OECD, 2013) http://www.oecd.org/dac/stats/statisticsonresourceflowstodevelopingcountries.htm

Italian multilateral cooperation on climate change has been performed with different United Nations organizations, funds, and institutions[64]. Cooperation has involved from the supply of financial resources, to the design and implementation of programmes and projects, the promotion of transfer of environmentally-sound technologies aiming at reducing the impacts of human activities on climate change, and support to adaptation measures. Italian bilateral cooperation continues activities described in the Fourth National Communication to the UNFCCC and has implemented new projects on climate change. Focus is given to different geographical regions world-wide[65]. Funding climate change and related topics in developing countries has different and ambitious objective: efficient use of energy, implementation of innovative financial mechanisms, efficient water management, carbon sequestration, professional training, and exchange of know-how, promotion of eco-efficient technologies. Further detailed description is given in 'Chapter 7 Financial assistance and Technology Transfer' of the Sixth National Communication from Italy (MATTM, 2014).

The DGCS of the Ministry of Foreign Affairs is contributing with bilateral projects in the energy sector, for example, in Albania, Bangladesh, Sierra Leone and Palestinian territories (improvement of electric system or hydroelectric power generation) (DGCS, 2011). An example is the hydroelectric project in Ethiopia that has been supported by the Ministry of Foreign Affairs. Next step of this project will be an ex-post assessment of adverse effects through the use of the OECD-DAC guidelines (MAE, 2010[b]). These guidelines include the

[64] Italian multilateral cooperation with the United Nations Educational, Scientific and Cultural Organization (UNESCO), United Nations Industrial Development Organization (UNIDO), Food and Agriculture Organization of the United Nations (FAO), the Regional Environmental Centre for Central and Eastern Europe (REC), the Global Environment Facility (GEF), the World Bank (WB), International Union for Conservation of Nature (IUCN), the United Nations Environment Programme (UNEP), United Nations Development Programme (UNDP) and the Mediterranean Action Plan (MAP).

[65] Italian bilateral cooperation with the Asian and Middle East countries (China, Iraq, Thailand and India), Mediterranean and African region (Algeria, Egypt, Israel, Tunisia, Morrocco), Central and Eastern European countries (Albania, Bosnia, Croatia, Bulgaria, Serbia, Montenegro, Macedonia, Poland, Romania, Turkey, Hungary, Kyrgyzstan and Tajikistan), and Latin America, the Caribean and the Pacific Islands (Belize, Argentina, Mexico, Cuba, Brazil, 14 countries of the South Pacific Small Islands Developing States).

assessment of the relevance, effectiveness, efficiency, impact (positive/negative) and sustainability of the activities (OECD, 2008). In June 2010 the guidelines for on-going and ex-post evaluation of official development assistance implemented by the DGCS-Ministry of Foreign Affairs were published (MAE, 2010[d]).
Evidence of technology transfer activities were found in the context of the Kyoto Mechanisms. An study analyzed comprehensively technology transfer in the CDM: 3296 registered and proposed projects (Seres et al., 2009). Results address that roughly 36% of the projects accounting for 59% of the annual emission reductions claim to involve technology transfer. These authors concluded that as the number of projects increases, technology transfer occurs beyond the individual projects. This is observed for several of the most common project types in China and Brazil with the result that the rate of technology transfer for new projects in those countries has fallen significantly.

14.5 Priority actions in implementing commitments under Article 3 paragraph 14

For the purposes of completeness in reporting, and according to the reporting guidelines for supplementary information (UNFCCC, 2002), a summary of how Italy gives priority to the actions specified in Decision 15/CMP.1, paragraph 24 is given below. More detailed information is found in the Sixth National Communication under the UNFCCC, Chapter 5 Projections and effects of policies and measures and Chapter 7 Financial resources and transfer of technology (MATTM, 2014). The preparation of this paragraph was discussed with energy experts from ISPRA (ISPRA, 2011[a], [b]).

Paragraph 24 (a)
The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities.

EU emissions trading scheme, promotion of biomass and biofuel, Common Agricultural Policy can potentially have impacts in developing countries (European Commission, 2009[b]; 2010[b]). Italy is subject to the European legal system and it will implement the EU legislation. At national level, it is not planned to further increase biomass – biofuel objectives already established (ISPRA, 2011[a]).

Paragraph 24 (b)
Removing subsidies associated with the use of environmentally unsound and unsafe technologies.
Council regulation EC No 1407/2002 rules for granting state aid to contribute to restructure coal industry (European Commission, 2010). Anyway, Italy has a negligible domestic coal production.

Paragraph 24 (c)
Cooperating in the technological development of non-energy uses of fossil fuels, and supporting developing country Parties to this end.
At European level and national level, ‘non-energy uses of fossil fuels’ is not a current research priority (European Commission, 2010).

Paragraph 24 (d)
Cooperating in the development, diffusion, and transfer of less greenhouse gas emitting advanced fossil-fuel technologies, and/or technologies relating to fossil fuels that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other non-Annex I Parties in this effort.
The ongoing activities on multilateral and bilateral Italian cooperation are coordinated through the Ministry of Foreign Affairs and the Ministry for the Environment, Land and Sea, see MATTM (2009, 2014).
For example, Italy has signed with India a Memorandum of Understanding (MoU) on “Co-operation in the Area of Climate Change and Development and Implementation of Projects under the CDM/ Kyoto Protocol”. In this framework, the MATTM supported a project on Carbon Sequestration Potential Assessment.
The Italian Government has already funded research on carbon capture and storage (CCS) technologies carried out by several organizations and institutions: total value 10-15 million euro for the period 2009-2011.

A draft decree transposing EU directive 2009/31/CE in the Italian legislation has been presented to the Parliament by the MATTM and the Ministry for Economic Development. ENEL and ENI, the two major energy utilities in the country, have signed a general agreement for CCS development and will apply for EU funds to set up a pilot unit in Brindisi and a demonstration unit in Porto Tolle. At the international level, Enel is developing a project to build a CO_2 capture system in China and has signed agreements for the development of CCS with other countries like South Korea (ISPRA, 2011[b]).

Paragraph 24 (e)
Strengthening the capacity of developing country Parties identified in Article 4, paragraphs 8 and 9, of the Convention for improving efficiency in upstream and downstream activities relating to fossil fuels, taking into consideration the need to improve the environmental efficiency of these activities.
The ongoing activities on multilateral and bilateral Italian cooperation are coordinated through the Ministry of Foreign Affairs and the Ministry for the Environment, Land and Sea, see MATTM (2009, 2014).
For example, in Central Eastern Europe Italy has multilateral activities within the Regional Environmental Center for Central and Eastern Europe (REC CEE). More than 100 projects have been implemented for the region, specifically, to climate change and energy issues, several programs were carried out on training and capacity building, energy efficiency in small and medium-sized enterprises, public access to information and participation in climate decision-making processes, promotion of climate change mitigation and adaptation policies, development of solar passive and active systems and development of national GHG emission registries.

Paragraph 24 (f)
Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies.
The ongoing activities on multilateral and bilateral Italian cooperation are coordinated through the Ministry of Foreign Affairs and the Ministry for the Environment, Land and Sea, see MATTM (2009, 2014). For example, within the framework of the Mediterranean Renewable Energy Programme (MEDREP) Initiative, the MATTM has signed a MoU with UNEP-DTIE in order to carry out projects helping the establishment of a regional RET market in the Mediterranean region (Tunisia, Egypt, Montenegro and Albania). After, the Mediterranean Investment Facility was launched aiming to the development (2007–2011) of several projects having an important impact on CO_2 emissions by diversifying the use of small scale renewable energy and energy efficiency technologies by targeting different niche markets.
In 2007, the MATTM supported the “Observatory for Renewable Energy in Latin America and the Caribbean” through the signature of a Trust Fund Agreement with UNIDO. Activities are focused on biomass utilization in Uruguay and Brazil in order to reduce the methane emissions and the GHGs’ climate change effects, promoting the utilization of bio-digester plants for the electricity production into the livestock farms, based on a local energy management distributed generation system.

14.6 Additional information and future activities related to the commitment of Article 3.14 of the Kyoto Protocol

Italy is aware of its commitments under Article 3.14 of KP, and it is also well aware of the need to assess social, environmental and economic impacts. Different national and international mechanisms and guidelines are guiding the prevention of adverse effects while implementing projects in developing countries. Different activities have been identified for future commitments under Art 3.14. For instance, priority actions need to be further classified into positive and negative, direct and indirect features.
Italian private companies are participating to flexible mechanisms. For instance, ENI an Italian world-wide energy company, projects to reduce gas flaring associated with oil production, with the goal of reducing by 70% emissions from gas flaring, compared to 2007. For some of these projects, ENI promotes the recognition flexible mechanisms within the CDM (ENI, 2010). ENEL is the Italian largest power company that is one of the main worldwide operators applying the CDM. Most of these initiatives were developed bilaterally between Enel-Endesa and the Host country. The group portfolio includes 105 direct participation projects, mostly located in China (79 projects) and other located in India, Africa and Latin America. As for the JI mechanism, the Group’s portfolio includes 7 projects in Uzbekistan and Ukraine and 32 indirect-participation projects in the European Union, Russia, Moldova and Ukraine (ENEL, 2011).

Finally, projects from decentralized development cooperation are to be considered (OICS, 2011). Principles, actors, priority areas and instruments relating to programs conducted by DGCS with the regions and local authorities (provinces and municipalities) are defined in specific guidelines for decentralized cooperation (MAE, 2010[e]).

14.7 Review process of Article 3.14 of the Kyoto Protocol

In 2011 an in-country review process for the Fifth National Communication took place. During this process also the minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol was reviewed. Additional information reported for submission 2010 and 2011 related with this theme was also provided. According to the UNFCCC review report, the Expert review team (ERT) considers the reported information to be transparent and complete. The ERT also commends Italy for its comprehensive, transparent and well-documented information on the minimization of adverse impacts and encourages it to continue exploring and reporting on the adverse impacts of the response measures (UNFCCC, 2011[a]).

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15.1 INTRODUCTION

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ANNEX 1: KEY CATEGORIES AND UNCERTAINTY

A1.1 Introduction

The 2006 IPCC Guidelines (IPCC, 2006) recommends as good practice the identification of *key categories* in national GHG inventories. A *key category* is defined as an emission source that has a significant influence on a country's GHG inventory in terms either of the absolute/relative level of emissions or the trend in emissions, or both. The concept of key sources was originally derived for emissions excluding the LULUCF sector and expanded, referring to categories, in the IPCC Good Practice Guidance for LULUCF (IPCC, 2003) to cover also LULUCF emissions by sources and removals by sinks. In this document whenever the term *category* is used, it includes both sources and sinks. The 2006 Guidelines provide a harmonized method to deal with both sources and removals and correct some inconsistencies between the previous versions. For these reasons, the updated IPCC guidelines have been followed to implement the key category and uncertainty analyses in the Italian inventory. Two different approaches are reported in the guidelines according to whether or not a country has performed an uncertainty analysis of the inventory: Approach 1 and Approach 2.

When using Approach 1, key categories are identified by means of a pre-determined cumulative emissions threshold, usually fixed at 95% of the total. If an uncertainty analysis is carried out at category level for the inventory, Approach 2 can be used to identify key categories. Approach 2 is a more detailed analysis that builds on Approach 1; in fact, the results of Approach 1 are multiplied by the relative uncertainty of each source/sink category. Key categories are those that represent 90% of the uncertainty contribution. So the factors which make a source or a sink a key category have a high contribution to the total, a high contribution to the trend and a high uncertainty. If both the approaches are applied it is good practice to use the results of the Approach 2 analysis.

For the Italian inventory, a key category analysis has been carried out according to both the methods, excluding and including the LULUCF sector. National emissions have been disaggregated, as far as possible, into the categories proposed in the IPCC guidelines; other categories have been added to reflect specific national circumstances. Both level and trend analysis have been applied. For the base year, the level assessment has been carried out.

Summary of the results of the key category analysis, for the base year and 2012, is reported in Tables 1.3–1.6 of chapter 1. The tables indicate whether a key category derives from the level assessment or the trend assessment, according to Approach 1, Approach 2 or both.

For the base year, 20 categories were individuated according to Approach 1, whereas 17 categories were carried out by Approach 2. Including the LULUCF sector in the analysis, 26 categories were selected according to Approach 1 and 22 with and Approach 2.

For the year 2012, 18 categories were individuated by the Approach 1 accounting for 95% of the total emissions, without LULUCF; for the trend 15 key categories were selected. Jointly for the Approach 1, both level and trend, 24 key categories were totally individuated.

Repeating the key category analysis for the full inventory including the LULUCF sector, 23 categories were individuated accounting for 95% of the total emissions and removals in 2012, and 21 key categories in trend assessment. Jointly for the Approach 1, both level and trend, 29 key categories were totally individuated.

The application of the Approach 2 to the 2012 emission levels gives as a result 16 key categories accounting for the 90% of the total levels with uncertainty; when applying the trend analysis the key categories are equal to 19 with differences with respect to the previous list.

The application of the Approach 2 including the LULUCF categories results in 20 key categories, for the year 2012, accounting for the 90% of the total levels with uncertainty; for the trend analysis including LULUCF categories, the results were 19 key categories. Jointly for both the level and trend, 24 key categories were totally individuated.

A1.2 Approach 1 key category assessment

As described in the 2006 IPCC Guidelines (IPCC, 2006), and previously in the IPCC Good Practice Guidance (IPCC, 2000; IPCC, 2003), the Approach 1 for identifying key categories assesses the impact of

various categories on the level and on the trend of the national emission inventory. Both level and trend assessments should be applied to an emission GHG inventory.
As regards the level assessment, the contribution of each source or sink category to the total national inventory level is calculated as follows:

$$\text{Category Level Assessment} = \frac{|\text{Source or Sink Category Estimate}|}{\text{Total Contribution}}$$

$$L_{x,t} = \frac{|E_{x,t}|}{\sum_y |E_{y,t}|}$$

where

$L_{x,t}$ = level assessment for source or sink *x* in year *t*;

$|E_{x,t}|$ = absolute value of emission and removal estimate of source or sink category *x* in year *t*;

$\sum_y |E_{y,t}|$ = total contribution, which is the sum of the absolute values of emissions and removals in year *t*.

The contribution of all categories (including the LULUCF sector) is entered as absolute values.
Therefore, key categories are those which, when summed in descending order of magnitude, add up to over 95% of the total emissions.
As far as the trend assessment is concerned, the contribution of each source and sink category's trend can be assessed by the following equation:

$$\text{Category Trend Assessment} = (\text{Source or Sink Category Level Assessment}) \cdot |\text{Source or Sink Category Trend - Total Trend}|$$

$$T_{x,t} = |E_{x,0}| \Big/ \sum_y |E_{y,0}| \cdot \left| \left[(E_{x,t} - E_{x,0}) \big/ |E_{x,0}| \right] - \left[(E_t - E_0) \Big/ \sum_y |E_{y,0}| \right] \right|$$

where

$T_{x,t}$ = trend assessment, which is the contribution of the source or sink category trend to the overall inventory trend;

$|E_{x,0}|$ = absolute value of emission and removal estimate of source or sink category *x* in the base year (year *0*);

$\sum_y |E_{y,0}|$ = total contribution, which is the sum of the absolute values of emissions and removals in year *0*;

$E_{x,t}\ and\ E_{x,0}$ = real values of estimates of source or sink category *x* in years *t* and 0, respectively;

$E_t\ and\ E_0 = \sum_y E_{y,t}\ and \sum_y E_{y,0}$ = total inventory estimates in years *t* and 0, respectively.

The source or sink category trend is the change in the category emissions over time, computed by subtracting the base year estimate for a generic category from the latest inventory year estimate and dividing by the absolute value of the latest inventory year estimate; the total trend is the change in the total inventory emissions over time, computed by subtracting the base year estimate for the total inventory from the current year estimate and dividing by the current year estimate.
In circumstances where the base year emissions for a given category are zero, the expression is reformulated to avoid zero in the denominator:

$$T_{x,t} = \left| E_{x,t} \big/ |E_{x,0}| \right|$$

As differences in trend are more significant to the overall inventory level for larger categories, the results of the trend difference is multiplied by the results of the level assessment to provide appropriate weighting.
Thus, key categories will be those for which the category trend diverges significantly from the total trend, weighted by the emission level of the category.
Both level and trend assessments have been carried out for the Italian GHG inventory. For the base year, a level assessment is computed.

In this section, detailed results are reported for the 2012 inventory.
The results of Approach 1 are shown in Table A1.1 and Table A1.2, level and trend assessments without LULUCF categories. Results of the key category analysis with the LULUCF are reported in Table A1.3 and Table A1.4.

Table A1.1 Results of the key category analysis without LULUCF. Approach 1 Level assessment, year 2012

CATEGORIES	2012 CO_2 eq.	Level assessment	Cumulative Percentage
CO2 stationary combustion gaseous fuels	142,425	0.310	0.31
CO2 Mobile combustion: Road Vehicles	97,038	0.211	0.52
CO2 stationary combustion solid fuels	61,976	0.135	0.66
CO2 stationary combustion liquid fuels	51,805	0.113	0.77
CH4 from Solid waste Disposal Sites	11,303	0.025	0.79
CH4 Enteric Fermentation in Domestic Livestock	10,667	0.023	0.82
CO2 Cement production	10,071	0.022	0.84
HFC, PFC substitutes for ODS	9,236	0.020	0.86
Direct N2O Agricultural Soils	8,051	0.017	0.87
Indirect N2O from Nitrogen used in agriculture	7,147	0.016	0.89
CH4 Fugitive emissions from Oil and Gas Operations	4,943	0.011	0.90
CO2 stationary combustion other fuels	4,900	0.011	0.91
CO2 Mobile combustion: Waterborne Navigation	4,890	0.011	0.92
N2O Manure Management	3,742	0.008	0.93
N2O stationary combustion	3,641	0.008	0.94
CH4 Emissions from Wastewater Handling	2,725	0.006	0.94
CO2 Fugitive emissions from Oil and Gas Operations	2,223	0.005	0.95
CO2 Mobile combustion: Aircraft	2,167	0.005	0.95
CO2 Lime production	2,038	0.004	0.96
N2O Emissions from Wastewater Handling	1,935	0.004	0.96
CH4 Manure Management	1,704	0.004	0.97
CH4 from Rice production	1,533	0.003	0.97
CO2 Other industrial processes	1,511	0.003	0.97
CH4 stationary combustion	1,465	0.003	0.98
N2O from animal production	1,426	0.003	0.98
CO2 Iron and Steel production	1,291	0.003	0.98
PFC from the production of halocarbons and SF6	1,183	0.003	0.98
CO2 Mobile combustion: Other	1,076	0.002	0.99
CO2 Limestone and Dolomite Use	1,072	0.002	0.99
CO2 Ammonia production	1,013	0.002	0.99
CO2 Emissions from solvent use	1,001	0.002	0.99
N2O Mobile combustion: Road Vehicles	921	0.002	1.00
N2O Emissions from solvent use	514	0.001	1.00
SF6 Electrical Equipment	307	0.001	1.00
CH4 Mobile combustion: Road Vehicles	198	0.000	1.00
CO2 Emissions from Waste Incineration	170	0.000	1.00
PFC, HFC, SF6 Semiconductor manufacturing	152	0.000	1.00
N2O Nitric Acid	148	0.000	1.00
N2O Adipic Acid	86	0.000	1.00
CH4 Fugitive emissions from Coal Mining and Handling	62	0.000	1.00
CH4 Industrial Processes	55	0.000	1.00
CH4 Emissions from Waste Incineration	51	0.000	1.00
N2O Mobile combustion: Other	46	0.000	1.00
N2O Mobile combustion: Waterborne Navigation	37	0.000	1.00
PFC Aluminium production	33	0.000	1.00
N2O Emissions from Waste Incineration	24	0.000	1.00
N2O Mobile combustion: Aircraft	19	0.000	1.00
CH4 Mobile combustion: Waterborne Navigation	17	0.000	1.00
CH4 Agricultural Residue Burning	14	0.000	1.00
N2O Fugitive emissions from Oil and Gas Operations	11	0.000	1.00
CH4 Emissions from Other Waste	6	0.000	1.00
N2O Agricultural Residue Burning	4.5	0.000	1.00
SF6, HFC Magnesium production	4.2	0.000	1.00
CH4 Mobile combustion: Aircraft	1.3	0.000	1.00
CH4 Mobile combustion: Other	1.3	0.000	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.8	0.000	1.00
N2O Other industrial processes	0.0	0.000	1.00
SF6 Production of SF6	0.0	0.000	1.00

Table A1.2 Results of the key category analysis without LULUCF. Approach 1 Trend assessment, 1990- 2012

CATEGORIES	Contribution to trend (%)	Cumulative Percentage
CO2 stationary combustion liquid fuels	0.386	0.39
CO2 stationary combustion gaseous fuels	0.307	0.69
CO2 Mobile combustion: Road Vehicles	0.065	0.76
CO2 stationary combustion solid fuels	0.044	0.80
HFC, PFC substitutes for ODS	0.042	0.84
CO2 Cement production	0.019	0.86
CO2 stationary combustion other fuels	0.019	0.88
N2O Adipic Acid	0.018	0.90
CH4 from Solid waste Disposal Sites	0.010	0.91
N2O Nitric Acid	0.008	0.92
CH4 Fugitive emissions from Oil and Gas Operations	0.007	0.93
CO2 Iron and Steel production	0.007	0.93
PFC Aluminium production	0.007	0.94
CO2 Ammonia production	0.007	0.95
CH4 Manure Management	0.006	0.95
CO2 Limestone and Dolomite Use	0.005	0.96
CH4 Emissions from Wastewater Handling	0.004	0.96
CH4 stationary combustion	0.004	0.96
CO2 Fugitive emissions from Oil and Gas Operations	0.003	0.97
CO2 Mobile combustion: Aircraft	0.003	0.97
CO2 Mobile combustion: Other	0.003	0.97
Direct N2O Agricultural Soils	0.002	0.98
N2O stationary combustion	0.002	0.98
CH4 Mobile combustion: Road Vehicles	0.002	0.98
PFC from the production of halocarbons and SF6	0.002	0.98
CO2 Emissions from solvent use	0.002	0.99
N2O Emissions from Wastewater Handling	0.001	0.99
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.001	0.99
CO2 Emissions from Waste Incineration	0.001	0.99
N2O Manure Management	0.001	0.99
CO2 Lime production	0.001	0.99
CH4 Enteric Fermentation in Domestic Livestock	0.001	0.99
N2O Emissions from solvent use	0.001	0.99
CO2 Other industrial processes	0.001	0.99
PFC, HFC, SF6 Semiconductor manufacturing	0.001	1.00
N2O Mobile combustion: Road Vehicles	0.001	1.00
CH4 from Rice production	0.001	1.00
SF6 Electrical Equipment	0.001	1.00
N2O from animal production	0.001	1.00
SF6 Production of SF6	0.000	1.00
CO2 Mobile combustion: Waterborne Navigation	0.000	1.00
Indirect N2O from Nitrogen used in agriculture	0.000	1.00
N2O Mobile combustion: Other	0.000	1.00
CH4 Fugitive emissions from Coal Mining and Handling	0.000	1.00
CH4 Industrial Processes	0.000	1.00
CH4 Emissions from Waste Incineration	0.000	1.00
N2O Emissions from Waste Incineration	0.000	1.00
N2O Other industrial processes	0.000	1.00
CH4 Mobile combustion: Waterborne Navigation	0.000	1.00
N2O Mobile combustion: Aircraft	0.000	1.00
CH4 Emissions from Other Waste	0.000	1.00
SF6, HFC Magnesium production	0.000	1.00
CH4 Mobile combustion: Other	0.000	1.00
CH4 Agricultural Residue Burning	0.000	1.00
N2O Mobile combustion: Waterborne Navigation	0.000	1.00
N2O Agricultural Residue Burning	0.000	1.00
CH4 Mobile combustion: Aircraft	0.000	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.000	1.00

Table A1.3 Results of the key category analysis with LULUCF. Approach 1 Level assessment, year 2012

CATEGORIES	2012 CO_2 eq.	Level assessment	Cumulative Percentage
CO2 stationary combustion gaseous fuels	142,425	0.279	0.28
CO2 Mobile combustion: Road Vehicles	97,038	0.190	0.47
CO2 stationary combustion solid fuels	61,976	0.121	0.59
CO2 stationary combustion liquid fuels	51,805	0.101	0.69
CO2 Forest land remaining Forest Land	-24,180	0.047	0.74
CH4 from Solid waste Disposal Sites	11,303	0.022	0.76
CH4 Enteric Fermentation in Domestic Livestock	10,667	0.021	0.78
CO2 Cement production	10,071	0.020	0.80
HFC, PFC substitutes for ODS	9,236	0.018	0.82
Direct N2O Agricultural Soils	8,051	0.016	0.84
CO2 Land converted to Settlements	7,774	0.015	0.85
Indirect N2O from Nitrogen used in agriculture	7,147	0.014	0.86
CO2 Land converted to Forest Land	-5,883	0.012	0.88
CH4 Fugitive emissions from Oil and Gas Operations	4,943	0.010	0.89
CO2 stationary combustion other fuels	4,900	0.010	0.90
CO2 Mobile combustion: Waterborne Navigation	4,890	0.010	0.90
CO2 Land converted to Grassland	-4,653	0.009	0.91
CO2 Cropland remaining Cropland	4,030	0.008	0.92
N2O Manure Management	3,742	0.007	0.93
N2O stationary combustion	3,641	0.01	0.94
CO2 Grassland remaining Grassland	2,849	0.01	0.94
CH4 Emissions from Wastewater Handling	2,725	0.005	0.95
CO2 Fugitive emissions from Oil and Gas Operations	2,223	0.004	0.95
CO2 Mobile combustion: Aircraft	2,167	0.004	0.96
CO2 Lime production	2,038	0.004	0.96
N2O Emissions from Wastewater Handling	1,935	0.004	0.96
CH4 Manure Management	1,704	0.003	0.97
CH4 from Rice production	1,533	0.003	0.97
CO2 Other industrial processes	1,511	0.003	0.97
CH4 stationary combustion	1,465	0.003	0.98
N2O from animal production	1,426	0.003	0.98
CO2 Iron and Steel production	1,291	0.003	0.98
PFC from the production of halocarbons and SF6	1,183	0.002	0.98
CO2 Mobile combustion: Other	1,076	0.002	0.99
CO2 Limestone and Dolomite Use	1,072	0.002	0.99
CO2 Ammonia production	1,013	0.002	0.99
CO2 Emissions from solvent use	1,001	0.002	0.99
N2O Mobile combustion: Road Vehicles	921	0.002	0.99
N2O Emissions from solvent use	514	0.001	0.99
CH4 Grassland remaining Grassland	508	0.001	1.00
CH4 Forest land remaining Forest Land	451	0.001	1.00
SF6 Electrical Equipment	307	0.001	1.00
N2O Grassland remaining Grassland	235	0.000	1.00
CH4 Mobile combustion: Road Vehicles	198	0.000	1.00
CO2 Land converted to Cropland	197	0.000	1.00
CO2 Emissions from Waste Incineration	170	0.000	1.00
PFC, HFC, SF6 Semiconductor manufacturing	152	0.000	1.00
N2O Nitric Acid	148	0.000	1.00
N2O Adipic Acid	86	0.000	1.00
CH4 Land converted to Forest Land	84	0.000	1.00
CH4 Fugitive emissions from Coal Mining and Handling	62	0.000	1.00
CH4 Industrial Processes	55	0.000	1.00
CH4 Emissions from Waste Incineration	51	0.000	1.00
N2O Mobile combustion: Other	46	0.000	1.00
N2O Mobile combustion: Waterborne Navigation	37	0.000	1.00
PFC Aluminium production	33	0.000	1.00
N2O Emissions from Waste Incineration	24	0.000	1.00
N2O Land converted to Cropland	22	0.000	1.00
N2O Mobile combustion: Aircraft	19	0.000	1.00
CH4 Mobile combustion: Waterborne Navigation	17.2	0.000	1.00
CH4 Agricultural Residue Burning	14.2	0.000	1.00
N2O Fugitive emissions from Oil and Gas Operations	10.9	0.000	1.00
CH4 Emissions from Other Waste	5.7	0.000	1.00
N2O Agricultural Residue Burning	4.5	0.000	1.00
SF6, HFC Magnesium production	4.2	0.000	1.00

Table A1.4 Results of the key category analysis with LULUCF. Approach 1 Trend assessment, 1990-2012

CATEGORIES	Contribution to trend (%)	Cumulative Percentage
CO2 stationary combustion liquid fuels	0.333	0.33
CO2 stationary combustion gaseous fuels	0.291	0.62
CO2 Mobile combustion: Road Vehicles	0.071	0.69
CO2 stationary combustion solid fuels	0.048	0.74
HFC, PFC substitutes for ODS	0.039	0.78
CO2 Forest land remaining Forest Land	0.026	0.81
CO2 Land converted to Grassland	0.019	0.83
CO2 stationary combustion other fuels	0.017	0.84
N2O Adipic Acid	0.016	0.86
CO2 Cement production	0.015	0.88
CO2 Cropland remaining Cropland	0.011	0.89
CO2 Land converted to Forest Land	0.010	0.90
CO2 Grassland remaining Grassland	0.008	0.90
CO2 Land converted to Settlements	0.007	0.91
CH4 from Solid waste Disposal Sites	0.007	0.92
N2O Nitric Acid	0.007	0.93
PFC Aluminium production	0.006	0.93
CO2 Iron and Steel production	0.006	0.94
CO2 Ammonia production	0.006	0.94
CH4 Fugitive emissions from Oil and Gas Operations	0.005	0.95
CH4 Manure Management	0.005	0.95
CO2 Limestone and Dolomite Use	0.005	0.96
CH4 Emissions from Wastewater Handling	0.004	0.96
CH4 stationary combustion	0.003	0.97
CO2 Mobile combustion: Aircraft	0.003	0.97
CO2 Fugitive emissions from Oil and Gas Operations	0.003	0.97
N2O stationary combustion	0.003	0.97
CO2 Mobile combustion: Other	0.002	0.98
PFC from the production of halocarbons and SF6	0.002	0.98
CH4 Mobile combustion: Road Vehicles	0.002	0.98
CO2 Emissions from solvent use	0.002	0.98
N2O Manure Management	0.002	0.98
N2O Emissions from Wastewater Handling	0.002	0.99
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.001	0.99
CO2 Lime production	0.001	0.99
CO2 Emissions from Waste Incineration	0.001	0.99
CO2 Land converted to Cropland	0.001	0.99
CO2 Mobile combustion: Waterborne Navigation	0.001	0.99
Direct N2O Agricultural Soils	0.001	0.99
CH4 Forest land remaining Forest Land	0.001	0.99
CH4 from Rice production	0.001	0.99
N2O Emissions from solvent use	0.001	0.99
N2O Mobile combustion: Road Vehicles	0.001	1.00
Indirect N2O from Nitrogen used in agriculture	0.001	1.00
PFC, HFC, SF6 Semiconductor manufacturing	0.001	1.00
CH4 Enteric Fermentation in Domestic Livestock	0.001	1.00
SF6 Electrical Equipment	0.001	1.00
SF6 Production of SF6	0.000	1.00

The application of Approach 1, excluding LULUCF categories, gives as a result 18 key categories accounting for the 95% of the total levels; when applying the trend analysis, excluding LULUCF categories, the key categories decreased to 15 with some differences with respect to the previous list (Tables A1.1, A1.2).

The Approach 1 *key category* level assessment, repeated for the full inventory including the LULUCF, results in 23 key categories (sources and sinks), whereas 21 key categories outcome from the trend analysis, with some differences as respect to the list resulting from level assessment (Tables A1.3, A1.4).

A1.3 Uncertainty assessment (IPCC Approach 1)

Approach 2 for the identification of key categories implies the assessment of the uncertainty analysis to an emission inventory. As already mentioned, the IPCC Approach 1 has been applied to the Italian GHG inventory to estimate uncertainties for the base year and the last submitted year. In this section, detailed results are reported for the 2012 inventory. The uncertainty analysis has also been implemented both excluding and including the LULUCF sector in the national totals.
Results are reported in Table A1.5, for the year 2012, excluding the LULUCF sector. Details on the method used for LULUCF are described in chapter 7. In Table A1.6, results by category, concerning only CO_2 emissions and removals, are reported whereas in Table A1.7, results include CO_2, CH_4, N_2O emissions and removals. Finally, in Table A1.8 figures of inventory total uncertainty, including the LULUCF sector, are shown.

Table A1.5 Results of the uncertainty analysis excluding LULUCF (Approach 1). Year 2012

IPCC category	Gas	Emissions 1990	Emissions 2012	Uncertainty AD	Uncertainty EF	Uncertainty Combined	Contribution to variance	Sensitivity Type A	Sensitivity Type B	Uncertainty in trend introduced by EF uncertainty	Uncertainty in trend introduced by AD uncertainty	Uncertainty in trend in total national emissions
		Gg CO_2 eq.										
CO2 stationary combustion liquid fuels	CO2	153,467	51,805	3%	3%	0.042	0.000	0.162	0.100	0.005	0.004	0.000
CO2 stationary combustion solid fuels	CO2	58,993	61,976	3%	3%	0.042	0.000	0.019	0.119	0.001	0.005	0.000
CO2 stationary combustion gaseous fuels	CO2	85,066	142,425	3%	3%	0.042	0.000	0.129	0.274	0.004	0.012	0.000
CO2 stationary combustion other fuels	CO2	887	4,900	3%	3%	0.042	0.000	0.008	0.009	0.000	0.000	0.000
CH4 stationary combustion	CH4	784	1,465	3%	50%	0.501	0.000	0.001	0.003	0.001	0.000	0.000
N2O stationary combustion	N2O	3,533	3,641	3%	50%	0.501	0.000	0.001	0.007	0.000	0.000	0.000
CO2 Mobile combustion: Road Vehicles	CO2	93,387	97,038	3%	3%	0.042	0.000	0.027	0.187	0.001	0.008	0.000
CH4 Mobile combustion: Road Vehicles	CH4	792	198	3%	40%	0.401	0.000	0.001	0.000	0.000	0.000	0.000
N2O Mobile combustion: Road Vehicles	N2O	879	921	3%	50%	0.501	0.000	0.000	0.002	0.000	0.000	0.000
CO2 Mobile combustion: Waterborne Navigation	CO2	5,420	4,890	3%	3%	0.042	0.000	0.000	0.009	0.000	0.000	0.000
CH4 Mobile combustion: Waterborne Navigation	CH4	29	17	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Waterborne Navigation	N2O	39	37	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion: Aircraft	CO2	1,613	2,167	3%	3%	0.042	0.000	0.001	0.004	0.000	0.000	0.000
CH4 Mobile combustion: Aircraft	CH4	1	1	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Aircraft	N2O	14	19	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion: Other	CO2	1,894	1,076	3%	5%	0.058	0.000	0.001	0.002	0.000	0.000	0.000
CH4 Mobile combustion: Other	CH4	5	1	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Other	N2O	131	46	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Fugitive emissions from Coal Mining and Handling	CH4	127	62	3%	200%	2.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Fugitive emissions from Oil and Gas Operations	CO2	3,344	2,223	3%	25%	0.252	0.000	0.001	0.004	0.000	0.000	0.000
CH4 Fugitive emissions from Oil and Gas Operations	CH4	7,298	4,943	3%	25%	0.252	0.000	0.003	0.010	0.001	0.000	0.000
N2O Fugitive emissions from Oil and Gas Operations	N2O	12	11	3%	25%	0.252	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Cement production	CO2	16,084	10,071	3%	10%	0.104	0.000	0.008	0.019	0.001	0.001	0.000
CO2 Lime production	CO2	2,042	2,038	3%	10%	0.104	0.000	0.000	0.004	0.000	0.000	0.000
CO2 Limestone and Dolomite Use	CO2	2,540	1,072	3%	10%	0.104	0.000	0.002	0.002	0.000	0.000	0.000
CO2 Iron and Steel production	CO2	3,124	1,291	3%	10%	0.104	0.000	0.003	0.002	0.000	0.000	0.000
CO2 Ammonia production	CO2	2,765	1,013	3%	10%	0.104	0.000	0.003	0.002	0.000	0.000	0.000
CO2 Other industrial processes	CO2	1,880	1,511	3%	10%	0.104	0.000	0.000	0.003	0.000	0.000	0.000
N2O Adipic Acid	N2O	4,579	86	3%	10%	0.104	0.000	0.008	0.000	0.001	0.000	0.000
N2O Nitric Acid	N2O	2,086	148	3%	10%	0.104	0.000	0.003	0.000	0.000	0.000	0.000
N2O Other industrial processes	N2O	11	0	3%	10%	0.104	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Industrial Processes	CH4	108	55	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000

Table A1.5 Results of the uncertainty analysis excluding LULUCF (Approach 1). Year 2012 (continued)

IPCC category	Gas	Emissions 1990	Emissions 2012	Uncertainty AD	Uncertainty EF	Uncertainty Combined	Contribution to variance	Sensitivity Type A	Sensitivity Type B	Uncertainty in trend introduced by EF uncertainty	Uncertainty in trend introduced by AD uncertainty	Uncertainty in trend in total national emissions
		Gg CO_2 eq.										
PFC Aluminium production	PFC	1,673	33	5%	10%	0.112	0.000	0.003	0.000	0.000	0.000	0.000
SF6, HFC Magnesium production	SF6-HI	0	4	5%	5%	0.071	0.000	0.000	0.000	0.000	0.000	0.000
SF6 Electrical Equipment	SF6	213	307	5%	10%	0.112	0.000	0.000	0.001	0.000	0.000	0.000
SF6 Production of SF6	SF6	120	0	5%	10%	0.112	0.000	0.000	0.000	0.000	0.000	0.000
PFC, HFC, SF6 Semiconductor manufacturing	PFC-HFC	0	152	30%	50%	0.583	0.000	0.000	0.000	0.000	0.000	0.000
HFC, PFC substitutes for ODS	HFC	0	9,236	30%	50%	0.583	0.000	0.018	0.018	0.009	0.008	0.000
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	HFC	351	1	5%	10%	0.112	0.000	0.001	0.000	0.000	0.000	0.000
PFC from the production of halocarbons and SF6	PFC	813	1,183	5%	10%	0.112	0.000	0.001	0.002	0.000	0.000	0.000
CH4 Enteric Fermentation in Domestic Livestock	CH4	12,278	10,667	20%	20%	0.283	0.000	0.000	0.021	0.000	0.006	0.000
CH4 Manure Management	CH4	3,467	1,704	20%	100%	1.020	0.000	0.003	0.003	0.003	0.001	0.000
N2O Manure Management	N2O	3,934	3,742	20%	100%	1.020	0.000	0.000	0.007	0.000	0.002	0.000
CH4 Agricultural Residue Burning	CH4	13	14	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
N2O Agricultural Residue Burning	N2O	4	5	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
Direct N2O Agricultural Soils	N2O	9,673	8,051	20%	100%	1.020	0.000	0.001	0.016	0.001	0.004	0.000
Indirect N2O from Nitrogen used in agriculture	N2O	8,148	7,147	20%	100%	1.020	0.000	0.000	0.014	0.000	0.004	0.000
CH4 from Rice production	CH4	1,576	1,533	3%	20%	0.202	0.000	0.000	0.003	0.000	0.000	0.000
N2O from animal production	N2O	1,736	1,426	20%	100%	1.020	0.000	0.000	0.003	0.000	0.001	0.000
CH4 from Solid waste Disposal Sites	CH4	15,254	11,303	20%	30%	0.361	0.000	0.004	0.022	0.001	0.006	0.000
CH4 Emissions from Wastewater Handling	CH4	1,990	2,725	100%	30%	1.044	0.000	0.002	0.005	0.001	0.007	0.000
N2O Emissions from Wastewater Handling	N2O	1,831	1,935	30%	30%	0.424	0.000	0.001	0.004	0.000	0.002	0.000
CO2 Emissions from Waste Incineration	CO2	507	170	5%	25%	0.255	0.000	0.001	0.000	0.000	0.000	0.000
CH4 Emissions from Waste Incineration	CH4	44	51	5%	20%	0.206	0.000	0.000	0.000	0.000	0.000	0.000
N2O Emissions from Waste Incineration	N2O	39	24	5%	100%	1.001	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Emissions from Other Waste	CH4	0	6	10%	100%	1.005	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Emissions from solvent use	CO2	1,642	1,001	30%	50%	0.583	0.000	0.001	0.002	0.000	0.001	0.000
N2O Emissions from solvent use	N2O	812	514	50%	10%	0.510	0.000	0.000	0.001	0.000	0.001	0.000
TOTAL		**519,055**	**460,083**				**0.001**					**0.001**
						Percentage uncertainty in total inventory	**3.6%**				**Trend uncertainty**	**2.5%**

Table A1.6 Results of the uncertainty analysis for the LULUCF sector – CO_2 (Approach 1)

IPCC	Gas	Emissions		Uncertainty				Sensitivity		Trend uncertainty		
Category		1990	2012	AD	EF	Combined uncertainty	Contribution to variance	Type A	Type B	in LULUCF emissions introduced by EF uncertainty	in LULUCF emissions introduced by AD uncertainty	in total LULUCF emissions
		Gg CO_2 eq										
A. Forest Land	CO_2	-18,943	-30,062	*18%*	*15%*	23%	11%	771%	142%	116%	36%	148%
B. Cropland	CO_2	2,175	4,228	*75%*	*75%*	106%	5%	78%	20%	58%	21%	38%
C. Grassland	CO_2	4,329	-3,053	*75%*	*75%*	106%	2%	367%	14%	276%	15%	762%
D. Wetlands	CO_2	0	0			0%	0%	0%	0%	0%	0%	0%
E. Settlements	CO_2	6,996	7,774	*75%*	*75%*	106%	15%	360%	37%	270%	39%	746%
F. Other Land	CO_2	0	0			0%	0%	0%	0%	0%	0%	0%
G. Other	CO_2	0	0			0%	0%	0%	0%	0%	0%	0%
TOTAL		**-5,443**	**-21,113**				**33%**					**1695%**
						Percertage uncertainty	**58%**				Trend uncertainty	**412%**

[a] the combined uncertainty has been calculated as explained in Chapter 7, 7.2.3 Uncertainty and time series consistency; in order to provide estimate of uncertainties in trend in national emissions introduced by emission factor and activity data, values for the uncertainty related to activity data and emission factor have been assigned by expert judgment, taking into account the final combined uncertainty

Table A1.7 Results of the uncertainty analysis for the LULUCF sector – CO_2, CH_4, N_2O (Approach 1)

IPCC	Gas	Emissions		Uncertainty				Sensitivity		Trend uncertainty		
Category		1990	2012	AD	EF	Combined uncertainty	Contribution to variance	Type A	Type B	in LULUCF emissions introduced by EF uncertainty	in LULUCF emissions introduced by AD uncertainty	in total LULUCF emissions
		Gg CO_2 eq										
A. Forest Land	CO_2 eq	-18,061	-29,526	*18%*	*15%*	23%	12%	1837%	149%	277%	38%	783%
B. Cropland	CO_2 eq	2,241	4,256	*75%*	*75%*	106%	5%	224%	21%	168%	23%	288%
C. Grassland	CO_2 eq	5,215	-2,309	*75%*	*75%*	106%	2%	870%	12%	652%	12%	4257%
D. Wetlands	CO_2 eq	0	0			0%	0%	0%	0%	0%	0%	0%
E. Settlements	CO_2 eq	6,996	7,774	*75%*	*75%*	106%	17%	865%	39%	649%	42%	4230%
F. Other Land	CO_2 eq	0	0			0%	0%	0%	0%	0%	0%	0%
G. Other	CO_2 eq	0	0			0%	0%	0%	0%	0%	0%	0%
TOTAL		**-3,609**	**-19,805**				**36%**					**9559%**
						Percertage uncertainty	**60%**				Trend uncertainty	**978%**

Table A1.8 Results of the uncertainty analysis including LULUCF (Approach 1). Year 2012

IPCC category	Gas	Emissions 1990	Emissions 2012	Uncertainty AD	Uncertainty EF	Uncertainty Combined	Contribution to variance	Sensitivity Type A	Sensitivity Type B	Uncertainty in trend introduced by EF uncertainty	Uncertainty in trend introduced by AD uncertainty	Uncertainty in trend in total national emissions
		Gg CO_2 eq.										
CO2 stationary combustion liquid fuels	CO2	153,467	51,805	3%	3%	0.042	0.000	0.154	0.101	0.005	0.004	0.000
CO2 stationary combustion solid fuels	CO2	58,993	61,976	3%	3%	0.042	0.000	0.022	0.120	0.001	0.005	0.000
CO2 stationary combustion gaseous fuels	CO2	85,066	142,425	3%	3%	0.042	0.000	0.135	0.276	0.004	0.012	0.000
CO2 stationary combustion other fuels	CO2	887	4,900	3%	3%	0.042	0.000	0.008	0.010	0.000	0.000	0.000
CH4 stationary combustion	CH4	784	1,465	3%	50%	0.501	0.000	0.002	0.003	0.001	0.000	0.000
N2O stationary combustion	N2O	3,533	3,641	3%	50%	0.501	0.000	0.001	0.007	0.001	0.000	0.000
CO2 Mobile combustion: Road Vehicles	CO2	93,387	97,038	3%	3%	0.042	0.000	0.033	0.188	0.001	0.008	0.000
CH4 Mobile combustion: Road Vehicles	CH4	792	198	3%	40%	0.401	0.000	0.001	0.000	0.000	0.000	0.000
N2O Mobile combustion: Road Vehicles	N2O	879	921	3%	50%	0.501	0.000	0.000	0.002	0.000	0.000	0.000
CO2 Mobile combustion: Waterborne Navigation	CO2	5,420	4,890	3%	3%	0.042	0.000	0.000	0.009	0.000	0.000	0.000
CH4 Mobile combustion: Waterborne Navigation	CH4	29	17	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Waterborne Navigation	N2O	39	37	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion: Aircraft	CO2	1,613	2,167	3%	3%	0.042	0.000	0.002	0.004	0.000	0.000	0.000
CH4 Mobile combustion: Aircraft	CH4	1	1	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Aircraft	N2O	14	19	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion: Other	CO2	1,894	1,076	3%	5%	0.058	0.000	0.001	0.002	0.000	0.000	0.000
CH4 Mobile combustion: Other	CH4	5	1	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Other	N2O	131	46	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Fugitive emissions from Coal Mining and Handling	CH4	127	62	3%	200%	2.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Fugitive emissions from Oil and Gas Operations	CO2	3,344	2,223	3%	25%	0.252	0.000	0.001	0.004	0.000	0.000	0.000
CH4 Fugitive emissions from Oil and Gas Operations	CH4	7,298	4,943	3%	25%	0.252	0.000	0.003	0.010	0.001	0.000	0.000
N2O Fugitive emissions from Oil and Gas Operations	N2O	12	11	3%	25%	0.252	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Cement production	CO2	16,084	10,071	3%	10%	0.104	0.000	0.007	0.020	0.001	0.001	0.000
CO2 Lime production	CO2	2,042	2,038	3%	10%	0.104	0.000	0.001	0.004	0.000	0.000	0.000
CO2 Limestone and Dolomite Use	CO2	2,540	1,072	3%	10%	0.104	0.000	0.002	0.002	0.000	0.000	0.000
CO2 Iron and Steel production	CO2	3,124	1,291	3%	10%	0.104	0.000	0.003	0.003	0.000	0.000	0.000
CO2 Ammonia production	CO2	2,765	1,013	3%	10%	0.104	0.000	0.003	0.002	0.000	0.000	0.000
CO2 Other industrial processes	CO2	1,880	1,511	3%	10%	0.104	0.000	0.000	0.003	0.000	0.000	0.000
N2O Adipic Acid	N2O	4,579	86	3%	10%	0.104	0.000	0.007	0.000	0.001	0.000	0.000
N2O Nitric Acid	N2O	2,086	148	3%	10%	0.104	0.000	0.003	0.000	0.000	0.000	0.000
N2O Other industrial processes	N2O	11	0	3%	10%	0.104	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Industrial Processes	CH4	108	55	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
PFC Aluminium production	PFC	1,673	33	5%	10%	0.112	0.000	0.003	0.000	0.000	0.000	0.000
SF6, HFC Magnesium production	SF6-H	0	4	5%	5%	0.071	0.000	0.000	0.000	0.000	0.000	0.000
SF6 Electrical Equipment	SF6	213	307	5%	10%	0.112	0.000	0.000	0.001	0.000	0.000	0.000
SF6 Production of SF6	SF6	120	0	5%	10%	0.112	0.000	0.000	0.000	0.000	0.000	0.000
PFC, HFC, SF6 Semiconductor manufacturing	PFC-H	0	152	30%	50%	0.583	0.000	0.000	0.000	0.000	0.000	0.000
HFC, PFC substitutes for ODS	HFC	0	9,236	30%	50%	0.583	0.000	0.018	0.018	0.009	0.008	0.000
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	HFC	351	1	5%	10%	0.112	0.000	0.001	0.000	0.000	0.000	0.000
PFC from the production of halocarbons and SF6	PFC	813	1,183	5%	10%	0.112	0.000	0.001	0.002	0.000	0.000	0.000

Table A1.8 Results of the uncertainty analysis including LULUCF (Approach 1). Year 2012 (continued)

		Emissions		Uncertainty				Sensitivity		Uncertainty in trend		
IPCC category	Gas	1990	2012	AD	EF	Combined	Contribution to variance	Type A	Type B	introduced by EF uncertainty	introduced by AD uncertainty	in total national emissions
		Gg CO_2 eq.										
CH4 Enteric Fermentation in Domestic Livestock	CH4	12,278	10,667	20%	20%	0.283	0.000	0.000	0.021	0.000	0.006	0.000
CH4 Manure Management	CH4	3,467	1,704	20%	100%	1.020	0.000	0.002	0.003	0.002	0.001	0.000
N2O Manure Management	N2O	3,934	3,742	20%	100%	1.020	0.000	0.001	0.007	0.001	0.002	0.000
CH4 Agricultural Residue Burning	CH4	13	14	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
N2O Agricultural Residue Burning	N2O	4	5	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
Direct N2O Agricultural Soils	N2O	9,673	8,051	20%	100%	1.020	0.000	0.000	0.016	0.000	0.004	0.000
Indirect N2O from Nitrogen used in agriculture	N2O	8,148	7,147	20%	100%	1.020	0.000	0.000	0.014	0.000	0.004	0.000
CH4 from Rice production	CH4	1,576	1,533	3%	20%	0.202	0.000	0.000	0.003	0.000	0.000	0.000
N2O from animal production	N2O	1,736	1,426	20%	100%	1.020	0.000	0.000	0.003	0.000	0.001	0.000
CH4 from Solid waste Disposal Sites	CH4	15,254	11,303	20%	30%	0.361	0.000	0.003	0.022	0.001	0.006	0.000
CH4 Emissions from Wastewater Handling	CH4	1,990	2,725	100%	30%	1.044	0.000	0.002	0.005	0.001	0.007	0.000
N2O Emissions from Wastewater Handling	N2O	1,831	1,935	30%	30%	0.424	0.000	0.001	0.004	0.000	0.002	0.000
CO2 Emissions from Waste Incineration	CO2	507	170	5%	25%	0.255	0.000	0.001	0.000	0.000	0.000	0.000
CH4 Emissions from Waste Incineration	CH4	44	51	5%	20%	0.206	0.000	0.000	0.000	0.000	0.000	0.000
N2O Emissions from Waste Incineration	N2O	39	24	5%	100%	1.001	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Emissions from Other Waste	CH4	0	6	10%	100%	1.005	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Emissions from solvent use	CO2	1,642	1,001	30%	50%	0.583	0.000	0.001	0.002	0.000	0.001	0.000
N2O Emissions from solvent use	N2O	812	514	50%	10%	0.510	0.000	0.000	0.001	0.000	0.001	0.000
CO2 Forest land remaining Forest Land	CO2	-15,794	-24,180	18%	15%	0.234	0.000	0.021	0.047	0.003	0.012	0.000
CH4 Forest land remaining Forest Land	CH4	798	451	18%	15%	0.234	0.000	0.000	0.001	0.000	0.000	0.000
N2O Forest land remaining Forest Land	N2O	4	2	18%	15%	0.234	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Cropland remaining Cropland	CO2	1,641	4,030	75%	75%	1.061	0.000	0.005	0.008	0.004	0.008	0.000
CH4 Cropland remaining Cropland	CH4	5	4	75%	75%	1.061	0.000	0.000	0.000	0.000	0.000	0.000
N2O Cropland remaining Cropland	N2O	2	2	75%	75%	1.061	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Land converted to Forest Land	CO2	-3,149	-5,883	75%	75%	1.061	0.000	0.006	0.011	0.005	0.012	0.000
CH4 Land converted to Forest Land	CH4	80	84	75%	75%	0.234	0.000	0.000	0.000	0.000	0.000	0.000
N2O Land converted to Forest Land	N2O	0	0	75%	75%	0.234	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Land converted to Cropland	CO2	534	197	1	1	1.061	0.000	0.001	0.000	0.000	0.000	0.000
CO2 Grassland remaining Grassland	CO2	5,603	2,849	1	1	1.061	0.000	0.004	0.006	0.003	0.006	0.000
CH4 Grassland remaining Grassland	CH4	606	508	1	1	1.061	0.000	0.000	0.001	0.000	0.001	0.000
N2O Grassland remaining Grassland	N2O	281	235	1	1	1.061	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Land converted to Grassland	CO2	-1,275	-4,653	1	1	1.061	0.000	0.007	0.009	0.005	0.010	0.000
N2O Land converted to Cropland	N2O	59	22	1	1	1.061	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Land converted to Settlements	CO2	6,996	7,774	1	1	1.061	0.000	0.003	0.015	0.003	0.016	0.000
TOTAL		**515,446**	**441,527**				**0.002**					**0.001**
						Percertage uncertainty in total inventory	**4.9%**				**Trend uncertainty**	**3.8%**

Emission sources of the Italian inventory are disaggregated into a detailed level, 58 sources, according to the IPCC list in the guidelines and taking into account national circumstances and importance. Considering also the LULUCF sector, sources and sinks of the Italian inventory are disaggregated into 74 categories. Uncertainties are therefore estimated for these categories. To estimate uncertainty for both activity data and emission factors, information provided in the IPCC Good Practice Guidance and Guidelines, as well as expert judgement have been used; standard deviations have also been considered whenever measurements were available.
The assumptions on which uncertainty estimations are based on are documented for each category. Figures to draw up uncertainty are checked with the relevant analyst experts and literature references and they are consistent with the IPCC Good Practice Guidance and the 2006 IPCC Guidelines (IPCC, 2000; IPCC, 2006).
The general approach followed for quantifying a level of uncertainty to activity data and emission factors is to set values within a range low, medium and high according to the confidence the expert relies on the value. For instance, a low value (e.g. 3-5%) has been attributed to activity data derived from the energy balance and statistical yearbooks, medium-high values within a range of 20-50% for all the data which are not directly or only partially derived from census or sample surveys or data which are simple estimations. For emission factors, the uncertainties set are usually higher than those for activity data; figures suggested by the IPCC good practice guidance and guidelines (IPCC, 2000; IPCC, 2006) are used when the emission factor is a default value or when appropriate, low values are attributed to measured data whereas the uncertainty values are high in all other cases.
For the base year, the uncertainty estimated by Approach 1 is equal to 3.5%; if considering the LULUCF sector the overall uncertainty increases to 4.1%.
In 2012, the results of Approach 1 suggest an uncertainty of 3.6% in the combined GWP total emissions. The analysis also estimates an uncertainty of 2.5 % in the trend between 1990 and 2012.
For the LULUCF sector, the uncertainty value resulting from Approach 1 is 60% in the combined GWP total emissions for the year 2012, whereas the uncertainty in the trend is 978%. A value equal to 58% is resulting from the Approach 1 uncertainty analysis, applied to LULUCF CO_2 emissions only, whereas the uncertainty in the trend is 412%. Details are shown in Tables A1.6 and A1.7.
Including the LULUCF sector in the total uncertainty assessment, Approach 1 shows an uncertainty of 4.9% in the combined GWP total emissions for the year 2012, whereas the uncertainty in the trend between 1990 and 2012 is equal to 3.8%. Results are shown in Table A1.8.
Further investigation is needed to better quantify the uncertainty values for some specific source, nevertheless it should be noted that a conservative approach has been followed.

