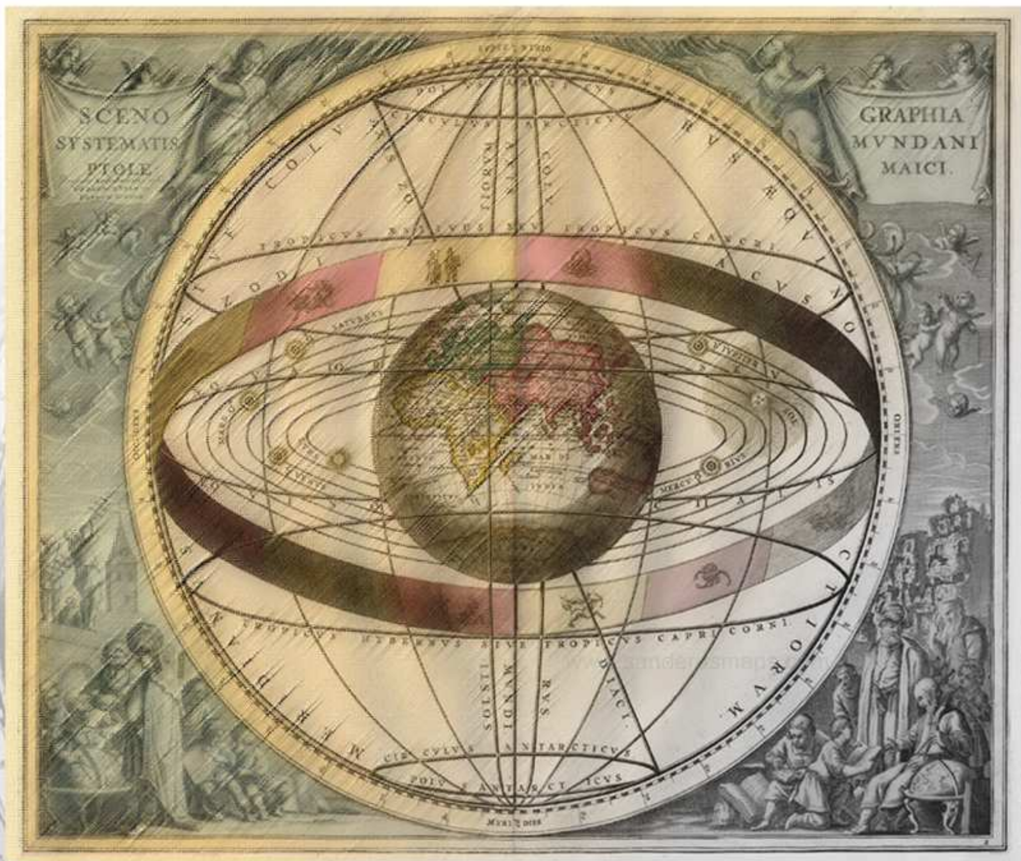
ISPRA

Istituto Superiore per la Protezione
e la Ricerca Ambientale

RAPPORTI

Italian Greenhouse Gas Inventory 1990 - 2009

National Inventory Report 2011



139 / 2011

ISPRA
Istituto Superiore per la Protezione
e la Ricerca Ambientale

Italian Greenhouse Gas Inventory 1990 - 2009

National Inventory Report 2011

Rapporti 139/2011

ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale
(Institute for Environmental Protection and Research)
Via Vitaliano Brancati, 48 – 00144 Rome
www.isprambiente.it

ISPRA is the Institute for Environmental Protection and Research established by Italian Law 133/2008, as published in the Official Journal n. 195, August 21 2008. The Institute performs the functions of three former institutions: APAT (Agency for Environmental Protection and Technical Services), ICRAM (Central Institute for Applied Marine Research), INFS (National Institute for Wildlife).

ISBN 978-88-448-0496-1

Cover design
Franco Iozzoli

Cover photo
“Scenographia systematis mundani ptolemaici” - Andreas Cellarius, in Atlas coelestis seu armonia macrocosmica, Amsterdam, 1661.

Typographic coordination
Daria Mazzella
ISPRA - Section for Publishing

Administration
Olimpia Girolamo
ISPRA - Section for Publishing

Distribution
Michelina Porcarelli
ISPRA - Section for Publishing

Text available on ISPRA website at www.isprambiente.it

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

Authors

Daniela Romano, Chiara Arcarese, Antonella Bernetti, Antonio Caputo, Rocío D. Cóndor, Mario Contaldi, Riccardo De Lauretis, Eleonora Di Cristofaro, Sandro Federici, Andrea Gagna, Barbara Gonella, Francesca Lena, Riccardo Liburdi, Ernesto Taurino, Marina Vitullo

PART 1: ANNUAL INVENTORY SUBMISSION

INTRODUCTION
Daniela Romano
Riccardo De Lauretis
Marina Vitullo (§1.2.2)
Chiara Arcarese (§1.2.3)

TRENDS IN GREENHOUSE GAS EMISSIONS
Marina Vitullo
Daniela Romano

ENERGY
Mario Contaldi
Riccardo De Lauretis
Ernesto Taurino
Daniela Romano (§3.5.1, §3.5.4)
Antonella Bernetti, Francesca Lena (§3.5.3)
Eleonora Di Cristofaro (§3.5.4)
Antonio Caputo (§3.9)

INDUSTRIAL PROCESSES
Andrea Gagna
Barbara Gonella
Ernesto Taurino

SOLVENT AND OTHER PRODUCT USE
Daniela Romano
Eleonora Di Cristofaro

AGRICULTURE
Rocío D. Cóndor

LAND USE, LAND USE CHANGE AND FORESTRY
Marina Vitullo

WASTE
Barbara Gonella
Ernesto Taurino

RECALCULATIONS AND IMPROVEMENTS
Daniela Romano

PART II: SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1

KP-LULUCF
Marina Vitullo

INFORMATION ON ACCOUNTING OF KYOTO UNITS
Chiara Arcarese
Marina Vitullo

INFORMATION ON MINIMIZATION OF ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14
Rocío D. Cóndor

ANNEXES
KEY CATEGORIES AND UNCERTAINTY
Daniela Romano
Antonio Caputo
Marina Vitullo

ENERGY CONSUMPTION FOR POWER GENERATION
Mario Contaldi
Riccardo De Lauretis
Ernesto Taurino

ESTIMATION OF CARBON CONTENT OF COALS USED IN INDUSTRY
Ernesto Taurino
Mario Contaldi

CO_2 REFERENCE APPROACH
Mario Contaldi
Riccardo De Lauretis

NATIONAL EMISSION FACTORS
Mario Contaldi
Riccardo De Lauretis
Ernesto Taurino

AGRICULTURE SECTOR
Rocío D. Cóndor

THE NATIONAL REGISTRY FOR FOREST CARBON SINKS
Marina Vitullo
Sandro Federici

THE NATIONAL REGISTRY
Chiara Arcarese
Riccardo Liburdi

Contact: Riccardo De Lauretis
Telephone +39 0650072543
Fax +39 0650072657
E-mail riccardo.delauretis@isprambiente.it

ISPRA- Institute for Environmental Protection and Research
Environment Department
Monitoring and Prevention of Atmospheric Impacts
Air Emission Inventory Unit
Via V. Brancati, 48 00144 Rome - Italy

Premessa

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

A garantire questa funzione, in Italia, è l'ISPRA (ex APAT) su incarico del Ministero dell'Ambiente attraverso il Decreto Legislativo n. 51 del 7 marzo 2008 che istituisce il Sistema Nazionale, *National System*, relativo all'inventario delle emissioni dei gas serra.

L'ISPRA, infatti, realizza ogni anno l'inventario nazionale delle emissioni in atmosfera, che è strumento indispensabile di verifica degli impegni assunti a livello internazionale sulla protezione dell'ambiente atmosferico, come la Convenzione Quadro sui Cambiamenti Climatici (UNFCCC), il Protocollo di Kyoto, la Convenzione di Ginevra sull'inquinamento atmosferico transfrontaliero (UNECE-CLRTAP), le Direttive europee sulla limitazione delle emissioni.
In particolare, ogni Paese che partecipa alla Convenzione sui Cambiamenti Climatici, oltre a fornire annualmente l'inventario nazionale delle emissioni dei gas serra secondo i formati richiesti, deve documentare in uno specifico documento, il *National Inventory Report*, le metodologie di stima 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 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, il trasferimento delle tecnologie (TT), l'implementazione di progetti con i paesi in via di sviluppo (CDM) e l'implementazione di progetti congiunti con i paesi delle economie in transizione (JI).

In particolare, il rapporto "Italian Greenhouse Gas Inventory 1990-2009. National Inventory Report 2011" descrive la comunicazione annuale italiana dell'inventario delle emissioni dei gas serra dal 1990 al 2009.

Il documento è uno strumento fondamentale per la pianificazione e l'attuazione di efficaci politiche ambientali e fornisce alle istituzioni centrali e periferiche un adeguato contributo conoscitivo sulle problematiche inerenti ai cambiamenti climatici a livello settoriale.

Nuove politiche e interventi a livello nazionale ed internazionale saranno, infatti, indispensabili per garantire nel futuro il rispetto degli obiettivi del Protocollo di Kyoto, dal momento che, come emerge dal rapporto, le emissioni totali dei gas serra (espressi in termini di CO_2 equivalente) sono diminuite, dal 1990 al 2009, del 5.4% a fronte di un impegno nazionale di riduzione pari al 6.5% entro il periodo 2008-2012.

Contents

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 2011, including the update for the year 2009 and the revision of the entire time series 1990-2008.

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 last 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.apat.it/it/sinanet/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/5270.php.

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

Total greenhouse gas emissions, in CO_2 equivalent, excluding emissions and removals of CO_2 from land use, land use change and forestry, decreased by 5.4% between 1990 and 2009 (from 519 to 491 millions of CO_2 equivalent tons), whereas the national Kyoto target is a reduction of 6.5% as compared to the base year levels by the period 2008-2012.

The most important greenhouse gas, CO_2, which accounted for 85% of total emissions in CO_2 equivalent in 2009, showed a decrease by 4.3% between 1990 and 2009. In the energy sector, specifically, emissions in 2009 reduced of 2.8% as compared those in 1990.
CH_4 and N_2O emissions were equal to 7.6% and 5.7%, respectively, of the total CO_2 equivalent greenhouse gas emissions in 2009. Both gases showed a decrease from 1990 to 2009, equal to 14.3% and 25.3% for CH_4 and N_2O, respectively.
Other greenhouse gases, HFCs, PFCs and SF_6, ranged from 0.04% to 1.7% of total emissions.

Table ES.1 illustrates the national trend of greenhouse gases for 1990-2009, expressed in CO_2 equivalent terms, by substance and category.

GHG emissions	1990 base year	1995	2000	2005	2006	2007	2008	2009
	CO_2 equivalent (Gg)							
CO_2 emissions including net CO_2 from LULUCF	373,817	365,997	384,685	399,534	388,430	402,699	373,126	322,481
CO_2 emissions excluding net CO_2 from LULUCF	435,895	445,959	463,670	490,119	485,428	476,226	466,004	417,212
CH_4 emissions including CH_4 from LULUCF	43,671	44,164	45,733	41,024	39,485	39,408	38,152	37,352
CH_4 emissions excluding CH_4 from LULUCF	43,524	44,132	45,649	40,986	39,454	39,211	38,105	37,297
N_2O emissions including N_2O from LULUCF	37,382	38,103	39,506	37,572	32,236	31,582	29,495	27,827
N_2O emissions excluding N_2O from LULUCF	37,246	38,096	39,497	37,568	32,233	31,562	29,490	27,822
HFCs	351	671	1,986	5,401	6,106	6,855	7,513	8,173
PFCs	1,808	491	345	354	284	287	201	218
SF_6	333	601	493	465	406	428	436	398
Total (including LULUCF)	**457,362**	**450,027**	**472,749**	**484,351**	**466,947**	**481,259**	**448,921**	**396,449**
Total (excluding LULUCF)	**519,157**	**529,951**	**551,640**	**574,893**	**563,911**	**554,569**	**541,749**	**491,120**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990 base year	1995	2000	2005	2006	2007	2008	2009
	CO_2 equivalent (Gg)							
1. Energy	418,545	431,380	450,764	473,538	468,311	458,519	450,802	406,743
2. Industrial Processes	37,673	35,111	35,315	41,108	36,590	37,144	34,286	29,940
3. Solvent and Other Product Use	2,455	2,235	2,302	2,139	2,141	2,104	1,998	1,862
4. Agriculture	40,623	40,435	40,044	37,289	36,695	37,311	35,950	34,481
5. Land Use, Land-Use Change and Forestry	-61,795	-79,924	-78,891	-90,542	-96,965	-73,310	-92,828	-94,671
6. Waste	19,861	20,790	23,215	20,819	20,175	19,491	18,713	18,094
7. Other	NA	NA	NA	NA	NA	NA	NA	NA

Table ES.1. Total greenhouse gas emissions and removals in CO_2 equivalent (Gg CO_2 eq)

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 2009, of 82.8%. Emissions from this sector decreased by about 2.8% from 1990 to 2009. Substances with decrease rates were CO_2, whose levels reduced by 2.4% from 1990 to 2009 and accounts for 97.3% of the total in the energy sector, and CH_4 which showed a reduction of 29% but its share out of the sectoral total is only 1.5%; N_2O, on the other hand, showed an increase of 6.2% from 1990 to 2009 but it is not relevant on total emissions, accounting for 1.4%. Specifically, in terms of total CO_2 equivalent, an increase in emissions was observed in the transport sector, and in the other sectors, about 15.9% and 13.1%, from 1990 to 2009, respectively; in 2009 these sectors, altogether, account for 51.1% of total emissions.

For the industrial processes sector, emissions showed a decrease of 29.6% from the base year to 2009. Specifically, by substance, CO_2 emissions account for 66.7% and showed a decrease by about 29.6%, CH_4 decreased by 63.9%, but it accounts only for 0.1%, while N_2O, whose levels share 3.8% of total industrial emissions, decreased by 83.1%. 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-gas emissions (about 252.7%), whose level on total sectoral emissions is 23.5%. It should be noted that, except for the motivations explained, in the last two years, the economic recession has had a remarkable influence on the production levels of most the industries and consequent emissions.

Emissions from the solvent and other product use sector, which refer to CO_2 and N_2O emissions except for gases other than greenhouse, decreased by 24.6% from 1990 to 2009. The reduction is mainly to be attributed to a decrease by 27.5% in CO_2 emissions, which account for 64% of the sector. As regards CO_2, emission levels from paint application sector, which accounts for 53.7% of total CO_2 emissions from this sector, decreased by 24.2%; 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 40.8% of the total, show a decrease of 21.9%. Finally, CO_2 emissions from metal degreasing and dry cleaning activities, decreased by 63.3% but they account for only 5.5% of the total.
The level of N_2O emissions shows a decrease of 17.4%, accounting for 36.4% of total emissions in the sector in 2009.

For agriculture, emissions refer to CH_4 and N_2O levels, which account for 44.2% and 55.8% of the sectoral total, respectively. The decrease observed in the total emissions (-15.1%) was mostly due to the decrease of CH_4 emissions from enteric fermentation (-11.5%), which account for 31.3% of sectoral emissions and to the decrease of N_2O (-20.6%) from agricultural soils, which accounts for 44.8% of sectoral emissions.

As regards land use, land-use change and forestry, from 1990 to 2009 total removals in CO_2 equivalent increase by 53.2%; CO_2 accounts for almost the total emissions and removals of the sector.

Finally, emissions from the waste sector decreased by 8.9% from 1990 to 2009, mainly due to a decrease in the emissions from solid waste disposal on land (-16.5%), which account for 70.4% of waste emissions. The most important greenhouse gas in this sector is CH_4 which accounts for 87.1% of the sectoral emissions and shows a decrease of 9.5% from 1990 to 2009. N_2O emission levels increased by 8.9%, whereas CO_2 decreased by 53.5%; these gases account for 11.6% and 1.4%, respectively.

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

Category	**1990 base year**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**
	CO_2 equivalent (Gg)							
1A. Energy: fuel combustion	**407,769**	**421,308**	**441,740**	**465,698**	**460,948**	**451,311**	**443,452**	**399,611**
CO_2: 1. Energy Industries	136,503	139,841	151,894	160,133	161,510	161,140	157,278	132,368
CO_2: 2. Manufacturing Industries and Construction	86,480	86,023	83,699	80,392	78,958	75,731	72,785	56,433
CO_2: 3. Transport	101,269	111,445	120,101	125,825	127,145	127,209	122,252	117,873
CO_2: 4. Other Sectors	76,677	76,090	78,596	91,830	85,958	79,894	84,156	86,101
CO_2: 5. Other	1,046	1,440	806	1,198	982	896	738	844
CH_4	1,376	1,516	1,347	1,198	1,212	1,304	1,307	1,297
N_2O	4,418	4,952	5,296	5,121	5,183	5,136	4,936	4,694
1B2. Energy: fugitives from oil & gas	**10,776**	**10,072**	**9,024**	**7,841**	**7,363**	**7,208**	**7,351**	**7,132**
CO_2	3,344	3,178	2,588	2,117	2,194	2,181	2,264	2,170
CH_4	7,420	6,882	6,424	5,710	5,156	5,013	5,073	4,950
N_2O	12	12	13	14	14	14	13	12
2. Industrial processes	**37,673**	**35,111**	**35,315**	**41,108**	**36,590**	**37,144**	**34,286**	**29,940**
CO_2	28,397	25,995	24,509	27,063	27,082	27,618	25,010	19,982
CH_4	108	113	63	64	66	65	61	39
N_2O	6,676	7,239	7,918	7,760	2,647	1,891	1,066	1,130
HFCs	351	671	1,986	5,401	6,106	6,855	7,513	8,173

Category	1990 base year	1995	2000	2005	2006	2007	2008	2009
	CO_2 equivalent (Gg)							
PFCs	1,808	491	345	354	284	287	201	218
SF_6	333	601	493	465	406	428	436	398
3. Solvent and other product use	**2,455**	**2,235**	**2,302**	**2,139**	**2,141**	**2,104**	**1,998**	**1,862**
CO_2	1,643	1,463	1,276	1,315	1,333	1,316	1,271	1,191
N_2O	812	772	1,027	823	808	788	727	671
4. Agriculture	**40,623**	**40,435**	**40,044**	**37,289**	**36,695**	**37,311**	**35,950**	**34,481**
CH_4: Enteric fermentation	12,179	12,267	12,165	10,841	10,626	11,024	10,921	10,779
CH_4: Manure management	3,462	3,286	3,278	3,149	3,028	3,054	2,961	2,886
CH_4: Rice Cultivation	1,562	1,657	1,382	1,472	1,477	1,523	1,396	1,579
CH_4: Field Burning of Agricultural Residues	13	13	12	13	13	13	14	13
N_2O: Manure management	3,921	3,782	3,862	3,709	3,601	3,779	3,775	3,762
N_2O: Agriculture soils	19,482	19,426	19,341	18,101	17,947	17,914	16,879	15,459
N_2O: Field Burning of Agricultural Residues	4	4	4	4	4	4	4	4
5A. Land-use change and forestry	**-61,795**	**-79,924**	**-78,891**	**-90,542**	**-96,965**	**-73,310**	**-92,828**	**-94,671**
CO_2	-62,077	-79,963	-78,984	-90,585	-96,998	-73,527	-92,879	-94,731
CH_4	146	31	85	39	31	197	46	55
N_2O	136	7	9	4	3	20	5	6
6. Waste	**19,861**	**20,790**	**23,215**	**20,819**	**20,175**	**19,491**	**18,713**	**18,094**
CO_2	537	483	202	245	267	240	250	250
CH_4	17,405	18,398	20,977	18,539	17,877	17,215	16,373	15,754
N_2O	1,920	1,908	2,037	2,036	2,031	2,036	2,090	2,090
TOTAL EMISSIONS (with LULUCF)	***457,362***	***450,027***	***472,749***	***484,351***	***466,947***	***481,259***	***448,921***	***396,449***
TOTAL EMISSIONS (without LULUCF)	***519,157***	***529,951***	***551,640***	***574,893***	***563,911***	***554,569***	***541,749***	***491,120***

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

ES.4. Other information

In Table ES.3 NO_X, CO, NMVOC and SO_2 emission trends from 1990 to 2009 are summarised. All gases showed a significant reduction in 2009 as compared to 1990 levels. The highest reduction is observed for SO_2 (-87.1%), while CO and NO_X emissions reduced by about 63.3% and 51.2% respectively; NMVOC levels showed a decrease by 45.4%.

Indirect greenhouse gases and SO_2	**1990**	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
	Gg											
NO_X	2,021	1,899	1,438	1,411	1,356	1,337	1,300	1,221	1,169	1,140	1,067	987
CO	7,191	7,107	4,890	4,583	4,184	3,978	3,773	3,377	3,163	3,083	2,881	2,637
NMVOC	2,030	2,096	1,625	1,539	1,466	1,402	1,351	1,274	1,245	1,230	1,163	1,109
SO_2	1,795	1,320	750	698	617	519	482	403	381	338	282	231

Table ES.3. Total emissions of indirect greenhouse gases and SO_2 (1990-2009) (Gg)

Sommario (*Italian*)

Nel documento “Italian Greenhouse Gas Inventory 1990-2009. National Inventory Report 2011” 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.apat.it/it/sinanet/serie_storiche_emissioni.

Da una analisi di sintesi della serie storica dei dati di emissione dal 1990 al 2009, si evidenzia che le emissioni nazionali totali dei sei gas serra, espresse in CO_2 equivalente, sono diminuite del 5.4% nel 2009 rispetto all’anno base (corrispondente al 1990), a fronte di un impegno nazionale di riduzione del 6.5% entro il periodo 2008-2012.

In particolare, le emissioni complessive di CO_2 sono pari all’85% del totale e risultano nel 2009 inferiori del 4.3% rispetto al 1990. Le emissioni di metano e di protossido di azoto sono pari a circa il 7.6 % e 5.7% del totale, rispettivamente, e presentano andamenti in diminuzione sia per il metano (-14.3%) che per il protossido di azoto (-25.3%). Gli altri gas serra, HFC, PFC e SF_6, hanno un peso complessivo sul totale delle emissioni che varia tra lo 0.04% e l’1.7%; le emissioni degli HFC evidenziano una forte crescita, mentre le emissioni di PFC decrescono e quelle di SF_6 mostrano un minore incremento. Sebbene al momento tali variazioni non risultino 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).

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 2009 Italian GHG emission inventory, and a revision of the entire time series 1990-2008, 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 [b]). 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.apat.it/it/sinanet/serie_storiche_emissioni. Information on accounts, legal entities, Art.6 projects, holdings and transactions is publicly available at www.greta-public.sinanet.apat.it.

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.
As required by article 5.1 of the Kyoto Protocol, Annex I Parties shall have in place a National System by the end of 2006 at the latest 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) requires that Member States establish a national greenhouse gas inventory system by the end of 2005 at the latest and that the Commission adopts the EC's inventory system by 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 a technical scientific support for specific activities as defined in the relevant protocol under approval. 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, 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 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, 2011 [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 Institute for Environmental Protection and Research (ISPRA) was established by Italian Law 133/2008 and performs the functions of three former institutions: APAT, ICRAM (Central Institute for Applied Marine Research) and INFS (National Institute for Wildlife).
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 national system document which includes 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.apat.gov.it/site/it-IT/APAT/Pubblicazioni/Altre_Pubblicazioni.html.
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 bears the responsibility for the general administration of the inventory, co-ordinates participation in reviews, publishes and archives the inventory results.
Specifically, ISPRA is responsible for all aspects of national inventory 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, which are 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) whereas 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, which established guiding 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 shall be drawn up and updated annually, as established in the Decree n. 322/89. 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 are 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, was issued on 6th August 2008; an update of the plan for 2012-2013 was approved by a Prime Ministerial Decree on 3rd August 2009. 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 MINT (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 itself is 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' has been instituted by a Ministerial Decree on 1st April 2008 and is part of the National Greenhouse Gas Inventory System in Italy (ISPRA, 2011 [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. A process of validation and verification of IUTI data has been put in place and is expected to supply data useful to update and improve the estimations. For this year submission, emissions and removals from 3.3 and 3.4 activities have been estimated on the basis of data and methodologies used for the inventory under the Convention.
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 year 2008 and 2009, 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

The Italian National Registry is administrated by ISPRA (former APAT) under the supervision of the national Competent Authority for the implementation of directive 2003/87/CE, jointly established by the Ministry for Environment, Land and Sea and the Ministry for Economic Development.
ISPRA, as Registry Administrator, becomes responsible for the management and functioning of the Registry, including Kyoto protocol obligations. Since January 2011 ISPRA has continuous agreement with Innofactor Oy which covers any kind of support needed for the National Registry. The contract also includes hosting and maintenance of the registry software.

The registry was connected to the international transaction log (ITL) of the UNFCCC secretariat in October 2008.

A full 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 year 2010 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 (MINT), 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, emission data collected in the framework of the European Emissions Trading Scheme, the National Pollutant Emission Register (EPER/E-PRTR) and the Large Combustion Plant (LCP) Directive have yielded considerable developments in the inventory of the relative sectors. In fact, these data are always used either directly in the estimation process or as a verification of emission estimates, improving national emissions factors as well as activity data figures.
In addition, final estimates are checked and verified also in view of annual environmental reports by industries.
For large industrial point sources, emissions are registered individually, when communicated, based upon detailed information such as fuel consumption.
Other small plants communicate their emissions which are also considered individually.

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.

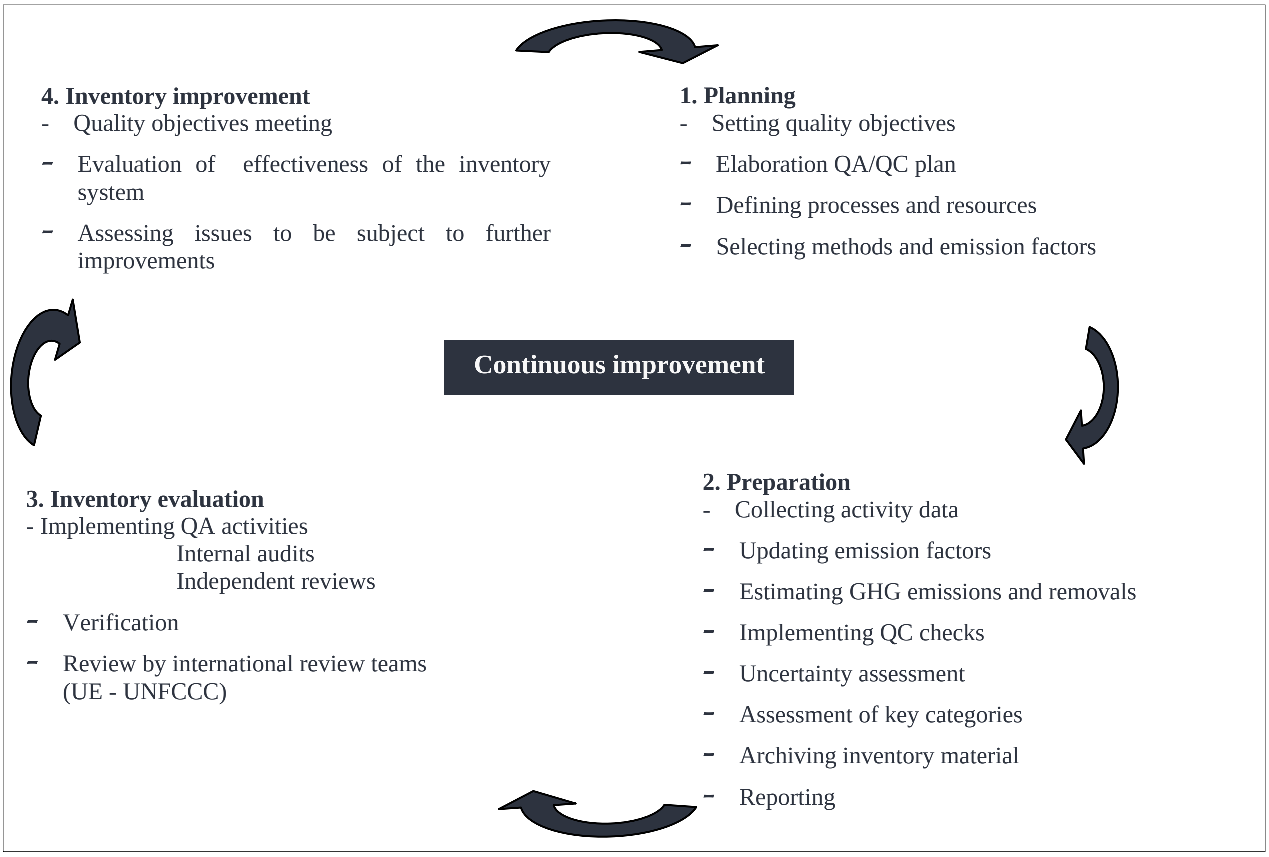


Figure 1.1 National Greenhouse Gas Inventory: annual inventory process

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 year inventory compilation.

Technical reports and emission figures are publicly accessible by website at the address http://www.sinanet.apat.it/it/sinanet/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-CORINAIR Emission Inventory Guidebook (IPCC, 1997; IPCC, 2006; IPCC, 2000; IPCC, 2003; EMEP/CORINAIR, 2007; EMEP/EEA, 2009); 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.

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 Emission Registry 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 and soil surfaces Amount of biomass Biomass burnt Biomass growth	Statistical Yearbooks - National Institute of Statistics State Forestry Corps National and Regional Forestry Inventory Universities and Research Institutes
6 Waste	Amount of waste	National Waste Cadastre - Institute for Environmental Protection and Research , National Waste Observatory

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

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, as communicated to the European Community in the framework of the monitoring mechanism of GHG emission inventory for the purpose of Article 4(1)(b) under the Implementing Provisions (EC, 2005), is included in Annex 9.

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	**D,M,T1, T2,T3**	**CS,D**	**D,M,T1, T2,T3**	**CR,CS,D**	**D,M,T1, T2,T3**	**CR,CS,D**						
A. Fuel Combustion	D,M,T1, T2,T3	CS	D,M,T1, T2,T3	CR,CS,D	D,M,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	D,M,T1, T2	CS	D,M,T1, T2	CR,CS	D,M,T1, T2	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	T1,T2	CR,CS,D	T1	D						
1. Solid Fuels	NA	NA	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**	**CR,CS,PS**	**D**	**D,PS**	**CS,D,T2**	**CS,PS**	**CS,T2**	**D,PS**	**CS,D,T3**	**CS,PS**
A. Mineral Products	D,T2	CS,D,PS	NA	NA	NA	NA						
B. Chemical Industry	D	CR,PS	D	CR,CS,PS	D	D,PS	NA	NA	NA	NA	NA	NA
C. Metal Production	D	CR,CS,PS	D	CR,CS,PS	NA	NA	NA	NA	T2	D,PS	D	PS
D. Other Production	NA	NA										
E. Production of Halocarbons and SF_6							NA	NA	NA	NA	NA	NA
F. Consumption of Halocarbons and SF_6							CS,T2	CS,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			**CS,T1,T 2**	**CS,D**	**CS,D,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	D,T1	CS,D						
E. Prescribed Burning of Savannas			NA	NA	NA	NA						
F. Field Burning of Agricultural Residues			CS	CS,D	CS	CS,D						
G. Other			NA	NA	NA	NA						
5. Land Use, Land-Use Change and Forestry	**T1,T2, T3**	**CS,D**	**T1**	**D**	**T1**	**D**						
A. Forest Land	T1,T2, T3	CS,D	T1	D	T1	D						
B. Cropland	T1,T2, T3	CS,D	NA	NA	NA	NA						
C. Grassland	T1,T2, T3	CS,D	NA	NA	NA	NA						
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,T2**	**CR,CS,D**	**CS,D**	**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	CS,D	CR,CS,D	CS,D	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, resp **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

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

Table 1.2 Methods and emission factors used in the inventory preparation

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

In general, for the energy sector, basic statistics for estimating emissions are fuel consumption published in the Energy Balance by the Ministry of Economic Development. Additional information for electricity production is provided 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 provided in statistical yearbooks published both by the National Institute of Statistics and the Ministry of Transportation. Other data are communicated by different category associations.

Data from the Italian Emissions Trading Scheme database are incorporated into the national inventory whenever the sectoral coverage is complete; in fact, not always do ETS data entirely cover the energy categories whereas national statistics, such as 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 always 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 Emission Register (EPER/E-PRTR) 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 from the Italian E-PRTR are validated and communicated by ISPRA to the Ministry for the Environment, Land and Sea and to the European Commission within October of the current 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 split by product but reported as an overall value. Anyway, E-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 communicate their emissions which are also considered individually.
ISPRA personally collects data from the industrial associations under the ETS and other European directives, Large Combustion Plant and EPER/E-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 sector 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 and soil surfaces are provided by the National Institute of Statistics while statistics on forest fires are supplied by the State Forestry Corps.
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.
All the material and documents used for the inventory emission estimates are stored at the Institute for Environmental Protection and Research. 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. 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 these 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, 19 sources were individuated implementing Approach 1, whereas 15 sources were carried out by Approach 2. Including the LULUCF categories in the analysis, 24 categories were selected jointly by the two approaches. The description of these sources is shown in Table 1.3 and Table1.4.

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
N2O stationary combustion	L
CO_2 Mobile combustion: Road Vehicles	L1
CO_2 Fugitive emissions from Oil and Gas Operations	L1
CH_4 Fugitive emissions from Oil and Gas Operations	L
CO_2 Cement production	L
N_2O Adipic 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
N_2O from animal production	L2
CH_4 Emissions from Wastewater Handling	L2

Table 1.3 Key categories (excluding 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

Key categories (including the LULUCF sector)	
CO_2 Cement production	L1
CH_4 Enteric Fermentation in Domestic Livestock	L
CH_4 Manure Management	L1
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 Cropland remaining Cropland	L
CO_2 Grassland remaining Grassland	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
CO_2 Limestone and Dolomite Use	L1
CO_2 Ammonia production	L1
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

Applying the analysis to the 2009 inventory, without the LULUCF sector, 24 key categories were totally individuated, both at level and trend. Results are reported in Table 1.5.

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, T2
Direct N_2O Agricultural Soils	L, T
Indirect N_2O from Nitrogen used in agriculture	L, T2
CO_2 Cement production	L, T1
N_2O Manure Management	L
CH_4 Manure Management	L, T2
CH_4 from Solid waste Disposal Sites	L, T
CO_2 Fugitive emissions from Oil and Gas Operations	T2
N_2O stationary combustion	L
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	T
CO_2 Ammonia production	T
N_2O Nitric Acid	T1

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

Table 1.5 Key categories (excluding LULUCF) by the IPCC Approach 1 and Approach 2. Year 2009

If considering emissions and removals from the LULUCF sector, 27 key categories were individuated as reported in Table 1.6.

There are no additional categories as compared to the previous analysis expect for those referring to the LULUCF sector.

Key categories (including the LULUCF sector)	
CO_2 stationary combustion liquid fuels	L, T
CO_2 stationary combustion solid fuels	L, T1
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, T1
HFC, PFC substitutes for ODS	L, T
CH_4 Enteric Fermentation in Domestic Livestock	L
Direct N_2O Agricultural Soils	L, T2
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
CH_4 from Solid waste Disposal Sites	L
CO_2 Cement production	L1
CO_2 Land converted to Settlements	L, T
CH_4 Manure Management	L2
CO_2 stationary combustion other fuels	L1, T1
CH_4 Emissions from Wastewater Handling	L2, T2
N_2O stationary combustion	L1
CO_2 Mobile combustion: Waterborne Navigation	L1
N_2O Adipic Acid	T1
CO_2 Iron and steel production	T1
CO_2 Ammonia production	T1
N_2O Nitric Acid	T1
CO_2 Land converted to Cropland	T2

Table 1.6 Key categories (including LULUCF) by the IPCC IPCC Approach 1 and Approach 2. Year 2009

Key category analysis for KP-LULUCF was performed according to section 5.4 of the IPCC GPG for LULUCF (IPCC 2003). Only total CO_2 emissions and removals from *forest management* (art. 3.4) have been assessed as key category. The value has been compared with Table 1.6 Key categories for the latest reported year (2009) based on level of emissions (including LULUCF). The associated UNFCCC subcategory *Forest land remaining Forest land* is a key category in level and in trend assessment. The *forest management* category contribution is also greater than other categories in the UNFCCC key category. CO_2 emissions and removals from the associated UNFCCC subcategory *land converting to forest land* have not been identified as key category either with Tier 2 approach, both in level and trend assessment. Moreover, total CO_2 emissions and removals from *Afforestation and reforestation* (art. 3.3) are not larger than the smallest UNFCCC key category. Therefore *Afforestation and reforestation* is stated to be not a key category.

The key category analysis 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, it should be noted that 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 1.2, there are only a few key categories which estimates do not meet these quality objectives, such as some categories in the LULUCF sector, in terms of the methodology and emission factors used, some emission estimates from the consumption of F-gases and CH_4 and N_2O emissions from stationary combustion, because of 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 have been 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, this year, activities are planned for direct N_2O emissions from agricultural soils and indirect N_2O from nitrogen used in agriculture 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 (APAT, 2006 [a]) 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 plans (APAT, 2005; APAT, 2006 [b]; APAT, 2007 [a]; APAT, 2008 [b]; ISPRA, 2009 [a], ISPRA, 2011 [b]). These documents are publicly available at ISPRA website http://www.apat.gov.it/site/it-IT/APAT/Pubblicazioni/Altre_Pubblicazioni.html.

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 inventory UNFCCC 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.

Even though official independent and public reviews prior to the Italian inventory submission are not implemented yet, emission figures are 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.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 two 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 directives. ISPRA collects data from the industrial associations under the ETS and other European directives, as Large Combustion Plant and E-PRTR. 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, first years of data collected from ETS plants and EPER/E-PRTR, respectively). Figures submitted under the ETS, emissions and activity data, 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 E-PRTR data is guaranteed by art.9 of the Regulation 2006/166/EC.
In addition, ISPRA is building a unique database with all this information to help in highlighting the main discrepancies among data, and improving the management of the time series consistency.

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 directives, Large Combustion Plant, EPER/E-PRTR and Emissions Trading, are gathered together thus highlighting the main discrepancies in information and detecting potential errors. The database is under finalisation but all the actual figures are considered in an overall approach and used in the compilation of the inventory.

In 2008, ISPRA finalised the provincial inventory at local scale for the years 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.apat.it/it/inventaria and a report which describes detailed methodologies to carry out estimates has been published (Liburdi et al., 2004; ISPRA, 2009 [b]).
Additional comparisons between top-down and local inventories have been carried out during the last year; results are shared among the 'local inventories' expert group and usually lead to an improvement in methodologies for both the inventories whenever large differences occur.

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 task 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.
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 results of the last centralised reviews are reported in UNFCCC (2009) and UNFCCC (2010).

Moreover, at European level, voluntary reviews of the European inventory are undertaken by experts from different Member States for critical sectoral categories.

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 in 2008 at the Workshop 'Assessing and improving methodologies for GHG projections'. Further analyses were presented in the Workshop on 'Quantification of the effects on greenhouse gas emissions of policies and measures'.

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 explained in the reports 'Carbon Dioxide Intensity Indicators' (APAT, 2007 [b], ISPRA, several years). Also these documents are posted on ISPRA website http://www.apat.gov.it/site/it-IT/APAT/Pubblicazioni/Altre_Pubblicazioni.html.

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 two days 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 will be 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 2010’ (ISPRA, 2011 [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) defines two approaches to estimating uncertainties in national greenhouse gas inventories: Approach 1 and Approach 2. Quantitative estimates of the uncertainties for the Italian GHG inventory are calculated using Approach 1, which provides a calculation based on the error propagation equations. In addition, following the IPCC Good Practice Guidance (IPCC, 2000), corresponding to the application of Monte Carlo analysis, a Tier 2 has been applied to specific categories of the inventory but the results show that, with the information available at present, applying methods higher than the Tier 1 does not make a significant difference in figures. 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 2.06, lower than the Tier 1 approach 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 32.44, lower than the uncertainty by the Tier 1 approach 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, was also carried out (Romano et al., 2004).

For the Italian inventory, the application of Approach 1 is described in Annex 1 considering national total with or without emissions and removals from the LULUCF sector. Emission sources are disaggregated into a detailed level and uncertainties are therefore estimated for these categories.

For the 2009 total emission figures without LULUCF, an uncertainty of 3.4% in the combined global warming potential (GWP) total emissions is estimated, whereas for the trend between 1990 and 2009 the analysis assesses an uncertainty of 2.5%.

Including the LULUCF sector into the national figures, the uncertainty according to Approach 1 is equal to 10.4% for the year 2009, whereas the uncertainty for the trend is estimated to be 8%.

The differences in the uncertainty levels, including the LULUCF sector, as compared the 2010 submission, are due to the different weights of the categories and their uncertainties as a consequence of the recalculation in the LULUCF sector.

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 7.6% including the LULUCF sector.

Following the recommendations of the last and previous UNFCCC reviews, Approach 2 has been implemented to estimate uncertainty of some key categories, for the year 2009. The results show, also in these examples, that uncertainty values are lower than those derived from the application of Approach 1. Details on the categories for which the analysis has been already implemented are reported in Annex 1. The study will be extended to the entire inventory categories for the next submission.

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 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, plant data are used to check and verify data in the industrial sector; these data also include information from the European Emissions Trading Scheme, the European E-PRTR registry 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 this year, the priorization of improvements related to the results of uncertainty analysis, and following the recommendations of the last review report, lead 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. Specifically, the activity data related to litter and soil pools have been updated, increasing the number of sampling used and reducing notably the uncertainty related to these pools (litter pool passed from 161% to 101%, while soil pool passed 152% from to 113%).

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.

Sources and sinks not estimated (NE)[(1)]			
GHG	**Sector[(2)]**	**Source/sink category [(2)]**	**Explanation**
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.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.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.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
CH_4	1 Energy	1.C2 Multilateral Operations	Information and statistical data are not available
CO_2	1 Energy	1.C2 Multilateral Operations	Information and statistical data are not available
N_2O	1 Energy	1.C2 Multilateral Operations	Information and statistical data are not available

Table 1.7 Source and sinks not estimated in the 2009 inventory

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. With respect to the last year submission, improvements concerned the estimation of emissions from the combustion of biomass in the pulp and paper industry and emissions from the use of N_2O in explosives also in response to the recommendations of the last UNFCCC review.

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.

Sources and sinks reported elsewhere (IE)[3]				
GHG	**Source/sink category**	**Allocation as per IPCC Guidelines**	**Allocation used by the Party**	**Explanation**
CH_4	1.B.2.A.1 Exploration	1.B.2.A.1	1.B.2.A.2	Emissions are included in 1.B.2.A.2 Production
CH_4	1.B.2.B.1 Exploration	1.B.2.B.1	1.B.2.B.2	Emissions are included in 1.B.2.B.2 Production
CH_4	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
CH_4	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
CH_4	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
CH_4	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
CH_4	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
CH_4	1.AA.3.B Road Transportation	1.AA.3B biomass	1.AA.3B liquid fuel	Emissions are included in liquid fuel - gasoil/diesel category
CO_2	1.B.2.A.1 Exploration	1.B.2.A.1	1.B.2.A.2	Emissions are included in 1.B.2.A.2 Production
CO_2	1.B.2.B.1 Exploration	1.B.2.B.1	1.B.2.B.2	Emissions are included in 1.B.2.B.2 Production
CO_2	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
CO_2	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).
CO_2	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
CO_2	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)
N_2O	1.B.2.A.1 Exploration	1.B.2.A.1	1.B.2.c.2	Emissions are included in 1.B.2.c.2 oil flaring
N_2O	1.B.2.A.4 Refining / Storage	1.B.2.A.4	1.B.2.C.2	Emission are included in 1.B.2.C.2 flaring oil
N_2O	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
N_2O	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
N_2O	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
N_2O	1.AA.3.B Road Transportation	1.AA.3B biomass	1.AA.3B liquid fuel	Emissions are included in liquid fuel - gasoil/diesel category
SF_6	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
SF_6	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
SF_6	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
SF_6	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

Table 1.8 Source and sinks reported elsewhere in the 2009 inventory

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 1990-2009 are reported in Tables A8.1- A8.5 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 5.4% between 1990 and 2009, varying from 519 to 491 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. 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.

The most important greenhouse gas, CO_2, which accounts for 85.0% of total emissions in CO_2 equivalent, shows a decrease by 4.3% between 1990 and 2009. In the energy sector, in particular, emissions in 2009 are 2.8% lower than in 1990.

CH_4 and N_2O emissions are equal, respectively, to 7.6% and 5.7% of the total CO_2 equivalent greenhouse gas emissions. CH_4 emissions have decreased by 14.3% from 1990 to 2009, while N_2O has decreased by 25.3%.

Other greenhouse gases, HFCs account for 1.7% of total emissions, PFCs and SF_6 are equal to 0.04% 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 lighter 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 1990-2009, 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.

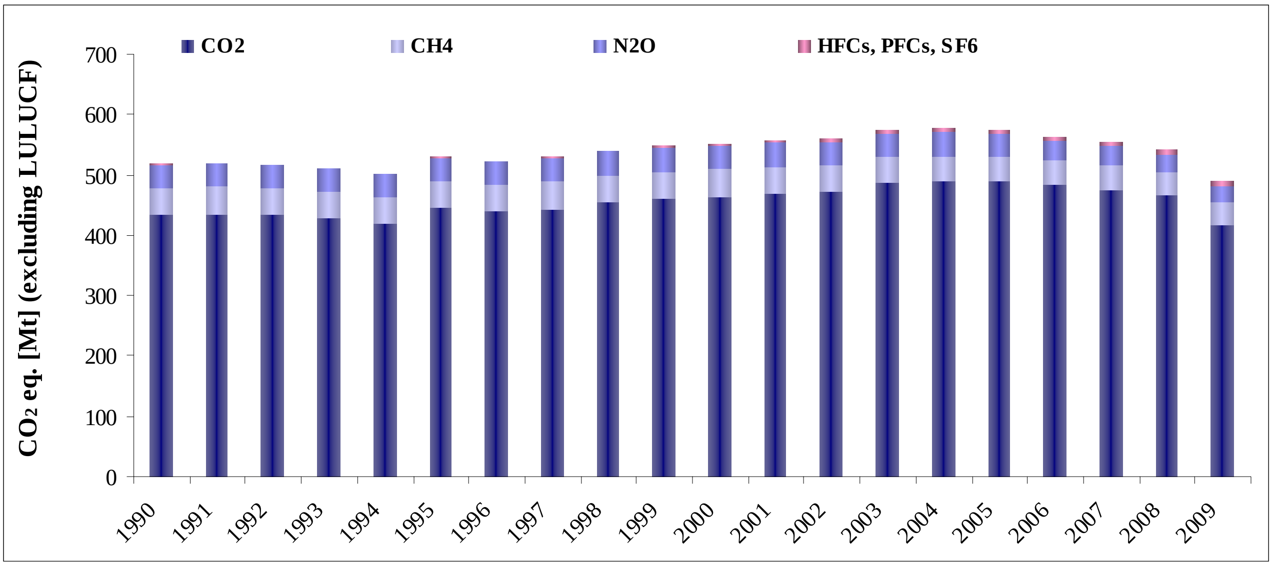


Figure 2.1 National greenhouse gas emissions from 1990 to 2009 (without LULUCF) (Mt CO_2 eq.)

The share of the different sectors in terms of total emissions remains nearly unvaried over the period 1990-2009. Specifically for the year 2009, the greatest part of the total greenhouse gas emissions is to be attributed to the energy sector, with a percentage of 82.8%, followed by

agriculture and industrial processes, accounting respectively for 7.0% and 6.1% of total emissions, waste contributing with 3.7% and use of solvents with 0.4%.
Considering total greenhouse gas emissions with emissions and removals from LULUCF, the energy sector accounts, in 2009, for 69.4% of total emissions and removals, as absolute weight, followed by the LULUCF sector which contributes with 16.2%.

Figure 2.2 shows total greenhouse gas emissions and removals subdivided by sector.

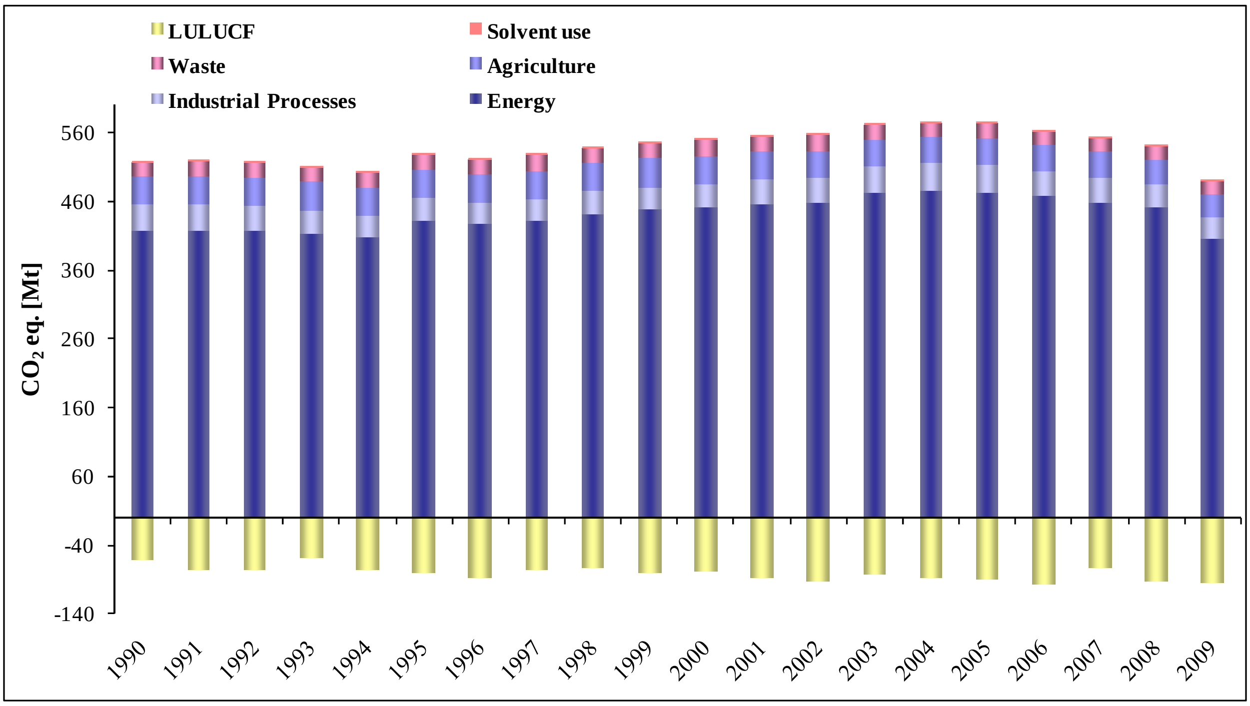


Figure 2.2 Greenhouse gas emissions and removals from 1990 to 2009 by sector (Mt CO_2 eq.)

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 4.3% from 1990 to 2009, ranging from 436 to 417 million tons.
The most relevant emissions derive from the energy industries (31.7%) and transportation (28.3%). Non-industrial combustion accounts for 20.8% and manufacturing and construction industries for 13.5%, while the remaining emissions derive from industrial processes (4.8%) and other sectors (0.9%).

The performance of CO_2 emissions by sector is shown in Figure 2.3.

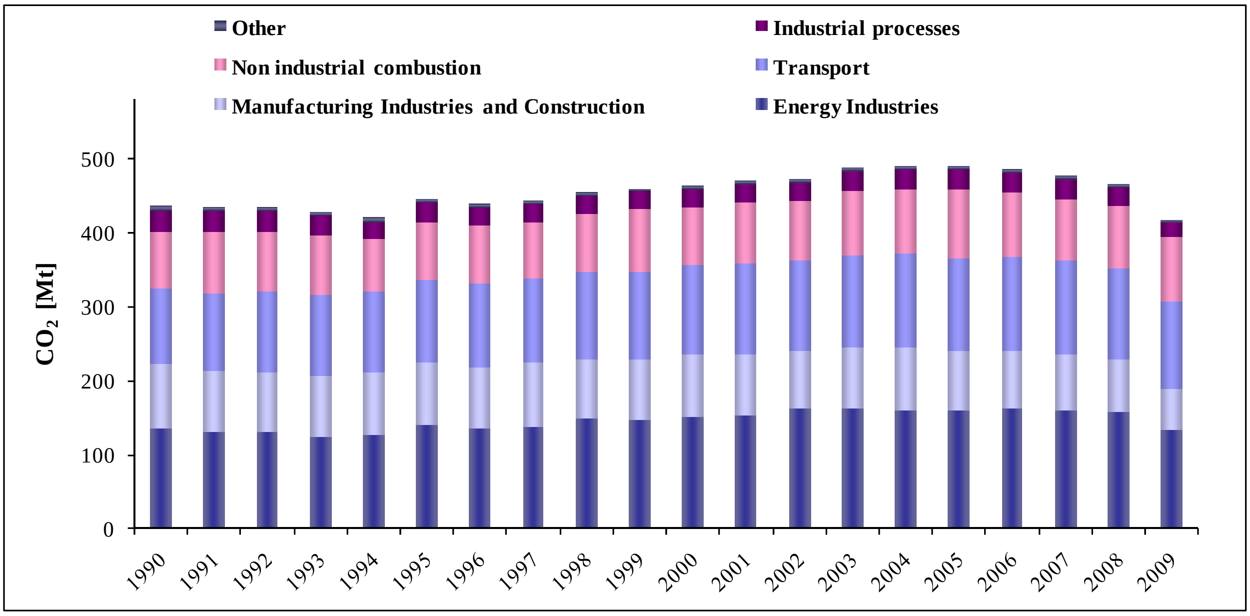


Figure 2.3 National CO_2 emissions by sector from 1990 to 2009 (Mt)

The main sectors responsible for CO_2 emissions are transport and energy industries; in the period 1990-2009, emissions from transport have increased by 16.4% from 1990 to 2009 while those from energy industries decreased by 3.0%. Non industrial combustion emissions have increased by 11.9% and those from industrial processes decreased by 29.6%; emissions from manufacturing industries and construction show a decrease of 34.7%, emissions in the 'Other' sector, mostly fugitive emissions from oil and natural gas and emissions from solvent and other product use, reduced by 34.6%.