A1.4 Approach 2 key category assessment

Approach 2 can be used to identify key categories when an uncertainty analysis has been carried out on the inventory. It is helpful in prioritising activities to improve inventory quality and to reduce overall uncertainty.
Under Approach 2, the source or sink category uncertainties are incorporated by weighting the Approach 1 level and trend assessment results with the source category's relative uncertainty.
Therefore the following equations:

Level Assessment, with Uncertainty = Approach 1 Level Assessment · Relative Category Uncertainty

Trend Assessment, with Uncertainty = Approach 1 Trend Assessment · Relative Category Uncertainty

Approach 2 has been applied both to the base and the current year submission. In this section, detailed results are reported for the 2012 inventory, whereas for the base year results of the analysis excluding and including LULUCF categories are reported in Table A1.13 and Table A1.14.
The results of the Approach 2 key category analysis, without LULUCF categories, are provided in Table A1.9, for 2012, while in Table A1.10 results, including LULUCF categories, are shown.
The application of Approach 2 to the base year gives as a result 17 key categories accounting for the 90% of the total levels uncertainty. Including the LULUCF categories, 22 key categories result accounting for 90% of the total uncertainty levels.

For the year 2012, 16 key categories accounting for the 90% of the total levels uncertainty were identified; when applying the trend analysis the key categories increased to 18 with differences with respect to the previous list.
The application of Approach 2 to the inventory, including the LULUCF categories, results in 20 key categories which account for the 90% of the total levels uncertainty; for the trend analysis, with LULUCF, the number of key categories is 19, with differences with respect to the previous list.

Table A1.9 Results of the key category analysis without LULUCF. Approach 2 Level assessment, year 2012

CATEGORIES	Share	Uncertainty	L*U	Level assessment with uncertainty	Cumulative Percentage
Direct N2O Agricultural Soils	0.02	1.0198	0.0178	0.1310	0.13
Indirect N2O from Nitrogen used in agriculture	0.02	1.0198	0.0158	0.1163	0.25
CO2 stationary combustion gaseous fuels	0.31	0.0424	0.0131	0.0964	0.34
HFC, PFC substitutes for ODS	0.02	0.5831	0.0117	0.0859	0.43
CO2 Mobile combustion: Road Vehicles	0.21	0.0424	0.0089	0.0657	0.50
CH4 from Solid waste Disposal Sites	0.02	0.3606	0.0089	0.0650	0.56
N2O Manure Management	0.01	1.0198	0.0083	0.0609	0.62
CH4 Enteric Fermentation in Domestic Livestock	0.02	0.2828	0.0066	0.0481	0.67
CH4 Emissions from Wastewater Handling	0.01	1.0440	0.0062	0.0454	0.71
CO2 stationary combustion solid fuels	0.13	0.0424	0.0057	0.0419	0.76
CO2 stationary combustion liquid fuels	0.11	0.0424	0.0048	0.0351	0.79
N2O stationary combustion	0.01	0.5009	0.0040	0.0291	0.82
CH4 Manure Management	0.00	1.0198	0.0038	0.0277	0.85
N2O from animal production	0.00	1.0198	0.0032	0.0232	0.87
CH4 Fugitive emissions from Oil and Gas Operations	0.01	0.2518	0.0027	0.0199	0.89
CO2 Cement production	0.02	0.1044	0.0023	0.0168	0.91
N2O Emissions from Wastewater Handling	0.00	0.4243	0.0018	0.0131	0.92
CH4 stationary combustion	0.00	0.5009	0.0016	0.0117	0.93
CO2 Emissions from solvent use	0.00	0.5831	0.0013	0.0093	0.94
CO2 Fugitive emissions from Oil and Gas Operations	0.00	0.2518	0.0012	0.0089	0.95
N2O Mobile combustion: Road Vehicles	0.00	0.5009	0.0010	0.0074	0.96
CH4 from Rice production	0.00	0.2022	0.0007	0.0049	0.96
N2O Emissions from solvent use	0.00	0.5099	0.0006	0.0042	0.97
CO2 Lime production	0.00	0.1044	0.0005	0.0034	0.97
CO2 stationary combustion other fuels	0.01	0.0424	0.0005	0.0033	0.97
CO2 Mobile combustion: Waterborne Navigation	0.01	0.0424	0.0005	0.0033	0.98
CO2 Other industrial processes	0.00	0.1044	0.0003	0.0025	0.98
CO2 Iron and Steel production	0.00	0.1044	0.0003	0.0022	0.98
PFC from the production of halocarbons and SF6	0.00	0.1118	0.0003	0.0021	0.98
CH4 Fugitive emissions from Coal Mining and Handling	0.00	2.0002	0.0003	0.0020	0.99
CO2 Limestone and Dolomite Use	0.00	0.1044	0.0002	0.0018	0.99
CO2 Ammonia production	0.00	0.1044	0.0002	0.0017	0.99
CO2 Mobile combustion: Aircraft	0.00	0.0424	0.0002	0.0015	0.99
PFC, HFC, SF6 Semiconductor manufacturing	0.00	0.5831	0.0002	0.0014	0.99
CH4 Mobile combustion: Road Vehicles	0.00	0.4011	0.0002	0.0013	0.99
CO2 Mobile combustion: Other	0.00	0.0583	0.0001	0.0010	1.00
N2O Mobile combustion: Other	0.00	1.0004	0.0001	0.0007	1.00
CO2 Emissions from Waste Incineration	0.00	0.2550	0.0001	0.0007	1.00

Table A1.10 Results of the key category analysis without LULUCF. Approach 2 Trend assessment, 1990- 2012

CATEGORIES	Trend assessment	Uncertainty	T*U	Relative trend assessment with uncertainty	Cumulative Percentage
HFC, PFC substitutes for ODS	0.0178	0.5831	0.0104	0.251	0.25
CO2 stationary combustion liquid fuels	0.1623	0.0424	0.0069	0.166	0.42
CO2 stationary combustion gaseous fuels	0.1291	0.0424	0.0055	0.132	0.55
CH4 Manure Management	0.0026	1.0198	0.0027	0.065	0.61
CH4 Emissions from Wastewater Handling	0.0019	1.0440	0.0019	0.047	0.66
CH4 from Solid waste Disposal Sites	0.0043	0.3606	0.0015	0.037	0.70
CO2 Mobile combustion: Road Vehicles	0.0275	0.0424	0.0012	0.028	0.73
Direct N2O Agricultural Soils	0.0010	1.0198	0.0010	0.025	0.75
CO2 Cement production	0.0081	0.1044	0.0008	0.020	0.77
N2O Adipic Acid	0.0077	0.1044	0.0008	0.019	0.79
CO2 stationary combustion solid fuels	0.0187	0.0424	0.0008	0.019	0.81
CH4 stationary combustion	0.0015	0.5009	0.0007	0.018	0.83
CH4 Fugitive emissions from Oil and Gas Operations	0.0029	0.2518	0.0007	0.018	0.85
CO2 Emissions from solvent use	0.0009	0.5831	0.0005	0.012	0.86
N2O Manure Management	0.0005	1.0198	0.0005	0.012	0.87
N2O stationary combustion	0.0010	0.5009	0.0005	0.012	0.88
CH4 Mobile combustion: Road Vehicles	0.0010	0.4011	0.0004	0.009	0.89
CO2 Fugitive emissions from Oil and Gas Operations	0.0014	0.2518	0.0004	0.009	0.90
N2O Nitric Acid	0.0033	0.1044	0.0003	0.008	0.91
CO2 stationary combustion other fuels	0.0079	0.0424	0.0003	0.008	0.92
PFC Aluminium production	0.0028	0.1118	0.0003	0.008	0.92
CO2 Iron and Steel production	0.0028	0.1044	0.0003	0.007	0.93
CO2 Ammonia production	0.0028	0.1044	0.0003	0.007	0.94
N2O Emissions from Wastewater Handling	0.0006	0.4243	0.0003	0.006	0.94
CO2 Limestone and Dolomite Use	0.0023	0.1044	0.0002	0.006	0.95
N2O from animal production	0.0002	1.0198	0.0002	0.005	0.96
N2O Emissions from solvent use	0.0004	0.5099	0.0002	0.005	0.96
CH4 Fugitive emissions from Coal Mining and Handling	0.0001	2.0002	0.0002	0.005	0.97
PFC, HFC, SF6 Semiconductor manufacturing	0.0003	0.5831	0.0002	0.004	0.97
Indirect N2O from Nitrogen used in agriculture	0.0001	1.0198	0.0001	0.004	0.97
CO2 Emissions from Waste Incineration	0.0005	0.2550	0.0001	0.003	0.98
N2O Mobile combustion: Road Vehicles	0.0003	0.5009	0.0001	0.003	0.98
N2O Mobile combustion: Other	0.0001	1.0004	0.0001	0.003	0.98
CH4 Enteric Fermentation in Domestic Livestock	0.0004	0.2828	0.0001	0.003	0.99
PFC from the production of halocarbons and SF6	0.0009	0.1118	0.0001	0.002	0.99
CO2 Mobile combustion: Other	0.0012	0.0583	0.0001	0.002	0.99
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.0006	0.1118	0.0001	0.002	0.99
CO2 Mobile combustion: Aircraft	0.0014	0.0424	0.0001	0.001	0.99
CH4 from Rice production	0.0003	0.2022	0.0001	0.001	0.99
CO2 Lime production	0.0004	0.1044	0.0000	0.001	1.00
CH4 Industrial Processes	0.0001	0.5009	0.0000	0.001	1.00
CO2 Other industrial processes	0.0003	0.1044	0.0000	0.001	1.00
SF6 Electrical Equipment	0.0002	0.1118	0.0000	0.001	1.00
SF6 Production of SF6	0.0002	0.1118	0.0000	0.001	1.00
N2O Emissions from Waste Incineration	0.0000	1.0012	0.0000	0.000	1.00
N2O Mobile combustion: Aircraft	0.0000	1.0004	0.0000	0.000	1.00
CH4 Emissions from Other Waste	0.0000	1.0050	0.0000	0.000	1.00
CH4 Mobile combustion: Waterborne Navigation	0.0000	0.5009	0.0000	0.000	1.00
CO2 Mobile combustion: Waterborne Navigation	0.0002	0.0424	0.0000	0.000	1.00
CH4 Emissions from Waste Incineration	0.0000	0.2062	0.0000	0.000	1.00
N2O Mobile combustion: Waterborne Navigation	0.0000	1.0004	0.0000	0.000	1.00
CH4 Agricultural Residue Burning	0.0000	0.5385	0.0000	0.000	1.00

Table A1.11 Results of the key category analysis with LULUCF. Approach 2 Level assessment, year 2012

CATEGORIES	Share	Uncertainty	L*U	Level assessment with uncertainty	Cumulative Percentage
CO2 Land converted to Settlements	0.02	1.0607	0.0161	0.0857	0.09
Direct N2O Agricultural Soils	0.02	1.0198	0.0161	0.0853	0.17
Indirect N2O from Nitrogen used in agriculture	0.01	1.0198	0.0143	0.0758	0.25
CO2 Land converted to Forest Land	0.01	1.0607	0.0122	0.0648	0.31
CO2 stationary combustion gaseous fuels	0.28	0.0424	0.0118	0.0628	0.37
CO2 Forest land remaining Forest Land	0.05	0.2343	0.0111	0.0589	0.43
HFC, PFC substitutes for ODS	0.02	0.5831	0.0105	0.0560	0.49
CO2 Land converted to Grassland	0.01	1.0607	0.0097	0.0513	0.54
CO2 Cropland remaining Cropland	0.01	1.0607	0.0084	0.0444	0.58
CO2 Mobile combustion: Road Vehicles	0.19	0.0424	0.0081	0.0428	0.63
CH4 from Solid waste Disposal Sites	0.02	0.3606	0.0080	0.0424	0.67
N2O Manure Management	0.01	1.0198	0.0075	0.0397	0.71
CO2 Grassland remaining Grassland	0.01	1.0607	0.0059	0.0314	0.74
CH4 Enteric Fermentation in Domestic Livestock	0.02	0.2828	0.0059	0.0314	0.77
CH4 Emissions from Wastewater Handling	0.01	1.0440	0.0056	0.0296	0.80
CO2 stationary combustion solid fuels	0.12	0.0424	0.0051	0.0273	0.83
CO2 stationary combustion liquid fuels	0.10	0.0424	0.0043	0.0228	0.85
N2O stationary combustion	0.01	0.5009	0.0036	0.0190	0.87
CH4 Manure Management	0.00	1.0198	0.0034	0.0181	0.89
N2O from animal production	0.00	1.0198	0.0028	0.0151	0.90
CH4 Fugitive emissions from Oil and Gas Operations	0.01	0.2518	0.0024	0.0129	0.92
CO2 Cement production	0.02	0.1044	0.0021	0.0109	0.93
N2O Emissions from Wastewater Handling	0.00	0.4243	0.0016	0.0085	0.94
CH4 stationary combustion	0.00	0.5009	0.0014	0.0076	0.94
CO2 Emissions from solvent use	0.00	0.5831	0.0011	0.0061	0.95
CO2 Fugitive emissions from Oil and Gas Operations	0.00	0.2518	0.0011	0.0058	0.96
CH4 Grassland remaining Grassland	0.00	1.0607	0.0011	0.0056	0.96
N2O Mobile combustion: Road Vehicles	0.00	0.5009	0.0009	0.0048	0.97
CH4 from Rice production	0.00	0.2022	0.0006	0.0032	0.97
N2O Emissions from solvent use	0.00	0.5099	0.0005	0.0027	0.97
N2O Grassland remaining Grassland	0.00	1.0607	0.0005	0.0026	0.98
CO2 Lime production	0.00	0.1044	0.0004	0.0022	0.98
CO2 Land converted to Cropland	0.00	1.0607	0.0004	0.0022	0.98
CO2 stationary combustion other fuels	0.01	0.0424	0.0004	0.0022	0.98
CO2 Mobile combustion: Waterborne Navigation	0.01	0.0424	0.0004	0.0022	0.98
CO2 Other industrial processes	0.00	0.1044	0.0003	0.0016	0.99
CO2 Iron and Steel production	0.00	0.1044	0.0003	0.0014	0.99
PFC from the production of halocarbons and SF6	0.00	0.1118	0.0003	0.0014	0.99
CH4 Fugitive emissions from Coal Mining and Handling	0.00	2.0002	0.0002	0.0013	0.99
CO2 Limestone and Dolomite Use	0.00	0.1044	0.0002	0.0012	0.99
CO2 Ammonia production	0.00	0.1044	0.0002	0.0011	0.99
CH4 Forest land remaining Forest Land	0.00	0.2343	0.0002	0.0011	0.99
CO2 Mobile combustion: Aircraft	0.00	0.0424	0.0002	0.0010	0.99
PFC, HFC, SF6 Semiconductor manufacturing	0.00	0.5831	0.0002	0.0009	0.99
CH4 Mobile combustion: Road Vehicles	0.00	0.4011	0.0002	0.0008	1.00
CO2 Mobile combustion: Other	0.00	0.0583	0.0001	0.0007	1.00
N2O Mobile combustion: Other	0.00	1.0004	0.0001	0.0005	1.00

Table A1.12 Results of the key category analysis with LULUCF. Approach 2 Trend assessment, 1990- 2012

CATEGORIES	Trend assessment	Uncertainty	T*U	Relative trend assessment with uncertainty	Cumulative Percentage
HFC, PFC substitutes for ODS	0.0166	0.5831	0.0097	0.15	0.15
CO2 Land converted to Grassland	0.0084	1.0607	0.0089	0.13	0.28
CO2 stationary combustion liquid fuels	0.1433	0.0424	0.0061	0.09	0.37
CO2 stationary combustion gaseous fuels	0.1251	0.0424	0.0053	0.08	0.45
CO2 Cropland remaining Cropland	0.0047	1.0607	0.0050	0.08	0.53
CO2 Land converted to Forest Land	0.0041	1.0607	0.0044	0.07	0.59
CO2 Grassland remaining Grassland	0.0035	1.0607	0.0037	0.06	0.65
CO2 Land converted to Settlements	0.0032	1.0607	0.0034	0.05	0.70
CO2 Forest land remaining Forest Land	0.0110	0.2343	0.0026	0.04	0.74
CH4 Manure Management	0.0023	1.0198	0.0023	0.03	0.77
CH4 Emissions from Wastewater Handling	0.0018	1.0440	0.0019	0.03	0.80
CO2 Mobile combustion: Road Vehicles	0.0307	0.0424	0.0013	0.02	0.82
CH4 from Solid waste Disposal Sites	0.0032	0.3606	0.0011	0.02	0.84
CO2 stationary combustion solid fuels	0.0206	0.0424	0.0009	0.01	0.85
N2O Adipic Acid	0.0069	0.1044	0.0007	0.01	0.86
CH4 stationary combustion	0.0014	0.5009	0.0007	0.01	0.87
CO2 Cement production	0.0067	0.1044	0.0007	0.01	0.88
N2O Manure Management	0.0007	1.0198	0.0007	0.01	0.89
CH4 Fugitive emissions from Oil and Gas Operations	0.0024	0.2518	0.0006	0.01	0.90
N2O stationary combustion	0.0011	0.5009	0.0006	0.01	0.91
CO2 Land converted to Cropland	0.0005	1.0607	0.0005	0.01	0.92
Direct N2O Agricultural Soils	0.0004	1.0198	0.0004	0.01	0.92
CO2 Emissions from solvent use	0.0007	0.5831	0.0004	0.01	0.93
CH4 Mobile combustion: Road Vehicles	0.0009	0.4011	0.0003	0.01	0.93
CO2 stationary combustion other fuels	0.0074	0.0424	0.0003	0.00	0.94
Indirect N2O from Nitrogen used in agriculture	0.0003	1.0198	0.0003	0.00	0.94
N2O Nitric Acid	0.0029	0.1044	0.0003	0.00	0.95
CO2 Fugitive emissions from Oil and Gas Operations	0.0012	0.2518	0.0003	0.00	0.95
PFC Aluminium production	0.0025	0.1118	0.0003	0.00	0.96
N2O Emissions from Wastewater Handling	0.0007	0.4243	0.0003	0.00	0.96
CO2 Iron and Steel production	0.0025	0.1044	0.0003	0.00	0.97
CO2 Ammonia production	0.0024	0.1044	0.0003	0.00	0.97
CO2 Limestone and Dolomite Use	0.0020	0.1044	0.0002	0.00	0.97
N2O Emissions from solvent use	0.0003	0.5099	0.0002	0.00	0.97
CH4 Fugitive emissions from Coal Mining and Handling	0.0001	2.0002	0.0002	0.00	0.98
PFC, HFC, SF6 Semiconductor manufacturing	0.0003	0.5831	0.0002	0.00	0.98
N2O Mobile combustion: Road Vehicles	0.0003	0.5009	0.0002	0.00	0.98
CO2 Emissions from Waste Incineration	0.0005	0.2550	0.0001	0.00	0.98
N2O Mobile combustion: Other	0.0001	1.0004	0.0001	0.00	0.99
N2O from animal production	0.0001	1.0198	0.0001	0.00	0.99
CH4 Forest land remaining Forest Land	0.0004	0.2343	0.0001	0.00	0.99
PFC from the production of halocarbons and SF6	0.0009	0.1118	0.0001	0.00	0.99
CH4 Enteric Fermentation in Domestic Livestock	0.0003	0.2828	0.0001	0.00	0.99
CH4 from Rice production	0.0003	0.2022	0.0001	0.00	0.99

Table A1.13 Results of the key category analysis without LULUCF. Approach 2 Level assessment, year 1990

CATEGORIES	Share	Uncertainty	L*U	Level assessment with uncertainty	Cumulative Percentage
Direct N2O Agricultural Soils	0.02	1.0198	0.0190	0.1443	0.14
Indirect N2O from Nitrogen used in agriculture	0.02	1.0198	0.0160	0.1216	0.27
CO2 stationary combustion liquid fuels	0.30	0.0424	0.0125	0.0952	0.36
CH4 from Solid waste Disposal Sites	0.03	0.3606	0.0106	0.0805	0.44
N2O Manure Management	0.01	1.0198	0.0077	0.0587	0.50
CO2 Mobile combustion: Road Vehicles	0.18	0.0424	0.0076	0.0580	0.56
CO2 stationary combustion gaseous fuels	0.16	0.0424	0.0070	0.0528	0.61
CH4 Manure Management	0.01	1.0198	0.0068	0.0517	0.66
CH4 Enteric Fermentation in Domestic Livestock	0.02	0.2828	0.0067	0.0508	0.71
CO2 stationary combustion solid fuels	0.11	0.0424	0.0048	0.0366	0.75
CH4 Emissions from Wastewater Handling	0.00	1.0440	0.0040	0.0304	0.78
CH4 Fugitive emissions from Oil and Gas Operations	0.01	0.2518	0.0035	0.0269	0.81
N2O from animal production	0.00	1.0198	0.0034	0.0259	0.83
N2O stationary combustion	0.01	0.5009	0.0034	0.0259	0.86
CO2 Cement production	0.03	0.1044	0.0032	0.0246	0.88
CO2 Emissions from solvent use	0.00	0.5831	0.0018	0.0140	0.90
CO2 Fugitive emissions from Oil and Gas Operations	0.01	0.2518	0.0016	0.0123	0.91
N2O Emissions from Wastewater Handling	0.00	0.4243	0.0015	0.0114	0.92
N2O Adipic Acid	0.01	0.1044	0.0009	0.0070	0.93
N2O Mobile combustion: Road Vehicles	0.00	0.5009	0.0008	0.0064	0.93
N2O Emissions from solvent use	0.00	0.5099	0.0008	0.0061	0.94
CH4 stationary combustion	0.00	0.5009	0.0008	0.0057	0.95
CO2 Iron and Steel production	0.01	0.1044	0.0006	0.0048	0.95
CH4 from Rice production	0.00	0.2022	0.0006	0.0047	0.96
CH4 Mobile combustion: Road Vehicles	0.00	0.4011	0.0006	0.0046	0.96
CO2 Ammonia production	0.01	0.1044	0.0006	0.0042	0.96
CO2 Limestone and Dolomite Use	0.00	0.1044	0.0005	0.0039	0.97
CH4 Fugitive emissions from Coal Mining and Handling	0.00	2.0002	0.0005	0.0037	0.97
CO2 Mobile combustion: Waterborne Navigation	0.01	0.0424	0.0004	0.0034	0.98
N2O Nitric Acid	0.00	0.1044	0.0004	0.0032	0.98
CO2 Lime production	0.00	0.1044	0.0004	0.0031	0.98
CO2 Other industrial processes	0.00	0.1044	0.0004	0.0029	0.99
PFC Aluminium production	0.00	0.1118	0.0004	0.0027	0.99
N2O Mobile combustion: Other	0.00	1.0004	0.0003	0.0019	0.99
CO2 Emissions from Waste Incineration	0.00	0.2550	0.0002	0.0019	0.99
CO2 Mobile combustion: Other	0.00	0.0583	0.0002	0.0016	0.99
PFC from the production of halocarbons and SF6	0.00	0.1118	0.0002	0.0013	0.99
CO2 Mobile combustion: Aircraft	0.00	0.0424	0.0001	0.0010	1.00
CH4 Industrial Processes	0.00	0.5009	0.0001	0.0008	1.00
N2O Mobile combustion: Waterborne Navigation	0.00	1.0004	0.0001	0.0006	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.00	0.1118	0.0001	0.0006	1.00

Table A1.14 Results of the key category analysis with LULUCF. Approach 2 Level assessment, year 1990

CATEGORIES	Share	Uncertainty	L*U	Level assessment with uncertainty	Cumulative Percentage
Direct N2O Agricultural Soils	0.02	1.0198	0.0177	0.1053	0.11
Indirect N2O from Nitrogen used in agriculture	0.01	1.0198	0.0149	0.0887	0.19
CO2 Land converted to Settlements	0.01	1.0607	0.0133	0.0792	0.27
CO2 stationary combustion liquid fuels	0.28	0.0424	0.0117	0.0695	0.34
CO2 Grassland remaining Grassland	0.01	1.0607	0.0107	0.0634	0.41
CH4 from Solid waste Disposal Sites	0.03	0.3606	0.0099	0.0587	0.46
N2O Manure Management	0.01	1.0198	0.0072	0.0428	0.51
CO2 Mobile combustion: Road Vehicles	0.17	0.0424	0.0071	0.0423	0.55
CO2 Forest land remaining Forest Land	0.03	0.2343	0.0067	0.0395	0.59
CO2 stationary combustion gaseous fuels	0.15	0.0424	0.0065	0.0385	0.63
CH4 Manure Management	0.01	1.0198	0.0064	0.0377	0.67
CH4 Enteric Fermentation in Domestic Livestock	0.02	0.2828	0.0062	0.0371	0.70
CO2 Land converted to Forest Land	0.01	1.0607	0.0060	0.0356	0.74
CO2 stationary combustion solid fuels	0.11	0.0424	0.0045	0.0267	0.76
CH4 Emissions from Wastewater Handling	0.00	1.0440	0.0037	0.0222	0.79
CH4 Fugitive emissions from Oil and Gas Operations	0.01	0.2518	0.0033	0.0196	0.81
N2O from animal production	0.00	1.0198	0.0032	0.0189	0.83
N2O stationary combustion	0.01	0.5009	0.0032	0.0189	0.84
CO2 Cropland remaining Cropland	0.00	1.0607	0.0031	0.0186	0.86
CO2 Cement production	0.03	0.1044	0.0030	0.0179	0.88
CO2 Land converted to Grassland	0.0023	1.0607	0.0024	0.0144	0.90
CO2 Emissions from solvent use	0.00	0.5831	0.0017	0.0102	0.91
CO2 Fugitive emissions from Oil and Gas Operations	0.01	0.2518	0.0015	0.0090	0.91
N2O Emissions from Wastewater Handling	0.00	0.4243	0.0014	0.0083	0.92
CH4 Grassland remaining Grassland	0.00	1.0607	0.0012	0.0069	0.93
CO2 Land converted to Cropland	0.00	1.0607	0.0010	0.0060	0.94
N2O Adipic Acid	0.01	0.1044	0.0009	0.0051	0.94
N2O Mobile combustion: Road Vehicles	0.00	0.5009	0.0008	0.0047	0.95
N2O Emissions from solvent use	0.00	0.5099	0.0007	0.0044	0.95
CH4 stationary combustion	0.00	0.5009	0.0007	0.0042	0.95
CO2 Iron and Steel production	0.01	0.1044	0.0006	0.0035	0.96
CH4 from Rice production	0.00	0.2022	0.0006	0.0034	0.96
CH4 Mobile combustion: Road Vehicles	0.00	0.4011	0.0006	0.0034	0.96
N2O Grassland remaining Grassland	0.00	1.0607	0.0005	0.0032	0.97
CO2 Ammonia production	0.00	0.1044	0.0005	0.0031	0.97
CO2 Limestone and Dolomite Use	0.00	0.1044	0.0005	0.0028	0.97
CH4 Fugitive emissions from Coal Mining and Handling	0.00	2.0002	0.0005	0.0027	0.98
CO2 Mobile combustion: Waterborne Navigation	0.01	0.0424	0.0004	0.0025	0.98
N2O Nitric Acid	0.00	0.1044	0.0004	0.0023	0.98
CO2 Lime production	0.00	0.1044	0.0004	0.0023	0.98
CO2 Other industrial processes	0.00	0.1044	0.0004	0.0021	0.99
PFC Aluminium production	0.00	0.1118	0.0003	0.0020	0.99
CH4 Forest land remaining Forest Land	0.00	0.2343	0.0003	0.0020	0.99
N2O Mobile combustion: Other	0.00	1.0004	0.0002	0.0014	0.99
CO2 Emissions from Waste Incineration	0.00	0.2550	0.0002	0.0014	0.99
CO2 Mobile combustion: Other	0.00	0.0583	0.0002	0.0012	0.99
PFC from the production of halocarbons and SF6	0.00	0.1118	0.0002	0.0010	0.99
CH4 Land converted to Forest Land	0.00	1.0607	0.0002	0.0009	1.00

A1.5 Uncertainty assessment (IPCC Approach 2)

Montecarlo analysis was applied in the last year submissions to estimate uncertainty of some of the key categories of the Italian inventory. The description of the key categories to which the analysis was applied and the reference year are reported in Table A1.15. Most of the results prove that both approaches (Approach 1 and 2) produce comparable results.
In Table A.1.15 the outcomes of the Approach 1 (error propagation) and Approach 2 (Montecarlo analysis) are shown.

Table A1.15 Comparison between uncertainty assessment by Approach 1 and Approach 2

Sector	*Categories*	*Key*	**Approach 1** %	**Approach 2 (Montecarlo)** %
Energy	CO_2 stationary combustion liquid fuels	L, T	4.2	3.3
Energy	CO_2 stationary combustion solid fuels	L, T1	4.2	5.1
Energy	CO_2 stationary combustion gaseous fuels	L, T	4.2	5.8
Energy	CO_2 Mobile combustion: Road Vehicles	L, T	4.2	7.4
Energy	CH_4 Mobile combustion: Road Vehicles	-	40.1	77.8
Energy	N_2O Mobile combustion: Road Vehicles	-	50.1	19.4
Energy	CH_4 Fugitive emissions from Oil and Gas Operations	L1, T1	25.2	17.4
Industrial Processes	CO_2 Cement production	L1	10.4	10.0
Agriculture	CH_4 Enteric Fermentation in Domestic Livestock	L	28.3	-21.8; +31.7
Agriculture*	Direct N_2O Agriculture soils	L, T	101.9	21.34
Agriculture*	Indirect N_2O from Nitrogen used in agriculture	L, T	101.9	21.67
Agriculture*	N_2O Manure management	L	101.9	10.19
Agriculture*	CH_4 Manure management	L, T2	101.9	22.96
Waste	CH_4 from Solid waste Disposal Sites	L, T1	36.1	12.6
LULUCF	CO_2 Forest land remaining Forest land	L, T	49.0	42.9
LULUCF	CO_2 Land converted to Forest land	-	106.1	-147.6; 192.3
LULUCF	CO_2 Cropland remaining Cropland	L, T	106.1	-108.5; 210.2
LULUCF	CO_2 Land converted to Cropland	T2	106.1	-408.2; 178.5
LULUCF	CO_2 Grassland remaining Grassland	L, T	106.1	-67.7; 75.0
LULUCF	CO_2 Land converted to Grassland	L, T	106.1	-119.3; 194.5
LULUCF	CO_2 Land converted to Settlements	L, T	106.1	-100.3; 49.2

*** These categories have been processes in the 2012 submission. The other categories have been assessed in the 2011 submission. The results of the key category analysis is therefore to be attributed to the respective annual submission**

A summary of the results is described in the following by category.
Additional information on the choice of underlying distributions of each AD, parameter and EF related to an emission estimate, and relevant statistical parameters describing each distribution are documented in an internal report.

Energy: CO_2 from stationary combustion liquid fuels

Montecarlo analysis has been carried out for CO_2 emissions from stationary combustion of liquid fuels, for the reporting year 2009. In Table A1.16 a description of the main statistics resulting from the Montecarlo analysis is shown.

Table A1.16 Statistics of the Montecarlo analysis for CO_2 emissions from stationary combustion of liquid fuels, year 2009

	Value
Trials	5000
Mean	72,096,300
Median	72,096,998

Standard Deviation	1,181,053
Range Minimum	68,046,555
Range Maximum	77,401,681
Uncertainty (%)	**3.28**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.1.

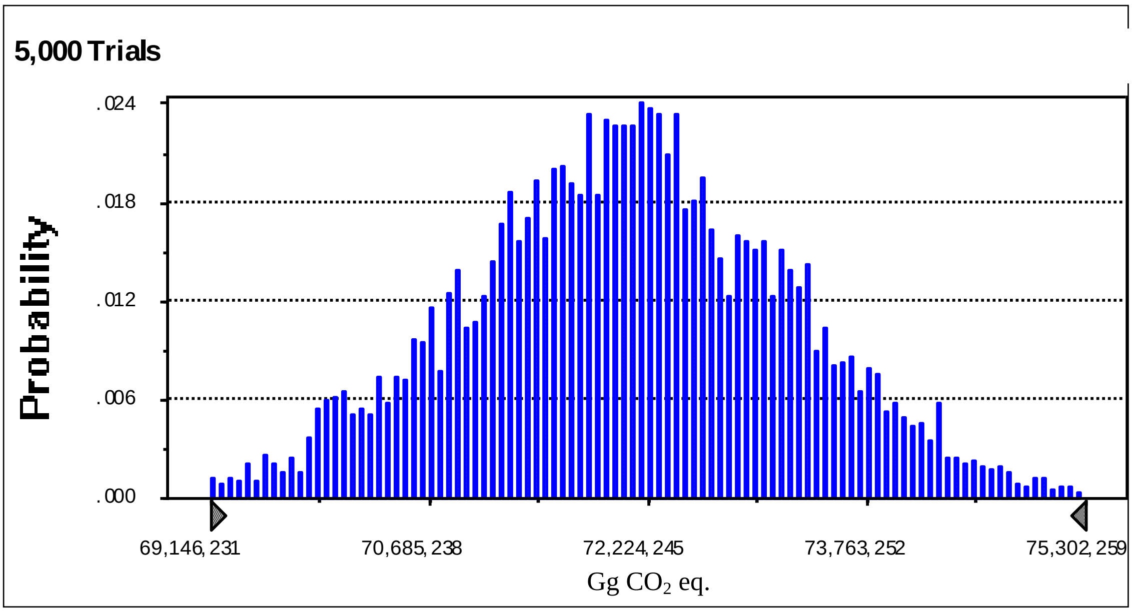


Figure A1.1 Probability density function resulting from Montecarlo analysis for CO_2 emissions from stationary combustion of liquid fuels, year 2009

Energy: CO_2 from stationary combustion solid fuels

Montecarlo analysis has been carried out for the CO_2 emissions from stationary combustion of solid fuels, for the reporting year 2009. In Table A1.17 a description of the main statistics resulting from the Montecarlo analysis is shown.

Table A1.17 Statistics of the Montecarlo analysis for CO_2 emissions from stationary combustion of solid fuels, year 2009

	Value
Trials	5000
Mean	49,289,917
Median	49,285,332
Standard Deviation	1,253,323
Range Minimum	44,384,889
Range Maximum	53,681,603
Uncertainty (%)	**5.08**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.2.

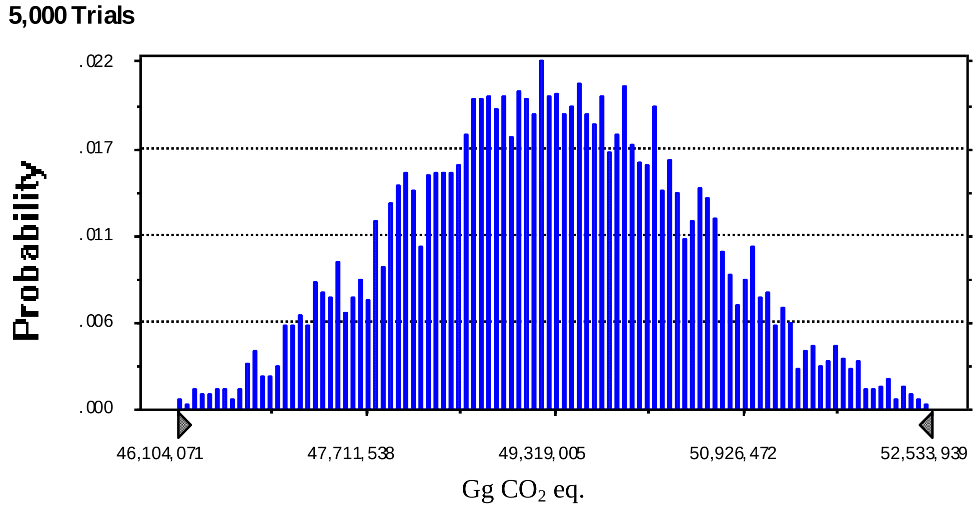


Figure A1.2 Probability density function resulting from Montecarlo analysis for CO_2 emissions from stationary combustion of solid fuels, year 2009

Energy: CO_2 from stationary combustion gaseous fuels

Montecarlo analysis has been carried out for the CO_2 emissions from stationary combustion of gaseous fuels, for the reporting year 2009. In Table A1.18 a description of the main statistics resulting from the Montecarlo analysis is shown.

Table A1.18 Statistics of the Montecarlo analysis for CO_2 emissions from stationary combustion of gaseous fuels, year 2009

	Value
Trials	5000
Mean	149,122,449
Median	149,184,196
Standard Deviation	4,355,657
Range Minimum	133,814,642
Range Maximum	165,672,245
Uncertainty (%)	**5.84**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.3.

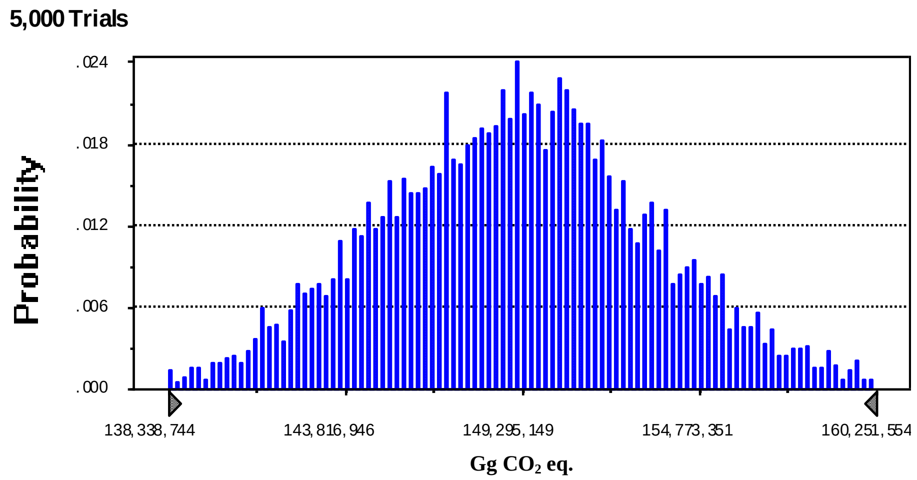


Figure A1.3 Probability density function resulting from Montecarlo analysis for CO_2 emissions from stationary combustion of gaseous fuels, year 2009

Energy: CO_2, CH_4 and N_2O Mobile combustion: Road Vehicles

Uncertainty of road transport emissions, at national level, has been assessed in the framework of study[66] "Uncertainty estimates and guidance for road transport emission calculations" performed by EMISIA[67] on behalf of the Joint Research Centre. The uncertainty has been assessed on the basis of 2005 input parameters of the COPERT 4 model (v. 7.0). In Table A1.19 a description of the statistics resulting for Mobile combustion: Road Vehicles is shown.

Table A1.19 Statistics of the Montecarlo analysis for GHG emissions from Mobile combustion: Road Vehicles, year 2005

	CO_2	CH_4	N_2O
Mean	110,735	19	614
Median	110,622	18	608
Standard Deviation	4,079	7	59
Variation (%)	4	34	10
Uncertainty (%)	**7.37**	**77.78**	**19.41**

The probability density functions, for CO_2, CH_4 and N_2O emissions from mobile combustion, resulting from the Montecarlo assessment is shown in Figure A1.4.

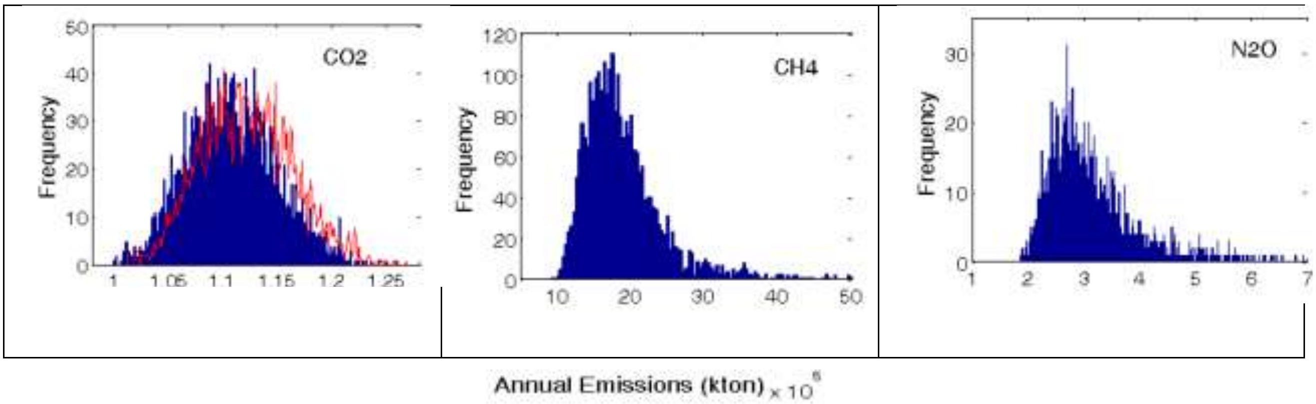


Figure A1.4 Probability density function resulting from Montecarlo analysis for CO_2, CH_4 and N_2O emissions from Mobile combustion: Road Vehicles, year 2005 (Kouridis et al., 2010)

Industrial Processes: CO_2 from Cement production

Montecarlo analysis has been carried out for the CO_2 emissions from cement production, for the reporting year 2009. In Table A1.20 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.20 Statistics of the Montecarlo analysis for CO_2 emissions from cement production, year 2009

	Value
Trials	5000
Mean	13,447,765
Median	13,452,009
Standard Deviation	670,995
Range Minimum	11,167,723
Range Maximum	16,119,133
Uncertainty (%)	**9.98**

[66] Kouridis C., Gkatzoflias D., Kioutsioukis I., Ntziachristos L., Pastorello P., Dilara P., 2010 .Uncertainty Estimates and Guidance for Road Transport Emission Calculations, Joint Research Centre 2010; URL: http://www.emisia.com/docs/COPERT%20uncertainty.pdf

[67] EMISIA: www.emisia.com

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.5.

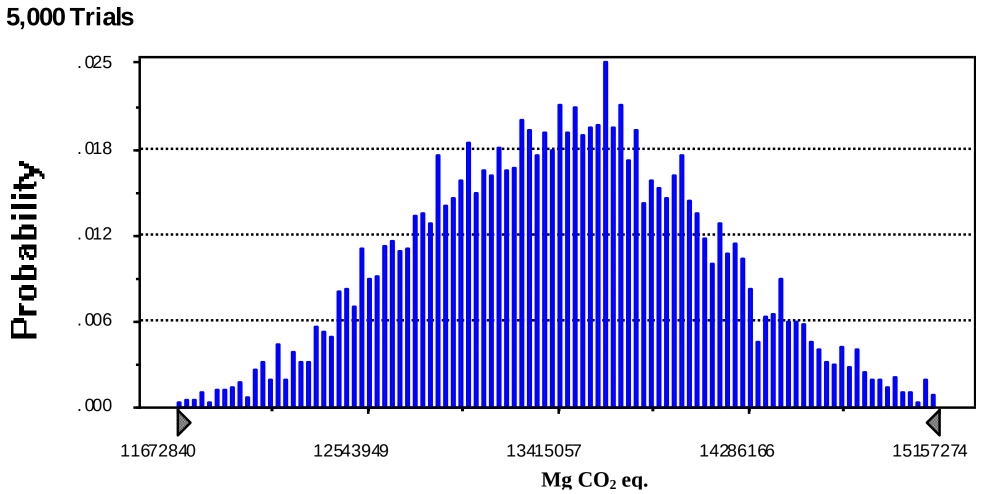


Figure A1.5 Probability density function resulting from Montecarlo analysis for CO_2 emissions from cement production, year 2009

Energy: CH_4 Fugitive emissions from Oil and Gas Operations

Montecarlo analysis has been carried out for CH_4 fugitive emissions from oil and gas operations, for the reporting year 2009. In Table A1.21 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.21 Statistics of the Montecarlo analysis for CH_4 from fugitive emissions, year 2009

	Value
Trials	5000
Mean	4904
Median	4903
Standard Deviation	427
Range Minimum	3027
Range Maximum	6532
Uncertainty (%)	**17.40**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.6.

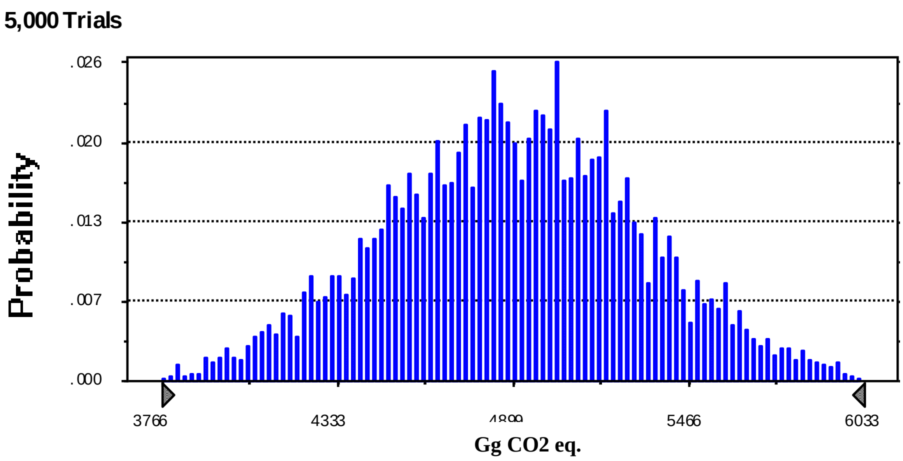


Figure A1.6 Probability density function resulting from Montecarlo analysis for CH_4 from fugitive emissions, year 2009

Agriculture: CH_4 Enteric Fermentation in Domestic Livestock

Montecarlo analysis has been carried out for the CH_4 emissions from enteric fermentation in domestic livestock, for the reporting year 2009. In Table A1.22 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.22 Statistics of the Montecarlo analysis for CH_4 emissions from enteric fermentation, year 2009

	Value
Trials	5000
Mean	519,226
Median	512,480
Standard Deviation	71,264
Range Minimum	340,639
Range Maximum	869,092
Uncertainty (%)	**-21.8; +31.7**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.7.

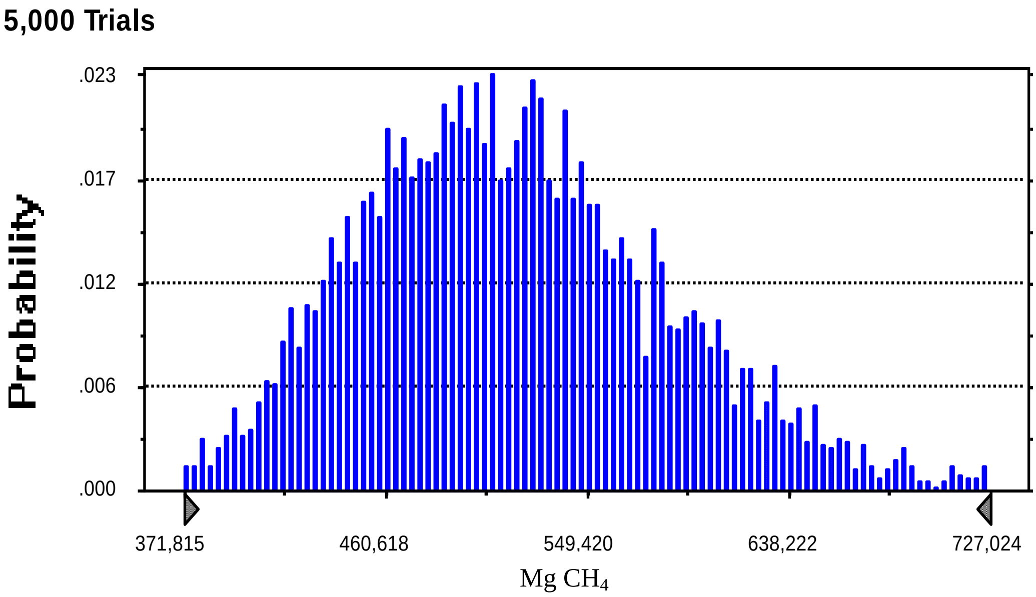


Figure A1.7 Probability density function resulting from Montecarlo analysis for CH_4 emissions from enteric fermentation, year 2009

Agriculture: Direct N_2O Agriculture soils

Montecarlo analysis has been carried out for the Direct N_2O emissions from Agriculture soils, for the reporting year 2010. In Table A1.23 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.23 Statistics of the Montecarlo analysis for Direct N_2O Agriculture soils emissions, year 2010

	Value
Trials	10000
Mean	23.24
Median	23.08
Standard Deviation	2.48
Range Minimum	16.85
Range Maximum	33.43
Uncertainty (%)	**21.34**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.8.