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

- Gross Domestic Product (GDP) at market prices as of 2000 (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.

The figures of CO_2 emissions per total energy unit show that 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; nevertheless, this trend slowed in 2002, due to the increase of coal consumption in power plants. In the last year, all the indicators show a significant drop on account of the economic recession which has also influenced the production levels affecting the energy and industrial process sectors, with a consequent notable reduction of total emissions.

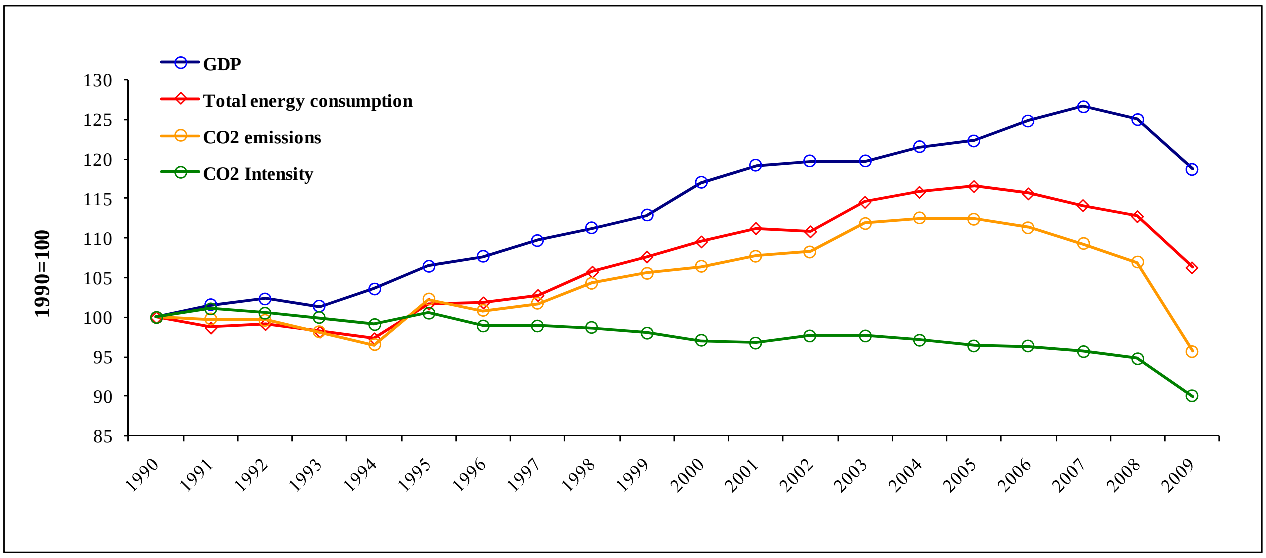


Figure 2.4 Energy-related and economic indicators and CO_2 emissions

2.2.2 Methane emissions

Methane emissions (excluding LULUCF) in 2009 represent 7.6% of total greenhouse gases, equal to 37.3 Mt in CO_2 equivalent, and show a decrease of 6.2 Mt (-14.3%) as compared to 1990 levels.
CH_4 emissions, in 2009, are mainly originated from waste sector which accounts for 42.2 % of total methane emissions, as well as from the agriculture (40.9%) and energy (16.8%) 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, 9.5% compared to 1990; the solid waste disposal on land, which represents the largest emission sectoral share (80.9%), decreases of 16.5%, while the highest increases concern waste incineration (77.8%) waste-water handling (36.8%) subcategories.
Emissions in the agricultural sector regard mainly the enteric fermentation (70.7%) and manure management (18.9%) categories. The agriculture sector shows a decrease of emissions equal to 11.4% as compared to 1990.
In terms of CH_4 emissions in the energy sector, the reduction (-29.0%) 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 in heating systems. Figure 2.5 shows the emission figures by sector.

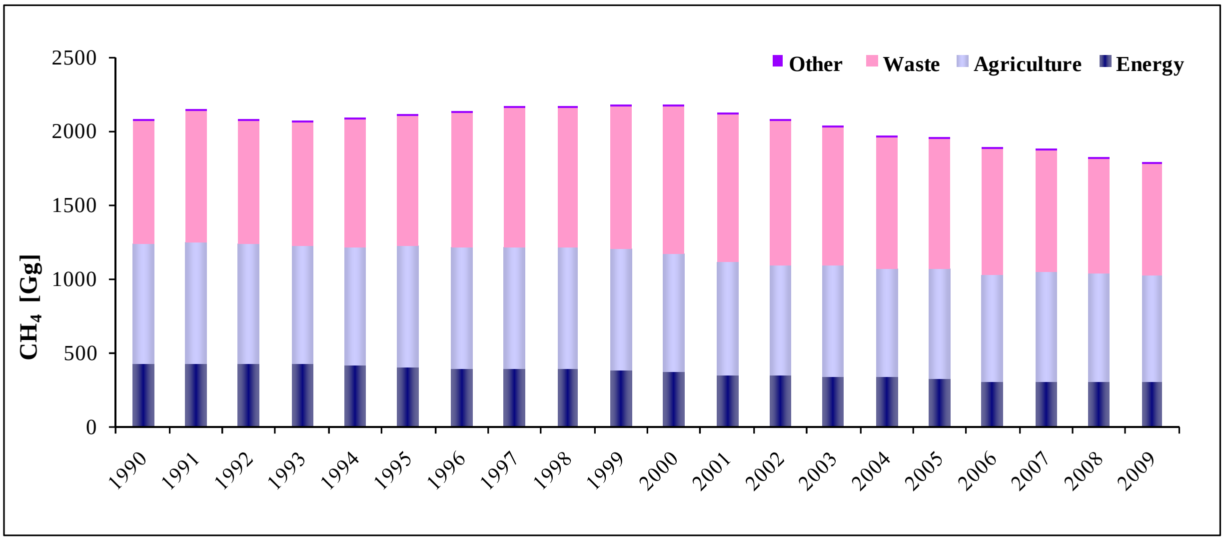


Figure 2.5 National CH_4 emissions by sector from 1990 to 2009 (Gg)

2.2.3 Nitrous oxide emissions

In 2009 nitrous oxide emissions (excluding LULUCF) represent 5.7% of total greenhouse gases, with a decrease of 25.3% between 1990 and 2009, from 37.2 to 27.8 Mt CO_2 equivalent.
The major source of N_2O emissions is the agricultural sector (69.1%), 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 17.9% during the period 1990-2009.
Emissions in the energy-use sector (16.9% of the total) show an increase by 6.2% from 1990 to 2009; 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 the N_2O emission factors of catalysed automobiles.
Emissions from production of nitric acid have decreased from 1990 to 2009 of 81.7%; emissions from production of adipic acid show an increase from 1990 to 2005 of 32.6% and a decrease from 2005 to 2009 of 87.7% because of the introduction of an abatement technology, showing a global reduction of 83.7%.
Other emissions in the waste sector primarily regard the processing of industrial and domestic waste-water (7.1% of national N_2O emissions). Figure 2.6 shows national emission figures by sector.

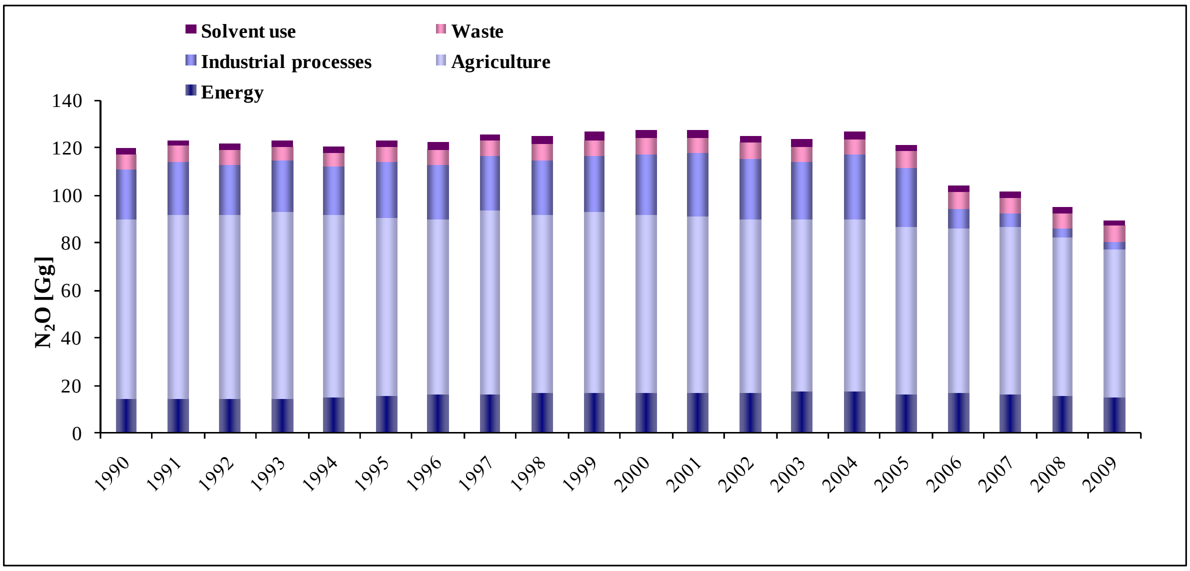


Figure 2.6 National N_2O emissions by sector from 1990 to 2009 (Gg)

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 1.8% of total greenhouse gases in CO_2 equivalent in 2009, and they show an increase of 252.7% between 1990 and 2009. This increase is the result of different features for the different gases.

HFCs, for instance, have increased considerably from 1990 to 2009, from 0.4 to 8.2 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 88.0% from 1990 to 2009. The level of PFCs emissions in 2009 is 0.2 Mt in CO_2 equivalent, and it is due to the use of the gases in the production of aluminium (66.8%) and in the production of semiconductors (33.2%). Although the production of PFCs is equal to zero in Italy from the year 1999 onwards, the upward trend shown by the series is due to their consumption and to their use in metal production.

Emissions of SF_6 are equal to 0.4 Mt in CO_2 equivalent in 2009, with an increase of 19.6% as compared to 1990 levels. In 2009 2.3% of SF_6 emissions derive from the use of gas in aluminium and magnesium foundries, 92.2% from the gas contained in electrical equipments, and 5.5% from the gas use in the semiconductors manufacture. From 2005 to 2006, emissions of SF_6 have fallen of 12.8%, showing between 2006 and 2009 a decrease of 1.9%.

The National Inventory of fluorinated gases has largely improved in terms of the sources and the 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.

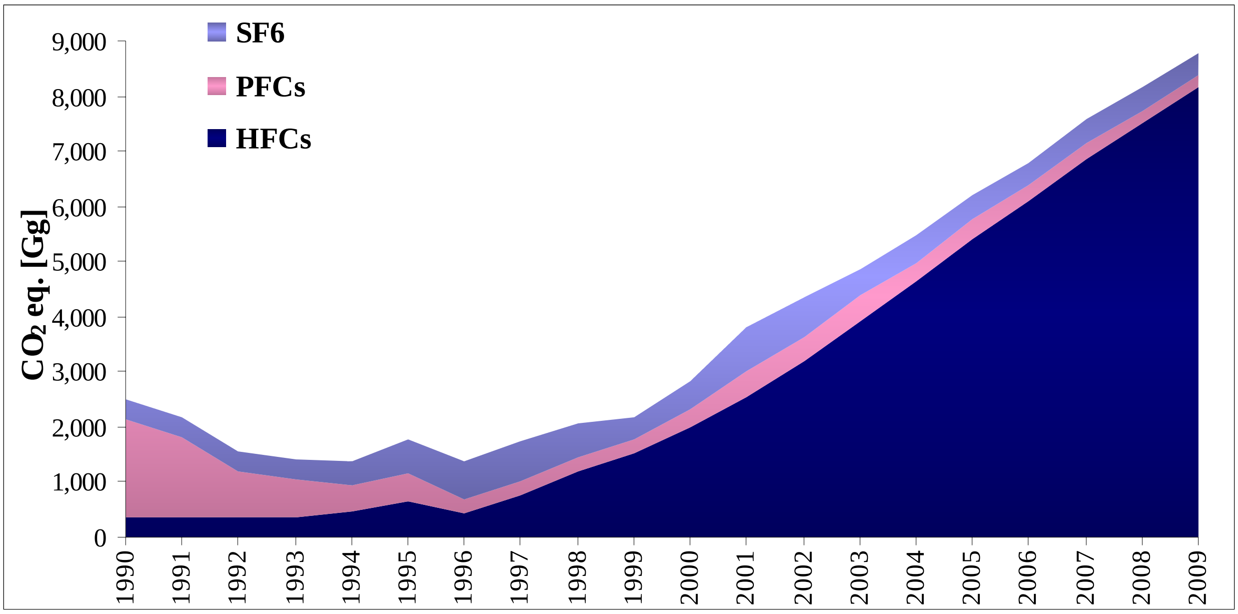


Figure 2.7 National emissions of fluorinated gases by sector from 1990 to 2009 (Gg CO_2 eq.)

2.3 Description and interpretation of emission trends by source

2.3.1 Energy

Emissions from the energy sector account for 82.8% 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
	Gg CO_2 eq							
Total emissions	**418,545**	**431,380**	**450,764**	**473,538**	**468,311**	**458,519**	**450,802**	**406,743**
Fuel Combustion (Sectoral Approach)	*407,769*	*421,308*	*441,740*	*465,698*	*460,948*	*451,311*	*443,452*	*399,611*
Energy Industries	137,214	140,541	152,556	160,856	162,224	161,839	157,972	132,989
Manufacturing Industries and Construction	88,152	87,572	85,264	82,080	80,655	77,412	74,354	57,754
Transport	102,897	113,703	122,409	127,354	128,740	128,766	123,687	119,258
Other Sectors	78,387	77,982	80,660	94,116	88,270	82,325	86,639	88,690
Other	1,120	1,511	851	1,291	1,058	969	801	920
Fugitive Emissions from Fuels	*10,776*	*10,072*	*9,024*	*7,841*	*7,363*	*7,208*	*7,351*	*7,132*
Solid Fuels	122	65	73	69	54	84	73	45
Oil and Natural Gas	10,654	10,007	8,951	7,772	7,309	7,124	7,278	7,088

Table 2.1 Total emissions in CO2 equivalent from the energy sector by source (1990-2009) (Gg CO_2 eq.)

An upward trend is noted from 1990 to 2004, total greenhouse gas emissions, in CO_2 equivalent, show an increase by 13.3%, while between 2004 and 2009 emissions have decreased by 14.3%, showing from 1990 to 2009 a decrease of about 2.8%.
Substances with the highest impact are CO_2, whose levels have decreased by 2.4% from 1990 to 2009 and account for 97.3% of the total, and N_2O which shows an increase of 6.2% but its share out of the total is only 1.2%; CH_4, on the other hand, shows a decrease of 29.0% from 1990 to 2009, accounting only for 1.5%.
It should be noted that from 1990 to 2009 the most significant increase, in terms of total CO_2 equivalent, is observed in transport and in the other sectors, about 15.9%, and 13.1%, respectively; in 2009 these sectors, altogether, account for 51.1% of total emissions. In the period 1990-2009, energy industries emissions have decreased by 3.1%, accounting for 32.7% of total emissions.
Details on these figures are described in the specific chapter.

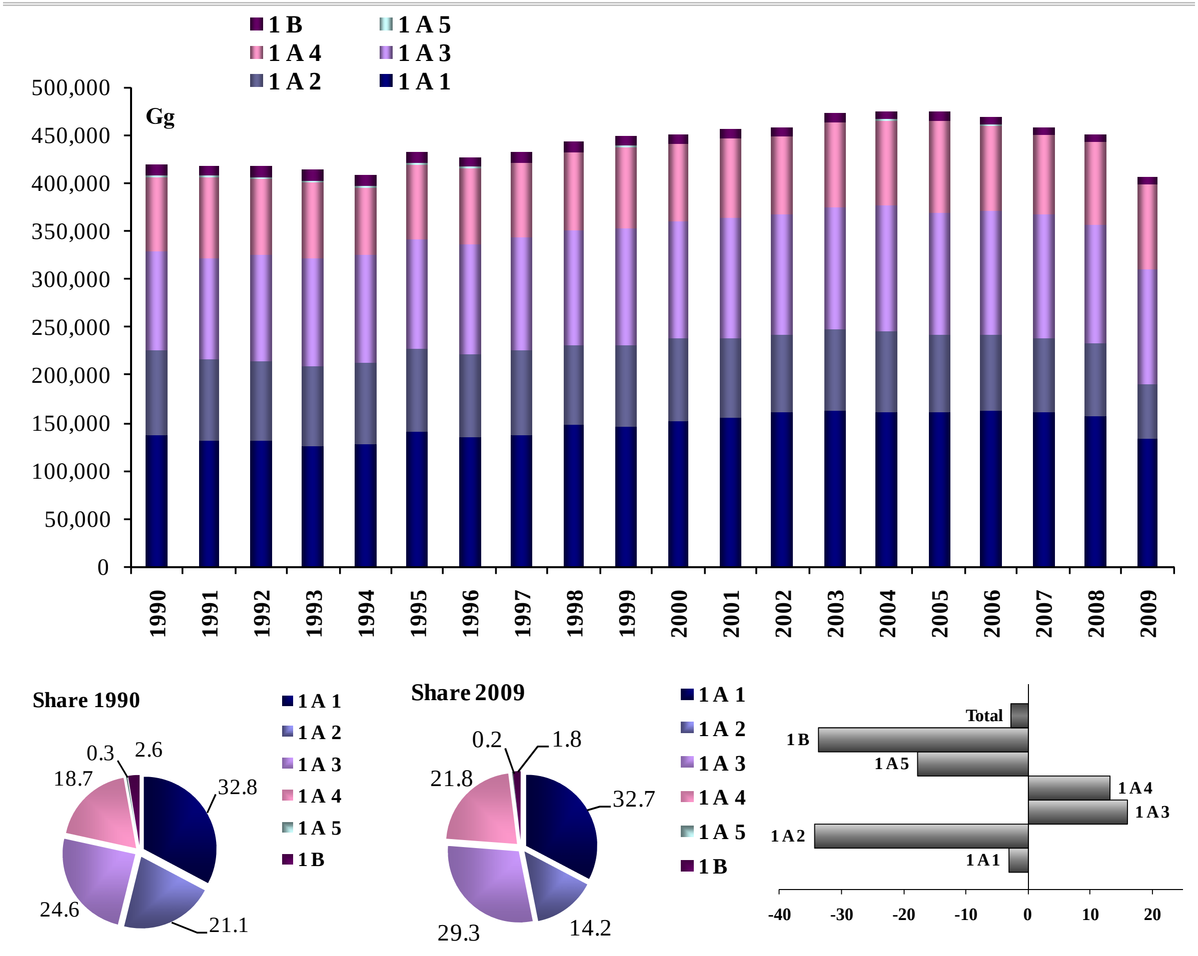


Figure 2.8 Trend of total emissions in CO_2 equivalent from the energy sector (1990-2009) (Gg CO_2 eq.)

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 emission levels, in CO_2 equivalent, show a decrease of 20.5%, from the base year to 2009. Taking into account emissions by substance, CO_2 level decreased by 29.6%, while N_2O level decreased by 83.1%; these two substances account altogether for about 70.5% of the total emissions from industrial processes (CO_2 for 66.7% and N_2O for 3.8%). CH_4 decreased by 63.9 but it accounts only for 0.1%. The decrease in emissions is mostly due to a decrease in chemical industry and metal production emissions. The decrease of GHG emissions in the chemical industry (-76.8%) is due to the decreasing trend of the emissions deriving from nitric acid and adipic acid production (as regards the last one, due to a fully operational abatement technology). Emissions from metal production decreased by 65.9% mostly for the different materials used in the pig iron and steel production processes.

A considerable increase is observed in F-gas emissions (252.7%), whose share on total emissions is 29.4%.

Details for industrial processes emissions can be found in the specific chapter.

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	Gg CO_2 eq											
Total	**37,673**	**35,111**	**35,315**	**37,397**	**37,599**	**38,871**	**41,207**	**41,108**	**36,590**	**37,144**	**34,286**	**29,940**
CO_2	28,397	25,995	24,509	25,310	25,287	26,390	27,219	27,063	27,082	27,618	25,010	19,982
CH_4	108	113	63	59	57	58	61	64	66	65	61	39
N_2O	6,676	7,239	7,918	8,232	7,902	7,557	8,443	7,760	2,647	1,891	1,066	1,130
F-gases	2,492	1,764	2,824	3,796	4,354	4,866	5,485	6,220	6,796	7,570	8,149	8,788
HFCS	351	*671*	*1,986*	*2,550*	*3,191*	*3,902*	*4,635*	*5,401*	*6,106*	*6,855*	*7,513*	*8,173*
PFCS	1,808	*491*	*345*	*451*	*423*	*497*	*348*	*354*	*284*	*287*	*201*	*218*
SF_6	333	*601*	*493*	*795*	*740*	*468*	*502*	*465*	*406*	*428*	*436*	*398*

Table 2.2 Total emissions in CO_2 equivalent from the industrial processes sector by gas (1990-2009)

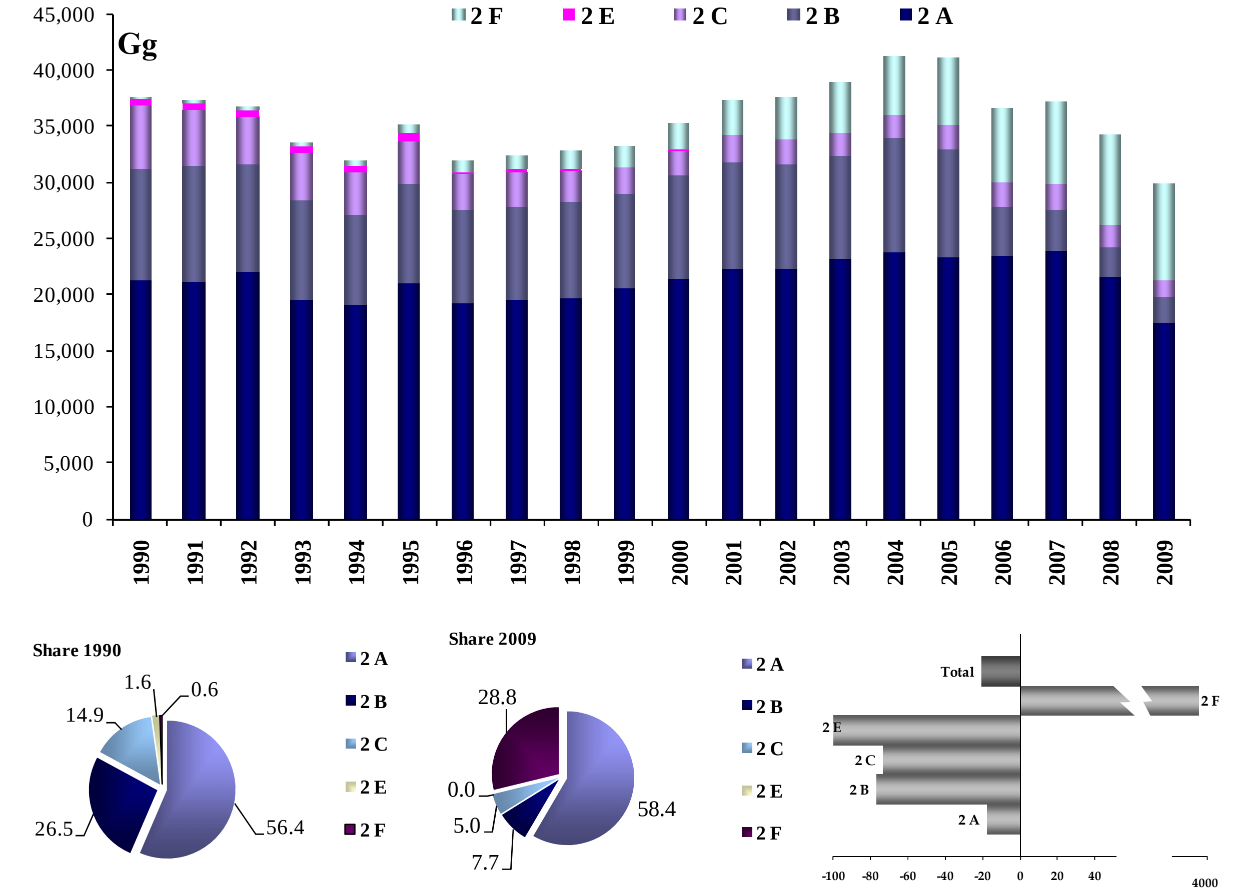


Figure 2.9 Trend of total emissions in CO_2 equivalent from industrial processes (1990-2009) (Gg CO_2 eq.)

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 gases that are not greenhouse.

Emission trends for CO_2 and N_2O from solvent and other product use are reported in Table 2.3 and Figure 2.10.

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Gg CO_2 eq												
Total emissions	**2,455**	**2,235**	**2,302**	**2,217**	**2,219**	**2,168**	**2,144**	**2,139**	**2,141**	**2,104**	**1,998**	**1,862**
CO_2	1,643	1,463	1,276	1,286	1,290	1,296	1,300	1,315	1,333	1,316	1,271	1,191
N_2O	812	772	1,027	931	929	873	845	823	808	788	727	671

Table 2.3 Total emissions in CO_2 equivalent from the solvent and other product use sector by gas (1990-2009)

A considerable amount of emissions from this sector is, in fact, mostly to be attributed to NMVOC. In 2009, solvent use is responsible for 0.4% of the total CO_2 equivalent emissions (excluding LULUCF).

The share of CO_2 emissions, in this sector, is 64.0% out of the total, while N_2O emissions represent 36.0% of the sectoral total; a decrease by 24.2% is noted from this sector from 1990 to 2009, which is to be attributed to different sources. As regards CO_2, emission levels from paint application sector, which accounts for 53.7% of total CO_2 emissions from this sector, decreased by 24.2%; 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 40.8% of the CO_2 total emissions, show a decrease of 21.9%. Finally, CO_2 emissions from metal degreasing and dry cleaning activities, decreased by 63.3% but they account for only 5.5% of the total.

N_2O emissions from this sector, in 2009, represent 2.4% of the total N_2O national emissions.

The level of N_2O emissions shows a decrease of 17.4%. 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, there appears to be a reduction in N_2O emissions, 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.

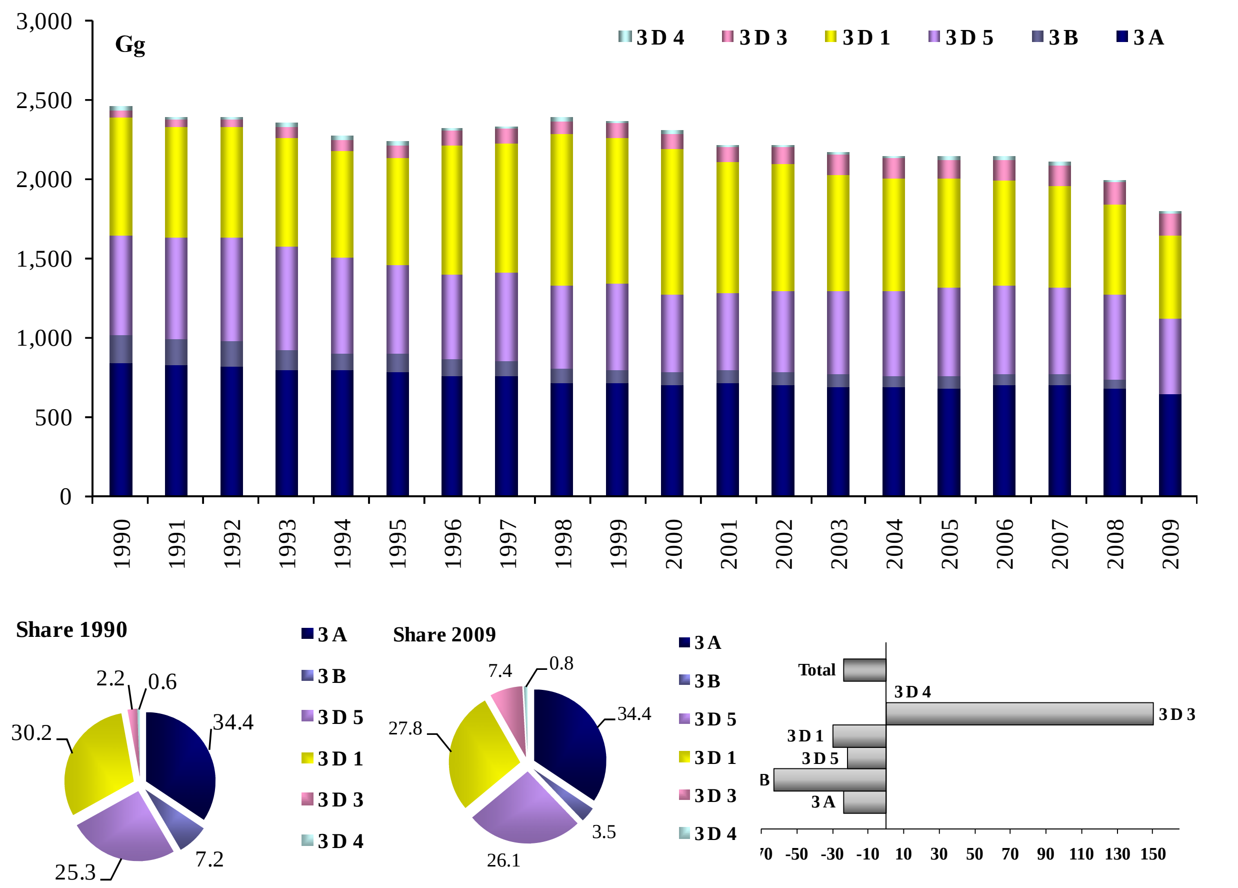


Figure 2.10 Trend of total emissions in CO_2 equivalent from the solvent and other product use sector (1990-2009) (Gg CO_2 eq.)

2.3.4 Agriculture

Emissions from the agriculture sector account for 7.0% 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	2001	2002	2003	2004	2005	2006	2007	2008	2009
	Gg CO_2 eq											
Total emissions	**40,623**	**40,435**	**40,044**	**39,110**	**38,404**	**38,255**	**37,959**	**37,289**	**36,695**	**37,311**	**35,950**	**34,481**
Enteric Fermentation	12,179	12,267	12,165	11,340	11,031	11,057	10,834	10,841	10,626	11,024	10,921	10,779
Manure Management	7,383	7,068	7,140	7,344	7,115	7,075	6,868	6,857	6,629	6,833	6,736	6,648
Rice Cultivation	1,562	1,657	1,382	1,382	1,420	1,463	1,534	1,472	1,477	1,523	1,396	1,579
Agricultural Soils	19,482	19,426	19,341	19,029	18,822	18,645	18,705	18,101	17,947	17,914	16,879	15,459
Field Burning of Agricultural Residues	17	17	16	15	17	15	18	17	17	17	18	17

Table 2.4 Total emissions in CO_2 equivalent from the agricultural sector by source (1990-2009) (Gg CO_2 eq.)

Emissions refer to CH_4 and N_2O levels, which account for 44.2% and 55.8% of the total emission of the sector, respectively. The decrease observed in the total emissions (-15.1%) is mostly due to the decrease of CH_4 emissions from enteric fermentation (-11.5%) and to the decrease of N_2O (-20.6%) from agricultural soils, which account for 31.3% and 44.8% of the total emissions, respectively.

Detailed comments can be found in the specific chapter.

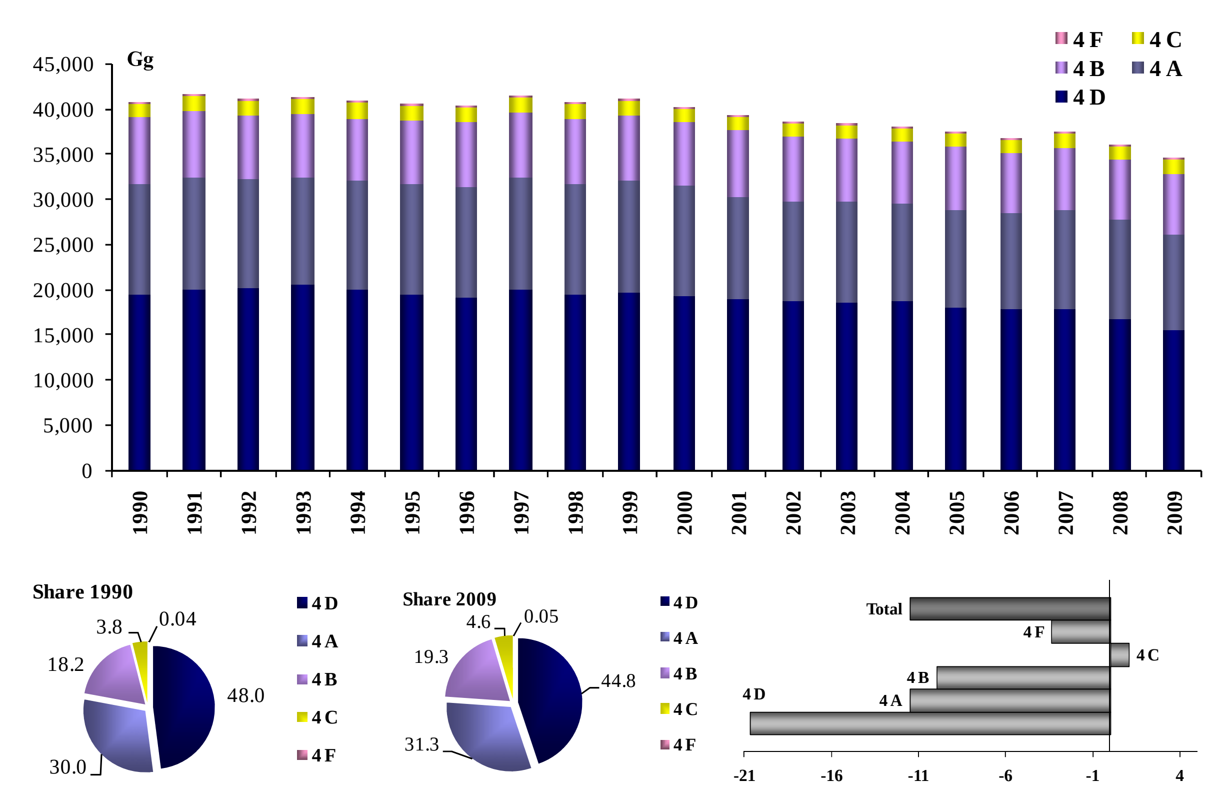


Figure 2.11 Trend of total emissions in CO_2 equivalent from agriculture (1990-2009) (Gg CO_2 eq.)

2.3.5 LULUCF

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

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	Gg CO_2 eq											
Total emissions	**-61,795**	**-79,924**	**-78,891**	**-86,910**	**-92,832**	**-83,619**	**-87,971**	**-90,542**	**-96,965**	**-73,310**	**-92,828**	**-94,671**
Forest Land	-41,540	-61,721	-54,328	-62,466	-67,594	-59,054	-65,331	-66,617	-67,117	-45,600	-62,969	-66,369
Cropland	-18,828	-14,432	-14,116	-13,630	-14,089	-13,743	-11,451	-12,611	-12,821	-13,152	-12,928	-12,299
Settlements	-3,954	-6,295	-12,944	-14,171	-14,514	-14,194	-14,570	-14,703	-20,430	-17,976	-20,391	-19,518
Grassland	0	0	0	0	0	0	0	0	0	0	0	0
Wetlands	2,526	2,525	2,497	3,357	3,365	3,373	3,381	3,389	3,404	3,417	3,460	3,516
Other Land	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0

Table 2.5 Total emissions in CO_2 equivalent from the LULUCF sector by source/sink (1990-2009) (Gg CO_2 eq.)

Total removals, in CO_2 equivalent, in the LULUCF sector, show from the base year to 2009, an increase of 53.2%.
CO_2 accounts for more than 99% of total emissions and removals of the sector.

Further details for LULUCF emissions and removals can be found in the specific chapter.

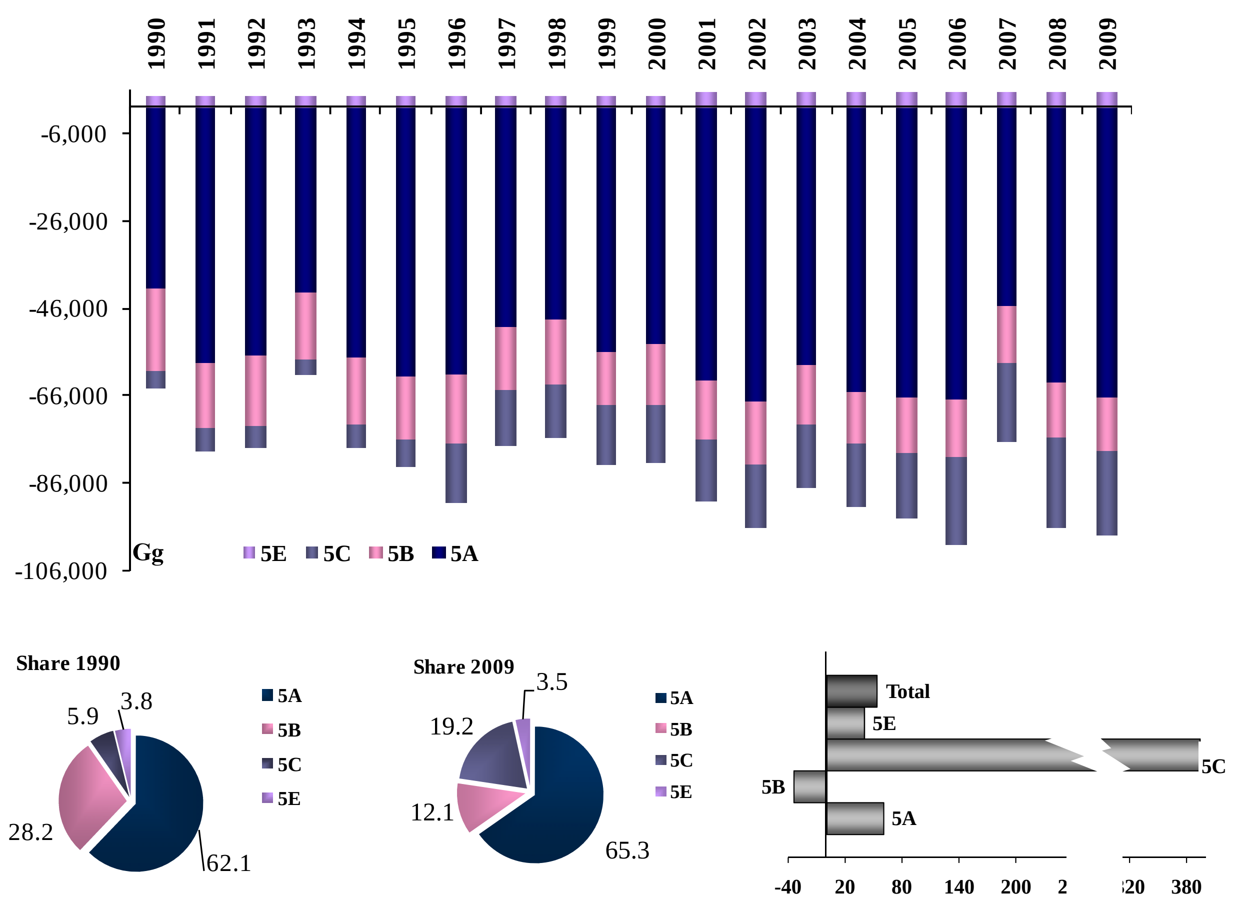


Figure 2.12 Trend of total emissions and removals in CO_2 equivalent from LULUCF (1990-2009) (Gg CO_2 eq.)

2.3.6 Waste

Emissions from the waste sector account for 3.7% of total national greenhouse gas emissions, excluding LULUCF.

Emissions from the waste sector are shown in Table 2.6 and Figure 2.13.

Total emissions, in CO_2 equivalent, decreased by 8.9% from 1990 to 2009. The decrease is mainly due to the decrease in emissions from solid waste disposal on land (-16.5%), accounting for 70.4% of the total. Considering emissions by gas, the most important greenhouse gas is CH_4 which accounts for 87.1% of the total and shows a decrease of 9.5% from 1990 to 2009. N_2O levels have increased by 8.9% while CO_2 decreased by 53.5%; these gases account for 11.6% and 1.4%, respectively.

Further details can be found in the specific chapter.

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	Gg CO_2 eq											
Total emissions CO_2 equivalent	**19,861**	**20,790**	**23,215**	**23,212**	**22,781**	**21,865**	**20,927**	**20,819**	**20,175**	**19,491**	**18,713**	**18,094**
Solid Waste Disposal on Land	15,254	15,909	18,357	18,263	17,744	16,806	15,673	15,514	14,851	14,194	13,364	12,741
Waste-water Handling	3,822	3,996	4,292	4,330	4,406	4,451	4,565	4,629	4,645	4,663	4,689	4,687
Waste Incineration	785	884	564	617	627	604	686	671	675	630	655	661
Other	0	0	2	3	3	4	4	4	4	5	4	4

Table 2.6 Total emissions in CO_2 equivalent from the waste sector by source (1990-2009) (Gg CO_2 eq.)

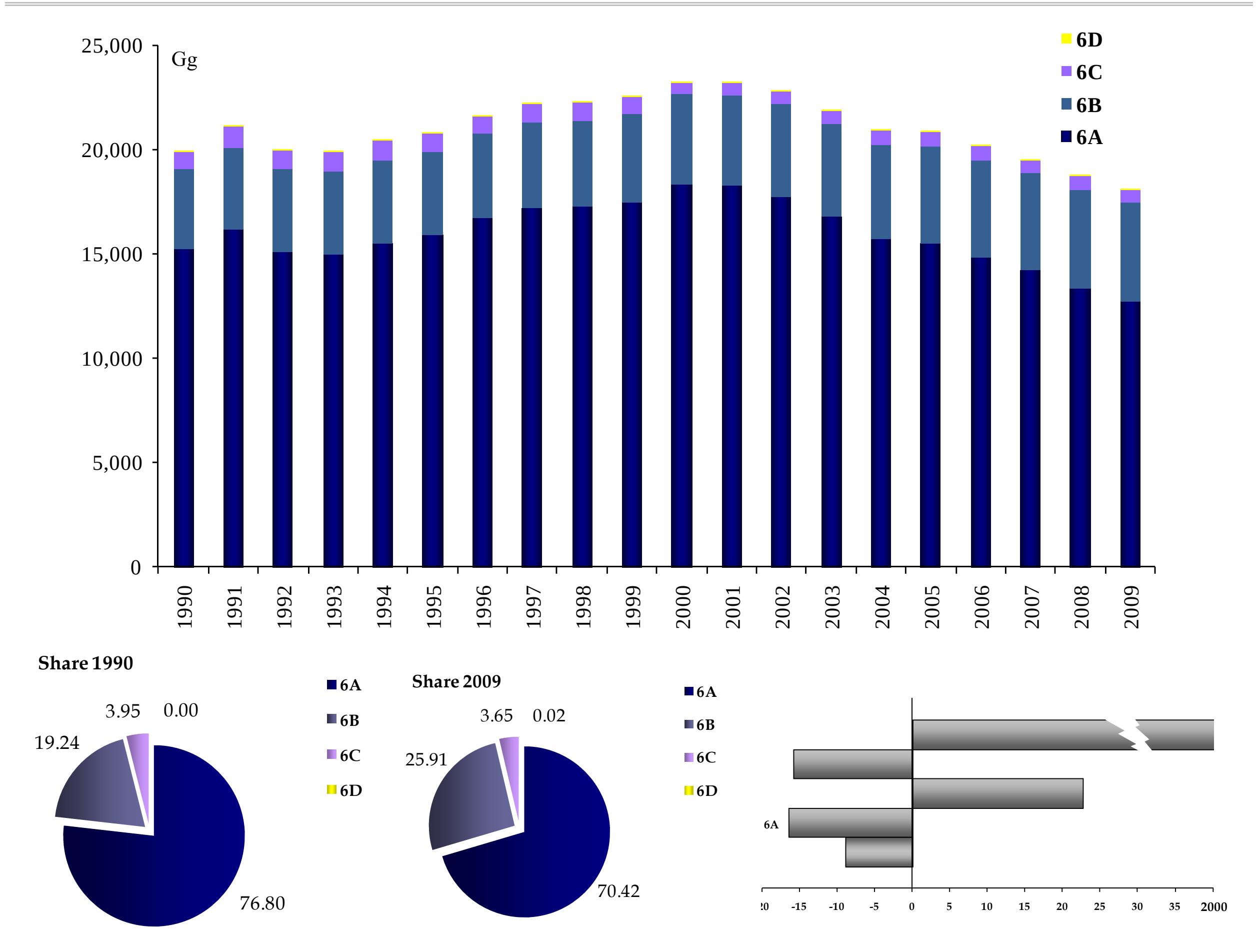


Figure 2.13 Trend of total emissions in CO_2 equivalent from waste (1990-2009) (Gg CO_2 eq.)

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 2009 are presented in Table 2.7 and Figure 2.14.

Indirect GHG and SO_2	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Gg												
NO_X	2,021	1,899	1,438	1,411	1,356	1,337	1,300	1,221	1,169	1,140	1,067	987
CO	7,191	7,107	4,890	4,583	4,184	3,978	3,773	3,377	3,163	3,083	2,881	2,637
NMVOC	2,030	2,096	1,625	1,539	1,466	1,402	1,351	1,274	1,245	1,230	1,163	1,109
SO_2	1,795	1,320	750	698	617	519	482	403	381	338	282	231

Table 2.7 Total emissions for indirect greenhouse gases and SO_2 (1990-2009) (Gg)

All gases show a significant reduction in 2009 as compared to 1990 levels. The highest reduction is observed for SO_2 (-87.1%), CO levels have reduced by 63.3%, while NO_X and NMVOC show a decrease by 51.2% and 45.4%, 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 of the 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.

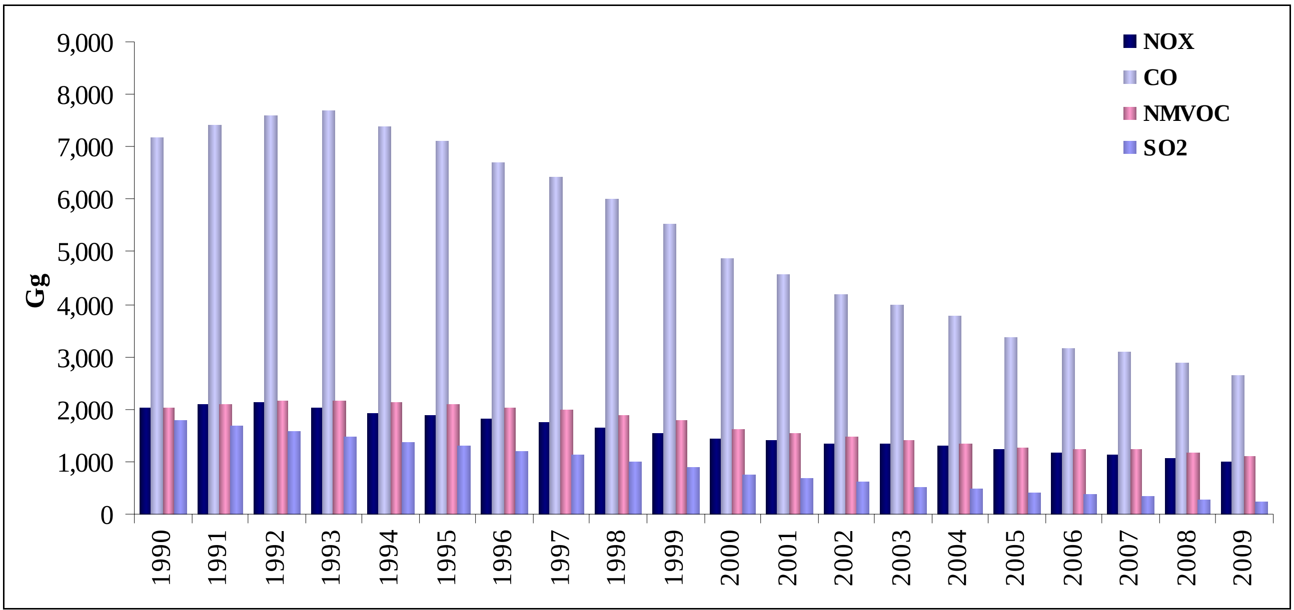


Figure 2.14 Trend of total emissions for indirect greenhouse gases and SO_2 (1990-2009) (Gg)

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 a different number of publications and 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.

Those 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), 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 2009, 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 2009, the resulting average emission factor is equal to 113.5 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. 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 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 2009, the energy sector accounts for 94.9% of CO_2 emissions, 16.8% of CH_4 and 16.9% of N_2O. In terms of CO_2 equivalent, the energy sector shares 82.8% of total national greenhouse gas emissions excluding LULUCF.

Emission trends of greenhouse gases from the energy sector are reported in Table 3.1.

	1990	1995	2000	2005	2006	2007	2008	2009
	Mt CO_2 eq							
Energy	418.5	431.4	450.8	473.5	468.3	458.5	450.8	406.7
CO_2	405.3	418.0	437.7	461.5	456.7	447.1	439.5	395.8
CH_4	8.8	8.4	7.8	6.9	6.4	6.3	6.4	6.2
N_2O	4.4	5.0	5.3	5.1	5.2	5.1	4.9	4.7

Source: ISPRA elaborations

Table 3.1 GHG emission trends in the energy sector 1990-2009 (Mt CO_2 eq.)

The emission trend is generally driven by the economic indicators as already shown in chapter 2. A drop of emissions is observed in 1993 and 1994 because of economic crisis.

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. In 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).

Source	1990	1995	2000	2005	2006	2007	2008	2009
	GWh							
Hydroelectric	35,079	41,907	50,900	42,927	43,425	38,481	47,227	53,443
Thermoelectric	178,590	196,123	220,455	253,073	262,165	265,764	261,328	226,638
- solid fuels	32,042	24,122	26,272	43,606	44,207	44,112	43,074	39,745
- natural gas	39,082	46,442	97,607	149,259	158,079	172,646	172,697	147,270
- derivated gases	3,552	3,443	4,252	5,837	6,251	5,645	5,543	3,701
- oil products	102,718	120,783	85,878	35,846	33,830	22,865	19,195	15,878
- other fuels	1,196	1,333	6,446	18,525	19,797	20,495	20,820	20,044
Geothermic	3,222	3,436	4,705	5,325	5,527	5,569	5,520	5,342
Eolic and Photovoltaic	0	14	569	2,347	2,973	4,073	5,054	7,219
Total	***216,891***	***241,480***	***276,629***	***303,672***	***314,090***	***313,888***	***319,130***	***292,642***

Source: Terna

Table 3.2 Production of electricity by sources 1990-2009 (GWh)

More in general the share of the total energy consumption by primary sources in the period 1990-2009, 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.

Sources	1990	1995	2000	2005	2006	2007	2008	2009
	%							
renewable	0.7	0.9	1.1	2.0	2.2	2.6	2.9	3.2
solid fuels	9.6	7.9	6.9	8.6	8.7	8.9	8.8	7.4
natural gas	23.7	25.7	31.4	36.0	35.5	36.0	36.4	35.5
crude oil	56.2	54.9	49.5	43.1	43.4	42.4	41.4	41.0
primary electricity	9.8	10.5	11.1	10.3	10.1	10.0	10.6	13.0

Source: Ministry Economic Development

Table 3.3 Total energy consumptions by primary sources 1990-2009 (%)

Recalculations

In 2011 submission, recalculations regarded different sub-sectors.

For the whole energy sector, natural gas CO_2 emission factors have been updated for 2008 because of additional information collected on the chemical composition of natural gas imported.

Coal CO_2 average emission factors have also been revised from 2005 based on an analysis of the information collected by the plants in the framework of EU ETS.

The whole time series of road transport emissions has been recalculated because of the updated version of the model/software, COPERT4 version 8.0, used to estimate emissions. Recalculation affected mainly CH_4 and N_2O emissions. Detailed information is reported in paragraph 3.5.3.

The carbon balance of the iron and steel sector (1.A.2.a) has been updated, according to the review process, taking into account the quantity of carbon stored in steel produced. The use of reductants is also included in this balance. The carbon balance methodology does not imply to separate off input between the energy and industrial sectors but ensures no double counting occurs.

Moreover, as requested by the review process, N_2O emissions from flaring in refineries have been estimated for the whole time series, fugitive emissions from oil and gas production from venting, flaring and production have been disaggregated and reallocated in the relevant categories, fugitive emissions from petroleum refining have been reallocated between the energy and industrial processes for the whole time series. Other minor changes in activity data occurred, including maritime data which have been updated for 2008.

Recalculations affected the whole time series 1990-2008 for all gases. The following table shows the percentage differences between the 2011 and 2010 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 0.01% and 0.46% in 2008 mainly due to the update of the carbon balance in the iron and steel production and the update of CO_2 emission factors for the main fuels in 2008.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
	%																		
Energy	***-0.01***	***-0.01***	***-0.01***	***-0.01***	***-0.01***	***-0.01***	***-0.01***	***-0.01***	***-0.01***	***-0.01***	***-0.01***	***-0.01***	***-0.01***	***0.05***	***-0.01***	***-0.08***	***-0.19***	***-0.12***	***-0.46***
CO_2	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.04	-0.01	-0.08	-0.20	-0.13	-0.48
CH_4	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.03	0.03	-0.60
N_2O	0.31	0.29	0.38	0.33	0.32	0.29	0.23	0.27	0.30	0.31	0.27	0.29	0.27	0.28	0.28	0.40	0.46	0.58	0.83

Source: ISPRA elaborations

Table 3.4 Emission recalculations in the energy sector 1990-2008 (%)

Key categories

Key category analysis, for the years 1990 and 2009, identified 9 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 2009

KEY CATEGORIES	TIER	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,T1	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 3.26, 3.27
5. N_2O stationary combustion	L	L1	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,T1	3.9	Table 3.40
8. CO_2 fugitive emissions from Oil and Gas Operations	T2		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

With reference to the box, half of the key categories (n. 1, 2, 3, 5, and 9) 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 five 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 most of the emissions increase from 1990 to 2009, for CO_2, N_2O and CH_4, is due to the increase of thermoelectric production, see Tables A2.1 and A2.4 for more details.
In the following table key category emissions are summarized. From 1990 to 2009, 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.

	1990	2009
CO_2 stationary combustion liquid fuels, Gg	153,467	84,009
CO_2 stationary combustion solid fuels, Gg	59,397	65,128
CO_2 stationary combustion gaseous fuels, Gg	85,066	162,029
CO_2 stationary combustion other fuels, Gg	1,779	4,943
N_2O stationary combustion, Mg	3,445	3,768

Source: ISPRA elaborations

Table 3.5 Stationary combustion, GHG emissions in 1990 and 2009

Another group of key categories (n. 4, 6) 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 3.18 and Table 3.27, respectively. 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 2009 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. In case of differences between IPCC and national emission factors, the latter have been usually preferred.
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.

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 system 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, 2008 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 2009, Primary fuels. From 2004 onwards, it has been necessary to use also those quantities to calculate emissions in the reference approach, so as to minimize differences with sectoral approach. From 2004, the energy balances prepared by MSE do 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. Those producers account in 2009 for 92.6% 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.

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 2009 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. Those 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, so it is possible to use almost any data available at national level. 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.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.

	1990	1995	2000	2005	2006	2007	2008	2009
Fuel consumption (TJ)	1,428,137	1,468,278	1,668,305	1,799,929	1,822,784	1,838,270	1,745,590	1,492,844
GHG (Mt)	107,544	103,584	103,273	98,208	100,612	109,875	105,640	102,124
CO_2 (Mt)	107,136	109,477	115,159	119,509	121,105	120,325	116,252	97,886
CH_4 (Mt)	3.9	4.1	3.9	4.4	4.5	4.3	4.2	4.0
N_2O (Mt)	1.1	1.0	0.9	1.1	1.1	1.1	1.0	1.0

Source: ISPRA elaborations

Table 3.6 Public electricity and heat production: Energy data (TJ) and GHG emissions (Mt), 1990-2009

Because 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 (16 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. Those power plants are generally owned by other companies but are located inside the refinery premises or just sideway. In 2009 the power plants included in this source category have generated 4.5% 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 surveys performed for the large combustion plants European Directive (LCP) and the E-PRTR registry; both surveys include most of refineries but not all 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 by the power plants the source is Terna and please refers to Annex 2 for further details. The quota of the 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 2009 is reported, with energy and emission data.

	Consumption, TJ				CO_2 emissions, Gg			
REFINERIES	Petroleum coke	Ref. gas	Liquid fuels	Natural gas	Petroleum coke	Ref. gas	Liquid fuels	Natural gas
energy			85,551	32,301			7,375	1,845
furnaces	35,855	110,708	73,795		3,606	6,873	5,552	
TOTAL				338,210				25,251

Source: ISPRA elaborations
Table 3.7 Refineries, CO_2 emission calculation, year 2009

From 2008, the weighted average of CO_2 emission factor reported by operators in the framework of the EU ETS scheme is used for petroleum coke. The increase in the last years of the consumption of fuels with higher carbon content, as petroleum coke and synthesis gas obtained from heavy residual fuels, explain the growth of the IEF for liquid fuel reported in the CRF for this sector.

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, 2005-2009 are reported.

	1990	1995	2000	2005	2006	2007	2008	2009
CO_2 emissions, Mt	16.3	18.6	22.4	27.1	26.2	27.3	27.5	25.3
CH_4 emissions, Gg	0.46	0.53	0.59	0.67	0.67	0.70	0.70	0.65
N_2O emissions, Gg	0.49	0.56	0.60	0.68	0.65	0.67	0.68	0.62
Refinery, total, Mt CO_2 eq	16.5	18.8	22.6	27.4	26.4	27.5	27.7	25.5

Source: ISPRA elaborations
Table 3.8 Refineries, GHG emission time series

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. Fuel consumptions have reached a plateau in 2005 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. In 2009 a drop is noted due to the effects of the economic recession.

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 by other surveys that include refineries, EU ETS, LCP and E-PRTR surveys 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.

3.3.2.5 Source-specific recalculations

In 2011 submission no recalculations occurred for this category except those due to the update of natural gas CO_2 emission factor for 2008, resulting in a decrease of emission less than 0.001%.

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 2009 the power plants included in this source category have generated about 2% 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 at more detail 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 surveys performed for the large combustion plants European Directive (LCP) and the E-PRTR registry; both surveys include most of the iron and steel integrated plants and the only coke producing plant but not all 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 are assimilated to the renewable sources and incentives are 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 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 cookeries are estimated on the basis of production data to take in account additional volatile emissions due to the specific process.

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, 2005-2009 are reported.

	1990	1995	2000	2005	2006	2007	2008	2009
CO_2 emissions, Mt	13.0	11.8	14.4	13.8	15.0	14.0	15.4	9.2
CH_4 emissions, Gg	4.9	4.0	2.3	1.2	1.0	0.7	0.7	0.6
N_2O emissions, Gg	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	13.8	15.0	14.1	15.5	9.3

Source: ISPRA elaborations

Table 3.9 Manufacture of solid fuels, GHG emission time series

An upward trend in emission levels is observed from 1990 to 2008, especially for the last years. That is explained by the increasing quantities of steel production, from 25.5 Mt in 1990 to 30.6 Mt in 2008 and siderurgical products, from 25.0 Mt in 1990 to 35.0 Mt in 2008, and the specialisation of the national industry in high quality steel products, more energy intensive. In 2009 a strong reduction of emissions is observed due to the effects of the economic recession.
The strong reduction of CH_4 emissions in the last years refers to coke production and it 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.

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 by other surveys that include integrated iron and steel plants, such as EU ETS Directive, LCP and E-PRTR surveys, 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 E-PRTR registry 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. In 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 2011 submission, no recalculations occurred for this category except those due to the update of natural gas CO_2 emission factor for 2008, resulting in a decrease of emission equal to 0.001%.

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 Overview of sector

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 2009, energy use in industry account for 13.5% of total national CO_2 emissions, 0.2% of CH_4, 4.4% of N_2O. In term of CO_2 equivalent, manufacturing industry share 11.8% of total national greenhouse gas emissions.

Five key categories have been identified for this sector in 2009, 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).

All these categories are also key category sources 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 2000-2009. Industrial emissions show oscillations, related to economic cycles.

	1990	1995	2000	2005	2006	2007	2008	2009
CO_2 emissions, Gg	86,480	86,023	83,699	80,392	78,958	75,731	72,785	56,433
CH_4 emissions, Mg	6,819	7,021	5,723	6,276	6,243	6,526	6,246	4,176
N_2O emissions, Mg	4,931	4,519	4,662	5,019	5,050	4,981	4,638	3,981
Industry, total, Gg CO_2 eq	88,152	87,572	85,264	82,080	80,655	77,412	74,354	57,754

Source: ISPRA elaborations

Table 3.10 Manufacturing industry, GHG emission time series

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.

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008	2009
CO_2 (Gg)								
1.A.2.a Iron and Steel	18,272	18,854	13,535	14,459	13,835	14,250	13,192	8,551
1.A.2.b Non-Ferrous Metals	738	907	1,252	1,167	1,173	1,142	1,096	1,021
1.A.2.c Chemicals	20,052	18,059	13,497	12,017	11,709	11,313	10,633	8,481
1.A.2.d Pulp, Paper and Print	3,076	4,163	4,223	4,563	4,563	5,194	4,289	3,802
1.A.2.e Food	3,853	5,062	6,238	6,441	5,688	5,429	5,568	4,660
1.A.2.f Other	40,489	38,978	44,954	41,745	41,990	38,403	38,007	29,918
CH_4 (Mg)								
1.A.2.a Iron and Steel	3,795	4,226	3,093	3,304	3,275	3,592	3,521	1,892
1.A.2.b Non-Ferrous Metals	13	16	27	24	25	23	22	20
1.A.2.c Chemicals	798	677	318	340	323	301	231	177
1.A.2.d Pulp, Paper and Print	77	94	91	104	114	124	115	77
1.A.2.e Food	105	127	175	410	390	428	455	464
1.A.2.f Other	2,031	1,880	2,019	2,094	2,116	2,057	1,901	1,546
N_2O (Mg)								
1.A.2.a Iron and Steel	362	370	302	330	326	316	295	191
1.A.2.b Non-Ferrous Metals	13	16	25	23	23	22	21	19
1.A.2.c Chemicals	346	285	159	152	148	143	125	94
1.A.2.d Pulp, Paper and Print	64	82	81	89	90	101	84	70
1.A.2.e Food	52	53	76	91	87	81	81	61
1.A.2.f Other	4,093	3,712	4,020	4,335	4,375	4,317	4,032	3,545

Source: ISPRA elaborations

Table 3.11 Trend in greenhouse gas emissions from the manufacturing industry sector, 1990-2009

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 has not changed significantly in the 1990-2008 period due to an expansion in capacity of the two 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.

Non-Ferrous Metals

In Italy there is a production of primary aluminium (232 Gg in 1990 and 166 Gg in 2009) and of secondary aluminium (350 Gg in 1990 and 700 Gg in 2007 and 450 in 2009). Those productions

however use electricity as the primary energy source so the emissions due to the direct use of fossil fuels are limited, about 23% of the total emissions of source 1.A.2.b in 2008. At present in Italy, there are two 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, about 19% in 2008. 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 2009, 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 2009 the production has been greatly reduced, with less than half of the 1990 production still occurring in 2009.
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 changed from 22% in 1990 to 19% in 2009.

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 2009. Most of the pulp was imported in 1990, while in 2009 nearly 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 8.4 Mt in 2009. 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 changed from 13% in 1990 to 1.2% in 2009.

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 consumption was estimated to be 137 PJ in 1990 and 188 PJ in 2009. Value added in constant money has increased of 0.6% per years from 1990 to 2003 and of 0.3% yearly from 2004 to 2008.
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 CO2 emissions due to electricity generation has changed from 3% in 1990 to 0.0% in 2009.

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 process implemented is efficient with reference to the average European level and those processes 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 because this subsector is a key sector and accounts, in 2009, for 53.0% of the total source 1.A.2 CO_2 emissions, and for 6.3 % of the 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 changed from 1.9% in 1990 to 0.3% in 2009.

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. Those 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).

	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	100.573	3.493	4.208
Gasoil	73.274	3.127	3.066
Orimulsion	77.733	2.177	3.252
Synthesis gas from heavy residual, 2009 average	91.899		
Gaseous fuels, national data			
Natural gas, 2009 average	57.128	1.958 (sm^3)	2.390
Solid fuels			
Steam coal, 2009 average	92.035	2.285	3.851
"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	62.080	3.117	2.597
Coke Gas	41.900	0.375	1.753
Blast furnace – oxygen converter Gas	261.711	1.293	10.950
Fossil fuels, national data			
Fuel oil , 2009 average	75.684	3.112	3.167
Coking coal	95.702	2.963	4.004
Other fuels			
Municipal solid waste	47.877	0.718	2.003

Source: ISPRA elaborations

Table 3.12 Emission Factors for Power, Industry and Civil sector

Starting from 2008, the oxidation factors for petroleum coke have been modified based on the data reported by operators under the EU ETS scheme. Weighted average of oxidation factor reported for petroleum coke is 0.998.
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.

Other sources of information are the yearly survey performed for the E-PRTR, since 2003, and 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.
In general, in the industrial sector 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 BEN than ETS, at fuel sector level, a verification procedure starts.
Since 2007 data, ISPRA verifies actual data from both sources and communicate to MSE eventual discrepancies. This starts a verification procedure that eventually can 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.

Non-Ferrous Metals

Those plants are mostly excluded from EU ETS; some aluminium producing plants will be included from 2013, but only for CO_2 and PFCs emissions from the production process. Those 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.

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. The ETS data contain info on the energy and emissions relative to electricity, but this 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.

In 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). Statistics on biomass fuel consumption appears from 1998; 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.

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. No info on this sector can be found in ETS survey, the sector is not included in the scope of ETS.

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.

3.4.4 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions in Industry 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 2009 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.

	1990	1995	2000	2005	2006	2007	2008	2009
	TJ							
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**	**1,115,681**	**872,753**
a. Iron and Steel	271,413	273,216	231,016	250,701	245,646	240,587	225,891	147,637
b. Non-Ferrous Metals	12,067	15,145	20,609	19,950	20,010	19,545	18,371	17,184
c. Chemicals	290,074	269,682	203,069	180,188	176,096	172,116	154,054	123,562
d. Pulp, Paper and Print	50,520	70,371	74,175	79,633	79,610	91,069	73,674	65,142
e. Food Processing, Beverages and Tobacco	62,141	85,138	103,552	108,371	94,999	91,438	92,042	79,102
f. Other	579,213	595,277	673,555	619,793	624,002	572,093	551,648	440,127

Source: ISPRA elaborations

Table 3.13 Fuel consumptions for Manufacturing Industry sector, 1990-2009 (TJ)

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 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

There has been an overall recalculation of emissions from the sector, due to the update of the emission factor based on detailed EU ETS operator’s reports for year 2009 (paragraph 3.1). The

recalculation refers to the years 2005-2008 for coal CO_2 emission factors and to 2008 for natural gas CO_2 emission factor.
The carbon balance in the iron and steel sector (1.A.2.a) has been updated taking in account of the quantity of carbon stored in steel produced for the whole time series.
The recalculation affected the whole time series for CO_2 emissions with differences ranging from -0.06% to -0.03%, with respect to earlier submissions.

3.4.7 Source-specific planned improvements

No specific improvements are planned for the next submission.

3.5 Transport

This sector shows a pronounced increase in emissions over time, reflecting the huge increase in fuel consumption for road transportation. The mobility demand and, particularly, the road transportation share have constantly increased in the period from 1990 to 2009, although since 2007 emissions from the sector slightly decreased.

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 gasoline and diesel fuel 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 2009) that use gasoline and is increasing every year since 1990. Only a small part of this fleet complies with strict VOC emissions controls.

		1990	1995	2000	2005	2006	2007	2008	2009
CO_2	Mt	101.3	111.4	120.1	125.8	127.1	127.2	122.3	117.9
CH_4	Mt	0.7	0.8	0.6	0.4	0.4	0.4	0.3	0.3
N_2O	Mt	0.9	1.5	1.7	1.1	1.2	1.2	1.1	1.1
Total, CO_2 eq.	Mt	102.9	113.7	122.4	127.4	128.7	128.8	123.7	119.3

Source: ISPRA elaborations

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

CO_2 from road vehicles and CO_2 from waterborne navigation are key categories both in 1990 and in 2009.

3.5.1 Aviation

3.5.1.1 Source category description

The IPCC 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 2009 total GHG emissions from this source category were about 1.8 per cent of the national total emissions from transport, and about 0.4 per cent of the GHG national total; in terms of CO_2 only, the share is almost the same.
From 1990 to 2009, GHG emissions from the sector increased by 36% 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. In the last two years, however, emissions decreased by about 5% annually.
Civil aviation is not a key category in the Italian inventory.

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 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 (MINT, several years) and the Italian civil aviation in the national aviation statistics yearbooks (ENAC/MINT, 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. 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/MINT, 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 2009 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.

N° Flights	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**
Domestic	186,446	199,585	319,963	311,218	324,779	346,724	331,004	312,257
International	139,733	184,233	303,747	363,140	385,159	420,021	403,436	378,888

Source: ISTAT, several years [a]; ENAC/MINT, several years
Table 3.15 Aircraft Movement Data (LTO cycles)

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

a Emission factor as kg carbon/t.
Table 3.16 CO_2 and SO_2 emission factors for Aviation (kg/t) 1990-2009

	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	-	0.152	24.003	3.313	0.822	-
International Cruise	kg/Mg fuel	-	0.535	70.916	7.190	2.569	-
Aircraft Military [a]	kg/Mg fuel	0.4	0.2	15.8	126	3.6	-

a EMEP/CORINAIR, 2007
Table 3.17 Non-CO_2 emission factors for Aviation (2009)

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

Source: ISPRA elaborations

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

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 2009 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 two years.

		1990	1995	2000	2005	2006	2007	2008	2009
CO_2	Gg	1,613	1,709	2,649	2,204	2,291	2,428	2,301	2,197
CH_4	Mg	29	32	60	102	89	65	62	59
N_2O	Mg	45	48	74	62	64	68	64	61

Source: ISPRA elaborations

Table 3.19 GHG emissions from domestic aviation

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, sulphur dioxide and N_2O emissions are calculated on fuel based emission factors using fuel consumption data from BEN. Emissions of CO, NMVOC, NO_x 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.

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	Gg/Mt						
Diesel trains	857	0.14	1.2	40.5	4.9	3.6	2.8

Source: EMEP/CORINAIR, 2007

Table 3.20 Emission factors for railway (Gg/Mt)

GHG emissions from railways accounted in 2009 for less than 0.2% of the total transport sector emissions. In 2011, no recalculation affected this category except for SO_X emissions which emission factor changed for 2007 and 2008. No specific improvements are planned for the next submission.

3.5.3 Road Transport

3.5.3.1 Source category description

The IPCC requires the estimation of emissions for category 1.A.3.b Road transportation.
In 2009, total GHG emissions from this category were about 93.2% of the total national emissions from transport, 27.3% of the energy sector and about 22.6% of the GHG national total.
From 1990 to 2009, GHG emissions from the sector increased by 17.2% due to the increase of vehicle fleet, total mileage and consequently fuel consumptions. In the last years, the trend of fuel consumption and emissions slightly changed. From 2007 GHG emissions from road transport started to decrease and were about 4.1% and 3.5% respectively lower than those of the previous year were.
CO_2 emissions from road transport are a key category in 2009 with Tier 1 and Tier 2 methods at level and trend assessment, with and without LULUCF. N_2O emissions and CH_4 emissions are not key category.
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.

3.5.3.2 Methodological issues

According to the IPCC Guidelines and Good Practice Guidance (IPCC, 1997; IPCC, 2000; IPCC, 2006) and the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2009), a national methodology has been developed and applied to estimate emissions. In particular, the model COPERT 4 (EEA, 2010) has been used to estimate emissions for the whole time series. In the 2011 submission, the new version of COPERT 4 (EEA, October 2010) has been used, in particular the version 8.0 which upgrade the methodology, the software and fixed some bugs in the model, determining a recalculation of emission estimates. The annual update of the model is based on the availability of new measurements and studies regarding road transport emissions.
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 ratio of the fuel; emissions of SO_2 are based on the sulphur content of the fuel. 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).
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).

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, 2000-09[b]	71.145	3.109
Gas oil, 1990-'99, IPCC OECD[a]	73.274	3.127
Gas oil, engines, test data, 2000-09[b]	73.153	3.138
LPG, 1990-'99, IPCC[a] Europe	64.350	3.000
LPG, test data, 2000-09[b]	64.936	2.994
Natural gas (dry) 1990	55.328	-
Natural gas (dry) 2009	57.128	-

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])

Table 3.21 Fuel-Based Emission Factors for Road Transport

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 2009 inventory used fuel consumption factors expressed as g 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 (EEA, 2010). The updated version 8.0 of the model Copert 4 has been used for the whole time series of the 2011 submission. As reported more in detail in the following, the updated version of the model revised emission and consumption factors of heavy duty trucks and buses, revised some functions of the software and fixed some bugs, compared to the previous version 7.1.

Fuel consumptions calculated from Copert functions are shown in Table 3.22 for each vehicle type, emission regulation and road type in Italy. A normalisation procedure was used to ensure that the breakdown of gasoline and diesel consumption by each vehicle type calculated on the basis of the fuel consumption factors added up to the BEN figures for total fuel consumption in Italy (adjusted for off-road consumption).

SNAP CODE	Sub sector	Type of fuel	Mg of fuel consumed	Mileage, km_kVeh
070101	PC Hway	diesel	3,651,140	67,671,580
070101	PC Hway	gasoline	2,045,722	41,876,875
070101	PC Hway	lpg	360,960	5,465,528
070102	PC rur	diesel	5,385,929	115,480,958
070102	PC rur	gasoline	3,070,866	71,949,109
070102	PC rur	lpg	329,128	7,287,371
070103	PC urb	diesel	2,127,166	30,157,102
070103	PC urb	gasoline	3,505,900	45,922,944
070103	PC urb	lpg	406,893	5,465,528
070201	LDV Hway	diesel	1,323,848	12,934,032
070201	LDV Hway	gasoline	49,168	710,305
070202	LDV rur	diesel	2,140,928	35,568,588
070202	LDV rur	gasoline	138,673	1,953,339
070203	LDV urb	diesel	1,749,737	16,167,540
070203	LDV urb	gasoline	143,755	887,881
070301	HDV Hway	diesel	3,800,103	20,036,287
070301	HDV Hway	gasoline	720	4,821
070302	HDV rur	diesel	2,618,943	13,641,347
070302	HDV rur	gasoline	2,087	14,464
070303	HDV urb	diesel	1,458,394	4,673,243
070303	HDV urb	gasoline	942	4,821
070400	mopeds	gasoline	372,401	17,102,853
070501	Moto Hway	gasoline	68,676	1,776,178
070502	Moto rur	gasoline	360,761	12,433,248
070503	Moto urb	gasoline	640,416	21,314,139
Total				550,500,080

Source: ISPRA elaborations

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

Table 3.22 Average fuel consumption and mileage for main vehicle category and road type, year 2009

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 account of data released from Ministry of Transport (MINT, several years). 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 (EEA, 2010). 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.

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 diesel-fuelled and petrol-fuelled vehicles on the road and in terms of the fraction of vehicles on the road made to the different emission regulations which applied when the vehicle was first registered. These are related to the age profile of the vehicle fleet.
Additional data are required for the estimation of consumption of buses, because the available traffic data seldom distinguish beyond “heavy vehicles”. Moreover, traffic data on motorcycles are not exhaustive. In both cases, the energy consumption is estimated on the basis of the oil companies’ reports on sold fuels.

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, for NMVOC and methane, evaporative emissions.
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;
- 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);
- Buses and coaches;
- Mopeds and motorcycles.

Basic data derive from different sources. Detailed data on the national fleet composition is found in the yearly report from ACI (ACI, several years). The National Association of Cycle-Motorcycle

Accessories (ANCMA, several years) supplies useful information on mopeds fleet composition and mileages. The Ministry of Transport in the national transport yearbook (MINT, several years) reports passenger car mileages time series. 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 3.23, 3.24 and 3.25 detailed data on the relevant vehicle mileages in the circulating fleet are reported, subdivided according to the main emission regulations.

	1990	1995	2000	2009
pre-1972, PRE ECE	0.05	0.03	0.01	0.005
1972 -1977, ECE 15.00/.01	0.11	0.04	0.01	0.003
1978 -1986, ECE 15.02/.03	0.32	0.15	0.03	0.01
1987 -1992, ECE 15.04	0.52	0.56	0.29	0.07
91/441/EC, from 1/1/93, euro I	0.001	0.22	0.27	0.08
94/12/ EC, from 1-1-97 , euro II	-	-	0.37	0.27
98/69/EC, from 1/1/2001, euro III	-	-	-	0.20
98/69/EC, from 1/1/2006, euro IV, V	-	-	-	0.37
Total	1.00	1.00	1.00	1.00

Source: ISPRA elaborations on ACI data

Table 3.23 Gasoline cars technological evolution: circulating fleet calculated as stock data multiplied by effective mileage (%)

	1990	1995	2000	2009
pre- 1993	1.00	0.91	0.34	0.02
91/441/EC, from 1/1/93, euro I	-	0.09	0.10	0.02
94/12/ EC, from 1-1-97 , euro II	-	-	0.56	0.10
98/69/EC, from 1/1/2001, euro III	-	-	-	0.33
98/69/EC, from 1/1/2006, euro IV, V	-	-	-	0.53
Total	1.00	1.00	1.00	1.00

Source: ISPRA elaborations on ACI data

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

	1990	1995	2000	2009
pre -1996	1.00	0.93	0.61	0.09
from 1/1/96, Dir. 91/542 EEC, euro I	-	0.07	0.21	0.08
from 1/1/97, Dir. 91/542 EEC, euro II	-	-	0.18	0.23
from 1/1/2001, Dir. 99/96, euro III	-	-	-	0.34
from 1/1/2006, Dir. 99/96, euro IV, V	-	-	-	0.25
Total	1.00	1.00	1.00	1.00

Source: ISPRA elaborations on ACI data

Table 3.25 Trucks technological evolution: circulating fleet for light duty (%)

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 3.26, based on data from various sources:

- Ministry of Transport (MINT, several years) for rural roads and on other motorway; 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).

	1990	1995	2000	2005	2006	2007	2008	2009
All passenger vehicles, total mileage (10^9 veh-km/y)	304	362	391	418	425	425	409	395
Car fleet (10^6)	27	30	32	34	35	35	36	36
Moto, total mileage (10^9 veh-km/y)	31	39	45	49	50	51	52	53
Moto fleet (10^6)	7	7	9	10	10	10	10	11
Goods transport, total mileage (10^9 veh-km/y)	70	75	90	99	102	105	104	103
Truck fleet (10^6), including LDV	2	3	3	4	4	5	5	5

Source: ISPRA elaborations

Table 3.26 Evolution of fleet consistency and mileage

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. The procedure for estimating evaporative emissions of NMVOCs and methane takes account of changes in ambient temperature and fuel volatility.

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 assessement, at Italian level, for road transport emissions on the basis of 2005 input parameters of the COPERT 4 model (v. 7.0).
The Montecarlo analysis is being implemented, using the software tool Copert 4 MC, considering the 2009 emissions.

The following Table 3.27 summarizes the time series of GHG emissions in CO_2 equivalent from road transport, highlighting the evolution of this growing source. An upward trend in CO_2 emission levels is observed from 1990 to 2007, which is explained by the increasing of the fleet, total mileages, and fuel consumptions. Nevertheless, the propagation of the number of vehicles, with low fuel consumption per kilometre, slows down the tendency in the last years. In 2009, with respect to 2007, a reduction in total mileages, especially for passenger cars, fuel consumptions and

[1] EMISIA: www.emisia.com

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.

		1990	1995	2000	2005	2006	2007	2008	2009
CO_2	Gg CO_2 eq.	93,387	103,552	110,377	117,029	118,263	118,718	113,919	109,906
CH_4	Gg CO_2 eq.	694	771	567	361	339	319	298	285
N_2O	Gg CO_2 eq.	789	1,339	1,580	1,024	1,105	1,096	1,008	980
Total	**Gg CO_2 eq.**	**94,870**	**105,663**	**112,524**	**118,414**	**119,706**	**120,133**	**115,226**	**111,171**

Source: ISPRA elaborations

Table 3.27 GHG emissions from road transport (Gg CO_2 equivalent)

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://www.sinanet.isprambiente.it/it/EPT/convegni/annunci-e-convegni.

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 2011 and 2010 submissions, the new versions of COPERT 4 revised both the estimation methodology and the software, but not in such significant way as the transition to COPERT 4. In 2009 in fact, the transition from COPERT III to COPERT 4 was the occasion for a general review of input data, as activity data, model parameters and emission factors.

The most recent update of the software is COPERT 4, version 8.0 (EEA, October 2010). This is a user-friendly version that upgraded the methodology and the software and fixed some bugs, and it has been used to estimate emissions in the 2011 submission determining a recalculation of emission estimates, but did not produce significant changes with respect to the previous submission.

This updated version of the model revised hot emission factors of CO, VOC, NO_X, PM exhaust and FC, for heavy duty trucks and buses (except CNG buses) on the basis of the latest Handbook of Emission Factors for Road Transport (HBEFA, 2010).
As regards Euro V vehicles, the new methodology distinguishes between the technologies EGR (exhaust gas recirculation) and SCR (selective catalytic reduction), but did not provide significant changes with respect to 2010 submission because of the still small number of Euro V vehicles in the Italian fleet.
As regards the software, some modifications relating to the worksheet of import/export and the installation were carried out; improvements concerning the exporting functions and the selection of load/slope effects were implemented and bugs relating to the calculation of mileage degradation

factors, evaporation factors and the export process of fuel balance results, were fixed. The updating of the minimum speed limit of hot emission factors parameters for hybrid passenger cars does not affect the Italian case.

Differences between the two last submissions 2010 and 2011 are very low, in fact recalculations, in the total road transport GHG emissions, account for 0.003% in 1990 and 0.01% in 2008. Carbon dioxide values are the same in 1990, while in 2008 show a difference of -0.02%. As regards methane and nitrous oxide, discrepancies range respectively from 0.08% in 1990 to 0.63% in 2008 and from 0.31% in 1990 to 3.11 in 2008.

3.5.3.6 Source-specific planned improvements

Improvements for the next submission will derive from the annual update of the software. In particular a Montecarlo analysis will be completed, using the software tool Copert 4 MC, considering the 2009 emissions.

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% of the total GHG in the transport sector in 2009 and about 1% of the national total. If considering CO_2 only, emissions from navigation are 1.1% out of the national CO_2 emissions. GHG emissions decreased by 12% from 1990 to 2009, because of the reduction in fuel consumed in harbour and navigation activities although the increase in the number of movements; from 2008 to 2009, however, a decrease in the number of movements is also observed.

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 (MINT, 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 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.

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 3.28. 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; from 2008 to 2009 a decrease in the number of ship movements is also observed.

	1990	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**
Fuel in domestic travels (Gg)	778	706	811	740	709	673	670	650
Fuel in harbours (dom+int ships) (Gg)	748	693	818	759	727	690	687	667
Fuel in international Bunkers (Gg)	1,398	1,286	1,333	2,203	2,369	2,468	2,685	2,309
CO_2 (Gg)	5,420	5,117	5,842	5,403	5,204	4,970	4,914	4,762
CH_4 (Gg CO_2 eq.)	29	32	32	30	29	29	28	27
N_2O (Gg CO_2 eq.)	39	37	43	39	38	36	36	35

Source: ISPRA elaborations

Table 3.28 Marine fuel consumptions in domestic and international travels (Gg) and GHG emissions from domestic navigation (Gg CO_2 eq.)

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 on going collaboration and data exchange with regional environmental agencies on this issue.

3.5.4.5 Source-specific recalculations

In 2011 submission, a verification of activity data from different sources was undertaken. The only recalculation regarded the update of ship movements for 2008, on the basis of EUROSTAT figures, which affected diesel and residual oil fuel consumption and related emissions.
The recalculation accounted for an increase equal to 3.8% of GHG emissions, 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.

3.6 Other sectors

3.6.1 Overview of sector

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 2009, energy use in other sectors account for 20.8% of CO_2 emissions, 2.1% of CH_4, 6.7% of N_2O emissions. In term of CO_2 equivalent, other sectors share 18.2% of total national greenhouse gas emissions and 22.0 of total GHG emissions of the energy sector.

The trends of greenhouse gas emissions are summarised in Table 3.29. 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 crescent use of woody biomass for heating.

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008	2009
CO_2 (Gg)								
1.A.4.a Commercial/ Institutional	16,187	17,240	20,407	26,120	25,479	25,589	26,822	27,409
1.A.4.b Residential	52,118	50,103	50,159	57,339	52,239	46,456	49,741	51,012
1.A.4.c Agriculture/ Forestry/ Fisheries	8,372	8,747	8,030	8,371	8,239	7,849	7,593	7,679
1.A.5 Other (Not elsewhere specified)	1,046	1,440	806	1,198	982	896	738	844
CH_4 (Mg)								
1.A.4.a Commercial/ Institutional	1,079	1,308	2,231	3,388	3,572	3,711	3,960	4,168
1.A.4.b Residential	12,382	15,756	18,129	19,528	21,029	25,811	27,004	29,263
1.A.4.c Agriculture/ Forestry/ Fisheries	1,269	947	2,449	2,616	2,847	3,516	3,663	3,964
1.A.5 Other (Not elsewhere specified)	173	223	126	160	127	114	74	73
N_2O (Mg)								
1.A.4.a Commercial/ Institutional	428	500	694	978	965	969	998	1,003
1.A.4.b Residential	1,570	1,625	1,730	1,894	1,873	1,980	2,074	2,186
1.A.4.c Agriculture/ Forestry/ Fisheries	2,520	2,756	2,687	2,772	2,761	2,653	2,591	2,630
1.A.5 Other (Not elsewhere specified)	225	215	135	291	239	227	199	239

Source: ISPRA elaborations

Table 3.29 Trend in greenhouse gas emissions from the other sectors, 1990-2009

Five key categories have been identified for this sector for 2009, 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).

All these categories are also key categories including the LULUCF sector in the key category assessment; see paragraph 3.1 for further details.

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 2009, this sector has a share of 5.1% 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.
In 2009, this sector has a share of 9.7% 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.
In 2009, this sector has a share of 1.6% 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 2009, this sector has a share of 0.2% 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 paragraph 3.7.2 Others. Emissions from fishing vessels are estimated from fuel consumption data (MSE, several years [a]). Emission factors are shown in Table 3.12.

Others
In this paragraph, we summarize the methodology used to estimate emissions from a range of portable or mobile equipment powered by reciprocating diesel or petrol driven engines. 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 1990-2009 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 2009 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 3.30.

	1990	1995	2000	2005	2006	2007	2008	2009
				TJ				
1.A.4a. Commercial/ Institutional	268,011	295,694	357,066	459,958	455,282	461,464	475,853	487,089
1.A.4b. Residential	861,865	868,489	888,941	1,031,079	945,857	864,793	911,343	940,477
1.A.4c. Agriculture/ Forestry/ Fisheries	114,964	121,138	117,029	123,208	122,082	119,048	115,832	118,109
1.A.5 Other	14,830	20,800	11,587	16,935	13,887	12,654	10,411	11,898

Source: ISPRA elaborations

Table 3.30 Trend in fuel consumption for the other sector, 1990-2009 (TJ)

In the following Table 3.31, total GHG emissions connected to the use of fossil fuels and waste derived fuels are reported for the years 1990, 1995 and 2000-2008. 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 crescent use of woody biomass for heating.

	1990	1995	2000	2005	2006	2007	2008	2009
CO_2 (Gg)	77,723	77,530	79,402	93,028	86,939	80,790	84,894	86,945
CH_4 (Mg)	14,903	18,233	22,936	25,693	27,575	33,151	34,701	37,469
N_2O (Mg)	4,743	5,096	5,247	5,935	5,838	5,828	5,862	6,057
GHG (Gg CO_2 eq)	79,507	79,493	81,510	95,408	89,328	83,293	87,440	89,610

Source: ISPRA elaborations

Table 3.31 Other sectors, GHG emission time series 1990-2009

In Table 3.32, other sectors emissions are summarized according to key categories. From 1990 to 2009, 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.

		1990	2009
CO_2 stationary combustion liquid fuels	Gg	38,770	20,296
CO_2 stationary combustion solid fuels	Gg	920	17
CO_2 stationary combustion gaseous fuels	Gg	36,418	62,882
CO_2 stationary combustion other fuels	Gg	569	2,906
N_2O stationary combustion	Mg	4,518	5,818

Source: ISPRA elaborations

Table 3.32 Others, GHG emissions in 1990 and 2009

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 3.7.2 *others.*

3.6.6 Source-specific recalculations

CO_2 emission factors have been updated from 2005 for steam coal and for the year 2008 for natural gas. In addition, 2003 data were revised. The recalculation affected only slightly CO_2 emissions for those years with differences equal to 0.03 % in 2003 and 0.01% in 2008, 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 3.33 and 3.34 detailed data on petrochemical and other non-energy use for the year 2009 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 prepare 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 the output quantity could be greater than the input quantity, due to internal transformation. Therefore it is possible to have negative values for some products (mainly gasoline, refinery gas, fuel oil).
The quantities of fuels stored in products, in percentage on net and gross petrochemical input, are estimated with these data, see Table 3.34 for details by product and Table 3.33 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 3.34. The amount of fuels stored is also reported in Table 1.A(d) of the CRF in TJ so the fuel quantity reported is the amount of fuels stored and the fractions of carbon stored are equal to 1. Non-energy products quantity amount stored are reported in the BEN and the carbon stored is estimated with emission factors reported in Table 3.35.
As can be seen from the value reported for the year 2009, 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 product 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 3.35. The resulting estimate of about 5,396 Gg of products, for the year 2009, is almost 50% bigger than the quantities reported, 3,825 Gg.

Breakdown of total petrochemical flow

	Petrochemical Input	Returns to refinery/market	Internal consumption / losses	Quantity stored in products
ALL ENERGY CARRIERS, Gg	8,392	2,436	2,131	3,825
% of total input		29.0%	25.4%	45.6%
% of net input			35.8%	64.2%

Source: ISPRA elaborations

Table 3.33 Other non-energy uses, year 2009

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	554	550	30	-26			0.8137
Refinery gas	89	40	743	-694			0.8549
Virgin naphtha	4,600	0	0	4,600			0.8703
Gasoline	811	1,219	55	-463			0.8467
Kerosene	466	352	0	114			0.8485
Gas oil	443	117	0	326			0.8569
Fuel oil	474	106	379	-11			0.8678
Petroleum coke	0	0	0	0			0.955
Others (feedstock)	116	52	85	-21			0.8368
Losses			0	0			0.8368
Natural gas	839	0	839	0			0.727
total	8,392	2,436	2,131	3,825	46%	64%	

Source: ISPRA elaborations

Table 3.34 Petrochemical, detailed data from MSE, year 2009 (MSE, detailed petrochemical breakdown)

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	3,852	40.19	0.8841	154.8
lubricants	954	40.19	0.8038	38.3
recovered lubricant oils	157	40.19	0.8038	6.3
paraffin	71	40.19	0.8368	2.9
others (benzene, others)	645	40.19	0.8368	25.9
Totals	5,679			228.2

Source: ISPRA elaborations

Table 3.35 Other non-energy uses, year 2009, MSE several years [a]

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 3.35, those 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 those products do occur if the calculation is based on national data or IPCC default values.

3.8.3 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions in “Other sectors” is estimated to be about 4% in annual emissions.
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 for the years 2007 and 2008 on account of new information on the amount of recovered oil from refineries for no energy use and CO_2 emission factor for natural gas.

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 2009, GHG emissions from this source category account for 1.8% out of the total emissions in the energy sector. Trends in fugitive emissions are summarised in Table 3.40.

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 for 2009

1B2	CH_4	Fugitive emissions from oil and gas operations	Key (L, T)
1B2	CO_2	Fugitive emissions from oil and gas operations	Key (T2)

Specifically, methane emissions from oil and gas operations are a key category according to the level and trend assessment with Approach 1 and Approach 2, excluding LULUCF emissions and removals and with Approach 1 including LULUCF.
CO_2 emissions from oil and gas operations are a key category for trend assessment with Approach 2, without LULUCF; these emissions are no more key categories when including LULUCF. Both categories are key categories for the year 1990, either including or excluding LULUCF emissions and removals.

Fugitive CH_4 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, a surface one, 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 the coke production in the iron and steel industry, which is also decreasing in the last years. CO_2 and N_2O emissions from 1.B.1 are not occurring.

Fugitive CO_2 emissions reported in 1.B.2 refer to fugitive emissions in refineries during petroleum production processes, e.g. fluid catalytic cracking and flaring, and emissions from the production 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.

For the completeness of the related CRF tables, in particular 1.B.2, the rationale beyond the values reported and not reported is explained below.
CO_2 and CH_4 fugitive emissions from oil exploration are included in those from production because no detailed information is available. N_2O emissions from flaring in oil exploration are reported under refinery flaring. Emissions from transport and distribution of oil result as not occurring. CO_2 and CH_4 emissions from gas exploration are also included in those from production while CH_4 and CO_2 emissions from other leakage are included in distribution emission estimates.
A summary of the completeness of CO_2, CH_4 and N_2O fugitive emissions is shown in the following Table 3.36.

1.B. 2.a. Oil		
i. Exploration	CO_2,CH_4	Included in 1.B.2.a production
i. Exploration	N_2O	Included in 1.B.2.d refinery flaring
1.B.2.b. Natural Gas		
i. Exploration	CO_2,CH_4	Included in 1.B.2.b production
iii. Other leakage	CH_4,CO_2	Included in 1.B.2.b distribution

Table 3.36 Completeness of CO_2, CH_4 and N_2O fugitive emissions

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). 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).

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. Total fugitive emissions from refineries 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 3.37, the time series of crude oil losses published in the BEN and crude oil processed in Italian refineries are shown.

	1990	1995	2000	2005	2006	2007	2008	2009
Crude Oil losses (Mg)	1,004	937	757	576	608	603	642	624
Crude oil processing (Gg)	93,711	91,014	98,003	106,542	104,388	105,384	99,696	91,105

Source: MSE, UP

Table 3.37 Refineries activities and losses

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), and 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 were 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 3.38, the time series of national production of oil and gas are reported. Natural gas production should further reduce in the next years.

	1990	1995	2000	2005	2006	2007	2008	2009
Oil (Gg)	4,668	5,236	4,586	6,111	5,781	5,860	5,243	4,573
Natural gas (Mm^3)	17,296	20,383	16,766	11,963	10,837	9,634	9,071	7,909

Source: MSE

Table 3.38 National production of oil and natural gas

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 and competent 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]); 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). CO_2 emissions were calculated considering CO_2 content in the leaked natural gas.
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 3.39 provides the trend of natural gas distribution network length for each pipeline material and the average CH_4 emission factor.

Material	**1990**	**1995**	**2000**	**2005**	**2008**	**2009**
Steel and cast iron (km)	102,061	131,271	141,848	154,886	191,567	195,918
Grey cast iron (km)	24,164	23,229	21,314	15,080	4,816	4,586
Polyethylene (km)	775	7,300	12,550	31,530	45,135	47,098
Total (km)	127,000	161,800	175,712	201,496	241,518	247,602
CH_4 Emission Factors (kg/km)	**1,958**	**1,417**	**1,227**	**999**	**725**	**716**

Table 3.39 Length of low and medium pressure distribution network (km) and network emission factors for CH_4

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.
Applying Montecarlo analysis to estimate uncertainty of CH_4 emissions, the resulting figure decreases to 17.2%. 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.

Fugitive emissions, in CO_2 equivalent, account for 1.8% out of the total emissions in the energy sector in 2009. Both CH_4 and CO_2 emissions show a reduction from 1990 to 2009 by 33% and 35%, respectively.
The decrease of CO_2 fugitive emissions is driven by the reduction in crude oil losses in refineries. Fugitive emissions from solid fuels are not significant.
The trend of CH_4 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 regard the flaring activity from oil and gas production, the N_2O emissions account for less than 1.5 Gg of CO_2 equivalent in the whole time series.
Fugitive emissions since 1990 are reported in Table 3.40.

	1990	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**
	Gg CO_2 eq.							
CO_2								
Oil and natural gas	3,344	3,178	2,588	2,117	2,194	2,181	2,264	2,170
CH_4								
Solid fuels	122	65	73	69	54	84	73	45
Oil and natural gas	7,298	6,817	6,351	5,641	5,102	4,929	5,001	4,906
N_2O								
Oil and natural gas	12	12	13	14	14	14	13	12
Total emissions	10,766	10,072	9,025	7,841	7,364	7,208	7,351	7,132

Table 3.40 Fugitive emissions from oil and gas 1990-2009 (Gg CO_2 eq.)

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]), national authorities (AEEG, several years; ISTAT, several years), gas operators (ENI, several years [b]; EDISON, 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 2011 submission, some recalculations affected emission estimates of the sector.
The activity data time series for oil production (1.B.2.a) have been updated from 1990 adding the natural gasoline production. Also CO_2 emissions from gas transmission and distribution have been added from 1990.
Emissions from refinery flaring (CH_4, CO_2) have been moved from oil flaring (1.B.2.c) to 1.B.2.d to improve the transparency of reporting. Moreover N_2O emissions from refinery flaring have been estimated and included in 1.B.2.d from 1990.
Recalculations accounted for a decrease by -0.004% of CO_2eq. emissions on total emissions.
Other change occurred that does not imply any recalculation of emissions. A small change in network length for natural gas distribution (1.B.2.b) occurred from 2006. In particular the not functioning trunks of the network, as stated by AEEG (AEEG, several years), were subtracted. Fugitive emissions (CH_4, CO_2) from oil extraction have been disaggregated among venting, flaring and production, while emissions from gas extraction have been disaggregated between flaring and production.

3.9.6 Source-specific planned improvements

No further improvements are planned for the next submission.

4 INDUSTRIAL PROCESSES [CRF sector 2]

4.1 Overview of sector

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 2009 industrial processes account for 4.8% of CO_2 emissions, 0.1% of CH_4, 4.1% 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 2009, while CO_2 emissions from chemical and metal industry reduced sharply in the period.

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008	2009
CO_2 (Gg)								
2A. Mineral Products	21,265	20,933	21,393	23,358	23,412	23,934	21,647	17,498
2B. Chemical Industry	3,254	1,659	1,362	1,784	1,727	1,759	1,488	1,178
2C. Metal Production	3,878	3,403	1,754	1922	1,942	1,925	1,875	1,307
CH_4 (Gg)								
2B. Chemical Industry	2.45	2.65	0.40	0.33	0.32	0.34	0.30	0.28
2C. Metal Production	2.71	2.71	2.61	2.72	2.81	2.75	2.61	1.58
N_2O (Gg)								
2B. Chemical Industry	21.54	23.35	25.54	25.03	8.54	6.10	3.44	3.64
HFCs (Gg CO_2 eq.)	351	671	1,986	5,401	6,106	6,855	7,513	8,173
PFCs (Gg CO_2 eq.)	1,808	491	345	354	284	287	201	218
SF_6 (Gg CO_2 eq.)	333	601	493	465	406	428	436	398

Table 4.1 Trend in greenhouse gas emissions from the industrial processes sector, 1990-2009 (Gg)

Six 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 2009

2F	HFC, PFC	Emissions from substitutes for ODS	Key (L, T)
2A	CO_2	Emissions from cement production	Key (L, T1)
2B	N_2O	Emissions from adipic acid	Key (T)
2C	CO_2	Emissions from iron and steel production	Key (T)
2B	CO_2	Emissions from ammonia production	Key (T)
2B	N_2O	Emissions from nitric acid production	Key (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 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 key category for trend assessment and for level assessment with the Approach 2. N_2O emissions from adipic acid production, CO_2 emissions from iron and steel and ammonia are key categories only with the Approach 1 including LULUCF.

In addition CO_2 emissions from limestone and dolomite use is a key category in the base year at level assessment with the Approach 1 including and excluding 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 (with both the Approach 1 and Approach 2) and trend assessment (with the Approach 1) and accounts for 3.2% 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. There are 29 companies (88 plants of which: 58 full cycle and 30 grinding plants) currently operating 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: 45% is in northern Italy, 17% 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 2009 the larger size cement plants (i.e. with cement production capacity > 1 Mt/y) contributed with less than 10% to the national cement production; due to resizing of 6 plants, only 3 plants keep a cement production capacity >1 Mt/year. In Italy different types of cement are produced; as for 2009 AITEC, the national cement association, has characterised the national production as follows: 73% is CEM II (Portland composite cement); 13.3% is CEM IV (pozzolanic cement); 7.9% is CEM I (ordinary Portland Cement) and 4.6% 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) and a decrease in the CO_2 emission from cement production has been observed in the same way.

Lime

CO_2 emissions occur also from processes where lime is produced and account for 0.4% 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 in iron and steel making facilities and lime production in sugar mills.
The number of lime producing facilities has been relevantly changing through the years: 85 operating plants in 1990, 46 plants in 2003, 38 plants in 2008 (this figure is based on the European

emission trading scheme data). 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 Italian lime industry uses natural gas, 20% uses coke.

Limestone and dolomite use (brick and tiles; fine ceramics)
CO_2 emissions are also related to the use of limestone and dolomite in different industrial processes, and they account for 0.4% 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 decrease in the production processes and the relevant use of limestone in 2009 led to a decrease (-25%) in CO_2 emissions.

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 Italian 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 0.16% of the total national emissions.

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 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 0.05% of the total national emissions.

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 ISTAT (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 and emissions, split between combustion process and decarbonising process. For the years from 1990 up 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. 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.

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 and in 532 kg CO_2/t clinker in 2009, based on the average CaO content in the clinker and taking into account the contribute of carbonates and additives.

Lime

CO_2 emissions from lime have been estimated on the basis of production activity data supplied by ISTAT (ISTAT, several years) adding the amount of lime produced and used in the sugar and iron and steel production sectors; emission factors have been estimated on the basis of detailed information supplied by plants in the framework of the European emission trading scheme and checked with the industrial association (CAGEMA, 2005). The resulting values, in the last years, for the implied emission factor were 706 kg CO_2/t lime production in 2005; 694 kg CO_2/t lime production in 2006; 707 kg CO_2/t lime production in 2007; 710 kg CO_2/t lime production in 2008 and 648 kg CO_2/t lime in 2009.

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. CO_2 emissions from paper production were accounted for, in the previous submission, only from 2000 to 2008, while in the present submission they are accounted for the whole time series as requested by the 2010 review report. CO_2 emissions deriving from the treatment of flue gases have been accounted for the whole time series in the present submission. 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 products. Detailed production 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).

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.

Glass

CO_2 emissions from glass production have been estimated by production activity data (ISTAT, several years) and emission factors estimated on the basis of information supplied by plants in the framework of the European emissions trading scheme.

Asphalt roofing and road paving

NMVOC emissions from asphalt roofing and road paving have been estimated by production activity data (ISTAT, several years; Federchimica, several years; SITEB, several years) and default emission factors (EMEP/CORINAIR, 2007).

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. 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.

ACTIVITY DATA	1990	1995	2000	2005	2006	2007	2008	2009
	(Gg)							
Cement production (decarbonizing)	29,786	28,778	29,816	33,122	33,210	33,742	31,119	25,259
Glass (decarbonizing)	3,779	4,259	4,930	5,328	5,327	5,385	5,365	4,670
Lime (decarbonizing)	2,583	2,873	2,760	3,344	3,496	3,444	3,206	2,608
Limestone and dolomite use	5,773	5,283	5,132	6,076	6,015	6,035	5,345	3,752
Soda ash production and use	610	1,070	1,000	915	883	874	836	587

Table 4.2 Production of mineral products, 1990 – 2009 (Gg)

CO_2 EMISSIONS	1990	1995	2000	2005	2006	2007	2008	2009
	(Gg)							
Cement production (decarbonizing)	16,084	15,540	16,101	17,403	17,474	17,914	16,127	13,454
Glass (decarbonizing)	416	468	549	645	618	663	627	530
Lime (decarbonizing)	2,042	2,279	2,185	2,361	2,426	2,434	2,276	1,689
Limestone and dolomite use	2,540	2,325	2,258	2,674	2,647	2,655	2,352	1,651
Soda ash production and use	183	321	300	275	247	268	265	174

Table 4.3 CO_2 emissions from mineral products, 1990 – 2009 (Gg)

Emission trends are related to the production level, which has been decreasing for the last two years; in particular, for 2009, the decrease is mostly affected by 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. 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. In particular, comparisons has been carried out for cement, lime, limestone and dolomite, and glass sectors.

4.2.5 Source-specific recalculations

Recalculations occurred as, in the current submission, CO_2 emissions from the use of limestone and dolomite in the pulp and paper production have been accounted also for 1990-1999 and because CO_2 emissions from limestone and dolomite use in the treatment of flue gases from power plants have been accounted for in the whole time series. Consequently, for CO_2 emissions, recalculations for the mineral industry result in +0.01% increase, mainly due to the increases along the time series for limestone and dolomite use as shown in the following box.

Recalculations (%) in CO_2 emissions time series for the limestone and dolomite use, 1990-2008

GAS/SUBSOURCE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2										
2A.3. Limestone and dolomite use	0.065	0.062	0.061	0.065	0.071	0.071	0.075	0.077	0.077	0.075

GAS/SUBSOURCE	2000	2001	2002	2003	2004	2005	2006	2007	2008
CO_2									
2A.3. Limestone and dolomite use	0.055	0.063	0.083	0.067	0.058	0.046	0.044	0.053	0.062

4.2.6 Source-specific planned improvements

No further improvements 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.

<u>*Adipic acid*</u>

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 and 2.69% in 2009; 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 95% (efficiency of the abatement system while in operation) of N_2O emissions. Since 2007 the operating time has been 11 months (about one month was needed for maintenance operations) and the abatement rate for N_2O emissions has reached an efficiency of the abatement system while in operation of 90% (Radici Chimica, several years).
Also CO_2 emissions are estimated from this source.

Ammonia production
In Italy only two plants had been producing ammonia up to 2008 as a consequence of the resizing of the production at national level after the crisis of the largest fertilizer producer, Enichem Agricoltura. In 2008 another plant stopped producing ammonia thus leaving this production in only one plant. 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 (UREA or Calcium nitrate lines) on site or can be sold to technical gas manufacturers. The results of the investigation concerning the recovered CO_2 were accounted for in previous submission: 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 thus leaving nitric acid production 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 is concerned, the decrease in N_2O emissions is also related to the implementation of catalytic N_2O decomposition in the oxidation reactor (YARA De-N_2O patented technology, based on the use of CeO_2 catalyst) (YARA, several 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.