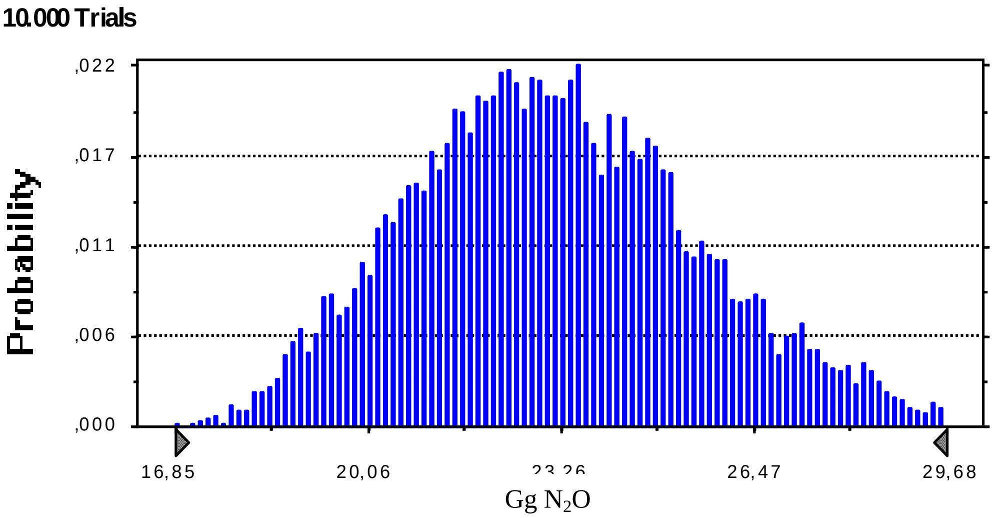


Figure A1.8 Probability density function resulting from Montecarlo analysis for Direct N2O Agriculture soils emissions, year 2010

Agriculture: Indirect N_2O from Nitrogen used in agriculture

Montecarlo analysis has been carried out for the indirect N_2O emission from nitrogen used in agriculture, for the reporting year 2010. In Table A1.24 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.24 Statistics of the Montecarlo analysis for indirect N_2O emissions from nitrogen used in agriculture, year 2010

	Value
Trials	10000
Mean	20.58
Median	20.47
Standard Deviation	2.23
Range Minimum	13.53
Range Maximum	29.42
Uncertainty (%)	**21.67**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.9.

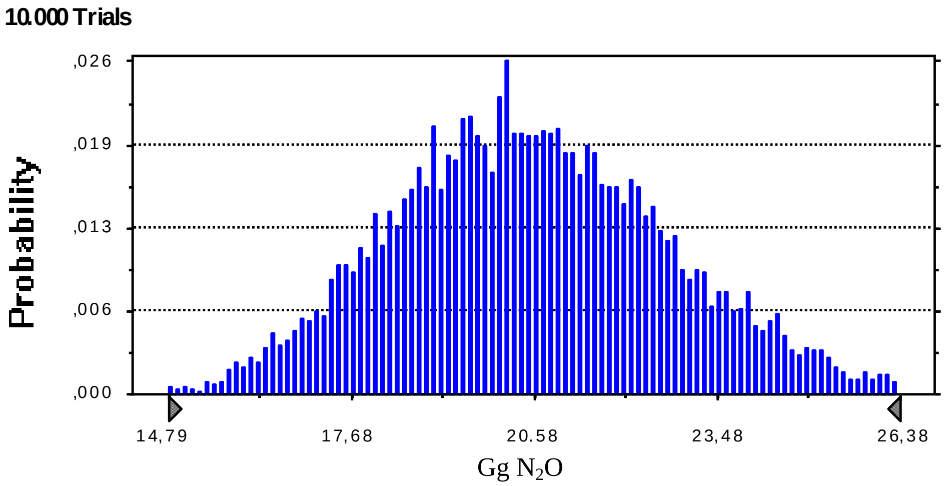


Figure A1.9 Probability density function resulting from Montecarlo analysis for indirect N_2O emissions from nitrogen used in agriculture, year 2010

Agriculture: N_2O manure management

Montecarlo analysis has been carried out for N_2O emissions from manure management, for the reporting year 2010. In Table A1.25 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.25 Statistics of the Montecarlo analysis for N_2O emissions from Manure management, year 2010

	Value
Trials	10000
Mean	11.9438
Median	11.9284
Standard Deviation	0.6087
Range Minimum	9.5877
Range Maximum	14.6361
Uncertainty (%)	**10.19**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.10.

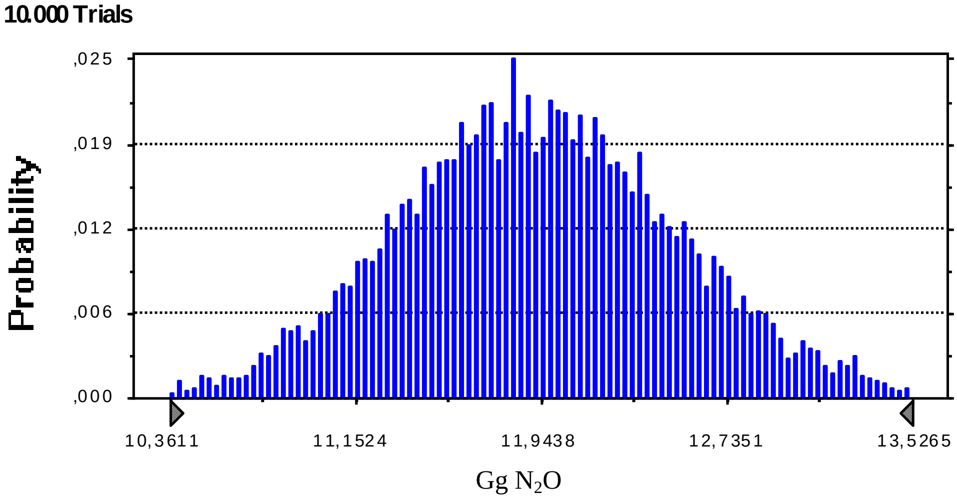


Figure A1.10 Probability density function resulting from Montecarlo analysis for N_2O emissions from Manure management, year 2010

Agriculture: CH_4 manure management

Montecarlo analysis has been carried out for the CH4 emissions from manure management, for the reporting year 2010. In Table A1.26 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.26 Statistics of the Montecarlo analysis for CH_4 emissions from enteric fermentation, year 2010

	Value
Trials	10000
Mean	121.44
Median	120.93
Standard Deviation	13.94
Range Minimum	78.05
Range Maximum	180.80
Uncertainty (%)	**22.96**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.11.

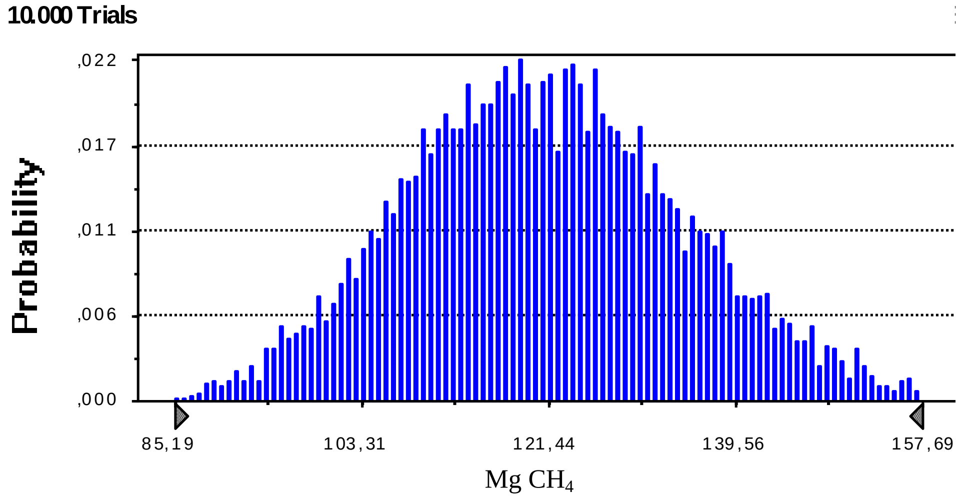


Figure A1.11 Probability density function resulting from Montecarlo analysis for CH_4 emissions from enteric fermentation, year 2010

LULUCF: CO_2 Forest Land remaining Forest Land

Montecarlo analysis has been carried out for the **CO_2** emissions and removals from *Forest Land remaining Forest Land*, considering the different reporting pools (*aboveground*, *belowground*, *litter, deadwood and soils*), and the subcategories stands, coppices and rupicolous and riparian forests for the reporting year 2009. In Table A1.27 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.27 Statistics of the Montecarlo analysis for CO_2 emissions and removals from Forest Land remaining Forest Land, year 2009

	Value					
	aboveground	*belowground*	*litter*	*deadwood*	*soils*	**total**
Trials	10000	10000	10000	10000	10000	10000
Mean	433	75	31	64	493	1,097
Median	431	75	31	64	494	1,098
Standard Deviation	82	14	12	12	122	236
Range Minimum	152	24	-16	24	2	197
Range Maximum	822	129	79	117	947	2,063
Uncertainty (%)	**37.86**	**37.18**	**79.40**	**36.87**	**49.33**	**42.93**

In Table A1.28 the results of the uncertainty assessment for the different subcategories are reported, related to the year 2009.

Table A1.28 Uncertainties assessed for the different subcategories, year 2009

	aboveground	*belowground*	*litter*	*deadwood*	*soils*	*total*
stands	40.78	39.93	88.16	39.32	44.65	**41.91**
coppices	53.81	54.99	74.81	53.47	67.35	**59.51**
rupicolous and riparian forests	56.53	61.49	79.66	56.91	58.52	**55.03**
total	**37.86**	**37.18**	**79.40**	**36.87**	**49.33**	**42.93**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.12.

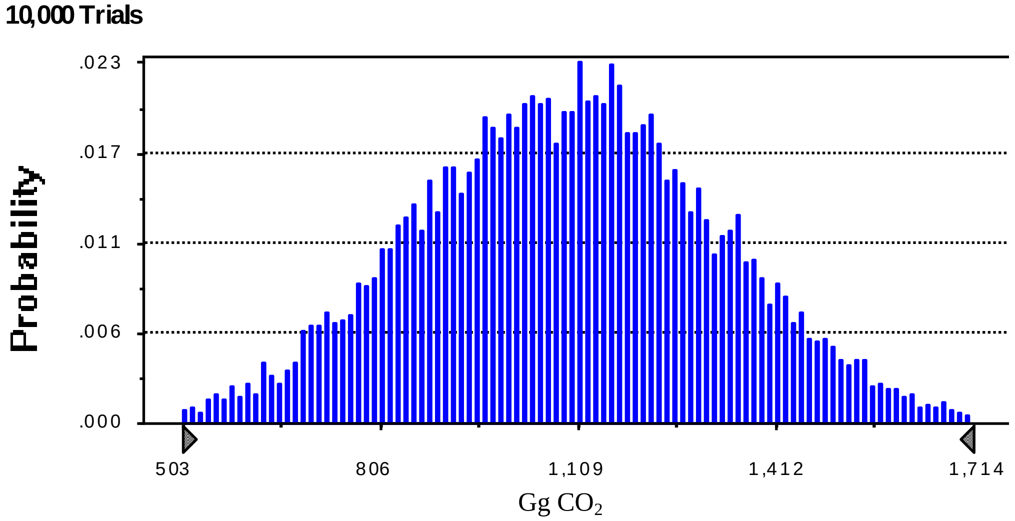


Figure A1.12 Probability density function resulting from Montecarlo analysis for the CO_2 emissions and removals from Forest Land remaining Forest Land category, year 2009

In Table A.1.29 the outcomes of the Approach 1 (error propagation) and Approach 2 (Montecarlo analysis) are shown, for the reporting pools. A general reduction in the uncertainty estimates has to be noted by comparing Montecarlo analysis results with the Approach 1 outcomes.

Table A1.29 Comparison between uncertainty assessment with Approach 1 and Approach 2

	Approach 1 %	**Approach 2 (Montecarlo analysis)** %
aboveground	42.68	37.86
belowground	42.68	37.18
litter	52.17	79.40
deadwood	101.62	36.80
soils	113.00	49.33
total	**67.98**	**42.93**

LULUCF: CO_2 Land converting to Forest Land

For *Land converting to Forest Land* **category, Approach 2 has been carried out taking into account** the different reporting pools (aboveground, belowground, litter, deadwood and soils), for the year 2009. In Table A1.30 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.30 Statistics of the Montecarlo analysis for Land converting to Forest Land, year 2009

	Value					
	aboveground	*belowground*	*litter*	*deadwood*	*soils*	**total**
Trials	10000	10000	10000	10000	10000	10000
Mean	6	1	0.43	0.83	13.64	22
Median	6	1	0.40	0.82	12.25	20
Standard Deviation	2	0	0.25	0.34	18.63	18
Range Minimum	-1	0	-0.01	-0.18	-48.94	-37
Range Maximum	15	2	1.74	2.21	108.58	108
Uncertainty (%)	**-72.6; 85.8**	**-72.5; 86.2**	**-91.3; 153.1**	**-72.5; 84.8**	**-257.2; 342.8**	**-147.6; 192.3**

The probability function resulting from the Montecarlo assessment is shown in Figure A1.13.

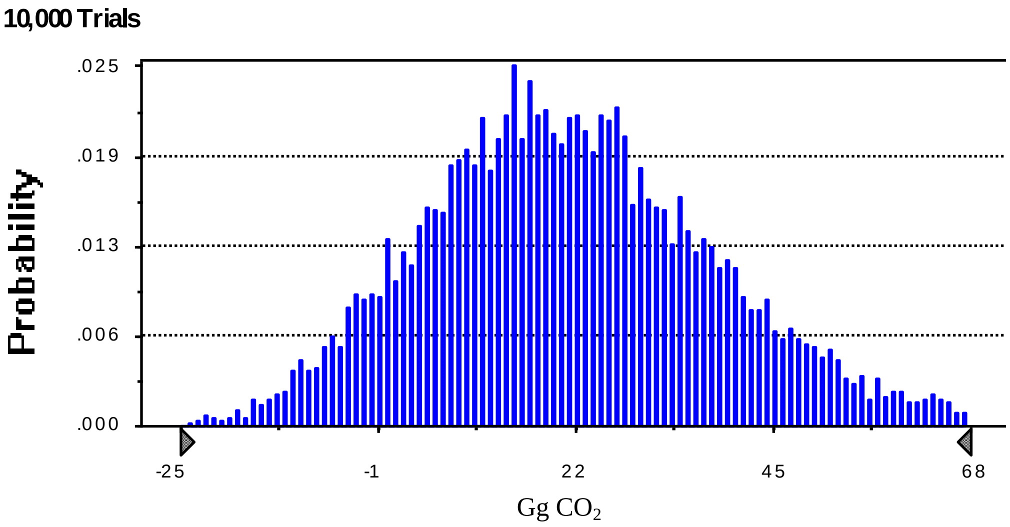


Figure A1.13 Probability density function resulting from Montecarlo analysis for the Land converting to Forest Land, year 2009

LULUCF: CO_2 Cropland remaining Cropland

For CO_2 emissions and removals from Cropland remaining Cropland, Approach 2 has been carried out taking into account the reporting subcategories (*woody crops, plantations*, *CO_2 emissions from organic soils*, *CO_2 emissions from lime application*), for the year 2009. In Table A1.31 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.31 Statistics of the Montecarlo analysis for CO_2 emissions and removals from Cropland remaining Cropland, year 2009

	Value				
	woody crops	*plantations*	*CO_2 emissions from organic soils*	*CO_2 emissions from lime application*	**total**
Trials	10000	10000	10000	10000	10000
Mean	3,017	-3.58	-90.26	-4.58	2,919
Median	2,662	-35.06	-81.65	-4.50	2,568
Standard Deviation	2,090	369.65	41.40	1.20	2,124
Range Minimum	-1,403	-1,595	-427.49	-10.59	-1913
Range Maximum	18,326	1739	409.17	-0.97	18,865
Uncertainty (%)	**-100.2; 199.4**	**-2173; 2454**	**-136.4; 57.3**	**-58.5; 46.4**	**-108.5; 210.2**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.14.

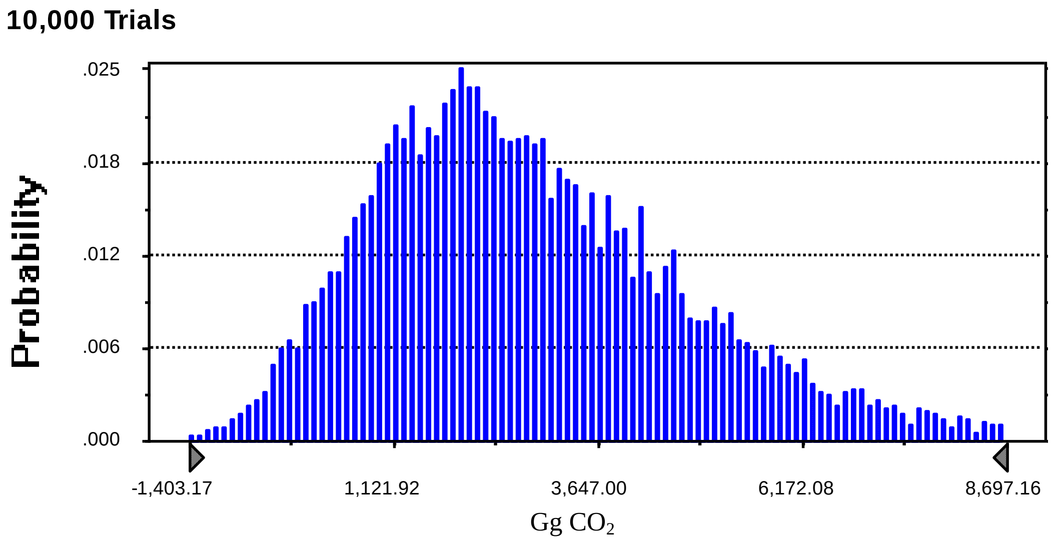


Figure A1.14 Probability density function resulting from Montecarlo analysis for the CO_2 emissions and removals from Cropland remaining Cropland, year 2009

LULUCF: CO_2 Land converting to Cropland

For CO_2 emissions and removals from Land converting to Cropland**, Approach 2 has been carried out taking into account** the *living biomass* and *soils* carbon pools, for the year 2009. In Table A1.32 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.32 Statistics of the Montecarlo analysis for CO_2 emissions and removals from *Land converting to Cropland*, year 2009

	Value		
	Living biomass	*Soils*	**total**
Trials	5000	5000	5000
Mean	7	-112	-105
Median	4	-85	-79
Standard Deviation	11	119	118
Range Minimum	-7	-1,169	-1,097
Range Maximum	149	414	410
Uncertainty (%)	**-150.7; 821.7**	**-384.1; 160.3**	**-408.2; 178.5**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.15.

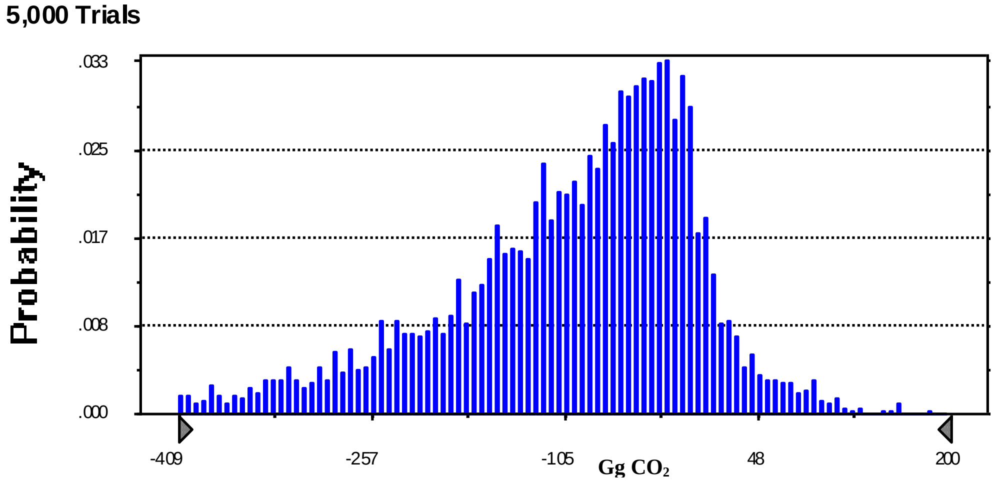


Figure A1.15 Probability density function resulting from Montecarlo analysis for CO_2 emissions and removals from Land converting to Cropland, year 2009

LULUCF: CO_2 Grassland remaining Grassland

For CO_2 emissions and removals from Grassland remaining grassland**, Approach 2 has been carried out taking into account** the different carbon pools, for the year 2009. In Table A1.33 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.33 Statistics of the Montecarlo analysis for CO_2 emissions and removals from Grassland remaining Grassland, year 2009

	Value					
	aboveground	*belowground*	*litter*	*deadwood*	*soils*	**total**
Trials	10000	10000	10000	10000	10000	10000
Mean	26.59	11.05	9.66	3.63	82.86	133.79
Median	25.72	10.61	9.65	3.52	82.25	132.04
Standard Deviation	10.63	5.34	3.45	1.47	30.48	48.08
Range Minimum	-4.54	-3.88	-3.19	-0.69	-8.88	-9.27
Range Maximum	81.63	37.31	23.31	11.27	204.58	354.91
Uncertainty (%)	**-68.6; 94.6**	**-82.6; 114.5**	**-70.4; 70.5**	**-69.9; 95.4**	**-70.6; 74.3**	**-67.7; 75.0**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.16.

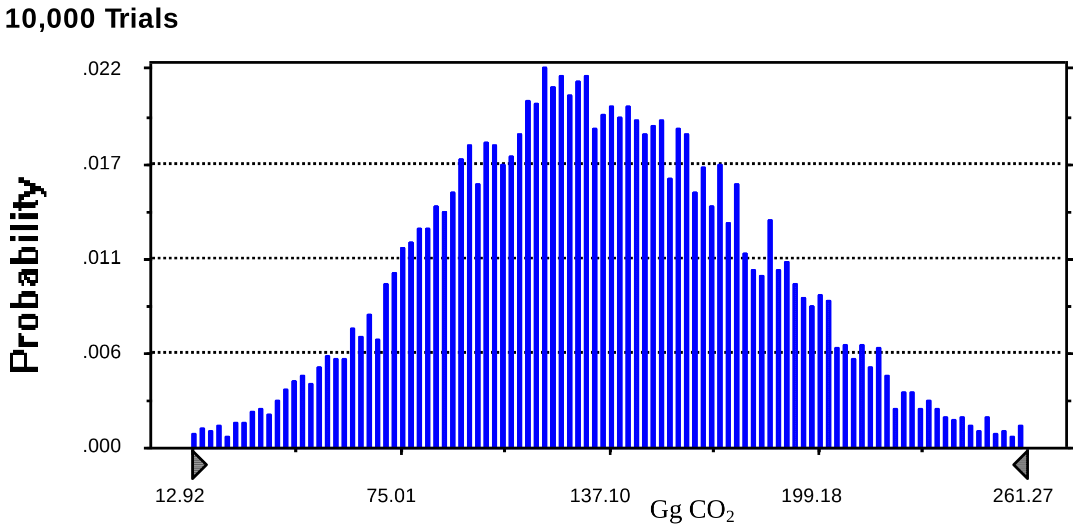


Figure A1.16 Probability density function resulting from Montecarlo analysis for CO_2 emissions and removals from Grassland remaining Grassland, year 2009

LULUCF: CO_2 Land converting to Grassland

For CO_2 emissions and removals from Land converting to Grassland**, Approach 2 has been carried out taking into account** the *living biomass* and *soils* carbon pools, for the year 2009. In Table A1.34 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.34 Statistics of the Montecarlo analysis for CO_2 emissions and removals from Land converting to Grassland, year 2009

	Value		
	Living biomass	*Soils*	**total**
Trials	5000	5000	5000
Mean	-371.6	4,006	3,635
Median	-304.7	3,650	3,283
Standard Deviation	462.0	2,654	2,623
Range Minimum	-5,426	4,813	-6,794
Range Maximum	1,640	20,503	19,126
Uncertainty (%)	**-383.8; 222.9**	**-106.1; 179.8**	**-119.3; 194.5**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.17.

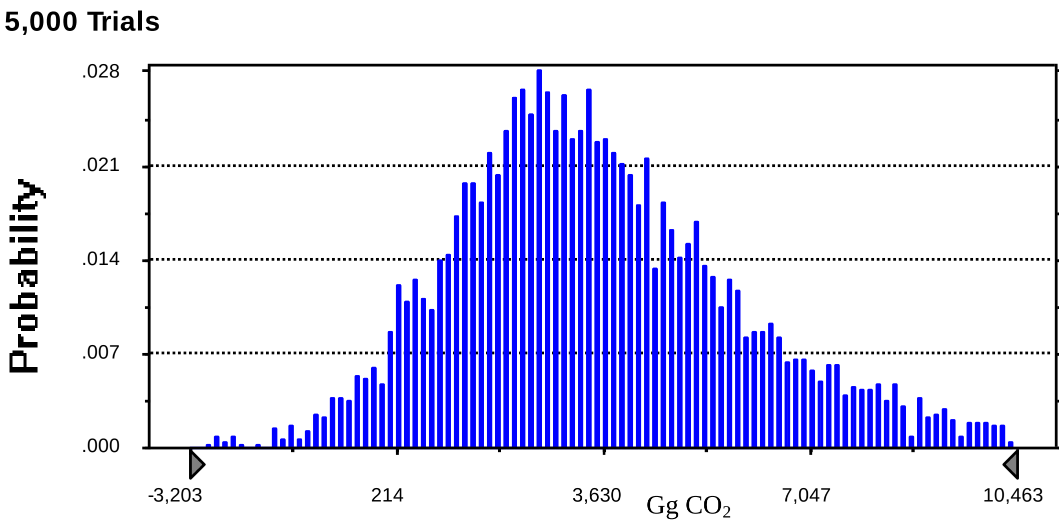


Figure A1.17 Probability density function resulting from Montecarlo analysis for the CO_2 emissions and removals from Land converting to Grassland, year 2009

LULUCF: CO_2 Land converting to Settlements

For CO_2 emissions from Land converting to Settlements**, Approach 2 has been carried out taking into account** the reporting subcategories (*annual crops converting to Settlements*, *woody crops converting to Settlements*, *Grassland converting to Settlement*, *Forest land converting to Settlements*), for the year 2009**.** In Table A1.35 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.35 Statistics of the Montecarlo analysis for CO_2 emissions from Land converting to Settlements, year 2009

	Value				
	Annual crops to SL	*woody crops to SL*	*Grassland to SL*	*Forest land to SL*	**total**
Trials	10000	10000	10000	10000	10000
Mean	-450.9	-377.7	-274.7	-100.4	-4,428.4
Median	-362.8	-312.3	-240.7	-100.7	-4,116.9
Standard Deviation	323.9	262.3	175.8	23.68	1,693.4
Range Minimum	-3,739.5	-4,229.4	-2,423.8	-283.7	-18,736.0
Range Maximum	-22.0	-29.5	-2.3	-40.3	-1.073.8
Uncertainty (%)	**-262.1; 72.0**	**-238.1; 70.8**	**-193.5; 82.9**	**-56.0; 35.1**	**-100.3; 49.2**

In Table A1.36 the results of the uncertainty assessment for the different subcategories are reported, related to the year 2009.

Table A1.36 Uncertainties assessed for the different subcategories, year 2009

	living biomass %	**dead organic matter %**	**Soils %**	**Total %**
annual crops to SL	*-300.9; 75.5*	-	*-267.1; 72.0*	*-262.1;72.0*
woody crops to SL	*-288.8; 74.3*	-	*-235.5; 70.5*	*-238.1; 70.8*
Cropland to SL	-288.8; 67.0	-	-187.0; 62.5	**-193.5; 82.9**
Grassland to SL	-	-	-193.5; 82.9	**-193.5; 82.9**
Forest land to SL	-115.9; 54.3	-56.9; 51.3	68.2; 40.0	**-56.0; 35.1**
Land to SL	-	-	-	**-100.3; 49.2**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.18.

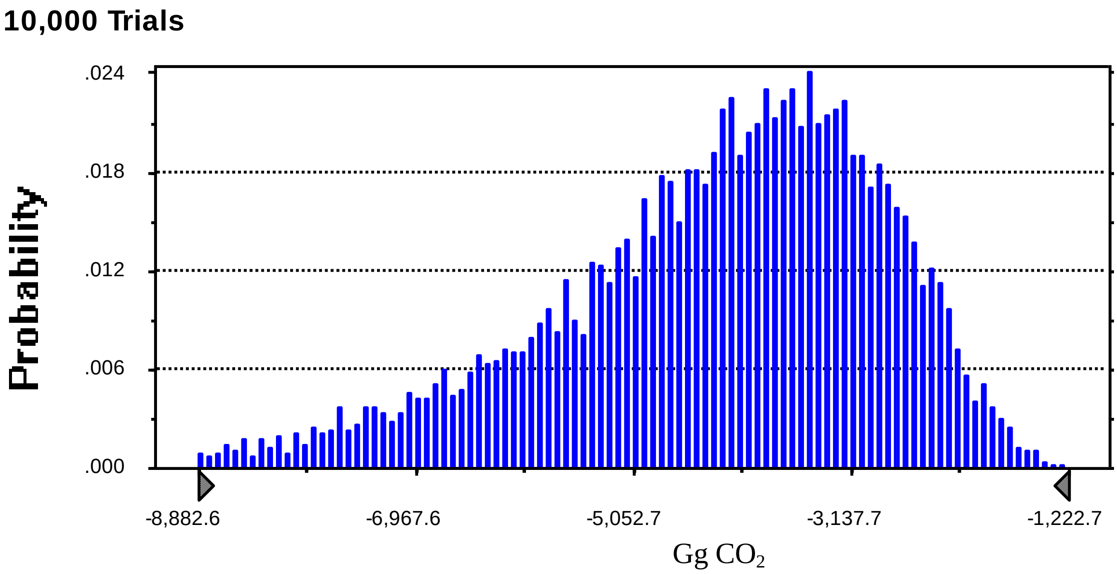


Figure A1.18 Probability density function resulting from Montecarlo analysis for the CO_2 emissions from Land converting to Settlements, year 2009

Waste: CH_4 from Solid waste Disposal Sites

Montecarlo analysis has been carried out for the CH_4 emissions from Solid waste disposal sites, for the reporting year 2009. In Table A1.37 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.37 Statistics of the Montecarlo analysis for Solis waste disposal on land category, year 2009

	Value
Trials	5000
Mean	595,157
Median	595,893
Standard Deviation	37,423
Range Minimum	469,077
Range Maximum	728,751
Uncertainty (%)	**12.58**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.19.

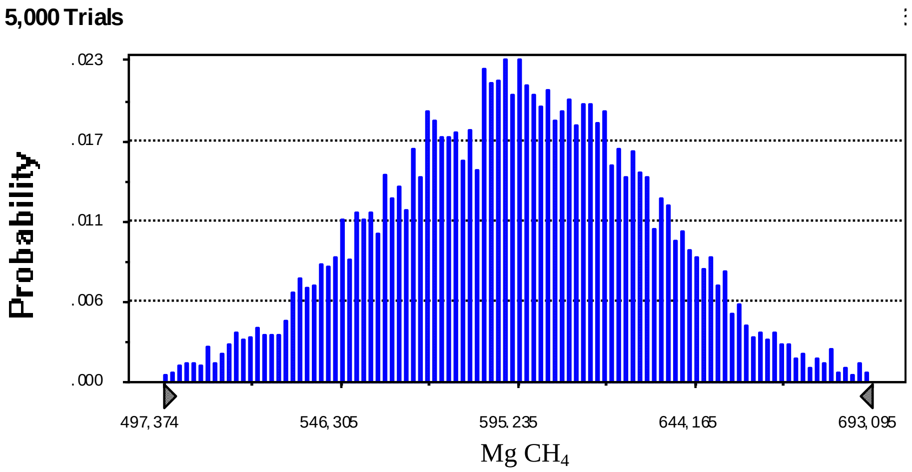


Figure A1.19 Probability density function resulting from Montecarlo analysis for the Solis waste disposal on land category, year 2009

ANNEX 2: ENERGY CONSUMPTION FOR POWER GENERATION

Source category description

The main source of data on fuel consumption for electricity production is the annual report “Statistical data on electricity production and power plants in Italy” (“Dati statistici sugli impianti e la produzione di energia elettrica in Italia”), edited from 1999 by the Italian Independent System Operator (TERNA), a public company that runs the high voltage transmission grid. For the period 1990-1998 the same data were published by ENEL (ENEL, several years), former monopolist of electricity distribution. The time series is available since 1963. In these publications, consumptions of all power plants are reported, either public or privately owned.

Detailed data are collected at plant level, on monthly basis. They include electricity production and estimation of physical quantities of fuels and the related energy content; for the largest installations, the energy content is based on laboratory tests. Up to 1999, the fuel consumption was reported at a very detailed level, 17 different fuels, allowing a quite precise estimation of the carbon content. From 2000 onward, the published data aggregate all fuels in five groups that do not allow for a precise evaluation of the carbon content. In Table A2.1, the time series of fuel consumptions for power sector production is reported.

Table A2.1 Time series of power sector production by fuel, Gg or Mm^3

	1990	1995	2000	2005	2008	2009	2010	2011	2012
national coal	58	-	Solids	Solids	Solids	Solids	Solids	Solids	Solids
imported coal	10,724	8,216	9,633	16,253	16,878	15,218	14,998	16,614	17,965
lignite	1,501	380							
Natural gas, m^3	9,731	11,277	22,334	30,544	33,706	28,634	29,630	27,857	25,005
BOF(steel converter) gas, m^3	509	633	Coal	Coal	Coal	Coal	Coal	Coal	Coal
Blast furnace gas, m^3	6,804	6,428	Gases	Gases	Gases	Gases	Gases	Gases	Gases
Coke gas, m^3	693	540	8,690	12,104	10,648	6,661	8,822	10,016	8,029
Light distillate	5	6	oil products	oil products	oil products	oil products	oil products	oil products	oil products
Diesel oil	303	184							
Heavy fuel oil	21,798	25,355	19,352	7,941	4,366	3,715	2,152	1,802	1,640
Refinery gas	211	378							
Petroleum coke	186	189							
Orimulsion	-	-							
Gases from chemical processes	444	803	Others	Others	Others	Others	Others	Others	Others
Tar	2	-		Mm^3= 978	Mm^3= 1,414	Mm^3= 1,289	Mm^3= 1,501	Mm^3= 1,673	Mm^3= 2,172
Heat recovered from Pyrite	146	3		Gg= 15,460	Gg= 16,520	Gg= 14,789	Gg= 18,160	Gg= 18,387	Gg= 18,535
Other fuels	344	697	5,153						

Source: TERNA, several years

Figures reported in the table show that natural gas has substituted oil products, from 1990 to 2012, becoming the main fuel for electricity production while coal consumption has increased in the last years as compared to 1990.
For the purpose of calculating GHG emissions, a detailed list of 25 fuels was delivered to ISPRA by TERNA for the years from 2000 to 2007. From 2008 the list of the fuels used to estimate emissions was expanded by TERNA, up to 40 different types in 2012. The list includes different variety of renewable sources according to their composition and origin, useful to estimate the percentage of renewable sources for electricity generation and to comply with national regulations of waste derived fuels. A list of different quantities of fuel oils used according to the sulphur content was also added. Energy data of previous years have not changed (see previous reports).
The detailed information is confidential and only the output of the simulation model applied to calculate emissions for the year 2012, at an aggregated level, is reported in Table A2.2. The consumption of municipal solid waste (MSW) / industrial wastes is separated from the biomass consumption, and reported under other fuels, since the use of this fuel for electricity generation is expanding and EFs are different.
It has to be underlined that fuels used to cogenerate heat and electricity in some power plants are not included in TERNA data, where only the fuel used for electricity production is reported.
At national level, other statistics on the fuel used for electricity production exist, the most remarkable being the National Energy Balance (BEN), published annually (MSE, several years) and those published by Unione Petrolifera, the Oil companies association (UP, several years). In the past, also the association of the industrial electricity producers (UNAPACE, several years) up to the year 1998, and ENI, the former national oil company up to the year 2000, published production data with the associated fuel consumptions (ENI, several years).

A2.2 Methodological issues

Both BEN and TERNA publications could be used for the inventory preparation, as they are part of the national statistical system and published regularly. The preference, up to date, for TERNA data arises from the following reasons:

- BEN data are prepared on the basis of TERNA reports to IEA, so both data sets come from the same source;
- before publication in the BEN, TERNA data are revised to be adapted to the reporting methodology: balance is done on the energy content of fuels and the physical quantities of fuels are converted to energy using standard conversion factors; so the total energy content of the fuels is the "right" information extracted from the TERNA reports and the physical quantities are changed to avoid discrepancies; the resulting information cannot be cross checked with detailed plant data (point source evaluation) based on the physical quantities;
- the used fuel types are much more detailed in TERNA database, 40 fuels as above mentioned, whereas in BEN all fuels are added up (using energy content) and reported together in 12 categories: emission factors for certain fuels (coal gases or refinery by-products) are quite different and essential information is lost with this process;
- finally, the two data sets usually differ, even considering the total energy values of fuels or the produced electricity, there are always small differences, usually less than 1%, that increase the already sizable discrepancy between the reference approach and the detailed approach; the BEN adjust the physical quantities according to fixed low heating values and this process combined with the reduction of fuel types adds rounding errors and this may cause the small difference between the production of electricity of the two sources, -3.4% in 2012. The difference in the energy consumption value is equal to -0.69%.

Table A2.2 reports the differences between the national energy balance and TERNA data for 2012. For the other years, differences are explained in previous NIR reports. In Table A2.2, annual data from different sources are reported: detailed data reported by TERNA are compared with data available in the national energy balance.
For each source, three types of data are presented: electricity production, physical quantities of fuel consumptions and amount of energy used.

Table A2.2 Energy consumption for electricity production, year 2012

Fuels	TERNA			BEN		
	GWe, gross	Gg / Mm^3	Pj	GWe, gross	Gg/ Mm^3	Pj
Coal	49,141.3	17,965	452.0	46,755.0	16,988	431.7
Coke oven gas	1,913.2	901	16.9	4,625.6	936	16.6
Blast furnace gas	3,020.7	7,017	26.0	7,222.1	6,902	26.0
Oxi converter gas	65.6	111	0.6	65.6		0.6
total derived gases	4,999.5	8,029	43.6	11,913.3	7,838	43.3
Coal	**54,140.8**		**495.5**	**58,668.3**		**474.9**
Light distillates	2.7	0	0.02	60.5	8	0.3
Light fuel oil	505.8	126	5.7	2,894.2	646	27.6
Fuel oil - high sulfur content	3,858.6	963	39.7	11,452.3	1,766	72.4
Fuel oil - low sulfur content	0.0		0.0	3,783.7	829	34.0
Refinery gas	2,062.2	333	15.5	1,981.4	299	15.0
Petroleum coke	529.9	209	7.3	531.4	209	7.3
Oriemulsion	0.0	0	0.0			
total fuel oil	*7,022.7*		*68.2*	*20,703.5*	*3,757*	*156.6*
Gas from chemical proc.	452.4	979	14.4	1,426.3	2,290	24.5
Heavy residuals/ tar	11,293.0	8,558	66.2			
Others	90.7		1.1			
total residual	*11,836.1*		*81.7*	*1,426.3*		*24.5*
Oil+residuals	**18,858.8**		**149.9**	**22,129.7**		**208.0**
Natural gas	**129,058.1**	25,005	**866.8**	**129,055.8**	25,291	**869.7**
Biofuels	3,095.2	653	24.0			0.0
Biogas	4,620.0	2,149	40.8			40.8
Biomass	2,569.1	2,868	45.6	5,664.9	8,403	69.6
Municipal waste	4,468.6	5,421	63.6	4,366.3	5,909	61.8
Grand total	**216,811**		**1,686.2**	**224,505**		**1,697.9**
TERNA /BEN differences				-3.4%		-0.69%

Source: ISPRA elaborations

The other two statistical publications quoted before, UP (UP, several years) and ENI (ENI, several years), have direct access to fuel consumption data from the associated companies, but both rely on TERNA data for the complete picture. Data from those two sources are used for cross checking and estimation of point source emissions.

To estimate CO_2 emissions, and also N_2O and CH_4 emissions, a rather complex calculation sheet is used (APAT, 2003). The data sheet summarizes all plants existing in Italy divided by technology, about 60 typologies, and type of fuel used; the calculation sheet can be considered a model of the national power system. The main scope of the model is to estimate the emissions of pollutants different from CO_2 that are technology dependent. For each year, a run estimates the fuel consumed by each plant type, the pollutant emissions and GHG emissions.

The model has many possible outputs; same of which are built up in such a way to reproduce the data available from statistical source. The model is revised every year to mirror the changes occurred in the power plants. Moreover, the model is also able to estimate the energy/emissions data related to the electricity produced and used on site by the main industrial producers. Those data are reported in the other energy industries, Tables 1.A.1.b and 1.A.1.c of the CRF, and in the industrial sector section, Table 1.A.2 of the CRF.

The following Table A2.3 shows an intermediate step of the process, with all energy and emissions summarized by fuel and split in two main categories of producers: public services and industrial producers for the year 2011. Since 1998, expansion of industrial cogeneration of electricity and split of national monopoly has transformed many industrial producers into “independent producers”, regularly supplying the national grid. So part of the energy/emissions of the industrial producers are added to Table 1.A.1.a of the CRF, according to the best information available.

Table A2.3 Power sector, Energy/CO_2 emissions in CRF format, year 2012

	TJ	C, Gg	CO_2, Gg
For Table 1.A.1, a. Public Electricity and Heat Production			
Liquid fuels	121,327	2,565	9,398
Solid fuels	431,649	10,797	39,563
Natural gas	746,648	11,604	42,517
Refinery gases	11,596	182	667
Coal gases	23,054	1,078	3,951
Biomass	141,483	3,859	14,140
Other fuels (incl.waste)	43,068	997	3,655
Total	**1,518,826**	**27,224**	**99,750**
Industrial producers (Table 1.A.1, a-b-c) and auto-producers,			
to table "1.A.2 Manufacturing Industries "			
Liquid fuels	2,767	67	245
Solid fuels	6	0	1
Natural gas	120,179	1,868	6,843
Refinery gases	4,296	67	247
Other refinery products	17,921	389	1,427
Coal gases	20,472	957	3,508
Biomass			
Other fuels (incl.waste)	3,854	53	195
Total	**169,495**	**3,402**	**12,466**
General total	**1,688,321**	**30,626**	**112,216**

Source: ISPRA elaborations

In conclusion, the main question of the accuracy of the underlying energy data of key sources is connected to the discrepancies between BEN and TERNA in the estimates of electricity produced and of the energy content of the used fuels. The difference is small but it should not occur because both data sets derive from the same source. On the basis of this consideration, we decided to base the inventory on TERNA data that are expected to be more reliable. In particular because the emission factors used are based on the energy content of the fuel we have made an effort to reproduce with the model the TERNA energy consumption figure and ignored discrepancies in the electricity production or in the physical quantities of fuel used.

A2.3 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions from electricity production is estimated to be about 4.2% in annual emissions; a higher uncertainty, equal to 50.1%, is calculated for CH_4 and N_2O emissions on account of the uncertainty levels attributed to the related emission factors.
For the year 2009, Montecarlo analysis has been carried out to estimate uncertainty of CO_2 emissions from stationary combustion of solid, liquid and gaseous fuels emissions, resulting in 5.1%, 3.3% and 5.8%, respectively. Normal distributions have been assumed for all the parameters. A summary of the results is reported in Annex 1.
Estimates of fuel consumption for electricity generation in 2012 are reported in Table A2.3.
In Table A2.4, the time series of the total CO_2 emissions from electricity generation activities is reported, including total electricity produced and specific indicators of CO_2 emissions for the total energy production and for the thermoelectric production respectively, expressed in grams of CO_2 per kWh. The emission factors are reported excluding the electricity produced from pumped storage units using water that has previously been pumped uphill, as requested by Directive 2009/28/EC of the European Parliament and of the Council promoting the electricity renewable sources.

The time series clearly shows that although the specific carbon content of the kWh generated in Italy has constantly improved over the years, total emissions have raised till 2006 due to the even bigger increase of electricity production. The decreasing trend starting from 2005 results from an increase in energy production from renewable sources, combined with a further reduction in the use of oil products for electricity production. In the last years the decrease is even more accentuated because of the economic recession.

Table A2.4 Time series of CO_2 emissions from electricity production

	1990	1995	2000	2005	2008	2009	2010	2011	2012
Total electricity produced (gross), TWh	216.9	241.5	276.6	303.7	319.1	292.6	302.1	302.6	299.3
Total CO_2 emitted, Mt	126.4	135.4	142.6	143.2	140.3	119.5	119.9	118.2	114.5
g CO_2 / kwh of gross thermo-electric production	708.4	691.9	649.2	568.4	538.6	528.7	520.3	519.0	528.3
g CO_2 / kwh of total gross* production	592.0	570.7	528.3	482.5	447.3	414.4	401.3	393.1	385.3

* excluding electricity production from pumped storage units using water that has previously been pumped uphill
Source: ISPRA elaborations

The trend of CO_2 emissions for thermoelectric production is the result of an increase of natural gas share due to the entry into service of more efficient combined cycle plants. The downward trend takes also into account the general increase in efficiency of the power plants.

A2.4 Source-specific QA/QC and verification

Basic activity data to estimate emissions from all operators are annually collected and reported by the national grid administrator (TERNA, several years). Other data are collected directly from operators for plants bigger than 20 MWh, with a yearly survey since 2005 and communicated at international level in the framework of the EU ETS scheme. Activity data and other parameters, as net calorific values, are compared every year at an aggregate level, by fuel; differences and problems have been identified, analysed in detail and solved with sectoral experts.
In addition, time series resulting from the recalculation have been presented to the national experts in the framework of an *ad hoc* working group on air emissions inventories. The group is chaired by ISPRA and includes participants from the local authorities responsible for the preparation of local inventories, sectoral experts, the Ministry of Environment, Land and Sea, and air quality model experts. Top-down and bottom-up approaches have been compared with the aim to identify the potential problems and future improvements to be addressed.

A2.5 Source-specific recalculations

Recalculations of the energy industry sector refer to CO_2 emission factors for the year 2011 for natural gas that has been updated for change of imported gas parameters. The recalculations affected only slightly the 2011 values with difference equal to -0.003% for CO_2 with respect to the earlier submission.

A2.6 Source-specific planned improvements
No specific improvements are planned for the next submission.

ANNEX 3: ESTIMATION OF CARBON CONTENT OF COALS USED IN INDUSTRY

The preliminary use of the CRF software in 2001 underlined an unbalance of emissions in the solid fuel rows above 20%. A detailed verification pointed out to an already known issue for Italy: the combined use of standard IPCC emission factors for coals, national emission factors for coal gases and CORINAIR methodology emission factors for steel works processes produces double counting of emissions.
The main reason for this is the specific national circumstance of extensive recovery of coal gases from blast furnaces, coke ovens and oxygen converters for electricity generation. The emissions from those gases are separately accounted for and reported in the electricity generation sector.
Another specific national circumstance is the concentration of steel works in two sites, since the year 2005, with integrated steel plants, coke ovens and electricity self-production. Limited quantities of pig iron are produced also in one additional location. This has allowed for careful check of the processes involved and the emissions estimates at site level and, with reference to other countries, may or may not have exacerbated the unbalances in carbon emissions due to the use of standard emission factor developed for other industrial sites.

To avoid the double counting a specific methodology has been developed: it balances energy and carbon content of coking coals used by steelworks, industry, for non energy purposes and coal gasses used for electricity generation.
A balance is made between the coal used for coke production and the quantities of derived fuels used in various sectors. The iron and steel sector gets the resulting quantities of energy and carbon after subtraction of what is used for electricity generation, non energy purposes and other industrial sectors. According to the IPCC Good Practice Guidance (IPCC, 2000), the use of reductants is also included in this balance because no sufficient information to detail emissions between the energy and industrial processes sectors is available. The carbon balance methodology does not imply to separate off input between the energy and industrial sectors but ensures no double counting occurs.
The base statistical data are all reported in the BEN (with one exception) and the methodology starts with a verification of the energy balance reported in the BEN, see also Annex 5, table A5.3/.4, that seldom presents problems, and then apply the emission factors to the energy carriers, trying to balance the carbon inputs with emissions. The exception mentioned refers to the recovered gases of BOFs (Basic Oxygen Furnace) that are used to produce electricity but were not accounted for by BEN from the year 1990 up to 1999. From the year 2000 those gases are (partially, only in one plant) included in the estimate of blast furnace gas. The data used to estimate the emissions from 1990 to 1999 are reported by GRTN – ENEL (TERNA, several years). The consideration of the BOF gases does not change the following discussion, because its contribution to the total emissions is quite limited.

Table A3.1 summarises the quantities of coal and coal by-products used by the energy system in the year 2012, all the data mentioned can be found in “enclosures 1/a, 2/a and 3/a” of BEN, see also Annex 5 (MSE, several years).
In the table A3.1 the quantities of coke, coke gas and blast furnace gas used by the different sectors are detailed as well as the quantities of the same energy carriers that are self-used, used for the production of coke or wasted. Inputs are indicated in the blue cells while outputs are reported in the orange ones. Major figures have been verificated with Eurostat data demonstrating an acceptable agreement.

Table A3.1 Energy balance, 2012, TJ

	TJ input	TJ output	
steam coal	511,626	11,263	clinker/industry
		451,608	thermoelectric power plants
		48,755	blast furnace
anthracite	2,632	2,632	steel plants
sub bituminous and lignite	1,683	1,683	clinker/industry
coking coal	162,331	1,579	coking coal consumption
		4,706	energy trasformation losses
Coke import/export/stock change	-7,070		
coke		536	other industry and domestic
			ferroalloys
		89,685	blast furnace consumption
coke oven gas		1,014	coke oven gas in coke oven and blast furnace
		9,922	coke oven gas reheating
		16,644	coke oven gas thermoelectric
blast furnace gas		29	BF gas in coke oven
		25,991	BF gas thermoelectric
		657	BF gas reheating
BOF gas		879	coal gasses in thermoelectric + reheating
			carbon stored in products
tot	671,201	667,582	**Input – output= 3,619 TJ unbalance: 0.54%**

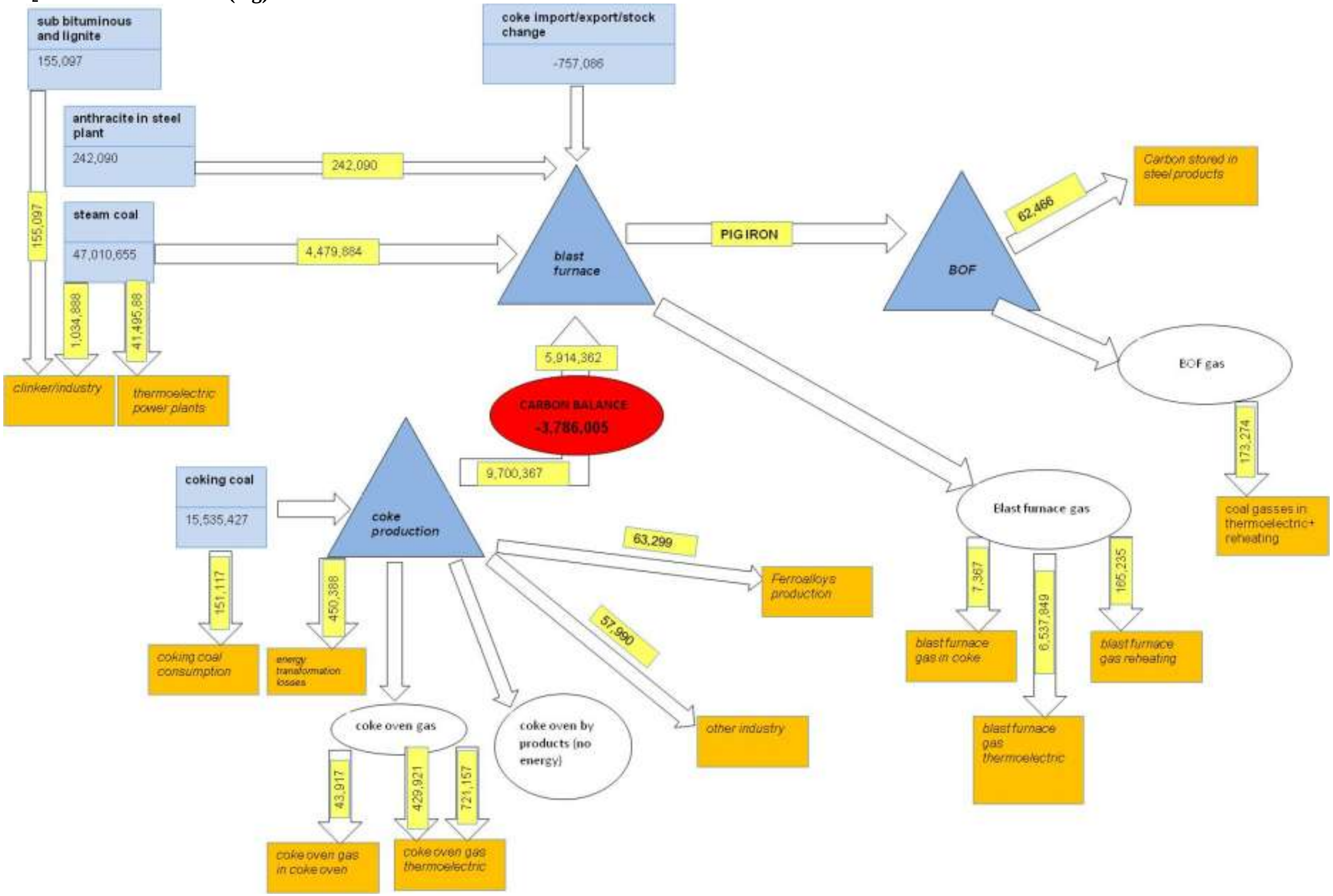
In Table A3.2, the same energy data of Table A3.1 valuated for their carbon content are reported, according to the emission factors reported in Table 3.12 of the NIR.
The balance is the resulting quantity of emissions after subtraction of carbon emissions estimated for coke ovens, electricity production, other coal uses and non energy uses.
The low implied emission factors in CRF and annual variations in the average CO_2 emission factor for solid fuel are due to the fact that both activity data and emissions reported under this category include the results of the carbon balance.
All main installations of the iron and steel sector are included in EU ETS, but not all sources of emission. Only part of the processes of integrated steel making is subject to EU ETS, in particular the manufacturing process after the production of row steel was excluded up to 2007 and only the lamination processes have been included from 2008 onwards. Additional information from the operators on fuel consumptions and average emission factors is used to verify our calculation and CO_2 emissions at plant level and to calculate average CO_2 emission factors for coal and derived gases from 2005, see Annex 6 for further details.