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, Syndial Spa (ex Enichem) and Polimeri Europa 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 production plants. 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:

$CaO+3C \rightarrow CaC_2+CO$

In Italy CARBITALIA SPA is the only facility which can operate calcium carbide production (CARBITALIA SPA, 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. Improving the efficiency in operation, the technology system it is expected to reach 95% of abatement rate in the future with respect to the default emission factor 300 kg/t adipic acid produced. Thus, both for the period 1990-2005 and from 2006 onwards the estimates are provided according to the GPG (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. Based on this information EFs are calculated for the plant and compared to those resulting from the formula included in the following box (referred to the IPCC default EFs for adipic acid production, abatement rate and operating time of the abatement technology). The formula shown in the box does not correspond to the emission estimation methodology at plant level; furthermore the formula can be used to verify the emission factor for the production plant only if all the relevant information is available, otherwise strong deviation in the result is to be observed if compared to the figures submitted, e.g. monthly varying production levels together with approximation of the operating times to be filled in the formula explain the deviation observed in the last review report (UNFCCC, 2010). The EFs submitted for the adipic acid production in the CRF and the EFs calculated for the plant in the following box are basically the same.

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

Year	A	EFp	T	EFs
2006	0.78	0.3	9/11	0.054
2007	0.90	0.3	11/11	0.030
2008	0.90	0.3	11/11	0.030
2009	0.90	0.3	11/11	0.031

Values resulting according to the following formula

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

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 out of the 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, in particular CO_2 emissions referred to 2008 have been revised on the basis of more available data.

<u>*Ammonia*</u>

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. 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 in this submission. The analysis has allowed to understand 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. Differently from the previous submissions the resulting average CO_2 emission factors are 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). For the years 2002-2007, 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. As for 2008 the average emission factor is 1.86 t CO_2/t ammonia production, whilst for 2009 the implied emission factor is 1.96 t CO_2/t ammonia production. 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. 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)

	1990-2001	2002	2003	2004	2005	2006	2007	2008	2009
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

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). 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 production levels of the different plants and it was equal to 6.49 and 7.07 kg N_2O/Mg nitric acid production, in 1990 and in 2007 respectively. In 2008, the implementation of catalyst N_2O abatement technology in one of the major production plants, and specifically 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), while the implied emission factor for 2009 is 2.94 kg N_2O/Mg nitric acid production.

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 2005, the CO_2 implied emission factor is 2.55 t CO_2/t carbon black production, in 2008 it is equal to 2.59 t CO_2/t carbon black production, while in 2009 the IEF is 2.49 t CO_2/t carbon black production.

Calcium carbide

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 reductions in productions (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.

ACTIVITY DATA	1990	1995	2000	2005	2006	2007	2008	2009
				(Gg)				
Adipic acid	49	64	71	75	84	84	76	78
Ammonia	1,455	592	414	607	559	578	474	354
Calcium carbide	12	7	-	-	-	-	-	-
Caprolactame	120	120	111	-	-	-	-	-
Carbon black	184	208	221	214	226	234	210	167
Ethylene	1,466	1,807	1,771	1,721	1,639	1,797	1,465	1,350
Ethylene oxide	61	54	13	-	-	-	-	-
Nitric acid	1,037	588	556	572	526	505	505	419
Propylene	774	693	690	1.037	988	971	870	760
Styrene	365	484	613	520	558	549	504	497
Titanium dioxide	58	69	72	60	68	72	59	64

Table 4.4 Production of chemical industry, 1990 – 2009 (Gg)

EMISSIONS	1990	1995	2000	2005	2006	2007	2008	2009
CO_2 (Gg)								
Ammonia	2,764.50	1,124.80	786.18	1,171.94	1,075.54	1,097.36	881.72	694.83
Calcium carbide	13.08	7.09	-	-	-	-	-	-
Carbon black	422.05	477.48	508.83	548.22	579.21	585.73	544.24	414.96
Titanium dioxide	52.80	48.11	64.70	62.01	70.57	74.28	60.70	66.27
Adipic acid	1.33	1.72	1.93	1.50	1.68	1.68	1.52	1.61
CH_4 (Gg)								
Carbon black	1.84	2.08	0.11	0.10	0.10	0.10	0.10	0.10
Ethylene	0.12	0.15	0.15	0.15	0.14	0.15	0.12	0.11
Propylene	0.07	0.06	0.06	0.09	0.08	0.08	0.07	0.06
Styrene	0.01	NA	NA	NA	NA	NA	NA	NA
Ethylene oxide	0.42	0.37	0.09	NA	NA	NA	NA	NA
N_2O (Gg)								
Nitric acid	6.73	4.22	4.09	5.44	3.95	3.58	1.16	1.23
Adipic acid	14.77	19.09	21.42	19.59	4.58	2.52	2.28	2.41
Caprolactame	0.04	0.04	0.03	-	-	-	-	-

Table 4.5 CO_2, CH_4 and N_2O emissions from chemical industry, 1990 – 2009 (Gg)

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.

4.3.5 Source-specific recalculations

CO_2 emissions from adipic acid production process have been revised for the year 2008, based on the operator’s communication. The recalculation is not significant.

4.3.6 Source-specific planned improvements

Further investigations regarding completeness of CO_2 emissions sources from the activities of this sector are planned.
Additional checks regarding emissions for 2005-2009 will be carried out on account of information from new entrance installations that will be included in the ETS from 2013.
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 are key sources at trend assessment, using both Tier 1 and Tier 2 approaches.
The share of CO_2 emissions from metal production accounts, in the year 2009, for 0.31% of the national total CO_2 emissions, and 6.5% of the total CO_2 from industrial processes.
The share of CH_4 emissions is, in 2009, equal to 0.09% 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 67.2% in the base-year and has decreased to 1.66% (0.03% of the national total greenhouse gas emissions) in the year 2009.

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.

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 2009, there are only three of the above mentioned plants, one of which lacks sintering facilities. Oxygen steel production represents about 29% of the total production and the arc furnace steel the remaining 71% (FEDERACCIAI, several years).

Currently, long products represent about 50% of steel production in Italy, flat products about 40% and pipes the remaining 10%. 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.

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.
At present in Italy two primary aluminium production plants, which use a prebake technology with point feeding, characterised by low emissions, are operating. Primary aluminium production passed from 232 kt in 1990 to 166 kt in 2009.

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 HFC 125, due to the enforcement of fluorinated gases regulation (EC, 2006) which, however, allows for the use of SF_6 in annual amounts less than 850 kg.

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/CORINAIR Guidebook (EMEP/CORINAIR, 2007), 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 1990-2009.
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 2002-2009 data have also been supplied by all the four 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 is sharply decreased. 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 2009 it reduced to 0.072 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 0.025 t CO_2/t steel production, from 1990 to 2009, due to the reduction in the basic oxygen furnaces.
CO_2 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.
As recommended in the last review report (UNFCCC, 2010), 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 49,511 tonnes in 1990 and equal to 59,090 tonnes in 2009.
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	2006	2007	2008	2009		IPCC 2006 EF kg/t
FeCr	0.30	0.26	-							1,300
FeMn	0.24	0.10	0.28	0.5	0.5	0.3	0.4	0.4		1,500
FeSi	0.02	-	-							4,800
SiMn	0.32	0.53	0.62	0.5	0.5	0.7	0.6	0.6		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 2009 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 42 kt) has resulted in CO_2 emissions decreasing from 395 Gg in 1990 to 61 Gg in 2009.

<u>*Aluminium production*</u>

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. It is reaffirmed that Alcoa could not provide data for the period from 1990 to 1999 as the plants were managed by a different operator; thus the decision to use both tiers, 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.

	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 4.6 Historical default Tetrafluoromethane (CF_4) emission values by reduction 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

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

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).

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

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

Anode Effects (minutes/cell day)

	2000	2005	2006	2007	2008	2009
Primary Aluminium Plant	0.96	0.73	0.65	0.90	0.46	0.74

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, as corresponding to the data provided by the producer for 2002 and consistent with the emission factor contained in the IPCC Guidelines and in the Aluminium Sector Greenhouse Gas Protocol. Since 2002 the emission factor has been updated on account of new information from the relevant plant supplied to EPER/EPRTR registry (emissions and productions).
Since 2002, thanks to the availability of additional information, CO_2 emissions have been carried out by the operator 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 information is not currently available for previous years (1990-1999) so the Tier 2 approach can not be applied to those years and Tier 1 has to be used.
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.

	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 4.9 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

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

Magnesium foundries

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 HFC 125, 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 in 2008. HFC 125 emissions 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.

EMISSIONS	1990	1995	2000	2005	2006	2007	2008	2009
CO_2 (Gg)								
Iron and steel	3,124	2,897	1,230	1,533	1,562	1,485	1,424	901
Aluminium production	359	276	295	299	297	354	370	345
Ferroalloys	395	230	229	89	83	86	81	61
CH_4 (Gg)								
Pig iron	2.13	2.10	2.02	2.06	2.07	2.00	1.88	1.02
Steel	0.58	0.60	0.60	0.67	0.74	0.75	0.73	0.56
PFC (Gg CO_2 eq.)								

EMISSIONS	1990	1995	2000	2005	2006	2007	2008	2009
Aluminium production	1,673	298	198	182	156	199	111	146
SF_6 (Gg)								
Magnesium foundries	-	-	0.0072	0.0035	0.0026	0.0023	0.0004	0.0004

Table 4.11 CO_2, CH_4 and F-gas emissions from metal production, 1990 – 2009 (Gg)

COMPOUND	1990	1995	2000	2005	2006	2007	2008	2009
Gg CO_2 eq.								
CF_4 (PFC-14)	1,289.2	235.8	169.2	155.5	133.0	170.3	94.6	124.3
C_2F_6 (PFC-16)	384.1	61.7	29.0	26.6	22.8	29.1	16.2	21.3
Total PFC emissions from aluminium production	*1,673.4*	*297.5*	*198.2*	*182.1*	*155.7*	*199.4*	*110.8*	*145.6*
Total SF_6 emissions from magnesium foundries	-	-	*172.1*	*84.7*	*61.2*	*53.9*	*10.5*	*9.2*
HFC-125 in Magnesium foundries	-	-	-	-	-	*0.9*	*6.5*	*1.6*
Total F-gas emissions from metal production	1,673.4	297.5	370.3	266.8	217.0	254.3	127.9	156.4

Table 4.12 Actual F-gas emissions per compound from metal production in Gg CO_2 equivalent, 1990 – 2009

In response to the last 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.

	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 4.13 Default CF_4 and C_2F_6 Emission Factors

	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

Table 4.14 Default CF_4 and C_2F_6 Slope Coefficients

Worthy of remark is that IAI 2003 is the only document including emission factors for Point Fed Prebake technology, which is the technology implemented at the two remaining production sites 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 2000-2009 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 4.1 and 4.2 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.

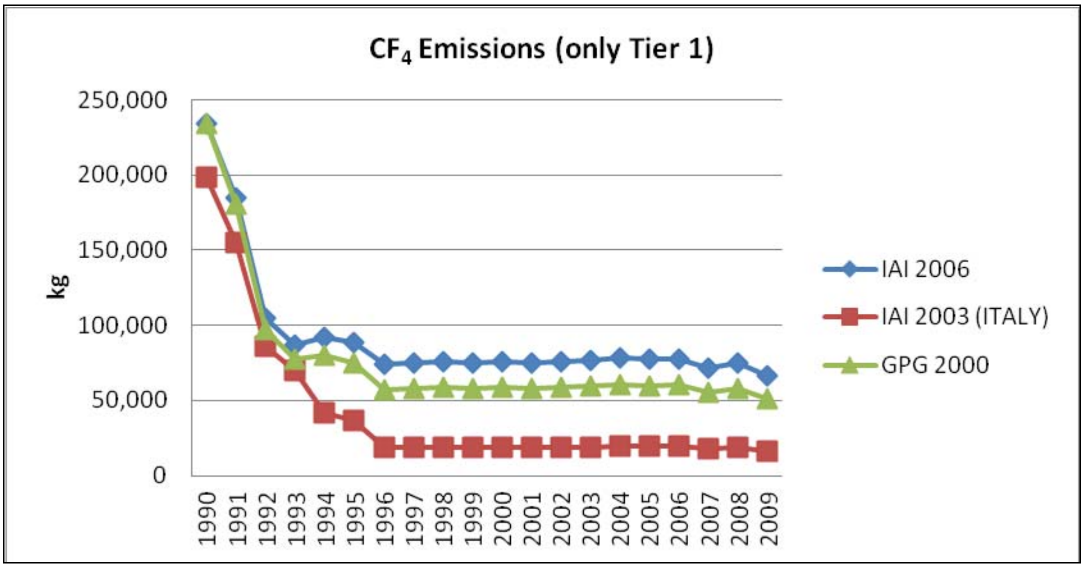


Figure 4.1 CF_4 emissions (only Tier 1)

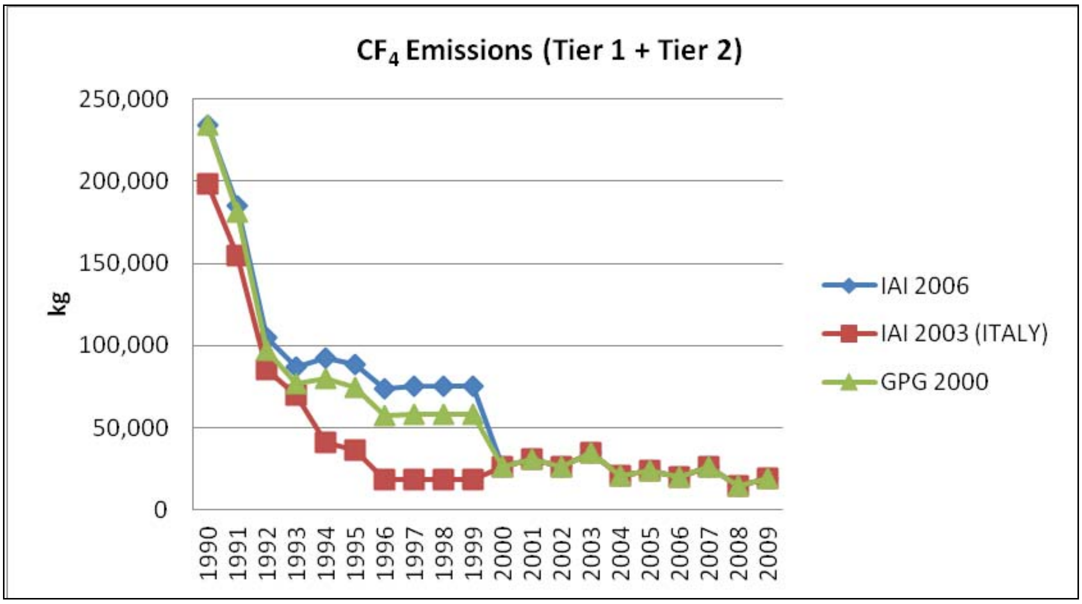


Figure 4.2 CF_4 emissions (Tier 1+Tier 2)

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 to onwards. Moreover, emission factor values reported in the IPCC Good Practice Guidance or in the 2006 IAI document lead to higher values for the emissions time series than those calculated out of emission factor values in 2003 IAI document (supplied by ALCOA and used by the Party), which means that national estimates can be considered conservative for the period.
Tier1 (1990-1999) and Tier 2 (2000-2009) time series are also better linked using IAI 2003 EFs (see Figure 4.2) because the mean implied emission factor value for CF_4 over the period 2000-2009 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).

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

Recalculations in the sector have been done because iron and steel activity data for 1991 - 1995, 2008, activity data and F-gas from aluminium production since 2000 and ferroalloys activity data since 2002 have been updated.
Additional data supplied by the integrated iron and steel plants allowed to improve 2008 estimates. This refing process has resulted in an increase of CH_4 emissions in iron and steel equal to 0.62% for 2008. Activity data relative to early nineties have been compared and checked with old database CORINAIR recovering useful data which have resulted to a decrease of CO_2 emissions by 0.04% in 1991 and 0.02% in 1995.

Regarding F-gas, recalculations in primary aluminium sector have been done because ALCOA has provided certificated emissions from 2005, calculated under Emission Trading Scheme. Moreover, as reported by ALCOA (ALCOA, 2006), slope coefficient data have been updated from 2000, using IAI 2006 (IAI, 2006). For this reason, recalculation results in a decrease of PFC emissions by 0.24% from 2000 to 2004 and slight differences comprised from + 0.88% and - 0.35% from 2005 to 2008.
CO_2 emissions from primary aluminium have been updated from 2000 on the basis of activity data derived from ETS. Recalculation results in an increase of CO_2 emissions by 0.14% in 2000 and 0.02% in 2008.
Activity data from ferroalloys production have been updated since 2002 on the basis of new information derived from ETS and personal communication. In terms of CO_2 emissions from ferroalloys production, recalculation results in a decrease of 54.8% in 1990 and of 55.4% in 2008.

4.4.6 Source-specific planned improvements

The average emission factor of CO_2 from electric arc furnaces will be checked with ETS data communicated in next years.

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. Emissions refer to the paper and pulp production from acid sulphite and neutral sulphite semichemical processes; activity data and emissions are provided by the two Italian production plants.

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. At present, only one production plant is present in Italy, located in Spinetta Marengo. The other production plant in Porto Marghera has stopped its activity in the first quarter of 2008. Within by-product emissions, HFC 23 emissions are released from HCFC 22 manufacture, whereas C_2F_6, CF_4 and HFC 143a emissions are released from the production of CFC 115, SF_6 and HFC 134a, respectively. Production of HFC 125, HFC 134a, HFC 227ea and SF_6 lead to fugitive emissions of the same gases. In particular, production of HFC 227ea only occurred in 1999; while CFC 115 and SF_6 production stopped in 1998 and in 2005, respectively. Since 2004 the plant in Spinetta Marengo has not been producing halocarbons and SF_6 any longer.

The share of F-gas emissions from the production of halocarbons and SF_6 in the national total of F-gases was 24.3% in the base-year, 1990 and is zero from 2008; the share in the national total greenhouse gas emissions was 0.12% in the base-year and 0.003% in 2007 and zero from 2008.

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).

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.

HFC 23 emissions from HCFC 22 had already been drastically reduced in 1996 due to the installation of a thermal afterburner in the plant located in Spinetta Marengo. 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 afterburner, thus allowing reduction of emissions to zero.

This information is yearly directly updated by the producer, and it is also reported in the framework of the European EPER registry, confirming that the technology is fully operating. Further information on the operating regime has been requested to the industry, contacts with the operator are still going on. Anyway in the first quarter of 2008 the production of HCFC and other products has stopped. PFC by-product emissions and SF_6 fugitive emissions, from the same plant, are constant from 1990 to 1995 and from 1996 to 1998, reducing to zero from 1999 due to the stop of the CFC 115 production and the use of the thermal afterburner mentioned above. Besides SF_6 production stopped from the 1st of January 2005.

Regarding fugitive emissions, emissions of HFC 125 and HFC 134a have been cut in 1999 thanks to a rationalisation in the new production facility located in Porto Marghera, whereas HFC 143 released as by-products from the production of HFC 134a has been recovered and commercialised.

In Table 4.15 an overview of the emissions from production of halocarbons and SF_6 is given for the 1990-2009 period, per compound.

COMPOUND	1990	1995	2000	2005	2006	2007	2008	2009
				Gg CO_2 eq.				
HFC 23	351.0	351.0	-	-	-	-	-	-
HFC 143a	-	22.8	3.8	4.2	4.6	4.6	-	-
CF_4	97.5	97.5	-	-	-	-	-	-
PFC C2÷C3 (C_2F_6)	36.8	36.8	-	-	-	-	-	-
Total F-gas by product emissions	*485.3*	*508.1*	*3.8*	*4.2*	*4.6*	*4.6*	-	-
HFC 125	-	28.0	2.8	3.4	3.9	5.0	0.01	-
HFC 134a	-	39.0	15.6	12.6	12.4	8.8	-	-
HFC 227ea	-	-	-	-	-	-	-	-
SF_6	119.5	119.5	-	-	-	-	-	-
Total F-gas fugitive emissions	*119.5*	*186.5*	*18.4*	*16.0*	*16.3*	*13.9*	*0.01*	-
Total F-gas emissions from production of halocarbons and SF_6	604.8	694.6	22.2	20.2	20.8	18.4	0.01	-

Table 4.15 Actual emissions of F-gases per compound from production of halocarbons and SF_6 in Gg CO_2 equivalent, 1990 – 2009

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.

4.6.5 Source-specific recalculations

A minor recalculation for the year 2008 has been done, due to the update of HFC 125 emission data.

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 8.6% in the base-year 1990 and 98.2% in 2009; the share in the national total greenhouse gas emissions was 0.04% in the base-year and 1.76% in 2009.

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 3c

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 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); the semiconductor manufacturing industry has supplied consumption data for four 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).

Losses rates have been checked with industry and they are distinguished by domestic equipment, small and large commercial equipment, industrial chillers, mobile air conditioning equipment, foaming, aerosols and fire extinguishers.

Refrigeration activities, such as commercial, transport, industrial and other stationary, are all reported under domestic refrigeration because no detailed information is available to split consumptions and emissions in the different sectors. Anyway, appropriate losses rates have been applied for each gas, taking into account the equipment where refrigerants are generally used. Therefore implied product life factors, especially for HFC 134a, result from the weighted average of different losses rates, from 0.7% for domestic refrigeration to 10% for large chillers.
In general, concerning the air-conditioning and refrigeration sector, the emissions from equipment disposal have been included into the emissions during the product's life for the whole time series.
SF_6 emissions from electrical equipment have been estimated according to the IPCC Tier 2a approach from 1990 to 1994, and IPCC Tier 3c from 1995 (for both medium and high voltage electrical equipment).Tier 3b is applied for the part of emissions from the energy production plant during services. SF_6 leaks from installed equipment have been estimated on the basis of the total amount of sulphur hexafluoride accumulated and average leakage rates; leakage data published in environmental reports have also been used for major electricity producers (ANIE, several years). Additional data on SF_6 used in high voltage gas-insulated transmission lines have been supplied by the main energy distribution companies checked with data declared under E-PRTR register (ACEA, several years; A2A, several years; AEM, several years; EDIPOWER, several years; EDISON, several years; ENDESA, 2004; ENDESA, several years [a] and [b]; ENEL, several years; TERNA, several years).
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 have reported data and we expect that more information will be available in the next years (General Gas, several years; Mariel, several years; Safety Hi Tech, several years; Solvay Flour Italia, several years; Tazzetti, several years; Sinteco, several years; Synthesis Chimica, several years; Trench Italia, several years; Coferc, 2008). 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 4.16 an overview of the emissions from consumption of halocarbons and SF_6 is given for the 1990-2009 period, per compound.
HFC emissions from refrigeration and air conditioning equipment increased from 1994 driven by the increase of their consumptions, especially HFC 134a consumption for mobile air conditioning. HFC emissions from ODS substitutes started in 1996 and they have been increasing since then, especially HFC 134a 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.

COMPOUND	1990	1995	2000	2005	2006	2007	2008	2009
				Gg CO_2 eq.				
HFC 23	0.0	1.6	7.1	17.0	19.2	20.8	22.7	24.6
HFC 32	0.0	0.0	52.6	235.3	276.5	316.7	355.1	391.8
HFC 125	0.0	1.8	371.5	1,643.2	1,932.3	2,215.3	2,488.5	2,752.8
HFC 134a	0.0	224.3	1,128.6	1,888.8	2,056.4	2,209.0	2,329.8	2,441.3
HFC 143a	0.0	2.7	206.3	901.5	1,062.0	1,220.7	1,377.9	1,533.7
Total HFC emissions from refrigeration and air conditioning equipment	*0.0*	*230.5*	*1,766.1*	*4,685.7*	*5,346.4*	*5,982.6*	*6,574.1*	*7,144.2*
HFC 134a emissions from foam blowing	0.0	0.0	64.2	234.1	247.4	259.0	268.9	277.2
HFC 245fa emissions from foam blowing	0.0	0.0	0.0	133.5	150.0	166.6	183.4	200.4
HFC 227ea emissions from fire extinguishers	0.0	0.0	19.6	79.9	97.7	114.6	130.6	145.8
HFC 134a emissions from aerosols/metered dose inhalers	0.0	0.0	108.4	240.2	237.3	307.7	341.1	397.7
Total HFC emissions from ODS substitutes	*0.0*	*0.0*	*192.2*	*687.7*	*732.4*	*847.9*	*923.9*	*1,021.1*
HFC 23	0.0	0.0	5.1	7.0	6.5	5.4	8.4	5.6
HFC 134a	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
CF_4	0.0	24.4	64.8	96.8	87.0	71.5	59.4	42.6
C_2F_6	0.0	34.6	82.0	62.8	30.8	11.4	12.9	11.3
C_3F_8	0.0	0.0	0.0	3.5	3.5	0.1	0.1	0.0
C_4F_8	0.0	0.0	0.4	8.7	6.6	4.6	17.4	18.3
SF_6	0.0	0.0	20.9	61.5	46.5	36.3	31.4	21.8
Total PFC. HFC. SF_6 *emissions from semiconductor manufacturing*	*0.0*	*59.0*	*173.2*	*240.4*	*181.0*	*129.4*	*129.6*	*99.6*
SF_6 emissions from electrical equipment	*213.4*	*482.0*	*300.4*	*319.1*	*298.1*	*337.4*	*393.7*	*367.0*
Total F-gas emissions from consumption of halocarbons and SF_6	**213.4**	**771.4**	**2,432.0**	**5,932.9**	**6,557.9**	**7,297.2**	**8,021.2**	**8,631.9**

Table 4.16 Actual F-gas emissions per compound from the consumption of halocarbons and SF_6 in Gg CO_2 equivalent. 1990-2009

In Table 4.17 an overview of the potential emissions is given for the 1990-2009 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.

COMPOUND	1990	1995	2000	2005	2006	2007	2008	2009
				Gg CO_2 eq.				
HFC 32	0.0	0.0	10.4	31.9	129.4	139.1	184.0	98.1
HFC 125	0.0	148.4	268.8	1,131.2	1,456.0	4,704.0	-1,551.2	1,417.7
HFC 134a	0.0	1,739.4	2,107.3	5,575.7	6,026.8	5,671.9	3.5	793.5
HFC 143a	0.0	11.4	68.4	801.8	1,691.0	1,417.4	2,200.2	1,375.6
HFC 152a	0.0	0.0	0.0	0.0	0.0	-4.3	14.7	7.9
HFC 227ea	0.0	0.0	72.5	0.0	0.0	0.0	0.0	32.3
HFC 245fa	0.0	0.0	0.0	760.0	790.4	822.0	854.9	889.1
Total HFC potential emissions	*0.0*	*1,899.2*	*2,527.4*	*8,300.6*	*10,093.6*	*12,750.1*	*1,706.0*	*4,614.2*

COMPOUND	1990	1995	2000	2005	2006	2007	2008	2009
				Gg CO_2 eq.				
CF_4	0.0	0.0	55.8	148.9	159.9	141.3	127.0	83.3
C_2F_6	0.0	0.0	65.5	111.4	67.8	54.9	67.3	65.7
C_3F_8	0.0	0.0	0.0	17.9	17.9	1.5	1.5	0.6
C_4F_8	0.0	0.0	0.5	29.0	28.8	53.5	74.0	58.7
Total PFC potential emissions	*0.0*	*0.0*	*121.8*	*307.2*	*274.4*	*251.2*	*269.8*	*208.3*
SF_6	*3,752.3*	*3,675.8*	*3,919.6*	*1,541.8*	*2,182.9*	*1,985.9*	*1,881.6*	*1,521.9*
Total F-gas potential emissions	**3,752.3**	**5,575.0**	**6,568.8**	**10,149.6**	**12,550.9**	**14,987.2**	**3,857.3**	**6,344.4**

Table 4.17 Potential F-gas emissions per compound from the consumption of halocarbons and SF_6 in Gg CO_2 equivalent. 1990 – 2009

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.

4.7.5 Source-specific recalculations

HFC 245fa emissions from foam blowing have been estimated for the whole time series on the basis of updated information on gas consumption from the relevant industrial industry. Moreover, HFC 152a potential emissions have been added considering the information under the reporting of fluorinated gases (EC, 2006), of some companies resubmitting data on production, import or export, for the years 2007 and 2008. Minor modifications have been made because of update of activity data in estimating emissions from semiconductor manufacturing and from mobile air conditioning.

4.7.6 Source-specific planned improvements

Further investigation is planned on account of the implementation of the European Regulation on these gases.

5 SOLVENT AND OTHER PRODUCT USE [CRF sector 3]

5.1 Overview of sector

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 from this sector are also estimated. These emissions arise from the use of N_2O in medical applications, such as anaesthesia, and in 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 this sector.

In 2009, solvent use is responsible for about 0.3% of the total CO_2 emissions (excluding LULUCF) and 41.1% of total NMVOC emissions, and represents the main source of anthropogenic NMVOC national emissions.
N_2O emissions, in 2009, share 2.4% of the total N_2O national emissions.
The sector is responsible, in 2009, for about 0.4% of the total CO_2 equivalent emissions (excluding LULUCF).

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008	2009
NMVOC (Gg)								
3A. Paint application	270.79	252.60	226.07	219.24	223.47	224.16	216.54	205.21
3B. Degreasing and dry cleaning	56.66	34.12	26.40	23.10	22.50	21.92	21.36	20.81
3C. Chemical products	77.21	88.25	103.64	72.70	78.08	79.35	75.01	73.54
3D. Other	199.59	182.76	156.88	179.67	181.53	176.19	169.81	155.95
CO_2 (Gg)								
3A. Paint application	844.07	787.35	704.65	683.37	696.57	698.72	674.95	639.63
3B. Degreasing and dry cleaning	176.62	106.34	82.27	72.01	70.14	68.33	66.56	64.86
3D. Other	622.12	569.66	489.00	560.04	565.84	549.20	529.31	486.10
N_2O (Gg)								
3D. Other (use of N_2O for anaesthesia, aerosol cans and explosives)	2.62	2.49	3.31	2.66	2.61	2.54	2.35	2.16

Table 5.1 Trend in NMVOC, CO_2 and N_2O emissions from the solvent use sector, 1990 – 2009 (Gg)

CO_2 emissions from the sector are a key category, in 2009, 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.

Key-source identification in the solvent and other product use sector with the IPCC Approach1 and Approach 2 approaches (without LULUCF) for 2009

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 to 2009 (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 decrease in NMVOC emission levels from 1990 to 2009 is about 25%, mainly due to the reduction of emissions in degreasing and dry cleaning; in the last year, the drop of production data in the chemical industry also caused a decrease in emissions. 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 respectively, establishing a reduction of the solvent content in products. Figure 5.1 shows NMVOC emission trend from 1991 to 2009, by sub-sector, with respect to 1990.

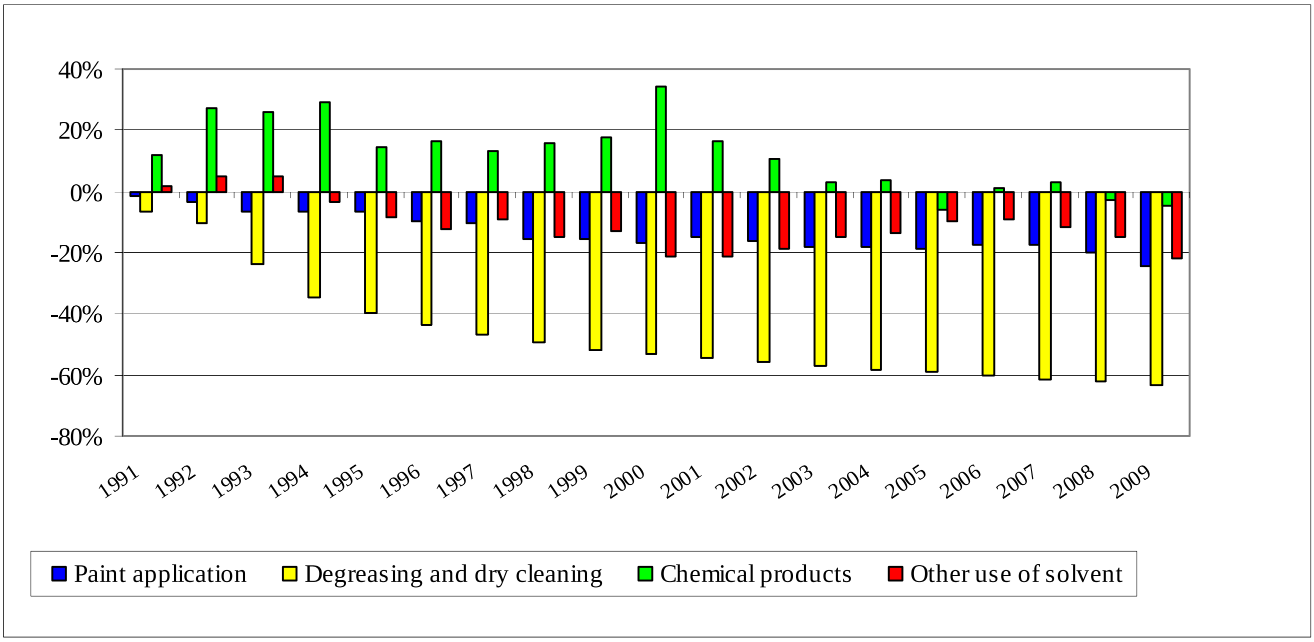


Figure 5.1 Trend of NMVOC emissions from 1991 to 2009 as compared to 1990

From 2000, the reduction in N_2O emissions is 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. At the end of 2008, ISPRA commissioned to Techne Consulting S.r.l. another survey to compare emission factors with the last update published in the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2008). 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.

5.6 Source-specific recalculations

In Table 5.2 the comparison of CO_2 and NMVOC emissions between the actual and previous submission is reported only for those years where recalculations actually occurred.
The main modifications involved category 3D with respect to CO_2 and NMVOC emissions from both domestic solvent use and fat edible and non edible oil extraction. Specifically, the time series from 1994 to 1998 and from 2005 to 2008 has been revised considering an updating of the apparent consumption of cosmetics and from 2006 also modifications of fat edible and non edible oil activity data. For NMVOC emissions from category 3C, the only change regarded an update of polystyrene foam processing for 2008 on account of new information provided by the relevant industry.

	CO_2	NMVOC	NMVOC
	3D. Other	3C. Chemical products	3D. Other
1994	-0.12%		-0.12%
1995	-0.71%		-0.71%
1996	-2.80%		-2.80%
1997	-1.07%		-1.07%
1998	-0.91%		-0.91%
2005	0.04%		0.04%
2006	0.01%		0.01%
2007	0.01%		0.01%
2008	-0.26%	0.02%	-0.26%

Table 5.2 Differences in CO_2 and NMVOC emissions between the updated time series and the 2009 submission

5.7 Source-specific planned improvements

No further improvements are planned.

6 AGRICULTURE [CRF sector 4]

6.1 Overview of sector

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[2] (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 Farm Structure Survey 2007 (FSS 2007) are reported. In Italy, there are 1.7 millions of agricultural holdings with a Utilized Agricultural Area (UAA) of 12.7 million hectares, +0.3% more than FSS 2005. Between 2000 (Agricultural Census) and 2007, agricultural holdings have decreased by 22% (474,000 units). At national level, the average size of the agricultural holdings varied from 7.4 hectares in 2005 to 7.6 hectares in 2007. With respect to 2000 Agricultural Census, holdings have gained 1.5 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 1.6 million (93.9% of total agricultural holdings with UAA) which hold 10 million hectares of UAA (78.8% of total) (EUROSTAT, 2007[a], [b]; ISTAT, 2008[a]). Updated figures of the agriculture sector such as added value, employment, productivity are available (INEA, 2010).

6.1.1 Emission trends

Emission trends per gas

In 2009, 7.0% of the Italian GHG emissions, excluding emissions and removals from LULUCF, (7.8% in 1990) originated from the agriculture sector, which is the second source of emissions, after the energy sector which accounts for 82.8%. For the agriculture sector, the trend of GHGs from 1990 to 2009 shows a decrease of 15.1% due to reduction in activity data, such as the number of animals and cultivated surface/crop production (see Figure 6.1). CH_4 and N_2O emissions have decreased by 11.4% and 17.9%, respectively (see Table 6.1). In 2009, the agriculture sector has been the dominant national source for CH_4 and N_2O emissions, sharing 41% and 69%, respectively.

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
						($Gg\ CO_2$ eq.)						
CH_4	17,216	17,223	16,837	16,076	15,727	15,785	15,535	15,475	15,144	15,613	15,291	15,256
N_2O	23,407	23,212	23,207	23,034	22,677	22,471	22,424	21,814	21,551	21,697	20,658	19,225
Total	**40,623**	**40,435**	**40,044**	**39,110**	**38,404**	**38,255**	**37,959**	**37,289**	**36,695**	**37,311**	**35,950**	**34,481**

Table 6.1 GHG emissions and trend from 1990 to 2009 for the agriculture sector (Gg CO_2 eq.)

[2] http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/4303.php

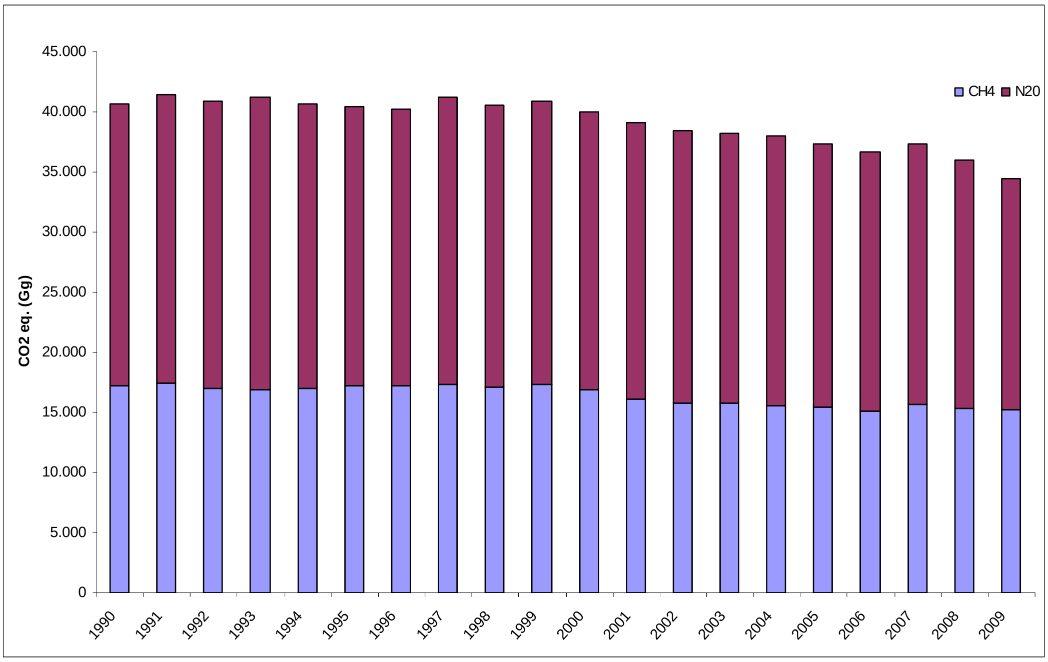


Figure 6.1 Trend of GHG emissions for the agriculture sector from 1990 to 2009 (Gg CO_2 eq.)

Emission trends per sector

Total GHG emissions and trends by sub category from 1990 to 2009 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 source categories. In 2009, their individual share in national GHG emissions excluding LULUCF was 2.2% and 3.1 %, respectively.

Year	GHG emissions (Gg CO_2 eq.) by sub category					
	4A	4B	4C	4D	4F	TOTAL
1990	12,179	7,383	1,562	19,482	17	40,623
1991	12,449	7,376	1,493	20,084	19	41,420
1992	12,071	7,081	1,551	20,186	18	40,907
1993	11,944	7,038	1,627	20,579	17	41,205
1994	12,051	6,920	1,664	20,049	18	40,701
1995	12,267	7,068	1,657	19,426	17	40,435
1996	12,323	7,119	1,623	19,097	18	40,179
1997	12,377	7,138	1,615	20,106	16	41,253
1998	12,292	7,253	1,533	19,421	18	40,516
1999	12,429	7,344	1,497	19,591	17	40,878
2000	12,165	7,140	1,382	19,341	16	40,044
2001	11,340	7,344	1,382	19,029	15	39,110
2002	11,031	7,115	1,420	18,822	17	38,404
2003	11,057	7,075	1,463	18,645	15	38,255
2004	10,834	6,868	1,534	18,705	18	37,959
2005	10,841	6,857	1,472	18,101	17	37,289
2006	10,626	6,629	1,477	17,947	17	36,695
2007	11,024	6,833	1,523	17,914	17	37,311
2008	10,921	6,736	1,396	16,879	18	35,950
2009	10,779	6,648	1,579	15,459	17	34,481

Table 6.2 Total GHG emissions from 1990 to 2009 for the agriculture sector (Gg CO_2 eq.)

6.1.2 Key categories

In 2009, N_2O from agricultural soils, both direct and indirect emissions, CH_4 from enteric fermentation, N_2O and CH_4 from manure management were ranked among the top-10 level key sources with the Approach 2, including the uncertainty (L2). CH_4 enteric fermentation and N_2O from agricultural soils, both direct and indirect 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 sources from the agriculture sector are shown, with a level and/or trend assessment (*IPCC Approach 1 and Approach 2*). These sources are also key categories when including the LULUCF sector in the analysis.

Key-source identification in the agriculture sector with the IPCC Approach 1 and Approach 2 for 2009

4A	CH_4	Emissions from enteric fermentation	Key (L, T2)
4B	CH_4	Emissions from manure management	Key (L, T2)
4B	N_2O	Emissions from manure management	Key (L, T2)
4D1	N_2O	Direct soil emissions	Key (L, T)
4D2	N_2O	Emissions from animal production	Key (L2, T2)
4D3	N_2O	Indirect soil emissions	Key (L, T2)
4C	CH_4	Rice cultivation	Non-key
4F	CH_4	Emissions from field burning of agriculture residues	Non-key
4F	N_2O	Emissions from field burning of agriculture residues	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, 2011). Moreover, an internal report describes the procedure for preparing the agriculture UNFCCC/CLRTAP national emission inventory, 2010 previsions and projections (Cóndor, 2011).

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]; ISPRA, 2011). 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, 2006; Cóndor and De Lauretis, 2007; Cóndor *et al*., 2007[b]; Cóndor *et al*., 2008[b]; Cóndor and De Lauretis, 2009; Cóndor and Vitullo, 2010).

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[a], [b]; ISPRA, 2009). Methodologies used for the inventory, emission scenarios and projections are similar (MATTM, 2007; MATTM, 2009).

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

[3] SISTAN, *Sistema Statistico Nazionale* (http://www.sistan.it/)

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);
- Conjunctural surveys[4] (survey on the area and production of the cultivation, livestock number, milk production, slaughter, etc.);
- General Agricultural Census5, 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 the quality reports of the FSS 2005 and FSS 2007 (ISTAT, 2008[b]; ISTAT, 2007[e]). The main agricultural statistics used for the agriculture emission inventory, are available on-line and a new database was launched in April 2009. 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 6.30	http://agri.istat.it/jsp/Introduzione.jsp
Crops production/surface	Table 6.26; 6.32; 6.33	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 at 1 January of the *x* year. Each year ISPRA verifies the official statistics contacting directly 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 European statistics database[7] (EUROSTAT). As soon as outliers are identified ISTAT and category associations are contacted. The verification of statistics is part of the QA/QC procedures which is done.

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 source, both in terms of level and trend for Tier 1 and Tier 2 approaches. 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 IPCC guidelines.

In 2009, CH_4 emissions from this category were 513.30 Gg which represents 70.7% of CH_4 emissions for the agriculture sector (70.7% in 1990) and 28.9% for national CH_4 emissions (28.0% in 1990). Methane emissions from this source consist mainly of cattle emissions: dairy cattle (212.34 Gg) and non-dairy cattle (188.23 Gg). These sub-categories sources represented 41.4% (42.3% in 1990) and 36.7% (40.2% in 1990), respectively, of total enteric fermentation emissions.

[4] http://www.istat.it/agricoltura/datiagri/
[5] http://www.census.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

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]; ISTAT, 1991; 2007[a],[b]; 2011[a]). 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 6.20. 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 UNA (FAO, 2011; UNA, 2011).

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/UNA(b)
Rabbits	ISTAT(c)

(a) Reconstruction of a consistent time series; (b) For 1990 data from the census and reconstruction for brood-rabbits and other rabbits based on meat; production (UNA, 2011); (c) For 1990 data from the census and reconstruction based on a production index (ISTAT, 2007[b]; 2010)

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

Parameters	Value	Reference
Average weight (kg)	602.7	CRPA, 2006[a]
Coefficient NE_m (dairy cattle)	0.335	NRC, 2001; IPCC, 2000
Pasture (%)	5	CRPA, 2006[a]; ISTAT, 2003
Weight gain (kg day^{-1})	0.051	CRPA, 2006[a]; CRPA, 2004[b]
Milk fat content (%)	3.59-3.72	ISTAT, several years [a], [b], [d], [e]; ISTAT, 2011[b]
Hours of work per day	0	CRPA, 2006[a]
Portion of cows giving birth	0.90-0.97	AIA, 2010
Milk production (kg $head^{-1}$ day^{-1})	11.5-17.7	CRPA, 2006[a]; ISTAT, 2011[b]; OSSLATTE/ISMEA, 2003; ISTAT, several years [a], [b], [c] [d], [e],[f] OSSLATTE, 2001
Digestibility of feed (%)	65	CRPA, 2006[a]; CRPA, 2005
Methane conversion rate (%)	6	CRPA, 2006[a]
MJ/kg methane	55.65	IPCC, 2000

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, 2011[b]). 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 2009, the CH_4 dairy cattle EF was 113.0 kg CH_4 head^{-1} year^{-1} with an average milk production of 6,336 kg head^{-1} year^{-1} (17.4 kg head^{-1} day^{-1}). IPCC report a default EF of 109 kg CH_4 head^{-1} year^{-1} with a milk production of 6,000 kg head^{-1} year^{-1} (IPCC, 2006).

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	0.973	11.5
1991	2,339,520	3.59	0.971	13.0
1992	2,146,398	3.59	0.961	13.9
1993	2,118,981	3.63	0.955	13.8
1994	2,011,919	3.64	0.963	14.5
1995	2,079,783	3.64	0.948	14.8
1996	2,080,369	3.65	0.948	15.2
1997	2,078,388	3.66	0.946	15.5
1998	2,116,176	3.71	0.931	15.3
1999	2,125,571	3.69	0.919	15.3
2000	2,065,000	3.65	0.926	15.1
2001	2,077,618	3.65	0.915	14.9
2002	1,910,948	3.67	0.913	16.2
2003	1,913,424	3.67	0.913	16.2
2004	1,838,330	3.71	0.899	16.8
2005	1,842,004	3.71	0.910	17.2
2006	1,821,370	3.69	0.901	17.4
2007	1,838,783	3.71	0.897	17.3
2008	1,830,711	3.72	0.897	17.7
2009	1,878,421	3.67	0.901	17.4

Table 6.3 Parameters used for the estimation of the CH_4 emission factor for dairy cattle

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.

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**
1991	300,000	2,060,091	71,191	732,421	1,077,802	197,078	82,957	498,136	59,281	503,041	**5,581,998**
1992	300,000	2,036,527	65,656	654,622	1,019,928	197,507	102,182	464,814	49,749	534,632	**5,425,617**
1993	300,000	2,002,856	63,214	639,922	995,481	175,146	95,929	449,996	47,921	551,683	**5,322,148**
1994	300,000	1,794,806	63,926	651,708	1,040,424	145,475	107,640	451,864	31,569	569,429	**5,156,841**
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**
1996	405,986	1,802,849	29,877	721,711	700,560	166,137	119,478	416,038	34,167	696,760	**5,093,563**
1997	354,006	1,910,283	62,983	600,315	699,133	160,238	162,187	413,383	63,765	668,553	**5,094,846**
1998	392,432	1,865,075	25,454	611,973	677,915	166,266	115,269	413,456	60,962	684,530	**5,013,332**
1999	385,251	1,807,169	28,133	655,749	708,152	179,488	101,922	410,062	46,392	713,872	**5,036,190**
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	183,420	617,494	83,087	478,782	67,781	373,865	**4,224,396**

Table 6.4 Non-dairy cattle population (heads) classified by type of production and age

	<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	2.0	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	197.31	214.78	156.92	171.21	315.50	212.18	212.18	195.26
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 take into account fattening male cattle, fattening heifer and heifer for replacement.

Table 6.5 Main parameters used for non-dairy cattle CH4 emission factor estimations

National characteristics of Italian breeding are reflected in EFs, and 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 2009, the non dairy-cattle EF was 44.56 kg CH_4 head^{-1} year^{-1} while IPCC default EF is 48 kg CH_4 head^{-1} year^{-1} (IPCC, 1997). 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).

Buffalo
Data collected in the framework of the MeditAIRaneo project allowed 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 are reported in Cóndor *et al*. (Cóndor *et al*., 2008[a]). In 2009, the cow buffalo CH_4 EF was 68.23 kg CH_4 head^{-1} year^{-1} and for other buffaloes the value was 56.0 kg CH_4 head^{-1} year^{-1}. The CRF IEF is an average value for the two categories (63.83 kg CH_4 head^{-1} year^{-1}). Parameters used for the Tier 2 approach are shown:

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})	0.27	Estimations
Milk fat content (%)	7.73-7.78	ISTAT, several years [a], [b], [d], [e]; ISTAT, 2011[b]
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})	1.9-3.3	ISTAT, 2011[b]; OSSLATTE/ISMEA, 2003; ;OSSLATTE, 2001; ISTAT, several years [a], [b], [c] [d], [e], [f]
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 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 rabbit) are presented. In Table 6.7, time series of the number of animals are shown.

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	92.8	45.6	61.7	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1991	97.7	47.5	62.9	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1992	100.9	47.5	62.4	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1993	100.6	47.4	65.5	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1994	103.4	48.7	65.6	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1995	104.3	47.4	63.2	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1996	105.8	47.5	62.4	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1997	106.7	47.8	62.9	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1998	106.4	47.0	62.0	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1999	106.3	47.3	64.9	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2000	105.3	47.0	65.7	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2001	104.6	46.7	68.2	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2002	109.1	46.5	66.4	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2003	109.0	46.6	66.2	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2004	111.5	46.3	68.3	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2005	112.9	46.4	71.0	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2006	113.24	44.7	69.7	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2007	113.19	46.1	67.1	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2008	114.7	45.5	65.7	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2009	113.0	44.6	63.8	8.0	5.0	18.0	10.0	1.5	1.5	0.08

Table 6.6 Average CH_4 emission factors for enteric fermentation (kg CH_4 head^{-1} year^{-1})

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
1991	83,300	8,397,070	1,260,980	314,125	66,255	711,500	7,837,300	15,877,391	173,060,622
1992	103,200	8,460,557	1,355,485	315,848	56,946	691,400	7,553,000	16,398,563	172,683,589
1993	100,900	8,669,560	1,408,767	323,305	49,383	702,900	7,645,200	16,530,691	173,261,404
1994	108,300	9,964,108	1,658,051	323,986	43,063	677,100	7,346,300	16,905,054	178,659,192
1995	148,404	10,667,971	1,372,937	314,778	37,844	689,846	7,370,830	17,110,587	184,202,416
1996	171,558	10,943,457	1,419,225	312,080	34,120	726,155	7,444,937	17,433,566	183,044,930
1997	161,491	10,893,711	1,351,003	313,000	30,000	693,366	7,599,426	17,609,737	186,815,499
1998	186,276	10,894,264	1,331,077	290,000	33,500	707,644	7,614,981	17,705,163	198,799,819
1999	200,481	11,016,784	1,397,329	288,000	33,000	691,590	7,722,893	18,020,802	196,573,062
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

Year	Buffalo	Sheep	Goats	Horses	Mules and asses	Sows	Other swine	Rabbits	Poultry
	(heads)								
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	19,957,348	199,924,644

Table 6.7 Time series of number of animals from 1990 to 2009 (heads)

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.
Montecarlo analysis was also applied to estimate uncertainty of this category; 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 2009, livestock CH_4 emissions from enteric fermentation were 11.5% (513.30 Gg) lower than in 1990 (579.93 Gg). Between 1990 and 2009 cattle livestock has decreased by 21.3% (from 7,752,152 to 6,102,817 heads). Dairy cattle and non-dairy cattle have decreased by 28.9% (from 2,641,755 to 1,878,421) and 17.3% (from 5,110,397 to 4,224,396), 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 2009, cattle contribute with 78.0% 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 2011, are represented by 'other swine' and 'sow' (13.74 Gg).

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sheep	Goats	Horses	Mules and asses	Sows	Other swine	Rabbits	TOTAL
	(Gg)										
1990	245.11	233.00	5.83	69.91	6.29	5.18	0.84	0.98	11.63	1.16	**579.93**
1991	228.61	265.10	5.24	67.18	6.30	5.65	0.66	1.07	11.76	1.23	**592.81**
1992	216.49	257.52	6.44	67.68	6.78	5.69	0.57	1.04	11.33	1.27	**574.81**
1993	213.23	252.38	6.61	69.36	7.04	5.82	0.49	1.05	11.47	1.28	**568.74**
1994	207.94	251.21	7.10	79.71	8.29	5.83	0.43	1.02	11.02	1.31	**573.87**
1995	216.88	246.22	9.38	85.34	6.86	5.67	0.38	1.03	11.06	1.33	**584.15**
1996	220.10	241.79	10.71	87.55	7.10	5.62	0.34	1.09	11.17	1.35	**586.80**
1997	221.80	243.78	10.15	87.15	6.76	5.63	0.30	1.04	11.40	1.37	**589.39**
1998	225.18	235.38	11.54	87.15	6.66	5.22	0.34	1.06	11.42	1.38	**585.33**
1999	225.85	238.33	13.00	88.13	6.99	5.18	0.33	1.04	11.58	1.40	**591.84**
2000	217.40	234.48	12.61	88.71	6.88	5.04	0.33	1.06	11.40	1.39	**579.30**
2001	217.22	217.91	13.22	66.49	5.12	5.13	0.33	1.05	12.10	1.44	**540.01**
2002	208.45	213.95	12.31	65.11	4.94	5.00	0.29	1.13	12.62	1.46	**525.27**
2003	208.65	214.17	14.71	63.61	4.80	5.09	0.29	1.10	12.63	1.47	**526.52**
2004	204.92	206.60	14.36	64.85	4.89	5.00	0.29	1.09	12.37	1.53	**515.89**
2005	207.95	204.65	14.57	63.63	4.73	5.01	0.30	1.08	12.72	1.59	**516.24**
2006	206.26	192.10	16.08	65.82	4.78	5.17	0.31	1.16	12.76	1.57	**506.01**
2007	208.13	205.03	19.72	65.89	4.60	5.68	0.35	1.13	12.78	1.63	**524.93**

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sheep	Goats	Horses	Mules and asses	Sows	Other swine	Rabbits	TOTAL
						(Gg)					
2008	209.99	197.94	20.17	65.40	4.79	5.98	0.36	1.13	12.74	1.52	**520.04**
2009	212.34	188.23	21.96	64.10	4.80	6.18	0.41	1.12	12.62	1.55	**513.30**

Table 6.8 Trend of CH_4 emissions from enteric fermentation (Gg)

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). In Table 6.9, a list of parameters from the QA/QC plan is reported.

6.2.5 Source-specific recalculations

No recalculations were completed for this submission. In Table 6.10, previous and current dairy cattle and buffalo EFs are shown.

Sub category	Parameter	Year of submission 2011	2012	Activities
Dairy cattle	Fat content	√		Data from 2009 fat parameter has been collected (ISTAT new database on-line)
Dairy cattle	Portion cow giving birth	√		Data from 2009 has been collected (AIA, 2010)
Dairy cattle/buffalo	Milk production	√		Data from 2009 on milk production has been collected (ISTAT new database on-line)

Table 6.9 Improvements for the enteric fermentation category according to the QA/QC plan

	Dairy cattle		Buffalo	
Year	EF 2009 submission	EF 2011 submission	EF 2010 submission	EF 2011 submission
	(kg head^{-1} year^{-1})			
1990	92.8	92.8	61.7	61.7
1991	97.7	97.7	62.9	62.9
1992	100.9	100.9	62.4	62.4
1993	100.6	100.6	65.5	65.5
1994	103.4	103.4	65.6	65.6
1995	104.3	104.3	63.2	63.2
1996	105.8	105.8	62.4	62.4
1997	106.7	106.7	62.9	62.9
1998	106.4	106.4	62.0	62.0
1999	106.3	106.3	64.9	64.9
2000	105.3	105.3	65.7	65.7
2001	104.6	104.6	68.2	68.2
2002	109.1	109.1	66.4	66.4
2003	109.0	109.0	66.2	66.2
2004	111.5	111.5	68.3	68.3
2005	112.9	112.9	71.0	71.0
2006	113.2	113.24	69.7	69.7

Year	Dairy cattle		Buffalo	
	EF 2009 submission	EF 2011 submission	EF 2010 submission	EF 2011 submission
	(kg head^{-1} year^{-1})			
2007	113.2	113.19	67.1	67.1
2008	114.7	114.7	65.7	65.7
2009	-	113.0	-	63.8

Table 6.10 Dairy cattle and buffalo CH_4 EF for the enteric fermentation category (kg head^{-1}year^{-1})

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 (UNA, 2011; AIA, 2010).

6.3 Manure management (4B)

6.3.1 Source category description

In 2009, CH_4 emissions from manure management were 137.41 Gg, which represents 18.9% of CH_4 emissions for the agriculture sector (20.1% in 1990) and 7.7% of national CH_4 emissions (8.0% in 1990). CH_4 emissions from swine were 61.55 Gg and from cattle were 51.76 Gg. These sub-categories represented 45% and 38%, respectively, of total CH_4 manure management emissions.
In 2009, N_2O emissions from manure management were 12.14 Gg, which represents 20% of total N_2O emissions for the agriculture sector (17% in 1990) and 13.5% of national N_2O emissions (10.5% in 1990). In 2009, N_2O emissions from this source mainly consist of the solid storage source (10.64 Gg), accounting for 88% 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).
CH_4 and N_2O emissions from manure management are key sources at level, following the Tier 1 and Tier 2 approaches, and trend (Tier 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, 2010), 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:

$$CH_4\ (g\ m^{-3}\ day^{-1}) = e^{(0.68+0.12*\text{average regional monthly temperature})} \quad \textit{Eq. 6.1}$$

For solid manure:

$$CH_4\ (g\ m^{-3}\ day^{-1}) = e^{(-2.3+0.1*\ \text{monthly storage temperature})} \quad \textit{Eq. 6.2}$$

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, which will be updated with information coming from the 2010 Agricultural Census. 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 6.11, EF estimations are shown.

$$EF\ slurry = 15.32\ gCH_4/Kg\ VS \bullet VS\ production\ slurry\ (kg\ VS\ head^{-1}\ day\text{-}^{1}) \bullet 365\ days \quad \textit{Eq. 6.3}$$

$$EF\ manure = 4.8\ gCH_4/Kg\ VS \bullet VS\ production\ slurry\ (kg\ VS\ head^{-1}\ day\text{-}^{1}) \bullet 365\ days \quad \textit{Eq. 6.4}$$

Livestock category	Slurry (kg CH_4 $head^{-1}$ yr^{-1})	Solid manure (kg CH4 head-1 yr-1)	CH_4 manure management EF (kg CH_4 $head^{-1}$ yr^{-1})
Calf (*vitelli*)	6.22	0.00	**6.22**
Cattle (*bovini*)	5.18	3.57	**8.75**
Female cattle (*bovine*)	3.45	3.79	**7.24**
Other dairy cattle (*altre vacche*)	4.01	6.65	**10.66**

Livestock category	Slurry (kg CH_4 head^{-1} yr^{-1})	Solid manure (kg CH4 head-1 yr-1)	CH_4 manure management EF (kg CH_4 head^{-1} yr^{-1})
Dairy cattle (*vacche da latte*)	5.64	9.41	**15.04**
Cow buffalo (*bufale*)	4.99	10.26	**15.25**
Other buffaloes (*altri bufalini*)	3.13	3.16	**6.29**

Table 6.11 Methane manure management EFs for cattle and buffalo in 2009 (kg CH_4 head^{-1} yr^{-1})

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 6.12 the disaggregated manure management EFs for cattle and buffalo are shown. See also Table 6.14 for the average EFs of main categories (dairy, non-dairy and buffalo).

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
1991	6.22	8.06	6.91	10.66	15.04	15.25	6.34
1992	6.22	8.01	6.86	10.66	15.04	15.25	6.34
1993	6.22	7.99	6.83	10.66	15.04	15.25	6.33
1994	6.22	8.20	6.93	10.66	15.04	15.25	6.33
1995	6.22	8.56	6.71	10.66	15.04	15.25	6.33
1996	6.22	8.29	6.76	10.66	15.04	15.25	6.32
1997	6.22	8.33	6.62	10.66	15.04	15.25	6.32
1998	6.22	8.16	6.65	10.66	15.04	15.25	6.32
1999	6.22	8.22	6.71	10.66	15.04	15.25	6.31
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	7.24	10.66	15.04	15.25	6.29

Table 6.12 Methane manure management EFs for cattle and buffalo (kg CH_4 head^{-1} yr^{-1})

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 from the National Electric Network (TERNA, 2011). For further information on biogas activity data see Annex 7.2.

Reduction 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 2009, the CRF IEFs, for dairy cattle and non-dairy cattle, were 12.67 kg CH_4 head^{-1} year^{-1}, and 6.62 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 2005/2006 of the non-dairy IEF reflects the strong increase of biogas recovery.

Livestock category	EF (kg CH_4 head^{-1} yr^{-1})	IEF(*) (kg CH_4 head^{-1} yr^{-1})
Dairy cattle	15.04	12.67
Non-dairy cattle	7.86	6.62
Buffalo	12.03	12.03

(*) IEF as reported in the CRF submission 2011

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]). 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. 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	4.13	0.14	0.24
Non-dairy cattle	2.79	2.68	0.13	0.17
Buffalo	5.17	2.68	0.13	0.10
Swine	0.32	0.50	0.46	0.46

(*) IEF as reported in the CRF submission 2011

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 structure of the storage 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]). Then, a reduction of emissions of 8% for covered storage structures is applied to the *methane emission rate*. Characteristics of swine breeding and EFs are shown in Table 6.13. 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 2009, the EF from sow was 22.17 kg CH_4 head^{-1}year^{-1}, and for the other swine category was 8.40 kg CH_4 head^{-1} year^{-1} (average swine EF is 7.98 kg CH_4 head^{-1}year^{-1}). In Table 6.14 the time series of EFs for the swine category (sow and other swine) are shown. The CRF IEF reported is 6.72 kg CH_4 head^{-1} year^{-1}. 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/a/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).

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	**85**	**569,206**	**13,768**	**8.40**
20-50 kg	35	64,690	13,768	3.48
50-80 kg	65	92,471	13,768	6.46
80-110 kg	95	133,263	13,768	9.44
110 kg and more	135	274,196	13,768	13.41
Boar	200	4,585	13,768	19.86
Sow	**172**	**145,141**	**15,783**	**22.17**
Piglets	10	16,839	15,783	1.14
Sow	172.1	128,302	15,783	19.60
			TOTAL	**7.98**

Table 6.13 Methane manure management parameters and emission factors for swine in 2009

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 IPCC. Since the yearly average temperature in Italy is 13 °C, EFs are characteristic of the "cold" climatic region (IPCC, 1997).

In Table 6.14, 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}
- hen, 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}

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
1991	15.04	7.61	11.94	22.03	8.42
1992	15.04	7.59	12.02	22.01	8.41
1993	15.04	7.59	11.93	22.05	8.43
1994	15.04	7.73	11.90	21.96	8.42
1995	15.04	7.82	11.95	21.96	8.52
1996	15.04	7.79	11.92	21.95	8.54
1997	15.04	7.70	11.90	22.05	8.34
1998	15.04	7.66	12.06	22.04	8.36
1999	15.04	7.72	12.12	22.12	8.44
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	7.86	12.03	22.17	8.40

(*) These are the EFs used for estimating CH_4 emissions from manure management. CH_4 reductions are not included.

Table 6.14 Average methane EF for manure management (kg CH^4 head^{-1} year^{-1})

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 6.15). 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 6.15, nitrogen excretion rates used for the estimation of N_2O are shown. The nitrogen excretion rate for swine is 11.78 kg head^{-1} yr^{-1}. This last parameter is a weighted average: sow (28.13 kg head^{-1} yr^{-1}) and other swine (12.92 kg head^{-1} yr^{-1}).

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	386	47.77	0.95	**48.72**
Dairy cattle	603	110.20	5.80	**116.00**
Buffalo	516	90.34	2.70	**93.04**
Other swine	85	12.92	0.00	**12.92**
Sow	172	28.13	0.00	**28.13**
Sheep	47	1.62	14.58	**16.20**
Goat	47	1.62	14.58	**16.20**
Horses	524	20.00	30.00	**50.00**
Mules and asses	300	20.00	30.00	**50.00**
Poultry	1.8	0.53	0.00	**0.53**
Rabbit	1.6	1.02	0.00	**1.02**

Table 6.15 Average weight and nitrogen excretion rates in 2009

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 alance methodology was followed, as suggested by the IPCC. As a result, estimations of nitrogen excretion rates[8] and net nitrogen arriving to the field[9] 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 6.16, 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 below:

- sheep, 16.2 kg head^{-1} year^{-1}
- goats, 16.2 kg head^{-1} year^{-1}
- horses, 50.0 kg head^{-1} year^{-1}
- mules and asses, 50.0 kg head^{-1} year^{-1}
- hen, 0.66 kg head^{-1} year^{-1}
- broilers, 0.36 kg head^{-1} year^{-1}
- other poultry, 0.825 kg head^{-1} year^{-1}
- rabbits, 1.0 kg head^{-1} year^{-1}
- fur animals, 4.1 kg head^{-1} year^{-1}

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.

[8] Nitrogen excretion = N consumed – N retained
[9] 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})		
1990	116.0	50.00	93.94	13.13	28.10
1991	116.0	51.43	92.27	12.94	27.94
1992	116.0	50.97	92.89	12.93	27.92
1993	116.0	50.82	92.24	12.97	27.97
1994	116.0	51.83	92.04	12.95	27.85
1995	116.0	49.86	92.42	13.10	27.86
1996	116.0	49.83	92.17	13.12	27.84
1997	116.0	49.81	92.04	12.82	27.98
1998	116.0	49.19	93.21	12.86	27.96
1999	116.0	49.62	93.68	12.98	28.06
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
2008	116.0	49.76	91.05	12.79	28.09
2009	116.0	48.72	93.04	12.92	28.13

Table 6.16 Nitrogen excretion rates for main livestock categories (kg N head^{-1} yr^{-1})

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[10] (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 2009, livestock CH_4 emissions from manure management were 16.7% (137.41 Gg CH_4) lower than in 1990 (164.86 Gg CH_4). From 1990 to 2009, dairy and non-dairy cattle livestock population decreased by 29% and 17%, respectively, whereas swine increased by 9%. Consequently, the reduction in the number of cattle has mainly driven down manure management emissions. Cattle CH_4 emissions contribute with 38% (in 1990 with 47%) to total CH_4 manure management emissions and swine with 45% (41% in 1990).

[10] ASSONAPA, Associazione Nazionale della Pastorizia Ufficio Centrale dei Libri Genealogici e dei Registri Anagrafici.

In Table 6.17, CH_4 emission trends from manure management are shown. These emissions considered the reduction of CH_4 because of biogas recovery.

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sows	Other swine	Sheep	Goats	Horses	Mules and asses	Poultry	Rabbits	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	**164.86**
1991	35.12	42.40	0.99	15.64	53.06	1.83	0.18	0.46	0.06	13.80	1.27	**164.82**
1992	32.26	41.15	1.24	15.20	51.18	1.84	0.20	0.47	0.05	13.77	1.31	**158.67**
1993	31.86	40.36	1.20	15.49	51.67	1.89	0.20	0.48	0.04	13.82	1.32	**158.32**
1994	29.93	39.40	1.29	14.70	49.50	2.17	0.24	0.48	0.04	14.24	1.35	**153.34**
1995	30.85	40.01	1.77	14.94	49.85	2.32	0.20	0.47	0.03	14.67	1.36	**156.48**
1996	30.88	39.14	2.04	15.73	50.08	2.38	0.21	0.46	0.03	14.57	1.39	**156.90**
1997	30.89	38.76	1.92	15.11	50.25	2.37	0.20	0.46	0.03	14.87	1.40	**156.26**
1998	31.52	38.00	2.25	15.44	50.46	2.37	0.19	0.43	0.03	15.85	1.41	**157.94**
1999	31.62	38.47	2.43	15.13	51.67	2.40	0.20	0.43	0.03	15.67	1.44	**159.48**
2000	30.80	37.92	2.25	15.42	51.14	2.41	0.20	0.41	0.03	14.09	1.42	**156.10**
2001	30.78	35.43	2.66	15.25	54.51	1.81	0.15	0.42	0.03	16.68	1.47	**159.19**
2002	28.17	34.54	2.61	16.40	53.46	1.77	0.14	0.41	0.02	16.39	1.50	**155.42**
2003	28.11	34.47	2.89	15.96	53.97	1.73	0.14	0.42	0.02	15.68	1.50	**154.89**
2004	26.73	33.38	2.70	15.57	52.58	1.76	0.14	0.41	0.02	15.27	1.57	**150.14**
2005	26.44	32.74	2.52	15.36	53.87	1.73	0.14	0.41	0.03	15.05	1.63	**149.93**
2006	25.21	30.31	2.76	15.73	52.04	1.79	0.14	0.42	0.03	14.15	1.61	**144.20**
2007	25.05	31.28	3.52	15.16	51.26	1.79	0.13	0.47	0.03	15.07	1.67	**145.43**
2008	24.11	29.32	3.61	14.66	49.56	1.78	0.14	0.49	0.03	15.74	1.56	**140.99**
2009	23.81	27.96	4.14	13.92	47.62	1.74	0.14	0.51	0.03	15.95	1.59	**137.41**

Table 6.17 Trend in CH_4 emissions from manure management (Gg)

In Table 6.18, N_2O emissions from liquid systems, solid storage and 'other' sources are shown.

Year	Liquid system	Solid storage	Other	TOTAL
	(Gg)			
1990	0.62	12.03	0.00	12.65
1991	0.62	12.01	0.00	12.63
1992	0.59	11.50	0.00	12.09
1993	0.59	11.39	0.00	11.98
1994	0.57	11.37	0.00	11.93
1995	0.57	11.54	0.09	12.20
1996	0.56	11.61	0.17	12.34
1997	0.56	11.63	0.25	12.44
1998	0.56	11.72	0.42	12.70
1999	0.56	11.80	0.53	12.89
2000	0.54	11.36	0.56	12.46
2001	0.54	11.59	0.78	12.91
2002	0.52	11.05	0.84	12.42
2003	0.52	10.92	0.89	12.33
2004	0.51	10.59	0.89	11.98
2005	0.51	10.49	0.97	11.96
2006	0.50	10.16	0.95	11.61
2007	0.51	10.73	0.94	12.19
2008	0.51	10.71	0.96	12.18

Year	Liquid system	Solid storage	Other	TOTAL
	(Gg)			
2009	0.51	10.64	0.98	12.14

Table 6.18 Trend in N_2O emissions due to manure management, (Gg)

In 2009, N_2O emissions from manure management were 4% (12.14 Gg N_2O) lower than in 1990 (12.65 Gg N_2O). The major contribution is given by the 'solid storage system' with 88% (in 1990 with 95%).

6.3.4 Source-specific QA/QC and verification

In Table 6.19, future improvements in agreement with the QA/QC plan are presented.

Category/sub category	Parameter	Year of submission 2011	Year of submission 2012	Activities
Dairy cattle	N excretion		√	Still further efforts on theoretical assessment of N excretion data will be done based on N balance methodology (Gruber and Poesch, 2006).
Livestock categories	Type of housing		√	A query on the type of housing of different livestock categories has been introduced in the Farm and structure survey 2005. Results have been analysed. According to experts from CRPA, information collected from SPA 2005 (housing data) needs to be validated with information from the Agricultural Census (CRPA, 2010).
Livestock categories	Slurry and solid manure storage facilities		√	We are analysing and verifying information coming from the Farm and Structure Survey 2007, where a query related to storage facilities for slurry and solid manure was incorporated. Validation will be executed with data coming from the 2010 Agricultural census.
Livestock categories	Production methods		√	Different queries have been incorporated in an specific section of the 2010 Agricultural Census. Grazing, housing, storage systems and land spreading information will be collected.
Livestock categories	Biogas	√		Data on biogas from 2009 has been collected (web site TERNA)

Table 6.19 Improvements for manure management category according to the QA/QC plan

6.3.5 Source-specific recalculations

No recalculations were performed for this submission. Parameters used for this submission are shown in Table 6.20.

6.3.6 Source-specific planned improvements

Future agricultural surveys will contribute to the improvement of the national agriculture emission inventory (Cóndor *et al*., 2005; Cóndor and De Lauretis, 2009). Information from the FSS 2005 and FSS 2007 on housing and storage systems, respectively, was analysed. Information obtained from these surveys will be validated with information from the Agricultural Census (CRPA, 2010). Furthermore, we expect that in the 2010 Italian Agricultural Census, detailed information on production systems will be obtained with an *ad hoc* survey. Finally, a specific research on land spreading practices finished at the end of 2009. Results need to be analysed before incorporating them for future submissions (CRPA, 2009).

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). Still 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, therefore, N coefficients will be revised.

Livestock category		Average weight (kg) Submission 2011	N excretion (kg N $head^{-1}$ yr^{-1}) Submission 2011
DAIRY CATTLE (*vacche da latte*)		603	116
NON- DAIRY CATTLE			
Less than 1 year (*)		210(**)	24.8 (**)
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 (*manze da allevamento*)	540	90.2
	Slaughter heifer (*manze da macello*)	540	64.8
	Other dairy cattle (*altre vacche)*	557	54.1
BUFFALO	Cow buffalo (*bufale*)	630	116
	Other buffaloes (*altri bufalini*)	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 (*verri*)	200	30.5
	For slaughter (*macello*)		
	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 (*scrofe*)		172.1	28.1 (**)
SHEEP	Sheep (*pecore*)	51	16.2
	Other sheep (*altri ovini*)	21	16.2
GOAT	Goat (*capre*)	54	16.2
	Other goat (*altri caprini*)	15	16.2
EQUINE	Horses (*cavalli*)	550	50.0
	Mules and asses (*altri equine*)	300	50.0
POULTRY	Broilers (*polli da carne*)	1.2	0.36
	Hen (*galline da uova*)	1.8	0.66
	Other poultry (*atri avicoli*)	3.3	0.83
RABBIT	Female rabbits (f*attrici*)	4	2.5
	Other rabbit (*altri conigli*)	1.3	0.8

Table 6.20 Parameters used for the different livestock categories in 2011 submission

(*) Categories included in less than 1 year are: calf (*vitelli carne bianca*), fattening male cattle (*bovini maschi ingrasso*), fattening heifer (*manze ingrasso*) and heifer for replacement (*manze rimonta*); (**) 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. In 2009, CH_4 emissions from rice cultivation were 75.17 Gg, which represent 10.3 % of CH_4 emissions for the agriculture sector (9.1% in 1990) and 4.2% 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 (14.64 Gg) and multiple aeration (60.53 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[11].

The quality of the Italian rice emission inventory was verified with the DNDC[12] model. 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[13] (ENR, 2010). 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, 2010
Cultivated surface – national (ha)	ISTAT, 2011[d],[e]; ISTAT, several years [a],[b]; ENR, 2010
Cultivated surface by rice varieties (ha)	ENR, 2010
Cultivation period of rice varieties (days)	ENR, 2010
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]; ISTAT, 2011[d],[e]
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

[11] 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).
[12] DNDC, Denitrification Decomposition model
[13] ENR, Ente Nazionale Risi

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 6.21, water regimes descriptions are presented. 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).

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
		1°aeration - AR	2° aeration-AA		3° 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	3°aeration - 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		2° 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 (*lotta al crodo*); AR=drained, aeration in order to promote rice rooting, (*asciutta di radicamento*); AA=drained, tillering aeration (*asciutta di accestimento*).

Table 6.21 Water regimes in Italy and classification according to IPCC guidelines

In general, rice seeds are mechanically broadcasted in flooded fields. However, in Italy for the last 15 years, 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, 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, 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 (*semina interrata a file*), 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 6.21 and Table 6.22, respectively. Total CH_4 emissions for rice cultivation in 2009 were 75.17 Gg.

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)	58,648	80,915	98,896
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	155	155
Seasonal EF (g CH_4 m^{-2} yr^{-1})	24.96	33.67	33.67
Methane emissions (Gg)	**14.64**	**27.24**	**33.29**

Table 6.22 Parameters used for estimating CH_4 emissions from rice cultivation in 2009

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.
In 2009, CH_4 emissions from rice cultivation were 1.1% (75.17 Gg CH_4) higher than in 1990 (74.39 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). CH_4 emissions have increased by 1.1% from 1990-2009 and the harvest area has increased by 11%, from 215,442 ha $year^{-1}$ (1990) to 238,458 ha $year^{-1}$ (2009). The percentage of single aerated surface has increased from 1% (1990) to 26.4% (2009). Water regime trends were estimated together with expert judgement expertise (Tinarelli, 2005; Lupotto *et al*., 2005) and national available statistics (ENR, 2010). In Table 6.24, CH_4 emissions from rice cultivation and harvested area are shown.

6.4.4 Source-specific QA/QC and verification

In Table 6.23, improvements according to the QA/QC plan are shown.

Category/sub category	**Parameter**	**Year of submission 2011**	**2012**	**Activities**
Activity data	Days of cultivation and cultivars	√		Data from 2009 and provisional data from 2010 has been uploaded. Cultivation dates for rice varieties have been updated from 2005-2008.
Rice	Emission factor	√	√	We have contact DG Joint Research Centre Institute for Environment and Sustainability - Climate Change Unit, which have been in charge of measuring rice paddy fields in Italy. New measurements have been done since 2007. Data is still not available. Probably during 2011 a publication will be available.

Table 6.23 Improvements for the rice cultivation category according to the QA/QC plan

6.4.5 Source-specific recalculations

In Table 6.24, CH_4 emissions from 2010 and 2011 submissions are shown. For this submission recalculations between 2005 and 2008 were done because of updating the days of cultivation for some rice varieties.

Year	Harvested area ($10^9 m^2 yr^{-1}$)	Emissions 2010 submission (Gg)	Emissions 2011 submission (Gg)
1990	2.15	74.4	74.4
1991	2.06	71.1	71.1
1992	2.16	73.9	73.9
1993	2.32	77.5	77.5
1994	2.36	79.2	79.2
1995	2.39	78.9	78.9
1996	2.38	77.3	77.3
1997	2.33	76.9	76.9
1998	2.23	73.0	73.0
1999	2.21	71.3	71.3
2000	2.20	65.8	65.8
2001	2.18	65.8	65.8
2002	2.19	67.6	67.6
2003	2.20	69.7	69.7
2004	2.30	73.0	73.0
2005	2.24	70.1	70.1
2006	2.29	70.3	70.3
2007	2.33	72.5	72.5
2008	2.24	66.5	66.5
2009	2.38	-	75.2

Table 6.24 Harvest area and CH_4 emissions from the rice cultivation sector

6.4.6 Source-specific planned improvements

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 Table 6.21, a general classification has been done for the most common agronomic practices in Italy. Since the 2006 submission, a trend in water regime has been calculated together with expert judgement expertise (Tinarelli, 2005; Lupotto *et al.*, 2005) and available statistics (Centro Ricerche sul Riso, 2007). 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 2009 they represented 93.7% (ENR, 2010; Confalonieri and Bocchi, 2005).

6.5 Agriculture soils (4D)

6.5.1 Source category description

In 2009, N_2O emissions from agricultural soils were 49.87 Gg, representing 80% of N_20 emissions for the agriculture sector (83% in 1990) and 55.6% for national N_2O emissions (52.3% in 1990). N_2O emissions from this source consist of direct soil (23.72 Gg), animal production (4.97 Gg) and indirect soil (21.17 Gg) emissions.

Direct N_2O emissions from agricultural soils are key sources at level and trend assessment, both with Tier 1 and Tier 2 approaches. Indirect N_2O emissions are key sources at level for Tier 1 and Tier 2, and trend assessment (Tier 2). Animal Production is a key source at level and trend assessment with the Tier 2 approach, 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 and cultivation of histosols. 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 (former APAT) 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_20 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, 2011[c]; ISTAT, several years [a], [b]
Nitrogen content (%)	ISTAT, 2011[c]; ISTAT, several years [a], [b]
N excretion rates (kg $head^{-1}$ yr^{-1})	CRPA, 2006[a]; GU, 2006; Xiccato *et al.*, 2005
Cultivated surface (ha yr^{-1})	ISTAT, 2011[d],[e]; ISTAT, several years [a], [b]
Annual crop production (t yr^{-1})	ISTAT, 2011[d]; ISTAT, several years [a], [b]
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, 2011[a]; ISTAT, several years [a], [b]

In Table 6.32 and Table 6.33, time series of cultivated surface and crop production used for the preparation of the inventory are shown. In Table 6.30 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}), crop residues (F_{CR}), N-fixing crops (F_{BN}) and cultivation of histosols (F_{OS}). 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 6.25). 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-NH_3 and N-NOx emissions from fertilizers are divided by the total nitrogen content of fertilizers. N_2O emissions for synthetic fertilizers is obtained multiplying F_{SN} by the emission factor, 0.0125 kg N-N_2O/kg N (IPCC, 1997). In 2009, the total use of synthetic fertilizers was 518,778 t N, while F_{SN} parameter was 469,086 t N (see Table 6.27). 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.

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 2009, F_{AM} parameter was 446,413 t N.

Type of fertilizers	Fertilizers distributed (t yr^{-1})	Nitrogen content (%)	Nitrogen content of synthetic fertilizers (t N yr^{-1})
Ammonium sulphate	114,736	20.7%	28,803
Calcium cyanamide	23,692	16.3%	3,864
Ammonium nitrate < 27%	220,880	19.2%	42,510
Ammonium nitrate > 27%	52,680	59.1%	31,151
Calcium nitrate	19,406	26.8%	5,198
Urea	506,694	45.9%	232,815
Other nitric nitrogen (*Altri azotati nitrico*)	117,436	27.9%	3,671
Other ammoniacal nitrogen (*Altri azotati ammoniacale*)	-	-	13,018
Other amidic nitrogenous (*Altri azotati ammidico*)	-	-	16,101
Phosphate nitrogen	263,887	18.0%	47,397
Potassium nitrogen	94,180	18.4%	17,369
NPK nitrogen	452,369	12.4%	56,191
Organic mineral	251,756	10.2%	25,691
TOTAL	**2,117,716**		**518,778**

Table 6.25 Total use of synthetic fertilizer in 2009 (t N yr^{-1})

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 6.26, cultivated surface from N-fixing species (ha yr^{-1}) and N fixed by each species (kg N ha^{-1} yr^{-1}) are shown. In 2009 F_{BN} parameter was 163,797 t N (see Table 6.27).

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) are 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 2009, F_{CR} parameter was 113,568 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 6.32.

	N fixed	1990	1995	2000	2007	2008	2009
	(kg N $ha^{-1}yr^{-1}$)			(ha)			
Bean, fresh seed (*fagiolo*)	40	29,096	23,943	23,448	22,130	20,736	20,108
Bean, dry seed (*fagiolo*)	40	23,002	14,462	11,046	6,923	5,972	6,290
Broad bean, fresh seed (*fava*)	40	16,564	14,180	11,998	9,792	9,547	8,563
Broad bean, dry seed (*fava*)	40	104,045	63,257	47,841	49,972	54,310	49,784
Pea, fresh seed (*pisello*)	50	28,192	21,582	11,403	11,805	12,854	15,295
Pea, dry seed (*pisello*)	72	10,127	6,625	4,498	12,957	10,378	10,751
Chickpea (*cece*)	40	4,624	3,023	3,996	5,299	5,265	5,929
Lentil (*lenticchia*)	40	1,048	1,038	1,016	1,806	1,821	1,868
Tare (*veccia*)	80	5,768	6,532	6,500	6,500	6,500	6,500
Lupin (*lupino*)	40	3,303	3,070	3,000	3,000	3,000	3,000
soya bean (*soia)*	58	521,169	195,191	252,647	130,335	107,795	134,704
Alfalfa (*erba medica)*	194	987,000	823,834	810,866	705,370	712,674	720,382
Clover grass (*trifoglio)*	103	224,087	125,009	114,844	98,772	98,301	100,484
TOTAL		**1,958,025**	**1,301,746**	**1,307,102**	**1,064,660**	**1,049,153**	**1,083,659**

Table 6.26. Cultivated surface (ha) and nitrogen fixed by each variety (kg N ha^{-1} yr^{-1})

Cultivation of histosols (F_{os})

In Italy, the area of organic soils cultivated annually (histosols) is estimated to be 9,000 hectares for the whole time series (CRPA, 1997[b]). This value is multiplied by 8 kg N-N_2O ha^{-1} yr^{-1}, as suggested by IPCC (IPCC, 2000). The data for surface area, reproduced in the national soil map of the year 1961, were supplied by the Experimental Institute for the study and protection of soil in Florence (ISSDS). These values have been verified with related data for Emilia Romagna region, where this type of soil is most prevalent.

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	473,798	254,654	147,541	4,875	0.087	0.319	0.328
1991	764,911	473,322	240,032	149,041	5,107	0.087	0.319	0.328
1992	808,237	454,546	228,560	152,456	4,702	0.086	0.315	0.324
1993	860,390	451,431	211,235	141,823	4,472	0.090	0.311	0.321
1994	795,479	445,195	201,884	141,799	6,332	0.091	0.301	0.311
1995	726,343	453,396	191,018	142,216	7,823	0.089	0.298	0.308
1996	691,890	454,382	190,601	145,826	8,667	0.085	0.295	0.305
1997	782,973	456,903	194,257	147,351	10,814	0.086	0.293	0.303
1998	703,640	463,904	202,718	150,090	10,292	0.089	0.292	0.302
1999	716,405	469,740	191,722	150,228	8,706	0.091	0.290	0.300
2000	715,366	457,669	189,545	144,372	10,954	0.089	0.286	0.296
2001	737,063	467,361	182,928	137,779	16,076	0.089	0.299	0.307
2002	745,286	453,308	177,529	142,457	15,339	0.090	0.297	0.305
2003	750,296	452,998	175,154	119,184	14,648	0.090	0.296	0.304
2004	765,064	440,098	172,532	143,172	8,055	0.091	0.293	0.302
2005	710,888	439,882	176,624	145,247	8,874	0.088	0.292	0.301
2006	713,369	430,604	175,243	128,431	7,778	0.092	0.290	0.299
2007	694,048	446,953	160,575	125,878	8,305	0.093	0.292	0.301
2008	595,641	445,723	160,572	126,173	8,841	0.097	0.291	0.300
2009	469,086	446,413	163,797	113,568	11,365	0.096	0.292	0.301

(*) $FRAC_{GASM}$(indirect) is reported in the Table4.Ds2 as "other fractions"

Table 6.27 Parameters used for the estimation of direct and indirect N_2O emissions

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, 2010). 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 6.15, 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 which are used are the: total use of synthetic fertilizer, t N yr^{-1}, $FRAC_{GASF}$ emission factor, total N excreted by livestock (kg $head^{-1}yr^{-1}$), $FRAC_{GASM}$ emission factor (see Table 6.27) 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 which are used are the: total use of synthetic fertilizer, t N yr^{-1} (see Table 6.25), total N excreted by livestock (kg $head^{-1}$ yr^{-1}), $FRAC_{LEACH}$ 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 Table 6.28, time series of N_2O emissions are reported.

Year	Direct Soil Emissions	Animal Production	Indirect Soil emissions	TOTAL
	(Gg)			
1990	30.98	5.60	26.26	62.84
1991	32.16	5.45	27.18	64.79
1992	32.48	5.47	27.17	65.12
1993	32.89	5.59	27.91	66.39
1994	31.33	6.27	27.07	64.67
1995	29.99	6.44	26.24	62.66
1996	29.37	6.58	25.65	61.60
1997	31.35	6.52	26.99	64.86
1998	30.14	6.50	26.01	62.65
1999	30.27	6.59	26.34	63.20
2000	29.89	6.60	25.90	62.39
2001	30.32	5.18	25.88	61.38
2002	30.18	5.03	25.51	60.72
2003	29.76	4.93	25.45	60.15
2004	30.11	4.98	25.24	60.34
2005	29.18	4.90	24.31	58.39
2006	28.67	5.02	24.20	57.89
2007	28.28	5.06	24.44	57.79
2008	26.34	5.06	23.05	54.45
2009	23.72	4.97	21.17	49.87

Table 6.28 Nitrous oxide emission trends from Agricultural soils (Gg)

In 2009, N_2O emissions from agricultural soils were 21% (49.87 Gg N_2O) lower than in 1990 (62.84 Gg N_2O). Major contributions were given by direct soil (23.72 Gg) and indirect soil emissions (21.17 Gg). Indirect N_2O emissions from nitrogen leaching and run-off sub-category has the highest individual contribution with respect to total 4D N_2O emissions (16.32 Gg N_2O; 33%). 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 2009, the second individual source with respect to total N_2O emissions was the direct emissions of synthetic fertilizers with 9.21 Gg (17.5%), followed by animal wastes applied to soils, with 8.77 Gg (17.6%). 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 (see Table 6.30). Between 2007/2008 (-17%) and 2008/2009 (-25%) N fertiliser distribution has decreased. According to the Italian Fertilizer Association (AIF, *Associazione Italiana Fertilizzanti*) 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).

	Direct N_2O emissions						**Animal Production**	**Indirect N_2O emissions**	
Year	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	9.31	5.00	2.90	0.11	0.08	5.60	5.99	20.27
1991	15.03	9.30	4.71	2.93	0.11	0.08	5.45	6.05	21.13
1992	15.88	8.93	4.49	2.99	0.11	0.07	5.47	5.88	21.29
1993	16.90	8.87	4.15	2.79	0.11	0.07	5.59	5.95	21.96
1994	15.63	8.74	3.97	2.79	0.11	0.10	6.27	5.79	21.27
1995	14.27	8.91	3.75	2.79	0.11	0.16	6.44	5.69	20.55
1996	13.59	8.93	3.74	2.86	0.11	0.14	6.58	5.54	20.10
1997	15.38	8.97	3.82	2.89	0.11	0.17	6.52	5.68	21.31
1998	13.82	9.11	3.98	2.95	0.11	0.16	6.50	5.61	20.39
1999	14.07	9.23	3.77	2.95	0.11	0.14	6.59	5.67	20.67
2000	14.05	8.99	3.72	2.84	0.11	0.17	6.60	5.49	20.41
2001	14.48	9.18	3.59	2.71	0.11	0.25	5.18	5.54	20.35
2002	14.64	8.90	3.49	2.80	0.11	0.24	5.03	5.39	20.11
2003	14.74	8.90	3.44	2.34	0.11	0.23	4.93	5.35	20.10
2004	15.03	8.64	3.39	2.81	0.11	0.13	4.98	5.25	20.00
2005	13.96	8.64	3.47	2.85	0.11	0.14	4.90	5.10	19.22
2006	14.01	8.46	3.44	2.52	0.11	0.12	5.02	5.06	19.14
2007	13.63	8.78	3.15	2.47	0.11	0.13	5.06	5.20	19.24
2008	11.70	8.76	3.15	2.48	0.11	0.14	5.06	5.08	17.97
2009	9.21	8.77	3.22	2.23	0.11	0.18	4.97	4.86	16.32

Table 6.29 Nitrous oxide emission trends from Agricultural soils (Gg)

6.5.4 Source-specific QA/QC and verification

Synthetic fertilizers and nitrogen content are compared with the international FAO agriculture database statistics (FAO, 2011). 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. In Table 6.31, activity data used for N_2O estimations have been provided. In Table 6.32, the QA/QC plan for this category is presented.

6.5.5 Source-specific recalculations

Following recommendations from the UNFCCC review report, direct and indirect N_20 emissions for the use of sewage sludge in agricultural soils were estimated (UNFCCC, 2010[b]). Recalculations for 4D are linked to update of direct and indirect emission because of these new estimations. Other recalculations were done because of updating surfaces/productions of industrial cultivations (2007, 2008).

Year	National data (t N)	FAO 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
2003	824,649	Not available
2004	841,363	Not available
2005	779,846	Not available
2006	785,265	Not available
2007	765,490	Not available
2008	659,922	Not available
2009	518,778	Not available

Table 6.30 Total annual N content in fertilizer applied from 1990 to 2009

Year	Cultivated surface (ha)	Crop production (t)	Total residue production (dry matter)
1990	2,128,674	82,247,958	20,719,032
1991	1,945,347	83,683,020	21,282,647
1992	1,831,020	86,462,112	21,505,656
1993	1,623,307	80,844,539	20,516,890
1994	1,568,346	81,267,156	20,465,054
1995	1,484,453	81,343,949	20,466,710
1996	1,484,242	83,163,618	21,302,559
1997	1,548,889	83,792,787	20,778,350
1998	1,622,647	84,466,234	21,453,885
1999	1,494,345	87,413,587	21,412,200
2000	1,491,315	82,090,948	20,685,353
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	1,338,663	84,706,239	20,800,493
2006	1,352,385	71,186,530	19,239,493

Year	Cultivated surface (ha)	Crop production (t)	Total residue production (dry matter)
2007	1,242,481	69,147,007	18,845,035
2008	1,220,887	68,508,147	19,419,500
2009	1,258,535	62,564,634	16,914,244

Table 6.31 Cultivated surface, crop production and total residue production time series

6.5.6 Source-specific planned improvements

For this submission direct and indirect sewage sludge emissions applied to soil were estimated for the 4D category (see Table 6.32).

Category/sub category	Parameter	Year of submission 2011	2012	Activities
Direct emissions	Sewage sludge	√		Italy has reconstructed a complete and consistent time series for the amount of sewage sludge applied to soils. Estimations have been provided in the 2011 submission, according to GPG IPCC guidelines.
Activity data	Fertilizer	√		Results obtained from the research study on land spreading have been compared with those obtained with the inventory process (CRPA, 2009).

Table 6.32 Improvements for the agricultural soils category in the QA/QC plan

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 2009, CH_4 emissions from this source were 0.60 Gg, representing 0.08% of emissions for the agriculture sector. N_2O emissions were 0.013 Gg, representing 0.02% of emissions for the agriculture sector.

6.6.2 Methodological issues

A country-specific 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. Activity data (agricultural production) used for estimating burning of agriculture residues is summarised in the following box (see Table 6.33).

Data used for estimating field burning of agriculture residues emission

Data	Reference
Annual crop production	ISTAT, 2011[d],[e]; ISTAT, several years [a], [b]
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

The same methodology is used to estimate emissions from burning of agriculture residues. Emissions from fixed residues and stubble (*stoppie*), burnt on open fields, are reported in this category (4F) while emissions from removable residues (*asportabili*) burnt off-site, are reported under the waste sector (waste incineration- 6C category).

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
1991	9,415,700	1,792,900	6,237,700	359,400	18,800	1,235,600	149,500
1992	8,938,400	1,742,087	7,394,100	333,100	22,586	1,271,600	178,700
1993	8,169,800	1,634,200	8,028,900	372,200	22,800	1,305,100	226,800
1994	8,251,401	1,467,378	7,483,438	354,660	20,295	1,360,519	236,060
1995	7,946,081	1,387,069	8,454,164	301,322	19,780	1,320,851	214,802
1996	8,424,492	1,350,494	9,547,541	351,622	20,400	1,359,697	209,191
1997	6,758,351	1,179,575	10,004,700	310,706	19,000	1,442,400	173,570
1998	8,338,301	1,359,076	9,054,600	362,627	20,100	1,407,100	159,872
1999	7,742,782	1,313,323	10,017,178	331,150	12,363	1,427,130	202,370
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

Table 6.33 Time series of activity data (t) used for 4F estimations

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” burnable residues[14] (t), estimated with annual crop production, removable residues/product ratio, and “fixed” residue/removable residues ratio.
b) Amount of dry residues in “fixed” residue[15] (t dry matter), calculated with amount of burnable residues and fraction of dry matter.
c) Amount of “fixed” dry residues oxidized[16] (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[17] (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[18] (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 2009, final CH_4 emissions from on field burning of agriculture residues (0.60 Gg CH_4) have been estimated multiplying the C-CH_4 value (0.447 Gg C-CH_4) by the coefficient 16/12. In Table 6.34,

[14] Quantità di residuo "fisso" bruciabile (produzione totale) (ton)
[15] Quantità di residuo secco nel residuo "fisso" (tonnellate di sostanza secca)
[16] Quantità residuo secco "fisso" ossidato (ton di sost. secca)
[17] Quantità di carbonio rilasciato in aria dalla combustione delle stoppie (tonnellate di carbonio)
[18] Emissione di C-CH4 dalla combustione delle stoppie (tonnellate di C-CH4)

parameters used for estimating of CH_4 emissions from on field burning of agriculture residues are shown.

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 (*frumento*)	6,535	1,127	962	84	41	204
Rye (*segale*)	12	2	2	0	0	0
Barley (*orzo*)	1,049	210	180	16	6	30
Oats (*avena*)	314	55	47	4	2	9
Rice (*riso*)	1,644	275	207	93	39	193
Maize (*granoturco)*	8,143	814	339	0	0	0
Sorghum (*sorgo da granella*)	243	85	71	6	2	12
TOTAL	**17,941**	**2,569**	**1,807**	**204**	**89**	**447**

Table 6.34 Parameters used for the estimation of CH_4 emissions from agriculture residues in 2009

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[19] (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[20] (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 2009, final N_2O emissions from on field burning of agriculture residues (0.013 Gg N_2O) are estimated by multiplying the N-N_2O value (0.008 Gg N) with the coefficient 44/28. Table 6.35 shows the parameters for the estimation of CH_4 emissions from field burning of agriculture residues.

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 (*frumento*)	84	0.030	0.005	0.404	2.8
Rye (*segale*)	0	0.036	0.006	0.001	0.01
Barley (*orzo*)	16	0.037	0.006	0.096	0.7
Oats (*avena*)	4	0.04	0.006	0.027	0.2
Rice (*riso*)	93	0.041	0.007	0.610	4.3
Maize (*granoturco)*	0		0.007	0.000	0.0
Sorghum (*sorgo da granella*)	6	0.037	0.006	0.038	0.3
TOTAL	**204**			**1.176**	**8.2**

Table 6.35 Parameters used for the estimation of nitrous oxide from agriculture residues in 2009

[19] Quantità di azoto rilasciato in aria dalla combustione delle stoppie (ton di azoto)
[20] Emissione di N-N2O dalla combustione delle stoppie (tonnellate di N-N2O)

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 2009, CH_4 emissions from field burning of agriculture residues were 0.60 Gg emissions of CH_4 and 0.013 Gg emissions of N_2O emissions (see Table 6.36). Variation in emissions trend is related to cereal production trends.

Year	CH_4 (Gg)	N_2O (Gg)
1990	0.6232	0.0130
1991	0.6770	0.0139
1992	0.6618	0.0137
1993	0.6354	0.0133
1994	0.6410	0.0134
1995	0.6157	0.0129
1996	0.6418	0.0133
1997	0.5749	0.0123
1998	0.6432	0.0134
1999	0.6211	0.0131
2000	0.5779	0.0121
2001	0.5343	0.0114
2002	0.6013	0.0126
2003	0.5462	0.0117
2004	0.6687	0.0140
2005	0.6212	0.0131
2006	0.6040	0.0129
2007	0.6119	0.0131
2008	0.6523	0.0134
2009	0.5966	0.0129

Table 6.36 CH_4 and N_2O emission trends from field burning of agriculture residues (Gg)

6.6.4 Source-specific QA/QC and verification

In response to the review process (UNFCCC, 2007[a]) and in order to verify the national assumption, which considered that 10% of the cultivated surface (cereals) are burned in Italy, a specific elaboration of data was done (FSS 2003). ISTAT provided information regarding the regional practise of field burning (cereals). We have confirmed the assumption with data coming from national agricultural statistics (ISTAT, 2007[c]).

6.6.5 Source-specific recalculations

For this submission recalculations were done because of updating surfaces/productions of industrial cultivations for the year 2007 and 2008 (ISTAT, 2011[d]).

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 Overview of sector

CO_2 emissions and removals occur as a result of changes in land-use and from forestry. The sector is responsible for 94.7 Mt of CO_2 removals from the atmosphere in 2009.

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 researches 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 used emission factors.

CO_2 emissions from forest fires have been included 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 2009 are shown in Figure 7.1:

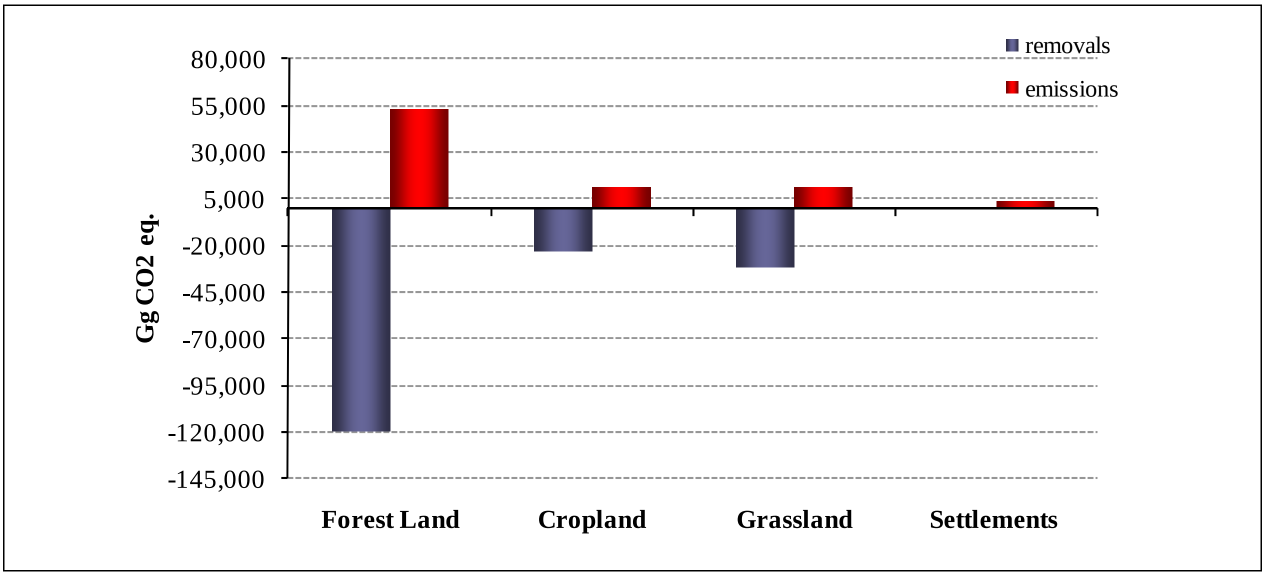


Figure 7.1 Greenhouse gas removals and emissions in LULUCF sector in 2009 [Gg CO_2 eq.]

In Table 7.1 emissions and removals time series is reported.

GHG Gas Source and Sink Categories	1990	1995	2000	2005	2006	2007	2008	2009
CO_2	**-62,077**	**-79,963**	**-78,984**	**-90,585**	**-96,998**	**-73,527**	**-92,879**	**-94,731**
A. Forest Land	-41,701	-61,756	-54,422	-66,660	-67,151	-45,817	-63,019	-66,430
B. Cropland	-18,949	-14,436	-14,116	-12,611	-12,821	-13,152	-12,928	-12,299
C. Grassland	-3,954	-6,295	-12,944	-14,703	-20,430	-17,976	-20,391	-19,518
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	2,526	2,525	2,497	3,389	3,404	3,417	3,460	3,516
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA
CH_4	**6.96**	**1.50**	**4.02**	**1.83**	**1.46**	**9.37**	**2.20**	**2.61**
A. Forest Land	6.96	1.50	4.02	1.83	1.46	9.37	2.20	2.61
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA
N_2O	**0.44**	**0.02**	**0.03**	**0.01**	**0.01**	**0.06**	**0.02**	**0.02**
A. Forest Land	0.05	0.01	0.03	0.01	0.01	0.06	0.02	0.02
B. Cropland	0.39	0.01	NO	NO	NO	NO	NO	NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA
LULUCF (*Gg CO_2 equivalent*)	**-61,795**	**-79,924**	**-78,891**	**-90,542**	**-96,965**	**-73,310**	**-92,828**	**-94,671**

Table 7.1 Trend in greenhouse gas emissions from the LULUCF sector in the period 1990-2009

CO_2 emissions and removals in LULUCF sector, in the period 1990-2009, are shown in Figure 7.2:

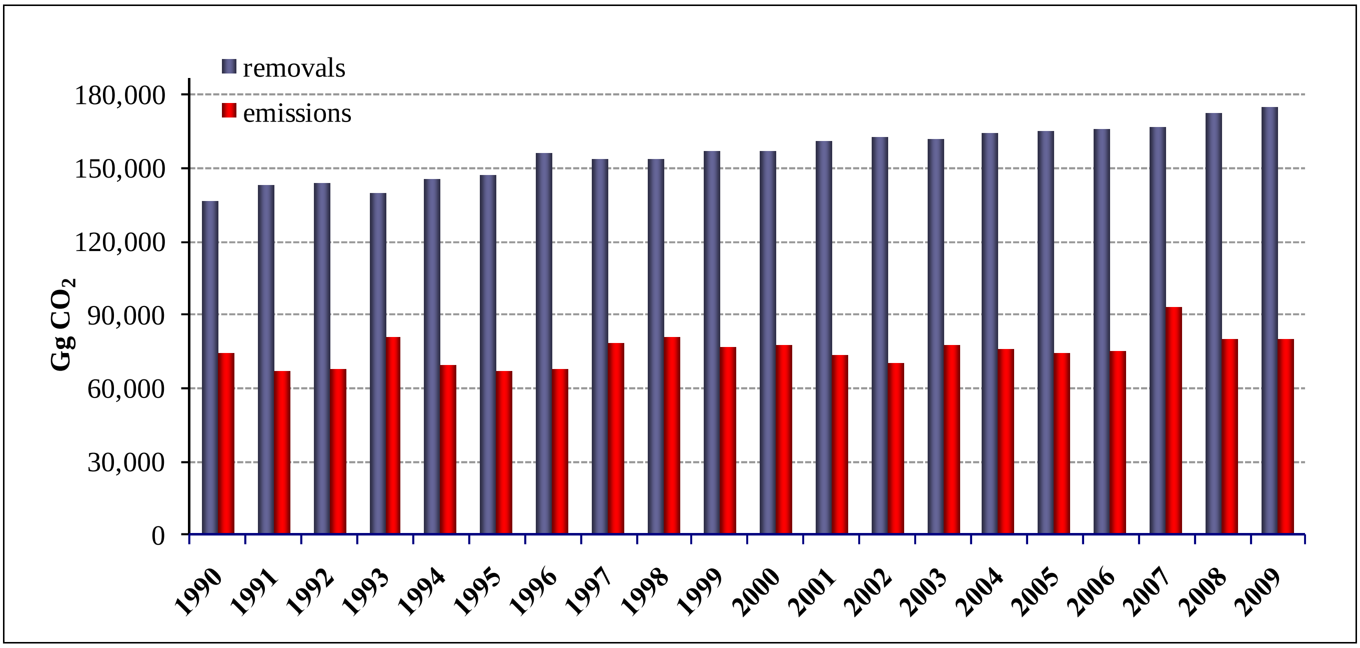


Figure 7.2 CO_2 removals and emissions in LULUCF sector in the period 1990-2009 [Gg CO_2]

The outcome of the key category analysis for 2009, according to level and/or trend assessment (*IPCC Tier 1 and Tier 2 approaches*), is listed in Table 7.2. CO_2 emissions and removals from forest land remaining forest land, cropland remaining cropland and grassland remaining grassland, 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 at Tier 2 concerning trend assessment. Concerning CH_4 or N_2O emissions, no categories have resulted as a key source.

	gas	*categories*	2009
5.A.1	CO_2	Forest land remaining 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	CO_2	Land converted to Settlements	key (L, T)
5.B.2	CO_2	Land converted to cropland	key (T2)
5.A.2	CO_2	Land converted to forest land	Non-key
5.D	CO_2	Wetlands	Non-key
5.E	CO_2	Settlements remaining Settlements	Non-key
5.A.1	CH_4	Forest land remaining forest land	Non-key
5.A.1	N_2O	Forest land remaining forest land	Non-key
5.B.2	N_2O	Land converted to cropland	Non-key

Table 7.2 Key categories identification in the LULUCF sector

For the land use conversion, land use change matrices have been used; the matrices have allowed pointing out the average areas of transition land, separately for each initial and final land use (i.e. forest land, grassland, etc.).