Table A3.2 Carbon balance, 2012, Gg CO_2

	input	output	
steam coal	47,010,655	1,034,888	clinker/industry
		41,495,882	thermoelectric power plants
		4,479,884	blast furnace
anthracite	242,090	242,090	steel plants
sub bituminous and lignite	155,097	155,097	clinker/industry
coking coal	15,535,427	151,117	coking coal consumption
		450,388	energy trasformation losses
coke import/export/stock change	-757,086		
coke		57,990	other industry and domestic
		63,299	ferroalloys
		9,700,367	blast furnace consumption
coke oven gas		43,917	coke oven gas in coke oven and blast furnace
		429,921	coke oven gas reheating
		721,157	coke oven gas thermoelectric
blast furnace gas		7,367	BF gas in coke oven
		6,537,849	BF gas thermoelectric
		165,235	BF gas reheating
BOF gas		173,274	coal gasses in thermoelectric + reheating
		62,466	carbon stored in products
tot	62,186,183	65,972,188	**Input-output=-3,786,005 Gg CO_2 unbalance -5.74%**

In 2012 the unbalance in terms of CO2 is equal to 3,786,005; this amount has been subtracted from the total to avoid double counting of carbon.The flowchart of carbon - cycle for the year 2012 is reported below. CO_2 emissions from primary input fuels and from final fuel consumptions are compared. Emissions related to fuel input data are enhanced in light-blue whereas emissions estimated from final fuel consumptions are highlighted in orange. Emissions from the use of coke in blast furnaces result from differences between emissions from final consumption of coke and the value of the carbon balance for 2012. The amount of carbon stored in steel produced was estimated and subtracted from the balance to avoid the subsequent overestimation of CO_2 .The amount of coke used for ferroalloys production has also been subtracted to avoid a double counting of emissions already estimated and reported in the industrial processes sector.

CO_2 emission calculation (Gg) Year 2012



ANNEX 4: CO_2 REFERENCE APPROACH

A4.1 Introduction

The IPCC Reference Approach is a 'top down' inventory based on data on production, imports, exports and stock changes of crude oils, feedstock, natural gas and solid fuels. Estimates are made of the carbon stored in manufactured products, the carbon consumed as international bunker fuels and the emissions from biomass combustion.
The methodology follows the IPCC Guidelines (IPCC, 1997); table 1.A(b) of the Common Reporting Format "Sectoral background data for energy - CO_2 from Fuel Combustion Activities - Reference Approach" is a self sustaining explanation of the methodology.
However it was necessary to make a few adaptations to allow full use of the Italian energy and emission factor data (ENEA, 2002 [a]), and these are described in the following. The BEN (MSE, several years [a]) reports the energy balances for all primary and secondary fuels, with data on imports, exports and production. See Annex 5, Tables A5.1-A5.10, for an example of the year 2012 and to the web site of the Ministry of Economic Development for the whole time series http://dgerm.sviluppoeconomico.gov.it/dgerm/.

Starting from those data and using the emission factors reported in chapter 3, Table 3.12, it is possible to estimate the total carbon entering in the national energy system. It has been developed a direct connection between relevant cells of the CRF tables and the BEN tables and a procedure to insert some additional activity data needed.
The 'missing' data refer to import – export of lubricants, petrol additives, asphalt, other chemical products with energy content, energy use of exhausted lubricants and the evaluation of marine and aviation bunkers fuels used for national traffic.
Those 'missing' data are in fact reported in the BEN but all mixed up together with other substances as sulphur and petrochemicals. The aggregate data do not allow the use of the proper emission factor so inventory is based on more detailed statistics from foreign trade surveys.
The carbon stored in products is estimated according to the procedure illustrated in the paragraph 3.8 and directly subtracted to the emission balance by the CRF software in the current version used by Italy. It may be the case to underline that no direct subtraction of the energy content of the feedstock is performed by CRF. In the cases, as Italy, where those products are not considered in the energy balances this bring to an unbalanced control sheet, as discussed in the following.

With reference to table 1.A(b) of the CRF, we make reference to the BEN tables reported in Annex 5. In particular the following data are reported and used for the *Reference Approach*:

1) crude oil imports, exports and production;
2) natural gas liquids data;
3) import-export data of gasoline, aviation fuel, other kerosene, diesel, fuel oil, LPG and virgin naphta;
4) import-export data of bitumen and motor oil derive from foreign trade statistics, estimated by an ENEA consultant for the period 1990-1998. BPT data (MSE, several years [b]) are used from 1999 onwards;
5) import-export data of petroleum coke and refinery feedstock are also found in BEN; it has to be underlined that the data reported as "feedstock production" have been ignored up to year 2000 because it is explicitly excluded by the IPCC methodology. From 2001 onward a careful check with the team in charge to prepare the energy balances induced the inventory team to revise its position on this matter[68];

[68] Feedstock production refer to petrochemical feedstock and other fuel streams returning to the refineries from the internal market. Those quantities do not contain additional carbon inputs but as they are not properly subtracted to the final fuel consumption section of the energy balances they should be accounted for also as inputs. A more precise solution would be to reduce the quantities of fuels consumed by the industrial sector, but this is not possible because the team in the Ministry of Economic Development has only a few details about the origin of those fuel streams returned to refineries. Since 2001 those fuel streams are needed to close the energy balances, which now are much more precise than before. Not considering them in the CRF as input will increase the difference between reference and sectoral approach in the oil section, while with those fuels as inputs the difference is nearly zero. The inventory team considers those fuels as "stock changes" of petrochemical input.

6) all coal data are available in BEN, coke import-export included;
7) natural gas import-export and production data;
8) waste production data;
9) Biomass fuel data.

The following additional information is needed to complete table 1.A(b) of CRF and it is found in other sources:

1) Orimulsion, this fuel is mixed up with imported fuel oil (on the base of the energy content), the quantities used for electricity generation are reported by ENEL (ENEL, several years), the former electricity monopoly, presently the only user of this fuel, in their environmental report. This fuel is not used any more since 2004.
2) Motor oils and bitumen.
    a) Data on those materials are mixed up in the no energy use by BEN, while detailed data are available in BPT (MSE, several years [b]). The quantities of those materials are quite relevant for the no energy use of oil.
    b) In the BEN those materials are estimated in bulk with other products to have an energy content of about 5100 kcal/kg. Average OECD data are equal to 9000 kcal/kg for bitumen and 9800 kcal/kg for motor oils. In the CRF those products are estimated with the OECD energy content and this could explain part of the unbalance between imported oil and used products.

For further information see the paper by ENEA (ENEA, 2002 [b]) in Italian.

A4.2 Comparison of the sectoral approach with the reference approach

The detailed inventory contains a number of sources not accounted for in the IPCC Reference Approach and so gives a higher estimate of CO_2 emissions. The unaccounted sources are:

- Land use change and forestry
- Offshore flaring and well testing
- Non-Fuel industrial processes

First of all, the IPCC Reference total can be compared with the CRF Table 1A total. Results show the IPCC Reference totals are between 0-2.6 percent lower than the comparable ‘bottom up’ totals. Only in 2012 the reference approach results 0.9 higher than the sectoral one. The highest difference between the two approaches is observed in 1999 and is equal to 2.6%; input data have been checked in details, the difference could be attributed to higher thermo electric fuel input registered by ENEL/TERNA than the figure reported in the energy balance and higher quantities of pet coke calculated from cement production data than those reported in the energy balance. In addition, till 2006, data on waste consumption reported in the energy balance are considerably lower than data from incinerations on waste for energy recovery used in the sectoral approach. Differences between emissions estimated by the reference and sectoral approach are reported in Table A4.1.

Table A4.1 Reference and sectoral approach CO_2 emission estimates 1990-2012 (Mt) and percentage differences

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Sectoral approach	400.7	413.8	433.6	457.2	452.6	444.1	434.9	391.3	400.9	389.7	366.3
Reference approach	396.2	406.5	422.9	448.9	446.3	436.2	431.4	391.0	399.5	389.5	369.5
Δ %	-1.14	-1.76	-2.47	-1.83	-1.40	-1.77	-0.80	-0.07	-0.36	-0.07	0.87

There are a number of reasons why the totals differ and these arise from differences in the methodologies and the statistics used.
Explanations for the discrepancies:

1. The IPCC Reference Approach is based on statistics of production, imports, exports and stock changes of fuels whilst the ‘bottom-up’ approach uses fuel consumption data. The two sets of statistics can be related using mass balances (MSE, several years [a]), but these show that some fuel is unaccounted for. This fuel is reported under ‘statistical differences’ which consist of measurement errors and losses. A significant proportion of the discrepancy between the IPCC Reference approach and the ‘bottom up’ approach arises from these statistical differences particularly with liquid fuels.
2. In the power sector, in the detailed approach, statistics from producers are used, whereas for the reference approach the BEN data are used. The two data sets are not connected; in the BEN sections used, only the row data of imports-exports are contained. But if one considers the process of “balancing” the import – production data with the consumption ones and the differences between the two data sets, a sizable part of the discrepancy may be connected to this reason only. In addition, waste consumption data reported in the BEN were not such accurate from 1990 up to 2002 as the subsequent years.
3. The ‘bottom up’ approach only includes emissions from the no energy use of fuel where they can be specifically identified and estimated such as with fertilizer production and iron and steel production. The IPCC Reference approach implicitly treats the non-energy use of fuel as if it were combustion. A correction is then applied by deducting an estimate of carbon stored from non-energy fuel use. The carbon stored is estimated from an approximate procedure which does not identify specific processes. The result is that the IPCC Reference approach is based on a higher estimate of non-energy use emissions than the ‘bottom-up’ approach.

The IPCC Reference Approach uses data on primary fuels such as crude oil and natural gas liquids which are then corrected for imports, exports and stock changes of secondary fuels. Thus the estimates obtained will be highly dependent on the default carbon contents used for the primary fuels.
The ‘bottom-up’ approach is based wholly on the consumption of secondary fuels where the carbon contents are known with greater certainty. In particular the carbon contents of the primary liquid fuels are likely to vary more than those of secondary fuels. Carbon content of solid fuels and of natural gas is quite precisely accounted for; a survey to improve the estimate of carbon content of liquid fuel is in progress.

A4.3 Comparison of the the sectoral approach with the reference approach and international statistics

A verification of national energy balance and CO_2 emissions with data communicated to the joint EUROSTAT/IEA/UNECE questionnaire was carried out in 2004 and results are reported in the document “Energy data harmonization for CO_2 emission calculations: the Italian case” (ENEA/MAP/APAT, 2004).
The analysis enhanced the main differences and the critical points to harmonize the data and their reporting. The most critical issues concerned the calorific value, EUROSTAT and MAP should apply the same calorific value; the distribution of fuel consumptions to the relevant sectors, e.g., in some cases EUROSTAT assigned “building materials industry” consumptions in “glass, pottery and building materials industry” consumptions, in other cases in “other industries”; the definition of coke, in particular, the distribution of consumptions between the iron and steel sector final consumption and transformation input; the definition of derived gases have to be harmonized, because differences in allocation of steelworks gases and gas from chemical processes were found.
In addition, “exchange and transfers, returns” and “statistical difference” rows were used in the national statistics to balance the energy resources with the energy uses whereas in the international statistics the two items, in some cases, were cancelled.
From 2004 some improvements were implemented both in the national and international statistics also through the revision of the questionnaire but difference in apparent consumptions still occur.
At European level, further examination is in progress. In the framework of the Monitoring Mechanism Decision jointly with EUROSTAT, a project which compares Eurostat energy data with energy data included in the CRF has been developed. The background of the project is the Energy Statistics Regulation (EC/1099/2008), which is the legal basis of the reporting of energy data to Eurostat, in particular Article 6, paragraph 2, of the regulation stipulating that: “Every reasonable effort shall be undertaken to ensure coherence between energy data declared in the energy statistics regulation, and data declared in accordance

with Commission Decision No 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol".
Member States' reference approach data as submitted in CRF Table 1A(b) under the EU GHG Monitoring Mechanism (as available by 15 May 2011) were compared with Eurostat energy data as available in the Eurostat database in April 2011: http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/database.
The comparison was carried out for the years 2009 and 2008. Specifically, for Italy, major discrepancies identified were only related to the consumption of refinery feedstocks which differs considerably between annual Eurostat data and the CRF: Annual Eurostat consumption is 30% and 40% lower than the CRF for 2008 and 2009 respectively. The same issue was identified during the last review process and corrected in this year submission.
In terms of CO_2 emissions, for Italy the preliminary comparison results in a difference in total equal to 2% in 2009, with higher differences for solid and other fuels. In the submission 2013, in response to the review process, waste data for energy recovery have been included in the reference approach resulting in a decrease of the differences especially for the last years.

ANNEX 5: NATIONAL ENERGY BALANCE, YEAR 2011

The official National Energy Balance (BEN) of the year 2012 is available, in Italian, on the website of the Italian Ministry of the Economic Development (MSE): http://dgerm.sviluppoeconomico.gov.it/dgerm/. Also, the time series from the year 1998 onwards are available at the same address.

The national energy balance consists of two "sets" of tables fuel consumptions expressed in physical quantities (Gg or Mm^3) and in energy equivalents (10^9 kcal). In the current annex, tables reproduce only figures expressed in amount of energy equivalents for the year 2011 (MSE, several years). Sectors and fuel definitions have been translated in English for the purposes of the NIR.

Reference is made here to the second set of tables because the reporting methodology of the BEN applies the same lower heat value to each primary fuel in various years, to take into account for the variable energy content of each shipment, . This means, for example, that the primary fuel quantities of two shipments of imported coal are "adjusted" using their energy content as the main reference (see Table A5.1) and the value reported in page 2 of the national energy balance (not reported here)is an "adjusted" quantity of Gg or Mm^3. This process is routinely applied to most primary sources, including imported and nationally produced natural gas.
For the final uses of energy (Tables A5.7-8 and Tables A5.9-10), the same methodology is applied but it runs the other way: the physical quantities of energy vectors are the only values actually measured on the market and the energy content is actually estimated using fixed average estimates of lower heat value. Measurements of the actual energy content of fuels show minor variations from one year to another, especially for liquid fuels.

In the case of natural gas, the use of a fixed heat value to summarize all transactions was particularly complicated due to the fact that Italy used fuel from four main different sources: Russia, Netherlands, Algeria and national production. Since 2003-2004 Norway and Libya have also been added to the supply list. The big customers were actually billed according to the measured heat value of the natural gas delivered. After the end of the state monopoly on this market, the system changed. Since 2004, the price refers e to the energy content of natural gas and the metered physical quantities of gas delivered to all final customers have been billed according to an energy content variable from site to site and from year to year. The BEN still tries to summarize all production and consumption using only one conventional heat value.

Therefore the physical quantities are the most reliable data for the estimations of liquid fuels used in the civil and transportation sector .This information is used to calculate emissions, using updated data for the emission factors which are estimated from samples of marketed fuels.
For this reason we attach also the copies of tables in physical quantities (see Tables A5.9-10), mirror sheet of the tables in energy equivalents, (Tables A5.7-8), that are the base for our emission calculation in the civil and transport sectors.

Table A5.1 – National Energy Balance, year 2012, Primary fuels, 10^9 kcal

BALANCE	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts (a)	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy (e)	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Wood	Biomass (f)	Biodiesel	TOTAL PRIMARY SOURCES
	PRIMARY SOURCES															
Conversion factor (b)	7,400	6,073	7,400	2,500	2,500	8,191	10,000	10,000	2,200	2,200	2,200	2,500	2,500	2,500	8,900	
1. PRODUCTIONS (c)	0	486	0	0	6.003	70.484	53.970	25.080	92.125	12.302	70.991	14.773	25.383	26.380	2.554	400.531
2. IMPORTS	35.335	118.940	1.014	10	0	554.735	688.260	70.010	0	0	0	0	10.875	0	10.342	1.489.521
3. EXPORTS		340	15			1.139	8810	13000					80	0	490	23.874
4. Stock changes (d)	-3.463	-3.401	-22	0	0	10.452	-2.970	-3.760	0	0	0	0	0	0	-312	-3.476
5. TOTAL RESOURCES	38.798	122.487	1.021	10	6.003	613.629	736.390	85.850	92.125	12.302	70.991	14.773	36.178	26.380	12.718	1.869.655
6. Transformations (Enclosure 1/a)	38.421	108.021		0	6.003	207.159	822.240	0	92.125	12.302	70.991	14.773	135	26.380	0	1.398.550
7. Consumptions and Losses (Encl.2/a)	377		0	0	0	16.226	0	0	0	0	0	0	0	0	0	16.603
8. Final Consumptions (Enclosure 3/a)	0	14.466	1.021	10	0	390.244	0	0				0	36.043	0	12.718	454.502
a) Agriculture	0	0	0	0	0	1.286	0	0	0	0	0	0	35	0	0	1.321
b) Industry	0	14.466	991	10	0	122.825		0				0	183	0	0	138.475
c) Services						7.568		0					0	0	12.718	20.286
d) Domestic and civil uses			30	0		253.929		0					35.825	0	0	289.784
Total (a+b+c+d)	0	14.466	1.021	10	0	385.608		0				0	36.043	0	12.718	449.866
e) Non energy uses						4.636	0	0	0	0	0	0	0	0	0	4.636
TOTAL ENERGY CONSUMPTIONS (7+8)	377	14.466	1.021	10	0	406.470	0	0	0	0		0	36.043	0	12.718	471.105
9. Non energy final uses																
10. BUNKERS																
12. TOTAL USES	38.798	122.487	1.021	10	6.003	613.629	822.240	0	92.125	12.302	70.991	14.773	36.178	26.380	12.718	1.869.655

(a) - Including secondary products, heat recovered, oxygen furnace gas and compressed gas expansion evaluated at the thermic equivalent of 2200 kcal/kWh, used by electric energy production

(b) - Lower heat value has been adopted for all fuels

(c) - Oil products include: returns from petrochemical industry, some reclassification of feedstocks and regeneration of lubricant oils

(d) - In the "TOTAL RESOURCES", this entry is considered negative

Table A5.2 -National Energy Balance, year 2012, Secondary fuels, 10^9kcal

BALANCE	SECONDARY SOURCES																		
	Electric Energy	Char- coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	17	18	19	20	22	23	21	24	25	26	27	28	29	30	31	32	33	34	35
Conversion factor (b)	0,860	7,500	7,119	4,250	0,900	7,400	4,250	11,000	12,000	10,400	10,500	10,400	10,300	10,200	9,800	9,800	8,300	6,375	
1. PRODUCTIONS (c)	255.675	38	29.786	6.592	6.376	1.095	0	16.951	32.748	32.469	191.258	27.040	6.922	358.010	(g) 54.488	47.569	11.172	37.358	1.115.547
2. IMPORTS	39.051	450	0					23.485	0	11.794	462	10.795	1.988	21.440	(h) 2.675	3.205	15.978	4.545	135.868
3. EXPORTS	1.981	8	1.808			200		4.301		12.511	96.905	530	1.483	109.609	13.779	17.042	224	17.499	277.880
4. Stock changes (d)		0	-135					-1.771		-1.383	-2.300	-2.371	-309	-1.132	3.822	1.901	58	880	-2.740
5. TOTAL RESOURCES	292.745	480	28.113	6.592	6.376	895	0	37.906	32.748	33.135	97.115	39.676	7.736	270.973	39.562	31.831	26.868	23.524	976.275
6. Transformations (Encl.1/a)			6.549	3.979	(c) 6.212	0		0	3.589	82	0	0	0	1.283	17.306	8.125	1.738	0	48.863
7. Consumptions and Losses (Encl.2/a)	37.548	0	0	241	7	1	0	253	20.519	106		0	1	227	3.352	7.978	7.982	0	77.961
8. Final Consumptions (Encl.3/a)	255.197	480	21.564	2.372	157	894	0	37.653	8.640	32.947	97.117	39.676	7.735	263.486	3.880	7.349	17.148	2.684	819.589
a) Agriculture	5.094							594	0	0	95	0	0	20.655	0	0	0	0	26.438
b) Industry	97.987	75	21.564	2.372	157		0	2.541	5.808	0	221	125	10	3.264	2.704	6.781	17.148	2.684	163.441
c) Services	39.318							14.905			87.802	39.551	52	217.025	0	0	0	0	398.653
d) Domestic and civil uses	112.798	405	0				0	16.478	0	0	0		10	15.922	0	147	0	0	145.760
Total (a+b+c+d)	255.197	480	21.564	2.372	157	0	0	34.518	5.808	0	88.118	39.676	72	256.866	2.704	6.928	17.148	2.684	734.292
e) No energetic uses				0		894		3.135	2.832	32.947	8.999	0	7.663	6.620	1.176	421	0	20.610	85.297
TOTAL ENERGY CONSUMPTIONS (7+8)	292.745	480	21.564	2.613	164	895	0	37.906	29.159	33.053	97.115	39.676	7.736	263.713	7.232	15.327	25.130	2.684	877.192
9. Non energy final uses																			
10. BUNKERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20.610	20.610
12. TOTAL USES	0	0	0	0	0	0	0	0	0	0	0	0	0	5.977	15.024	8.379	0	230	29.610

Table A5.3 -National Energy Balance, year 2012, Primary fuels used by transformation industries, "Enclosure 1/a", 10^9kcal

TRANSFORMATIONS	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts (a)	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy (e)	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass	TOTAL PRIMARY SOURCES
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Conversion factor (b)	7,400	6,073	7,400	2,500	2,500	8,191	10,000	10,000	2,200	2,200	2,200	2,500	2,500	
1) INPUT QUANTITY														
a) Charcoal pit													135	135
b) Coking	38.421													38.421
c) Town gas Workshop														
d) Blast furnaces														
e) Petroleum refineries							822.240							822.240
f) Hydroelectric power plants									92.125					92.125
g) Geothermal power plants										12.302				12.302
h) Thermoelectric power plants		108.021			6.003	207.159						14.773	26.379	362.335
i) Wind / Photovoltaic power plants						-					70.991			70.991
TOTAL	38.421	108.021			6.003	207.159	822.240		92.125	12.302	70.991	14.773	26.514	1.398.549
2) OUTPUT QUANTITY														
A) Obtained sources														
a) Charcoal pit													68	68
b) Coking	35.890													35.890
c) Town gas Workshop														
d) Blast furnaces														
e) Petroleum refineries							778.622							778.622
f) Hydroelectric power plants									36.012					36.012
g) Geothermal power plants										4.809				4.809
h) Thermoelectric power plants		42.261			1.283	110.990						3.755	8.844	167.133
i) Wind / Photovoltaic power plants											27.751			27.751
Sub-Total A	35.890	42.261			1.283	110.990	778.622		36.012	4.809	27.751	3.755	8.912	1.050.285

TRANSFORMATIONS	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts (a)	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy (e)	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass	TOTAL PRIMARY SOURCES
B) Losses of transformation														
a) Charcoal pit													67	[illegible]
b) Coking	1.125													1.1
c) Town gas Workshop														
d) Blast furnaces														
e) Petroleum refineries							6.260							6.2
f) Hydroelectric power plants									56.113					56.1
g) Geothermal power plants										7.493				7.4
h) Thermoelectric power plants		65.760			4.720	96.169						11.018	17.535	195.2
i) Wind / Photovoltaic power											43.240			43.2
Sub-Total B	1.125	65.760			4.720	96.169	6.260		56.113	7.493	43.240	11.018	17.602	309.5
C) Non energy products														
a) Coke ovens (c)	1.406													1.4
b) Town Gas Workshop														
c) Petroleum refineries (d)							37.358							37.3
Sub-Total C	1.406						37.358							38.7
TOTAL A+B+C	38.421	108.021			6.003	207.159	822.240		92.125	12.302	70.991	14.773	26.514	1.398.5

(a) - See note (a) in the table of the Balance

(b) - Lower heat value has been adopted for all fuels

(c) - Including tars, benzol and ammonic sulphate

(d) - Including solvent gasoline, turpentine, lubricants, white oils, insulating oils, vaseline, paraffin, bitumen and other products

(e) - Pumping excluded

Table A5.4 -National Energy Balance, year 2012, Secondary fuels used by transformation industries, "Enclosure 1/a", 10^9kcal

TRANSFORMATIONS	SECONDARY SOURCES																		
	Electric Energy	Char- coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor (b)	0,860	7,500	7,119	4,250	0,900	7,400	4,250	11,000	12,000	10,400	10,500	10,400	10,300	10,200	9,800	9,800	8,300	6,375	
1) INPUT QUANTITY																			
a) Charcoal pit																			
b) Coking																			
c) Town gas Workshop																			
d) Blast furnaces			6.549																6.549
e) Petroleum refineries																			
f) Hydroelectr.power plants																			
g) Geothermal power plants																			
h) Thermoelectr. power plants				3.979	6.212				3.589	82				1.283	17.306	8.125	1.738		42.314
i) Wind / Photovoltaic power plants																			
TOTAL			6.549	3.979	6.212				3.589	82				1.283	17.306	8.125	1.738		48.863
2) OUTPUT QUANTITY																			
A) Obtained sources																			
a) Charcoal pit																			
b) Coking																			
c) Town gas Workshop																			
d) Blast furnaces			6.549																6.549
e) Petroleum refineries																			
f) Hydroelectric power plants																			
g) Geothermal power plants																			
h) Thermoelectric power plants				1.620	2.598				1.701	57				435	9.852	3.250	456		19.969
i) Wind / Photovoltaic power plants																			
Sub-Total A			6.549	1.620	2.598				1.701	57				435	9.852	3.250	456		26.518

TRANSFORMATIONS	SECONDARY SOURCES																		
	Electric Energy	Char- coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
B) Losses of transformation																			
a) Charcoal pit																			
b) Coking																			
c) Town gas Workshop																			
d) Blast furnaces																			
e) Petroleum refineries																			
f) Hydroelectric power plants																			
g) Geothermal power plants																			
h) Thermoelectric power plants				2.359	3.614				1.888	25				848	7.454	4.875	1.282		22.345
i) Wind / Photovoltaic power plants																			
Sub-Total B				2.359	3.614				1.888	25				848	7.454	4.875	1.282		22.345
C) Non energy products																			
a) Coking																			
b) Town Gas Workshop																			
c) Petroleum refineries																			
Sub-Total C																			
TOTAL A+B+C			6.549	3.979	6.212				3.589	82				1.283	17.306	8.125	1.738		48.863

Table A5.5 -National Energy Balance, year 2012, Primary fuels losses, "Enclosure 2/a", 10^9kcal

CONSUMPTIONS AND LOSSES (d)	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts (a)	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass	TOTAL PRIMARY SOURCES
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Conversion factor (b)	7,400	6,073	7,400	2,500	2,500	8,191	10,000	10,000	2,200	2,200			2,500	
1) Consumptions for production														
of primary sources														
a) Biomass														
b) Coal														
c) Lignite														
d) Nuclear fuels														
e) Natural Gas						3.539								3.539
f) Natural gas liquids														
g) Crude oil														
h) Hydraulic Energy														
i) Geothermal Energy														
Sub-total						3.539								3.539
2) Consumptions for production														
of secondary sources (c)														
a) Charcoal pit														
b) Coke ovens	377													377
c) Town Gas Workshop														
d) Blast furnaces														
e) Petroleum refineries						8.338								8.338
f) Hydraulic power plants														
g) Geothermal power plants														
h) Thermoelectric power plants														
i) Nuclear power plants														
Sub-total	377					8.338								8.715

CONSUMPTIONS AND LOSSES (d)	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts (a)	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass	TOTAL PRIMARY SOURCES
3) Consumptions and Losses of														
transport and distribution						4.349								4.349
4) Differences :														
- Statistics														
- of conversion		-1												-1
TOTAL (1+2+3+4)	377	-1				16.226								16.602

(a) - See note (a) in the table of the Balance

(b) Lower heat value has been adopted for all fuels

(c) Consumptions for internal uses of energy industries

Table A5.6 -National Energy Balance, year 2012, Secondary fuels losses, "Enclosure 2/a", 10^9kcal

CONSUMPTIONS AND LOSSES	SECONDARY SOURCES																		
	Electric Energy	Char- coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor (b)	0,860	7,500	7,119	4,250	0,900	7,400	4,250	11,000	12,000	10,400	10,500	10,400	10,300	10,200	9,800	9,800	8,300	6,375	
1) Consumptions for production of primary sources a) Biomass																			
b) Coal	42																		42
c) Lignite																			
d) Nuclear fuels	5																		5
e) Natural Gas	294																		294
f) Natural gas liquids																			
g) Crude oil																			
h) Hydraulic Energy	611	(d)																	611
i) Geothermal Energy	-																		
Sub-total	952																		952

CONSUMPTIONS AND LOSSES	SECONDARY SOURCES																		
	Electric Energy	Char- coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
2) Consumptions for production of secondary sources (c)																			
a) Charcoal pit																			
b) Coke ovens	119			242	7														368
c) Town Gas Workshop	313																		313
d) Blast furnaces																			
e) Petroleum refineries	4.814							253	20.519	104				225	3.351	7.976	7.985		45.227
f) Hydraulic power plants	514																		514
g) Geothermal power plants	292																		292
h) Thermoelectric power plants	8.801																		8.801
i) Wind / Photovoltaic power plants	257																		
Sub-total	15.110			242	7			253	20.519	104				225	3.351	7.976	7.985		55.515
3) Consumptions and Losses of transport and distribution	21.486																		21.486
4) Differences :																			
- Statistics	-																		
- of conversion			3			1				2	-2		1	2	1	2	-3	1	8
TOTAL (1+2+3+4)	37.548		3	242	7	1		253	20.519	106	-2		1	227	3.352	7.978	7.982	1	77.961

Table A5.7 -National Energy Balance, year 2012, Primary fuels used by end use sectors, "Enclosure 3/a", 10^9kcal

FINAL CONSUMPTIONS	PRIMARY SOURCES														
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Wood	Biodiesel	TOTAL PRIMARY SOURCES
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Conversion factor (a)	7,400	6,073	7,400	2,500	2,500	8,191	10,000	10,000	2,200	2,200	2,200	2,500	2,500	8,900	
1) AGRICULTURE AND FISHING															
I- Agriculture						1.286							35		1.321
II- Fishing															
Sub-Total						1.286							35		1.321
2) INDUSTRY															
I- Iron and steel industry		11.751	629			17.177									29.557
II- Other industry		2.715	363	10		105.648							183		108.919
a) Mining industry						344									344
b) Non-Ferrous Metals			30			3.997									4.027
c) Metal works factories						16.669									16.669
d) Food Processing, Beverages						13.925									13.925
e) Textile and clothing						5.988									5.988
f) Construction industries (cement, bricks)		2.715	318	10		5.881							183		9.107
g) Glass and pottery						17.578									17.578
h) Chemical			15			20.207									20.222
i) Petrochemical															
l) Pulp, paper and print						17.480									17.480
m) Other industries						3.579									3.579
n) Building and civil works															
Sub-Total		14.466	992	10		122.825							183		138.476

FINAL CONSUMPTIONS	PRIMARY SOURCES														
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Wood	Biodiesel	TOTAL PRIMARY SOURCES
3) SERVICES															
I - Railways															
II - Navigation															
III - Road transportation						7.568								12.718	20.286
IV - Civil aviation															
V - Other transportation															
VI - Public Service															
Sub-Total						7.568								12.718	20.286
4) DOMESTIC AND COMMERCIAL USES			30			253.929							35.825		289.784
TOTAL (1+2+3+4)		14.466	1.022	10		385.608							36.043	12.718	449.867
5) NON ENERGY USE (b)															
I - Chemical industry															
II - Petrochemical						4.636									4.636
III - Agriculture															
IV - Other sectors															
Sub-Total						4.636									4.636
TOTAL (1+2+3+4+5)		14.466	1.022	10		390.244							36.043	12.718	454.503

(a) - Lower heat value has been adopted for all fuels

Table A5.8-National Energy Balance, year 2012, Secondary fuels used by end use sectors, "Enclosure 3/a", 10^9kcal

FINAL CONSUMPTIONS	SECONDARY SOURCES																		
	Electric Energy	Char- coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	16	17	18	19	21	22	20	23	24	25	26	27	28	29	30	31	32	33	34
Conversion factor	0,860	7,500	7,119	4,250	0,900	7,400	4,250	11,000	12,000	10,400	10,500	10,400	10,300	10,200	9,800	9,800	8,300	6,375	
1) AGRICULTURE AND FISHING																			
I- Agriculture	5.094							572			84			18.972					24.722
II- Fishing								22			11			1.683					1.716
Sub-Total	5.094							594			95			20.655					26.438
2) INDUSTRY																			
I- Iron and steel industry	17.004		21.435	2.372	157			176						143	343	216			41.846
II- Other industry	80.983	76	126					2365	5.808		221	125	10	3.121	2.361	6.565	17.147	2.684	121.592
a) Mining industry	671							22						214	69				976
b) Non-Ferrous Metals	3.256		14					132						51	176				3.629
c) Metal works factories	20.257							506			221	125	10	959	559	843			23.480
d) Food Processing, Beverages	10.372	53						297						347	764	1.362			13.195
e) Textile and clothing	5.135							143						245		529			6.052
f) Construction industries (cement, bricks)	4.675		64					528						377	274	421	17.081	2.391	25.811
g) Glass and potter	3.918							506						133		1.401			5.958
h) Chemical	16.602	23	21					33						173		578	66		17.496
i) Petrochemical	1.429							66	5.808						343	960		293	8.899
l) Pulp, paper and print	7.830							66						163		353			8.412
m) Other industries	5.595		27					55						102	176	118			6.073
n) Building and civil works	1.243							11						357					1.611
Sub-Total	97.987	75	21.561	2.372	157			2.541	5.808		221	125	10	3.264	2.704	6.781	17.148	2.684	163.438

FINAL CONSUMPTIONS	SECONDARY SOURCES																		
	Electric Energy	Char- coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
3) SERVICES																			
I - Railways	4.672													143					4.815
II - Navigation	44													2.519					2.563
III - Road transportation	4.349							14.850			87.581			212.507					319.287
IV - Civil aviation	188										95	38.293	52						38.628
V - Other transportation	20.264																		20.264
VI - Public Service	9.801							55			126	1.258		1.856					13.096
Sub-Total	39.318							14.905			87.802	39.551	52	217.025					398.653
4) DOMESTIC AND COMMERCIAL USES	112.798	405						16.478					10	15.922		147			145.760
TOTAL (1+2+3+4)	255.197	480	21.561	2.372	157			34.518	5.808		88.118	39.676	72	256.866	2.704	6.928	17.148	2.684	734.289
5) NON ENERGY USE (b)																			
I - Chemical industry																			
II - Petrochemical								3.135	2.832	32.947	8.999		7.663	6.620	1.176	421		567	64.360
III - Agriculture						80													80
IV - Other sectors						814												20.043	20.857
Sub-Total						894		3.135	2.832	32.947	8.999		7.663	6.620	1.176	421		20.610	85.297
TOTAL (1+2+3+4+5)	255.197	480	21.561	2.372	157	894		37.653	8.640	32.947	97.117	39.676	7.735	263.486	3.880	7.349	17.148	23.294	819.586

Table A5.9 -National Energy Balance, year 2012, Primary fuels used by end use sectors, "Enclosure 3/a", quantity

FINAL CONSUMPTIONS	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass	TOTAL PRIMARY SOURCES
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Unit of measurement	kt	kt	kt	kt		Mmc	kt	kt	GWh	GWh	GWh	kt	kt	
1) AGRICULTURE AND FISHING														
I- Agriculture						157							14	
II- Fishing														
Sub-Total	0	0	0	0		157	0	0	0	0			14	
2) INDUSTRY														
I- Iron and steel industry		1.935	85			2.097								
II- Other industry	0	447	49	4		12.898	0		0	0		0	73	
a) Mining industry						42								
b) Non-Ferrous Metals			4			488								
c) Metal works factories						2.035								
d) Food Processing, Beverages						1.700								
e) Textile and clothing						731								
f) Construction industries (cement, bricks)		447	43	4		718							73	
g) Glass and pottery						2.146								
h) Chemical			2			2.467								
i) Petrochemical														
l) Pulp, paper and print						2.134								
m) Other industries						437								
n) Building and civil works														
Sub-Total	0	2.382	134	4	0	14.995	0	0	0	0		0	73	

FINAL CONSUMPTIONS	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass	TOTAL PRIMARY SOURCES
3) SERVICES														
I - Railways														
II - Navigation														
III - Road transportation						924							(b) 1.429	
IV - Civil aviation														
V - Other transportation														
VI - Public Service														
Sub-Total	0	0	0	0		924	0	0	0	0			1.429	
4) DOMESTIC AND COMMERCIAL USES			4			31.001							(b) 14.330	
TOTAL (1+2+3+4)	0	2.382	138	4		47.077	0	0	0	0			15.846	
5) NON ENERGY USE (a)														
I - Chemical industry														
II - Petrochemical						566								
III - Agriculture														
IV - Other sectors														
Sub-Total	0	0	0	0		566	0	0	0	0			-	
TOTAL (1+2+3+4+5)	0	2.382	138	4		47.643	0	0	0	0			15.846	

(a) - Non energy uses of energetic sources

(b) - Biodiesel for road transport

Table A5.10 -National Energy Balance, year 2012, Secondary fuels used by end use sectors, "Enclosure 3/a", quantity

FINAL CONSUMPTIONS	SECONDARY SOURCES																		
	Electric Energy	Char- coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Unit of measurement	GWh	kt	kt	Mmc	Mmc	kt	Mmc	kt	kt	kt		kt	kt	kt	kt	kt	kt	kt	
1) AGRICULTURE AND FISHING																			
I- Agriculture	5.924							52			8			1.860					
II- Fishing								2			1			165					
Sub-Total	5.924	0	0	0	0		0	54	0	0	9	0	0	2.025	0	0	0	0	
2) INDUSTRY																			
I- Iron and steel industry	19.772		3.011	558	174			16						14	35	22			
II- Other industry	94.166	10	18	0	0	0	0	215	484	0	21	12	1	306	241	670	2.066	421	
a) Mining industry	781							2						21	7	0			
b) Non-Ferrous Metals	3.786		2					12						5	18	0			
c) Metal works factories	23.554							46			21	12	1	94	57	86			
d) Food Processing, Beverages	12.060	7						27						34	78	139			
e) Textile and clothing	5.970							13						24	0	54			
f) Construction industries (cement, bricks)	5.436		9					48						37	28	43	2.058	375	
g) Glass and pottery	4.556							46						13	0	143			
h) Chemical	19.305	3	3					3						17	0	59	8		
i) Petrochemical	1.661							6	484	0	0	0	0	0	35	98	0	46	
l) Pulp, paper and print	9.104							6						16	0	36			
m) Other industries	6.507		4					5						10	18	12			
n) Building and civil works	1.446							1						35	0	0			
Sub-Total	113.938	10	3.029	558	174	0	0	231	484	0	21	12	1	320	276	692	2.066	421	

FINAL CONSUMPTIONS	SECONDARY SOURCES																		
	Electric Energy	Char- coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
3) SERVICES																			
I - Railways	5.433													14					
II - Navigation	51													247					
III - Road transportation	5.057							1.350			(b) 8.341			20.834					
IV - Civil aviation	219										9	3.682	5						
V - Other transportation	23.561																		
VI - Public Service	11.396							(a) 5			12	121		(a) 182					
Sub-Total	45.717	0	0	0	0	0	0	1.355	0	0	8.362	3.803	5	21.277	0	0	0	0	
4) DOMESTIC AND COMMERCIAL USES	131.162	54						1.498					1	1.561		15			
TOTAL (1+2+3+4)	296.741	64	3.029	558	174	0	0	3.138	484	0	8.392	3.815	7	25.183	276	707	2.066	421	29.583
5) NON ENERGY USE																			
I - Chemical industry																			
II - Petrochemical								285	236	3168	857	0	744	649	120	43	0	89	
III - Agriculture						11													
IV - Other sectors						110												3.144	
Sub-Total	-	0	0	0	0	121	0	285	236	3.168	857	0	744	649	120	43	0	3.233	
TOTAL (1+2+3+4+5)	296.741	64	3.029	558	174	121	0	3.423	720	3.168	9.249	3.815	751	25.832	396	750	2.066	3.654	

(c) 34 kt of gas oil and 2 kt of LPG used for heating for Public Service

ANNEX 6: NATIONAL EMISSION FACTORS

Monitoring of the carbon content of the fuels used nationally is an ongoing activity at ISPRA. The purpose is to analyse regularly the chemical composition of the used fuel or relevant commercial statistics to estimate the carbon content / emission factor (EF) of the fuels. For each primary fuel (natural gas, oil, coal) a specific procedure has been established.

A6.1 Natural gas

The national market is characterized by the commercialisation of gases with different chemical composition in variable quantities from one year to the other. Since 1990 natural gas has been produced in Italy and imported by pipelines from Russia, Algeria and the Netherlands. Moreover an NGL facility is importing gas from Algeria and Libya. From 2003-2004 onwards Norway and Libya have also been added to the supply list, through new pipeline connections, and from 2008 a new NGL facility has entered into service, using mainly liquefied gas from Oman. There are also sizeable underground storage facilities and additional pipelines/NGL facilities are planned.

The estimation of an average EF for natural gas is the only way to calculate total emissions from this source in Italy, because the origin of the gas used by final consumers can not be tracked trough the national statistics and it is subject to variations during the year, according to supply. Only the main industrial installations perform routine checks to estimate the average chemical composition / energy content of natural gas used.

Another task connected to the use of natural gases of different origin and composition is linked to the estimation of an average content of methane to estimate fugitive emissions of this gas from the transmission / distribution network. Since the beginning of the inventory estimations, the average EF of the used gas in Italy has been estimated by the inventory team and it changes every year.

From 2008 in the energy balance, BEN 2008, (MSE, several years [a]) some modifications have occurred; a new average lower heat value has been derived from Eurostat methodology. This new conversion factor did imply a methodological revision to estimate the average national EF. Additionally, the IPCC 2006 guidelines, see table A6.1, contain important information to consider: the recognition of a certain variability of the EF for this source; the estimation of a lower and upper bound for the EFs; the link between energy content and EF; the statement that, by converting to energy units all EFs, their variability can be reduced. Moreover default oxidation factor is estimated to be equal to 1 (full oxidation). The 2006 guidelines do not apply in the national inventory up to 2012, but some of the scientific information could and should be considered in the estimation of the national emission factors (IPCC, 2006).

Each of natural gases transmitted by the grid operator is regularly analysed at import gates, for budgetary reasons. Energy content for cubic meters, percentage of methane and other substances are calculated. For example, methane content can considerably vary: national produced gas sold to the grid is almost 99% methane (% moles), the one coming from Algeria has less than 85% of methane and significant quantities of propane-butane. Also carbon content varies significantly.

Natural gas properties are more stable referring to the country of origin, with small variations in chemical composition from year to year. Speciation of gas from each import manifold is regularly published by national transmission grid operator (Snam Rete Gas, several years). Other information is also available from the main final users (TERNA, several years).

So, for each year, the average methane and carbon content of the natural gas used in Italy are estimated, using international trade statistical data, and a national emission factor is estimated.

The list of factors for the years of interest is reported in Table A6.1.

In the 2014 submission, the average emission factors for the year 2011 have been slightly revised on account of updated information on energy conversion factor of imported fuels. As shown in the table, the ranges of national EFs are within the lower and upper threshold of the IPCC 2006 guidelines.

Table A6.1 Natural gas carbon emission factors

	$t\ CO_2$ / TJ (stechiometric)	$t\ CO_2$ / TJ (with oxidation factor equal to 0.995)	$t\ CO_2 / 10^3$ std cubic mt (with oxidation factor equal to 0.995)	$t\ CO_2$ / toe (with oxidation factor equal to 0.995)
Natural gas (dry) IPCC '96	56.061	55.780	1.925	2.334
Natural gas, IPCC '06 average	56.100			
lower	54.100			
upper	58.100			
National Emission Factors				
Natural gas , 1990	55.606	55.328	1.942	2.315
Natural gas, 1995	55.702	55.423	1.961	2.319
Natural gas , 2000	55.751	55.472	1.971	2.321
Natural gas , 2001	55.699	55.421	1.960	2.319
Natural gas , 2002	56.255	55.974	1.965	2.342
Natural gas, 2003	55.874	55.594	1.961	2.326
Natural gas, 2004	55.874	55.595	1.945	2.326
Natural gas, 2005	55.869	55.590	1.944	2.326
Natural gas, 2006	55.946	55.666	1.949	2.329
Natural gas, 2007	55.917	55.637	1.947	2.328
Natural gas, 2008	56.025	55.745	1.950	2.332
Natural gas, 2008, with 8190 lhv	57.196	56.910	1.950	2.381
Natural gas, 2009	56.050	55.769	1.958	2.333
Natural gas, 2009, with 8190 lhv	57.418	57.131	1.958	2.390
Natural gas, 2010	55.998	55.718	1.962	2.331
Natural gas, 2010, with 8190 lhv	57.527	57.239	1.961	2.395
Natural gas, 2011	55.803	55.524	1.955	2.323
Natural gas, 2011, with 8190 lhv	57.044	56.758	1.945	2.375
Natural gas, 2012	55.862	55.582	1.957	2.326
Natural gas, 2012, with 8190 lhv	57.220	56.934	1.951	2.382

Source: ISPRA elaborations

The methodology used to estimate the EF is based on the available data. Each year the quantities of natural gas imported or produced in Italy are published on the web by the MSE http://dgerm.sviluppoeconomico.gov.it/dgerm/bilanciogas.asp.Those data are produced by the national grid operator and are concerned on all imported gas by point of entrance in the country and all natural gas produced. To compare quantities of different gases, the physical quantities of imported/produced gas are normalized to a higher heat value (hhv) equal to 9100 kcal/m^3 and standard conditions. Other data input used in the estimation are the average chemical composition and the hhv of the gas at each import "gate" and for the national production. Those data are published by Snam Rete Gas in its yearly "Bilancio di Sostenibilità" (Snam Rete Gas, several years) and with them it is possible to estimate the average carbon content of the fuel. Those data are referred to the physical quantities of imported / produced gas.
So the total quantities of imported gas (normalized at the hhv of 9100) published by MSE are transformed back to the physical quantities of actually imported gas using the hhv ratio and then average carbon content of the total gas imported or produced in Italy can be estimated. Those data are then referred back to the normalized quantities of gas used in national statistics.

Data on final consumption of gas refers to the lower heat value (lhv). In particular the electricity production companies regularly estimate the actual lhv of the gas they are using and this figure is published yearly by TERNA. Operator's data are used to verify the calculation results. Weighted average lhv of the imported and produced natural gas in 2012 is 8,393 kcal/m^3.
As mentioned above in the BEN 2008, the average lhv has been changed from 8250 kcal/m^3 (historical value) to 8190 kcal/m^3, to harmonize national data with Eurostat methodology. Eurostat considers the lhv as

being 10% less than hhv, regardless of the actual value. As reported in table A6.1, this change influences the EF, if it is referred to the energy content (lhv) of the fuel, but it has no influence if the EF is referred to cubic meters. The total amount of carbon emitted by natural gas in Italy from 2008 do not change using both EFs reported in the table because the total energy content of the natural gas use changes according to the statistical methodology used.

A6.2 Diesel oil, petrol and LPG

APAT (now ISPRA) has made an investigation of the carbon content of the main transportation fuels sold in Italy: petrol, diesel and LPG, with the aim of testing the average fuels sold in the year 2000 and collecting available information on previous year fuels. The goal of this work is the verification of CO_2 emission factors of Italian energy system, with a particular focus on the transportation sector. The results of analysis of fuel samples performed by "Stazione Sperimentale Combustibili" (APAT, 2003) were compared with emission factors used in Reference Approach of the Intergovernmental Panel for Climate Change (IPCC, 1997) and emission factors considered in the COPERT 4 programme (EMISIA SA, 2012).
These two methodologies are widely used to prepare data at the international level but, when applied to the Italian data set produce results with significant differences, around 2- 4%. The reason has been traced back to the emission factors that are referred to the energy content of the fuel for IPCC and to the physical quantities for the COPERT methodology.
The results of the study link the chemical composition of the fuel to the lhv for a series of fuels representative of the national production in the years 2000-2001, allowing for more precise evaluations of the emission factors.

IPCC 1996 emission factors for diesel fuels and IPCC-Europe for LPG are almost identical to the experimental results (less than 1% difference), and it has been decided to use IPCC emission factors for the period 1990-1999 and the measured EF from the year 2000 onwards.
Relevant quantities of LPG used in Italy are imported. The measured values refer only to the products produced in Italy, IPCC emission factors is used as a default for the imported quantities.

Concerning petrol, instead, IPCC 1996 emission factors is quite low and it has to be updated, the reason may be linked to the extensive use of additives in recent years to reach a high octane number after the lead has been phased out. For 2000 and the following years the experimental factor will be used, for the period 1990-1999 it has been decided to use an interpolate factor between IPCC emission factors and the measured value, using the lhv as the link between the national products and the international database. No other information was available.
The list of emission factors for the different years is reported in Table A6.2.

Table A6.2 Fuels, national production, carbon emission factors, with oxidation factor equal to 0.99

	t CO_2 / TJ	t CO_2 / t	t CO_2 / toe
Petrol, IPCC / OECD	68.559	3.071	2.868
Petrol, IPCC Europe	72.270	3.148	3.024
Petrol (Italian National Energy Balance), interpolated emission factor 1990-1999	71.034	3.121	2.972
Petrol, experimental averages 2000-2011	71.145	3.109	2.977
Gas oil, IPCC / OECD	73.274	3.175	3.066
Gas oil, IPCC Europe	73.260	3.108	3.065
Gas oil, 1990 - 1999	73.274	3.127	3.066
Gas oil, engines, experimental averages 2000-2011	73.153	3.138	3.061
Gas oil, heating, experimental averages 2000-2011	73.693	3.141	3.083
LPG, IPCC / OECD	62.392	2.952	2.610
LPG, IPCC / Europe	64.350	3.000	2.692
LPG, 1990 – 1999	62.392	2.872	2.610
LPG, experimental averages 2000-2011	64.936	2.994	2.717

Source: ISPRA elaborations

A6.3 Fuel oil

The main information available nationally of fuel oil EF is a sizable difference in carbon content between high sulphur and light sulphur brands. The data were elaborated from literature and from an extensive series of samples (more than 400) analysed by ENEL and made available to ISPRA. Carbon content varies to a certain extent also between the medium sulphur content and the very low sulphur products, but the main discrepancies refer to the high sulphur type. According to the available statistical data, it was possible to trace back to the year 1990 the produced and imported quantities of fuel oil divided between high and low sulphur products and to estimate the average carbon emission factor for the years of interest, see Table A6.3 for details.

Table A6.3 Fuel oil, average of national and imported products, carbon emission factors

	t CO_2 / TJ (stechiometric)	t CO_2 / TJ (with oxidation factor equal to 0.99)	t CO_2 / t	t CO_2 / toe
Fuel oil , IPCC, 1996	77.310	76.539	3.148	3.202
Fuel oil , IPCC, 2006 average	77.400			
lower	75.200			
upper	79.600			
National emission factors				
Fuel oil, average 1990	77.339	76.565	3.111	3.203
Fuel oil, average 1995	77.425	76.650	3.127	3.207
Fuel oil, average 2000	76.665	75.898	3.124	3.176
Fuel oil, average 2001	76.665	75.889	3.122	3.175
Fuel oil, average 2002	76.709	75.942	3.125	3.177
Fuel oil, average 2003	76.921	76.151	3.131	3.186
Fuel oil, average 2004	76.939	76.170	3.132	3.187
Fuel oil, average 2005	75.875	75.116	3.110	3.143
Fuel oil, average 2006	75.952	75.193	3.111	3.146
Fuel oil, average 2007	76.326	75.562	3.113	3.162
Fuel oil, average 2008	76.393	75.629	3.111	3.164
Fuel oil, average 2009	76.449	75.684	3.112	3.167
Fuel oil, average 2010	76.424	75.660	3.110	3.166
Fuel oil, average 2011	76.391	75.627	3.111	3.164
Fuel oil, average 2012	76.188	75.426	3.110	3.156

Source: ISPRA elaborations

Data for all years are within IPCC 2006 ranges, but it can be noticed that are on the lower side from year 2000 onwards. The change from an average to a low EF is due to the harmful emissions limits and fuel regulations introduced in Italy between 1990 and 2000. Most of the fuel used from 2000 onwards is not heavy, high sulphur, fuel oil but light type, low sulphur.