LUC matrices for each year of the period 1990–2009 have been assembled based on time series of national land use statistics for forest lands, croplands, grasslands, wetlands and settlement areas. 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. 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; settlements area can only come from grassland or cropland; new cropland area can only come from grassland area, as new grassland area can only come from cropland area.

Changes in carbon stocks associated with the transitions have been reported as a whole in a single year (i.e. the year of conversion). While this may be valid for losses of aboveground biomass due to some land conversions, soil carbon is in a steady state equilibrium in natural ecosystems and change in land use is expected to affect soil carbon sequestration dynamics and consequently soil carbon stocks. Current approaches assume that after a cultivation of a forest or grassland, there is an initial carbon loss over the first years, which rapidly reduces to a lower subsequent loss rate in the following years (Davidson and Ackerman 1993). This loss could be attributed to the response of the faster-cycling C pools that contribute most of the decomposition flux, commonly described by first-order decomposition kinetics (Olson, 1963). In a similar way, soils are expected to gain carbon in cropland converted to grassland (Guo & Giffort 2002, Post and Kwon 2000) at fast rates in the first stages of the conversion (Reeder 1998). However, because the dynamics of soil carbon storage and release are complex and still not well understood, the magnitude and timing of the response of the soil carbon to change in land use should be considered affected by a large uncertainty.

On this basis and by considering the spatial resolution of data used, a reasonable approach, in calculating the effect of land use change, is assuming that the changes in carbon stocks occur in the first year after the land conversion, in spite of considering them over the time period (20 years as default) specified by IPCC GPG LULUCF (IPCC, 2003). From a technical point of view, we are confident to account, by this method, for the larger part of the total amount of carbon exchanged to the atmosphere; a severe effort and enhanced quality data would be required to obtain the necessary high degree of spatial disaggregation of areas affected by the land use change every year in a 20 years time period. The contribution from stock changes is thus applied in the first year following the relevant land-use change, and it is applied only once, for the year in which it is determined.
In the following Table 7.3, the land use matrices for each year of the period 1990–2009 are reported.

		1989						
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	*Initial sum*
	1990	7,373	9,319	11,156	57	1,340	887	*30,134*
1990	**Forest**	**7,373**				0.7		*7,373*
	Grassland	78	**9,319**	14		8		*9,319*
	Cropland		0	**11,156**		0		*11,156*
	Wetland				**57**			*57*
	Settlements					**1,340**		*1,340*
	Other Land						**887**	*887*
	Final sum	*7,450*	*9,220*	*11,170*	*57*	*1,349*	*887*	30,134

		1990						
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	*Initial sum*
	1991	7,450	9,220	11,170	57	1,349	887	*30,134*
1991	**Forest**	**7,450**				0.7		*7,450*
	Grassland	78	**9,220**	0		8		*9,220*
	Cropland		0	**11,170**		0		*11,170*
	Wetland				**57**			*57*
	Settlements					**1,349**		*1,349*
	Other Land						**887**	*887*
	Final sum	*7,527*	*9,135*	*11,171*	*57*	*1,357*	*887*	30,134

		1991						
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	*Initial sum*
	1992	7,527	9,135	11,171	57	1,357	887	*30,134*
1992	**Forest**	**7,527**				0.7		*7,527*
	Grassland	78	**9,135**	0		8		*9,135*
	Cropland		0	**11,171**		0		*11,171*
	Wetland				**57**			*57*
	Settlements					**1,357**		*1,357*
	Other Land						**887**	*887*
	Final sum	*7,604*	*9,049*	*11,171*	*57*	*1,365*	*887*	30,134

		1992						
		Forest	**Grassland**	**Cropland**	**Wetlands**	**Settlements**	**Other Land**	*Initial sum*
	1993	7,604	9,049	11,171	57	1,365	887	*30,134*
1993	**Forest**	**7,604**				0.7		*7,604*
	Grassland	78	**9,049**	0		8		*9,049*
	Cropland		0	**11,171**		0		*11,171*
	Wetland				**57**			*57*
	Settlements					**1,365**		*1,365*
	Other Land						**887**	*887*
	Final sum	*7,681*	*8,963*	*11,172*	*57*	*1,373*	*887*	30,134

		1993						
		Forest	**Grassland**	**Cropland**	**Wetlands**	**Settlements**	**Other Land**	*Initial sum*
	1994	7,681	8,963	11,172	57	1,373	887	*30,134*
1994	**Forest**	**7,681**				0.7		*7,681*
	Grassland	78	**8,963**	0		8		*8,963*
	Cropland		0	**11,172**		0		*11,172*
	Wetland				**57**			*57*
	Settlements					**1,373**		*1,373*
	Other Land						**887**	*887*
	Final sum	*7,758*	*8,877*	*11,172*	*57*	*1,382*	*887*	30,134

		1994						
		Forest	**Grassland**	**Cropland**	**Wetlands**	**Settlements**	**Other Land**	*Initial sum*
	1995	7,758	8,877	11,172	57	1,382	887	*30,134*
1995	**Forest**	**7,758**				0.7		*7,758*
	Grassland	78	**8,877**	0		8		*8,877*
	Cropland		0	**11,172**		0		*11,172*
	Wetland				**57**			*57*
	Settlements					**1,382**		*1,382*
	Other Land						**887**	*887*
	Final sum	*7,835*	*8,791*	*11,173*	*57*	*1,390*	*887*	30,134

		1995						
		Forest	**Grassland**	**Cropland**	**Wetlands**	**Settlements**	**Other Land**	*Initial sum*
	1996	7,835	8,791	11,173	57	1,390	887	*30,134*
1996	**Forest**	**7,835**				0.7		*7,835*
	Grassland	78	**8,791**	0		0		*8,791*
	Cropland		103	**11,173**		8		*11,173*
	Wetland				**57**			*57*
	Settlements					**1,390**		*1,390*
	Other Land						**887**	*887*
	Final sum	*7,912*	*8,817*	*11,062*	*57*	*1,398*	*887*	30,134

		1996						
		Forest	**Grassland**	**Cropland**	**Wetlands**	**Settlements**	**Other Land**	*Initial sum*
	1997	7,912	8,817	11,062	57	1,398	887	*30,134*
1997	**Forest**	**7,912**				0.7		*7,912*
	Grassland	78	**8,817**	0		0		*8,817*
	Cropland		103	**11,062**		8		*11,062*
	Wetland				**57**			*57*
	Settlements					**1,398**		*1,398*
	Other Land						**887**	*887*
	Final sum	*7,989*	*8,843*	*10,951*	*57*	*1,407*	*887*	30,134

		1997						
		Forest	**Grassland**	**Cropland**	**Wetlands**	**Settlements**	**Other Land**	*Initial sum*
	1998	7,989	8,843	10,951	57	1,407	887	*30,134*
1998	**Forest**	**7,989**				0.7		*7,989*
	Grassland	78	**8,843**	0		0		*8,843*
	Cropland		103	**10,951**		8		*10,951*
	Wetland				**57**			*57*
	Settlements					**1,407**		*1,407*
	Other Land						**887**	*887*
	Final sum	*8,066*	*8,868*	*10,840*	*57*	*1,415*	*887*	30,134

		1998						
		Forest	**Grassland**	**Cropland**	**Wetlands**	**Settlements**	**Other Land**	*Initial sum*
	1999	8,066	8,868	10,840	57	1,415	887	*30,134*
1999	**Forest**	**8,066**				0.7		*8,066*
	Grassland	78	**8,868**	0		0		*8,868*
	Cropland		103	**10,840**		8		*10,840*
	Wetland				**57**			*57*
	Settlements					**1,415**		*1,415*
	Other Land						**887**	*887*
	Final sum	*8,143*	*8,894*	*10,729*	*57*	*1,423*	*887*	30,134

		1999						
		Forest	**Grassland**	**Cropland**	**Wetlands**	**Settlements**	**Other Land**	*Initial sum*
	2000	8,143	8,894	10,729	57	1,423	887	*30,134*
2000	**Forest**	**8,143**				0.7		*8,143*
	Grassland	78	**8,894**	0		0		*8,894*
	Cropland		103	**10,729**		8		*10,729*
	Wetland				**57**			*57*
	Settlements					**1,423**		*1,423*
	Other Land						**887**	*887*
	Final sum	*8,220*	*8,920*	*10,618*	*57*	*1,431*	*887*	30,134

		2000						
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	*Initial sum*
	2001	8,220	8,920	10,618	57	1,431	887	*30,134*
2001	**Forest**	**8,220**				0.7		*8,220*
	Grassland	78	**8,920**	0		0		*8,920*
	Cropland		111	**10,618**		11		*10,618*
	Wetland				**57**			*57*
	Settlements					**1,431**		*1,431*
	Other Land						**887**	*887*
	Final sum	*8,297*	*8,953*	*10,497*	*57*	*1,443*	*887*	30,134

		2001						
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	*Initial sum*
	2002	8,297	8,953	10,497	57	1,443	887	*30,134*
2002	**Forest**	**8,297**				0.7		*8,297*
	Grassland	78	**8,953**	0		0		*8,953*
	Cropland		111	**10,497**		11		*10,497*
	Wetland				**57**			*57*
	Settlements					**1,443**		*1,443*
	Other Land						**887**	*887*
	Final sum	*8,374*	*8,986*	*10,375*	*57*	*1,454*	*887*	30,134

		2002						
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	*Initial sum*
	2003	8,374	8,986	10,375	57	1,454	887	*30,134*
2003	**Forest**	**8,374**				0.7		*8,374*
	Grassland	78	**8,986**	0		0		*8,986*
	Cropland		111	**10,375**		11		*10,375*
	Wetland				**57**			*57*
	Settlements					**1,454**		*1,454*
	Other Land						**887**	*887*
	Final sum	*8,451*	*9,019*	*10,254*	*57*	*1,465*	*887*	30,134

		2003						
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	*Initial sum*
	2004	8,451	9,019	10,254	57	1,465	887	*30,134*
2004	**Forest**	**8,451**				0.7		*8,451*
	Grassland	78	**9,019**	0		0		*9,019*
	Cropland		111	**10,254**		11		*10,254*
	Wetland				**57**			*57*
	Settlements					**1,465**		*1,465*
	Other Land						**887**	*887*
	Final sum	*8,528*	*9,052*	*10,133*	*57*	*1,476*	*887*	30,134

		2004						
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	*Initial sum*
	2005	8,528	9,052	10,133	57	1,476	887	*30,134*
2005	**Forest**	**8,528**				0.7		*8,528*
	Grassland	78	**9,052**	0		0		*9,052*
	Cropland		111	**10,133**		11		*10,133*
	Wetland				**57**			*57*
	Settlements					**1,476**		*1,476*
	Other Land						**887**	*887*
	Final sum	*8,605*	*9,085*	*10,012*	*57*	*1,488*	*887*	30,134

		2005						
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	*Initial sum*
	2006	8,605	9,085	10,012	57	1,488	887	*30,134*
2006	**Forest**	**8,605**				0.7		*8,605*
	Grassland	78	**9,085**	0		0		*9,085*
	Cropland		189	**10,012**		11		*10,012*
	Wetland				**57**			*57*
	Settlements					**1,488**		*1,488*
	Other Land						**887**	*887*
	Final sum	*8,683*	*9,195*	*9,812*	*57*	*1,499*	*887*	30,134

		2006						
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	*Initial sum*
	2007	8,683	9,195	9,812	57	1,499	887	*30,134*
2007	**Forest**	**8,683**				0.7		*8,683*
	Grassland	78	**9,195**	0		0		*9,195*
	Cropland		189	**9,812**		11		*9,812*
	Wetland				**57**			*57*
	Settlements					**1,499**		*1,499*
	Other Land						**887**	*887*
	Final sum	*8,761*	*9,306*	*9,612*	*57*	*1,510*	*887*	30,134

		2007						
		Forest	Grassland	Cropland	Wetlands	Settlements	Other Land	*Initial sum*
	2008	8,761	9,306	9,612	57	1,510	887	*30,134*
2008	**Forest**	**8,761**				0.7		*8,761*
	Grassland	78	**9,306**	0		0		*9,306*
	Cropland		189	**9,612**		11		*9,612*
	Wetland				**57**			*57*
	Settlements					**1,510**		*1,510*
	Other Land						**887**	*887*
	Final sum	*8,838*	*9,416*	*9,413*	*57*	*1,522*	*887*	30,134

		2008						
		Forest	**Grassland**	**Cropland**	**Wetlands**	**Settlements**	**Other Land**	*Initial sum*
	2009	8,838	9,416	9,413	57	1,522	887	*30,134*
2009	**Forest**	**8,838**				0.7		*8,838*
	Grassland	78	**9,416**	0		0		*9,416*
	Cropland		189	**9,413**		11		*9,413*
	Wetland				**57**			*57*
	Settlements					**1,522**		*1,522*
	Other Land						**887**	*887*
	Final sum	*8,916*	*9,527*	*9,213*	*57*	*1,533*	*887*	30,134

Table 7.3 Land use change matrices for the years 1990-2009

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 in forest land have been reported.
Forest land removals share 65% of total CO_2 2009 LULUCF emissions and removals, while the mean forest land removals for the years 1990-2009 is 66% of total mean CO_2 LULUCF emissions and removals; in particular the living biomass removals represent 50%, while the removals from dead organic matter and soils stand for 8% and 42% of total 2009 forest land CO_2 removals, respectively.

Forest Land	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
- living biomass	*37*	*49*	*46*	*49*	*51*	*48*	*50*	*51*	*51*	*40*	*49*	*50*
- dead organic matter	*6*	*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*	*7*	*8*	*8*
-soils	*56*	*43*	*47*	*43*	*41*	*44*	*42*	*41*	*41*	*53*	*43*	*42*

Table 7.4 Percentage contribution of carbon pools to forest land category, in 1990-2009

CO_2 removals from forest land remaining forest land have identified as key category (sinks) in level and in trend assessment either with Tier 1 and Tier 2 approaches. 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

In 2010 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 inventory under the Convention, in order to maintain coherence and congruity between the two forest-related reporting. Coherently with the 2010 submission, plantations and shrublands, that don't fulfil national forest definition, have been reported into cropland category (plantations) and in grassland category (shrublands).
For the land use conversion, land use change matrices have been used; as abovementioned, LUC matrices for each year of the period 1990–2009 have been assembled based on time series of national land use statistics for forest lands, croplands, grasslands, wetlands and settlement areas. 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. Growth in forest land area as detected by the First Italian National Forest Inventory (IFN) and the Inventory of Forests and

Carbon pools (INFC) was used as the basis. 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 IFN 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, 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 (INFC, 2007).
The estimation for 1990 was calculated through a linear interpolation between the 1985 and 2005 data. By assuming that the defined trend may well represent the near future, it was possible to extrapolate data for 2006-2009.
Additional source of information was the National Statistics Institute (ISTAT), which had provided annual data on forest area extent, till 2005. In 2006, the National Statistics Institute has officially recognized the INFC data, suspending the annual assessment on forest area extent.

7.2.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

In the current submission, forest definition adopted by Italy in the Framework of Kyoto Protocol has been adopted; the forest definition adopted by Italy agrees with the Food and Agriculture Organization of the United Nations definitions, therefore the 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

All the data concerning the growing stock and the related carbon are assessed by a model (Federici et al., 2008), 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.
The model has been applied at regional scale (NUTS2) because of availability of forest-related statistical data: the First Italian National Forest Inventory (IFN) data and the Inventory of Forests and Carbon pools (INFC) were input data for the forest area, per region and inventory typologies.
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 2009, 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[21], 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

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).

---

[21] 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.

$$y = a \cdot \left[1 \pm e^{(\beta - kt)}\right]^{-\frac{1}{\nu}} \quad \text{(Richard's function)}$$

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.

$$\frac{dy}{dt} = \frac{k}{\nu} \cdot y \cdot \left[1 - \left(\frac{y}{a}\right)^{\nu}\right] + y_0 \quad \text{(Richard's function - first derivative)}$$

where the general constrain for the parameters are the following:

$a,k>0$ $-1 \le \nu \le \infty$ and $\nu \ne 0$

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).

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 obtained from national statistics (ISTAT, several years [a]); several sources have considered data on biomass removed in commercial harvest 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])) underestimated, particularly concerning fuelwood consumption (APAT - ARPA Lombardia, 2007, UNECE – FAO, Timber Committee, 2008, Corona, 2007). In particular a specific survey conducted in the framework of the Inventory of Forests and Carbon pools (INFC) have done a regional assessment of the harvested biomass; these data were used to infer a correction factor[22], on regional basis, that was applied to the entire time series of commercial harvested wood. 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. Not having data on the fraction of growing stock oxidised as consequence of fires, the most conservative hypothesis has been adopted: all growing stock of burned forest areas has been assumed to be completely oxidised and so released. 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.

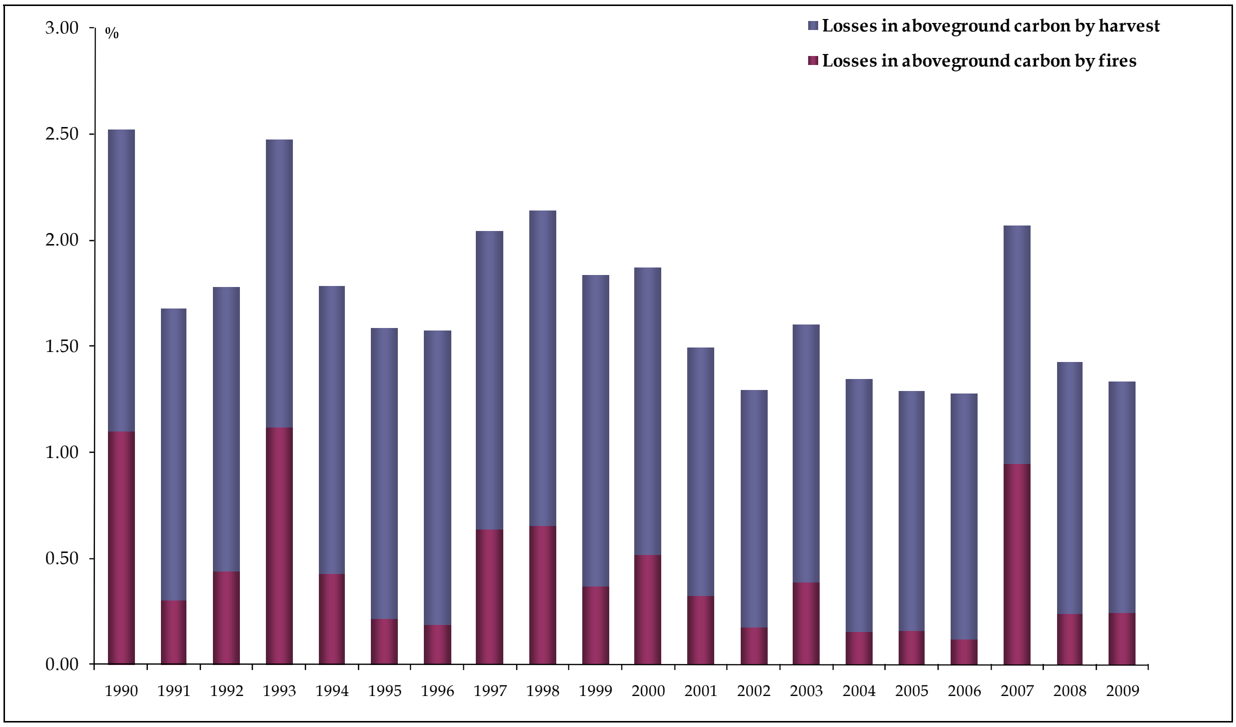


Figure 7.3 Losses by harvest and fires in relation to aboveground carbon

In the following Table 7.6, values of burned growing stocks, reported in cubic meter, and respective CO_2 released, for different categories (stands, coppices, plantations, protective forests) are shown.

[22] 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.

Year	burned growing stock m^3				CO_2 released Gg			
	stands	*coppice*	*protective*	*total*	*stands*	*coppice*	*protective*	*total*
1990	3,619,593	5,046,926	1,355,460	10,021,979	4,508	7,319	2,049	13,877
1991	982,390	1,265,383	437,679	2,685,452	1,226	1,832	661	3,719
1992	1,368,059	2,031,002	673,779	4,072,840	1,709	2,935	1,017	5,662
1993	3,768,021	4,081,274	1,748,270	9,597,565	4,709	5,888	2,637	13,234
1994	1,447,130	1,077,267	844,906	3,369,302	1,810	1,552	1,274	4,636
1995	696,804	1,229,406	270,598	2,196,808	873	1,768	408	3,049
1996	875,660	765,609	271,883	1,913,152	1,099	1,100	410	2,608
1997	2,464,735	3,356,507	825,884	6,647,127	3,097	4,815	1,243	9,156
1998	2,824,918	2,360,372	1,197,022	6,382,312	3,553	3,382	1,801	8,736
1999	1,232,176	1,761,685	586,933	3,580,794	1,552	2,521	883	4,956
2000	2,277,565	2,128,341	899,157	5,305,062	2,871	3,043	1,352	7,266
2001	1,353,580	1,478,267	578,592	3,410,439	1,708	2,111	870	4,689
2002	629,090	1,027,565	355,343	2,011,999	795	1,466	534	2,795
2003	1,440,422	1,977,267	708,596	4,126,285	1,822	2,818	1,064	5,704
2004	620,393	840,085	373,250	1,833,728	786	1,196	560	2,542
2005	586,855	973,420	369,150	1,929,425	744	1,384	554	2,683
2006	452,929	747,561	280,483	1,480,972	575	1,062	421	2,058
2007	4,919,292	4,306,775	1,738,644	10,964,711	6,247	6,113	2,607	14,967
2008	1,353,266	1,081,206	488,496	2,922,968	1,721	1,533	732	3,986
2009	1,164,503	822,636	657,423	2,644,561	1,482	1,166	985	3,633

Table 7.6 Burned growing stocks and CO_2 released for the years 1990-2009

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 2009. 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.
With regard to the aboveground biomass:

1. starting from the 1985 growing stock data, reported in the IFN, 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 (MATT/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] (MATT/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 7.7 biomass expansion factors for the conversions of volume to aboveground tree biomass and wood basic densities are reported.

	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
protective	rupicolous forest	1.44	0.52
	riparian forest	1.39	0.41

Table 7.7 Biomass Expansion Factors and Wood Basic Densities

Belowground biomass was estimated applying a Root/Shoot ratio to the aboveground biomass. The belowground biomass is computed, as:

$$\text{Belowground biomass(d.m.)} = GS \cdot WBD \cdot R \cdot A$$

where:
GS = volume of growing stock [m^3 ha^{-1}]
R = Root/Shoot ratio which converts growing stock biomass in belowground biomass

WBD = Wood Basic Density [t d.m. m^{-3}]
A = forest area occupied by specific typology [ha]
Also in this case, the BEFs and WBDs were derived for each forest typology.
In Table 7.8 root/shoot ratio and wood basic densities are reported

	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
protective	rupicolous forest	0.42	0.52
	riparian forest	0.23	0.41

Table 7.8 Root/Shoot ratio and Wood Basic Densities

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.

The deadwood mass was assessed applying a dead mass conversion factor (DCF) of respectively 0.2 for evergreen forests and 0.14 for deciduous forests, as reported in table 3.2.2 of GPG (IPCC 2003).
The dead mass [t] is:

$$\text{Dead mass (d.m.)} = \text{GS} \cdot BEF \cdot WBD \cdot DCF \cdot A$$

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
WBD = Wood Basic Density [t d.m. m^{-3}]
DCF = Dead mass Conversion Factor which converts aboveground woody biomass in dead mass
A = forest area occupied by specific typology [ha]

The amount of carbon in litter is estimated from the aboveground carbon amount with linear relations, [$C_{Litter} = f(C_{Aboveground})$] calculated on data collected within the European project Biosoil[23] (for litter) and a Life+ project FutMon[24] (*Further Development and Implementation of an EU-level Forest Monitoring System*), for the aboveground biomass. BioSoil (2005-2007) was a Demonstration project funded under Regulation (EC) n. 2152/2003 on forest monitoring and environment interactions in the Community (Forest Focus), part of the programme of the International Cooperative Programme on the Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests[25]). It was composed of a soil module and a biodiversity module. The soil module aimed at assessing soil chemistry and carbon stocks in European forests using the sampling design of ICP level I network with a common field and analytical protocol. In Italy, the BioSoil project was coordinated by the CONECOFOR division of the National Forest Service (CFS), who contracted research institution and university departments (BioSoil, 2011) for the technical work and elaboration. In total 239 forest plots have been surveyed belonging to a national grid of 15 by 18 km. The sites were a subset of the 1985 National Forest Inventory. Soil sampling and laboratory analysis were done in 2006 and 2007. The measurements and analyses performed by the FutMon project were carried out on the same 239 forest plots monitored by Biosoil.
Litter amount was assessed on the basis of weight of the OL horizon. OL horizon is characterised by an accumulation of mainly leaves/needles, twigs and woody materials (including bark), fruits etc. There may be some fragmentation, but most of the original biomass structures are easily discernible. Leaves and/or needles may be discoloured and slightly fragmented. Organic fine substance (in which the original organs are not recognisable with naked eye) amounts to less than 10% by volume. The total litter carbon amount has been estimated from aboveground carbon amount with linear relations differentiated per forestry use: stands (resinous, broadleaves, mixed stands) and coppices. In Table 7.9 the different relations used to obtain litter carbon amount per ha [t C ha^{-1}] from the aboveground carbon amount per ha [t C ha^{-1}] have been reported.

[23] BioSoil project – http://biosoil.jrc.ec.europa.eu/; http://forest.jrc.ec.europa.eu/contracts/biosoil
[24] 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
[25] International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests operating under the UNECE Convention on Long-range Transboundary Air Pollution – http://www.icp-forests.org/

	Inventory typology	Relation litter – aboveground C per ha	R^2	Standard error
stands	norway spruce	y = 0.0282x + 2.2494	0.2204	2.63
	silver fir	y = 0.0282x + 2.2494	0.2204	2.63
	larches	y = 0.0282x + 2.2494	0.2204	2.63
	mountain pines	y = 0.0282x + 2.2494	0.2204	2.63
	mediterranean pines	y = 0.0282x + 2.2494	0.2204	2.63
	other conifers	y = 0.0282x + 2.2494	0.2204	2.63
	european beech	y = 0.0197x + 2.4517	0.2037	1.83
	turkey oak	y = 0.0197x + 2.4517	0.2037	1.83
	other oaks	y = 0.0197x + 2.4517	0.2037	1.83
	other broadleaves	y = 0.0197x + 2.4517	0.2037	1.83
coppices	european beech	y = 0.0197x + 2.4517	0.2037	1.83
	sweet chestnut	y = 0.0197x + 2.4517	0.2037	1.83
	hornbeams	y = 0.0197x + 2.4517	0.2037	1.83
	other oaks	y = 0.0197x + 2.4517	0.2037	1.83
	turkey oak	y = 0.0197x + 2.4517	0.2037	1.83
	evergreen oaks	y = 0.0197x + 2.4517	0.2037	1.83
	other broadleaves	y = 0.0197x + 2.4517	0.2037	1.83
	conifers	y = 0.0282x + 2.2494	0.2204	2.63
protective	rupicolous forest	y = 0.0197x + 2.4517	0.2037	1.83
	riparian forest	y = 0.0197x + 2.4517	0.2037	1.83

Table 7.9 Relations litter - aboveground carbon per ha

The dead organic matter carbon pool is defined, in the GPG, as the sum of the dead wood and the litter.

$$\Delta C_{\text{Dead Organic Matter}} = \Delta C_{\text{dead mass}} + \Delta C_{\text{litter}}$$

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 total soil carbon amount is 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[26] (for soils) and a Life+ project FutMon[27] (*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 7.10 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.

[26] BioSoil project – http://biosoil.jrc.ec.europa.eu/; http://forest.jrc.ec.europa.eu/contracts/biosoil
[27] 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

	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
protective	rupicolous forest	y = 0.3262x + 68.648	0.1338	38.96
	riparian forest	y = 0.3262x + 68.648	0.1338	38.96

Table 7.10 Relations soil - aboveground carbon per ha

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. Net carbon stock change in dead organic matter and soil has been calculated as well. 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).

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 7.11 carbon stock changes due to conversion to forest land, for the living biomass, dead organic matter and soil pools, have been reported.

	Carbon stock change in living biomass			**Net C stock change in dead organic matter**	**Net C stock change in mineral soils**
	Increase	***Decrease***	***Net change***		
year	*Gg C*				
1990	197.6	-156.5	41.1	7.1	165.0
1991	198.3	-123.0	75.3	12.0	172.9
1992	198.8	-127.8	71.0	11.4	179.7
1993	199.1	-157.9	41.2	7.7	180.2

	Carbon stock change in living biomass			Net C stock change in dead organic matter	Net C stock change in mineral soils
	Increase	*Decrease*	*Net change*		
year	*Gg C*				
1994	199.4	-129.5	69.9	11.6	186.6
1995	199.7	-121.5	78.2	12.3	195.0
1996	200.0	-123.5	76.5	12.0	203.2
1997	200.2	-144.4	55.8	9.0	207.3
1998	200.1	-148.6	51.5	8.6	210.4
1999	200.2	-135.6	64.6	10.6	216.0
2000	200.4	-139.5	60.9	10.0	220.9
2001	200.7	-125.3	75.4	11.9	228.8
2002	200.8	-116.7	84.1	13.1	238.3
2003	201.0	-133.0	68.0	10.9	244.7
2004	201.1	-122.6	78.5	12.3	253.2
2005	201.2	-121.0	80.3	12.4	262.0
2006	201.3	-120.9	80.4	12.5	273.3
2007	203.8	-161.5	42.3	7.5	274.0
2008	203.7	-130.9	72.8	11.2	281.1
2009	204.6	-126.7	77.9	12.3	288.7

Table 7.11 Carbon stock changes in land converting to forest land

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.
Values of burned growing stocks and respective CO_2 released, for different categories (stands, coppices, protective forests), are reported in the previous Table 7.6.

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 1990–2009, Approach 1 of 2006 IPCC Guidelines (IPCC, 2006) has been followed. The uncertainty linked to the year 1985 has been computed (the first National Forest Inventory was carried out in 1985) with the relation:

$$E_{1985} = \frac{\sqrt{\left(E_{AG_{1985}} \cdot V_{AG_{1985}}\right)^2 + \left(E_{BG_{1985}} \cdot V_{BG_{1985}}\right)^2 + \left(E_{D_{1985}} \cdot V_{D_{1985}}\right)^2 + \left(E_{L_{1985}} \cdot V_{L_{1985}}\right)^2 + \left(E_{S_{1985}} \cdot V_{S_{1985}}\right)^2}}{\left|V_{AG_{1985}} + V_{BG_{1985}} + V_{D_{1985}} + V_{L_{1985}} + V_{S_{1985}}\right|}$$

where the terms $V_{AG_{1985}}$, $V_{BG_{1985}}$, $V_{D_{1985}}$, $V_{L_{1985}}$ e $V_{S_{1985}}$ stand for the 1985 carbon stocks of the five pools, aboveground, belowground, dead mass, litter and soil, while, with the letter E, the related uncertainties have been indicated. In Table 7.12 the relations for assessing the overall uncertainties associated to the carbon pools have been reported.

Carbon pool	Relation for uncertainty assessing
Aboveground	$E_{AG_{1985}} = \sqrt{E_{NFI}^2 + E_{BEF_1}^2 + E_{BD}^2 + E_{CF}^2}$
Belowground	$E_{BG_{1985}} = \sqrt{E_{NFI}^2 + E_R^2 + E_{BD}^2 + E_{CF}^2}$
Dead mass	$E_{D_{1985}} = \sqrt{E_{AG_{1985}}^2 + E_{DEF_{1985}}^2}$
Litter	$E_{L_{1985}} = \sqrt{E_{LS_{1985}}^2 + E_{LR_5}^2}$
Soil	$E_{S_{1985}} = \sqrt{E_{SS_{1985}}^2 + E_{SR_5}^2}$

Table 7.12 Relations for assessing uncertainties of the C pools

where the term E_{NFI} stands for the uncertainty associated to the growing stock data given by the first National Forest Inventory, E_{BEF_1} points to uncertainty related to biomass expansion factors for the aboveground biomass, E_{BD} is the basic density uncertainty and the term E_{CF} indicates the conversion factor uncertainty, where GPG default values have been used (IPCC, 2003). In the relation for the belowground carbon pool, the term E_R stands for the uncertainty related to root-shoot ratio used in the assessing of belowground biomass from growing stock data; GPG default value have been used (IPCC, 2003). Concerning the dead mass relation, E_{DEF} is the uncertainty of dead mass expansion factor, from the GPG (IPCC, 2003), while $E_{LS_{1985}}$ and $E_{SS_{1985}}$ are the uncertainties related to the litter and soil carbon stock data deduced from the Biosoil Project[28] data. Finally the terms $E_{LR_{1985}}$ and $E_{SR_{1985}}$ are defined as the uncertainties related to linear regressions used to assessing the litter and soil carbon stocks. In Table 7.13, the values of carbon stocks in the five pools, for the 1985, and the abovementioned uncertainties are reported.

Carbon stocks *t CO_2 eq. ha^{-1}*	*Aboveground biomass*	V_{AG}	137.8
	Belowground biomass	V_{BG}	31.5
	Dead mass	V_D	20.8
	Litter	V_L	11.9
	Soil	V_S	293.1
Uncertainty	*Growing stock*	E_{NFI}	3.2%
	Current increment (Richards)[29]	E_{NFI}	51.6%
	Harvest[30]	E_H	30%
	Fire[31]	E_F	30%
	Drain and grazing	E_D	30%
	Mortality	E_M	30%
	BEF	E_{BEF1}	30%

[28] BioSoil project – http://biosoil.jrc.ec.europa.eu/; http://forest.jrc.ec.europa.eu/contracts/biosoil
[29] 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
[30] Good Practice Guidance default value (IPCC, 2003)
[31] Good Practice Guidance default value (IPCC, 2003)

R	E_R	30%
DCF	E_{DEF}	30%
Litter (stock + regression)	E_L	102%
Soil (stock + regression)	E_S	113%
Basic Density	E_{BD}	30%
C Conversion Factor	E_{CF}	2%

Table 7.13 Carbon stocks and uncertainties for year 1985 and current increment related uncertainty

The uncertainties related to the carbon pools and the overall uncertainty for 1985 has been computed and shown in Table 7.14, using the relations in Table 7.11.

Aboveground biomass	E_{AG}	42.59%
Belowground biomass	E_{BG}	42.59%
Dead mass	E_D	52.10%
Litter	E_L	101.62%
Soil	E_S	113.00%
Overall uncertainty	$\mathbf{E_{1985}}$	**68.07%**

Table 7.14 Uncertainties for the year 1985

The overall uncertainty related to 1985 (the year of the first National Forest Inventory) has been propagated through the years, till 2009, following Tier 1 approach.
The equations for the years following 1985 are similar to the one for the 1985 uncertainty estimate, with the exception of the terms linked to aboveground biomass: the biomass increment was estimated with the methodology described in paragraph 7.2.2; therefore, the related uncertainty, e.g. for 1986, is expressed by the following formula:

$$E_{AG_{1986}} = \sqrt{\left(\frac{\sqrt{(E_{NFI}\cdot V_{NFI})^2+(E_I\cdot V_I)^2+(E_H\cdot V_H)^2+(E_F\cdot V_F)^2+(E_D\cdot V_D)^2+(E_M\cdot V_M)^2}}{\left|V_{NFI}+V_I+(-V_H)+(-V_F)+(-V_D)+(-V_{MOR})\right|}\right)^2+E_{BEF}^{\;2}+E_{BD}^{\;2}+E_{CF}^{\;2}}$$

The uncertainties related to the carbon pools and the overall uncertainty for 1986 are shown in Table 7.15.

Aboveground biomass	E_{AG}	42.68%
Belowground biomass	E_{BG}	42.68%
Dead mass	E_D	52.17%
Litter	E_L	101.62%
Soil	E_S	113.00%
Overall uncertainty	E_{1986}	67.98%

Table 7.15 Uncertainties for the year 1986

Following Approach 1 and the abovementioned methodology, the overall uncertainty in the estimates produced by the described model has been quantified; in Table 7.16 the uncertainties of the 1985-2009 period are reported.

1985	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
68.1%	70.5%	70.0%	69.48%	69.34%	69.13%	68.99%	68.85%	68.67%	68.50%	68.49%	68.41%	68.20%

Table 7.16 Overall uncertainties 1985 - 2009

The overall uncertainty in the model estimates between 1990 and 2009 has been assessed with the following relation:

$$E_{1990-2009} = \frac{\sqrt{(E_{1990} \cdot V_{1990})^2 + (E_{2009} \cdot V_{2009})^2}}{|V_{1990} + V_{2009}|}$$

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 1990–2009 is equal to 49.03%.
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). For Forest Land remaining Forest Land, the resulting uncertainty is estimated equal to 42.9%, taking into account all the carbon pools estimated. As for Land converted to Forest Land, an asymetricall 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 biomass pool, estimated with the described methodology, and INFC data about 2006 aboveground carbon stock of the whole Italian forest results in 11% difference (Table 7.17).

INFC aboveground carbon stock *t C*	**Estimated aboveground carbon stock** *t C*
486,018,500	431,710,577

Table 7.17 Comparison between estimated and INFC 2006 aboveground carbon stock

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[32], ISTAT data[33]) 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. A comparison of the model results versus data measured in the framework of Italian National Forest Inventory (INFC) has been conducted, relating to the year 2005 (Tabacchi et al., 2010). In Figure 7.4 outcome of the comparison is shown.

[32] FAO, 2005. FAOSTAT, http://faostat.fao.org
[33] ISTAT, several years [a], [b], [c]

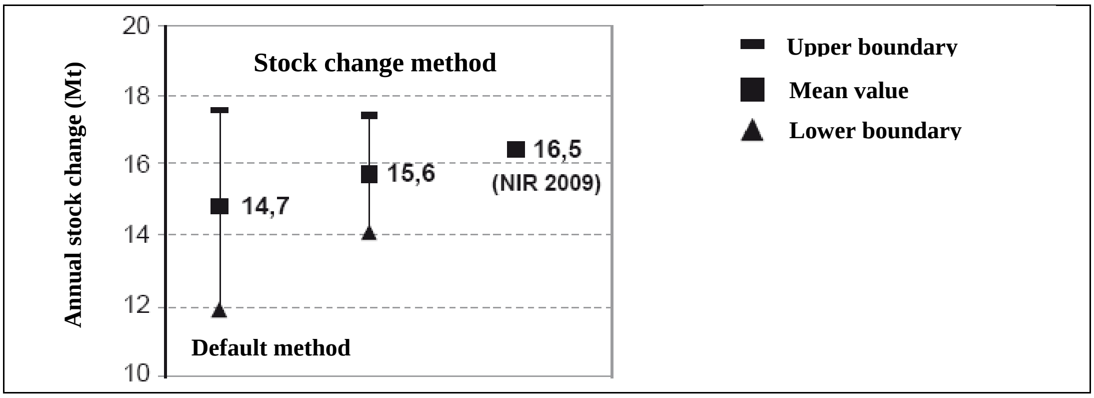


Figure 7.4 Comparison between carbon stock changes, for living biomass pool, by the National Inventory (NIR, 2009) and estimated data on the basis of INFC measurements (modified from Tabacchi et al., 2010)

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. Results show a good agreement between the two dataset either in litter and soil. An interregional project, named INEMAR[34], 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 7.5 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]).

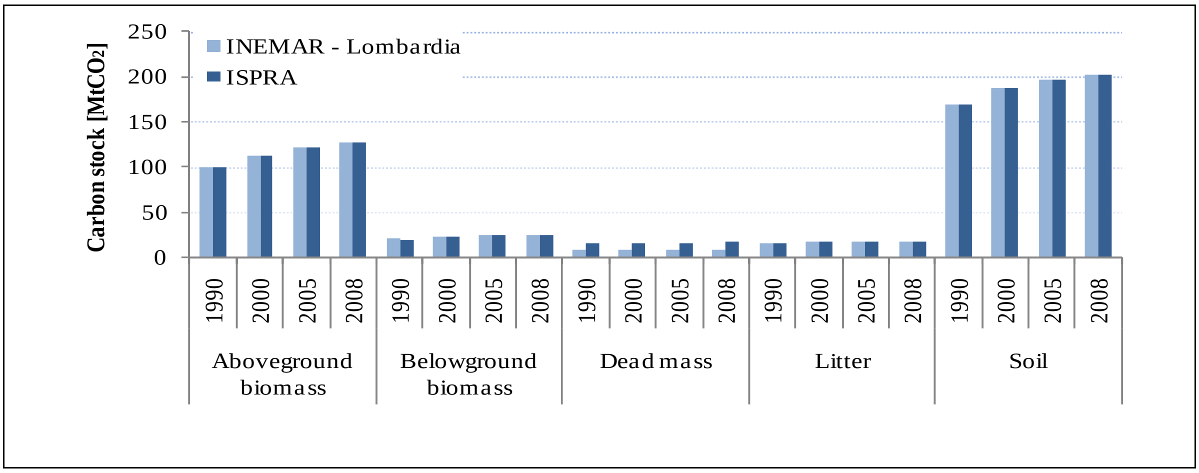


Figure 7.5 Carbon stocks estimates by the National Inventory (ISPRA) and the INEMAR project for Lombardia

In Table 7.18 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.

	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

[34] INEMAR: INventario EMissioni Aria: http://www.ambiente.regione.lombardia.it/inemar/e_inemarhome.htm

Table 7.18 Carbon stocks estimates by the National Inventory (ISPRA) and the INEMAR project for Lombardia

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.
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 decrease of 0.7%, concerning the whole forest land category. As well regards the different carbon pools, a slight decrease of 0.2% in living biomass pool, of 15.6% in dead organic matter and an increase 0.6% in soils carbon pools estimates, have to be noticed, as shown in the Figure 7.6.

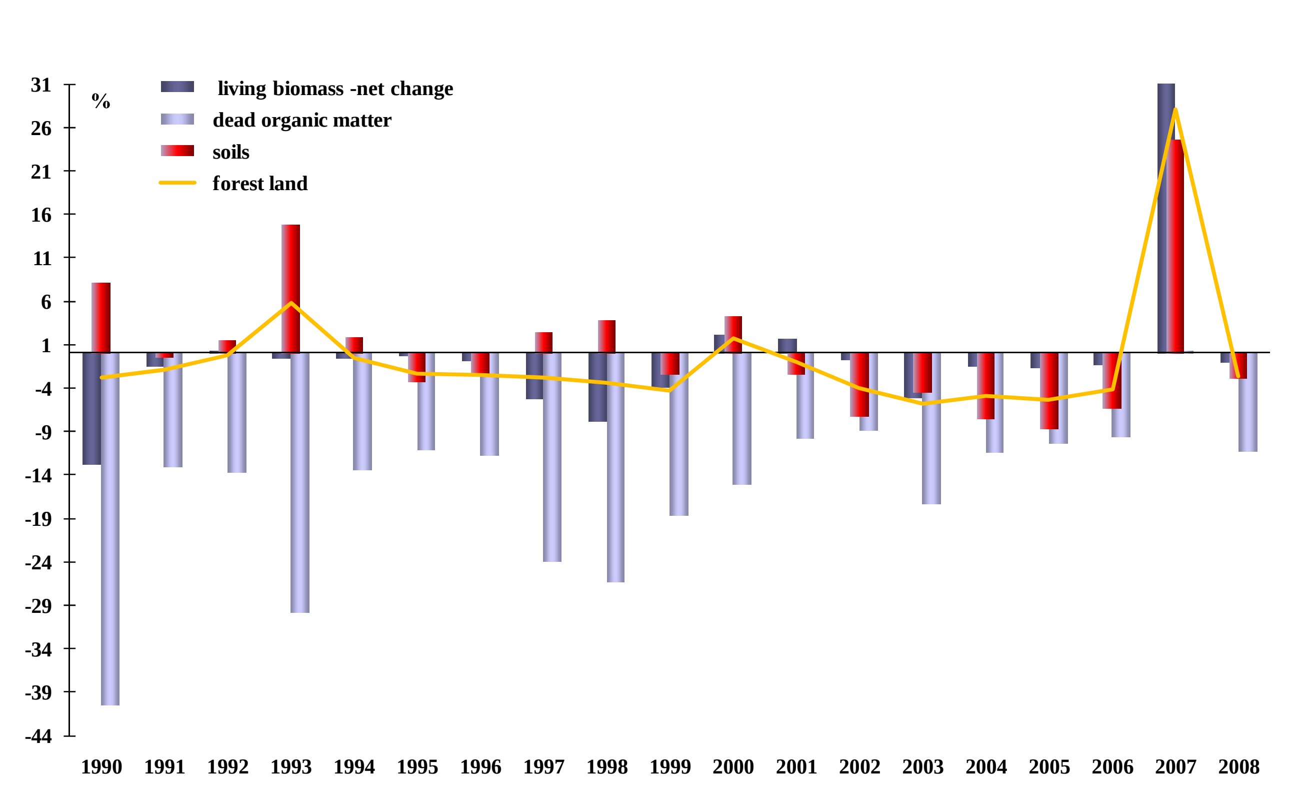


Figure 7.6 Differences between current and 2010 submission carbon pools estimates

Several differences from previous submissions affect dead organic matter and soils pools, resulting from the use of the dataset of European project Biosoil for litter and soil data. In addition computation errors occurred in the previous submission were detected and corrected in the current submission. The methodology used to derive the land use change matrices has been slightly modified, refining the smoothing process used to derive LUC matrices.

7.2.8 Category-specific planned improvements

The INFC data related to the soils survey, expected at the end of 2011, will definitely constitute a robust database, allowing for refined estimates and lower related uncertainty. 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. 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. A process of validation and verification of IUTI data has been put in place and is expected to supply data useful to update and improve the estimations. Activities planned in the framework of the National Registry for Forest Carbon Sinks should also provide data to improve estimate of carbon sequestration due to Afforestation/reforestation activities (with a special focus on soil organic content), and should allow to refine the estimate of forest land category. Specifically, 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.

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 LULUCF sector, this group, coordinated by the National Institute of Statistics, is constituted by both producers and users of statistical information with the aim of improving and monitoring statistical information for forest sector. These activities should improve the quality and details of basic data, as well as enable a more organized and timely communication.

The upgrade of the used model has been postponed, in order to implement INFC data related to the soils survey and the IUTI results, to achieve the above cited improvements and to obtain more accurate estimates of the carbon stored in the dead wood, litter and soil pools, using the outcomes of research projects on carbon stocks inventories, with a special focus on the Italian territory. The upgrading of the model will also allow the use of the INFC biomass data, actually not utilized, as classification system, and consequent categories list, has changed from the first forest inventory to INFC. A transition matrix, between the INFC and first forest inventory classification systems, has been planned to be elaborated in order to use all information acquired with INFC.

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 12.1% of total CO_2 LULUCF emissions and removals, in particular the living biomass removals represent 97%, while the emissions and removals from soils stand for 2.7% of total cropland CO_2 emissions and removals. The remaining 0.3% is due to dead organic matter pool.

Removals are almost entirely due to cropland remaining cropland, while only land converting to cropland category is responsible for emissions.

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 identified as key category in trend assessment (Approach 2). 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

Coherently with forest definition adopted by Italy in the framework of application of elected 3.4 activity, under Kyoto Protocol, plantations, that don't fulfil national forest definition, have been reported into cropland category. For the land use conversion, land use change matrices have been used; as abovementioned, LUC matrices for each year of the period 1990–2009 have been assembled based on time series of national land use statistics for forest lands, croplands, grasslands, wetlands and settlement areas. 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 ERT remark in the previous review, 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.

7.3.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Cropland areas have been determinated on the basis of national statistics (ISTAT, [b], [c]) related to annual crops and perennial woody crops. The subcategory "plantations" has been added; plantation areas have been derived from national forest inventories (IFN, IFNC), through a linear interpolation between the 1985 and 2005 data, extrapolating data for period 2006-2009. 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 remaining Cropland

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. The perennial crops have been further subdivided into woody crops and plantations.

Perennial – woody crops

Concerning woody crops, estimates of carbon stocks changes are applied to aboveground biomass only, according to the GPG (IPCC, 2003), as there is not sufficient information to estimate carbon stocks change in dead organic matter pools. 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; therefore default factors of aboveground biomass carbon stock at harvest, harvest/maturity cycle, biomass accumulation rate, biomass carbon loss, for the temperate climatic region have been applied, even though they are not very representative of the Mediterranean area, where the most common woody crops are crops like olive groves or vineyards that have, for instance, different harvest/maturity cycles.

Furthermore these crops are unlikely to be totally removed after an amount of time equal to a nominal harvest/maturity cycle (30 years for temperate climate region), as implied by the basic assumption of Tier 1, since the croplands are abandoned or consociated with annual crops. The biomass clearing is relatively unusual. Biomass carbon losses have been estimated, taking into account the pruning of woody cropland, using the same country-specific methodology developed for estimating emissions from field burning of agriculture residues (§ 6.6.2).

Net changes in cropland C stocks obtained are equal to 4.693 Tg C for 1990, and 2.992 Tg C for 2009, as far as living biomass pool is concerned.

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 1990-2009 under investigation; therefore, as no management changes can be documented, resulting change in carbon stock has been reported as zero.

Perennial – plantations

Regarding plantations, growing stock and the related carbon are assessed by a model (Federici et al., 2008), 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. Total harvested wood for construction and energy purposes has been obtained from national statistics (ISTAT, several years [a]); these figures have been subtracted, as losses, from growing stock volume, as mentioned above.

The aboveground biomass was calculated, for plantations typologies, through the relation:

$$\text{Aboveground tree biomass(d.m.)} = GS \cdot BEF \cdot WBD \cdot A$$

where:

GS = volume of growing stock (MATT/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] (MATT/ISAFA, 1988)

In Table 7.19 biomass expansion factors for the conversions of volume to aboveground tree biomass and wood basic densities are reported.

	Inventory typology	BEF *aboveground biomass / growing stock*	WBD *Dry weigth t/ fresh volume*
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

Table 7.19 Biomass Expansion Factors and Wood Basic Densities for plantations

Belowground biomass was estimated applying a Root/Shoot ratio to the aboveground biomass. The belowground biomass is computed, as:

$$\text{Belowground biomass(d.m.)} = GS \cdot WBD \cdot R \cdot A$$

where:
GS = volume of growing stock [m^3 ha^{-1}]
R = Root/Shoot ratio which converts growing stock biomass in belowground biomass
WBD = Wood Basic Density [t d.m. m^{-3}]
A = area occupied by specific typology [ha]

In Table 7.20 Root/shoot ratio for the conversion of growing stock biomass in belowground biomass and wood basic densities for plantations typologies are reported.

	Inventory typology	R *Root/shoot ratio*	WBD *Dry weigth t/ fresh volume*
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

Table 7.20 Root/shoot ratio and Wood Basic Densities for plantations

Concerning Dead Organic Matter pool, only carbon amount contained in litter pool has been estimated, through linear relation established with aboveground carbon, on the basis of the outcomes of European project Biosoil[35] (for litter) and a Life+ project FutMon[36], for the aboveground biomass. The total soil carbon amount is estimated from the aboveground carbon amount with linear relations, deduced from the results of the European project Biosoil (for soils) and a Life+ project FutMon, for the aboveground biomass. In Table 7.21 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.

[35] BioSoil project – http://biosoil.jrc.ec.europa.eu/; http://forest.jrc.ec.europa.eu/contracts/biosoil
[36] 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

	Inventory typology	Relation litter – aboveground C per ha	R^2	Standard error
plantations	eucalyptuses coppices	y = 0.0197x + 2.4517	0.2037	1.83
	other broadleaves coppices	y = 0.0197x + 2.4517	0.2037	1.83
	poplars stands	y = 0.0197x + 2.4517	0.2037	1.83
	other broadleaves stands	y = 0.0197x + 2.4517	0.2037	1.83
	conifers stands	y = 0.0282x + 2.2494	0.2204	2.63
	Inventory typology	**Relation soil – aboveground C per ha**	**R^2**	**Standard error**
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

Table 7.21 Relations litter – aboveground carbon per ha and soil - aboveground carbon per ha for plantations

In Table 7.22, plantations areas and net changes in carbon stock, for the different required pools, are reported, for the period 1990-2009.

	Area	Living biomass			Dead organic matter	Soil organic matter
		Increase	Decrease	Net Change		
	kha			*Gg C*		
1990	142	889	-305	583	14	248
1991	144	874	-326	548	13	241
1992	146	866	-353	513	13	234
1993	147	868	-367	500	12	231
1994	149	864	-396	468	12	224
1995	151	862	-421	440	12	218
1996	152	863	-364	499	13	230
1997	154	851	-380	471	12	224
1998	156	841	-414	427	11	215
1999	157	846	-468	378	11	205
2000	159	842	-409	433	12	216
2001	161	822	-324	498	13	229
2002	162	808	-327	482	12	225
2003	164	793	-324	469	12	223
2004	166	777	-324	452	12	219
2005	167	757	-312	445	12	217
2006	169	741	-349	392	11	206
2007	170	713	-368	345	10	197
2008	172	691	-313	379	11	204
2009	174	689	-421	268	9	181

Table 7.22 Change in carbon stock in living biomass, dead organic matter and soil organic matter in plantations

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 default EF for cultivated organic soils is equal to 10 t C ha^{-1} y^{-1}.
CO_2 emissions from urea application have been estimated, and reported in the following Table 7.23; 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.

	amount of urea	EF	C emissions	CO_2 emissions
	Mg	*t C^{-1}*	*Gg C*	*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	799,064	0.20	160	586
2002	863,113	0.20	173	633
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

Table 7.23 CO_2 emissions from urea application

Land converted to Cropland

In accordance with the GPG methodology, estimates of carbon stock change in living biomass have been provided, since there is not sufficient information to estimate carbon stock change in dead organic matter pool. Concerning soil carbon pool, changes in carbon stocks associated with the transitions have been reported as a whole in a single year (i.e. the year of conversion): dynamics of soil carbon storage and release are complex and still not well understood, even if current approaches assume that after a cultivation of a forest or grassland, there is an initial carbon loss over the first years which rapidly reduces to a lower subsequent loss rate in the following years (Davidson and Ackerman 1993). On this basis and by considering the spatial resolution of data used, reasonable approach, in calculating the effect of transition to cropland, is assuming that the changes in carbon stocks occur in the first year after the land conversion, in spite of considering them over the time period (20 years as default) specified by IPCC GPG LULUCF (2003).

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 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 2009, 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.
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- 2009. C emissions [Gg C] due to change in carbon stocks in living biomass in land converted to cropland are reported in Table 7.24.

	Conversion Area	**$\Delta C_{converted\ land}$**
year	*kha*	*Gg C*
1990	14.0	18.14
1991	0.48	0.63
1992	0.48	0.63
1993	0.48	0.63
1994	0.48	0.63
1995	0.48	0.63
1996	0	0
1997	0	0
1998	0	0
1999	0	0
2000	0	0
2001	0	0
2002	0	0
2003	0	0
2004	0	0
2005	0	0
2006	0	0
2007	0	0
2008	0	0
2009	0	0

Table 7.24 Change in carbon stock in living biomass in land converted to cropland

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. 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 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), only for the years where conversion has taken place. C emissions [Gg C] due to change in carbon stocks in soils in land converted to cropland are reported in Table 7.25.

	Conversion Area	**Carbon stock**
year	*k ha*	*Gg C*
1990	14.0	-299
1991	0.48	-10
1992	0.48	-10
1993	0.48	-10
1994	0.48	-10
1995	0.48	-10
1996	0	0
1997	0	0
1998	0	0
1999	0	0
2000	0	0
2001	0	0
2002	0	0
2003	0	0
2004	0	0
2005	0	0
2006	0	0
2007	0	0
2008	0	0
2009	0	0

Table 7.25 Change in carbon stock in soil in land converted to cropland

7.3.5 Uncertainty and time series consistency

Uncertainty estimates for the period 1990–2009 has 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 asymetricall 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 asymetricall 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 mean decrease of 3.79% in cropland category, in the period 1990-2008. In particular cropland remaining cropland subcategory decreases by 3.65%, while an increase of 11.4% has to be noted for land converting to cropland, in comparison with the previous submission. Notable deviations from the previous sectoral estimates occurred in soils pool (decrease of 113%), due to the revision of soil organic content reference value for grassland category (78.9 tC ha^{-1}).

7.3.8 Category-specific planned improvements

Additional researches will be made 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.

Further investigation will be made to obtain ancillary information about the final crop types, concerning the areas in transition to cropland, in order to obtain a more precise estimate of the carbon stocks change. Activities planned in the framework of the National Registry for Forest Carbon Sinks should also provide data to improve estimate of carbon sequestration due to Afforestation/reforestation activities (with a special focus on soil organic content), and should allow to refine the estimate of soil organic content in cropland category.

[37] FAO, 2005. FAOSTAT, http://faostat.fao.org
[38] ISTAT, several years [a], [b], [c]

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 19,518 Gg of CO_2 removals in 2009, with 318 Gg of CO_2 emissions due to living biomass pool, 367 Gg CO_2 removals due to dead organic matter pool and 19,469 Gg of CO_2 removals due the soils pool. In the period 1990-2009 mean grassland emissions share 13.6% of absolute CO_2 LULUCF emissions and removals, in particular the living biomass emissions represent 7%, while the removals from dead organic matter pool share for 3% and removals from soils stand for 91% of absolute total grassland CO_2 emissions and removals.
CO_2 emissions and removals from grassland remaining grassland 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 grassland have resulted as key category following Approach 1, concerning level and trend analysis, and by Approach 2 relating to trend assessment. Concerning N_2O emissions, the category land converting to cropland has not resulted as a key source.

7.4.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Coherently with forest definition adopted by Italy in the framework of application of elected 3.4 activities, under Kyoto Protocol, shrublands, that don't fulfil national forest definition, have been reported into grassland category. For the land use conversion, land use change matrices have been used; as abovementioned, LUC matrices for each year of the period 1990–2009 have been assembled based on time series of national land use statistics for forest lands, croplands, grasslands, wetlands and settlement areas. 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 grassland category, it has been assumed that only transition from cropland to grassland occurs.
In response to ERT remark in the previous review, 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.

7.4.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Grassland areas have been determinate on the basis of 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, IFNC), through a linear interpolation between the 1985 and 2005 data, extrapolating data for period 2006-2009. National statistics on cropland areas have been used, in order to derive the land in conversion from cropland to grassland, by the way of LU 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 don't fulfil 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 to 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 1990-2009 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 a model (Federici et al., 2008), 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 (MATT/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] (MATT/ISAFA, 1988)

In Table 7.26 biomass expansion factors for the conversions of volume to aboveground tree biomass and wood basic densities are reported.

Inventory typology	**BEF** *aboveground biomass / growing stock*	**WBD** *Dry weigth t/ fresh volume*
shrublands	1.49	0.63

Table 7.26 Biomass Expansion Factors and Wood Basic Densities for shriblands

Belowground biomass was estimated applying a Root/Shoot ratio to the aboveground biomass. The belowground biomass is computed, as:

$$\text{Belowground biomass(d.m.)} = GS \cdot WBD \cdot R \cdot A$$

where:

GS = volume of growing stock [m^3 ha^{-1}]

R = Root/Shoot ratio which converts growing stock biomass in belowground biomass

WBD = Wood Basic Density [t d.m. m^{-3}]

A = area occupied by specific typology [ha]

In Table 7.27 Root/shoot ratio for the conversion of growing stock biomass in belowground biomass and wood basic densities for plantations typologies are reported.

Inventory typology	R *Root/shoot ratio*	WBD *Dry weigth t/ fresh volume*
Shrublands	0.62	0.63

Table 7.27 Root/Shoot ratio and Wood Basic Densities for shrubland

The deadwood mass was assessed applying a dead mass conversion factor (DCF) of 0.14 for deciduous forests, as reported in table 3.2.2 of GPG (IPCC 2003).
The dead mass [t] is:

$$\text{Dead mass (d.m.)} = \text{GS} \cdot BEF \cdot WBD \cdot DCF \cdot A$$

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
WBD = Wood Basic Density [t d.m. m^{-3}]
DCF = Dead mass Conversion Factor which converts aboveground woody biomass in dead mass
A = area occupied by specific typology [ha]

Carbon amount contained in litter pool has been estimated, through linear relation established with aboveground carbon, on the basis of the outcomes of European project Biosoil[39] (for litter) and a Life+ project FutMon[40], for the aboveground biomass. The total soil carbon amount is estimated from the aboveground carbon amount, with linear relations, the results of the European project Biosoil (for soils) and a Life+ project FutMon, for the aboveground biomass. In Table 7.28 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.

Inventory typology	Relation litter – aboveground C per ha	R^2	Standard error
shrublands	y = 0.0249x + 2.6061	0.191	1.88
Inventory typology	**Relation soil – aboveground C per ha**	**R^2**	**Standard error**
shrublands	y = 0.2683x + 70.208	0.073	33.39

Table 7.28 Relations litter - aboveground carbon per ha and soil - aboveground carbon per ha for plantations

In Table 7.29, other wooded land areas and net changes in carbon stock, for the different required pools, are reported, for the period 1990-2009.

[39] BioSoil project – http://biosoil.jrc.ec.europa.eu/; http://forest.jrc.ec.europa.eu/contracts/biosoil
[40] 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

	Area	Living biomass			Dead organic matter	Soil organic matter
		Increase	Decrease	Net Change		
	kha			*Gg C*		
1990	1,561	2,477	-2,584	-106.47	32.07	1,153
1991	1,578	2,517	-2,356	161.38	63.26	1,204
1992	1,595	2,560	-2,487	73.01	52.97	1,186
1993	1,612	2,612	-2,852	-239.95	16.52	1,126
1994	1,629	2,652	-2,508	144.28	61.27	1,198
1995	1,646	2,685	-2,300	385.10	89.31	1,243
1996	1,663	2,718	-2,333	385.30	89.33	1,241
1997	1,680	2,755	-2,518	236.87	72.05	1,211
1998	1,697	2,796	-2,692	104.60	56.65	1,186
1999	1,714	2,829	-2,461	368.44	87.37	1,235
2000	1,731	2,866	-2,629	237.89	72.17	1,210
2001	1,748	2,899	-2,514	384.68	89.26	1,238
2002	1,766	2,930	-2,473	456.94	97.68	1,251
2003	1,783	2,962	-2,570	391.75	90.09	1,236
2004	1,800	2,992	-2,521	470.55	99.26	1,250
2005	1,817	3,021	-2,522	499.25	102.60	1,255
2006	1,834	3,050	-2,519	530.09	106.20	1,259
2007	1,851	3,093	-3,084	8.96	45.98	1,171
2008	1,868	3,122	-2,609	513.05	104.69	1,267
2009	1,886	3,153	-2,682	471.08	100.03	1,264

Table 7.29 Change in carbon stock in living biomass, dead organic matter and soil organic matter in other wooded land

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 has been provided, since there is not sufficient information to estimate carbon stock change in dead organic matter pool. Concerning soil carbon pool, changes in carbon stocks associated with the transitions have been reported as a whole in a single year (i.e. the year of conversion), assuming, as for the other categories in transition, that changes in carbon stocks occur in the first year after the land conversion, in spite of considering them over the time period (20 years as default) specified by IPCC GPG LULUCF (2003). 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, only cropland as far as Italy is concerned, to grassland during each year has been pointed out, from 1990 to 2009, for each initial and final land use, through the use of the land use change matrices, one for each year. Changes in biomass carbon stocks have been accounted for in the year of conversion. 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 1990-2009. C emissions [Gg C] due to change in carbon stocks in living biomass in land converted to grassland, are reported in Table 7.30.

	Conversion Area	**C_{before}**	**ΔC_{growth}**	**ΔC**
year	*kha*	*t C ha^{-1}*	*t C ha^{-1}*	*Gg C*
1990	0	5	3.05	0
1991	0	5	3.05	0
1992	0	5	3.05	0
1993	0	5	3.05	0
1994	0	5	3.05	0
1995	0	5	3.05	0
1996	103	5	3.05	-201.6
1997	103	5	3.05	-201.6
1998	103	5	3.05	-201.6
1999	103	5	3.05	-201.6
2000	103	5	3.05	-201.6
2001	111	5	3.05	-215.9
2002	111	5	3.05	-215.9
2003	111	5	3.05	-215.9
2004	111	5	3.05	-215.9
2005	111	5	3.05	-215.9
2006	189	5	3.05	-368.7
2007	189	5	3.05	-368.7
2008	189	5	3.05	-368.7
2009	189	6	3.05	-557.8

Table 7.30 Change in carbon stock in living biomass in land converted to grassland

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. 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 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 (Gardi 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 managements, 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.

With the stock change factors, the grassland soil carbon stock [t C] for the inventory year [SOC_0] and the cropland land use soil carbon stock [$SOC_{(0-T)}$] have been estimated, starting from the soil carbon stock for unit of area [t C ha^{-1}]. The inventory time period has been established, as abovementioned, in 1 year. 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, only for the years where conversion has taken place. C emissions [Gg C] due to change in carbon stocks in soils in land converted to grassland, are reported in Table 7.31.

	Conversion Area	**Carbon stock**
year	*kha*	*Gg C*
1990	0	0
1991	0	0
1992	0	0
1993	0	0
1994	0	0
1995	0	0
1996	103	2,211
1997	103	2,211
1998	103	2,211
1999	103	2,211
2000	103	2,211
2001	111	2,369
2002	111	2,369
2003	111	2,369
2004	111	2,369
2005	111	2,369
2006	189	4,046
2007	189	4,046
2008	189	4,046
2009	189	4,046

Table 7.31 Change in carbon stock in soils

7.4.5 Uncertainty and time series consistency

Uncertainty estimates for the period 1990–2009 has 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 asymetricall probability density distribution resulted from the analysis, showing uncertainties values equal to -67.7% and 75.0%. An asymetrical 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[41], ISTAT data[42]) 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 mean increase of 9.44% in grassland category, in the period 1990-2008. In particular grassland remaining grassland subcategory increases by 0.5%, while an increase of 29.1% has to be noted for land converting to grassland, in comparison with the previous submission. Notable deviations from the previous sectoral estimates occurred in soils pool (increase of 22%), due to the revision of soil organic content reference value for grassland category (78.9 tC ha^{-1}).

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.

Activities planned in the framework of the National Registry for Forest Carbon Sinks should also provide data to improve estimate of carbon sequestration due to Afforestation/reforestation activities (with a special focus on soil organic content), and should allow to refine the estimate of soil organic content in grassland category.

---

[41] FAO, 2005. FAOSTAT, http://faostat.fao.org

[42] ISTAT, several years [a], [b], [c]

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 1990–2009 have been assembled based on time series of national land use statistics for forest lands, croplands, grasslands, wetlands and settlement areas. 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 considering the need for the total national area to remain constant. Concerning land converted to wetland, during the period 1990-2009, it has been assumed that no land has been in transition to wetlands.

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, which harmonize with the definitions of the Ramsar Convention on Wetlands[43] 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. Concerning land converted to wetland, no land in transition to wetlands has occurred in 1990-2009.

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 the period 1990-2009 mean settlements emissions share 3.4% of absolute CO_2 LULUCF emissions and removals.

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 1990–2009 have been assembled based on time series of national land use statistics for forest lands, croplands, grasslands, wetlands and settlement areas.
Settlements time series has been developed through a linear interpolation between the 1990, 2000 and 2006 data, obtained by the Corine Land Cover[44] maps, relatively to the class "*Artificial surfaces*". By assuming that the defined trend may well represent the near future, it was possible to

[43] Ramsar Convention on Wetlands: http://www.ramsar.org/ (Ramsar, 2005)
[44] Corine Land Cover, http://www.clc2000.sinanet.apat.it/ (APAT, 2004)

extrapolate data for the years 2007-2009. The average area of land undergoing a transition from non-settlements to settlements during each year, from 1990 to 2009, 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 LU 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.
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 to settlements have occurred in the 1990-2009 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. In Table 7.33 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.

		Forest land to settlements			
Year	*Conversion Area*	*Living biomass*	*Dead organic matter*	*Soils*	***Total Carbon stock***
	kha	*Gg C*	*Gg C*	*Gg C*	*Gg C*
1990	0.72	-34	-6.49	-57.9	-98.46
1991	0.72	-34	-6.52	-58.0	-98.87
1992	0.72	-35	-6.55	-58.1	-99.22
1993	0.72	-35	-6.55	-58.1	-99.23
1994	0.72	-35	-6.58	-58.1	-99.58
1995	0.72	-35	-6.62	-58.2	-100.03
1996	0.72	-36	-6.66	-58.3	-100.47
1997	0.72	-36	-6.67	-58.3	-100.67
1998	0.72	-36	-6.68	-58.4	-100.81
1999	0.72	-36	-6.71	-58.4	-101.11
2000	0.72	-36	-6.73	-58.5	-101.37
2001	0.72	-37	-6.77	-58.5	-101.80
2002	0.72	-37	-6.82	-58.6	-102.32
2003	0.72	-37	-6.85	-58.7	-102.67

	Forest land to settlements				
Year	*Conversion Area*	*Living biomass*	*Dead organic matter*	*Soils*	***Total Carbon stock***
	kha	*Gg C*	*Gg C*	*Gg C*	*Gg C*
2004	0.72	-37	-6.89	-58.8	-103.13
2005	0.72	-38	-6.93	-58.8	-103.61
2006	0.72	-38	-6.98	-58.9	-104.09
2007	0.72	-38	-6.98	-58.9	-104.11
2008	0.72	-38	-7.01	-59.0	-104.49
2009	0.72	-39	-7.05	-59.1	-104.91

Table 7.32 Change in carbon stocks in forest land converted to settlements

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 7.33.

	Biomass carbon stock *t C ha^{-1}*
Annual cropland	5
Perennial woody cropland	63

Table 7.33 Stock change factors for cropland

In Table 7.34 C stocks [Gg C] related to change in carbon stocks in living biomass in cropland (annual and perennial) converted to settlements are reported.

	annual crops to settlements		perennial crops to settlements		
Year	*Conversion Area*	*Carbon stock*	*Conversion Area*	*Carbon stock*	***Total Carbon stock***
	kha	*Gg C*	*kha*	*Gg C*	*Gg C*
1990	0	0	0	0	0
1991	0	0	0	0	0
1992	0	0	0	0	0
1993	0	0	0	0	0
1994	0	0	0	0	0
1995	0	0	0	0	0
1996	5.58	-28	1.95	-123	-151
1997	5.58	-28	1.96	-123	-151
1998	5.57	-28	1.97	-124	-152
1999	5.57	-28	1.97	-124	-152
2000	5.56	-28	1.98	-125	-152
2001	7.76	-39	2.80	-176	-215
2002	7.73	-39	2.83	-178	-217
2003	7.70	-39	2.86	-180	-218
2004	7.67	-38	2.89	-182	-220
2005	7.64	-38	2.92	-184	-222
2006	7.58	-38	2.98	-188	-226
2007	7.52	-38	3.04	-192	-229
2008	7.45	-37	3.11	-196	-233
2009	7.38	-44	3.18	-203	-248

Table 7.34 Change in carbon stocks in living biomass in cropland converted to settlements

Changes in soil carbon stocks from land converting to settlements have been also estimated. In Table 7.35 soil C stocks [Gg C] of cropland (annual and perennial) and grassland converted to settlements are reported.

	annual crops to settlements		perennial crops to settlements		grassland to settlements	
Year	***Conversion Area***	***Carbon stock***	***Conversion Area***	***Carbon stock***	***Conversion Area***	***Carbon stock***
	kha	*Gg C*	*kha*	*Gg C*	*kha*	*Gg C*
1990	0	0	0	0	7.56	-591
1991	0	0	0	0	7.54	-589
1992	0	0	0	0	7.54	-589
1993	0	0	0	0	7.54	-589
1994	0	0	0	0	7.54	-589
1995	0	0	0	0	7.54	-589
1996	5.58	-317	1.95	-111	0	0
1997	5.58	-316	1.96	-111	0	0
1998	5.57	-316	1.97	-111	0	0
1999	5.57	-316	1.97	-112	0	0
2000	5.56	-315	1.98	-112	0	0
2001	7.76	-440	2.80	-159	0	0
2002	7.73	-438	2.83	-160	0	0
2003	7.70	-437	2.86	-162	0	0
2004	7.67	-435	2.89	-164	0	0
2005	7.64	-433	2.92	-165	0	0
2006	7.58	-430	2.98	-169	0	0
2007	7.52	-426	3.04	-172	0	0
2008	7.45	-430	3.11	-176	0	0
2009	7.38	-426	3.18	-180	0	0

Table 7.35 Change in carbon stocks in soil in cropland and grassland converted to settlements

7.6.5 Uncertainty and time series consistency

Uncertainty estimates for the period 1990–2009 has 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 asymetricall 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[45], ISTAT data[46]) 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

[45] FAO, 2005. FAOSTAT, http://faostat.fao.org

[46] ISTAT, several years [a], [b], [c]

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

Estimates of soil carbon stock changes resulting from transition of forest land, cropland and grassland to settlements have been provided. Moderate deviations from the previous sectoral estimates occurred, essentially due to the refining of procedure followed in building the land use matrices, with the smoothing of the sum of a 5 years changes over a 5-year period, harmonizing the cropland and grassland time series, and to the inclusion of conversion of areas in transition from forest land to settlements. The comparison with previous submission results in mean decrease of emissions equal to 9% in settlements category, in the period 1990-2008.

7.6.8 Category -specific planned improvements

Further investigation will be made to obtain additional statistics about settlements, comparing the added information to the time series developed from Corine Land Cover data (APAT, 2004). More accurate and resolute data will outcome from the actvities, in progress, related to the Kyoto reporting system (National registry for carbon sinks). Urban tree formations will be probed for information, in order to estimate carbon stocks. Moreover improvements will concern acquirement of data sufficient to give estimates of carbon stocks changes in dead organic matter for land in transition to settlements.

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 2009, 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 7.36 N_2O emissions resulting from the disturbance associated with land-use conversion to cropland are reported.

Year	**Conversion Area**	**Carbon stock**	**$N_{net-min}$**	**$N_2O_{net-min}$ -N**	**N_2O emissions**
	k ha	*Gg C*	*kt N*	*kt N_2O-N*	*Gg N_20*
1990	13.95	299	19.9	0.249	0.391
1991	0.48	10	0.7	0.009	0.013
1992	0.48	10	0.7	0.009	0.013
1993	0.48	10	0.7	0.009	0.013
1994	0.48	10	0.7	0.009	0.013
1995	0.48	10	0.7	0.009	0.013
1996	0	0	0	0	0
1997	0	0	0	0	0
1998	0	0	0	0	0
1999	0	0	0	0	0
2000	0	0	0	0	0
2001	0	0	0	0	0
2002	0	0	0	0	0
2003	0	0	0	0	0
2004	0	0	0	0	0
2005	0	0	0	0	0
2006	0	0	0	0	0
2007	0	0	0	0	0
2008	0	0	0	0	0
2009	0	0	0	0	0

Table 7.36 N_2O emissions from land-use conversion to cropland

7.10.3 Category-specific recalculations

Moderate deviations from the previous sectoral estimates occurred, essentially due to the refining of procedure followed in building the land use matrices, with the smoothing of the sum of 5 years changes over a 5-year period, harmonizing the cropland and grassland time series. This results in a mean decrease of emissions equal to 15%, in the period 1990-2008.

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 1998-2009, 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, hypothesising that 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.

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.

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), were used (ISTAT, several years [a]).

CO_2 emissions due to forest fires in forest land remaining forest land are included in Table 5.A.1 of the CRF, under carbon stock change in living biomass - decrease. Non CO_2 emissions from fires have been estimated and reported in CRF Table 5(V), while NO_x, CO and NMVOC emissions from forest fires have been reported in CRF Table 5. SO_2 emissions from forest fires are reported in 5G (Other - SO_2 from forest fires)

7.12.2 Methodological issues

In Italy, in consideration of national legislation[47], 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 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 7.2.2.

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 2009, calculated on the basis of regional parameters (Bovio, 1996), by the emission ratios from table 5.7 of IPCC Revised 1996 Guidelines. NMVOC and other pollutants have been estimated on the basis of methodology and emissions ratios included in the Guidebook EMEP EEA (Table 8.1).

In Table 7.37 CH_4 and N_2O emissions resulting from biomass burning are reported.

	CH_4 emissions	**N_2O emissions**
year	*Gg*	*Gg*
1990	6.964	0.048
1991	2.131	0.015
1992	3.158	0.022
1993	8.007	0.055

[47] 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

year	CH_4 emissions Gg	N_2O emissions Gg
1994	3.327	0.023
1995	1.500	0.010
1996	1.430	0.010
1997	4.444	0.031
1998	5.104	0.035
1999	2.828	0.019
2000	4.024	0.028
2001	2.640	0.018
2002	1.473	0.010
2003	3.084	0.021
2004	1.822	0.013
2005	1.834	0.013
2006	1.458	0.010
2007	9.369	0.064
2008	2.199	0.015
2009	2.615	0.018

Table 7.37 CH_4 and N_2O emissions from biomass burning

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; the overlapping of land use map and georeferenced data should assure the estimates of burned areas in the different land uses, with a particular focus on grassland fires in order to provide estimates of CO_2 emissions. 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 1990–2009 has 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

Time series of emissions from forest fires are not changed between current and previous submission.

8 WASTE [CRF sector 6]

8.1 Overview of sector

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 3.68% (and was 3.83% 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.

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008	2009
CO_2 (Gg)								
6C. Waste incineration	536.90	483.02	201.57	244.69	267.49	240.20	249.88	249.90
CH_4 (Gg)								
6A. Solid waste disposal on land	726.38	757.56	874.15	738.78	707.20	675.89	636.40	606.73
6B. Wastewater handling	94.76	105.62	112.73	129.67	130.40	130.77	129.62	129.67
6C. Waste incineration	7.65	12.91	11.94	14.14	13.47	12.89	13.43	13.59
6D. Other (compost production)	0.01	0.02	0.10	0.20	0.21	0.22	0.21	0.21
N_2O (Gg)								
6B. Wastewater handling	5.91	5.74	6.21	6.15	6.15	6.18	6.34	6.34
6C. Waste incineration	0.28	0.42	0.36	0.42	0.40	0.38	0.40	0.41

Table 8.1 Trend in greenhouse gas emissions from the waste sector 1990 – 2009 (Gg)

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 source at level and trend assessment calculated with Tier 1 and Tier 2; methane emission from wastewater handling is a key source at level assessment with Tier 1 and Tier 2, whereas 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 only at level assessment calculated with Tier 1 and Tier 2, whereas methane emission from wastewater handling is a key source at level and trend assessment only with Tier 2.

Key-source identification in the waste sector with the IPCC Approach 1 and Approach 2 (without LULUCF) for 2009

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 in the total national methane is presently 42.2% (and was about 40% in the base year 1990).

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 methane (Gaudioso et al., 1993): this assumption refers to US EPA data (US EPA, 1990).

Methane is emitted from the degradation of waste occur 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 landfill, 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 its generation, flow through collection and transportation, separation for resource recovery, treatment for volume reduction, stabilisation, recycling and energy recovery and terminate at landfill sites.

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 47.3% in 2009. This trend is strictly dependent from 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 increased: in 2009, the percentage of municipal solid waste separate collection is near 33%, but still far from legislative targets (fixed 50% in 2009).

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 2009, the non hazardous landfills in Italy dispose 16,158 kt of MSW and 3,216 kt of industrial wastes, as well as 364 kt of sludge from urban wastewater treatment plants.

Since 1999, the number of MSW landfills decreased by more than 500 plants, despite the decrease of the amount of wastes disposed of is less strong. This because both uncontrolled landfills and small controlled landfills have been progressively closed, especially in the south of the country, preferring the use of modern and larger plants, which cover large territorial areas.

Concerning the composition of waste which is disposed in municipal landfills, this has been changed within the years, because of the modification of waste production due to the life-style changing and not for 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 of wastes disposed; in the past, law’s disposition forced only this category to have a collecting gas system. Investigation has been carried out on C&D waste landfills to prove that inert typology do not generate methane emissions. Investigation on industrial sludge disposed into landfills for hazardous waste is planned for the future.

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).

The assumption that all the landfills, both managed and unmanaged, started operation in the same year, and have the same parameters, has been considered, although characteristics of individual 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 occur due to the waste disposed in the past years. The unmanaged sites have been considered shallow.

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 that provided by regional permits, provincial communications and by registrations in the national register of companies involved in waste management activities.
These figures are 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 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.

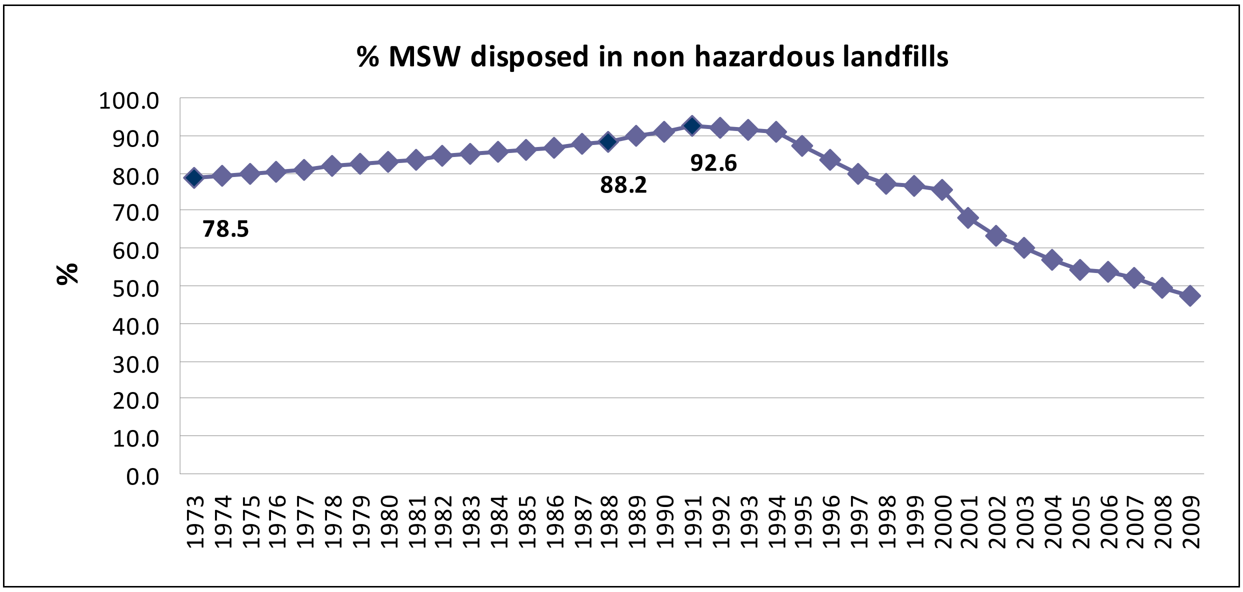


Figure 8.1 Percentage of MSW disposal on land (%)

In the following Table 8.2, the time series of MSW production and disposed into non hazardous landfills from 1990 is reported.

Industrial waste

In non hazardous landfills industrial wastes assimilated to municipal solid waste (AMSW) could be disposed. Their composition 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 is 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 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 into non hazardous landfills from 1990 is reported.

ACTIVITY DATA	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**
MSW production (Gg)	22,231	25,780	28,959	31,664	32,511	32,542	32,472	34,144
MSW disposed in landfills for non hazardous waste (Gg)	17,432	22,459	21,917	17,226	17,526	16,912	15,981	16,158
Assimilated MSW disposed in landfills for non hazardous waste (Gg)	2,828	2,978	2,825	2,914	2,481	2,777	3,703	3,216

ACTIVITY DATA	1990	1995	2000	2005	2006	2007	2008	2009
Sludge disposed in managed landfills for non hazardous waste (Gg)	2,454	1,531	1,326	544	525	407	364	364
Total Waste to managed landfills for non hazardous waste (Gg)	16,363	21,897	26,069	20,684	20,532	20,095	20,049	19,739
Total Waste to unmanaged landfills for non hazardous waste (Gg)	6,351	5,071	0	0	0	0	0	0
Total Waste to landfills for non hazardous waste (Gg)	22,714	26,968	26,069	20,684	20,532	20,095	20,049	19,739

Table 8.2 Trend of MSW production and MSW, AMSW and domestic sludge disposed in landfills, 1990 – 2009

Sludge from urban wastewater plants

In addition to municipal solid waste and assimilated, sludge from urban wastewater handling plants have also been considered, because they can be disposed in the same landfills, once they meet specific requirements.

The fraction of sludge disposed in landfill sites has been estimated to be 75% in 1990, decreasing to 9.7% in 2009.

On the basis of their characteristics, sludge from urban wastewater handling plants are also used in agriculture, 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 available for the year 1993 on tonnes of sludge treated in a given way are available from a survey conducted by the National Institute of Statistics on urban wastewater plants (ISTAT, 1998 [a] and [b]; De Stefanis P. et al., 1998). From 1990 onwards each percentage has been varied on the basis of data known for specific years: in particular, data on sludge use in agriculture are communicated by the Ministry for the Environment, Land and Sea from 1995 (MATTM, 2005; MATTM 2010); 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 from 1995 by the Ministry for the Environment, Land and Sea from 1995 (MATTM, 2005; MATTM 2010) in the framework of the reporting commitments fixed 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 result 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.

ACTIVITY DATA	1990	1995	2000	2005	2006	2007	2008	2009
Total sewage sludge production (Gg)	3,272	2,437	3,402	4,299	4,280	3,509	3,041	3,736
Sewage sludge landfilled (Gg)	2,454	1,531	1,326	544	525	407	364	364
Percentage (%)	75.0	62.8	39.0	12.7	12.3	11.6	12.0	9.7

Table 8.3 Trend of total sewage sludge production and landfilling, 1990 – 2009

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. Moreover, a fourth slot (2006-2009) has been individuated on the basis of the analysis of several regional waste composition and the analysis of waste disposed into non hazardous landfills specified by CER 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 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 fixed 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 CER 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.

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 8.4 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	**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 8.5 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	**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 8.6 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	**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%			

WASTE COMPONENT	Composition by weight (wet waste)	Moisture content	Organic carbon content (dry matter)	DOC_i (kgC/tMSW)
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**

Table 8.7 Waste composition and Degradable Organic Carbon calculation, 2006 – 2009

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.

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

Table 8.8 Waste biodegradability

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 caluculated 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 site) 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 managed SWDS. The MCF, in relation to solid waste management, is specific to that area and should be interpreted as the 'waste management correction factor', which reflects the management aspect that it encompasses.
The MCF value used for unmanaged landfill is the default IPCC value reported for uncategorised landfills: in fact, in Italy, before 2000 existing unmanaged landfills were mostly shallow, because they resulted in uncontrolled waste dumping instead of real deep unmanaged landfills. To be conservative, the default IPCC value reported for uncategorised landfills has been used.
It is assumed that landfill gas composition is 50% carbon dioxide and 50% methane.
The following Table 8.9 summarize the methane generation potential values (L_0) generated, distinguished for managed and unmanaged landfills.

L_0 ($m^3CH_4\ tMSW^{-1}$)	**1950 - 1970**	**1971 - 1990**	**1991 - 2005**	**2006 - 2009**
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

Table 8.9 Methane generation potential values by waste composition and landfill typology

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 taken 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.
Values are suggested by national experts Andreottola and Cossu (Andreottola and Cossu, 1988), and refer to a study in which *k* values have been determined through experimental tests (Ham, 1979); despite these figures are not from national experimental tests, they well adjust to the Italian landfills.

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

Table 8.10 Half-life values and related methane generation rate constant

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 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 (99/31/EC); 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 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 (GWh) annually 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). The methane flared has been estimated for the years 1990-1997 on the basis of information supplied by the plants (De Poli and Pasqualini, 1991); for the following years the methane flared has been estimated on the basis of information 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 value increased from 60% of the total, in 1998, to 70% since 2002.

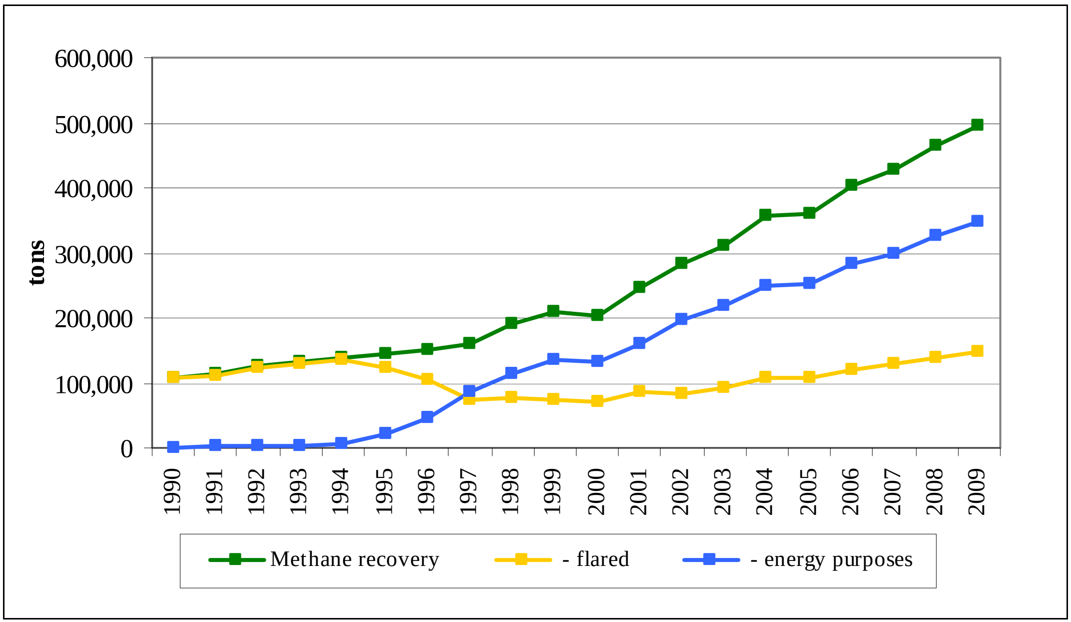


Figure 8.2 Methane recovery distinguished in flared amount and energy purposes (tons)

CH_4 and NMVOC emissions time series

The time series of CH_4 emissions is reported in Table 8.11; 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 industrial waste and sludge could influence this trend as for the year 2009 (see Table 8.2). 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.

EMISSIONS	1990	1995	2000	2005	2006	2007	2008	2009
Managed Landfills								
Methane produced (Gg)	648.1	755.0	1028.3	1084.6	1097.3	1091.3	1088.5	1091.2
Methane recovered (Gg)	108.9	144.1	203.4	360.5	403.2	427.3	464.3	495.9
Methane recovered (%)	16.8	19.1	19.8	33.2	36.7	39.2	42.7	45.4
CH_4 net emissions (Gg)	479.0	542.6	732.8	643.2	616.6	589.8	554.5	528.8
NMVOC net emissions (Gg)	6.3	7.1	9.7	8.5	8.1	7.8	7.3	7.0
Unmanaged Landfills								
Methane produced (Gg)	250.6	217.7	143.2	96.8	91.8	87.2	83.0	79.0
Methane recovered (Gg)	0	0	0	0	0	0	1	2
CH_4 net emissions (Gg)	247.3	214.9	141.4	95.6	90.6	86.1	81.9	77.9
NMVOC net emissions (Gg)	3.3	2.8	1.9	1.3	1.2	1.1	1.1	1.0

Table 8.11 Methane produced, recovered and CH4 and NMVOC net emissions, 1990 – 2009 (Gg)

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%. 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 are influenced (Table 8.11), apart from the amount of waste landfilled, also from its composition, as for each biodegradability class different parameters are used in the model. The total amount of waste disposed into managed landfills has increased until 2000 (in 2000 the landfilling of waste in unmanaged landfills has stopped too), then decreased from 2000 to 2003, while from 2003 it is quite stable. 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 2009 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 lead to an increase of methane production from 1990 to 2002 and stabilization from 2003 to 2009. At the same time, biogas recovery has increased from 1990 to 2009, but from 2000 the growing rate is higher: in 2009 the methane recovered is half of the methane produced.

8.2.4 Source-specific QA/QC and verification

The Waste Cadastre system, as reported above, 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.

Moreover, an in depth analysis of CER codes disposed 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.

8.2.5 Source-specific recalculations

Recalculations in the sector have been done because the quantity of sludge disposed of in landfills has been updated since 1990 (MATTM, 2010), assimilated municipal solid wastes have been added for the first time, as well as the revision and the updating of waste composition.

In particular, for this submission, the Ministry for the Environment, Land and Sea MATTM 2010) has supplied a complete summary of sewage sludge production in each region of Italy, as well as sewage sludge used for agricultural purposes, in the framework of the reporting commitments fixed by the European Sewage Sludge Directive (EC, 1986) transposed into the national Legislative Decree 27 January 1992, n. 99. Data are available from 1995. The analysis of these time series has convinced the Party to update the entire time series from 1990, because the published values already available for 1987, 1991 and 1993 but not used in previous submissions (MATTM, several years; ISTAT, 1998 [a] and [b]), are consistent with those communicated yearly from 1995. As regard sewage sludge landfilled, data are available from Waste Cadastre since 2001, consequently data have not changed; for previous years sewage sludge landfilled has been update because it is estimated as a percentage of sludge production.

In Table 8.12, sewage sludge production time series as well as sludge disposed into landfills are reported for both Submissions 2011 and 2010. Published and communicated data are marked in bold.

As reported in previous paragraphs, a new waste category disposed into non hazardous landfills has been added: industrial waste with composition comparable to MSW. This improvement has involved a revision of MSW landfilled from 1995 back to 1950, because for previous years this data partially included AMSW.

In Table 8.13, municipal and industrial (assimilated to MSW) wastes disposed into non hazardous landfills are reported also for Submission 2010, together with differences in percentage. Main gaps are in sewage sludge time series (see Table 8.12), which influence emissions also because sludge are rapidly biodegradable, and of course in AMSW time series because it is a new category waste.

Year	Submission 2011		Submission 2010		Δ% Sludge production	Δ% Sludge landfilled
	Total sewage sludge production (t)	Sewage sludge landfilled (t)	Total sewage sludge production (t)	Sewage sludge landfilled (t)		
1990	3,272,148	2,454,111	3,679,381	2,745,299	-11.1%	-10.6%
1991	**3,428,000**	2,571,000	3,986,418	2,964,685	-14.0%	-13.3%
1992	3,155,825	2,366,868	4,293,455	3,182,376	-26.5%	-25.6%
1993	**2,883,649**	2,087,000	4,600,492	3,398,385	-37.3%	-38.6%
1994	2,660,337	1,798,450	4,671,414	3,437,799	-43.1%	-47.7%
1995	**2,437,024**	1,531,210	4,742,116	3,415,671	-48.6%	-55.2%
1996	**2,563,404**	1,488,310	4,812,597	3,394,461	-46.7%	-56.2%
1997	**2,843,644**	1,515,340	4,882,859	3,268,832	-41.8%	-53.6%
1998	**3,532,924**	1,714,084	4,952,899	3,408,713	-28.7%	-49.7%
1999	**3,598,156**	1,574,056	3,938,155	2,454,572	-8.6%	-35.9%
2000	**3,402,016**	1,325,934	3,780,087	1,929,233	-10.0%	-31.3%
2001	**3,539,858**	**1,210,763**	3,539,858	**1,210,763**	0.0%	0.0%
2002	**3,771,044**	**748,586**	3,777,771	**748,586**	-0.2%	0.0%
2003	**3,621,346**	**397,204**	4,015,684	**397,204**	-9.8%	0.0%
2004	**3,880,940**	**395,812**	4,253,597	**395,812**	-8.8%	0.0%
2005	**4,298,576**	**544,225**	4,491,510	**544,225**	-4.3%	0.0%
2006	**4,280,324**	**525,417**	4,729,423	**525,417**	-9.5%	0.0%
2007	**3,509,775**	**407,239**	4,967,336	**407,239**	-29.3%	0.0%
2008	**3,040,723**	**364,193**	5,205,249	426,744	-41.6%	-14.7%
2009	**3,736,230**	364,193				

Table 8.12 Sewage sludge production time series, 1990 – 2009 (t), sewage sludge disposed into landfills time series, 1990 – 2009 (t), and differences in percentage between Submission 2011 and Submission 2010.

Year	Submission 2011			Submission 2010			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	20,259,627	-	20,259,627	-16.2%	100%	0%
1991	18,550,558	2,931,716	21,482,274	21,482,274	-	21,482,274	-15.8%	100%	0%
1992	19,251,520	2,972,180	22,223,700	22,241,091	-	22,241,091	-15.5%	100%	-0.1%
1993	21,129,759	3,011,947	24,141,705	23,531,707	-	23,531,707	-11.4%	100%	2.5%
1994	20,624,149	3,051,016	23,675,165	23,675,165	-	23,675,165	-14.8%	100%	0%
1995	22,458,880	2,977,672	25,436,552	22,044,438	-	22,044,438	1.8%	100%	13.3%
1996	21,623,467	2,899,513	24,522,980	21,623,467	-	21,623,467	0%	100%	11.8%
1997	21,275,185	2,834,004	24,109,189	21,275,185	-	21,275,185	0%	100%	11.8%
1998	20,767,673	2,790,247	23,557,920	20,767,673	-	20,767,673	0%	100%	11.8%
1999	21,744,692	2,813,541	24,558,233	21,744,692	-	21,744,692	0%	100%	11.5%
2000	21,917,417	2,825,340	24,742,757	21,917,417	-	21,917,417	0%	100%	11.4%
2001	20,002,860	3,057,757	23,060,617	20,002,860	-	20,002,860	0%	100%	13.3%
2002	18,847,827	1,946,816	20,794,643	18,847,827	-	18,847,827	0%	100%	9.4%
2003	17,996,328	2,054,949	20,051,277	17,996,328	-	17,996,328	0%	100%	10.2%
2004	17,741,733	2,251,691	19,993,424	17,741,733	-	17,741,733	0%	100%	11.3%
2005	17,225,728	2,913,697	20,139,425	17,225,728	-	17,225,728	0%	100%	14.5%
2006	17,525,881	2,480,830	20,006,711	17,525,881	-	17,525,881	0%	100%	12.4%
2007	16,911,545	2,776,637	19,688,182	16,911,545	-	16,911,545	0%	100%	14.1%
2008	15,981,406	3,703,220	19,684,626	15,981,406	-	15,981,406	0%	100%	18.8%
2009	16,158,457	3,216,432	19,374,888		-				

Table 8.13 MSW disposed into landfills time series, 1990 – 2009 (t), AMSW disposed into landfills time series, 1990 – 2009 (t), and differences in percentage between Submission 2011 and Submission 2010.

Finally, a recalculation has involved waste composition. As explained in previous paragraphs, a fourth slot (2006 – 2009) has been individuated on the basis of the analysis of several regional waste composition (Regione Piemonte, 2007; Regione Veneto, 2006; Regione Emilia Romagna, 2009; Regione Umbria, 2007; Provincia di Roma, 2008; Regione Calabria, 2002; Regione Sicilia 2004), available for recent years, and the analysis of waste disposed into landfills specified by CER code for the year 2007, available from Waste Cadastre database.
Moreover, 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).
In Table 8.14 a comparison of methane generation potential (L_0) and DOC values for submission 2011 and submission 2010 is reported, highlighting in grey difference values.

	1950 - 1970		1971 - 1990		1991 - 2005		2006 - 2008	
L_0 (m^3CH_4 $tMSW^{-1}$)	Submission 2011	Submission 2010	Submission 2011	Submission 2010	Submission 2011	Submission 2010	Submission 2011	Submission 2010
Rapidly biodegradable								
- Managed landfill	90.5	90.5	86.6	85.1	88.1	84.1	90.2	84.1
- Unmanaged landfill	54.3	54.3	52.0	51.1	52.9	50.5	54.1	50.5
Moderately biodegradable								
- Managed landfill	118.2	118.2	118.2	118.2	118.2	118.2	118.2	118.2
- Unmanaged landfill	70.9	70.9	70.9	70.9	70.9	70.9	70.9	70.9
Slowly biodegradable								
- Managed landfill	224.1	224.1	224.1	224.1	205.9	205.9	204.0	205.9
- Unmanaged landfill	134.5	134.5	134.5	134.5	123.5	123.5	122.4	123.5
DOC (kgC/tMSW)	211.59	211.59	192.04	176.54	209.93	199.82	188.76	199.82

Table 8.14 Comparison of methane generation potential and DOC values for submission 2011 and submission 2010

These improvements have influenced methane and NMVOC emissions. In Table 8.15 differences in percentage between emissions from landfills reported in the updated time series and 2010 submission are presented.

EMISSIONS	1990	1995	2000	2005	2006	2007	2008	2009
Managed Landfills								
Methane produced (Gg)	12.74%	-0.82%	7.41%	12.12%	13.50%	11.97%	11.69%	12.74%
Methane recovered (Gg)	-	-	-	-	-	-	-	-
CH_4 net emissions (Gg)	15.72%	-1.01%	9.41%	19.33%	23.16%	21.32%	22.32%	15.72%
NMVOC net emissions (Gg)	15.72%	-1.01%	9.41%	19.33%	23.16%	21.32%	22.32%	15.72%
Unmanaged Landfills								
Methane produced (Gg)	12.90%	11.32%	13.41%	10.67%	10.60%	10.55%	10.52%	12.90%
Methane recovered (Gg)	-	-	-	-	-	-	-	-
CH_4 net emissions (Gg)	12.90%	11.32%	13.41%	10.67%	10.60%	10.55%	10.52%	12.90%
NMVOC net emissions (Gg)	12.90%	11.32%	13.41%	10.67%	10.60%	10.55%	10.52%	12.90%

Table 8.15 Differences in percentage between emissions from landfills reported in the updated time series and 2010 submission

8.2.6 Source-specific planned improvements

A big effort has been done for this submission in order to update and improve waste composition and waste typology disposed into municipal landfills. Actually, more recent data on fraction of CH_4

in landfill gas and on the amount of landfill gas collected and treated are not available. Investigation on industrial sludge disposed into landfills is planned for the future.
Regarding the energy conversion efficiency of biogas engine, actually assumed equal to 0.3, as the technological evolution is probably leading to increase efficiency to around 40%, further investigations are planned. Moreover, a check of biogas Lower Calorific Value is planned, because of the availability of information from the national energy transmission grid operator (TERNA).

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.

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	

Table 8.16 Emissions reporting scheme

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. On the contrary, in treatment plants, methane is produced from the anaerobic treatment process used to stabilised wastewater sludge.
Actually, in Italy about 84% of population is served by sewer systems, whereas 74.8% of population is served by wastewater treatment plants (COVIRI, 2005). In unsewered areas, onsite systems, such as Imhoff tanks, are usually used. The minor percentage of population served by wastewater treatment plants implies a fraction of wastewater directly discharged in the soil or in surface water without any treatment.
On the basis of the characteristics of the influent, 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 standard design facility 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.
A percentage of 1.8% 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).
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 waste water production is resulting from the model for the estimation of methane emissions from industrial waste water.
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. No country specific emission factors of methane per Chemical Oxygen Demand (COD) are available so the default value of 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 2009 are reported: for these national data, slightly differences within the years can occur.

	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

	Wastewater generation (m^3/t)	References	COD (g/l)	References
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	7	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	34	ANPA-FLORYS, 2001; Assocarta, several years	0.1	ANPA-FLORYS, 2001; Assocarta, several years
Pulp	34	ANPA-FLORYS, 2001; 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	4.18	UNIC, several years

Table 8.17 Wastewater generation and COD values, 2009.

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 loading 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. 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 and the default value B_0 = 0.6 kgCH_4/kg BOD.

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.

Wastewater production (1000 m^3)	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**
Iron and steel	9,534	7,778	6,756	6,861	7,032	7,091	6,728	4,133
Oil refinery	NA	NA	NA	NA	NA	NA	NA	NA
Organic chemicals	210,936	212,317	215,049	214,735	214,972	215,265	214,747	214,056
Food and beverage	179,120	177,383	182,736	185,657	182,693	180,401	180,106	184,727
Pulp and paper	377,167	402,952	387,285	366,025	365,649	368,979	346,504	307,450
Textile industry	108,460	103,047	101,572	75,492	78,272	79,796	68,768	56,443
Leather industry	23,623	25,002	27,216	19,229	19,254	18,366	16,804	14,809
Total	908,840	833,209	825,798	799,368	796,632	797,192	771,615	729,306

Table 8.18 Total industrial wastewater production by sector, 1990 – 2009 (1000 m^3)

CH_4 Emissions (Gg)	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**
Iron and steel	0.036	0.029	0.025	0.026	0.026	0.027	0.025	0.015
Oil refinery	5.850	5.625	4.250	4.750	4.750	4.750	4.750	4.750
Organic chemicals	23.794	23.911	24.173	24.177	24.227	24.274	24.180	24.046
Food and beverage	22.946	22.112	22.871	23.197	23.220	23.085	22.757	23.506
Pulp and paper	0.923	0.986	1.055	0.997	0.996	1.005	0.944	0.837
Textile industry	4.067	3.864	3.809	2.831	2.935	2.992	2.579	2.117
Leather industry	3.192	3.378	3.677	2.901	3.122	3.100	2.632	2.319
Total	60.81	59.91	59.86	58.88	59.28	59.23	57.87	57.59

Table 8.19 CH_4 emissions from anaerobic industrial wastewater treatment, 1990 – 2009 (Gg)

N_2O Emissions (Gg)	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**
Industrial Wastewater	0.227	0.232	0.230	0.217	0.217	0.217	0.208	0.195
Human Sewage	5.682	5.505	5.979	5.933	5.932	5.967	6.136	6.141
Total	5.91	5.74	6.21	6.15	6.15	6.18	6.34	6.34

Table 8.20 N_2O emissions from industrial wastewater handling and human sewage, 1990 – 2009 (Gg)

Domestic and Commercial Wastewater	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**
Wastewater (5% treated anaerobically)								
Organic loading in wastewater (t $year^{-1}$)	49.80	63.75	74.03	105.63	106.25	107.04	107.53	108.25
CH_4 emissions (Gg)	29.88	38.25	44.42	63.38	63.75	64.23	64.52	64.95
Sludge (generated by Imhoff tanks)								
Eq. inhabitants treated in Imhoff tanks (10^3 millions)	1,033	1,893	2,144	1,880	1,870	1,855	1,834	1,808
Organic loading in sludge (t $year^{-1}$)	6.79	12.43	14.09	12.35	12.29	12.19	12.05	11.88
CH_4 emissions (Gg)	4.07	7.46	8.45	7.41	7.37	7.31	7.23	7.13

Table 8.21 CH_4 emissions from sludge generated by domestic and commercial wastewater treatment, 1990 – 2009 (Gg)

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 will be available to the operators of wastewater treatment plants for their data reporting.