A6.4 Coal

Italy has only negligible national production of coal; most part is imported from various countries and there are differences in carbon content of coal mined in different parts of the world. The variations in carbon content can be linked to the hydrogen content and to the LHV of the coal.
An additional national circumstance refers to the absence of long term import contracts. The quantities shipped by the main exporters change considerably from year to year. Detailed data are available in BPT (MSE, several years [b]) supplied from the Ministry of Economic Development and reported for 2012 in Table A6.4.

Table A6.4 – Coal imported by country in 2012 (Mg)

Country	Coaking coal	Coke	Steam coal	Lignite	Other	Total Coal	Petroleum coke
Cyprus	0	0	880,425	0	0	880,425	0
Germany	0	0	99	4,954	40	5,093	0
Letvia	0	0	665,615	0	0	665,615	0
Poland	0	796	0	0	0	796	0
Spain	0	0	1,028,986	0	0	1,028,986	9,444
Total EU	0	796	2,575,125	4,954	40	2,580,915	9,444
Other est european countries	0	0	49,192	0	0	49,192	0
Australia	1,358,811	0	107,166	0	0	1,465,977	0
Canada	723,814	0	69,412	0	0	793,226	0
Colombia	0	0	2,756,172	0	0	2,756,172	0
Egypt	0	0	0	0	0	0	65,744
Indonesia	0	0	3,782,072	0	0	3,782,072	0
Russia	0	0	1,520,292	0	23,158	1,543,450	0
Singapore	33,961	0	0	0	0	33,961	0
South africa	0	0	3,054,726	0	0	3,054,726	0
Ucraina	0	0	0	0	62,813	62,813	0
U.S.A.	2,454,620	0	5,637,279	0	0	8,091,899	1,338,954
Venezuela	0	0	112,617	0	22,028	134,645	20,409
Total non-EU	**4,571,206**	**0**	**17,088,928**	**0**	**107,999**	**21,768,133**	**1,425,107**
Total	**4,571,206**	**796**	**19,664,053**	**4,954**	**108,039**	**24,349,048**	**1,434,551**

Source: MSE, several years [b]

Therefore an attempt was made to find out a methodology allowing for a more precise estimation of the carbon content of this fuel. It is possible, using literature data for the coals and detailed statistical records of international trade, to find out the weighted average of carbon content and of the LHV of the fuel imported to Italy each year. The still unresolved problem is how to properly link statistical data, referred to the coal "as it is" without specifying moisture and ash content of the product, to the literature data, referring to sample coals.

We envisage improving the quality of the collected statistical data including moisture content of coals; currently we overcome this obstacle with the following procedure:

- using an ample set of experimental data on coals imported in a couple of years on an extensive series of samples, more than 200, analysed by ENEL (the main electricity producing company in Italy) it was possible to correlate "as it is" LHV and carbon content to the average properties of the coals imported in the same period of time and calculated from literature data (EMEP/CORINAIR, 2007);
- for each inventory year, it was possible to calculate the weighted average of LHV and carbon content of imported coals using available literature data;
- using this calculated data and the correlation found out, the estimate of carbon content of the average "as it is" coal reported in the statistics was possible.

Using this methodology and the available statistical data, it was possible to trace back to the year 1990 the average LHV of the imported coal and estimate average carbon EF for each year, see Table A6.4 for detailed data. The results do not show impressive changes yearly; anyway a noticeable difference in the emission factor is highlighted in the table. In Table A6.5 updated coal EFs from IPCC 2006 have been also reported. As can be seen, average values for steam coals have been slightly reduced in the updated methodology. National emission factors result in the range given by the old and new average values for "other bituminous coal".

From the 2011 submission, with the aim to improve the estimation of the coal CO_2 emission factors an in depth analysis of data reported in the framework of the European emissions trading scheme has been carried out. In consideration that these data referring to emission factors and activity data are validated and the amount of fuel reported accounts for more than 90% of the national coal fuel consumption, the average coal CO_2 emission factors, resulting from ETS data, have been applied from 2005.

Table A6.5 – Coal, average carbon emission factors

	t CO_2 / TJ (stechiometric)	t CO_2 / TJ	t CO_2 / t	t CO_2 / toe
		(with oxidation factor 0.98)		
Sub bituminous coal, IPCC 1996	98.200	96.234	2.557	4.026
Other Bituminous coal, IPCC 2006, av	94.600			
lower	87.300			
upper	102.500			
National emission factors				
Steam coal, 1990	96.512	94.582	2.502	3.960
Steam coal, 1995	95.926	94.007	2.519	3.936
Steam coal, 2000	93.312	91.446	2.404	3.826
Steam coal, 2001	95.304	93.398	2.434	3.908
Steam coal, 2002	94.727	92.832	2.423	3.884
Steam coal, 2003	95.385	93.478	2.435	3.911
Steam coal, 2004	95.382	93.474	2.430	3.911
Steam coal, 2005	94.403	92.515	2.419	3.871
Steam coal, 2006	94.630	92.737	2.368	3.880
Steam coal, 2007	95.192	93.288	2.386	3.903
Steam coal, 2008	93.775	91.900	2.242	3.845
Steam coal, 2009	93.913	92.035	2.285	3.851
Steam coal, 2010	93.781	91.905	2.290	3.845
Steam coal, 2011	93.526	91.655	2.307	3.835
Steam coal, 2012	93.755	91.885	2.315	3.844

Source: ISPRA elaborations

A6.5 Other fuels

Country specific emission factors have been calculated for other fuels and included in the inventory on account of the analysis of data reported by plants in the framework of the European emissions trading scheme. In consideration that these data referring to emission factors and activity data are validated and the amount of fuels reported accounts for more than 90% of the national fuels consumption, the average CO_2 emission factors have been applied from 2005.
In the following, values of CO_2 emission factors are specified for the different fuels. From 2005, figures result from a weighted average of ETS data; before that period, emission factors derive from literature data or other national data collection.

Table A6.6 – Refinery gas, average carbon emission factors

Refinery gas	t CO_2 / TJ (stechiometric)	t CO_2 / TJ	t CO_2 / t	t CO_2 / toe
		(with oxidation factor 0.995)		
National emission factors				
Refinery gas, 1990-2004	62.392	62.080	3.117	2.597
Refinery gas, 2005	58.255	57.963	2.753	2.425
Refinery gas, 2006	57.173	56.889	2.637	2.380
Refinery gas, 2007	56.985	56.700	2.653	2.372
Refinery gas, 2008	58.187	57.896	2.702	2.422
Refinery gas, 2009	57.625	57.337	2.694	2.399
Refinery gas, 2010	57.622	57.331	2.711	2.399
Refinery gas, 2011	57.485	57.205	2.697	2.393
Refinery gas, 2012	57.306	57.015	2.702	2.386

Source: ISPRA elaborations

Table A6.7 – Coke oven gas, average carbon emission factors

Coke oven gas	$t CO_2 / TJ$ (stechiometric)	$t CO_2 / TJ$	$t CO_2 / 10^3$ std cubic mt	$t CO_2$ / toe
		(with oxidation factor 0.995)		
National emission factors				
Coke oven gas, 1990-1999	47.200	46.964	0.835	1.965
Coke oven gas, 2000-2004	42.111	41.900	0.802	1.753
Coke oven gas, 2005	42.128	41.918	0.750	1.754
Coke oven gas, 2006	42.678	42.465	0.740	1.777
Coke oven gas, 2007	42.416	42.204	0.734	1.766
Coke oven gas, 2008	42.250	42.039	0.730	1.759
Coke oven gas, 2009	42.980	42.765	0.744	1.789
Coke oven gas, 2010	42.816	42.602	0.732	1.782
Coke oven gas, 2011	43.328	43.111	0.743	1.804
Coke oven gas, 2012	43.546	43.329	0.775	1.813

Source: ISPRA elaborations

Table A6.8 – Blast furnace gas, average carbon emission factors

Blast furnace gas	$t CO_2 / TJ$ (stechiometric)	$t CO_2 / TJ$	$t CO_2 / 10^3$ std cubic mt	$t CO_2$ / toe
		(with oxidation factor 0.995)		
National emission factors				
Blast furnace gas, 1990-1999	243.220	242.004	0.780	10.125
Blast furnace gas, 2000-2004	270.575	269.222	0.948	11.264
Blast furnace gas, 2005	263.653	262.334	0.924	10.976
Blast furnace gas, 2006	255.948	254.668	0.897	10.655
Blast furnace gas, 2007	261.469	260.162	0.916	10.885
Blast furnace gas, 2008	256.133	254.852	0.842	10.663
Blast furnace gas, 2009	259.560	258.263	0.854	10.806
Blast furnace gas, 2010	257.390	256.103	0.865	10.715
Blast furnace gas, 2011	255.351	254.074	0.880	10.630
Blast furnace gas, 2012	252.808	251.544	0.888	10.525

Source: ISPRA elaborations

Table A6.9 – Oxygen furnace gas, average carbon emission factors

Oxygen furnace gas	$t\ CO_2$ / TJ (stechiometric)	$t\ CO_2$ / TJ (with oxidation factor 0.995)	$t\ CO_2 / 10^3$ std cubic mt (with oxidation factor 0.995)	$t\ CO_2$ / toe (with oxidation factor 0.995)
National emission factors				
Oxygen furnace gas, 1990-2004	195.086	194.111	1.495	8.122
Oxygen furnace gas, 2005	197.579	196.591	1.514	8.225
Oxygen furnace gas, 2006	202.372	201.360	1.551	8.425
Oxygen furnace gas, 2007	195.871	194.892	1.501	8.154
Oxygen furnace gas, 2008	196.465	195.483	1.273	8.179
Oxygen furnace gas, 2009	196.970	195.986	1.277	8.200
Oxygen furnace gas, 2010	197.029	196.044	1.217	8.202
Oxygen furnace gas, 2011	198.482	197.489	1.165	8.263
Oxygen furnace gas, 2012	198.199	197.208	1.225	8.251

Source: ISPRA elaborations

Table A6.10 – Heavy residual fuels, average carbon emission factors

Heavy residual fuels	$t\ CO_2$ / TJ (stechiometric)	$t\ CO_2$ / TJ (with oxidation factor 0.99)	$t\ CO_2$ / t (with oxidation factor 0.99)	$t\ CO_2$ / toe (with oxidation factor 0.99)
National emission factors				
Heavy residual fuels, 1999-2005	80.317	79.514	3.121	3.327
Heavy residual fuels, 2006	81.817	80.999	3.179	3.389
Heavy residual fuels, 2007	81.823	81.005	3.179	3.389
Heavy residual fuels, 2008	81.823	81.005	3.179	3.389
Heavy residual fuels, 2009	79.319	78.526	3.082	3.286
Heavy residual fuels, 2010	79.259	78.466	3.085	3.283
Heavy residual fuels, 2011	80.421	79.617	3.099	3.331
Heavy residual fuels, 2012	80,167	79,365	3,091	3,321

Source: ISPRA elaborations

Table A6.11 – Synthesis gas, average carbon emission factors

Synthesis gas	$t\ CO_2$ / TJ (stechiometric)	Oxidation factor	$t\ CO_2$ / TJ	$t\ CO_2$ / t	$t\ CO_2$ / toe
National emission factors					
Synthesis gas, 1999-2004	96.800	1.000	96.800	0.895	4.050
Synthesis gas, 2005	98.103	0.994	97.527	0.927	4.080
Synthesis gas, 2006	98.566	0.994	97.958	1.032	4.099
Synthesis gas, 2007	98.321	0.992	97.545	0.899	4.081
Synthesis gas, 2008	98.860	0.992	98.085	0.961	4.104
Synthesis gas, 2009	97.555	0.990	96.579	0.947	4.041
Synthesis gas, 2010	101.930	0.990	100.911	0.902	4.222
Synthesis gas, 2011	100.627	0.990	99.620	0.883	4.168
Synthesis gas, 2012	99.823	0.990	98.825	0.870	4.135

Source: ISPRA elaborations

Table A6.12 – Residual gas of chemical processes, average carbon emission factors

Residual gas of chemical processes	t CO_2 / TJ (stechiometric)	Oxidation factor	t CO_2 / TJ	t CO_2 / t	t CO_2 / toe
National emission factors					
Residuals gas of chem.. processes, 1990-2007	51.500	0.995	51.243	2.276	2.144
Residuals gas of chem.. processes, 2008	51.308	0.995	51.052	2.485	2.136
Residuals gas of chem.. processes, 2009	50.588	0.995	50.342	2.515	2.106
Residuals gas of chem.. processes, 2010	50.425	0.996	50.209	2.527	2.101
Residuals gas of chem.. processes, 2011	50.886	0.995	50.651	2.388	2.119
Residuals gas of chem.. processes, 2012	51.547	0.995	51.309	2.504	2.147

Source: ISPRA elaborations

Table A6.13 – Petroleum coke, average carbon emission factors

Petroleum coke	t CO_2 / TJ (stechiometric)	Oxidation factor	t CO_2 / TJ	t CO_2 / t	t CO_2 / toe
National emission factors					
Petroleum coke, 1990-2004	100.762	0.990	99.755	3.464	4.174
Petroleum coke, 2005	92.955	0.998	92.787	3.169	3.882
Petroleum coke, 2006	93.290	0.998	93.118	3.192	3.896
Petroleum coke, 2007	93.428	0.998	93.244	3.188	3.901
Petroleum coke, 2008	93.531	0.998	93.351	3.200	3.906
Petroleum coke, 2009	93.722	0.991	92.881	3.177	3.886
Petroleum coke, 2010	94.023	0.990	93.104	3.199	3.895
Petroleum coke, 2011	94.079	0.997	93.770	3.221	3.923
Petroleum coke, 2012	94.104	0.997	93.802	3.221	3.925

Source: ISPRA elaborations

ANNEX 7: AGRICULTURE SECTOR

Additional information used for estimating categories 4A and 4B from the agriculture sector is reported in this section.

A7.1 Enteric fermentation (4A)

The time series of the parameters used for estimating the Dairy Cattle EF using the Tier 2 approach, are reported in Table A.7.1. Information on the equations used for estimating the different net energy (NE_m, NE_g, etc.) is described in IPCC Good Practice (IPCC, 2000).

Table A.7.1 Parameters used for the Tier 2 approach - dairy cattle

	NE_m (MJ/day)	NE_a (MJ/day)	NE_g (MJ/day)	NE_l (MJ/day)	NE_w (MJ/day)	NE_p (MJ/day)	NE_{ma}/DE	NE_{ga}/DE	GE (MJ/day)
1990	40.75	0.35	0.99	33.52	0.00	3.97	0.51	0.31	**240.23**
1991	40.75	0.35	0.99	37.71	0.00	3.96	0.51	0.31	**252.77**
1992	40.75	0.35	0.99	40.42	0.00	3.91	0.51	0.31	**260.76**
1993	40.75	0.35	0.99	40.25	0.00	3.89	0.51	0.31	**260.17**
1994	40.75	0.35	0.99	42.53	0.00	3.92	0.51	0.31	**267.10**
1995	40.75	0.35	0.99	43.38	0.00	3.86	0.51	0.31	**269.45**
1996	40.75	0.35	0.99	45.11	0.00	3.86	0.51	0.31	**274.63**
1997	40.75	0.35	0.99	45.46	0.00	3.85	0.51	0.31	**275.65**
1998	40.75	0.35	0.99	45.25	0.00	3.79	0.51	0.31	**274.86**
1999	40.75	0.35	0.99	45.17	0.00	3.75	0.51	0.31	**274.47**
2000	40.75	0.35	0.99	44.31	0.00	3.78	0.51	0.31	**271.99**
2001	40.75	0.35	0.99	43.74	0.00	3.73	0.51	0.31	**270.14**
2002	40.75	0.35	0.99	47.60	0.00	3.72	0.51	0.31	**281.66**
2003	40.75	0.35	0.99	47.57	0.00	3.72	0.51	0.31	**281.56**
2004	40.75	0.35	0.99	49.68	0.00	3.66	0.51	0.31	**287.72**
2005	40.75	0.35	0.99	50.84	0.00	3.71	0.51	0.31	**291.34**
2006	40.75	0.35	0.99	51.17	0.00	3.67	0.51	0.31	**292.23**
2007	40.75	0.35	0.99	51.15	0.00	3.65	0.51	0.31	**292.09**
2008	40.75	0.35	0.99	52.43	0.00	3.65	0.51	0.31	**295.94**
2009	40.75	0.35	0.99	51.00	0.00	3.67	0.51	0.31	**291.71**
2010	40.75	0.35	0.99	55.30	0.00	3.67	0.51	0.31	**304.57**
2011	40.75	0.35	0.99	54.66	0.00	3.68	0.51	0.31	**302.70**
2012	40.75	0.35	0.99	52.31	0.00	3.62	0.51	0.31	**295.48**

Source: ISPRA elaborations

A7.2 Manure management (4B)

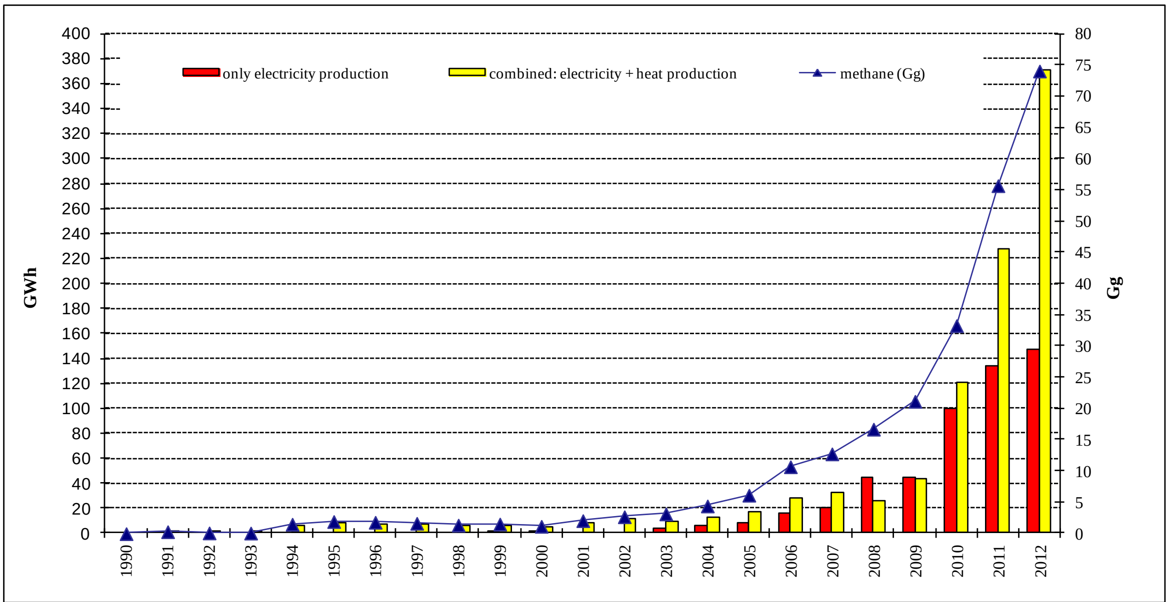
In this section the time series used to apply the methane emission reduction to the 4B Manure management category from the agriculture sector are reported. The source of information is the National Electric Network (TERNA, several years). The total gross production of biogas produced from animal manure is used for the production of electricity and combined (electricity and heat) production. The conversion of this information (GWh) into metane (Gg) has assumed a 30% yield and a net caloric value of 50.038 Gg/TJ. From 2010 a higher efficiency and a higher net calorific value was assumed.

A representation of the time series is presented in the following Table A.7.2 and Figure A.7.1.

Table A.7.2 Time series of gross production of biogas from animal manure

Year	BIOGAS			Methane (Gg)
	Only for electricity production (GWh)	Combined: for electricity + heat production (GWh)	TOTAL Gross production (GWh)	
1990	0	0	0.0	0.00
1991	0	1.3	1.3	0.31
1992	0	0.5	0.5	0.12
1993	0	0.4	0.4	0.10
1994	0	6.3	6.3	1.51
1995	0	8.1	8.1	1.94
1996	0	7.6	7.6	1.82
1997	0	6.9	6.9	1.65
1998	0	5.7	5.7	1.37
1999	0.8	5.6	6.4	1.53
2000	0.2	4.7	4.9	1.18
2001	0	8.7	8.7	2.09
2002	0	11.3	11.3	2.71
2003	3.5	9.7	13.2	3.17
2004	6.3	12.2	18.5	4.44
2005	8.8	16.9	25.7	6.16
2006	16.2	28.5	44.7	10.72
2007	20.9	32.4	53.3	12.78
2008	44.3	25.5	69.8	16.74
2009	44.3	44.1	88.4	21.20
2010	100.3	120.7	221.0	33.33
2011	133.8	227.8	361.6	55.76
2012	147.4	371.2	518.6	74.12

Source: ISPRA elaborations on TERNA data



Source: ISPRA elaborations

Figure A7.1 Time series of gross production of biogas from animal manure

In Table A.7.3 the percentages of animals in temperate zone based on data from the FSS 2005, provided by ISTAT, and the average temperature at provincial level are shown.

A7.3 Agricultural soils (4D)

In Table A.7.4 parameters used for estimating direct and indirect N_2O emissions from sewage sludge applied to soils are presented.

Table A.7.4 Time series of sewage sludge activity data

Year	**Total amount sewage sludge for agriculture** (t dry matter)	N content (%)	N sewage sludge (t)
1990	98,164	5.2	5,071
1991	102,840	5.2	5,313
1992	94,675	5.2	4,891
1993	90,039	5.2	4,652
1994	127,505	5.2	6,587
1995	157,512	5.2	8,137
1996	174,505	5.2	9,015
1997	217,747	5.2	11,249
1998	194,314	5.3	10,292
1999	215,024	5.2	11,104
2000	217,424	5.0	10,954
2001	293,253	5.5	16,076
2002	302,112	5.1	15,339
2003	297,861	4.9	14,648
2004	195,161	4.1	8,055
2005	215,742	4.1	8,874
2006	189,555	4.1	7,778
2007	202,098	4.1	8,305
2008	194,666	4.5	8,841
2009	289,620	3.9	11,365
2010	248,215	4.0	10,040
2011	299,159	3.7	11,119
2012	274,095	4.7	12,864

Source: ISPRA elaborations from MATTM (MATTM, 2014)

In tables A.7.5-8, the cultivated surface, crops production, residues production and parameters used for emission calculation of nitrogen input from crop residues (FCR) for each type of crop are shown, respectively.

Table A.7.5 Cultivated surfaces for the estimation of crop residues

Cultivated surfaces (ha)	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Sorghum	23,676	34,417	33,900	31,578	38,745	34,046	38,580	39,919	40,311	42,335	37,099
Asparagus	6,046	6,520	5,516	6,442	6,374	6,588	5,615	6,599	6,359	6,347	6,010
Salad	48,725	49,288	51,219	50,010	50,465	48,703	45,224	48,136	47,371	45,838	43,358
Spinach	7,573	7,959	6,992	7,367	6,993	6,649	7,179	6,305	6,406	6,810	4,862
Cauliflower	19,405	23,991	24,827	18,150	18,082	18,352	17,922	17,320	17,867	16,990	17,098
Pumpkin and zucchini	13,253	13,490	14,621	16,736	17,328	17,026	16,582	16,486	17,354	18,071	16,955
Cucumber	4,373	3,814	2,048	2,331	2,342	2,138	2,054	2,271	2,219	2,420	2,130
Eggplant	10,574	10,334	12,355	12,169	11,699	12,991	11,307	10,641	10,816	11,063	9,770
Pepper and chili	14,864	13,099	14,489	13,787	13,371	15,220	11,903	11,689	11,881	12,882	11,358
Onion	17,453	15,725	14,562	12,281	12,819	12,959	13,045	12,671	12,603	13,004	10,749
Garlic	4,707	4,070	3,677	3,163	3,071	3,141	2,937	2,954	2,966	3,124	2,980
Bean,freshseed	29,096	23,943	23,448	23,146	22,017	22,130	21,041	20,108	19,027	20,292	17,256
Bean,dryseed	23,002	14,462	11,046	8,755	8,179	6,923	5,972	6,290	7,001	6,235	6,154
Broadbean,freshseed	16,564	14,180	11,998	9,484	9,694	9,792	9,547	8,563	8,487	7,440	6,515
Broadbean,dryseed	104,045	63,257	47,841	48,507	44,617	49,972	54,310	49,784	52,108	43,477	46,130
Pea,freshseed	28,192	21,582	11,403	11,636	12,589	11,805	12,854	15,295	8,691	24,026	15,283
Pea,dryseed	10,127	6,625	4,498	11,134	13,625	12,957	10,690	10,751	11,692	10,770	9,861
Chickpea	4,624	3,023	3,996	5,256	5,188	5,299	5,265	5,929	6,813	5,830	7,928
Lentil	1,048	1,038	1,016	1,786	1,738	1,806	1,821	1,868	2,458	2,156	2,629
Tare	5,768	6,532	6,500	6,500	6,500	6,500	6,500	6,500	6,500	6,500	6,500
Lupin	3,303	3,070	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Soyabean	521,169	195,191	256,647	152,331	176,134	130,335	107,795	134,704	159,511	165,955	152,993
Alfalfa	987,000	823,834	810,866	779,430	766,316	746,131	712,674	720,382	745,128	728,034	599,031
Clovergrass	224,087	125,009	114,844	103,677	101,499	98,772	98,601	100,484	102,691	101,819	86,976
Total	**2,128,674**	**1,484,453**	**1,491,308**	**1,338,656**	**1,352,385**	**1,283,235**	**1,222,418**	**1,258,650**	**1,309,260**	**1,304,417**	**1,122,625**

Table A.7.6 Crops production for the estimation of crop residues

Crops production (t)	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Wheat	8,108,500	7,946,081	7,427,660	7,717,129	7,181,720	7,170,181	8,859,410	6,534,748	6,849,858	6,641,807	7,654,248
Rice	1,290,700	1,320,851	1,245,555	1,444,818	1,449,973	1,540,097	1,332,974	1,644,135	1,564,377	1,555,893	1,594,476
Barley	1,702,500	1,387,069	1,261,560	1,214,054	1,297,395	1,225,282	1,236,711	1,049,200	944,257	950,934	940,234
Maize, stalks	5,863,900	8,454,198	10,139,639	10,427,930	9,626,373	9,809,265	9,722,910	8,142,974	8,495,946	9,752,373	7,888,668
Maize, cobs	5,863,900	8,454,198	10,139,639	10,427,930	9,626,373	9,809,265	9,722,910	8,142,974	8,495,946	9,752,373	7,888,668
Rye	20,800	19,780	10,292	7,876	8,590	8,954	10,756	12,204	13,926	14,381	16,083
Oats	298,400	301,322	317,926	429,153	394,866	361,148	356,094	314,421	288,880	297,079	292,357
Triticum	10,480	13,210	0	0	0	0	0	0	0	0	

Crops production (t)	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Potatoes	2,308,700	2,080,896	2,053,043	1,755,686	1,784,704	1,781,648	1,737,986	1,753,218	1,558,030	1,557,489	1,486,292
Sweet potatoes	11,300	14,273	14,496	20,251	20,507	7,981	8,158	7,771	8,681	10,195	4,959
Sugar beet	11,768,400	13,188,317	11,569,182	14,155,683	4,769,614	4,664,243	3,520,855	3,307,681	3,549,871	2,501,159	2,492,466
Sunflower	403,500	533,581	460,714	289,365	308,038	277,424	260,927	199,997	212,900	274,520	185,494
Cabbage	491,600	450,687	482,147	478,972	467,834	465,683	484,412	484,229	502,955	485,725	474,539
Artichoke	487,000	517,229	512,946	469,975	468,964	474,283	483,561	486,595	480,112	474,550	364,871
Tomato	5,469,068	5,172,611	7,487,358	7,187,014	6,365,661	6,530,162	5,982,137	6,878,161	6,026,766	6,478,837	5,592,302
Soyabean	1,750,500	732,448	908,290	553,002	544,919	408,491	346,245	468,228	552,454	564,638	422,130
Alfalfa	30,094,610	27,858,100	25,662,700	25,924,100	24,742,900	23,479,600	22,596,500	21,246,200	21,928,700	20,833,200	15,142,100
Clovergrass	6,304,100	2,899,100	2,397,800	2,203,300	2,128,100	1,875,100	1,853,100	1,891,900	1,982,500	1,955,700	1,511,700
Total	**82,247,958**	**81,343,949**	**82,090,948**	**84,706,239**	**71,186,530**	**69,888,807**	**68,515,647**	**62,564,634**	**63,456,159**	**64,100,854**	**53,951,586**

Table A.7.7 Crops production for the estimation of crop residues

Residues production (t dry matter)	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Wheat	4,755,635	4,660,377	4,356,323	4,526,096	4,212,079	4,205,311	5,196,044	3,832,629	4,017,442	3,895,420	4,489,217
Rice	648,577	663,728	625,891	726,021	728,611	773,899	669,819	826,178	786,099	781,836	801,224
Barley	1,157,700	943,207	857,860	825,557	882,228	833,192	840,963	713,456	642,095	646,635	639,359
Maize, stalks	3,049,228	4,396,183	5,272,612	5,422,524	5,005,714	5,100,818	5,055,913	4,234,347	4,417,892	5,071,234	4,102,107
Maize, cobs	586,390	845,420	1,013,964	1,042,793	962,637	980,927	972,291	814,297	849,595	975,237	788,867
Rye	12,376	11,769	6,124	4,686	5,111	5,328	6,400	7,261	8,286	8,557	9,570
Oats	177,548	179,287	189,166	255,346	234,945	214,883	211,876	187,080	171,884	176,762	173,952
Sorghum	59,190	86,043	84,750	78,945	96,863	85,115	96,450	99,798	100,778	105,838	92,748
Triticum	7,126	8,983	0	0	0	0	0	0	0	0	0
Potatoes	369,392	332,943	328,487	280,910	285,553	285,064	278,078	280,515	249,285	249,198	237,807
Sweet potatoes	1,808	2,284	2,319	3,240	3,281	1,277	1,305	1,243	1,389	1,631	793
Sugar beet	823,788	923,182	809,843	990,898	333,873	326,497	246,460	231,538	248,491	175,081	174,473
Sunflower	484,200	640,297	552,857	347,238	369,645	332,909	313,112	239,997	255,480	329,424	222,593
Cabbage	184,350	169,008	180,805	179,615	175,438	174,631	181,655	181,586	188,608	182,147	177,952
Artichoke	182,625	193,961	192,355	176,241	175,862	177,856	181,336	182,473	180,042	177,956	136,827
Asparagus	16,929	18,256	15,444	18,038	17,847	18,447	15,721	18,477	17,805	17,771	16,828
Salad	165,665	167,579	174,144	170,035	171,581	165,591	153,761	163,663	161,060	155,849	147,416
Spinach	25,748	27,061	23,774	25,049	23,778	22,607	24,410	21,438	21,781	23,155	16,531
Tomato	246,108	232,767	336,931	323,416	286,455	293,857	269,196	309,517	271,204	291,548	251,654
Cauliflower	73,739	91,166	94,343	68,970	68,712	69,738	68,104	65,816	67,895	64,562	64,972
Pumpkin and zucchini	125,904	128,155	138,898	158,987	164,617	161,748	157,529	156,619	164,863	171,672	161,075
Cucumber	37,171	32,419	17,405	19,813	19,904	18,174	17,457	19,303	18,865	20,569	18,104
Eggplant	100,453	98,173	117,371	115,602	111,139	123,414	107,420	101,088	102,751	105,100	92,814

Residues production (t dry matter)	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Pepper and chili	141,208	124,441	137,648	130,975	127,021	144,589	113,079	111,042	112,871	122,376	107,902
Onion	12,217	11,008	10,193	8,597	8,973	9,071	9,132	8,870	8,822	9,103	7,524
Garlic	3,295	2,849	2,574	2,214	2,150	2,199	2,056	2,068	2,076	2,187	2,086
Bean,freshseed	103,000	84,758	83,004	81,936	77,942	78,338	74,486	71,183	67,354	71,832	61,086
Bean,dryseed	39,690	24,954	19,060	15,107	14,113	11,946	10,305	10,853	12,080	10,758	10,619
Broadbean,freshseed	58,637	50,197	42,473	33,573	34,317	34,664	33,796	30,313	30,044	26,338	23,063
Broadbean,dryseed	179,530	109,150	82,550	83,699	76,987	86,227	93,712	85,902	89,912	75,020	79,597
Pea,freshseed	99,800	76,400	40,366	41,193	44,566	41,788	45,503	54,145	30,766	85,051	54,101
Pea,dryseed	17,474	11,431	7,761	19,212	23,510	22,357	18,446	18,551	20,175	18,584	17,015
Chickpea	7,979	5,216	6,895	9,069	8,952	9,143	9,085	10,230	11,756	10,060	13,680
Lentil	1,808	1,791	1,753	3,082	2,999	3,116	3,142	3,223	4,241	3,720	4,536
Tare	9,953	11,271	11,216	11,216	11,216	11,216	11,216	11,216	11,216	11,216	11,216
Lupin	5,699	5,297	5,177	5,177	5,177	5,177	5,177	5,177	5,177	5,177	5,177
Soyabean	1,287,287	482,122	633,918	376,258	435,051	321,927	266,254	332,719	393,992	409,909	377,893
Alfalfa	4,514,192	4,178,715	3,849,405	3,888,615	3,711,435	3,521,940	3,389,475	3,186,930	3,289,305	3,124,980	2,271,315
Clovergrass	945,615	434,865	359,670	330,495	319,215	281,265	277,965	283,785	297,375	293,355	226,755
Total	**20,719,032**	**20,466,710**	**20,685,330**	**20,800,434**	**19,239,493**	**18,956,246**	**19,428,127**	**16,914,528**	**17,330,750**	**17,906,847**	**16,090,448**

Table A.7.8 Parameters used for emission of nitrogen input from crop residues (FCR)

Crops	Residues/Crop product mass ratio (1)	Residues/Crop surface (t/ha) (2)	Dry matter content (%) (1)	Reincorporated fraction (%) (3)	Protein content in dry matter (%) (1)	Nitrogen content in dry matter (%) (3)
Wheat	0.69		85	0.9	0.03	0.0048
Rice	0.67		75	0.5	0.045	0.0072
Barley	0.8		85	0.9	0.04	0.0064
Maize, stalks	1.3		40	0.9	0.045	0.0072
Maize, cobs	0.2		50	0.9	0.035	0.0056
Rye	0.7		85	0.9	0.04	0.0064
Oats	0.7		85	0.9	0.04	0.0064
Sorghum		2.5		0.9	0.045	0.0072
Triticum	0.8		85	0.9	0.04	0.0064
Potatoes	0.4		40	0.9	0.09	0.0144
Sweet potatoes	0.4		40	0.9	0.09	0.0144
Sugar beet	0.35		20	0.9	0.125	0.02
Sunflower	2		60	0.9	0.025	0.004
Cabbage	2.5		15	0.9	0.175	0.028
Artichoke	2.5		15	0.9	0.135	0.0216

Crops	Residues/Crop product mass ratio (1)	Residues/Crop surface (t/ha) (2)	Dry matter content (%) (1)	Reincorporated fraction (%) (3)	Protein content in dry matter (%) (1)	Nitrogen content in dry matter (%) (3)
Asparagus		2.8		0.9	0.09375	0.015
Salad		3.4		0.9	0.09375	0.015
Spinach		3.4		0.9	0.09375	0.015
Tomato	0.3		15	0.9	0.08	0.0128
Cauliflower		3.8		0.9	0.09375	0.015
Pumpkin and zucchini		9.5		0.9	0.09375	0.015
Cucumber		8.5		0.9	0.09375	0.015
Eggplant		9.5		0.9	0.09375	0.015
Pepper and chili		9.5		0.9	0.09375	0.015
Onion		0.7		0.9	0.09375	0.015
Garlic		0.7		0.9	0.09375	0.015
Bean,freshseed		17.7	20	0.9	0.125	0.02
Bean,dryseed		2.03	85	0.9	0.1	0.016
Broadbean,freshseed		17.7	20	0.9	0.125	0.02
Broadbean,dryseed		2.03	85	0.9	0.1	0.016
Pea,freshseed		17.7	20	0.9	0.125	0.02
Pea,dryseed		2.03	85	0.9	0.1	0.016
Chickpea		2.03	85	0.9	0.1	0.016
Lentil		2.03	85	0.9	0.1	0.016
Tare		2.03	85	0.9	0.1	0.016
Lupin		2.03	85	0.9	0.1	0.016
Soyabean		5.2	47.5	0.9	0.075	0.012
Alfalfa			15	0.2	0.16875	0.027
Clovergrass			15	0.2	0.16875	0.027

(1) CESTAAT, 1988; (2) CRPA/CNR, 1992; (3) See paragraph Crop residues (FCR) and references in the box containing data used for estimating field burning of agriculture residues emission

Table A.7.3 Distribution of animals in temperate zone

Percentage of animals in temperate zone based on data from the FSS 2005 (ISTAT)	Average temperature	Average temperature weighted by % animals for different altitudes (plain, hill, mountain)	Non-dairy cattle	Dairy cattle	Buffalo	Other swine	Sows	Sheep	Goats	Horses	Mules and asses	Broilers	hen	other poultry	Rabbits
(001) Torino	11.4	11.4	185,441	60,950	137	141,054	9,422	11,842	5,399	16,626	285	1,384,201	605,549	121,305	476,111
(002) Vercelli	11.4	11.4	6,139	3,361	0	19,044	3,023	4,530	2,747	378	177	240,844	90	367,320	38,487
(003) Novara	11.7	11.8	11,634	11,941	659	36,837	4,066	442	1,464	2,024	0	163,436	135,522	26,764	206,579
(004) Cuneo	11.4	11.5	360,266	79,864	0	731,302	51,882	24,890	7,375	353	7	1,906,594	513,460	794,541	1,533,321
(005) Asti	11.7	11.9	44,507	965	0	16,147	1,305	2,118	3,771	2,531	83	517,799	407,027	34,957	144,573
(006) Alessandria	11.5	11.6	37,346	3,671	0	24,322	1,120	3,109	3,929	277	80	73,144	216,432	360,226	43,049
(007) Aosta	11.5	11.6	17,379	22,332	0	26	0	2,586	3,339	116	32	9	2,602	98	1,832
(008) Imperia	11.1	11.1	2,372	353	0	3	0	843	2,686	53	0	26	557	4	7,288
(009) Savona	12.7	13.2	4,030	58	0	107	0	16,799	450	154	8	5,370	19,638	156	84,045
(010) Genova	12.4	12.9	5,357	1,551	0	134	39	4,984	3,266	2,844	149	12,259	46,343	5,251	29,698
(011) La Spezia	12.2	12.7	3,063	591	0	184	11	2,627	978	654	36	5,012	12,435	1,077	43,258
(012) Varese	11.4	11.5	13,632	5,249	7	2,161	88	5,275	2,655	3,128	465	50,165	344,100	175,959	22,252
(013) Como	12.1	12.4	11,270	7,743	2	844	178	5,475	9,227	3,616	591	135,711	29,395	13,744	88,340
(014) Sondrio	12.3	12.6	9,318	15,448	0	835	13	7,028	12,890	654	503	679,686	58,918	24	293
(015) Milano	12.2	12.5	62,266	36,960	1,782	105,264	7,399	2,833	1,551	2,431	122	97,755	710,011	59,622	5,330
(016) Bergamo	11.9	12.0	112,201	69,614	643	301,455	30,604	28,808	14,355	9,783	753	1,475,925	1,529,460	516,977	5,959
(017) Brescia	12.1	12.3	342,654	148,660	859	1,325,421	107,005	40,160	10,360	6,638	12	14,969,749	3,551,027	2,087,292	78,676
(018) Pavia	11.8	12.0	20,446	9,054	0	239,372	15,395	0	2,045	640	23	2,104	174,942	215,736	0
(019) Cremona	12.1	12.3	165,913	115,308	676	619,897	70,275	2,299	65	1,255	18	2,799,928	1,541,962	1,641,787	6,804
(020) Mantova	12.1	12.4	265,591	109,883	0	1,055,515	60,972	0	870	683	87	1,182,334	5,613,807	817,826	17,568
(021) Bolzano-Bozen	11.7	11.8	67,713	83,892	0	13,775	311	50,645	19,508	6,354	428	85	139,010	2,096	40,398
(022) Trento	10.8	11.3	17,303	29,737	0	7,205	171	29,731	9,778	3,313	571	1,182,144	397,493	34,367	174,295
(023) Verona	11.2	11.8	190,794	35,635	0	308,473	11,067	56	177	9,441	0	16,208,619	4,569,421	11,982,064	3,443,690

Percentage of animals in temperate zone based on data from the FSS 2005 (ISTAT)	Average temperature	Average temperature weighted by % animals for different altitudes (plain, hill, mountain)	Non-dairy cattle	Dairy cattle	Buffalo	Other swine	Sows	Sheep	Goats	Horses	Mules and asses	Broilers	hen	other poultry	Rabbits
(024) Vicenza	10.6	11.3	125,108	55,512	17	40,793	2,005	5,790	456	1,482	525	3,768,250	462,832	802,257	196,126
(025) Belluno	10.6	11.3	7,385	5,953	0	51,281	10,121	3,693	840	1,578	525	2,673	163	3,312	84,823
(026) Treviso	10.7	11.3	155,378	23,915	1,260	90,117	13,957	1	149	293	2	2,551,739	1,784,328	123,347	2,367,946
(027) Venezia	10.9	11.5	50,470	10,028	366	64,423	4,807	0	1,291	1,784	48	766,865	2,518,034	409,170	17,047
(028) Padova	10.7	11.3	157,703	35,518	916	116,291	12,043	3,763	86	3,291	41	1,988,851	1,801,912	1,194,511	3,613,169
(029) Rovigo	10.6	11.2	42,008	3,964	0	63,709	6,297	1,633	427	805	648	529,387	117,033	586,075	12,874
(030) Udine	10.8	11.4	28,891	32,597	0	61,905	2,591	2,065	1,821	1,717	202	2,801,700	5,597	284,658	871,719
(031) Gorizia	10.9	11.5	3,379	3,626	0	26,850	0	0	0	107	0	248,250	131,708	924,779	69,399
(032) Trieste	10.9	11.6	598	201	0	1,395	0	0	0	0	0	8,303	6,894	9,909	3,825
(033) Piacenza	10.7	11.2	46,684	31,700	13	73,967	4,598	44	8	2,589	273	84,174	173,053	0	153
(034) Parma	10.8	11.4	68,174	99,234	0	143,740	9,496	20	91	4,681	33	89,323	43,864	314	8,811
(035) Reggio nell'Emilia	10.8	11.4	66,270	79,949	247	458,294	21,186	607	725	3,827	243	361,411	76,942	42,922	3,023
(036) Modena	11.9	12.1	67,416	60,029	0	406,547	41,590	64	208	2,533	120	87,552	214,697	113,066	631,984
(037) Bologna	11.6	11.8	20,526	8,482	0	41,449	3,503	12,056	236	9,883	163	47,197	1,276,246	122,438	0
(038) Ferrara	11.7	12.0	45,143	10,999	0	23,212	3,623	0	98	4,385	91	0	102,049	57,109	7,138
(039) Ravenna	11.7	12.0	13,141	3,179	0	43,760	3,106	14,092	682	3,522	764	698,792	2,308,670	3,301,798	379,957
(040) Forli'-Cesena	11.8	12.1	18,275	2,382	1	93,476	15,742	26,716	1,127	3,380	12	16,350,182	7,581,497	7,795,705	243,449
(041) Pesaro e Urbino	12.4	12.7	30,155	2,429	0	12,423	623	100,473	1,654	3,286	64	39,984	311,955	51,308	298,142
(042) Ancona	12.0	12.3	9,137	1,141	0	14,308	1,415	11,661	486	137	25	1,382,625	67,488	19,237	108,960
(043) Macerata	13.0	13.3	13,794	1,378	0	9,894	738	46,279	903	589	102	1,167,510	67	0	375,329
(044) Ascoli Piceno	13.3	13.8	20,587	288	0	77,063	1,228	76,380	4,166	3,286	507	1,060,249	2,310,685	4,027	164,214
(045) Massa-Carrara	12.4	12.6	4,167	926	57	3,480	263	11,899	855	2,752	386	14,659	21,813	931	54,446
(046) Lucca	12.3	12.9	3,560	988	0	847	6	16,156	289	262	0	33,688	53,335	958	39,418
(047) Pistoia	12.5	13.2	8,092	86	0	673	38	5,605	388	4,210	804	0	516	0	1,645

Percentage of animals in temperate zone based on data from the FSS 2005 (ISTAT)	Average temperature	Average temperature weighted by % animals for different altitudes (plain, hill, mountain)	Non-dairy cattle	Dairy cattle	Buffalo	Other swine	Sows	Sheep	Goats	Horses	Mules and asses	Broilers	hen	other poultry	Rabbits
(048) Firenze	12.0	12.8	13,514	3,265	0	36,506	1,557	31,180	1,899	3,729	678	101,134	48,525	135,053	29,539
(049) Livorno	12.9	13.7	1,999	459	0	273	153	11,793	133	1,723	175	980	3,449	59,521	7,174
(050) Pisa	12.2	12.9	9,570	1,548	0	31,749	5,708	54,005	869	1,172	335	8,725	246,875	1,619	3,208
(051) Arezzo	12.2	12.7	9,710	246	22	76,399	8,336	33,407	3,649	1,144	491	187,271	105,848	1,436	283,164
(052) Siena	12.8	13.0	19,327	1,026	0	25,569	3,053	144,022	788	693	311	3,574	285,186	7,576	41,695
(053) Grosseto	13.8	14.0	24,968	5,363	395	30,962	2,853	375,071	1,617	7,262	241	6,741	16,471	8,498	68,160
(054) Perugia	13.2	13.3	41,054	11,904	0	223,062	4,769	145,178	6,516	7,151	251	2,786,387	1,035,490	310,913	146,088
(055) Terni	14.0	14.4	14,305	1,268	0	16,236	1,279	34,266	780	3,671	286	312,851	71,851	0	170,015
(056) Viterbo	14.0	14.1	21,859	10,870	921	14,188	1,027	290,585	415	2,287	641	509,739	124,450	80,398	238,483
(057) Rieti	14.0	14.1	26,425	7,172	868	3,744	204	92,899	4,755	9,425	861	362,698	126,234	1,552	51,895
(058) Roma	14.3	14.6	50,058	30,440	178	7,339	60	136,543	1,068	9,081	847	352,347	4,391	411	74,045
(059) Latina	14.6	15.0	37,987	31,533	28,647	13,181	96	62,152	20,800	2,925	509	39,081	292,776	1,160	632,981
(060) Frosinone	14.0	14.0	38,070	12,196	9,745	11,437	140	83,099	4,415	3,602	318	53,017	53,417	1,036	61,351
(061) Caserta	14.6	14.8	27,251	23,498	94,898	14,949	861	31,420	393	206	115	129,455	487,659	4,417	113,682
(062) Benevento	14.6	14.8	34,280	11,568	486	27,936	7,221	84,341	7,127	755	1,581	2,272,767	14,875	2,544	63,136
(063) Napoli	15.0	15.4	3,224	2,032	49	3,245	180	55	3,886	10	65	111,888	327,038	262,730	2,960
(064) Avellino	15.0	15.4	23,552	7,994	0	7,708	78	68,246	4,530	993	473	106,903	210,764	9,201	150,075
(065) Salerno	14.9	15.2	50,412	36,366	55,014	41,469	1,763	112,374	38,780	3,231	1,189	93,292	106,829	7,965	88,775
(066) L'Aquila	12.2	13.5	12,215	4,450	0	14,687	807	104,169	1,516	11,451	833	2,537	65,951	583	151,727
(067) Teramo	11.8	13.2	26,091	12,463	0	26,659	2,743	157,028	1,411	2,608	73	182,779	77,359	218,748	50,584
(068) Pescara	11.1	12.2	12,430	4,218	0	12,178	737	49,259	191	152	136	201,951	54,764	163	121,929
(069) Chieti	11.4	12.6	21,034	3,141	0	13,904	1,146	23,913	1,610	1,567	285	968,714	96,927	11,236	65,367
(070) Campobasso	13.9	14.3	18,793	13,149	229	27,232	1,345	60,164	3,301	1,482	29	7,067,027	144,105	923	3,226
(071) Foggia	13.6	14.1	27,297	6,128	4,543	10,279	61	100,938	23,540	2,851	1,403	699,034	14,783	102	6,242

Percentage of animals in temperate zone based on data from the FSS 2005 (ISTAT)	Average temperature	Average temperature weighted by % animals for different altitudes (plain, hill, mountain)	Non-dairy cattle	Dairy cattle	Buffalo	Other swine	Sows	Sheep	Goats	Horses	Mules and asses	Broilers	hen	other poultry	Rabbits
(072) Bari	13.7	14.2	35,866	31,546	199	5,149	752	64,117	3,937	3,065	32	4,673	306,370	1,409	117,228
(073) Taranto	13.9	14.5	22,345	25,796	0	12,844	178	24,980	6,611	3,611	93	1,163	211,415	60,027	80,720
(074) Brindisi	14.0	14.6	2,156	7,166	0	559	40	6,321	5,116	531	57	1,097	324,767	300	34,077
(075) Lecce	13.4	13.8	3,546	2,251	0	503	235	27,399	6,805	552	24	14	165,333	13	238
(076) Potenza	13.1	13.5	65,499	25,430	99	56,040	1,998	404,287	77,440	4,746	581	72,778	44,609	2,889	512,259
(077) Matera	13.5	13.8	15,452	9,590	515	7,642	293	102,658	37,197	2,988	103	3,752	74,191	5,249	314,349
(078) Cosenza	14.8	15.5	35,907	5,883	82	44,360	2,064	170,629	84,350	3,003	227	145,554	160,280	2,669	98,547
(079) Catanzaro	14.1	14.9	4,183	920	0	6,377	343	24,168	7,030	38	0	622	9,367	0	475
(080) Reggio di Calabria	14.5	15.5	19,585	1,807	0	14,070	1,037	50,802	38,585	253	0	13,029	48,974	253	40,978
(081) Trapani	14.4	15.3	3,430	888	0	186	69	57,240	1,065	3,544	73	129	31,954	34	3,647
(082) Palermo	14.5	15.4	46,032	4,790	0	2,679	875	132,035	12,444	1,562	63	32	316,059	0	290
(083) Messina	14.6	15.5	65,155	2,062	0	13,432	1,005	93,336	52,551	6,483	1,776	102	376,100	106	0
(084) Agrigento	14.4	15.2	3,567	1,073	0	2,436	237	46,636	1,332	19	20	0	26,829	0	35,568
(085) Caltanissetta	14.3	15.1	5,459	1,216	0	116	28	48,617	1,889	332	30	0	76,878	0	0
(086) Enna	15.0	15.6	48,664	1,489	0	4,227	440	110,030	5,190	594	172	5	65,692	0	0
(087) Catania	15.7	16.3	17,120	2,856	0	311	110	38,035	2,502	1,389	5	16	241,512	212	16,676
(088) Ragusa	15.7	16.3	49,505	26,664	0	4,967	315	18,496	0	903	90	392,370	721,491	0	561
(089) Siracusa	16.0	16.7	57,381	8,293	71	16,803	35	75,830	6,523	1,098	426	242,604	654,764	0	30,031
(090) Sassari	14.1	14.6	117,502	2,374	0	31,935	14,538	1,217,792	30,994	5,935	1,098	0	100,557	0	140,560
(091) Nuoro	15.0	15.4	64,036	5,800	0	35,439	13,568	918,328	85,029	10,951	687	42,136	211,093	282,830	272,447
(092) Cagliari	14.4	14.6	16,639	1,074	0	82,024	23,342	819,856	156,043	2,633	856	67,976	681,328	920,414	464
(093) Pordenone	11.3	11.3	26,760	14,452	0	147,435	40,071	997	0	665	10	1,303,096	262,413	138,240	78,768
(094) Isernia	11.5	11.4	16,093	7,221	131	11,785	174	45,531	3,122	1,008	35	641,701	1,511	0	14,747
(095) Oristano	11.5	11.4	37,907	24,089	0	11,760	7,127	455,419	10,775	3,026	556	14,240	6,134	767	25,286

Percentage of animals in temperate zone based on data from the FSS 2005 (ISTAT)	Average temperature	Average temperature weighted by % animals for different altitudes (plain, hill, mountain)	Non-dairy cattle	Dairy cattle	Buffalo	Other swine	Sows	Sheep	Goats	Horses	Mules and asses	Broilers	hen	other poultry	Rabbits
(096) Biella	11.4	11.4	8,850	3,617	0	16,082	5,709	13,521	2,721	606	240	222	765	97,447	0
(097) Lecco	11.5	11.6	4,335	1,634	0	2,460	339	1,924	1,189	1,908	277	288,301	5,001	1,219	7,950
(098) Lodi	12.2	12.5	53,611	46,294	353	358,589	25,804	0	6	745	0	16	1,257,958	92	0
(099) Rimini	11.7	12.0	4,523	166	0	22,083	1,454	7,946	0	1,077	150	184,953	145,785	621,136	0
(100) Prato	12.0	12.8	0	0	0	0	0	0	0	187	0	0	0	0	0
(101) Crotone	15.7	16.3	21,933	846	0	3,727	50	44,091	21,369	756	235	373,670	102,356	77	4,724
(102) Vibo Valentia	14.1	14.9	6,206	2,529	3	2,082	108	48,520	3,067	143	0	235	52,649	0	1,697
(103) Verbano-Cusio-Ossola	11.7	11.8	2,570	2,567	0	163	7	12,443	11,160	624	200	381	1,854	223	1,049
Total			4,409,921	1,842,004	205,093	8,478,427	721,843	7,954,167	945,895	278,471	30,254	97,532,025	52,692,584	38,370,412	20,504,282
N animals in temperate zone			552,951	140,747	83,864	208,355	21,948	2,046,930	380,826	38,047	6,040	1,560,813	3,971,390	567,236	1,378,261
% animals in temperate zone			12.5%	7.6%	40.9%	2.5%	3.0%	25.7%	40.3%	13.7%	20.0%	1.6%	7.5%	1.5%	6.7%
Based on temperature non weighted by % animals															
N animals in temperate zone			285,415	55,975	121	76,427	14,775	1,273,110	129,030	16,695	2,153	1,269,593	2,534,710	555,050	477,474
% animals in temperate zone			6.5%	3.0%	0.1%	0.9%	2.0%	16.0%	13.6%	6.0%	7.1%	1.3%	4.8%	1.4%	2.3%

ANNEX 8: Additional information to be considered as part of the annual inventory submission and the *supplementary information required under Article 7, paragraph 1*, of the Kyoto Protocol or other useful reference information

A8.1 Annual inventory submission

This appendix shows a copy of Tables 10s1-10s5 from the Common Reporting Format 2012, submitted in 2014, in which time series of emission estimates for the following gases are reported:

- CO_2
- CH_4
- N_2O
- HFCs, PFCs, SF_6
- All gases and sources categories

Table A8.1.1.1 CO_2 emissions trends, CRF year 2012 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

CO_2

(Part 1 of 3)

Inventory
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ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**404,072.23**	**404,004.24**	**403,166.60**	**399,823.23**	**393,701.63**	**416,988.58**	**412,954.68**	**416,863.11**	**428,077.16**	**433,320.38**
A. Fuel Combustion (Sectoral Approach)	400,728.45	400,736.85	399,952.02	396,440.70	390,472.88	413,810.90	409,917.09	413,617.34	424,956.37	430,913.41
1. Energy Industries	136,502.92	130,586.47	130,325.22	124,848.67	127,316.71	139,841.41	135,043.26	137,027.71	148,064.92	145,892.04
2. Manufacturing Industries and Construction	85,275.97	82,962.46	81,547.47	82,062.29	83,187.62	85,037.31	83,121.67	85,776.21	79,398.27	81,263.19
3. Transport	101,268.85	103,786.58	108,033.55	109,632.46	109,239.86	111,445.03	112,669.95	114,359.93	118,142.99	119,687.91
4. Other Sectors	76,634.39	82,204.76	78,764.85	78,449.21	69,269.50	76,047.16	77,900.09	75,228.73	78,310.91	82,959.84
5. Other	1,046.34	1,196.59	1,280.93	1,448.07	1,459.19	1,439.99	1,182.11	1,224.77	1,039.27	1,110.43
B. Fugitive Emissions from Fuels	3,343.78	3,267.39	3,214.58	3,382.52	3,228.74	3,177.67	3,037.59	3,245.76	3,120.79	2,406.97
1. Solid Fuels	0.12	0.10	0.12	0.06	0.03	0.02	0.02	0.01	0.00	0.00
2. Oil and Natural Gas	3,343.66	3,267.28	3,214.46	3,382.46	3,228.71	3,177.65	3,037.57	3,245.75	3,120.79	2,406.97
2. Industrial Processes	**28,434.49**	**27,992.04**	**28,539.49**	**25,278.77**	**24,204.52**	**26,037.93**	**23,490.76**	**23,616.25**	**23,645.56**	**23,775.07**
A. Mineral Products	21,302.86	21,256.87	22,067.74	19,612.09	19,121.11	20,976.08	19,282.70	19,528.94	19,787.55	20,595.65
B. Chemical Industry	3,253.76	3,110.90	3,048.80	2,115.60	1,650.97	1,659.19	1,250.42	1,358.27	1,337.32	1,224.53
C. Metal Production	3,877.87	3,624.28	3,422.94	3,551.09	3,432.45	3,402.65	2,957.64	2,729.04	2,520.69	1,954.89
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	1,642.40	1,628.27	1,630.15	1,576.93	1,503.51	1,463.28	1,404.34	1,414.68	1,331.18	1,335.90
4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										

Table A8.1.1.1 CO_2 emissions trends, CRF year 2012 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

Inventory
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CO_2

ITALY

(Part 1 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
G. Other										
5. Land Use, Land-Use Change and Forestry(2)	**-5,443.02**	**-20,755.54**	**-18,926.06**	**-4,257.28**	**-17,703.01**	**-24,214.83**	**-23,360.30**	**-14,652.92**	**-11,438.30**	**-20,363.78**
A. Forest Land	-18,942.88	-31,289.83	-29,831.74	-18,653.55	-29,672.90	-32,660.33	-32,018.59	-24,660.89	-23,051.45	-28,185.23
B. Cropland	2,174.78	1,348.84	1,427.16	1,520.68	1,603.56	1,658.82	2,431.33	2,329.95	2,240.07	2,112.38
C. Grassland	4,328.77	1,188.81	1,480.89	4,877.94	2,367.71	-1,214.18	-659.48	791.02	2,485.69	-1,179.14
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
E. Settlements	6,996.31	7,996.64	7,997.63	7,997.65	7,998.62	8,000.86	6,886.44	6,887.00	6,887.38	6,888.20
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**507.18**	**531.86**	**531.33**	**491.25**	**494.32**	**453.89**	**453.58**	**477.66**	**470.17**	**393.47**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
B. Waste-water Handling										
C. Waste Incineration	507.18	531.86	531.33	491.25	494.32	453.89	453.58	477.66	470.17	393.47
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CO_2 emissions including net CO_2 from LULUCF	**429,213.28**	**413,400.87**	**414,941.51**	**422,912.90**	**402,200.96**	**420,728.85**	**414,943.06**	**427,718.78**	**442,085.78**	**438,461.03**
Total CO_2 emissions excluding net CO_2 from LULUCF	**434,656.30**	**434,156.41**	**433,867.57**	**427,170.18**	**419,903.98**	**444,943.68**	**438,303.36**	**442,371.70**	**453,524.08**	**458,824.82**
Memo Items:										
International Bunkers	**8,549.97**	**8,576.11**	**8,392.37**	**8,762.20**	**8,992.41**	**9,708.35**	**8,936.90**	**9,260.17**	**9,930.35**	**10,691.95**
Aviation	4,160.77	4,993.23	4,940.81	5,082.84	5,353.48	5,673.52	6,081.29	6,200.46	6,737.93	7,392.96
Marine	4,389.20	3,582.88	3,451.56	3,679.36	3,638.93	4,034.83	2,855.61	3,059.71	3,192.42	3,298.98
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass	7,134.04	9,428.06	9,154.71	9,261.01	9,863.64	9,945.05	9,686.34	10,796.10	10,387.15	12,305.87

Table A8.1.1.1 CO_2 emissions trends, CRF year 2012 (years 2000 – 2009)

TABLE 10 EMISSION TRENDS

Inventory 2012
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CO_2

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000 (Gg)	2001 (Gg)	2002 (Gg)	2003 (Gg)	2004 (Gg)	2005 (Gg)	2006 (Gg)	2007 (Gg)	2008 (Gg)	2009 (Gg)
1. Energy	**436,230.37**	**441,387.14**	**443,693.34**	**458,529.73**	**460,499.38**	**459,366.63**	**454,781.02**	**446,236.48**	**437,182.88**	**393,482.93**
A. Fuel Combustion (Sectoral Approach)	433,642.47	438,944.25	441,428.32	455,689.89	458,345.05	457,249.63	452,587.30	444,055.62	434,918.48	391,312.78
1. Energy Industries	151,893.98	154,498.04	161,400.59	161,982.20	159,962.44	159,829.28	160,983.71	160,769.41	156,105.92	131,166.74
2. Manufacturing Industries and Construction	82,245.45	80,543.88	76,727.06	82,314.52	83,113.04	78,551.02	77,490.30	74,221.73	70,904.64	54,580.15
3. Transport	120,100.81	122,177.89	124,138.08	125,097.19	127,081.10	125,824.54	127,145.29	127,209.41	122,052.95	117,629.39
4. Other Sectors	78,596.13	81,370.50	78,849.04	85,635.83	87,097.49	91,847.10	85,986.38	80,958.88	85,117.20	87,092.17
5. Other	806.10	353.94	313.56	660.15	1,090.98	1,197.69	981.61	896.19	737.77	844.34
B. Fugitive Emissions from Fuels	2,587.90	2,442.89	2,265.01	2,839.84	2,154.33	2,117.00	2,193.72	2,180.86	2,264.40	2,170.15
1. Solid Fuels	0.05	0.06	0.07	0.11	0.04	0.04	0.01	0.07	0.05	0.03
2. Oil and Natural Gas	2,587.84	2,442.83	2,264.94	2,839.73	2,154.29	2,116.96	2,193.71	2,180.79	2,264.35	2,170.12
2. Industrial Processes	**24,570.91**	**25,391.76**	**25,380.25**	**26,542.68**	**27,404.60**	**27,186.45**	**27,205.40**	**27,710.92**	**25,092.58**	**19,950.52**
A. Mineral Products	21,455.32	22,329.47	22,392.53	23,310.95	23,896.04	23,480.87	23,536.18	24,027.16	21,729.03	17,466.05
B. Chemical Industry	1,361.64	1,345.67	1,426.49	1,679.37	1,838.90	1,783.68	1,727.00	1,759.05	1,488.19	1,177.67
C. Metal Production	1,753.95	1,716.63	1,561.23	1,552.36	1,669.66	1,921.91	1,942.23	1,924.71	1,875.37	1,306.80
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA
3. Solvent and Other Product Use	1,274.84	1,282.80	1,286.40	1,290.46	1,282.91	1,299.41	1,308.40	1,282.21	1,220.10	1,134.25
4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										
5. Land Use, Land-Use Change and Forestry(2)	**-18,020.27**	**-26,252.84**	**-31,295.05**	**-23,437.51**	**-29,114.29**	**-29,989.38**	**-30,577.19**	**-7,718.86**	**-26,396.76**	**-28,384.92**
A. Forest Land	-27,233.11	-33,434.73	-37,108.36	-30,783.12	-35,319.71	-36,281.16	-35,954.04	-19,705.62	-32,314.15	-35,155.68
B. Cropland	2,016.89	1,436.63	1,432.95	1,444.75	1,444.88	1,443.12	1,230.50	1,271.33	1,240.00	1,330.23
C. Grassland	305.94	-1,145.91	-2,512.24	-992.67	-2,134.24	-2,832.93	-3,543.47	3,023.82	-3,020.96	-2,309.50
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
E. Settlements	6,890.01	6,891.18	6,892.60	6,893.53	6,894.78	7,681.59	7,689.82	7,691.60	7,698.34	7,750.03
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A8.1.1.1 CO_2 emissions trends, CRF year 2012 (years 2000 – 2009)

TABLE 10 EMISSION TRENDS

Inventory
2012
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CO_2

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ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
6. Waste	**201.57**	**222.26**	**170.87**	**196.81**	**180.11**	**225.56**	**238.76**	**206.76**	**200.03**	**242.07**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
B. Waste-water Handling										
C. Waste Incineration	201.57	222.26	170.87	196.81	180.11	225.56	238.76	206.76	200.03	242.07
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CO_2 emissions including net CO_2 from LULUCF	**444,257.42**	**442,031.13**	**439,235.81**	**463,122.16**	**460,252.72**	**458,088.66**	**452,956.40**	**467,717.50**	**437,298.84**	**386,424.85**
Total CO_2 emissions excluding net CO_2 from LULUCF	**462,277.69**	**468,283.97**	**470,530.86**	**486,559.68**	**489,367.01**	**488,078.04**	**483,533.58**	**475,436.36**	**463,695.60**	**414,809.77**
Memo Items:										
International Bunkers	**12,196.09**	**12,824.92**	**12,862.42**	**14,809.34**	**15,426.56**	**16,029.88**	**17,274.95**	**18,185.82**	**18,524.22**	**16,225.87**
Aviation	8,015.50	8,011.06	7,312.69	8,526.80	8,620.09	9,110.86	9,833.14	10,430.30	10,087.15	8,968.33
Marine	4,180.59	4,813.86	5,549.73	6,282.54	6,806.47	6,919.02	7,441.81	7,755.53	8,437.07	7,257.54
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass	12,261.86	13,450.09	12,923.60	15,016.69	18,194.77	17,425.98	18,251.73	20,259.15	22,989.11	25,995.30

Table A8.1.1.1 CO_2 emissions trends, CRF year 2012 (years 2010 – 2011)

TABLE 10 EMISSION TRENDS

CO_2

(Part 3 of 3)

Inventory 2012 Submission 2014 v2.1

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	%
1. Energy	**403,219.12**	**392,049.50**	**368,499.47**	**-8.80**
A. Fuel Combustion (Sectoral Approach)	400,896.93	389,734.59	366,276.92	-8.60
1. Energy Industries	132,557.02	130,562.04	125,638.83	-7.96
2. Manufacturing Industries and Construction	60,015.12	59,852.15	53,655.54	-37.08
3. Transport	117,065.97	116,068.62	104,844.92	3.53
4. Other Sectors	90,631.35	82,756.81	81,811.63	6.76
5. Other	627.48	494.97	326.01	-68.84
B. Fugitive Emissions from Fuels	2,322.19	2,314.90	2,222.55	-33.53
1. Solid Fuels	0.05	0.04	0.04	-69.23
2. Oil and Natural Gas	2,322.14	2,314.86	2,222.51	-33.53
2. Industrial Processes	**20,562.75**	**20,086.04**	**16,995.88**	**-40.23**
A. Mineral Products	17,553.46	17,003.01	13,968.38	-34.43
B. Chemical Industry	1,543.89	1,472.77	1,507.08	-53.68
C. Metal Production	1,465.40	1,610.27	1,520.43	-60.79
D. Other Production	NA	NA	NA	0.00
E. Production of Halocarbons and SF_6				
F. Consumption of Halocarbons and SF_6				
G. Other	NA	NA	NA	0.00
3. Solvent and Other Product Use	1,043.02	1,071.18	1,001.45	-39.03
4. Agriculture				
A. Enteric Fermentation				
B. Manure Management				
C. Rice Cultivation				
D. Agricultural Soils				
E. Prescribed Burning of Savannas				
F. Field Burning of Agricultural Residues				

Table A8.1.1.1 CO_2 emissions trends, CRF year 2012 (years 2010 – 2011)

TABLE 10 EMISSION TRENDS

Inventory 2012
Submission 2014 v2.1
ITALY

CO_2

(Part 3 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	%
G. Other				
5. Land Use, Land-Use Change and Forestry[(2)]	**-31,566.99**	**-19,794.04**	**-19,864.17**	**264.95**
A. Forest Land	-36,536.44	-28,785.12	-30,062.40	58.70
B. Cropland	1,318.99	4,275.32	4,227.75	94.40
C. Grassland	-4,112.80	-3,052.52	-1,803.39	-141.66
D. Wetlands	NE,NO	NE,NO	NE,NO	0.00
E. Settlements	7,763.26	7,768.28	7,773.87	11.11
F. Other Land	NO	NO	NO	0.00
G. Other	NA	NA	NA	0.00
6. Waste	**168.31**	**172.68**	**169.92**	**-66.50**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	0.00
B. Waste-water Handling				
C. Waste Incineration	168.31	172.68	169.92	-66.50
D. Other	NA	NA	NA	0.00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**0.00**
Total CO_2 emissions including net CO_2 from LULUCF	**393,426.20**	**393,585.36**	**366,802.55**	**-14.54**
Total CO_2 emissions excluding net CO_2 from LULUCF	**424,993.19**	**413,379.40**	**386,666.73**	**-11.04**
Memo Items:				
International Bunkers	**16,413.07**	**16,915.34**	**14,964.24**	**75.02**
Aviation	9,440.35	9,725.54	9,315.84	123.90
Marine	6,972.72	7,189.80	5,648.40	28.69
Multilateral Operations	NE	NE	NE	0.00
CO_2 Emissions from Biomass	26,101.85	30,710.60	29,642.21	315.50

Table A8.1.2.2 CH_4 emission trends, CRF year 2012 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

CH_4

(Part 1 of 3)

Inventory 2012 Submission 2014 v2.1

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	430.27	437.56	440.03	435.32	425.68	415.80	407.42	407.64	408.89	401.02
A. Fuel Combustion (Sectoral Approach)	76.71	85.96	86.02	86.90	86.35	88.04	84.94	86.90	84.05	85.50
1. Energy Industries	9.27	8.93	8.59	8.14	8.39	8.63	8.41	8.60	8.52	8.26
2. Manufacturing Industries and Construction	6.82	6.67	6.49	6.62	6.59	7.02	6.48	6.69	6.44	6.06
3. Transport	39.19	41.87	43.90	45.41	43.88	43.65	42.99	41.21	39.51	37.21
4. Other Sectors	21.25	28.29	26.85	26.52	27.28	28.51	26.87	30.24	29.43	33.80
5. Other	0.17	0.19	0.20	0.22	0.21	0.22	0.19	0.17	0.16	0.18
B. Fugitive Emissions from Fuels	353.56	351.61	354.01	348.42	339.33	327.76	322.48	320.74	324.84	315.52
1. Solid Fuels	6.03	5.55	5.53	4.04	3.47	3.12	2.92	2.87	2.63	2.52
2. Oil and Natural Gas	347.54	346.06	348.48	344.38	335.86	324.64	319.56	317.87	322.20	313.00
2. Industrial Processes	**5.16**	**4.95**	**4.83**	**4.87**	**5.07**	**5.36**	**2.99**	**3.23**	**3.10**	**3.05**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry	2.45	2.43	2.40	2.28	2.49	2.65	0.60	0.62	0.59	0.59
C. Metal Production	2.71	2.51	2.43	2.59	2.58	2.71	2.39	2.61	2.51	2.46
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use										
4. Agriculture	**825.45**	**834.36**	**812.61**	**809.71**	**811.64**	**824.78**	**827.82**	**828.05**	**821.54**	**828.11**
A. Enteric Fermentation	584.69	597.01	578.70	572.58	577.53	587.98	591.74	593.23	589.27	595.82
B. Manure Management	165.08	165.03	158.86	158.49	153.48	156.63	157.05	156.41	158.09	159.63
C. Rice Cultivation	75.06	71.64	74.39	78.00	79.98	79.56	78.37	77.82	73.50	72.00
D. Agricultural Soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Table A8.1.2.2 CH_4 emission trends, CRF year 2012 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

CH_4

(Part 1 of 3)

Inventory 2012 Submission 2014 v2.1

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
F. Field Burning of Agricultural Residues	0.62	0.68	0.66	0.64	0.64	0.62	0.65	0.59	0.67	0.66
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**70.86**	**29.70**	**34.92**	**73.50**	**40.65**	**16.36**	**17.54**	**41.80**	**53.38**	**26.97**
A. Forest Land	41.78	12.63	18.23	44.68	17.99	8.68	7.94	25.98	29.64	16.77
B. Cropland	0.23	0.17	0.15	0.21	0.21	0.07	0.09	0.12	0.20	0.08
C. Grassland	28.84	16.90	16.54	28.62	22.45	7.61	9.52	15.70	23.54	10.12
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**823.24**	**869.72**	**822.03**	**819.83**	**845.79**	**865.61**	**904.86**	**929.66**	**931.47**	**943.44**
A. Solid Waste Disposal on Land	726.38	768.40	717.80	712.65	737.49	757.56	795.95	819.36	820.62	832.10
B. Waste-water Handling	94.76	98.63	101.80	104.73	105.83	105.62	106.46	107.85	108.27	108.66
C. Waste Incineration	2.09	2.68	2.41	2.44	2.45	2.41	2.42	2.41	2.52	2.60
D. Other	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.05	0.06	0.08
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CH_4 emissions including CH_4 from LULUCF	**2,154.97**	**2,176.29**	**2,114.42**	**2,143.23**	**2,128.82**	**2,127.90**	**2,160.63**	**2,210.38**	**2,218.38**	**2,202.59**
Total CH_4 emissions excluding CH_4 from LULUCF	**2,084.11**	**2,146.59**	**2,079.50**	**2,069.72**	**2,088.17**	**2,111.54**	**2,143.09**	**2,168.58**	**2,165.00**	**2,175.62**
Memo Items:										
International Bunkers	0.47	0.39	0.38	0.41	0.41	0.45	0.34	0.37	0.39	0.41
Aviation	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.08	0.09
Marine	0.42	0.34	0.33	0.35	0.35	0.39	0.27	0.29	0.31	0.32
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass										

Table A8.1.2.2 CH_4 emission trends, CRF year 2012 (years 2000 – 2009)

TABLE 10 EMISSION TRENDS

CH_4

(Part 2 of 3)

Inventory 2012
Submission 2014 v2.1
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	384.76	366.79	359.69	353.31	348.67	342.38	314.92	310.65	313.46	306.94
A. Fuel Combustion (Sectoral Approach)	78.88	77.95	72.23	72.06	75.57	70.17	69.20	71.90	72.16	70.97
1. Energy Industries	6.85	5.95	5.92	6.14	6.21	6.34	6.17	5.72	5.65	5.19
2. Manufacturing Industries and Construction	5.72	5.79	5.69	5.83	5.76	6.28	6.24	6.53	6.24	4.18
3. Transport	33.43	31.55	29.14	26.81	24.00	20.32	18.20	15.98	14.67	13.15
4. Other Sectors	32.75	34.58	31.41	33.18	39.47	37.08	38.47	43.56	45.52	48.38
5. Other	0.13	0.09	0.07	0.10	0.14	0.16	0.13	0.11	0.07	0.07
B. Fugitive Emissions from Fuels	305.88	288.84	287.45	281.24	273.10	272.21	245.71	238.75	241.29	235.97
1. Solid Fuels	3.55	3.94	3.82	4.65	3.10	3.33	2.57	4.09	3.52	2.17
2. Oil and Natural Gas	302.32	284.90	283.64	276.59	269.99	268.88	243.14	234.66	237.77	233.81
2. Industrial Processes	**3.01**	**2.83**	**2.71**	**2.77**	**2.91**	**3.06**	**3.14**	**3.08**	**2.91**	**1.82**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry	0.40	0.33	0.33	0.31	0.33	0.33	0.32	0.34	0.30	0.28
C. Metal Production	2.61	2.50	2.38	2.46	2.58	2.72	2.81	2.75	2.61	1.54
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA
3. Solvent and Other Product Use										
4. Agriculture	**806.27**	**770.06**	**753.68**	**755.83**	**743.46**	**740.57**	**724.68**	**746.89**	**731.38**	**736.19**
A. Enteric Fermentation	583.14	543.96	528.92	530.19	519.41	519.73	509.48	528.51	523.60	524.14
B. Manure Management	156.25	159.35	155.59	155.05	150.29	150.07	144.32	145.54	141.09	136.89
C. Rice Cultivation	66.26	66.19	68.52	70.00	73.04	70.11	70.23	72.18	65.99	74.51
D. Agricultural Soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	0.62	0.57	0.64	0.59	0.72	0.67	0.65	0.66	0.69	0.65

Table A8.1.2.2 CH_4 emission trends, CRF year 2012 (years 2000 – 2009)

TABLE 10 EMISSION TRENDS

CH_4

(Part 2 of 3)

Inventory 2012
Submission 2014 v2.1
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**40.08**	**26.36**	**14.64**	**31.64**	**18.29**	**16.08**	**12.95**	**76.78**	**20.20**	**24.62**
A. Forest Land	23.07	14.95	8.53	17.73	8.30	8.73	6.59	43.09	8.11	9.49
B. Cropland	0.13	0.09	0.05	0.11	0.09	0.06	0.06	0.26	0.09	0.09
C. Grassland	16.88	11.32	6.06	13.79	9.90	7.29	6.30	33.43	12.01	15.04
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**989.29**	**988.99**	**968.06**	**925.85**	**875.91**	**871.21**	**840.30**	**809.35**	**768.51**	**762.06**
A. Solid Waste Disposal on Land	874.15	869.64	844.96	800.29	746.31	738.78	707.20	675.89	636.40	630.32
B. Waste-water Handling	112.73	116.97	120.53	123.05	126.55	129.67	130.40	130.77	129.33	129.09
C. Waste Incineration	2.32	2.26	2.41	2.33	2.87	2.56	2.48	2.47	2.57	2.44
D. Other	0.10	0.12	0.16	0.18	0.18	0.20	0.21	0.22	0.21	0.21
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CH_4 emissions including CH_4 from LULUCF	**2,223.42**	**2,155.03**	**2,098.77**	**2,069.39**	**1,989.25**	**1,973.31**	**1,895.97**	**1,946.76**	**1,836.46**	**1,831.64**
Total CH_4 emissions excluding CH_4 from LULUCF	**2,183.34**	**2,128.67**	**2,084.13**	**2,037.75**	**1,970.95**	**1,957.23**	**1,883.03**	**1,869.98**	**1,816.26**	**1,807.01**
Memo Items:										
International Bunkers	0.51	0.58	0.65	0.74	0.80	0.83	0.88	0.87	0.93	0.81
Aviation	0.11	0.12	0.12	0.14	0.15	0.17	0.17	0.13	0.12	0.12
Marine	0.40	0.46	0.53	0.60	0.65	0.66	0.71	0.74	0.81	0.69
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass										

Table A8.1.2.2 CH_4 emission trends, CRF year 2012 (years 2010 – 2011)

TABLE 10 EMISSION TRENDS

Inventory 2012 Submission 2014 v2.1

CH_4

ITALY

(Part 3 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	%
1. Energy	321.24	318.15	318.50	-25.98
A. Fuel Combustion (Sectoral Approach)	74.40	76.26	80.13	4.47
1. Energy Industries	5.02	5.59	5.45	-41.27
2. Manufacturing Industries and Construction	5.51	6.89	8.14	19.38
3. Transport	12.47	11.68	10.36	-73.57
4. Other Sectors	51.34	52.04	56.16	164.26
5. Other	0.06	0.05	0.03	-83.93
B. Fugitive Emissions from Fuels	246.84	241.89	238.36	-32.58
1. Solid Fuels	3.16	3.40	2.97	-50.74
2. Oil and Natural Gas	243.68	238.49	235.39	-32.27
2. Industrial Processes	**2.48**	**2.73**	**2.62**	**-49.26**
A. Mineral Products	NA	NA	NA	0.00
B. Chemical Industry	0.31	0.27	0.26	-89.54
C. Metal Production	2.17	2.47	2.36	-12.82
D. Other Production				
E. Production of Halocarbons and SF_6				
F. Consumption of Halocarbons and SF_6				
G. Other	NA	NA	NA	0.00
3. Solvent and Other Product Use				
4. Agriculture	**708.56**	**687.20**	**662.78**	**-19.71**
A. Enteric Fermentation	511.05	512.07	507.98	-13.12
B. Manure Management	122.34	100.71	81.13	-50.85
C. Rice Cultivation	74.54	73.80	73.00	-2.74
D. Agricultural Soils	NA	NA	NA	0.00
E. Prescribed Burning of Savannas	NO	NO	NO	0.00
F. Field Burning of Agricultural Residues	0.64	0.64	0.67	8.30
G. Other	NA	NA	NA	0.00
5. Land Use, Land-Use Change and Forestry	**14.91**	**23.12**	**49.82**	**-29.69**
A. Forest Land	4.90	8.77	25.45	-39.09
B. Cropland	0.05	0.10	0.20	-14.75
C. Grassland	9.96	14.25	24.17	-16.20
D. Wetlands	NO	NO	NO	0.00
E. Settlements	NO	NO	NO	0.00
F. Other Land	NO	NO	NO	0.00
G. Other	NA	NA	NA	0.00

Table A8.1.2.2 CH_4 emission trends, CRF year 2012 (years 2010 – 2011)

TABLE 10 EMISSION TRENDS

CH_4

(Part 3 of 3)

Inventory
2012
Submission
2014 v2.1

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	%
6. Waste	**740.74**	**692.97**	**670.71**	**-18.53**
A. Solid Waste Disposal on Land	607.95	560.50	538.23	-25.90
B. Waste-water Handling	130.12	129.80	129.78	36.96
C. Waste Incineration	2.43	2.42	2.42	15.81
D. Other	0.25	0.25	0.27	2,467.92
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**0.00**
Total CH_4 emissions including CH_4 from LULUCF	**1,787.93**	**1,724.18**	**1,704.43**	**-20.91**
Total CH_4 emissions excluding CH_4 from LULUCF	**1,773.02**	**1,701.06**	**1,654.61**	**-20.61**
Memo Items:				
International Bunkers	0.78	0.81	0.66	41.32
Aviation	0.12	0.12	0.12	156.10
Marine	0.67	0.69	0.54	28.57
Multilateral Operations	NE	NE	NE	0.00
CO_2 Emissions from Biomass				

Table A8.1.3.2 N_2O emission trends, CRF year 2012 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

N_2O

(Part 1 of 3)

Inventory 2012
Submission 2014 v2.1

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**14.86**	**15.11**	**15.33**	**15.38**	**15.89**	**17.40**	**18.42**	**19.47**	**20.37**	**21.31**
A. Fuel Combustion (Sectoral Approach)	14.83	15.07	15.29	15.34	15.85	17.36	18.38	19.43	20.33	21.27
1. Energy Industries	1.67	1.58	1.55	1.47	1.49	1.67	1.61	1.61	1.64	1.58
2. Manufacturing Industries and Construction	4.93	4.89	4.90	4.51	4.47	4.52	4.42	4.47	4.49	4.51
3. Transport	3.20	3.41	3.65	3.84	4.55	5.62	6.84	7.78	8.61	9.39
4. Other Sectors	4.80	4.96	4.96	5.24	5.09	5.34	5.33	5.35	5.41	5.65
5. Other	0.23	0.24	0.24	0.28	0.25	0.21	0.18	0.21	0.17	0.14
B. Fugitive Emissions from Fuels	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2. Oil and Natural Gas	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2. Industrial Processes	**21.54**	**22.81**	**21.11**	**21.65**	**20.36**	**23.35**	**22.66**	**22.78**	**23.06**	**23.56**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry	21.54	22.81	21.11	21.65	20.36	23.35	22.66	22.78	23.06	23.56
C. Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	2.62	2.47	2.46	2.50	2.46	2.49	2.96	2.96	3.40	3.33
4. Agriculture	**75.79**	**77.71**	**77.50**	**78.64**	**76.88**	**75.10**	**74.22**	**77.58**	**75.61**	**76.42**
A. Enteric Fermentation										
B. Manure Management	12.69	12.67	12.13	12.01	11.96	12.23	12.36	12.47	12.72	12.92
C. Rice Cultivation										
D. Agricultural Soils	63.09	65.03	65.35	66.62	64.90	62.86	61.84	65.10	62.87	63.49
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Table A8.1.3.2 N_2O emission trends, CRF year 2012 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

N_2O

(Part 1 of 3)

Inventory 2012
Submission 2014 v2.1
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**1.12**	**0.75**	**0.77**	**1.18**	**1.00**	**0.55**	**0.57**	**0.74**	**0.95**	**0.48**
A. Forest Land	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01
B. Cropland	0.20	0.22	0.24	0.27	0.29	0.31	0.27	0.24	0.20	0.16
C. Grassland	0.91	0.53	0.52	0.90	0.71	0.24	0.30	0.49	0.74	0.32
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**6.03**	**6.12**	**6.06**	**5.90**	**5.91**	**5.85**	**6.00**	**5.98**	**6.14**	**6.27**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	5.91	5.98	5.92	5.78	5.78	5.73	5.89	5.85	6.02	6.15
C. Waste Incineration	0.13	0.15	0.14	0.13	0.13	0.12	0.12	0.12	0.12	0.12
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total N_2O emissions including N_2O from LULUCF	**121.96**	**124.98**	**123.22**	**125.25**	**122.50**	**124.74**	**124.83**	**129.50**	**129.53**	**131.37**
Total N_2O emissions excluding N_2O from LULUCF	**120.84**	**124.22**	**122.46**	**124.07**	**121.50**	**124.19**	**124.26**	**128.76**	**128.58**	**130.89**
Memo Items:										
International Bunkers	**0.23**	**0.21**	**0.22**	**0.24**	**0.24**	**0.26**	**0.25**	**0.27**	**0.29**	**0.31**
Aviation	0.12	0.12	0.13	0.14	0.15	0.16	0.18	0.19	0.21	0.23
Marine	0.11	0.09	0.09	0.09	0.09	0.10	0.07	0.08	0.08	0.08
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass										

Table A8.1.3.2 N_2O emission trends, CRF year 2012 (years 2000 – 2009)

TABLE 10 EMISSION TRENDS

N_2O

(Part 2 of 3)

Inventory 2012
Submission 2014 v2.1
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**17.35**	**17.61**	**17.53**	**17.87**	**18.44**	**17.25**	**17.19**	**17.10**	**16.67**	**15.93**
A. Fuel Combustion (Sectoral Approach)	17.31	17.57	17.49	17.82	18.39	17.20	17.14	17.06	16.63	15.89
1. Energy Industries	1.67	1.75	1.82	1.84	1.91	1.90	1.89	1.87	1.88	1.68
2. Manufacturing Industries and Construction	4.66	4.74	4.77	4.93	5.03	5.02	5.05	4.98	4.64	3.98
3. Transport	5.29	5.28	5.27	5.05	5.02	3.84	3.89	3.83	3.70	3.57
4. Other Sectors	5.55	5.77	5.61	5.87	6.16	6.15	6.08	6.15	6.22	6.42
5. Other	0.14	0.03	0.02	0.13	0.28	0.29	0.24	0.23	0.20	0.24
B. Fugitive Emissions from Fuels	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2. Oil and Natural Gas	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2. Industrial Processes	**25.54**	**26.55**	**25.49**	**24.38**	**27.24**	**25.03**	**8.54**	**6.10**	**3.44**	**3.64**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry	25.54	26.55	25.49	24.38	27.24	25.03	8.54	6.10	3.44	3.64
C. Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA
3. Solvent and Other Product Use	3.31	3.00	3.00	2.81	2.73	2.66	2.61	2.54	2.35	2.21
4. Agriculture	**75.12**	**74.56**	**73.41**	**72.74**	**72.59**	**70.61**	**69.76**	**70.40**	**66.88**	**62.55**
A. Enteric Fermentation										
B. Manure Management	12.49	12.94	12.45	12.36	12.01	11.99	11.64	12.21	12.20	12.32
C. Rice Cultivation										
D. Agricultural Soils	62.62	61.61	60.94	60.37	60.56	58.61	58.11	58.17	54.67	50.22
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01

Table A8.1.3.2 N_2O emission trends, CRF year 2012 (years 2000 – 2009)

TABLE 10 EMISSION TRENDS

N_2O

(Part 2 of 3)

Inventory 2012
Submission 2014 v2.1
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**0.66**	**0.48**	**0.31**	**0.56**	**0.43**	**0.35**	**0.32**	**1.19**	**0.50**	**0.60**
A. Forest Land	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00
B. Cropland	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.13	0.12	0.12
C. Grassland	0.53	0.36	0.19	0.43	0.31	0.23	0.20	1.05	0.38	0.47
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**6.30**	**6.13**	**6.13**	**6.11**	**6.25**	**6.24**	**6.24**	**6.27**	**6.43**	**6.40**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	6.21	6.04	6.05	6.02	6.15	6.15	6.15	6.18	6.34	6.32
C. Waste Incineration	0.09	0.09	0.08	0.08	0.09	0.09	0.09	0.09	0.08	0.08
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total N_2O emissions including N_2O from LULUCF	**128.27**	**128.34**	**125.88**	**124.46**	**127.67**	**122.14**	**104.65**	**103.60**	**96.26**	**91.33**
Total N_2O emissions excluding N_2O from LULUCF	**127.62**	**127.86**	**125.56**	**123.90**	**127.23**	**121.79**	**104.33**	**102.41**	**95.76**	**90.73**
Memo Items:										
International Bunkers	**0.35**	**0.36**	**0.35**	**0.37**	**0.38**	**0.39**	**0.41**	**0.44**	**0.45**	**0.41**
Aviation	0.25	0.24	0.21	0.21	0.21	0.21	0.22	0.24	0.24	0.22
Marine	0.11	0.12	0.14	0.16	0.17	0.18	0.19	0.20	0.21	0.18
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass										

Table A8.1.3.2 N_2O emission trends, CRF year 2012 (years 2010 – 2011)

TABLE 10 EMISSION TRENDS

N_2O

(Part 3 of 3)

Inventory 2012
Submission 2014 v2.1
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	%
1. Energy	**15.96**	**15.84**	**15.08**	**1.46**
A. Fuel Combustion (Sectoral Approach)	15.92	15.80	15.05	1.48
1. Energy Industries	1.68	1.77	1.76	5.61
2. Manufacturing Industries and Construction	4.01	3.96	3.53	-28.33
3. Transport	3.57	3.56	3.21	0.11
4. Other Sectors	6.53	6.41	6.45	34.42
5. Other	0.13	0.10	0.09	-59.00
B. Fugitive Emissions from Fuels	0.04	0.04	0.04	-8.93
1. Solid Fuels	NA	NA	NA	0.00
2. Oil and Natural Gas	0.04	0.04	0.04	-8.93
2. Industrial Processes	**2.09**	**0.95**	**0.76**	**-96.49**
A. Mineral Products	NA	NA	NA	0.00
B. Chemical Industry	2.09	0.95	0.76	-96.49
C. Metal Production	NA	NA	NA	0.00
D. Other Production				
E. Production of Halocarbons and SF_6				
F. Consumption of Halocarbons and SF_6				
G. Other	NA	NA	NA	0.00
3. Solvent and Other Product Use	2.02	1.86	1.66	-36.68
4. Agriculture	**60.98**	**61.74**	**65.71**	**-13.30**
A. Enteric Fermentation				
B. Manure Management	11.95	11.98	12.07	-4.88
C. Rice Cultivation				
D. Agricultural Soils	49.01	49.75	53.63	-15.00
E. Prescribed Burning of Savannas	NO	NO	NO	0.00
F. Field Burning of Agricultural Residues	0.01	0.01	0.01	11.78

Table A8.1.3.2 N_2O emission trends, CRF year 2012 (years 2010 – 2011)

TABLE 10 EMISSION TRENDS

N_2O

(Part 3 of 3)

Inventory 2012
Submission 2014 v2.1
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	%
G. Other	NA	NA	NA	0.00
5. Land Use, Land-Use Change and Forestry	**0.43**	**0.55**	**0.84**	**-24.45**
A. Forest Land	0.00	0.00	0.01	-39.09
B. Cropland	0.12	0.10	0.08	-61.28
C. Grassland	0.31	0.45	0.76	-16.20
D. Wetlands	NO	NO	NO	0.00
E. Settlements	NO	NO	NO	0.00
F. Other Land	NO	NO	NO	0.00
G. Other	NA	NA	NA	0.00
6. Waste	**6.46**	**6.34**	**6.32**	**4.78**
A. Solid Waste Disposal on Land				
B. Waste-water Handling	6.39	6.26	6.24	5.70
C. Waste Incineration	0.08	0.08	0.08	-38.48
D. Other	NA	NA	NA	0.00
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**0.00**
Total N_2O emissions including N_2O from LULUCF	**87.95**	**87.29**	**90.37**	**-25.90**
Total N_2O emissions excluding N_2O from LULUCF	**87.51**	**86.74**	**89.53**	**-25.91**
Memo Items:				
International Bunkers	**0.40**	**0.41**	**0.37**	**60.05**
Aviation	0.23	0.23	0.23	89.45
Marine	0.18	0.18	0.14	28.57
Multilateral Operations	NE	NE	NE	0.00
CO_2 Emissions from Biomass				

Table A8.1.4.1 HFC, PFC and SF_6 emission trends, CRF year 2012 (1990 – 1999)

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 1 of 3)

Inventory 2012
Submission 2014 v2.1
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs[(3)] - (Gg CO_2 equivalent)	**351.00**	**355.43**	**358.78**	**355.42**	**481.90**	**679.81**	**489.32**	**840.56**	**1,299.05**	**1,715.26**
HFC-23	0.03	0.03	0.03	0.03	0.03	0.03	0.00	0.00	0.00	0.00
HFC-32	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00	0.01	0.03
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-125	NA,NO	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.07	0.10
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-134a	NA,NO	0.00	0.00	0.00	0.10	0.20	0.29	0.43	0.67	0.83
HFC-152a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.01	0.02	0.03	0.05	0.08
HFC-227ea	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00	0.00	0.01
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed HFCs[(4)] - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of PFCs[(3)] - (Gg CO_2 equivalent)	**2,486.74**	**2,149.93**	**1,567.24**	**1,444.45**	**1,233.11**	**1,266.38**	**1,038.26**	**1,066.25**	**1,103.90**	**1,110.77**
CF_4	0.32	0.28	0.21	0.20	0.17	0.17	0.15	0.15	0.16	0.16
C_2F_6	0.05	0.04	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
C_3F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
$c\text{-}C_4F_8$	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed PFCs[(4)] - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO

Table A8.1.4.1 HFC, PFC and SF_6 emission trends, CRF year 2012 (1990 – 1999)

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 1 of 3)

Inventory 2012
Submission 2014 v2.1

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of SF6[(3)] - (Gg CO_2 equivalent)	**332.92**	**356.39**	**358.26**	**370.40**	**415.66**	**601.45**	**682.56**	**728.64**	**604.81**	**404.51**
SF_6	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.02

Table A8.1.4.2 HFC, PFC and SF_6 emission trends, CRF year 2012 (2000 – 2009)

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 2 of 3)

Inventory 2012
Submission 2014 v2.1
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs[3] - (Gg CO_2 equivalent)	**1,837.71**	**2,382.57**	**3,005.85**	**3,697.32**	**4,408.80**	**5,147.95**	**5,833.95**	**6,545.62**	**7,161.58**	**7,768.67**
HFC-23	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
HFC-32	0.02	0.03	0.04	0.05	0.07	0.09	0.10	0.12	0.14	0.16
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-125	0.10	0.16	0.22	0.30	0.38	0.47	0.56	0.64	0.72	0.79
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-134a	0.86	0.99	1.07	1.19	1.31	1.41	1.49	1.61	1.69	1.78
HFC-152a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143a	0.10	0.15	0.21	0.28	0.35	0.44	0.51	0.58	0.65	0.71
HFC-227ea	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.05
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed HFCs[4] - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of PFCs[3] - (Gg CO_2 equivalent)	**1,217.43**	**1,342.04**	**1,333.92**	**1,676.71**	**1,733.21**	**1,715.00**	**1,713.61**	**1,652.10**	**1,500.59**	**1,062.81**
CF_4	0.17	0.18	0.18	0.23	0.25	0.25	0.25	0.25	0.22	0.16
C_2F_6	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
C_3F_8	NA,NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
$c\text{-}C_4F_8$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed PFCs[4] - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO

Table A8.1.4.2 HFC, PFC and SF_6 emission trends, CRF year 2012 (2000 – 2009)

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 2 of 3)

Inventory 2012
Submission 2014 v2.1
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of SF6[(3)] - (Gg CO_2 equivalent)	**493.43**	**795.34**	**739.72**	**467.56**	**502.14**	**465.39**	**405.87**	**427.55**	**435.53**	**398.02**
SF_6	0.02	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02

Table A8.1.4.2 HFC, PFC and SF_6 emission trends, CRF year 2012 (2010 – 2011)

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 3 of 3)

Inventory 2012
Submission 2014 v2.1
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	%
Emissions of HFCs(3) - (Gg CO_2 equivalent)	**8,298.75**	**8,804.23**	**9,246.26**	**2,534.26**
HFC-23	0.01	0.01	0.01	-68.66
HFC-32	0.18	0.20	0.22	100.00
HFC-41	NA,NO	NA,NO	NA,NO	0.00
HFC-43-10mee	NA,NO	NA,NO	NA,NO	0.00
HFC-125	0.86	0.93	1.00	100.00
HFC-134	NA,NO	NA,NO	NA,NO	0.00
HFC-134a	1.82	1.86	1.86	100.00
HFC-152a	NA,NO	NA,NO	NA,NO	0.00
HFC-143	NA,NO	NA,NO	NA,NO	0.00
HFC-143a	0.77	0.82	0.88	100.00
HFC-227ea	0.06	0.06	0.06	100.00
HFC-236fa	NA,NO	NA,NO	NA,NO	0.00
HFC-245ca	NA,NO	NA,NO	NA,NO	0.00
Unspecified mix of listed HFCs(4) - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	0.00
Emissions of PFCs(3) - (Gg CO_2 equivalent)	**1,330.83**	**1,454.54**	**1,314.04**	**-47.16**
CF_4	0.20	0.22	0.20	-38.17
C_2F_6	0.00	0.00	0.00	-94.13
C_3F_8	0.00	0.00	0.00	100.00
C_4F_{10}	NA,NO	NA,NO	NA,NO	0.00
$c\text{-}C_4F_8$	0.00	0.00	0.00	100.00
C_5F_{12}	NA,NO	NA,NO	NA,NO	0.00
C_6F_{14}	NA,NO	NA,NO	NA,NO	0.00
Unspecified mix of listed PFCs(4) - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	0.00

Table A8.1.4.2 HFC, PFC and SF_6 emission trends, CRF year 2012 (2010 – 2011)

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 3 of 3)

Inventory 2012
Submission 2014 v2.1

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	%
Emissions of SF6[3] - (Gg CO_2 equivalent)	**373.27**	**351.38**	**355.72**	**6.85**
SF_6	0.02	0.01	0.01	6.85

Table A8.1.5.1 Total emission trends, CRF year 2012 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

SUMMARY

(Part 1 of 3)

Inventory 2012
Submission 2014 v2.1
ITALY

GREENHOUSE GAS EMISSIONS	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
CO_2 emissions including net CO_2 from LULUCF	429,213.28	413,400.87	414,941.51	422,912.90	402,200.96	420,728.85	414,943.06	427,718.78	442,085.78	438,461.03
CO_2 emissions excluding net CO_2 from LULUCF	434,656.30	434,156.41	433,867.57	427,170.18	419,903.98	444,943.68	438,303.36	442,371.70	453,524.08	458,824.82
CH_4 emissions including CH_4 from LULUCF	45,254.37	45,702.08	44,402.82	45,007.76	44,705.19	44,685.82	45,373.26	46,418.00	46,585.95	46,254.39
CH_4 emissions excluding CH_4 from LULUCF	43,766.38	45,078.35	43,669.52	43,464.18	43,851.57	44,342.35	45,004.85	45,540.18	45,465.01	45,688.01
N_2O emissions including N_2O from LULUCF	37,808.01	38,743.45	38,199.41	38,828.19	37,976.18	38,670.05	38,697.50	40,144.98	40,155.08	40,724.79
N_2O emissions excluding N_2O from LULUCF	37,461.55	38,509.50	37,961.35	38,462.02	37,665.42	38,498.90	38,519.44	39,916.44	39,860.83	40,575.55
HFCs	351.00	355.43	358.78	355.42	481.90	679.81	489.32	840.56	1,299.05	1,715.26
PFCs	2,486.74	2,149.93	1,567.24	1,444.45	1,233.11	1,266.38	1,038.26	1,066.25	1,103.90	1,110.77
SF_6	332.92	356.39	358.26	370.40	415.66	601.45	682.56	728.64	604.81	404.51
Total (including LULUCF)	**515,446.32**	**500,708.15**	**499,828.02**	**508,919.11**	**487,013.01**	**506,632.37**	**501,223.97**	**516,917.21**	**531,834.57**	**528,670.74**
Total (excluding LULUCF)	**519,054.90**	**520,606.01**	**517,782.73**	**511,266.65**	**503,551.64**	**530,332.58**	**524,037.79**	**530,463.76**	**541,857.68**	**548,318.91**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
1. Energy	417,715.70	417,878.18	417,159.65	413,731.59	407,566.60	431,113.11	427,220.91	431,458.82	442,979.11	448,347.53
2. Industrial Processes	38,389.92	38,028.62	37,469.02	34,263.50	32,752.96	35,937.40	32,788.70	33,382.24	33,866.97	34,372.45
3. Solvent and Other Product Use	2,454.62	2,393.98	2,393.71	2,350.74	2,266.57	2,234.87	2,320.85	2,331.38	2,385.84	2,369.20
4. Agriculture	40,829.71	41,610.98	41,088.99	41,382.82	40,877.08	40,601.81	40,390.98	41,438.47	40,691.68	41,081.68
5. Land Use, Land-Use Change and Forestry(5)	-3,608.58	-19,897.87	-17,954.71	-2,347.53	-16,538.63	-23,700.21	-22,813.82	-13,546.56	-10,023.11	-19,648.17
6. Waste	19,664.96	20,694.26	19,671.36	19,538.00	20,088.42	20,445.39	21,316.34	21,852.86	21,934.07	22,148.04
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)(5)	**515,446.32**	**500,708.15**	**499,828.02**	**508,919.11**	**487,013.01**	**506,632.37**	**501,223.97**	**516,917.21**	**531,834.57**	**528,670.74**

Table A8.1.5.1 Total emission trends, CRF year 2012 (years 2000 – 2009)

TABLE 10 EMISSION TRENDS

Inventory 2012
Submission 2014 v2.1
ITALY

SUMMARY

(Part 2 of 3)

GREENHOUSE GAS EMISSIONS	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
CO_2 emissions including net CO_2 from LULUCF	444,257.42	442,031.13	439,235.81	463,122.16	460,252.72	458,088.66	452,956.40	467,717.50	437,298.84	386,424.85
CO_2 emissions excluding net CO_2 from LULUCF	462,277.69	468,283.97	470,530.86	486,559.68	489,367.01	488,078.04	483,533.58	475,436.36	463,695.60	414,809.77
CH_4 emissions including CH_4 from LULUCF	46,691.77	45,255.59	44,074.12	43,457.14	41,774.16	41,439.56	39,815.39	40,881.95	38,565.65	38,464.39
CH_4 emissions excluding CH_4 from LULUCF	45,850.09	44,702.09	43,766.75	42,792.79	41,390.02	41,101.77	39,543.55	39,269.53	38,141.41	37,947.30
N_2O emissions including N_2O from LULUCF	39,765.12	39,786.91	39,021.34	38,584.06	39,576.48	37,862.54	32,441.79	32,115.63	29,840.82	28,311.00
N_2O emissions excluding N_2O from LULUCF	39,560.69	39,637.86	38,924.58	38,410.45	39,441.90	37,753.62	32,342.85	31,746.74	29,685.78	28,126.24
HFCs	1,837.71	2,382.57	3,005.85	3,697.32	4,408.80	5,147.95	5,833.95	6,545.62	7,161.58	7,768.67
PFCs	1,217.43	1,342.04	1,333.92	1,676.71	1,733.21	1,715.00	1,713.61	1,652.10	1,500.59	1,062.81
SF_6	493.43	795.34	739.72	467.56	502.14	465.39	405.87	427.55	435.53	398.02
Total (including LULUCF)	**534,262.90**	**531,593.57**	**527,410.76**	**551,004.95**	**548,247.51**	**544,719.09**	**533,167.01**	**549,340.34**	**514,803.02**	**462,429.74**
Total (excluding LULUCF)	**551,237.06**	**557,143.86**	**558,301.69**	**573,604.49**	**576,843.08**	**574,261.76**	**563,373.42**	**555,077.90**	**540,620.50**	**490,112.81**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
1. Energy	449,688.18	454,549.81	456,681.74	471,487.40	473,536.97	471,903.21	466,722.44	458,061.54	448,933.42	404,866.49
2. Industrial Processes	36,101.07	38,203.15	38,418.32	39,999.38	42,552.87	42,339.28	37,871.23	38,291.70	35,316.97	30,347.86
3. Solvent and Other Product Use	2,301.35	2,214.05	2,215.38	2,163.07	2,127.79	2,122.86	2,116.73	2,070.22	1,947.38	1,817.82
4. Agriculture	40,217.58	39,284.44	38,585.30	38,422.23	38,115.10	37,441.98	36,844.74	37,507.84	36,091.34	34,851.70
5. Land Use, Land-Use Change and Forestry(5)	-16,974.16	-25,550.29	-30,890.93	-22,599.55	-28,595.57	-29,542.67	-30,206.40	-5,737.56	-25,817.48	-27,683.08
6. Waste	22,928.87	22,892.42	22,400.95	21,532.42	20,510.35	20,454.43	19,818.27	19,146.60	18,331.38	18,228.94
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)(5)	**534,262.90**	**531,593.57**	**527,410.76**	**551,004.95**	**548,247.51**	**544,719.09**	**533,167.01**	**549,340.34**	**514,803.02**	**462,429.74**

Table A8.1.5.1 Total emission trends, CRF year 2011 (years 2010 – 2011)

TABLE 10 EMISSION TRENDS

Inventory 2011
Submission 2013 v2.1
ITALY

SUMMARY

(Part 3 of 3)

GREENHOUSE GAS EMISSIONS	2010	2011	2012	Change from base to latest reported year
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	(%)
CO_2 emissions including net CO_2 from LULUCF	393,426.20	393,585.36	366,802.55	-14.54
CO_2 emissions excluding net CO_2 from LULUCF	424,993.19	413,379.40	386,666.73	-11.04
CH_4 emissions including CH_4 from LULUCF	37,546.57	36,207.85	35,792.98	-20.91
CH_4 emissions excluding CH_4 from LULUCF	37,233.39	35,722.24	34,746.84	-20.61
N_2O emissions including N_2O from LULUCF	27,263.59	27,059.13	28,015.61	-25.90
N_2O emissions excluding N_2O from LULUCF	27,129.15	26,889.34	27,753.87	-25.91
HFCs	8,298.75	8,804.23	9,246.26	2,534.26
PFCs	1,330.83	1,454.54	1,314.04	-47.16
SF_6	373.27	351.38	355.72	6.85
Total (including LULUCF)	**468,239.23**	**467,462.50**	**441,527.15**	**-14.34**
Total (excluding LULUCF)	**499,358.60**	**486,601.13**	**460,083.45**	**-11.36**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	Change from base to latest reported year
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	(%)
1. Energy	414,913.91	403,641.41	379,862.79	-9.06
2. Industrial Processes	31,264.53	31,048.99	28,201.34	-26.54
3. Solvent and Other Product Use	1,669.45	1,647.93	1,515.72	-38.25
4. Agriculture	33,782.98	33,571.99	34,289.44	-16.02
5. Land Use, Land-Use Change and Forestry[(5)]	-31,119.38	-19,138.63	-18,556.30	414.23
6. Waste	17,727.73	16,690.81	16,214.17	-17.55
7. Other	NA	NA	NA	0.00
Total (including LULUCF)[(5)]	**468,239.23**	**467,462.50**	**441,527.15**	**-14.34**

A8.2 Supplementary information under Article 7, paragraph 1

A8.2.1 KP-LULUCF

Table A8.2.1.1 Table NIR1. Summary Table

Activity coverage and other information relating to activities under Article 3.3 and elected activities under Article 3.4

Activity		Change in carbon pool reported(1)					Greenhouse gas sources reported(2)						
		Above-ground biomass	Below-ground biomass	Litter	Dead wood	Soil	Fertilization(3)	Drainage of soils under forest management	Disturbance associated with land-use conversion to croplands	Liming	Biomass burning(4)		
							N_2O	N_2O	N_2O	CO_2	CO_2	CH_4	N_2O
Article 3.3 activities	Afforestation and Reforestation	R	R	R	R	R	NO			NO	IE	R	R
	Deforestation	R	R	R	R	R			NO	NO	NO	NO	NO
Article 3.4 activities	Forest Management	R	R	R	R	NR	NO	NO		NO	IE	R	R
	Cropland Management	NA	NA	NA	NA	NA			NA	NA	NA	NA	NA
	Grazing Land Management	NA	NA	NA	NA	NA				NA	NA	NA	NA
	Revegetation	NA	NA	NA	NA	NA				NA	NA	NA	NA

Table A8.2.1.2 Table NIR2. Land Transition Matrix – 2008

Areas and changes in areas between the previous and the current inventory year (1), (2), (3)

From previous inventory year \ To current inventory year		Article 3.3 activities: Afforestation and Reforestation	Article 3.3 activities: Deforestation	Article 3.4 activities: Forest Management (if elected)	Article 3.4 activities: Cropland Management (if elected)	Article 3.4 activities: Grazing Land Management (if elected)	Article 3.4 activities: Revegetation (if elected)	Other (5)	Total area at the beginning of the current inventory year(6)
		(kha)							
Article 3.3 activities	Afforestation and Reforestation	1,378.51	NO						1,378.51
	Deforestation		21.92						21.92
Article 3.4 activities	Forest Management (if elected)		3.69	7,486.23					7,489.93
	Cropland Management(4) (if elected)	NA	NA		NA	NA	NA		NA
	Grazing Land Management(4) (if elected)	NA	NA		NA	NA	NA		NA
	Revegetation(4) (if elected)	NA			NA	NA	NA		NA
Other (5)		58.31	0.00	0.00	0.00	0.00	0.00	21,184.93	21,243.24
Total area at the end of the current inventory year		1,436.83	25.61	7,486.23	0.00	0.00	0.00	21,184.93	30,133.60

Table A8.2.1.3 Table NIR2. Land Transition Matrix - 2009

Areas and changes in areas between the previous and the current inventory year (1), (2), (3)

From previous inventory year \ To current inventory year		Article 3.3 activities: Afforestation and Reforestation	Article 3.3 activities: Deforestation	Article 3.4 activities: Forest Management (if elected)	Article 3.4 activities: Cropland Management (if elected)	Article 3.4 activities: Grazing Land Management (if elected)	Article 3.4 activities: Revegetation (if elected)	Other (5)	Total area at the beginning of the current inventory year(6)
		(kha)							
Article 3.3 activities	Afforestation and Reforestation	1,436.83	NO						1,436.83
	Deforestation		25.61						25.61
Article 3.4 activities	Forest Management (if elected)		3.69	7,482.54					7,486.23
	Cropland Management(4) (if elected)	NA	NA		NA	NA	NA		NA
	Grazing Land Management(4) (if elected)	NA	NA		NA	NA	NA		NA
	Revegetation(4) (if elected)	NA			NA	NA	NA		NA
Other (5)		58.31	0.00	0.00	0.00	0.00	0.00	21,126.62	21,184.93
Total area at the end of the current inventory year		1,495.14	29.31	7,482.54	0.00	0.00	0.00	21,126.62	30,133.60

Table A8.2.1.4 Table NIR2. Land Transition Matrix - 2010

Areas and changes in areas between the previous and the current inventory year (1), (2), (3)

From previous inventory year \ To current inventory year		Article 3.3 activities: Afforestation and Reforestation	Article 3.3 activities: Deforestation	Article 3.4 activities: Forest Management (if elected)	Article 3.4 activities: Cropland Management (if elected)	Article 3.4 activities: Grazing Land Management (if elected)	Article 3.4 activities: Revegetation (if elected)	Other (5)	Total area at the beginning of the current inventory year(6)
		(kha)							
Article 3.3 activities	**Afforestation and Reforestation**	1,495.14	NO						1,495.14
	Deforestation		29.31						29.31
Article 3.4 activities	**Forest Management (if elected)**		3.69	7,478.84					7,482.54
	Cropland Management(4) (if elected)	NA	NA		NA	NA	NA		NA
	Grazing Land Management(4) (if elected)	NA	NA		NA	NA	NA		NA
	Revegetation(4) (if elected)	NA			NA	NA	NA		NA
Other (5)		58.31	0.00	0.00	0.00	0.00	0.00	21,068.30	21,126.62
Total area at the end of the current inventory year		1,553.46	33.00	7,478.84	0.00	0.00	0.00	21,068.30	30,133.60

Table A8.2.1.4 Table NIR2. Land Transition Matrix - 2011

Areas and changes in areas between the previous and the current inventory year (1), (2), (3)

From previous inventory year \ To current inventory year		Article 3.3 activities: Afforestation and Reforestation	Article 3.3 activities: Deforestation	Article 3.4 activities: Forest Management (if elected)	Article 3.4 activities: Cropland Management (if elected)	Article 3.4 activities: Grazing Land Management (if elected)	Article 3.4 activities: Revegetation (if elected)	Other (5)	Total area at the beginning of the current inventory year(6)
		(kha)							
Article 3.3 activities	Afforestation and Reforestation	1,553.46	NO						1,553.46
	Deforestation		33.00						33.00
Article 3.4 activities	Forest Management (if elected)		3.69	7,475.15					7,478.84
	Cropland Management(4) (if elected)	NA	NA		NA	NA	NA		NA
	Grazing Land Management(4) (if elected)	NA	NA		NA	NA	NA		NA
	Revegetation(4) (if elected)	NA			NA	NA	NA		NA
Other (5)		58.31	0.00	0.00	0.00	0.00	0.00	21,009.99	21,068.30
Total area at the end of the current inventory year		1,611.77	36.70	7,475.15	0.00	0.00	0.00	21,009.99	30,133.60

Table A8.2.1.4 Table NIR2. Land Transition Matrix - 2012

Areas and changes in areas between the previous and the current inventory year [(1), (2), (3)]

From previous inventory year \ To current inventory year		Article 3.3 activities: Afforestation and Reforestation	Article 3.3 activities: Deforestation	Article 3.4 activities: Forest Management (if elected)	Article 3.4 activities: Cropland Management (if elected)	Article 3.4 activities: Grazing Land Management (if elected)	Article 3.4 activities: Revegetation (if elected)	Other [(5)]	Total area at the beginning of the current inventory year[(6)]
		(kha)							
Article 3.3 activities	Afforestation and Reforestation	1,611.77	NO						1,611.77
	Deforestation		36.70						36.70
Article 3.4 activities	Forest Management (if elected)		3.69	7,471.45					7,475.15
	Cropland Management[(4)] (if elected)	NA	NA		NA	NA	NA		NA
	Grazing Land Management[(4)] (if elected)	NA	NA		NA	NA	NA		NA
	Revegetation[(4)] (if elected)	NA			NA	NA	NA		NA
Other [(5)]		58.31	0.00	0.00	0.00	0.00	0.00	20,951.67	21,009.99
Total area at the end of the current inventory year		1,670.08	40.39	7,471.45	0.00	0.00	0.00	20,951.67	30,133.60

Table A8.2.1.5 Table NIR3. Summary overview for key categories for LULUCF activities under Kyoto Protocol

TABLE NIR 3. SUMMARY OVERVIEW FOR KEY CATEGORIES FOR LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER THE KYOTO PROTOCOL

KEY CATEGORIES OF EMISSIONS AND REMOVALS	GAS	CRITERIA USED FOR KEY CATEGORY IDENTIFICATION			COMMENTS [3]
		Associated category in UNFCCC inventory[1] is key (indicate which category)	Category contribution is greater than the smallest category considered key in the UNFCCC inventory [1], [4] (including LULUCF)	Other [2]	
Specify key categories according to the national level of disaggregation used[1]					
Forest Management	CO_2	Forest land remaining forest land	Yes	no	no
Afforestation and Reforestation	CO_2	Conversion to forest land	Yes	no	category identified only for trend assessment with Tier2

Table A8.2.1.6 Table 5(KP). Report of supplementary information for LULUCF activities under Kyoto Protocol - 2008

TABLE 5(KP). REPORT OF SUPPLEMENTARY INFORMATION FOR LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER THE KYOTO PROTOCOL [(1), (2)]

ITALY

Inventory 2008

Submission 2014 v2.1

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Net CO_2 emissions/ removals[(3), (4)]	CH_4 [(5)]	N_2O [(6)]	Net CO_2 equivalent emissions/removals
	(Gg)			
A. Article 3.3 activities				**-4,421.43**
A.1. Afforestation and Reforestation [(7)]	-6,391.85	1.31	0.04	-6,351.72
A.1.1. Units of land not harvested since the beginning of the commitment period	-6,391.85	1.31	0.04	-6,351.72
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA
A.2. Deforestation	1,930.28	NA	NA	1,930.28
B. Article 3.4 activities				**-27,191.21**
B.1. Forest Management (if elected)	-27,400.33	6.80	0.21	-27,191.21
B.2. Cropland Management (if elected)	NA	NA	NA	NA
B.3. Grazing Land Management (if elected)	NA	NA	NA	NA
B.4. Revegetation (if elected)	NA	NA	NA	NA

Information item:				
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA

Table A8.2.1.7 Table 5(KP). Report of supplementary information for LULUCF activities under Kyoto Protocol - 2009

TABLE 5(KP). REPORT OF SUPPLEMENTARY INFORMATION FOR LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER THE KYOTO PROTOCOL [(1), (2)]

ITALY

Inventory 2009

Submission 2014 v2.1

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Net CO_2 emissions/ removals[(3), (4)]	CH_4 [(5)]	N_2O [(6)]	Net CO_2 equivalent emissions/removals
	(Gg)			
A. Article 3.3 activities				**-5,148.41**
A.1. Afforestation and Reforestation [(7)]	-7,137.09	1.58	0.05	-7,088.50
A.1.1. Units of land not harvested since the beginning of the commitment period	-7,137.09	1.58	0.05	-7,088.50
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA
A.2. Deforestation	1,940.08	NA	NA	1,940.08
B. Article 3.4 activities				**-29,779.41**
B.1. Forest Management (if elected)	-30,022.62	7.91	0.25	-29,779.41
B.2. Cropland Management (if elected)	NA	NA	NA	NA
B.3. Grazing Land Management (if elected)	NA	NA	NA	NA
B.4. Revegetation (if elected)	NA	NA	NA	NA

Information item:				
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA

Table A8.2.1.8 Table 5(KP). Report of supplementary information for LULUCF activities under Kyoto Protocol - 2010

TABLE 5(KP). REPORT OF SUPPLEMENTARY INFORMATION FOR LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER THE KYOTO PROTOCOL (1), (2)

ITALY

Inventory 2010

Submission 2014 v2.1

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Net CO_2 emissions/ removals(3), (4)	CH_4 (5)	N_2O (6)	Net CO_2 equivalent emissions/removals
	(Gg)			
A. Article 3.3 activities				**-5,757.41**
A.1. Afforestation and Reforestation (7)	-7,734.02	0.84	0.03	-7,708.11
A.1.1. Units of land not harvested since the beginning of the commitment period	-7,734.02	0.84	0.03	-7,708.11
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA
A.2. Deforestation	1,950.70	NA	NA	1,950.70
B. Article 3.4 activities				**-30,869.33**
B.1. Forest Management (if elected)	-30,994.08	4.06	0.13	-30,869.33
B.2. Cropland Management (if elected)	NA	NA	NA	NA
B.3. Grazing Land Management (if elected)	NA	NA	NA	NA
B.4. Revegetation (if elected)	NA	NA	NA	NA

Information item:				
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA

Table A8.2.1.8 Table 5(KP). Report of supplementary information for LULUCF activities under Kyoto Protocol - 2011

TABLE 5(KP). REPORT OF SUPPLEMENTARY INFORMATION FOR LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER THE KYOTO PROTOCOL [(1), (2)]

ITALY

Inventory 2011

Submission 2014 v2.1

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Net CO_2 emissions/ removals[(3), (4)]	CH_4 [(5)]	N_2O [(6)]	Net CO_2 equivalent emissions/removals
	(Gg)			
A. Article 3.3 activities				**-4,352.93**
A.1. Afforestation and Reforestation [(7)]	-6,358.10	1.56	0.05	-6,310.26
A.1.1. Units of land not harvested since the beginning of the commitment period	-6,358.10	1.56	0.05	-6,310.26
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA
A.2. Deforestation	1,957.33	NA	NA	1,957.33
B. Article 3.4 activities				**-23,564.13**
B.1. Forest Management (if elected)	-23,786.02	7.22	0.23	-23,564.13
B.2. Cropland Management (if elected)	NA	NA	NA	NA
B.3. Grazing Land Management (if elected)	NA	NA	NA	NA
B.4. Revegetation (if elected)	NA	NA	NA	NA

Information item:				
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA

Table A8.2.1.8 Table 5(KP). Report of supplementary information for LULUCF activities under Kyoto Protocol - 2012

TABLE 5(KP). REPORT OF SUPPLEMENTARY INFORMATION FOR LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER THE KYOTO PROTOCOL [(1), (2)]

ITALY

Inventory 2012

Submission 2014 v2.1

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Net CO_2 emissions/ removals[(3), (4)]	CH_4 [(5)]	N_2O [(6)]	Net CO_2 equivalent emissions/removals
	(Gg)			
A. Article 3.3 activities				**-4,629.75**
A.1. Afforestation and Reforestation [(7)]	-6,737.18	4.65	0.15	-6,594.25
A.1.1. Units of land not harvested since the beginning of the commitment period	-6,737.18	4.65	0.15	-6,594.25
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA
A.2. Deforestation	1,964.50	NA	NA	1,964.50
B. Article 3.4 activities				**-24,734.75**
B.1. Forest Management (if elected)	-25,374.17	20.80	0.65	-24,734.75
B.2. Cropland Management (if elected)	NA	NA	NA	NA
B.3. Grazing Land Management (if elected)	NA	NA	NA	NA
B.4. Revegetation (if elected)	NA	NA	NA	NA

Information item:				
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA

A8.2.2 Standard electronic format

Table A8.2.2.1 Total quantities of Kyoto Protocol units by account type at beginning of reported year

Party	Italy
Submission year	2014
Reported year	2013
Commitment period	1

Table 1. Total quantities of Kyoto Protocol units by account type at beginning of reported year

Account type	Unit type					
	AAUs	**ERUs**	**RMUs**	**CERs**	**tCERs**	**lCERs**
Party holding accounts	1.64E+09	15815	NO	83759	NO	NO
Entity holding accounts	1970000	5134484	NO	13845427	54670	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	NO	NO		
Non-compliance cancellation accounts	NO	NO	NO	NO		
Other cancellation accounts	NO	NO	NO	NO	NO	NO
Retirement account	7.38E+08	5561462	NO	43371714	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	2.38E+09	10711761	NO	57300900	54670	NO

Table A8.2.2.2.a Annual internal transactions

Party	Italy
Submission year	2014
Reported year	2013
Commitment period	1

Table 2 (a). Annual internal transactions

Transaction type	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Article 6 issuance and conversion												
Party-verified projects		NO					NO		NO			
Independently verifed projects		NO					NO		NO			
Article 3.3 and 3.4 issuance or cancellation												
3.3 Afforestation and reforestation			NO				NO	NO	NO	NO		
3.3 Deforestation			NO				NO	NO	NO	NO		
3.4 Forest management			NO				NO	NO	NO	NO		
3.4 Cropland management			NO				NO	NO	NO	NO		
3.4 Grazing land management			NO				NO	NO	NO	NO		
3.4 Revegetation			NO				NO	NO	NO	NO		
Article 12 afforestation and reforestation												
Replacement of expired tCERs							NO	NO	NO	NO	NO	
Replacement of expired lCERs							NO	NO	NO	NO		
Replacement for reversal of storage							NO	NO	NO	NO		NO
Replacement for non-submission of certification report							NO	NO	NO	NO		NO
Other cancellation							NO	NO	NO	4250	NO	NO
Sub-total		NO	NO				NO	NO	NO	4250	NO	NO

Transaction type	Retirement					
	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Retirement	NO	NO	NO	NO	NO	NO

Table A8.2.2.2.b Annual external transactions

Party	Italy
Submission year	2014
Reported year	2013
Commitment period	1

Table 2 (b). Annual external transactions

	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Transfers and acquisitions												
EU	NO	25265799	NO	25785173	NO	NO	98251977	6879693	NO	21156288	NO	NO
CH	NO	476991	NO	1827777	NO	NO	NO	NO	NO	NO	NO	NO
DE	NO	111	NO	4088	NO	NO	NO	17878	NO	174993	NO	NO
GB	NO	100000	NO	810827	NO	NO	NO	NO	NO	1000000	NO	NO
CDM	NO	NO	NO	9462488	62230	NO	NO	NO	NO	NO	NO	NO
NL	NO	NO	NO	875826	NO	NO	NO	NO	NO	508946	NO	NO
ES	NO	NO	NO	NO	NO	NO	NO	158000	NO	1656482	NO	NO
RU	NO	141960	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sub-total	NO	25984861	NO	38766179	62230	NO	98251977	7055571	NO	24496709	NO	NO

Additional information

Independently verified ERUs								NO				

A8.2.2.2.c Total annual transactions

Table 2 (c). Total annual transactions

Total (Sum of tables 2a and 2b)	NO	25984861	NO	38766179	62230	NO	98251977	7055571	NO	24500959	NO	NO

Table A8.2.2.3 Expiry, cancellation and replacement

Party	Italy
Submission year	2014
Reported year	2013
Commitment period	1

Table 3. Expiry, cancellation and replacement

	Expiry, cancellation and requirement to replace		Replacement					
	Unit type		Unit type					
Transaction or event type	**tCERs**	**lCERs**	**AAUs**	**ERUs**	**RMUs**	**CERs**	**tCERs**	**lCERs**
Temporary CERs (tCERS)								
Expired in retirement and replacement accounts	NO							
Replacement of expired tCERs			NO	NO	NO	NO	NO	
Expired in holding accounts	NO							
Cancellation of tCERs expired in holding accounts	NO							
Long-term CERs (lCERs)								
Expired in retirement and replacement accounts		NO						
Replacement of expired lCERs			NO	NO	NO	NO		
Expired in holding accounts		NO						
Cancellation of lCERs expired in holding accounts		NO						
Subject to replacement for reversal of storage		NO						
Replacement for reversal of storage			NO	NO	NO	NO		NO
Subject to replacement for non-submission of certification report		NO						
Replacement for non-submission of certification report			NO	NO	NO	NO		NO
Total			NO	NO	NO	NO	NO	NO

Table A8.2.2.4 Total quantities of Kyoto Protocol units by account type at end of reported year

Party	Italy
Submission year	2014
Reported year	2013
Commitment period	1

Table 4. Total quantities of Kyoto Protocol units by account type at end of reported year

Account type	Unit type					
	AAUs	**ERUs**	**RMUs**	**CERs**	**tCERs**	**lCERs**
Party holding accounts	1.54E+09	23605709	NO	22999923	NO	NO
Entity holding accounts	1970000	473880	NO	5194483	116900	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	NO	NO		
Non-compliance cancellation accounts	NO	NO	NO	NO		
Other cancellation accounts	NO	NO	NO	4250	NO	NO
Retirement account	7.38E+08	5561462	NO	43371714	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	2.28E+09	29641051	NO	71570370	116900	NO

Table A8.2.2.5.a Summary information on additions and subtractions

Party	Italy
Submission year	2014
Reported year	2013
Commitment period	1

Table 5 (a). Summary information on additions and subtractions

	Additions						Subtractions					
	Unit type						Unit type					
Starting values	**AAUs**	**ERUs**	**RMUs**	**CERs**	**tCERs**	**lCERs**	**AAUs**	**ERUs**	**RMUs**	**CERs**	**tCERs**	**lCERs**
Issuance pursuant to Article 3.7 and 3.8	2.42E+09											
Non-compliance cancellation									NO	NO	NO	NO
Carry-over	NO	NO	NO		NO							
Sub-total	2.42E+09	NO		2.42E+09	NO		NO			NO	NO	NO
Annual transactions												
Year 0 (2007)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 1 (2008)	20292957	NO	NO	19276322	NO	NO	3804703	NO	NO	9973920	NO	NO
Year 2 (2009)	20116642	NO	NO	22792461	NO	NO	26501513	NO	NO	4370667	NO	NO
Year 3 (2010)	1.83E+08	1340006	NO	20643648	NO	NO	1.93E+08	1050000	NO	13493232	NO	NO
Year 4 (2011)	40163828	3357194	NO	54089496	NO	NO	73259250	790000	NO	36533694	NO	NO
Year 5 (2012)	27102731	10487305	NO	31804742	54670	NO	31821064	2632744	NO	26934256	NO	NO
Year 6 (2013)	NO	25984861	NO	38766179	62230	NO	98251977	7055571	NO	24500959	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sub-total	2.9E+08	41169366	NO	1.87E+08	116900	NO	4.26E+08	11528315	NO	1.16E+08	NO	NO
Total	2.71E+09	41169366	NO	1.87E+08	116900	NO	4.26E+08	11528315	NO	1.16E+08	NO	NO

Table A8.2.2.5.b Summary information on replacement

Table 5 (b). Summary information on replacement

	Requirement for replacement		Replacement					
	Unit type		Unit type					
	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Previous CPs			NO	NO	NO	NO	NO	NO
Year 1 (2008)		NO	NO	NO	NO	NO	NO	NO
Year 2 (2009)		NO	NO	NO	NO	NO	NO	NO
Year 3 (2010)		NO	NO	NO	NO	NO	NO	NO
Year 4 (2011)		NO	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO	NO	NO
Total	NO	NO	NO	NO	NO	NO	NO	NO

Table A8.2.2.5.c Summary information on retirement

Table 5 (c). Summary information on retirement

	Retirement					
	Unit type					
Year	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Year 1 (2008)	NO	NO	NO	NO	NO	NO
Year 2 (2009)	NO	NO	NO	NO	NO	NO
Year 3 (2010)	NO	NO	NO	NO	NO	NO
Year 4 (2011)	5.68E+08	752006	NO	28577753	NO	NO
Year 5 (2012)	1.71E+08	4809456	NO	14793961	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO
Total	7.38E+08	5561462	NO	43371714	NO	NO

A8.2.3 National registry

A8.2.3.1 Changes to national registry

Changes to national registry are described in Chapter 13.

A8.2.3.2 Reports

i) list of discrepancies
no discrepancies occurred during the reporting period

ii) notifications from EB of CDM
no CDM notifications were received by the Registry during the reporting period

iii) non-replacements
no non-replacements occurred during the reporting period

iv) invalid units
no invalid units to list for the reporting period

A8.2.4 Adverse impacts under Article 3, paragraph 14 of the Kyoto Protocol

Chapter 14 presents information on the commitments to tackle adverse impacts under Article 3, paragraph 14, of the Kyoto Protocol. Additional information which can be added is the list of all registered CDM projects in which Italy is involved.

Table A8.2.3.1 Information of the 114 registered CDM projects where Italy is involved (as for 27/02/2014)

Title	Host Parties	Other Parties	Impacts assessment
Project for GHG emission reduction by thermal oxidation of HFC 23 in Gujarat, India.	India (b)	Switzerland, Japan, Netherlands, **Italy**, United Kingdom of Great Britain and Northern Ireland	-
La Esperanza Hydroelectric Project	Honduras (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Austria, Luxembourg, Belgium, Sweden, Germany, Switzerland, Japan, Norway, Spain	Nussbaumer (2009) + CDCF (*)
Santa Rosa	Peru (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Austria, Luxembourg, Belgium, Sweden, Germany, Switzerland, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
DSL Biomass based Power Project at Pagara	India (a)	**Italy**, Germany, United Kingdom of Great Britain and Northern Ireland	Sirohi (2007)
GHG emission reduction by thermal oxidation of HFC 23 at refrigerant (HCFC-22) manufacturing facility of SRF Ltd	India (b)	Netherlands, **Italy**, France, Germany, United Kingdom of Great Britain and Northern Ireland, Switzerland	Sirohi (2007)
Biogas Support Program - Nepal (BSP-Nepal) Activity-1	Nepal (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Sweden, Luxembourg, Switzerland, Austria, Germany, Belgium, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
Biogas Support Program - Nepal (BSP-Nepal) Activity-2	Nepal (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Sweden, Luxembourg, Switzerland, Austria, Germany, Belgium, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
Olavarría Landfill Gas Recovery Project	Argentina (c)	Canada, Netherlands, **Italy**, Denmark, Finland, Sweden, Luxembourg, Switzerland, Austria, Germany, Belgium, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
Moldova Biomass Heating in Rural Communities (Project Design Document No. 1)	Republic of Moldova (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Austria, Luxembourg, Belgium, Sweden, Germany, Switzerland, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
Moldova Biomass Heating in Rural Communities (Project Design Document No. 2)	Republic of Moldova (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Sweden, Luxembourg, Switzerland, Austria, Germany, Belgium, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
Moldova Energy Conservation and Greenhouse Gases Emissions Reduction	Republic of Moldova (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Sweden, Luxembourg, Switzerland, Austria, Germany, Belgium, Japan, Norway, Spain	-
Aleo Manali 3 MW Small Hydroelectric Project, Himachal Pradesh, India	India (a)	Switzerland, **Italy**, United Kingdom of Great Britain and Northern Ireland	Nussbaumer (2009), Sirohi (2007)
5 MW Wind Power Project at Baramsar and Soda Mada, district Jaisalmer, Rajasthan, India.	India (a)	**Italy**	Nussbaumer (2009), Sirohi (2007)
Landfill gas recovery at the Norte III Landfill, Buenos Aires, Argentina.	Argentina (b)	Switzerland, **Italy**	-
Project for GHG Emission Reduction by Thermal Oxidation of HFC23 in Jiangsu Meilan Chemical CO.	China (b)	Canada, Netherlands, **Italy**, Denmark, Finland, France, Sweden, Germany, United Kingdom of Great Britain and Northern Ireland, Switzerland, Japan,	-

Title	Host Parties	Other Parties	Impacts assessment
Ltd., Jiangsu Province, China		Norway, Spain	
Project for HFC23 Decomposition at Changshu 3F Zhonghao New Chemical Materials Co. Ltd, Changshu, Jiangsu Province, China	China (b)	Canada, Netherlands, **Italy**, Denmark, Finland, France, Sweden, Germany, United Kingdom of Great Britain and Northern Ireland, Switzerland, Japan, Norway, Spain	-
Puente Gallego Landfill gas recovery project, Gallego, Rosario, Argentina.	Argentina (b)	Switzerland, **Italy**	-
Djebel Chekir Landfill Gas Recovery and Flaring Project – Tunisia	Tunisia (c)	Italy	-
Project for HFC23 Decomposition at Zhejiang Dongyang Chemical Co., Ltd., China	China (b)	Switzerland, Netherlands, Italy, United Kingdom of Great Britain and Northern Ireland	-
Project for HFC23 Decomposition at Limin Chemical Co., Ltd. Linhai, Zhejiang Province, China	China (b)	Switzerland, Netherlands, **Italy**, United Kingdom of Great Britain and Northern Ireland	-
Recovery of associated gas that would otherwise be flared at Kwale oil-gas processing plant, Nigeria	Nigeria (b)	**Italy**	-
Facilitating Reforestation for Guangxi Watershed Management in Pearl River Basin	China (b,d)	Canada, **Italy**, Luxembourg, France, Japan, Spain	Cóndor et al. (2010)
Landfill Gas Recovery and Flaring for 9 bundled landfills in Tunisia	Tunisia (c)	**Italy**	-
India-FaL-G Brick and Blocks Project No.1	India (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Austria, Luxembourg, Belgium, Sweden, Germany, Switzerland, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
Huadian Inner Mongolia Huitengxile 100.25MW Wind Farm Project	China (c)	**Italy**	Boyd et al. (2009)
Yunnan Whitewaters Hydropower Development Project	China (c)	**Italy**	Nussbaumer (2009)
Hebbakavadi Canal Based Mini Hydro Project in Karnataka, India	India (a)	Switzerland, **Italy**	-
Guangrun Hydropower Project in Hubei Province, P.R. China	China (c)	Canada, Netherlands, **Italy**, Finland, Austria, Luxembourg, Belgium, Sweden, Germany, Switzerland, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
HFC23 Decomposition Project at Zhonghao Chenguang Research Institute of Chemical Industry, Zigong, SiChuan Province, China	China (b)	Switzerland, Netherlands, **Italy**, United Kingdom of Great Britain and Northern Ireland	-
Allain Duhangan Hydroelectric Project (ADHP)	India (c)	**Italy**	-
Rongcheng Dongchudao Wind Farm	China (a)	**Italy**	-
Landfill gas recovery and electricity generation at "Mtoni Dumpsite", Dar Es Salaam, Tanzania	United Republic of Tanzania (c)	**Italy**	-
Laizhou Diaolongzui Wind Farm	China (c)	**Italy**	-
Quezon City Controlled Disposal Facility Biogas Emission Reduction Project	Philippines (a)	Switzerland, Sweden, **Italy**, Spain	-

Title	Host Parties	Other Parties	Impacts assessment
Laguna de Bay Community Waste Management Project: Avoidance of methane production from biomass decay through composting -1	Philippines (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Austria, Luxembourg, Belgium, Sweden, Germany, Switzerland, Japan, Norway, Spain	-
Guyana Skeldon Bagasse Cogeneration Project	Guyana (c)	Canada, Netherlands, **Italy**, Denmark, Finland, Austria, Luxembourg, Belgium, Sweden, Germany, Switzerland, Japan, Norway, Spain	-
Guizhou Zhenyuan Putian Hydropower Station	China (a)	**Italy**	-
Kunming Dongjiao Baishuitang LFG Treatment and Power Generation Project	China (c)	Switzerland, **Italy**	-
Sichuan Shimian Xieluo Wanba River Hydropower Station	China (c)	**Italy**	-
Shenyang Laohuchong LFG Power Generation Project	China (c)	Switzerland, **Italy**	-
Expansion Project of Huadian Inner Mongolia Huitengxile Wind Farm	China (c)	**Italy**	-
Moldova Soil Conservation Project	Republic of Moldova (b,d)	Canada, Netherlands, **Italy**, Finland, Luxembourg, France, Sweden, United Kingdom of Great Britain and Northern Ireland, Japan, Norway, Spain	Cóndor et al. (2010)
Hubei Eco-Farming Biogas Project Phase I	China (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Austria, Luxembourg, Switzerland, Sweden, Germany, Belgium, Japan, Norway, Spain	-
Salta Landfill Gas Capture Project	Argentina (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Austria, Luxembourg, Switzerland, Sweden, Germany, Belgium, Japan, Norway, Spain	-
Coke Dry Quenching (CDQ) Waste Heat Recovery for Power Generation Project of Wugang No. 9 and 10 Coke Ovens	China (c)	**Italy**	-
Yingpeng HFC23 Decomposition Project	China (b)	France, **Italy**, Ireland, United Kingdom of Great Britain and Northern Ireland	-
Animal Manure Management System (AMMS) GHG Mitigation Project , Shandong Minhe Livestock Co. Ltd., Penglai, Shandong Province, P.R. of China	China (c)	Canada, Netherlands, **Italy**, Denmark, Finland, Austria, Luxembourg, Switzerland, Sweden, Germany, Belgium, Japan, Norway, Spain	-
Uganda Nile Basin Reforestation Project No.3	Uganda (a,d)	Canada, **Italy**, Luxembourg, France, Japan, Spain	-
Community-Based Renewable Energy Development in the Northern Areas and Chitral (NAC), Pakistan	Pakistan (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Sweden, Luxembourg, Switzerland, Austria, Germany, Belgium, Japan, Norway, Spain	-
NISCO Converter Gas Recovery and Utilization for Power Generation Project	China (c)	**Italy**	-
Humbo Ethiopia Assisted Natural Regeneration Project	Ethiopia (b,d)	Canada, **Italy**, Luxembourg, France, Japan, Spain	CCB
Jinping Ladeng River Hydropower Station	China (c)	**Italy**	-
Assisted Natural Regeneration of Degraded Lands in Albania	Albania (b,d)	Canada, **Italy**, Luxembourg, France, Japan, Spain	Cóndor et al. (2010)
Sichuan Mabian Yi Minority Autonomous County Yonglexi Hydropower Station	China (a)	**Italy**	-

Title	Host Parties	Other Parties	Impacts assessment
Rwanda Electrogaz Compact Fluorescent Lamp (CFL) distribution project	Rwanda (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Sweden, Luxembourg, Switzerland, Austria, Germany, Belgium, Japan, Norway, Spain	-
Reforestation as Renewable Source of Wood Supplies for Industrial Use in Brazil	Brazil (b,d)	Netherlands, **Italy**, Luxembourg, France, Ireland, Switzerland, Japan, Spain	-
Yunnan Maguan Mihu River 3rd Level Hydropower Station	China (c)	**Italy**	-
Jinping Maocaoping Hydropower Station	China (a)	**Italy**	-
Xianggelila Huajiaopo Hydropower Station	China (a)	**Italy**	-
Micro-hydro Promotion	Nepal (a)	Netherlands, **Italy**, Denmark, Finland, Austria, Luxembourg, Belgium, Sweden, Germany, Switzerland, Japan, Spain	-
Olkaria II Geothermal Expansion Project	Kenya (c)	Canada, Netherlands, **Italy**, Denmark, Finland, Sweden, Luxembourg, Switzerland, Austria, Germany, Belgium, Japan, Norway, Spain	-
Wugang Gas-Steam Combined Cycle Power Plant (CCPP) Project	China (c)	**Italy**	-
Wugang Waste Gas Recovery and Power Generation Project	China (c)	**Italy**	-
Chongqing Wanzhou Xiangjiazui Hydropower Station	China (a)	**Italy**	-
Mungcharoen Green Power - 9.9 MW Rice Husk Fired Power Plant Project	Thailand (a)	**Italy**	-
AES Tietê Afforestation/Reforestation Project in the State of São Paulo, Brazil	Brazil (b,d)	Canada, **Italy**, Luxembourg, France, Japan, Spain	-
Landfill biogas extraction and combustion plant in El Inga I and II landfill (Quito, Ecuador)	Ecuador (c)	**Italy**	-
Jinping Maguo River Hydropower Station	China (a)	**Italy**	-
Improving Rural Livelihoods Through Carbon Sequestration By Adopting Environment Friendly Technology based Agroforestry Practices	India (b,d)	Canada, **Italy**, Luxembourg, France, Japan, Spain	-
Yunnan Yingjiang Zhina River 2nd Level Hydropower Station Phase 1 and Phase 2	China (c)	**Italy**	-
Yunnan Er'yuan Misha River Longdi Hydropower Station	China (a)	**Italy**	-
Southern Nicaragua CDM Reforestation Project	Nicaragua (a,d)	Canada, **Italy**, Luxembourg, France, Japan, Spain	-
Yunnan Yingjiang Zhina River 1st Level Hydropower Station	China (a)	**Italy**	-
Shanxi Shuangliang Cement Company LTD. 4.5MW Waste Heat for Power Generation Project	China (c)	**Italy**	-
Aberdare Range/ Mt. Kenya Small Scale Reforestation Initiative Kamae-Kipipiri Small Scale A/R Project	Kenya (a,d)	Canada, **Italy**, Luxembourg, France, Japan, Spain	-

Title	Host Parties	Other Parties	Impacts assessment
India-FaL-G Brick and Blocks Project No.2.	India (a)	Netherlands, **Italy**, Denmark, Finland, Austria, Luxembourg, Sweden, Germany, Belgium, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
Uganda Nile Basin Reforestation Project No.5	Uganda (a,d)	Japan, **Italy**, Spain, Luxembourg, France	-
Jiangsu Hantian Cement Waste Heat Recovery Power Generation Project	China (c)	**Italy**	-
Improving Kiln Efficiency in the Brick Making Industry in Bangladesh	Bangladesh (a)	Netherlands, **Italy**, Denmark, Finland, Austria, Luxembourg, Switzerland, Sweden, Germany, Belgium, Japan, Norway, Spain	-
Uganda Nile Basin Reforestation Project No 1	Uganda (a,d)	Japan, **Italy**, Spain, Luxembourg, France	-
Uganda Nile Basin Reforestation Project No 2	Uganda (a,d)	Japan, **Italy**, Spain, Luxembourg, France	-
Uganda Nile Basin Reforestation Project No 4	Uganda (a,d)	Japan, **Italy**, Spain, Luxembourg, France	-
Aberdare Range / Mt. Kenya Small Scale Reforestation Initiative Kirimara-Kithithina Small Scale A/R Project	Kenya (a,d)	Canada, **Italy**, Luxembourg, France, Japan, Spain	-
Tongdao County Laorongtan Hydropower Station Project	China (a)	**Italy**	-
Biogas Support Program - Nepal Activity-3	Nepal (a)	Netherlands, **Italy**, Finland, Luxembourg, Switzerland, Austria, Germany, Belgium, Spain	-
Fujian Shanghang Jiantou 9.8 MW hydropower Station Project	China (a)	**Italy**	-
Gas-Steam Combined Cycle Power Plant (CCPP) Project of Laiwu Iron & Steel Group Corp.	China (c)	**Italy**	-
India-FaL-G Brick and Blocks Project No.3	India (a)	Netherlands, **Italy**	-
Nam Mo Hydropower Project	Viet Nam (c)	**Italy**	-
Nam Non Hydropower Project	Viet Nam (c)	**Italy**	-
Yunnan Province Deqin County Chunduole Hydropower Station	China (c)	**Italy**	-
Sichuan Province Li County Luganqiao Hydropower Project	China (c)	**Italy**	-
Guodian Weifang Binhai Wind Farm Phase II Project	China (c)	**Italy**	-
Wushan Houxihe Hydropower Station Project	China (c)	**Italy**	-
Ningxia Taiyangshan Windfarm Shenpeng 49.5MW Project	China (c)	**Italy**	-
Xuanen County Shuangxi Hydropower Project	China (c)	**Italy**	-
Ningxia Helanshan Wind-farm (Touguan) Dalisi 49.5MW Wind Power Project	China (c)	**Italy**	-
Fujian Shanghang Huilong 9.9 MW hydropower Station Project	China (a)	**Italy**	-
Aeolis 2011 Wind Parks	Brazil (c)	**Italy**	-
Aeolis Beberibe Wind Park	Brazil (c)	**Italy**	-

Title	Host Parties	Other Parties	Impacts assessment
Yanyuan County Majingzi Hydropower Project	China (a)	**Italy**	-
WISCO 1234# Coke Dry Quenching (CDQ) Waste Heat Recovery for Cogeneration Project in Hubei Province	China (c)	**Italy**	-
Golden Jumping Group 12MWp Solar Power Project	China (a)	**Italy**	-
LFG Recovery and Electricity Production at the Bubanj Landfill Site, Nis, Serbia	Serbia (a)	**Italy**	-
Hydropower Plant Otilovici	Montenegro (a)	**Italy**	-
Shanxi Linfen 2×6MW Coke Oven Gas Power Generation Project	China (c)	**Italy**	-
Yunnan Tengchong Longchuan River Stage I Hydropower Plant, China	China (c,+)	Sweden, Netherlands, **Italy**	-
Redevelopment of Tana Hydro Power Station Project	Kenia (c,+)	Netherlands, **Italy**, Finland, Luxembourg, Switzerland, Austria, Germany, Belgium, Japan, Spain	-
Biogas Support Program - Nepal Activity-4	Nepal (a,+)	Netherlands, **Italy**, Denmark, Finland, Luxembourg, Switzerland, Austria, Germany, Belgium, Japan, Spain	-
Carbon Sequestration in Small and Medium Farms in the Brunca Region, Costa Rica (COOPEAGRI Project)	Costa Rica (b,d,+)	Canada, **Italy**, Spain, France	-
Partial Fuel Switching to Agricultural Wastes & Refuse Derived Fuel (RDF) at Kattameya cement plant	Egypt (c,+)	**Italy**	-
Partial Fuel Switching to Agricultural Wastes, Sewage Sludge & Refuse Derived Fuel (RDF) at Helwan cement plant	Egypt (c,+)	**Italy**	-
Phu Quy Wind Power Project	Viet Nam (b,+)	**Italy**	-
Partial substitution of fossil fuels with biomass at “Les Ciments Artificiels Tunisiens” cement plant, Tunis.	Tunisia (c,+)	**Italy**	-

(a)AMS, Small scale; (b) AM - Large scale; (c) ACM - Consolidated Methodologies; (d) Afforestation/reforestation; (*) project which is included in the UNEP Risoe Centre Database that also is classified as Gold Standard projects (validation); (+) New CDM projects respect to 2012 submission; CCB= obtained the CCB standards (UNEP Risoe database); CDCF= Community Development Carbon Fund

ANNEX 9: METHODOLOGIES, DATA SOURCES AND EMISSION FACTORS

This appendix shows methodologies, data sources and emission factors used for the Italian greenhouse gas emission inventory.

Table A9.1 Methods, activity data and emission factors used for the Italian Inventory

Information on methods used could be the tier method, the model or a country-specific approach. Activity data could be from national statistics or plant-specific. Emission factors could be the IPCC default emission factors as outlined in the revised 1996 IPCC guidelines for national greenhouse gas inventories and in the IPCC good practice guidance, country-specific emission factors, plant-specific emission factors or CORINAIR emission factors developed under the 1979 Convention on Long-Range Transboundary Air Pollution.

Table I -1: Summary report for methods, activity data and emission factors used (Energy)

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	**Key source (1)**	**Method applied (2)**	**Activity data (3)**	**Emission factor (4)**	**Key source (1)**	**Method applied (2)**	**Activity data (3)**	**Emission factor (4)**	**Key source (1)**	**Method applied (2)**	**Activity data (3)**	**Emission factor (4)**
1. Energy												
A. Fuel Combustion												
1. Energy Industries												
a. Public Electricity and Heat Production												
Liquid fuels	Yes	T3	NS, PS	CS	Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
Solid fuels	Yes	T3	NS, PS	CS	Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
Gaseous fuels	Yes	T3	NS, PS	CS	Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
Biomass	No				Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
Other fuels	Yes	T3	NS, PS	CS	Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
b. Petroleum Refining												
Liquid fuels	Yes	T3	NS, PS	CS	Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
Solid fuels	No				No				No			
Gaseous fuels	Yes	T3	NS, PS	CS	Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
c. Manufacture of Solid Fuels and Other Energy Industries												
Liquid fuels	Yes	T3	NS, PS	CS	Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
Solid fuels	Yes	T3	NS, PS	CS	Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
Gaseous fuels	Yes	T3	NS, PS	CS	Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
2. Manufacturing Industries and Construction												
a. Iron and Steel												

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)
Liquid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Solid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Gaseous fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
b. Non-Ferrous Metals												
Liquid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Solid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Gaseous fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
c. Chemicals												
Liquid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Solid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Gaseous fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Biomass	No				Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Other fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
d. Pulp, Paper and Print												
Liquid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Gaseous fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Biomass	No				Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
e. Food Processing, Beverages and Tobacco												
Liquid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Solid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Gaseous fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Biomass	No				Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
f. Other												
Liquid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Solid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Gaseous fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Biomass	No				Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2				CH_4				N_2O			
	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)
3. Transport												
a. Civil Aviation												
Aviation gasoline	Yes	T1, T2	NS	CS	No				No			
Jet kerosene	Yes	T1, T2	NS	CS	No				No			
b. Road Transportation												
Gasoline	Yes	T3	NS, AS	CS	Yes	T3	NS, AS	CS	No			
Diesel oil	Yes	T3	NS, AS	CS	Yes	T3	NS, AS	CS	No			
LPG	Yes	T3	NS, AS	CS	Yes	T3	NS, AS	CS	No			
Gaseous fuel	Yes	T3	NS, AS	CS	Yes	T3	NS, AS	CS	No			
Biomass	No				No				No			
c. Railways												
Liquid fuels	No				No				No			
d. Navigation												
Gas/Diesel oil	Yes	T1, T2	NS	CS	No				No			
Residual Oil	Yes	T1, T2	NS	CS	No				No			
Gasoline	Yes	T1, T2	NS	CS	No				No			
e. Other Transportation												
Gaseous Fuels	No				No				No			
4. Other Sectors												
a. Commercial/Institutional												
Liquid fuels	Yes	T2	NS	CS	Yes	T2	NS	CR	Yes	T2	NS	CR
Solid fuels	No				No				No			
Gaseous fuels	Yes	T2	NS	CS	Yes	T2	NS	CR	Yes	T2	NS	CR
Biomass	No				Yes	T2	NS	CR	Yes	T2	NS	CR
Other fuels	Yes	T2	NS	CS	Yes	T2	NS	CR	Yes	T2	NS	CR
b. Residential												
Liquid fuels	Yes	T2	NS	CS	Yes	T2	NS	CR	Yes	T2	NS	CR

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)
Solid fuels	Yes	T2	NS	CS	Yes	T2	NS	CR	Yes	T2	NS	CR
Gaseous fuels	Yes	T2	NS	CS	Yes	T2	NS	CR	Yes	T2	NS	CR
Biomass	No				Yes	T2	NS	CR	Yes	T2	NS	CR
c. Agriculture/Forestry /Fisheries												
Liquid fuels	Yes	T2	NS	CS	Yes	T2	NS	CR	Yes	T2	NS	CR
Gaseous fuels	Yes	T2	NS	CS	Yes	T2	NS	CR	Yes	T2	NS	CR
Biomass	No				Yes	T2	NS	CR	Yes	T2	NS	CR
5. Other												
b. Mobile												
Liquid fuels	No				No				No			
B. Fugitive Emissions from Fuels												
1. Solid Fuels												
a. Coal Mining	No				No							
b. Solid Fuel Transformation					No							
2. Oil and Natural Gas												
a. Oil	Yes	T1, T2	NS	D, CS	Yes	T1, T2	NS	D, CS	No			
b. Natural Gas	Yes	T1, T2	NS	D, CS	Yes	T1, T2	NS	D, CS				
c. Venting and Flaring	Yes	T2	NS	CS	Yes	T2	NS	CS	No			
d. Other	Yes	T2	NS	CS	Yes	T2	NS	CS	No			

Table I -2: Summary report for methods, activity data and emission factors used (Industrial Processes)

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O				HFCs				PFCs				SF_6			
CATEGORIES	**Key source [1]**	**Method applied [2]**	**Activity data [3]**	**Emission factor [4]**	**Key source [1]**	**Method applied [2]**	**Activity data [3]**	**Emission factor [4]**	**Key source [1]**	**Method applied [2]**	**Activity data [3]**	**Emission factor [4]**	**Key source [1]**	**Method applied [2]**	**Activity data [3]**	**Emission factor [4]**	**Key source [1]**	**Method applied [2]**	**Activity data [3]**	**Emission factor [4]**	**Key source [1]**	**Method applied [2]**	**Activity data [3]**	**Emission factor [4]**
2. Industrial Processes																								
A. Mineral Products																								
1. Cement Production	Yes	T2	NS	CS, PS	No				No															
2. Lime Production	Yes	T2	NS	CS,PS	No				No															
3. Limestone and Dolomite Use	Yes	T2	NS	D, CS,PS	No				No															
4. Soda Ash Production and Use	No				No				No															
5. Asphalt Roofing	No				No				No															
6. Road Paving with Asphalt	No				No				No															
7. Other	No				No				No															
B. Chemical Industry																								
1. Ammonia Production	Yes	T2	NS, PS	PS	No				No															
2. Nitric Acid Production	No				No				Yes	T2	PS	D, PS												
3. Adipic Acid Production	No				No				Yes	T2	PS	D, PS												
4. Carbide Production	No				No				No															
5. Other					No																			
C. Metal Production																								
1. Iron and Steel Production	Yes	T2	NS	CR, CS, PS	No				No								No				No			
2. Ferroalloys Production	No				No				No								No				No			
3. Aluminium Production	No				No				No								Yes	T1, T2	PS	D, PS	No			
4. SF_6 Used in Aluminium and Magnesium Foundries	No				No				No								No				No			
5. Other	No				No				No								No				No			

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O				HFCs				PFCs				SF_6			
CATEGORIES	**Key source [1]**	**Method applied [2]**	**Activity data [3]**	**Emission factor [4]**	**Key source [1]**	**Method applied [2]**	**Activity data [3]**	**Emission factor [4]**	**Key source [1]**	**Method applied [2]**	**Activity data [3]**	**Emission factor [4]**	**Key source [1]**	**Method applied [2]**	**Activity data [3]**	**Emission factor [4]**	**Key source [1]**	**Method applied [2]**	**Activity data [3]**	**Emission factor [4]**	**Key source [1]**	**Method applied [2]**	**Activity data [3]**	**Emission factor [4]**
D. Other Production																								
1. Pulp and Paper	No																							
2. Food and Drink	No																							
E. Production of Halocarbons and SF_6																								
1. By-product Emissions													No				No				No			
2. Fugitive Emissions													No				No				No			
3. Other													No				No				No			
F. Consumption of Halocarbons and SF_6																								
1. Refrigeration and Air Conditioning Equipment													Yes	T2	AS	CS	No				No			
2. Foam Blowing													Yes	T2	AS	D	No				No			
3. Fire Extinguishers													Yes	T2	AS	CS	No				No			
4. Aerosols/ Metered Dose Inhalers													Yes	T2	AS	CS	No				No			
5. Solvents													No				No				No			
6. Other applications using ODS substitutes													No				No				No			
7. Semiconductor Manufacture													No				No				No			
8. Electrical Equipment													No				No				No			
9. Other													No				No				No			
G. Other													No											

Table I -3: Summary report for methods, activity data and emission factors used (Solvent and Other Product Use, Agriculture)

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)
3. Solvent and Other Product Use	Yes	CR, CS	NS, AS	CR, CS	No				No			
4. Agriculture												
A. Enteric Fermentation in Domestic Livestock					Yes	T1, T2	NS	D, CS				
B. Manure Management					Yes	T1, T2	NS	D, CS	Yes	T2	NS	D, CS
C. Rice Cultivation					No							
D. Agricultural Soils												
1. Direct Soil Emissions					No				Yes	T1, CS	NS	D, CS
2. Pasture, range and paddock manure					No				Yes	T1	NS	D, CS
3. Indirect Emissions					No				Yes	T1	NS	D, CS
F. Field Burning of Agricultural Residues					No				No			

Table I -4: Summary report for methods, activity data and emission factors used (Land-Use Change and Forestry, Waste, Other)

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)
5. Land-Use, Land-Use Change and Forestry												
A. Forest Land												
1. Forest Land remaining Forest Land	Yes	T1, T2, T3	NS	CS	No				No			
2. Land converted to Forest Land	Yes	T1, T2	NS	D, CS	No				No			
B. Cropland												
1. Cropland remaining Cropland	Yes	T1	NS	D, CS	No				No			
2. Land converted to Cropland	No				No				No			
C. Grassland												
1. Grassland remaining Grassland	Yes	T1, T2, T3	NS	CS	No				No			
2. Land converted to Grassland	Yes	T1	NS	D, CS	No				No			
D. Wetlands												
1. Wetlands remaining Wetlands												
2. Land converted to Wetlands												
E. Settlements												
1. Settlements remaining Settlements												
2. Land converted to Settlements	Yes	T1	NS	D, CS	No				No			
F. Other Land												
1. Other Land remaining Other Land												
2. Land converted to Other Land	No				No				No			
6. Waste												
A. Solid Waste Disposal on Land												
1. Managed Waste Disposal on Land	No				Yes	T2	NS	CS				
2. Unmanaged Waste Disposal Sites	No				Yes	T2	NS	CS				
B. Wastewater Handling												
1. Industrial Wastewater					Yes	D	NS	D	No			
2. Domestic and Commercial Wastewater					Yes	D	NS	D	No			
C. Waste Incineration	No				No				No			

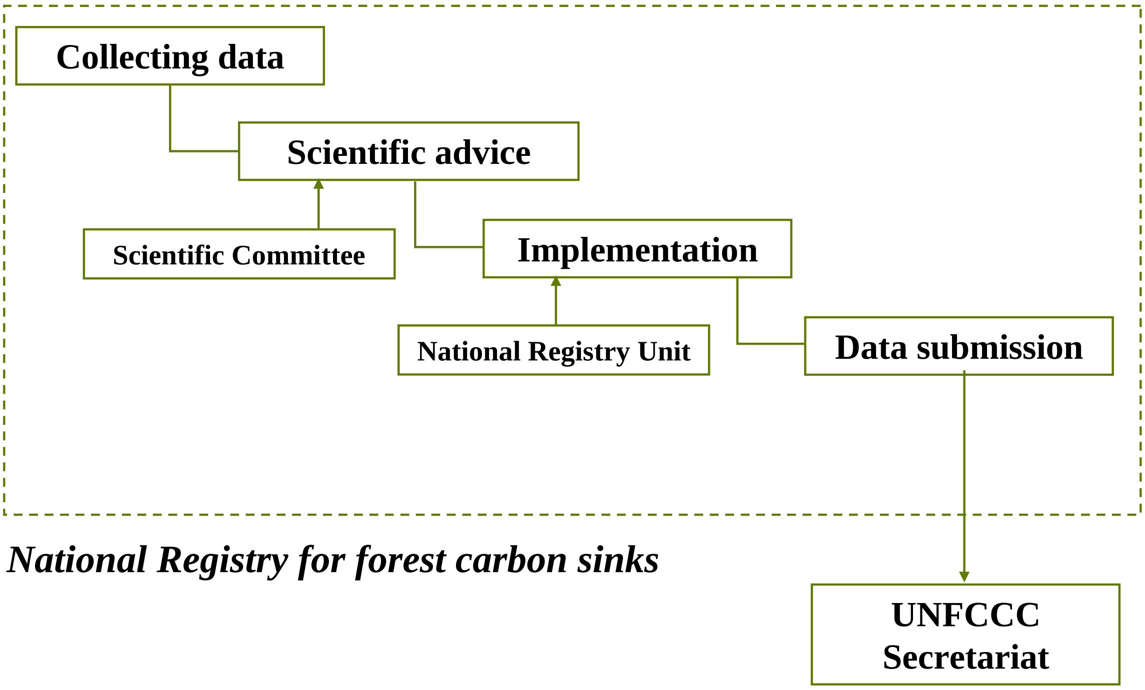
GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)
D. Other					No							

Legend for tables I -1 to I -4

(1) Key categories of the Italian inventory.		
(2) Method applied:		
D (IPCC default)	**T1a, T1b, T1c** (IPCC Tier 1a, Tier 1b and Tier 1c, respectively)	**CR** (CORINAIR)
RA (Reference Approach)	**T2** (IPCC Tier 2)	**CS** (Country Specific)
T1 (IPCC Tier 1)	**T3** (IPCC Tier 3)	**OTH** (Other)
(3) Activity data used		
NS (national statistics)	**IS** (International statistics)	**AS** (associations, business organizations)
RS (regional statistics)	**PS** (Plant Specific data)	**Q** (specific questionnaires, surveys)
(4) Emission factor used:		
D (IPCC default)	**CS** (Country Specific)	**OTH** (Other)
CR (CORINAIR)	**PS** (Plant Specific)	

ANNEX 10: THE NATIONAL REGISTRY FOR FOREST CARBON SINKS

The “National Registry for forest carbon sinks” is part of the Italian National System; it is the instrument to estimate, in accordance with the COP/MOP decisions, the IPCC Good Practice Guidance on LULUCF and every relevant IPCC guidelines, the greenhouse gases emissions by sources and removals by sinks in *forest land* and related land-use changes and to account for the net removals in order to allow the Italian Registry to issue the relevant amount of RMUs.



Italy has approved the National Plan for greenhouse gases reduction (PNR_{GHG}) with the CIPE (*Interministerial Economic Planning Committee*) decision n. 123, of 19 December 2002. The PNR_{GHG} sets policies and measures to act in order to achieve the national target of the Kyoto Protocol; Italy has committed to 6.5% reduction below 1990 greenhouse gases emission levels. The article 7.4 of CIPE decision (123/2002) states that Ministry for the Environment, Land and Sea (MATTM), in agreement with Ministry of Agriculture, Food and Forest Policies (MIPAAF) has to constitute, the National Registry for the forest carbon sinks to account for the net removals in the period 2008 – 2012, from *afforestation*, *reforestation* and *deforestation* activities (art. 3.3 KP) and from elected activities under article 3.4 of Kyoto Protocol (*forest management*). The National Registry for Carbon sinks, instituted by a Ministerial Decree on 1st April 2008, is part of National Greenhouse Gas Inventory System in Italy (ISPRA, 2011 [a]) and includes information on units of lands subject of activities under Article 3.3 and activities elected under Article 3.4 and related carbon stock changes. The National Registry for Carbon sinks is the instrument to estimate, in accordance with the COP/MOP decisions, the IPCC Good Practice Guidance on LULUCF and every relevant IPCC guidelines, the greenhouse gases emissions by sources and removals by sinks in forest land and related land-use changes and to account for the net removals in order to allow the Italian Registry to issue the relevant amount of RMUs. In 2009, a technical group, formed by experts from different institutions (ISPRA; Ministry of the Environment, Land and Sea; Ministry of Agriculture, Food and Forest Policies and University of Tuscia), set up the methodological plan of the activities necessary to implement the registry and defined the relative funding. . Several activities have been implemented and carried out; in particular IUTI, inventory of land use, has been completed, resulting in land use classification, for all national territory, for the years 1990, 2000 and 2008. For 2012, land use and land use changes data were assessed through the survey, carried out in the framework of the III NFI, on a IUTI's subgrid (i.e. 301,300 points, covering the entire country). Time series related to the areas to be included into the different IPCC categories have been assembled using IUTI data, and the data assessed by the national forest inventories (1985, 2005, 2012).Verification and validation activities have been undertaken and the resulting time series have been discussed with the institutions involved in the data providing (i.e. National Forest Service, Ministry of Agricultural, Food and Forestry Policies (MIPAAF), Forest Monitoring and Planning Research Unit (CRA-MPF)).

Italy, in the "*Report on the determination of Italy's assigned amount under Article 7, paragraph 4, of the Kyoto Protocol*" (Decision 13/CMP.1), has reported:

- the election of *forest management* as an activity under Article 3.4 of Kyoto Protocol and has adopted the forest definition in agreement with Food and Agriculture Organization of the United Nations definitions, with the following threshold values for tree crown cover, land area and tree height:
    a. a minimum area of land of 0.5 hectares;
    b. tree crown cover of 10 per cent;
    c. minimum tree height of 5 meters.

Italy's forest area eligible under *forest management* activity is the total forest area, since the entire Italian forest area has to be considered managed.
Following the Decision 8/CMP.2, credits from *forest management* are capped, in the first commitment period, to 2,78 Mt C (10.19 MtCO_2) per year, or 13.9 Mt C (50.97 MtCO_2) the whole commitment period per year.
Italy intends to account for Article 3.3 and 3.4 activities at the end of the commitment period.
Considering that the entire Italian forest area is subject to the *forest management* activity, under Kyoto Protocol, accounting for carbon stocks changes (and the related non-CO_2 emissions) on the national forest area, and on deforested areas, occurring in the first Commitments Period, is required.
The key elements of the accounting system in the National Registry for forest carbon sinks are:

National Land-Use Inventory (IUTI)
aimed at identifying and quantifying:
- *forest land* areas;
- land in conversion from *forest land* category since 31 December 1989;
- land in conversion to *forest land* category since 31 December 1989.

National Inventory of Carbon Stocks (ISCI)
aimed at quantifying:
- carbon stocks and carbon stock changes in any land-use category in the first Commitments Period.

National Census of Forest Fires (CIFI)
aimed at identifying and quantifying:
- *forest land* areas affected by fires.

National Inventory of non-CO_2 emissions from forest fires (IEIF)
aimed at quantifying:
- non-CO_2 emissions from *forest land* areas affected by fires.

National Land-Use Inventory (IUTI)
The National Land-Use Inventory (IUTI) is aimed at identifying the land uses and land-use changes over the national territory. IUTI supplies data concerning areas under *forest land* category (art. 3.4 of KP) and of land in conversion to and from *forest land* categories (art. 3.3 of KP). IUTI is based on a survey of sample points throughout Italian national territory considered as a population of points, and on the classification of the land use coupled with the sampling points. By using on-screen interpretation of digital orthophotos, land use is classified with a high degree of accuracy and precision, as required by IPCC standards. The following set of multi-temporal orthophotos was used as basis of photo-interpretation process:

- 1990, the black and white high resolution full national coverage aerial photography database of TerraItaly[69] was used to produce orthophotos in scale 1:75.000, spatial resolution of 1 m (the aerial

[69] http://www.cgrit.it/prodotti/voli_italia.html

photos, taken on 1988/89, have the same image acquisition standard adopted by USGS-National High Altitude Program at that time: panchromatic film, 400 lines per millimeter);

- 2000, TerraItaly[70] 2000 dataset, digital color aerial orthophotos with spatial resolution of 1 m;
- 2008, TerraItaly[71] 2008 dataset, digital color aerial orthophotos with spatial resolution of 0.5 m.

Furthermore, visual interpretation was supported by ancillary information from available thematic forest and land use maps at regional and sub-regional scales.

Time:

IUTI adopts statistical sampling procedures to estimate the area covered by IPCC land use categories in Italy at three points in time (1990, 2008 and 2012). As abovementioned, the 2012 land use assessment has been carried out in the framework of the III NFI, on a IUTI's subgrid (i.e. 301,300 points, covering the entire country). Time series related to the areas to be included into the different IPCC categories have been assembled using IUTI data, and the data assessed by the national forest inventories (1985, 2005, 2012). Annual estimates of land uses and land use changes are deduced to provide time-series of the areas devoted to any land-use category and any land-use change subcategory to and from *forest land* use, in the KP reporting. For the first Commitment Period accounting, the time series needed is related to the period 31/12/1989 - 1/1/2013; in particular the 31/12/1989 data are needed for identifying existing forest lands (*Forest Management*, art. 3.4) and setting land reference scenario for *Afforestation, Reforestation* and *Deforestation* (art. 3.3).

Space:

The sampling grid and the relative sample plots (1,206,000 sampling points) is uniformly distributed throughout the entire Italian national territory, using a non-aligned systematic sampling. The set of sample points was extracted using a 0.5 km square grid, for a total of about 1,206,000 geo-referenced points randomly located in each square cell and fully covering the Italian territory. A subset of the IUTI sample is represented by the 301,300 first phase sample points of the the national forest inventory (INFC).

Categories and subcategories:

Land use categories (Table A10.1) are defined according to IPCC Good Practice Guidance for LULUCF:

Table A10.1: IUTI classification system

IPCC Category Level I	IUTI Category Level II	IUTI Subcategory Level III	Code
1. Forest land	*Woodland*		**1.1**
	Wooded land temporarily unstocked		**1.2**
2. Cropland	*Arable land and other herbaceous cultivations*		**2.1**
	Arboreal cultivations	*Fruit orchards and plant nurseries*	**2.2.1**
		Wood product plantations	**2.2.2**
3. Grassland	*Grassland, pastures and uncultivated herbaceous areas*		**3.1**
	Other wooded land		**3.2**
4. Wetlands	*Marshlands and open waters*		**4**
5. Settlements	*Urban development*		**5**
6. Other land	*Non-productive areas or areas with scarce or absent vegetation*		**6**

Each sample point is photo-interpreted in order to classify the sample into IUTI land use classes at different points in time (1990, 2008) For 2012 the land classification, through the photo-interpretation, has been assessed on a IUTI's subgrid (i.e. 301,300 points, covering the entire country). For sample points where a land use change in the forest category is detected between 1990 and 2008, as a result of afforestation/reforestation/deforestation activities, the land use classification is performed also in an

[70] http://www.terraitaly.it/
[71] http://www.terraitaly.it/

intermediate point in time (2000), in order to estimate by interpolation the annual gain/loss of forest area in different time periods (1990-2000 and 2000-2008)

Quality assurance/Quality control:

Data supplied by IUTI is collected in the "*National Registry for the forest carbon sinks*" of Kyoto Protocol, and have to fulfil quality requirements as stated by the IPCC and UNFCCC guidelines. The photointerpreters have been trained through specific courses, in order to ensure a standard photointerpretation approach. In this phase, a particular attention was paid to the presence and distribution of forest formations. In cases of uncertain land use classification of the sample point, an internal expert panel classified the point.

The procedure of quality control has been carried out by an internal expert panel which led a new photointerpretation on a sub-sample of classified points (5%). The control activities have produced the same classification as carried out by the photointerpreters in more than of 95% of the cases.

Classification methodology

The adopted classification methodology ensures that any unit of land could be classified univocally (exclusion of multiple classification of the same unit of land) under a category (exclusion of the null case), by means of*:*

- a systematic sampling design to select classification points;
- a list of land-use definitions as reported in the IPCC GPG land-use classification;
- a list of land-use indicators able to indicate the presence of a certain use on the land;
- a classification hierarchy to facilitate land use classification (Table A10.2)

Concerning land use classification, the first step is related to a land classification, following artificial land level; the aim is to discriminate between land areas significantly modified by human activity, with an evolution strongly conditioned by prevalently residential and productive activities, and land areas characterized by a high degree of naturalness, in which natural evolution, although conditioned by human action, still exercises a predominant effect in the determination of the prevalent characteristics of the land.

Distinctions are therefore made between urbanized and agricultural territories, and natural and semi-natural territories (forest, pre-forest and herbaceous formations, open water, rocky areas).

At the subsequent levels, the classification process follows the prevalent use of land in the category of artificial territories, while the discriminating element for natural and semi-natural territories is essentially given by the vegetative cover degree, considering canopy, shrub and herbaceous cover.

Table A10.2: Classification hierarchy

A. LAND WITH ITS ORIGINAL CHARACTERISTICS OF PHYSIOGNOMY AND VEGETATION SIGNIFICANTLY MODIFIED BY HUMAN ACTION, CULTIVATED, CLEARED OR SUBJECT TO URBANIZATION WORK, AND DOMINATED BY ANTHROPIC ARTEFACTS DUE TO RESIDENTIAL, INDUSTRIAL, SOCIO-CULTURAL AND AGRICULTURAL ACTIVITIES.

AI. **Land occupied by other agricultural cultivations**

AI1. Herbaceous cultivations in open fields, subject to regular rotation, for the production of cereals, pulses, other food products or forage.

ARABLE

AI2. Arboreal cultivations not subject to regular rotation, destined permanently to the production of fruit or wood products.

AI2a. *Arboreal cultivations destined prevalently to the production of fruit for nutritional purposes (apple orchards, vineyards, olive groves, etc) or for the production of arboreal or shrub species for ornamental purposes*

ORCHARDS and NURSERIES

AI2b. *Arboreal cultivations destined prevalently to the production of wood products or of woody biomass for energy generation purposes*

ARBOREAL CULTIVATIONS FOR WOOD PRODUCTS

AII. **Areas with residential and industrial buildings and services, transport routes, infrastructures and urban green areas (parks and gardens)**

SETTLEMENTS

B. NATURAL OR SEMI-NATURAL LAND NOT SIGNIFICANTLY MODIFIED BY HUMAN ACTION OR IN PHASE OF RENATURALIZATION.

BI. **Formations constituted by trees able to reach the height on maturity *in situ* of 5 m, but temporarily lacking in canopy cover following accidental events or anthropic action.**

WOODED LAND TEMPORARILY WITHOUT ABOVE-GROUND COVER

BII. **Formations constituted by trees able to reach the height on maturity *in situ* of 5 m and procuring a degree of canopy cover on the terrain of ≥ 5%.**

BII1. Formation with a degree of cover < 10%

OTHER WOODED AREAS

BII2. Formation with a degree of cover ≥ 10%

WOODLAND

BIII. **Formations never as above**

BIII1. Formations constituted by shrubs or trees not able to reach a height on maturity *in situ* of 5 m, and procuring a degree of canopy cover on the terrain of ≥ 10%

OTHER WOODED LAND

BIII2. Formations constituted by shrubs or trees not able to reach a height on maturity *in situ* of 5 m and procuring a degree of canopy cover on the terrain of < 10%, and silvi-pastural formations with canopy cover from trees able to reach a height on maturity *in situ* of 5 m but with cover < 5%

BIII2a. *Natural herbaceous formations of ground species with a degree of herbaceous cover of ≥ 40%.*

PASTURES, MEADOWS and UNCULTIVATED HERBACEOUS AREAS

BIII2b. *Natural herbaceous formations with a degree of herbaceous cover of < 40% or land completely lacking herbaceous cover*

BIII2b1. *Land without vegetation or with sporadic herbaceous vegetation. Rocky outcrops and beaches.*

OTHER LANDS

C. AREAS WITHOUT VEGETATION AND COVERED BY STILL OR FLOWING WATER OR AREAS OCCUPIED BY PARTICULAR ECOSYSTEMS OTHER THAN TERRESTRIAL ECOSYSTEMS (FLOATING VEGETATION, WET VEGETATION, SALTWATER VEGETATION, ETC).

MARSHLANDS AND OPEN WATERS

To achieve land use classification, a 0.5 ha neighbourhood of the sample plot is investigated. The operative procedure consists in digital orthophotos processing, considering sampling points: for each point identified on the territory by coordinates in a known reference system, the land use category, defined according to the classification system, must be established.
A grid, composed of 9 squares (3 x 3) of 2500 m² each, for an overall surface area of 22,500 m² is used. This graphic object, at the centre of which the sampling point must be situated, allows to assess whether area intercepted by the sampling point has an extension equal to or greater than the established threshold (equivalent to the surface area of 2 of the 9 cells displayed).
If the surface area value is very close to the threshold and the use of the cells still leaves doubts, a graphic tool for surface area measurement is used for the classification process. The contour of the polygon containing the sampling point is mapped, computing the extent of the area.
In Figures A10.1, A10.2 and A10.3, examples from land use classification system are reported. In particular, in figure 1 the sampling point is classified as 3.1 Grassland, given that trees covering the sampling point have a surface area between 500 and 5000 m². In Figure A10.2, the sampling point is classified as 1.1 Woodland, while in Figure A10.3, the sampling point is classified as 3.1 Grassland.

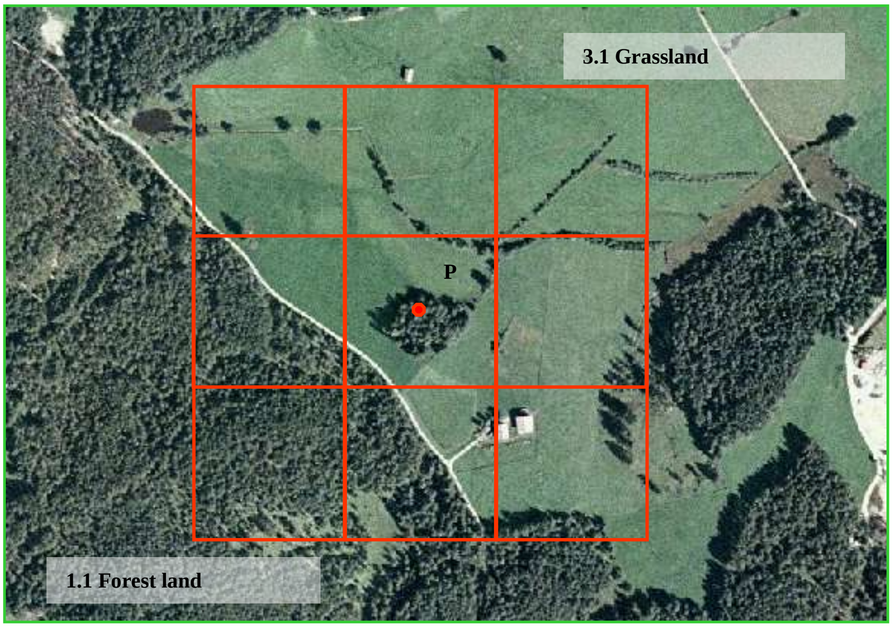


Figure A10.1: Land use classification system - grassland

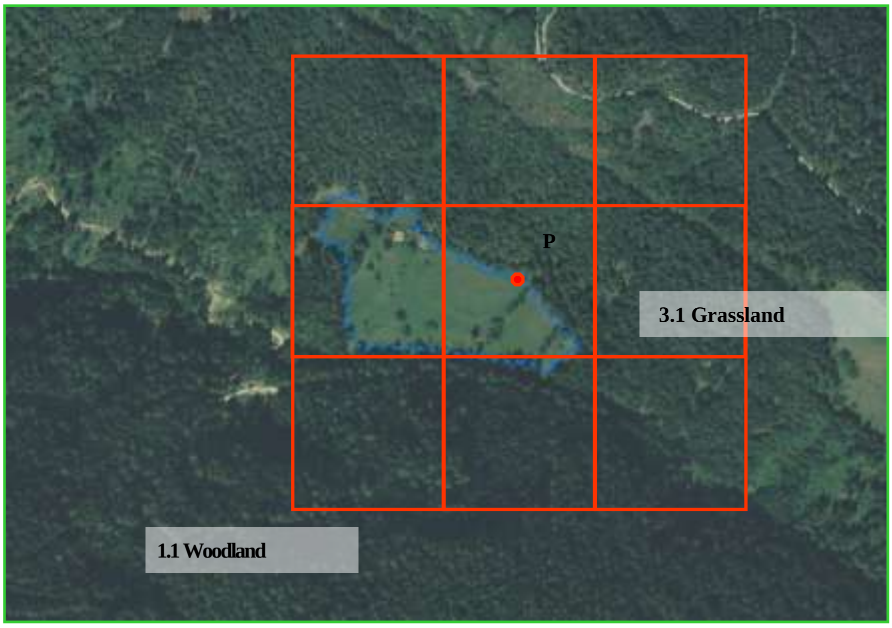


Figure A10.2: Land use classification system - Woodland

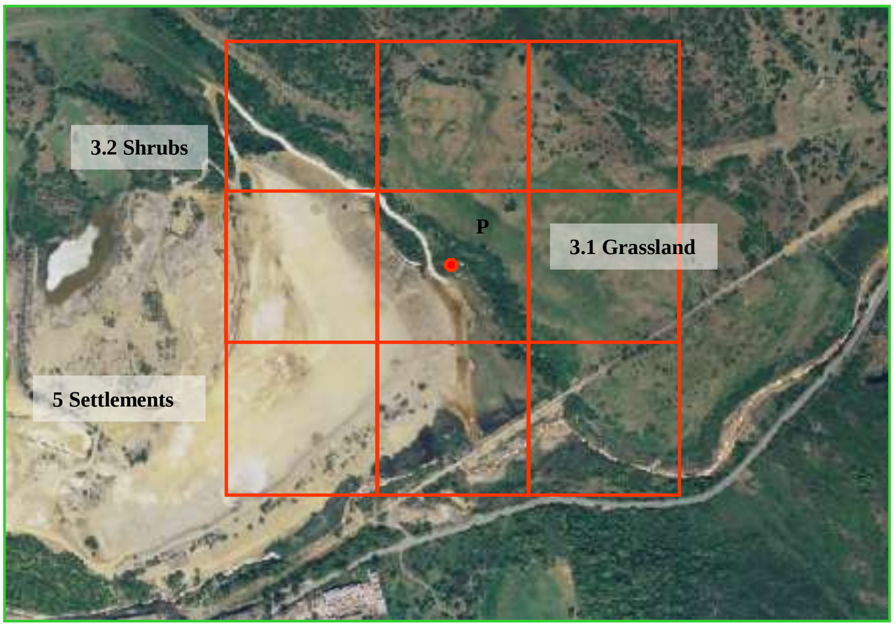


Figure A10.3: Land use classification system – grassland

National Inventory of Carbon Stocks (ISCI)
The National Inventory of the Carbon Stocks is a sampling of carbon stocks related to the different land-use categories.
The National Inventory of the Carbon Stocks includes:
- carbon stock changes in the land-use category forest land, the dataset is derived by the NFIs data;
- carbon stock changes in the subcategories of the conversion to or from forest land to other predominant uses, the land in conversion to and from *forest land* to other uses require data integration with studies and additional surveys in order to estimate, at regional level, the C stock levels related to non-forest land uses(i.e. *settlements*, *cropland*, *grassland*, *wetlands*).

Time:
ISCI annually provides time series of carbon stock levels and carbon stock changes for the category *forest land* and for the sub-categories land in conversion to and from *forest land* to other uses. For the Kyoto Protocol first Commitment Period accounting, the time series needed is related to the period 31/12/2007 - 1/1/2013.

Space:
Concerning the category *forest land* and any other category in conversion to and from *forest land,* the NFIs assure the spatial coverage, providing carbon stocks data, at NUT2 level.

Quality assurance:
Data supplied by ISCI is collected in the so-called "*National Registry for the forest carbon sinks*" of Kyoto Protocol, and fulfil quality requirements as stated by the IPCC and UNFCCC guidelines.

National Census of Forest Fires (CIFI)
The National Census of Forest Fires is a system aimed to detect, locate and classify *forest land* areas affected by fires; it will provide data on:
- forest areas affected by fires;
- forest typology and stand features;
- proxy parameters in order to estimate the initial C stock and losses by fire (e.g. vegetation height, altitude, slope, exposure).

Time:
CIFI annually provides, from 01/01/2008, time series of forest areas affected by fires. For the Kyoto Protocol first Commitment Period accounting, the time series needed is related to the period 01/01/2008 - 31/12/2012..

Space:
CIFI covers all the national territory and will provide geographically referenced data on burned *forest land remaining forest land* areas (art. 3.4) and on *land converted to forest land* burned areas (art. 3.3).

Key elements:
The key elements are:
- ground surveys that have to detect fires and record boundaries of burned areas. Additional data will concern collection of attributes as damage evaluation (percentage of oxidised biomass), forest typology (following NFI classification);
- remote sensed data will integrate data from ground surveys, in order to cross-check detected burned areas, at 0.5 ha spatial definition;

Quality assurance:
Data supplied by CIFI is collected in the so-called "*National Registry for the forest carbon sinks*" of Kyoto Protocol, and fulfil quality requirements as stated by the IPCC and UNFCCC guidelines.

National Inventory of non-CO_2 emissions from forest fires (IEIF)

The Forest fires GHG emissions National Inventory is aimed at estimating non-CO_2 emissions from forest fires (CO_2 emissions are not taken into account, being already computed by National Inventory Carbon Stocks as decreases in carbon stocks). It will provide:

- emission figures of the land-use category *forest land*;
- emission figures of the land-use categories in conversion to or from *forest land* to other predominant uses.

Time:

The Forest fires GHG emissions National Inventory annually provides time series of non-CO_2 emissions from forest fires. For the Kyoto Protocol first Commitment Period (CP) accounting, the needed time series is related to the period 01/01/2008 - 31/12/2012.

Space: IEIF supplies estimates of emissions released by fires detected by National Census of Forest Fires.

Key elements:

For any fire, once identified the prevalent forest typology and the damage of the stand (i.e. percentage of burned biomass) affected by fire, through the National Forest Service surveys, related carbon stocks are estimated by National Inventory Carbon Stocks. Emissions are calculated applying the damage coefficients and the emissions factors referenced or elaborated by research projects to the estimated carbon stocks.

Quality assurance:

Data supplied by IEIF is collected in the "*National Registry for the forest carbon sinks*" of Kyoto Protocol, fulfil quality requirements as stated by the IPCC and UNFCCC guidelines.

ANNEX 11: THE NATIONAL REGISTRY

According to Article 7 of the Kyoto Protocol each Party included in Annex I shall incorporate in its annual greenhouse gas inventory the necessary supplementary information for the purposes of ensuring compliance with Article 3 of the Kyoto Protocol.
Supplementary information under article 7, paragraph 1, with regards to units holdings and transactions during the year 2013, is reported in the SEF submission (figures are also included in tables A8.2.2.1 - A8.2.2.5c of this document).
This annex reports supplementary information with regards to the national registry and in accordance with the guidelines set down in Decision 15 CMP.1 (Annex II.E Paragraph 32).
More detailed information can be found in the relevant annexes that have been submitted to UNFCCC along with this document.

(a) ***The name and contact information of the registry administrator designated by the Party to maintain the national registry***

The Italian Registry is administrated by ISPRA (former APAT) under the supervision of the national Competent Authority for the implementation of the European directive 2003/87/CE, jointly established by the Ministry for Environment, Land and Sea and the Ministry for Economic Development. ISPRA, as Registry Administrator, is responsible for the management and functioning of the Registry, including Kyoto protocol obligations.

The contact person is: Mr Riccardo Liburdi
address: Via Vitaliano Brancati 48 – 00144 Rome – Italy
telephone: +390650072544
fax: +390650072657
e-mail: riccardo.liburdi@isprambiente.it

(b) ***The names of the other Parties with which the Party cooperates by maintaining their national registries in a consolidated system***

As reported in chapter 13, the EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and decision 24/CP.8. The consolidated platform which implements the national registries in a consolidated manner (including the registry of EU) is called Consolidated System of EU registries (CSEUR).

(c) ***A description of the database structure and capacity of the national registry***

In 2012, the EU registry has undergone a major redevelopment with a view to comply with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011 in addition to implementing the Consolidated System of EU registries (CSEUR).
The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries.
During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). All tests were executed successfully and lead to successful certification on 1 June 2012.
Iteration 5 of the national registry released in January 2013 and Iteration 6 of the national registry released in June 2013 introduced changes in the structure of the database.

Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. An updated diagram of the database structure is provided along with this submission as Annex A.

(d) ***A description of how the national registry conforms to the technical standards for data exchange between registry systems for the purpose of ensuring the accurate, transparent and efficient exchange of data between national registries, the clean development mechanism registry and the transaction log (decision 19/CP.7, paragraph 1)***

The overall change to a Consolidated System of EU Registries triggered changes to the registry software and required new conformance testing. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries.
During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). All tests were executed successfully and lead to successful certification on 1 June 2012.
Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality.
However, each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to the relevant major release of the version to Production (see Annex B).
Annex H testing was carried out in February 2014 and the successful test report is attached to this submission as Annex C.

(e) ***A description of the procedures employed in the national registry to minimize discrepancies in the issuance, transfer, acquisition, cancellation and retirement of ERUs, CERs, tCERs, lCERs, AAUs and/or RMUs, and replacement of tCERS and lCERs, and of the steps taken to terminate transactions where a discrepancy is notified and to correct problems in the event of a failure to terminate the transactions***

The overall change to a Consolidated System of EU Registries also triggered changes to discrepancies procedures, as reflected in the updated **manual intervention document** and the **operational plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries.

(f) ***An overview of security measures employed in the national registry to prevent unauthorized manipulations and to prevent operator error and of how these measures are kept up to date***

The overall change to a Consolidated System of EU Registries also triggered changes to security, as reflected in the updated **security plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries.

(g) ***A list of the information publicly accessible by means of the user interface to the national registry***

Non-confidential information required by Decision 13/CMP.1 annex II.E paragraphs 44-48, is publicly accessible through the public website http://www.info-ets.isprambiente.it

All required information is provided with the following exceptions:

- paragraph 45(d)(e): account number, representative identifier name and contact information is deemed as confidential according to Annex III and VIII (Table III-I and VIII-I) of Commission Regulation (EU) No 389/2013;

- paragraph 46: no Article 6 (Joint Implementation) project is reported as conversion to an ERU under an Article 6 project did not occur in the specified period;
- paragraph 47(a)(d)(f): holding and transaction information is provided on an account type level, due to more detailed information being declared confidential by article 110 of Commission Regulation (EU) No 389/2013.

(h) ***The Internet address of the interface to its national registry***

The italian registry can be accessed at the following URL:
https://ets-registry.webgate.ec.europa.eu/euregistry/IT/index.xhtml
A support portal, with news, procedures, documentation, is also available for the public at:
http://www.info-ets.isprambiente.it

(i) ***A description of measures taken to safeguard, maintain and recover data in order to ensure the integrity of data storage and the recovery of registry services in the event of a disaster***

The overall change to a Consolidated System of EU Registries also triggered changes to data integrity measures, as reflected in the updated **disaster recovery plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries.

(j) ***The results of any test procedures that might be available or developed with the aim of testing the performance, procedures and security measures of the national registry undertaken pursuant to the provisions of decision 19/CP.7 relating to the technical standards for data exchange between registry systems.***

On 2 October 2012 a new software release (called V4) including functionalities enabling the auctioning of phase 3 and aviation allowances, a new EU ETS account type (trading account) and a trusted account list went into Production. The trusted account list adds to the set of security measures available in the CSEUR. This measure prevents any transfer from a holding account to an account that is not trusted.
Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission; the report is attached to this submission as Annex B.
Annex H testing was carried out in February 2014 and the successful test report is attached to this submission as Annex C.

ANNEX 12: OVERVIEW OF THE CURRENT SUBMISSION IMPROVEMENTS

During the last UNFCCC review process, some issues were raised which have been taken into account to improve the current submission. Responses to the main recommendations are described in the following table.

Review report para	Subject	Description	Response
11	*Key category analysis*	Under Convention reporting, lands converted to settlements and grassland are key categories. The ERT recommends that Italy provide additional information in the NIR to document why these categories and hence deforestation are not identified as key under Kyoto Protocol reporting.	The ERT recommendation has been addressed and the categories have been identified as key in the current submission (§ 1.5, 10.6)
22	**Energy** - Reference and sectoral approaches - *Feedstocks and non-energy use of fuels*	Italy provided comments to the CRF tables with regard to the allocation of some fuels to naphtha in order to explain the negative figures obtained for the fraction of carbon stored in some fuels as a result of an input and output balance calculation. For lubricants, the Party estimated the carbon stored as the difference between the amount of lubricants and the amount of recovered lubricant oils. During the review, Italy also provided more information on the balance of input and output and explained that fractions of carbon oxidized are derived from actual carbon oxidized quantities calculated by the Party through this balance. As these fractions are derived from actual measurements they do not correspond to any default values and may vary over time. The fractions are country-specific and therefore more suitable to the country's conditions. The ERT recommends that Italy include information on the specific calculation of the fraction of carbon oxidized in the NIR of its next annual submission.	Additional information has been provided in the NIR (§ 3.8.2)
25	**Energy** - Stationary combustion: solid fuels – CH_4	The previous review report encouraged Italy to disaggregate process-related emissions from the iron and steel subcategory and to report process-related emissions in the industrial processes sector. In response to a question raised by the ERT, the Party stated that CH_4 process emissions for pig iron and steel production are already allocated to the industrial processes sector; fugitive CH_4 emissions from coke production are reported under fugitive emissions; and CH_4 emissions from the combustion of fuels are allocated to the energy sector. The ERT recommends that Italy include more detailed information in the NIR on the calculations performed by the Party to disaggregate and allocate emissions, so as to improve transparency of reporting.	Additional information has been provided in the NIR (§ 3.4.2)

Review report para	Subject	Description	Response
26	**Energy** - Stationary combustion: gaseous fuels, biomass – CO_2, CH_4 and N_2O	In public electricity and heat production, while CO_2 emissions dropped by 1.5 per cent, CH_4 and N_2O emissions rose in the same period by 13.9 per cent and 11.1 per cent, respectively. In response to questions raised by the ERT during the review, the Party explained that this is due to the increase in natural gas and biomass use, which drives the trend of the category. The ERT recommends that the Party include this explanation in the NIR in order to improve the transparency of the report.	Additional information has been provided in the NIR (§ 3.3.1)
27	**Energy** - Stationary combustion: other fuels – CH_4	In response to a recommendation made in the previous review report, Italy provided information in the NIR on the other fuels used for the public electricity and heat production, ~~and~~ commercial/institutional and chemical subcategories. For public electricity and heat production, other fuels include minor amounts of other liquid, solid and gaseous fuels from a mix of industrial wastes such as plastics, rubber and solvents, and synthesis gas from heavy residual fuel, while for the commercial/institutional subcategory other fuels refers to the amount of fossil waste burned in incinerators with energy recovered. For chemicals, other fuel includes the consumption of residual gases from chemical processes. Although transparency has been improved with the provision of this information, EFs have only been reported in the NIR for public electricity and heat production. The ERT reiterates the recommendation made in the previous review report that Italy include in the NIR the EFs used in all subcategories.	Additional information has been provided in the NIR (§ 3.4.3)
28	**Energy** - Fugitive emissions: oil and natural gas – CO_2, CH_4 and N_2O	In addition, Italy uses notation key “NO” for CO_2 and CH_4 exploration emissions, while a note in the CRF table indicates that these emissions are accounted for in 1.B.2.B.2 Production. The Party clarified that the notation key is correct as emissions do not occur in the years when it is reported as “NO”, and that the comments are outdated. The ERT recommends that Italy review and correct the comments provided in the cells with regard to this category	The inappropriate note in the CRF cells has been deleted
32	**Industrial processes** - Cement production – CO_2 - Transparency	In response to a recommendation made in the previous review report, Italy provided a statistical analysis of the clinker facility level IEFs for the years 2003 and 2005–2011. Italy stated in the NIR that the IEFs based on national ETS data from 2003 are in line with the value of 540 kg CO2/t clinker used for the period 1990–2003 as 88.0 per cent of the facilities had an IEF in the range of 535.00–549.99 kg CO2/t clinker and 75.0 per cent were in the range of 540.00–544.99 kg CO2/t clinker. The ERT recommends	Additional information has been added in the NIR (§ 4.2.1, 4.2.2)

Review report para	Subject	Description	Response
		that Italy in its next submission provide more information on the underlying drivers for the change in IEFs since 2003 and on how time-series consistency has been maintained. As an example, it could be clarified whether the lower IEFs are due to a change in the composition of the raw material, changes in the process or changes in estimation methods. The ERT also recommends that Italy provide more information about the method used to determine process emissions from cement production under the EU ETS and indicate whether this method is kiln input based or clinker output based.	
33	**Industrial processes** – Iron and steel production – CO_2	The previous review report encouraged Italy to disaggregate the process emissions due to the use of coke in iron and steel production from total emissions reported in fuel combustion and report them under the industrial processes sector. During the review, Italy reported on the preliminary results of an industry survey which found that there is no accurate information by which to disaggregate the emissions. As any arbitrary disaggregation would not reflect the real situation, the ERT agreed that leaving the total emissions from the use of coke in the iron and steel industry in the energy sector is appropriate. The ERT recommends that Italy report the details of the survey in the NIR in its next annual submission.	Additional information has been added in the NIR (§ 4.4.2; Annex 3). See also Annex 6 and § 3.4.3
34	**Industrial processes** - Consumption of HFCs and SF6 – HFCs	HFC emissions from domestic refrigeration, small and large commercial units and chillers have all been reported under domestic refrigeration in the NIR and the CRF table 2(II). As a consequence, it is not clear which product life factors and product manufacturing factors have been used for the different subcategories. This reduces transparency and prevents the assessment of comparability of these factors. During the review, Italy provided the ERT with the underlying calculations used to estimate emissions from refrigeration. These calculations show that Italy could report emissions from certain of the subcategories separately as the consumption of blends and gases are attributed to these different subcategories (data provided by the HFC manufacturer) and different country-specific product life and product manufacturing factors are used for each subcategory. The ERT strongly recommends that Italy report separately the AD, product life factors, product manufacturing factors and emissions for domestic and commercial refrigeration in CRF table 2(II) and document the factors	Italy has considered this recommendation in the estimations and consequently in the NIR (§ 4.7.2)

Review report para	Subject	Description	Response
		used in the NIR of the next annual submission.	
35	**Industrial processes** - Consumption of HFCs and SF6 – HFCs	As outlined in paragraph 34 above, Italy uses a bottom-up method to estimate emissions from refrigeration. In addition, Italy stated in the NIR and CRF tables that the emissions from equipment disposal have been included in the emissions during the product's life for the whole time series. In order to improve the transparency of the estimation methodology, the ERT recommends that Italy improve the description of the inventory and use a top-down approach to cross-check the final emission estimate.	The description has been improved (§ 4.7.2) while the cross check with the top-down approach is planned for the next submission
37	**Industrial processes** - Consumption of HFCs and SF6 – HFCs	In response to the list of potential problems and further questions raised by the ERT, Italy provided additional information, based on consultations with relevant industry associations, which confirmed that the product life factor for large commercial refrigeration is too low and should be 12.0 per cent. However, during these consultations it was also identified that the product life factor for chillers and the product manufacturing factors for both refrigeration and chillers were too high. The net result of implementing all the corrected factors would be a reduction in the 2011 emissions of 502.7 Gg CO2 eq. The ERT strongly recommends that Italy use the revised factors in the estimation of emissions in its next annual submission and that it document the methods appropriately in the NIR by specifying the manufacturing and product life factors used for each application.	Italy has considered this recommendation in the estimations and consequently in the NIR (§ 4.7.2)
38	**Industrial processes** - Lime production – CO_2	The NIR states that for the period 2005–2008 the emissions from lime production have been estimated using production data from the Italian National Institute of Statistics (ISTAT) and detailed information from the EU ETS, while from 2009 on the EU ETS has provided plant-specific lime production and CO2 emissions data. However, the NIR provides no information on how the EFs for years prior to 2005 are estimated. During the review, Italy provided the ERT with the information that the EFs for the period 2000–2003 are based on detailed information from the national allocation plan and that the EFs for 1990–1999 are based on the average of the 2000–2003 EFs. To improve transparency and information about consistency, the ERT recommends that Italy provide more information about the methods used to estimate emissions from lime production for the entire time series. Italy should also	Additional information has been added in the NIR (§ 4.2.1, 4.2.2)

Review report para	Subject	Description	Response
		clearly document whether the method is based on the amount of calcium and magnesium carbonate from the raw material, or on the amount of calcium and magnesium oxides in the lime produced for each of the periods.	
39	**Industrial processes** - Lime production – CO_2	For the period 1990–2004, the IEF for lime production is 0.8 t CO2/t lime, then from 2005 on, following the introduction of the EU ETS, the IEF changes to 0.7 t CO2/t lime. Since more detailed information about raw kiln input and the process became available with the introduction of the EU ETS, the IEF can be specified more accurately. The ERT recommends that Italy in its next annual submission provide more information about the underlying drivers for the change in the IEF since 2005 and on how time-series consistency has been maintained. As an example, it is not clear whether the lower IEFs are due to a change in the composition of the raw material, changes in the process or changes in the estimation methods.	Additional information has been added in the NIR (§ 4.2.1, 4.2.2)
43	**Agriculture** - Manure management – CH_4	To improve transparency the ERT recommends that Italy document the methods used to estimate the 8.0 per cent emission reduction in the next NIR submission, including information on the share of covered/uncovered storage and the emissions rate for covered storage systems. The ERT also observed that, there has been a rapid increase in biogas recovery in recent years which is likely to have increased the share of covered storage, reducing the accuracy of the 8.0 per cent value. The ERT recommends that Italy review and revise this value, as appropriate, to take into consideration changes in waste management through the time-series.	Additional information has been supplied in the NIR (§6.3.2 *Methane emissions (swine))*. The collection of additional information on the share of covered/uncovered storage, the emissions rate for covered storage systems and the review of the percentage emission reduction is in progress, in collaboration with the CRPA and the ISTAT
44	**Agriculture** - Agricultural soils – N_2O	The ERT recommends that Italy, in its next annual submission, include information about each crop production type and appropriate parameters for relevant crop production categories which are used for emission calculation to improve transparency	Additional information has been supplied in the NIR (§6.5.2 *Methodological issues (see Crop residues* (F_{CR})) and in the Annex 7, §A7.3 Agricultural soils)
45	**Agriculture** - Field burning of agricultural residues – CH_4 and N_2O	The ERT recommends that Italy correct the identification of the methodology used for field burning of agricultural residues in the NIR and in CRF table summary 3 in the next submission (IPCC methodology instead of CS methodology).	The identification of the methodology has been corrected in the NIR and in CRF.
47	**LULUCF** - Sector overview	… The ERT recommends that Italy provide detailed explanations for all recalculations in future submissions.	A detailed description related to the recalculations applied in the different categories has been provided in the NIR (§7.2.7, §7.3.7, §7.4.7, §7.6.7, §7.10.3, §7.12.6)
48	**LULUCF** -	The LULUCF inventory is complete with	Detailed information has been reported

Review report para	Subject	Description	Response
	Sector overview	respect to the coverage of categories but the dead organic matter pool for grassland and cropland converted to settlements has been reported as "NE" (not estimated). The Party reported in the CRF tables that this is due to lack of information. If conversion is from annual crops or pasture, as indicated by the reporting of NO for living biomass, dead organic matter could also be considered to be NO. The ERT recommends that Italy assess which type of cropland and grassland is converted to settlements and use the appropriate notation keys. Since the 2012 submission, Italy has improved completeness by estimating and reporting the dead organic matter pool in forest land and fires in non-forest land.	in the NIR (§7.3.4, §7.4.4, §7.6.4).
50	**LULUCF** - Sector overview	... The ERT reiterates the recommendation made in the previous review report that Italy use the IUTI data to update the land-use matrices and recalculate the estimates for the period 1990–2011 in its next annual submission.	The ERT's recommendation has been addressed and an updated methodology to assess land uses and land use changes has been used, on the basis of the IUTI data, as detailed in the NIR (§7.1).
51	**LULUCF** - Forest land remaining forest land - CO_2	... The ERT recommends that Italy improve the explanation of how the AD are derived in its next annual submission.	Detailed information has been reported in the NIR (§7.1, §7.2.2).
53	**LULUCF** - Forest land remaining forest land - CO_2	Italy has reported that the IPCC tier 1 method for mineral soils for forest land remaining forest land has been applied and as such has assumed no change in carbon stocks. However in the same section of the NIR (section 7.2.4 page 200) it is also stated that changes in minerals soils for forest land remaining forest land have been estimated. It is only on reading section 10.3.1.2 (page 276) that it becomes clear that the estimates are made using an alternative method in order to demonstrate that forest management soil pool is not a source. The ERT recommends that Italy-improve the clarity of the NIR text in the next annual submission.	Detailed information has been reported in the NIR (§7.2.4, §10.3.1.2).
55	**LULUCF** – Cropland remaining cropland - CO_2	… The ERT recommends that Italy for its next annual submission either report all areas of plantations in forest land or alternatively disaggregate the areas of plantations and report in cropland only those considered very short rotations used as energy crops.	The ERT's recommendation has been addressed and plantations, previously included into cropland category, have been allocated in forest land category as described in the NIR (§7.2.2, §7.2.3)
56	**LULUCF** – Land converted to settlements - CO_2	... The ERT recommends that Italy correct the value of the carbon content of woody crops biomass for land converted to settlements in the next annual submission.	The ERT's recommendation has been addressed and the correct value has been used to estimate carbon stock changes for cropland converted to settlements as described in the NIR (§7.6.4)
57	**LULUCF** – Land converted to settlements - CO_2	…The ERT notes that this method could, theoretically, introduce significant uncertainties if the linear relationships are not validated and reiterates the	In the NIR (§7.2.4) a detailed description of the methods and data used to estimate soils carbon stocks (and the consequent carbon stock changes) is

Review report para	Subject	Description	Response
		recommendation made in the previous review report that the Party provide further documentation on the adequacy of this method for the national circumstances of Italy.	reported. These SOCs have been used to assess the carbon stock changes for forest land converted to settlements.
60	**Waste** - Solid waste disposal on land - transparency	The transparency of information on CO2 emissions from recovered landfill gas has been improved in the 2013 submission with the provision of a detailed breakdown of the sources of biomass AD in the commercial/institutional subcategory in the energy sector (table 8.12 in the NIR). This table includes information relevant to other waste categories and the energy sector. To ensure transparency in all categories/subcategories, the ERT recommends that Italy appropriately reference table 8.12 in all relevant sections of the NIR in both the energy and the waste sector in its next annual submission.	Italy has considered this suggestion (§ 3.6.2; § 8.3.1)
62	**Waste** - Waste incineration – CO_2	When justifying the choice of the CO2 EF for municipal waste (289.26 kg/t) in the NIR of the 2013 submission, Italy stated that the CO2 EF for municipal waste has been calculated considering a carbon content equal to 23.0 per cent; moreover, on the basis of the Revised 1996 IPCC Guidelines and the average content analysis on a national scale reported by Federambiente (1992), a distinction was made between CO2 from fossil fuels (generally plastics) and CO2 from renewable organic sources (paper, wood, other organic materials). Only emissions from fossil fuels, which are equivalent to 35.0 per cent of the total, were included in the inventory. The ERT noted that the distribution of carbon content between fossil carbon and renewable carbon is actually presented in a report by De Stefanis (2002). In order to improve the transparency of the report, the ERT recommends that Italy replace the reference to Federambiente (1992) with De Stefanis (2002) in its next annual submission.	Italy has considered this suggestion (§8.4.2)
63	**Supplementary information required under Article 7.1 of the KP** – Overview – Table 6	Italy reported that a new system of identifying land using the national land-use inventory (IUTI) will be implemented in the 2014 submission to address this issue. The IUTI uses statistical sampling procedures to classify lands at three points in time (1990, 2008 and 2012). Where a land-use change has been detected in 2008, the classification is also performed for 2000. The process of collection, validation and verification of the 2012 IUTI data is currently ongoing. The ERT strongly recommends that Italy complete the IUTI and implement it in the 2014 submission so as to provide the necessary additional spatial data required to	The ERT's recommendation has been addressed and an updated methodology to assess land uses and land use changes has been used, on the basis of the IUTI data, as detailed in the NIR (§7.1).

Review report para	Subject	Description	Response
		meet the reporting requirements of decision 16/CMP.1	
64	**Supplementary information required under Article 7.1 of the KP** – Overview	…Following a similar rationale, the ERT recommends that Italy classify these plantations as forest and report them in the appropriate Article 3, paragraphs 3 and 4, categories in the next annual submission….	The ERT's recommendation has been addressed and plantations, previously not included in area subject to art. 3.3 and 3.4 activities, have been classified as forest and reported in the appropriate Art. 3.3 and 3.4, categories as described in the NIR (§10.1.1)
66	**Supplementary information required under Article 7.1 of the KP** - Activities under Article 3.3, of the KP -Afforestation and reforestation - CO_2	…To improve transparency, the ERT recommends that Italy improve the explanation and justification for abandoned arable lands which are "naturally forested" to be reported as afforestation/reforestation consistent with decision 16/CMP.1. Specifically, Italy should elaborate how the decree 227/2001 protects all naturally regenerated forest.	A description of legislative Italian context and the consequent implications for the direct human induced afforestation and reforestation activities has been provided in the NIR (§10.4.1)
68	**Supplementary information required under Article 7.1 of the KP** - Activities under Article 3.4 of the KP – Deforestation - CO_2	…The ERT recommends that Italy provide information in the next annual submission on how deforestation of these lands is identified and reported, ensuring appropriate accounting of emission/removals.	The ERT's recommendation has been addressed and updated data related to deforestation activities have been used, as described in the NIR (§10.1.3, §10.2.2, §10.4.1)
69	**Supplementary information required under Article 7.1 of the KP** - Activities under Article 3.4 of the KP – Forest management - CO_2	…The ERT recommends that the Party provide further documentation on the adequacy of this approach to estimate changes in SOC for the national circumstances of Italy (see para 56 above).	In the NIR (§10.3.1.2) a detailed description of the methods and data used to estimate soils carbon stocks (and the consequent carbon stock changes) is reported. These SOCs have been used to assess the carbon stock changes in AR activities.