Finally, a thesis on GHG emissions from wastewater handling has been carried out at Environmental, Hydraulic, Infrastructures and Surveying Engineering Department (DIIAR) of Politecnico di Milano, 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 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 regarding equivalent inhabitants served by treatment systems have been updated from 2000 (ISTAT, several years [c]). Methane emissions from domestic and commercial wastewater showed changes reported in Table 8.22.

Domestic and Commercial Wastewater	1990	1995	2000	2005	2006	2007	2008
Wastewater (5% treated anaerobically)	-	-					
Organic loading in wastewater (t year^{-1})			1.10%	4.64%	0.07%	-4.30%	-8.91%
CH_4 emissions (Gg)	-	-	1.10%	4.64%	0.07%	-4.30%	-8.91%

Table 8.22 Differences in percentages between time series reported in the updated time series and 2010 submission

Moreover, N_2O emissions from human sewage have been recalculated because FAO has updated protein intake time series. Other minor recalculations due to some updated data published occur (i.e. beer industry). However, the recalculation is not relevant. In Table 8.23, differences in percentage between new time series and 2010 submission are reported.

N_2O Emissions (Gg)	1990	1995	2000	2005	2006	2007	2008
Industrial Wastewater	-	-	-	-	-	-	0.01%
Human Sewage	-1.84%	-2.08%	-2.28%	-3.86%	-4.89%	-5.49%	-3.66%

Table 8.23 Differences in percentages between time series reported in the updated time series and 2010 submission

8.3.6 Source-specific planned improvements

No specific activities are planned.

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 from 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 that treat residual waste from waste treatments, as well as sewage sludge.
Emissions from incineration of human bodies in crematoria have been carried out.
As mentioned above, emissions from waste incineration facilities with energy recovery are reported under category 1A4a (Combustion activity, commercial/institutional sector), whereas emissions from other types of waste incineration facilities are reported under category 6C (Waste incineration). For 2009, about 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.
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 there was no information (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 of 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);
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.

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	0.46	0.07	289.26	0.1	1.15	0.39	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

Table 8.24 Waste incineration emission factors

Here below (Tables 8.25, 8.26, 8.27, 8.28), detail data and calculation for 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) and expert judgements.
In detail, as regard CO_2 emission factor for municipal waste, it 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 (FEDERAMBIENTE, 1992), 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.

MUNICIPAL WASTE	Average concentration values (mg/Nm^3)	Standard specific flue gas volume (Nm^3/KgMSW)	E.F. (g/t)
SO_2	78.00	5	390
NO_x	230.00		1,150
CO	14.00		70
N_2O			100
CH_4			59.80
NMVOC			460.46
C content, % weight	23		
CO_2			826.5 (kg/t)

Table 8.25 Municipal waste 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 8.26 Industrial waste and oils 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 8.27 Hospital waste 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			7,400
CO_2			1,200 (kg/t)

Table 8.28 Sewage sludge emission factors

	1990	1995	2000	2005	2006	2007	2008	2009
Total Waste incinerated	1,716.35	2,209.33	3,061.68	4,966.18	5,066.37	5,145.31	5,287.35	5,199.20
- with energy recovery	946.57	1,593.74	2,751.91	4,707.45	4,800.24	4,897.69	5,034.42	4,946.25
- without energy recovery	769.78	615.59	309.76	258.73	266.13	247.62	252.93	252.95
MSW incinerated	1,025.59	1,436.62	2,324.88	3,219.87	3,269.34	3,299.38	3,354.55	3,351.60
- with energy recovery	626.39	1,185.49	2,161.37	3,167.94	3,246.46	3,270.91	3,329.98	3,327.03
- without energy recovery	399.20	251.13	163.51	51.93	22.88	28.46	24.56	24.56
Industrial Waste incinerated								
- other waste	529.22	593.58	604.16	1,603.84	1,625.28	1,687.21	1,771.48	1,685.17
- hospital waste	138.15	154.54	110.32	126.20	145.34	131.92	134.97	136.18
- sludge	20.72	23.18	21.50	15.60	25.98	26.06	26.06	26.06
- waste oil	2.66	1.41	0.82	0.67	0.43	0.75	0.29	0.19

Table 8.29 Amount of waste incinerated by type, 1990 – 2009 (Gg)

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) or in fireplaces without abatement technology control, 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, 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).
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, 2010). 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.

	1990	1995	2000	2005	2006	2007	2008	2009
Cremations (no. of corpses)	5,809	15,436	30,167	48,196	53,013	58,554	63,611	71,898
Deaths (no. of corpses)	543,700	555,203	560,241	567,304	557,892	570,801	585,126	591,663
Cremation percentage	1.07%	2.78%	5.38%	8.50%	9.50%	10.26%	10.87%	12.15%
Crematoria (no.)	NA	31	35	43	44	45	46	51

Table 8.30 Cremation time series (activity data), 1990 – 2009

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.

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

Table 8.31 Cremation emission factors

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, whereas in CH_4 emissions is 20.6%, 5% and 20% for activity data and emission factor. For N_2O and CH_4 emissions, the combined uncertainty is estimated to be about 100% 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 1990-2009, total CO_2 emissions have increased by 185.5%, but whereas emissions from plants with energy recovery have increased by nearly 411%, emissions from plants without energy recovery decreased by 53.5%. 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.

Activity Data	1990	1995	2000	2005	2006	2007	2008	2009
MSW Production (Gg)	22,231	25,780	28,959	31,664	32,511	32,542	32,472	34,144
MSW Incinerated (%)	4.6%	5.6%	8.0%	10.2%	10.1%	10.1%	10.3%	9.8%
- in energy recovery plants	2.8%	4.6%	7.5%	10.0%	10.0%	10.1%	10.3%	9.7%
MSW to incineration (Gg)	1,026	1,437	2,325	3,220	3,269	3,299	3,355	3,352
Industrial, Sanitary, Sewage Sludge and Waste Oil to incineration (Gg)	691	773	737	1,746	1,797	1,846	1,933	1,848
Cremation (no. of corpses)	5,809	15,436	30,167	48,196	53,013	58,554	63,611	71,898
Total Waste to incineration, excluding cremation (6C and 1A4a) (Gg)	1,716	2,209	3,062	4,966	5,066	5,145	5,287	5,199

Table 8.32 Waste incineration activity data, 1990 – 2009 (Gg)

CO_2 Emissions	1990	1995	2000	2005	2006	2007	2008	2009
Incineration of domestic or municipal wastes (Gg)	115.47	72.64	47.30	15.02	6.62	8.23	7.11	7.11
Incineration of industrial wastes (except flaring) (Gg)	283.31	272.85	113.09	185.58	200.31	164.83	176.05	176.07
Incineration of hospital wastes (Gg)	135.46	136.12	40.36	43.72	60.33	66.72	66.72	66.72
Incineration of waste oil (Gg)	2.66	1.41	0.82	0.36	0.24	0.41	-	-
Waste incineration (6C) (Gg)	537	483	202	245	267	240	250	250
Waste incineration reported under 1A4a (Gg)	569	835	1,331	2,765	2,804	2,899	3,009	2,906
Total waste incineration (Gg)	1,105	1,318	1,532	3,009	3,072	3,140	3,259	3,156

Table 8.33 CO_2 emissions from waste incineration (without and with energy recovery), 1990 – 2009 (Gg)

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008	2009
N_2O (Gg)								
Waste incineration (6C)	0.28	0.42	0.36	0.42	0.40	0.38	0.40	0.41
MSW incineration reported under 1A4a	0.05	0.08	0.13	0.26	0.27	0.28	0.29	0.28
CH_4 (Gg)								
Waste incineration (6C)	7.65	12.91	11.94	14.14	13.47	12.89	13.43	13.59
MSW incineration reported under 1A4a	0.03	0.05	0.08	0.16	0.16	0.17	0.17	0.17

Table 8.34 N_2O and CH_4 emissions from waste incineration (cremation included), 1990 – 2009 (Gg)

8.4.4 Source-specific QA/QC and verification

For the incineration plants reported in the national EPER/E-PRTR registry, verification on emissions has been carried out.

8.4.5 Source-specific recalculations

For the year 2008, activity data from the two incineration plants, which treat industrial waste, have been updated. The main differences are related to cremation of human bodies although the contribution is insignificant.

8.4.6 Source-specific planned improvements

Investigation on waste composition will be taking into account, in order to verify and improve CO_2 emission factor on the basis of carbon content.
In order to improve QA/QC activity, a rearrangement of incinerators database is planned.

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 2009 (from 363,319 tons to 7,166,890 tons).
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: the plants that treat a selected waste (food, market, garden waste, sewage sludge and other organic waste, mainly from the agro-food industry); and the mechanical-biological treatment plants, that treat the unselected waste to produce compost, refuse derived fuel (RDF), and a waste with selected characteristics for landfilling or incinerating system.
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, equivalent to compost production.
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 8.35, activity data, CH_4 and NMVOC emissions are reported. Moreover, NO_x emissions from sludge spreading are reported.

	1990	1995	2000	2005	2006	2007	2008	2009
Waste treated in composting plants (t)								
CH_4 (Gg)								
Compost production (6D)	0.011	0.023	0.097	0.200	0.213	0.220	0.210	0.210
NMVOC (Gg)								
Compost production (6D)	0.018	0.040	0.168	0.346	0.369	0.380	0.364	0.364
NO_x (Gg)								
Sludge spreading (6D)	0.641	1.028	1.440	1.166	1.022	1.092	1.162	1.494

Table 8.35 CH_4 and NMVOC emissions from compost production, 1990 – 2009 (Gg)

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

No recalculation has been done.

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 2008 have been submitted as well as the CRF for the year 2009 and recalculation tables of the CRF have been filled in. Explanatory information on the major recalculations between the 2010 and 2011 submissions for the year 2008 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 2010 submission and the actual one (2011 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 +0.41% for the base year and +0.05% for 2008. Considering the national total with the LULUCF sector, the base year has increased by 1.12% and the 2008 emission levels decreased by 1.16%.

Detailed explanations of these recalculations are provided in the sectoral chapters.

Changes in the base year levels are related, primarly, to the energy sector due to a revision of fugitive emissions on account of the addition of N_2O emissions from flaring in refineries and CO_2 emissions from transmission and distribution of natural gas. In the industrial sector, revisions occurred considering the addition of CO_2 emissions from the use of limestone and dolomite in pulp and paper industries and in Power plants. The LULUCF sector was also affected by an update in methodology to derive Land use changes by the way of LU matrices and the availability of new information on forest fires areas and harvesting.

For 2008, changes regarded the energy sector, due to the update of emission factors for steam coal and natural gas. In the industrial sector, revisions are due to addition of CO_2 emissions from the use of limestone and dolomite in pulp and paper industries and from the treatment of the Power plants' flue gases. The LULUCF sector was also affected by the same revisions, as for 1990. In the waste sector, the revision regarded the addition of industrial wastes disposed into MSW landfills and revision of rapidly biodegradable fractions; there has also been a revision of sludge with the addition of industrial wastes and revision of waste compositions.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	RECALCULATIONS Please tick where this is also reflected in recalculations compared to the previous year CRF	REFERENCE If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc
Total (Net Emissions)	√	√	CO2 from 1A2 iron and steel production. Update of carbon balance CO2 from 1A1, 1A2, 1A3. Update of EF for steam coal and natural gas CO2 from 5. LUC areas were modified, refining the smoothing process used to derive LUC matrices CH4 from 6A1, 6A2. Addition of Industrial wastes disposed into MSW landfills and revision of rapidly biodegradable fractions. Revision of sludge with the addition of industrial wastes and revision of waste compositions N2O from 1B2. Addition of emissions from flaring in refineries N2O from 4D. New estimation for sewage sludge applied to soils
1. Energy		√	CO2 from 1A2 iron and steel production. Update of carbon balance CO2, CH4 and N2O from 1A3b. Use of an updated version of Copert4 CO2, CH4 and N2O from 1A3d. Update of maritime traffic data CO2 from 1A1, 1A2, 1A3. Update of EF for steam coal and natural gas N2O from 1B2. Addition of emissions from flaring in refineries
A. Fuel Combustion (Sectoral Approach)		√	CO2 from 1A2 iron and steel production. Update of carbon balance CO2, CH4 and N2O from 1A3b. Use of an updated version of Copert4 CO2, CH4 and N2O from 1A3d. Update of maritime traffic data for 2008 CO2 from 1A1, 1A2, 1A3. Update of EF for steam coal and natural gas
1. Energy Industries		√	CO2 from 1A1. Update of EF for steam coal and natural gas
2. Manufacturing Construction		√	CO2 from 1A2 iron and steel production. Update of carbon balance CO2 from 1A2. Update of EF for steam coal and natural gas CH4 and N2O from 1A2. Update of fuel oil activity data
3. Transport		√	CO2, CH4 and N2O from 1A3b. Use of an updated version of Copert4 CO2 from 1A3b. Update of EF for natural gas CO2, CH4 and N2O from 1A3d. Update of maritime traffic data for 2008
4. Other Sectors		√	CO2 from 1A4. Update of EF for steam coal and natural gas
5. Other			

Table 9.1 Explanations of the main recalculations in the 2011 submission (continued)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	RECALCULATIONS Please tick where this is also reflected in recalculations compared to the previous year CRF	REFERENCE If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc
B. Fugitive Emissions from Fuels	√	√	CO2 from 1B2. Addition of CO2 emissions from transmission and distribution of natural gas. Addition of natural gasoline production CH4 from 1B2. Addition of natural gasoline production N2O from 1B2. Addition of emissions from flaring in refineries
1. Solid Fuels			
2. Oil and Natural Gas	√	√	CO2 and CH4 from 1B2C.1.1. Disaggregation of fugitive emissions from oil among venting, flaring and production. Addition of natural gasoline production CO2 and CH4 from 1B2C.2.1. Disaggregation of fugitive emissions from oil among venting, flaring and production. Emissions from flaring in refineries have been moved from 1.B.2.C.2.1 to 1.B.2.D. Addition of natural gasoline production N2O from 1B2C.2.1. Emissions from flaring in refineries have been moved from 1.B.2.C.2.1 to 1.B.2.D CO2 and CH4 from 1B2C.2.2. Disaggregation of fugitive emissions from oil among venting, flaring and production CO2 from 1B2D. Emissions from flaring in refineries have been moved from 1.B.2.C.2.1 to 1.B.2.D. Reallocation of fugitive emissions from petroleum refining between production processes and flaring CH4 from 1B2D. Emissions from flaring in refineries have been moved from 1.B.2.C.2.1 to 1.B.2.D N2O from 1B2D. Emissions from flaring in refineries have been moved from 1.B.2.C.2.1 to 1.B.2.D. Addition of N2O emissions from flaring in refineries
2. Industrial Processes	√	√	CO2 from 2A3. Addition of emissions from the use of Limestone and Dolomite in Pulp&Paper and from the treatment of the Power plants' flue gases. PFCs from 2C3. Update of both activity data (primary aluminium production) and CF4 and C2F6 emissions HFCs from 2F. New information on HFC-245fa has been considered
A. Mineral Products		√	CO2 from 2A3. Addition of emissions from the use of Limestone and Dolomite in Pulp&Paper and from the treatment of the Power plants' flue gases
B. Chemical Industry		√	CO2 from 2B3. Update of the EF for adipic acid based on operator's data
C. Metal Production	√	√	PFCs from 2C3. From 2000 both activity data (primary aluminium production) and CF4 and C2F6 emissions have been updated on the basis of new communication by the operator
D. Other Production			
E. Production of Halocarbons and SF6			
F. Consumption of Halocarbons and SF6		√	HFCs from 2F. Availability of new information on HFC-245fa HFCs, PFCs and SF6. Update of activity data
G. Other			

Table 9.1 Explanations of the main recalculations in the 2011 submission (continued)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	RECALCULATIONS Please tick where this is also reflected in recalculations compared to the previous year CRF	REFERENCE If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc
3. Solvent and Other Product Use		√	CO_2. Update of activity data in fat edible and non edible oil extraction and domestic solvent use
4. Agriculture	√	√	N_2O from 4D. New estimation for sewage sludge applied to soils
A. Enteric Fermentation			
B. Manure Management			
C. Rice Cultivation			
D. Agricultural Soils	√	√	N_2O from 4D. New estimation for sewage sludge applied to soils
E. Prescribed Burning of Savannas			
F. Field Burning of Agricultural Residues			
G. Other			
5. Land Use, Land-Use Change and Forestry	√	√	CO_2. LUC areas were modified, refining the smoothing process used to derive LUC matrices
A. Forest Land	√	√	CO_2, carbon stock change living biomass/Carbon/Losses, net carbon stock change in dead organic matter/Carbon. LUC areas were modified, refining the smoothing process used to derive LUC matrices
B. Cropland	√	√	CO_2, carbon stock change living biomass/Carbon/Losses, net carbon stock change in dead organic matter/Carbon. LUC areas were modified, refining the smoothing process used to derive LUC matrices
C. Grassland	√	√	CO_2, carbon stock change living biomass/Carbon/Losses, net carbon stock change in dead organic matter/Carbon. LUC areas were modified, refining the smoothing process used to derive LUC matrices
D. Wetlands			
E. Settlements	√	√	CO_2, carbon stock change living biomass/Carbon/Losses, net carbon stock change in dead organic matter/Carbon. LUC areas were modified, refining the smoothing process used to derive LUC matrices
F. Other Land			
G. Other			

Table 9.1 Explanations of the main recalculations in the 2011 submission (continued)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	RECALCULATIONS Please tick where this is also reflected in recalculations compared to the previous year CRF	REFERENCE If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc
6. Waste	√	√	CH4 from 6A1, 6A2. Addition of Industrial wastes disposed into MSW landfills and revision of rapidly biodegradable fractions. Revision of sludge with the addition of industrial wastes and revision of waste compositions
A. Solid Waste Disposal on Land	√	√	CH4 from 6A1, 6A2. Addition of Industrial wastes disposed into MSW landfills and revision of rapidly biodegradable fractions. Revision of sludge with the addition of industrial wastes and revision of waste compositions
B. Waste-water Handling		√	CH4 and N2O from 6B. Update of activity data and parameters
C. Waste Incineration		√	CO2 from 6C. Update of data from incineration plants CH4 and N2O from 6C1. Update of data from incineration plants and addition of emission from corps incineration
D. Other			
7. Other (as specified in Summary 1.A)			
Memo Items:			
International Bunkers			
Aviation			
Marine		√	CO2, CH4 and N2O. Update of maritime data for 2008
Multilateral Operations			
CO2 Emissions from Biomass			

Table 9.1 Explanations of the main recalculations in the 2011 submission

	subm	1990	1995	2000	2005	2006	2007	2008
Net CO_2 emissions/removals (Gg CO_2-eq.)	2010	370,777	363,377	387,567	398,471	393,899	424,265	380,718
	2011	373,817	365,997	384,685	399,534	388,430	402,699	373,126
Differences		*0.82%*	*0.72%*	*-0.74%*	*0.27%*	*-1.39%*	*-5.08%*	*-1.99%*
CO_2 emissions (without LULUCF) (Gg CO_2-eq.)	2010	435,775	445,861	463,603	490,477	486,343	476,749	468,068
	2011	435,895	445,959	463,670	490,119	485,428	476,226	466,004
Differences		*0.03%*	*0.02%*	*0.01%*	*-0.07%*	*-0.19%*	*-0.11%*	*-0.44%*
CH_4 emissions (Gg CO_2-eq.)	2010	41,710	43,820	44,047	38,580	36,865	37,114	36,022
	2011	43,671	44,164	45,733	41,024	39,485	39,408	38,152
Differences		*4.70%*	*0.78%*	*3.83%*	*6.34%*	*7.11%*	*6.18%*	*5.91%*
CH_4 emissions (without LULUCF) (Gg CO_2-eq.)	2010	41,564	43,788	43,963	38,542	36,834	36,918	35,976
	2011	43,524	44,132	45,649	40,986	39,454	39,211	38,105
Differences		*4.72%*	*0.78%*	*3.83%*	*6.34%*	*7.11%*	*6.21%*	*5.92%*
N_2O emissions (Gg CO_2-eq.)	2010	37,313	38,036	39,429	37,538	32,228	31,566	29,439
	2011	37,382	38,103	39,506	37,572	32,236	31,582	29,495
Differences		*0.18%*	*0.18%*	*0.19%*	*0.09%*	*0.03%*	*0.05%*	*0.19%*
N_2O emissions (without LULUCF) (Gg CO_2-eq.)	2010	37,218	38,030	39,421	37,534	32,225	31,546	29,434
	2011	37,246	38,096	39,497	37,568	32,233	31,562	29,490
Differences		*0.07%*	*0.17%*	*0.19%*	*0.09%*	*0.03%*	*0.05%*	*0.19%*
HFCs (Gg CO_2-eq.)								
	2010	351	671	1,986	5,267	5,956	6,701	7,379
	2011	351	671	1,986	5,401	6,106	6,855	7,513
Differences		*0.00%*	*0.00%*	*0.00%*	*2.54%*	*2.52%*	*2.31%*	*1.81%*
PFCs (Gg CO_2-eq.)								
	2010	1,808	491	346	353	282	288	194
	2011	1,808	491	345	354	284	287	201
Differences		*0.00%*	*0.00%*	*-0.14%*	*0.38%*	*0.48%*	*-0.24%*	*3.18%*
SF_6 (Gg CO_2-eq.)								
	2010	333	601	493	465	406	428	434
	2011	333	601	493	465	406	428	436
Differences		*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.31%*
Total (with LULUCF) (Gg CO_2-eq.)	2010	452,292	446,996	473,868	480,674	469,637	500,361	454,187
	2011	457,362	450,027	472,749	484,351	466,947	481,259	448,921
Differences		*1.12%*	*0.68%*	*-0.24%*	*0.76%*	*-0.57%*	*-3.82%*	*-1.16%*
Total (without LULUCF) (Gg CO_2-eq.)	2010	517,049	529,444	549,812	572,638	562,046	552,629	541,485
	2011	519,157	529,951	551,640	574,893	563,911	554,569	541,749
Differences		*0.41%*	*0.10%*	*0.33%*	*0.39%*	*0.33%*	*0.35%*	*0.05%*

Table 9.2 Differences in time series between the 2011 and 2010 submissions due to recalculations

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 2010, emission levels of the base year, as total emissions in CO_2 equivalent without LULUCF, slightly changed (+0.41%) due to a revision in the industrial and waste sectors as previously described.

If considering emission levels with LULUCF, an increase by 1.12% is observed between the 2010 and 2011 total figures in CO_2 equivalent, mainly due to the refining of the smoothing process used to derive LUC matrices and consequent modification of LUC areas.
The trend ‘base year- year 2008’ 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 ten years (submissions 2001-2010) and the 2011 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. Moreover, it can be noted that recalculations usually result in higher figures as compared previous sumissions. 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.

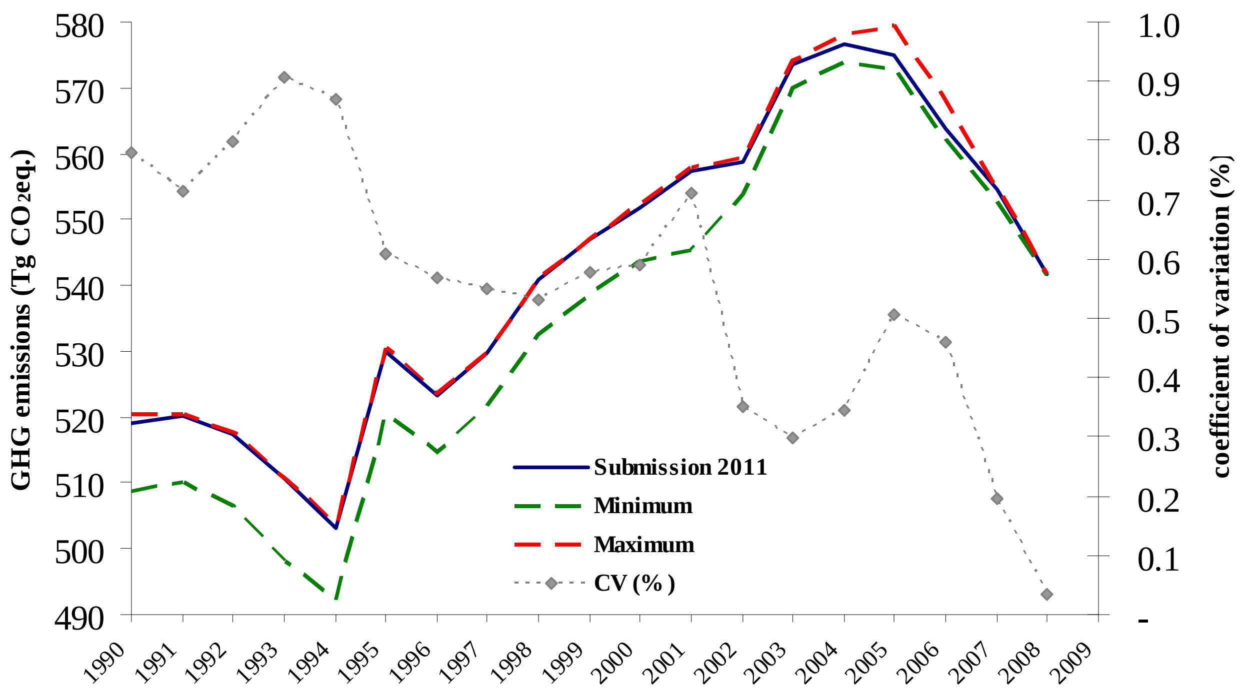


Figure 9.1 Range of national GHG emissions (Tg CO_2 eq.) in the 2001-2011 submissions and coefficient of variation (%)

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 2010 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 emissions from 1A2 iron and steel production have been recalculated on account of a revision of the carbon balance. CO_2 emission factors have been updated for steam coal and natural gas in the last years. A revision in the road transport sector affected all the gases for the use of the new version of COPERT 4; and the last years there has also been an update of maritime traffic data. N_2O emissions from flaring in refineries have been added for the all time series.
Industrial sector. Recalculations affected CO_2 emissions on account of new information available on the use of limestone and dolomite in the pulp and paper industries and from the treatment of power plants' flue gases. In addition, there has been an update of CO_2 emission factor for adipic acid based on operator's data. Activity data for F-gases have been updated and new information on HFC-245fa has been considered.
Solvent and other product use sector. A minor update of activity data occurred in this sector.
Agriculture. Besides the update of basic data for the estimation of emissions from rice cultivation, N_2O emissions from sewage sludge applied to soils have been estimated separately from those in the waste sector.
LULUCF. Recalculations affected CO_2 emissions, carbon stock change living biomass/Carbon/Losses and net carbon stock change in dead organic matter/Carbon on account of the update of LUC areas. The smoothing process used to derive LUC matrices was refined.
Waste. A revision concerned CH_4 emissions for the addition of industrial wastes disposed into MSW landfills and an update of rapidly biodegradable fractions. Moreover, the amount of sludge was updated considering industrial wastes and there also been a change in waste compositions.

9.4.2 Response to the UNFCCC review process

In 2010, the Italian GHG inventory was subject to the centralised review of the 2010 inventory submission.
Following the recommendations of the review processes different improvements have been carried out. A complete list of responses to the latest recommendations of the UNFCCC review is reported in Annex 12.

The main improvements regarded the completeness and transparency of the information reported in the NIR.
A reallocation of emissions within the petroleum refining subcategory has been carried out for the entire time series using the EU ETS data. The rationale behind the estimation of PFC emissions from aluminium production has been further detailed in the related section. Information on the amount of sewage sludge that is applied to agricultural soils has been collected and N_2O emissions have been separated off from those under the waste sector.

Verification and QA/QC procedures were explained more in detail for all the sectors especially for those mostly affected by recalculations.

More details on how the key category and uncertainty analyses help in prioritizing and planning the Italian inventory improvements have been reported in the NIR to clarify the issue. Specifically, the improvements regarded the LULUCF sector which is affected by a high level of uncertainty; the smoothing process used to derive LUC matrices was refined and uncertainty figures associated to the relevant categories decreased. The use of Montecarlo analysis to estimate uncertainty for the Italian inventory has been planned for the whole inventory and started to be implemented for the relevant categories.

The description of country specific methods and the rationale behind the choice of emission factors, activity data and other related parameters should have improved the transparency of the present NIR.

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. Some problems still regard the implementation of national registry for forest carbon sinks to identify areas of land and land-use change in accordance with paragraph 20 of the annex to decision 16/CMP.1, and to provide information, including estimates of emissions/removals, on activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol. However, actions to solve the question have been undertaken by the institutions involved. The INFC data related to the soils survey, expected at the end of 2011, will definitely constitute a robust database, allowing for refined estimates and lower related uncertainty.

Specific improvements are identified in the relevant chapters and specified in the 2011 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 directives, Large Combustion Plant, E-PRTR and Emissions Trading, is under finalisation. 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, improvements are expected for the review of nitrous oxide emission factors in the agricultural soil emissions and availability of information on waste composition and other parameters following the entering into force of the European landfill directive.
For the LULUCF; activities planned in the framework of the National Registry for Forest Carbon Sinks should provide data to improve estimate of emissions by biomass burning and the final results of the INFC data related to the soils survey will definitely constitute a robust database for forest fires, allowing refined estimates and lower related uncertainty.
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 definition given in Decision 16/CMP.1. Forest is a land with following threshold values for tree crown cover, land area and tree height:

d. a minimum area of land of 0.5 hectares;
e. tree crown cover of 10 per cent;
f. 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

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 two last Italian National Forest Inventories (IFN1985 and IFNC2005). *Deforestation* data have been derived from administrative records at NUT2 level collected by the National Institute of Statistics.

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. Therefore Italy's forest area is the total eligible area 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 and IFNC2005). 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 a 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). The phase 3 is currently elaborating data on soils, gained by 1500 sampling areas selected in the IFNC2005 original grid.

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 1990–2009 have been assembled based on time series of national land use statistics for forest lands, croplands, grasslands, wetlands and settlement areas. 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. It has been assumed that new forest land area can only come from grassland.

Deforestation data have been derived from administrative records at NUT2 level collected by the National Institute of Statistics. Since the activities planned in the framework of the registry for carbon sinks are still in progress, for the current submission no detailed information was available on the land use of the deforested area; consequently, 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).

kha		*2007* Art 3.3 Aff. / Ref.	Deforestation	Art. 3.4 FM	Other	*total (beginning of 2008)*
Art 3.3	**Aff. / Ref.**	**1,387**				*1,387*
	Deforestation		**12**			*12*
Art. 3.4	**FM**		0.72	**7,451**		*7,451*
	Other	78			**21,205**	*21,283*
	Total (end of 2008)	*1,465*	*13*	*7,451*	*21,205*	**30,134**

kha		*2008* Art 3.3 Aff. / Ref.	Deforestation	Art. 3.4 FM	Other	*total (beginning of 2008)*
Art 3.3	**Aff. / Ref.**	**1,465**				*1,465*
	Deforestation		**13**			*13*
Art. 3.4	**FM**		0.72	**7,451**		*7,451*
	Other	*78*			**21,126**	*21,204*
	Total (end of 2009)	*1,544*	*14*	*7,451*	*21,126*	*30,134*

Table 10.1 Land transition matrices - Areas and changes in areas between the previous and the current inventory years (2008 - 2009) [kha]

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[48], 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. The model has been applied at regional scale (NUTS2); input data for the forest area, per region and inventory typologies, were the First Italian National Forest Inventory (IFN1985) data and the Inventory of Forests and Carbon pools (INFC2005).
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 no detailed information was available on the land use of the deforested area, since the activities planned in the framework of the registry for carbon sinks are still in progress; consequently, a conservative approach was applied, hypothesising that the total deforested area is converted into settlements. 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.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).
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

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.

[48] Federici S, Vitullo M, Tulipano S, De Lauretis R, Seufert G, 2008. An approach to estimate carbon stocks change in forest carbon pools under the UNFCCC: the Italian case. iForest 1: 86-95 URL: http://www.sisef.it/iforest/

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 been supposed as not occurring in Italy, as total deforested area was assumed in transition into settlements. New data will become available in 2011, from the activities planned in the framework of the registry for carbon sinks; this will enable this assumption to be re-examined and new estimates to be produced if necessary.

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).
Several differences from previous KP-LULUCF submission affect each pool, as computation errors occurred in the previous submission were detected and corrected in the current submission. In addition, notable variations from previous submissions are due to the use of the dataset of European project Biosoil[49] for litter and soil data, to estimate carbon stock changes in litter and soils pools for activities under art. 3.3 and 3.4 of the Kyoto Protocol. Concerning afforestation/reforestation activities, the 2011 submission results in an average increase of 90.2% in net carbon stock changes for aboveground and of 89.8% for belowground pool. An average decrease of 102.3% for soils pool, respect the previous submission, emerges in 2011 submission, while remarkable variation results in dead wood pool and litter pools. Concerning deforestation activities, slight deviation are noticeable respect the previous submission for aboveground, belowground and dead wood pools (average decrease of 0.2%, 0.2% and 0.1%, respectively). A remarkable deviation results in litter pool (average decrease of 116% respect the 2010 submission), while an average increase of 5.8% affects the estimates of carbon stock changes in soils, for units of land under deforestation activities. With reference to forest management, the 2011 submission results in an average decrease of 111.2% in net carbon stock changes for aboveground, of 200% for belowground pools, an average decrease of 12.4% for soils pool, respect the previous submission. Remarkable variation results in dead wood pool and litter pools.

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 2009, in the table 10.2.

[49] BioSoil project – http://biosoil.jrc.ec.europa.eu/; http://forest.jrc.ec.europa.eu/contracts/biosoil

Aboveground biomass	E_{AG}	78.25%
Belowground biomass	E_{BG}	78.25%
Dead mass	E_D	83.92%
Litter	E_L	101.62%
Soil	E_S	113.00%
Overall uncertainty	E_{2008}	68.24%

Table 10.2 Uncertainties for the year 2009

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 cover the uncertainty of all gains and all losses in living tree biomass under FM and ARD. The Montecarlo analysis has been implemented for 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. Activities planned in the framework of the registry for carbon sinks are still in progress, therefore methodologies for area changes detection and the related uncertainties will be further developed. 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. A process of validation and verification of IUTI data has been put in place and is expected to supply data useful to update and improve the estimations. Moreover data on the last phase of national forest inventory, covering litter and soils pools, at NUT2 level, will be released in 2011, allowing Italy to report estimates of emissions and removals from litter and soils pools with a lower uncertainty.
On these bases, estimates presented in current submission for 2009 may change for the final report of the commitment period.

10.3.1.7 The year of the onset of an activity, if after 2008

Not applicable as the reporting is for the year 2008.

10.4 Article 3.3

Italy reports all emissions by sources and removals by sinks from 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 10.3) are included in the reporting of these activities:

- Planted or seeded croplands;
- Planted or seeded grasslands;
- Abandoned arable lands which are naturally forested

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[50]. 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 19/CMP.1[51], 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 these transitions are essentially due to political decisions under the EEC Regulations 2080/92 and 1257/99 (art.10.1 and 31.1), therefore induced by man.

Afforestation/Reforestation	**1990** *kha*	**2008** *kha*	**2009** *kha*
Abruzzo	4.7	90	95
Basilicata	2.4	46	49
Calabria	1.5	29	31
Campania	2.8	54	58
Emilia-Romagna	7.1	136	143
Friuli-Venezia Giulia	3.5	66	70
Lazio	6.1	117	123
Liguria	0.0	1	1
Lombardia	4.0	76	80
Marche	3.9	74	78
Molise	0.8	16	16
Piemonte	9.8	187	197
Puglia	1.2	23	25
Sardegna	5.3	100	105
Sicilia	2.9	56	59
Toscana	7.8	148	156
Trentino	5.0	95	156
Bolzano-Bozen	*2.3*	*52*	54
Trento	*2.7*	*43*	46
Umbria	2.6	49	52
Valle d'Aosta	1.0	19	20
Veneto	4.4	83	87
Italia	**77**	**1,465**	**1,543**

Table 10.3 Area estimates for 1990, and cumulative for 1990-2008 and 1990-2009 (kha) under Article 3.3 activities Afforestation/Reforestation.

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.

As for current submission no detailed information was available on the land use of the deforested area, a conservative approach was followed, hypothesising that the total deforested area is converted into settlements.

[50] In particular: Law Decree n. 227/2001; Law n. 353/2000; Law 1497/1939; Law Decree n. 3267/1923; 985, Law n. 431

[51] "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.

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 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).
Only total CO_2 emissions and removals from *forest management* (art. 3.4) has been assessed as key category, in accordance with the IPCC good practice guidance for LULUCF section 5.4.4. The value has been compared with Table 1.6 Key categories for the latest reported year (2009) 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 not been identified as key category either with Tier 2 approach, both in level and trend assessment. Moreover, total CO_2 emissions and removals from *Afforestation and reforestation* (art. 3.3) are not larger than the smallest UNFCCC key category. Therefore AR is stated to be not 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 (Tier 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 SEF tables are included in the submission as an Excel file named SEF_IT_2011_1_15-21-23 17-1-2011.xls. These tables report information on unit holdings in the Italian registry as well as on transfers of these units in 2010 to and from other Parties of the Kyoto Protocol.

11.2 Summary of information reported in the SEF tables

At the beginning of 2010, there were 2,426,381,281 AAUs in the IT registry of which 2,215,257,469 were in the party holding accounts and 211,123,812 in the entity holding accounts. The registry contained a total of 27,724,196 CERs: 7,411,755 in the Party holding accounts and 20,312,441 in the entity holding accounts.

At the end of 2010, there were 2,416,336,803 AAUs in the IT registry of which 2,185,496,062 were in the party holding accounts and 230,840,741 in the entity holding accounts.

The registry contained a total of 290,006 ERUs: 287,848 in the Party holding accounts and 2,158 in the entity holding accounts.

The registry contained a total of 34,874,612 CERs: 15,698,709 in the Party holding accounts and 19,175,903 in the entity holding accounts.

The registry does not contain any RMUs, t-CERs or l-CERs.

At the end of 2010, the total amount of the units in the registry corresponded to 2,451,501,421 tonnes CO2 eq. while Italy's assigned amount is 2,416,277,898 tonnes CO2 eq.

In total for 2010, the IT Registry received 182,734,218 AAUs, 1,340,006 ERUs and 20,643,648 CERs. Conversely, 192,778,696 AAUs, 1,050,000 ERUs and 13,493,232 CERs were externally transferred to other national registries. There were no transactions of any kind involving RMUs, tCERs or lCERs.

Full details are available in the SEF tables reported in Annex 8.

11.3 Discrepancies and notifications

During the reporting period (1st January 2010 - 31st December 2010), no invalid units have been detected, no non-replacements occurred, no notifications were received from the ITL. For a list of discrepant transactions, please refer to Table R-2 in the file included with this submission with the name “SIAR Reports 2011-IT v1.0”.

11.4 Publicly accessible information

Public information required by Decision 13/CMP.1 (account information, JI projects in Italy, holdings and overall transactions of units, authorised legal entities) is available on the registry website at http://www.greta.sinanet.isprambiente.it//.

In response to the recommendation from last year review process, a clear statement indicating which information is deemed as confidential has been put on the Registry website, together with reference to the relevant legislation supporting this confidentiality. The list of information publicly accessible has not changed from last year.

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 has not changed from the previous submission since it is based on the assigned amount and not on the most recent inventory.

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 and 2009 are given.

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Net emissions/removals(1)			Accounting Parameters(7)	Accounting Quantity (8)
	2008	2009	Total(6)		
A. Article 3.3 activities					
A.1. Afforestation and Reforestation					-13,038.80
A.1.1. Units of land not harvested since the beginning of the commitment period(2)	-6,329	-6,710	-13,039		-13,038.80
A.1.2. Units of land harvested since the beginning of the commitment period(2)					
A.2. Deforestation	388	390	778		778
B. Article 3.4 activities					
B.1. Forest Management (if elected)	-51,120	-48,451	-99,571		-50,966.67
3.3 offset(3)				0.00	0.00
FM cap(4)				50,966.67	-50,966.67

(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 activitity in accordance with the provisions of Article 7.4 of the Kyoto Protocol.

Table 11.1 Information table on accounting for activities under art. 3.3 and 3.4 of the Kyoto Protocol, for 2008 and 2009

12 Information on changes in national system

No changes with respect to the last year submission occurred in the Italian National System.

13 Information on changes in national registry

No relevant changes to the national registry have been made during 2010. Procedures have been implemented throughout the year in order to contract a new IT supplier for technical support and for the hosting and maintenance of the registry software. However the transition to the new premises and the upgrade to a new software version occurred only in January 2011.

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; MATTM, 2009).

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[52] 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[53], 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 (ex-APAT) 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. The second edition has updated information according to 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).

---

[52] **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."

[53] **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."

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 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[b]).

At European level, IA are 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, 2010[a]). Key questions on economic, social and environmental impacts in relation to third countries are listed in Table 14.1.

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[b]

Table 14.1 Questions in relation to impacts on Third countries

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[b]).

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 will also report 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 will be submitted in 2012 (European Commission, 2010[b]).

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[b]).

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[54] a companion to the OECD-country PEM[55] 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 4.6 in the Fifth National

[54] DEVPEM, Development Policy Evaluation Model

[55] PEM, Policy Evaluation Model examine the effects of agricultural policies in member countries

Communication (MATTM, 2009). Information of activities under Article 3 paragraphs 3 and 4 of the KP is described in ‘Chapter 10’ KP-LULUCF’ of this report.

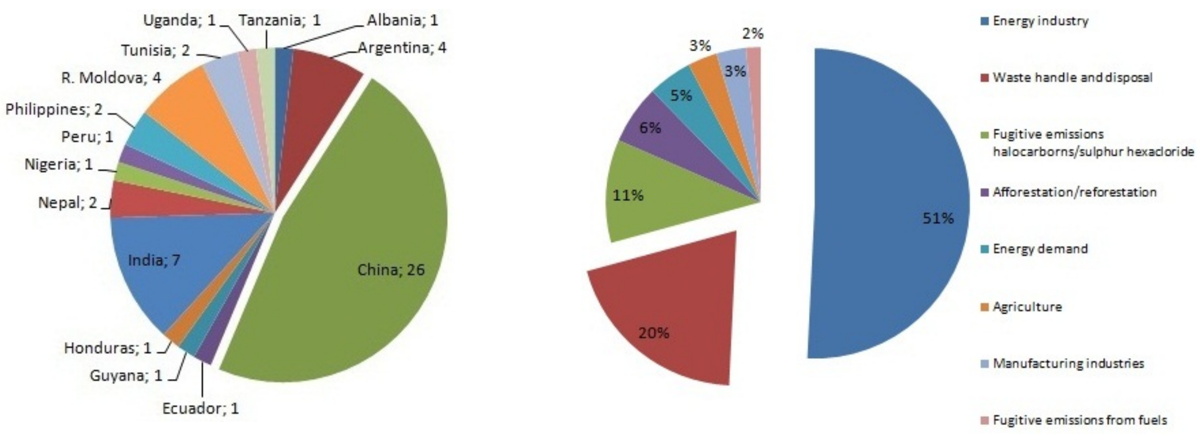
National and sectoral Italian policies are expected to have no direct impacts in developing countries. Policies and measures in the Italian energy sector aim to increase energy efficiency and develop a low-carbon energy system but in the context of a global energy scenarios that do not foresee a decline 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, 2011[a]). Direct contact with experts involved in the CDM project cycle and peer review article were revised. By the time CDM database was consulted world-wide 80% of CDM projects were registered in Asia and the Pacific Region, 18% in Latin America and Caribbean, 2% in Africa, and 0.5% Eastern Europe. The distribution of project by scope activity was mainly: energy industries (65%) and waste handling and disposal (15%). Registered projects by Host Party were mostly: China (43%), India (22%), Brazil (7%) and Mexico (4%). Italy as investor Party, contributes with 1.7% 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 day Italy is involved in the registration of 55 CDM projects (UNFCCC, 2011[a]). In Annex A8.2.4 a complete list of CDM projects is available. Projects by dimension are 58% large scale and 42% small-scale. Italy is the only proposer for 40% of the CDM projects. The distribution of CDM projects by Host country and scope is presented in Figure 14.1. CDM projects are mainly located in China (47%), India (13%), Argentina (7%), and Republic of Moldova (7%). Projects by scope are mainly related with the energy industry (51%) and waste handling and disposal (20%).



Source: UNFCCC (2011[a])

Figure 14.1 Italian CDM projects by Host country and scope (as for 16/02/2011)

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 (see 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 was consulted no JI projects were found for Italy (UNFCCC, 2011[b]). However, in the Italian Carbon Fund the 'Russian Federation:

Rosneft Associated Gas Recovery Project for the Komsomolskoye Oil Field' project is under a validation phase (Carbon Finance, 2011).

Voluntary validation of sustainable development is taking place at international level for CDM and JI projects. The UNEP Risoe Centre[56] database 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, 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). By the 1 February 2011, the UNEP Risoe Centre[57] database reports 381 JI projects (track1+track2) from which 211 projects are registered (87% track 1+13% track 2), and 2 of them are labelled with GS. By the 16 February 2011, from all registered CDM projects 2 were validated with CCB and 79 with GS (UNEP, 2011).

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

[56] http://uneprisoe.org/
[57] http://uneprisoe.org/ (accessed 07/02/2011)

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 an 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 an 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).

For this section we have accessed project databases (UNFCCC, Carbon Finance, UNEP Risoe Centre) and peer-reviewed articles. Eighteen out from fifty-five registered CDM projects (33%), in which Italy is involved, has participated to an international SD assessment (see Annex A8.2.4 for detail 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 4 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 (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 14.2 (OECD, 2011). 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, 2011). 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]).

	Italy				
	1998-99	**2006**	**2007**	**2008**	**2009**
NET DISBURSEMENTS			**USD million**		
I. Official Development Assistance (ODA) (A + B)	2 042	3 641	3 971	4 861	3 297
ODA as % of GNI	**0.17**	**0.20**	**0.19**	**0.22**	**0.16**
A. Bilateral Official Development Assistance (1 + 2)	574	2 001	1 270	1 838	875
1. Grants and grant-like contributions	588	2 147	1 252	1 919	871
of which: Technical co-operation	47	171	141	153	90
Developmental food aid	41	6	15	54	40
Humanitarian aid	54	74	83	119	114
Contributions to NGOs	19	10	-	0	0
Administrative costs	26	56	49	67	59
2. Development lending and capital	- 13	- 146	19	- 81	4
of which: New development lending	- 73	- 155	36	- 71	0
B. Contributions to Multilateral Institutions	1 468	1 640	2 700	3 022	2 423
Grants and capital subscriptions, Total	1 468	1 640	2 700	3 022	2 423
of which: EU	693	1 316	1 494	1 713	1 862
IDA	394	30	35	556	214
Regional Development Banks	165	16	10	351	24
II. Other Official Flows (OOF) net (C + D)	- 95	- 957	- 261	408	- 72
C. Bilateral Other Official Flows (1 + 2)	- 95	- 957	- 261	408	- 72
1. Official export credits (a)	13	38	81	34	- 28
2. Equities and other bilateral assets	- 108	- 995	- 342	374	- 44
D. Multilateral Institutions	-	-	-	-	-
III. Grants by Private Voluntary Agencies	34	123	63	105	162
IV. Private Flows at Market Terms (long-term) (1 to 4)	10 273	2 705	649	207	2 181
1. Direct investment	1 734	1 151	1 353	1 544	129
2. Private export credits	455	2 602	2 843	2	463
3. Securities of multilateral agencies	-	-	-	-	-
4. Bilateral portfolio investment	8 083	-1 049	-3 547	-1 339	1 590
V. Total Resource Flows (long-term) (I to IV)	**12 254**	**5 512**	**4 422**	**5 581**	**5 569**
Total Resource Flows as a % of GNI	**1.05**	**0.30**	**0.21**	**0.25**	**0.27**

Source: OECD (2011)

Table 14.2 Financial resources to developing countries and multilateral organisations from Italy

Italian multilateral cooperation on climate change has been performed with different United Nations organizations, funds, and institutions[58]. 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[59]. 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 Fifth National Communication from Italy (MATTM, 2007; 2009).
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 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 Fifth National Communication under the UNFCCC, Chapter 5 Projections and effects of policies and measures and Chapter 7 Financial resources and transfer of technology (MATTM, 2009). The preparation of this paragraph was discussed with energy experts from ISPRA (ISPRA, 2011[a], [b]).

[58] 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).

[59] 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).

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[b]). 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[b]).

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).

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).

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). 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, with 39 CDM projects being registered in 2009 alone. This makes Enel the company with the second-largest number of registered projects in the world. As for the JI mechanism, the Enel Group's portfolio includes 7 directly-managed projects in Uzbekistan and Ukraine and 14 initiatives of participation in funds in Russia, Moldova and Ukraine (ENEL, 2010).

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]).

15 REFERENCES

References for the main chapters and the annexes are listed here and are organised by chapter and annex.

15.1 INTRODUCTION

APAT, 2005. Quality Assurance/Quality Control plan for the Italian Inventory. September 2005. Internal document.

APAT, 2006 [a]. Quality Assurance/Quality Control plan for the Italian Emission Inventory. Procedures Manual. June 2006

APAT, 2006 [b]. Quality Assurance/Quality Control plan for the Italian Emission Inventory. Year 2006. June 2006

APAT, 2007 [a]. Quality Assurance/Quality Control plan for the Italian Emission Inventory. Year 2007. June 2007.

APAT, 2007 [b]. Carbon Dioxide Intensity Indicators. May 2007.

APAT, 2008 [a]. National Greenhouse Gas Inventory System in Italy. April 2008.

APAT, 2008 [b]. Quality Assurance/Quality Control plan for the Italian Emission Inventory. Year 2008. April 2008.

EC, 2005. Commission decision of 10 February 2005 laying down rules implementing Decision No 280/2004/EC concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol. 2005/166/EC.

Ecofys, 2001. Evaluation of national climate change policies in EU member states. Country report on Italy, The Netherlands 2001.

EMEP/CORINAIR, 2007. Atmospheric Emission Inventory Guidebook. Technical report No 16/2007.

EMEP/EEA, 2009. Air Pollutant Emission Inventory Guidebook. Technical report No 9/2009.

ENEA/MAP/APAT, 2004. Energy data harmonization for CO_2 emission calculations: the Italian case. Rome 23/02/04. EUROSTAT file n. 200245501004.

IPCC 2006, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds).Published: IGES, Japan

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Centre, Meteorological Office, Bracknell, UK.

IPCC, 2000. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. IPCC National Greenhouse Gas Inventories Programme, Technical Support Unit, Hayama, Kanagawa, Japan.

IPCC, 2003. Good Practice Guidance for Land Use, Land-Use Change and Forestry. IPCC Technical Support Unit, Kanagawa, Japan.

ISPRA, 2009 [a]. Quality Assurance/Quality Control plan for the Italian Emission Inventory. Year 2009. May 2009.

ISPRA, 2009 [b]. La disaggregazione a livello provinciale dell'inventario nazionale delle emissioni. Anni 1990-1995-2000-2005. ISPRA, 92/2009.

ISPRA, 2011 [a]. National Greenhouse Gas Inventory System in Italy. April 2011.

ISPRA, 2011 [b]. Quality Assurance/Quality Control plan for the Italian Emission Inventory. Year 2011.

ISPRA, several years. Dioxide Intensity Indicators. Internal document.

Liburdi R., De Lauretis R., Corrado C., Di Cristofaro E., Gonella B., Romano D., Napolitani G., Fossati G., Angelino E., Peroni E., 2004. La disaggregazione a livello provinciale dell'inventario nazionale delle emissioni". Rapporto APAT CTN-ACE 2004.

Romano D., Bernetti A., De Lauretis R., 2004. Different methodologies to quantify uncertainties of air emissions. Environment International vol 30 pp 1099-1107.

UNFCCC, 2007 [a]. Report of the individual review of the greenhouse gas inventory of Italy submitted in 2006. FCCC/ARR/2006/ITA. UNFCCC, 11 December 2007.

UNFCCC, 2007 [b]. Report of the review of the initial report of Italy. FCCC/IRR/2007/ITA. UNFCCC, 10 December 2007.

UNFCCC, 2009. Report of the individual review of the greenhouse gas inventories of Italy submitted in 2007 and 2008. FCCC/ARR/2008/ITA. UNFCCC, 16 January 2009.

UNFCCC, 2010. Report of the individual review of the greenhouse gas inventories of Italy submitted in 2009. FCCC/ARR/2009/ITA. UNFCCC, 12 February 2010. http://unfccc.int/resource/docs/2010/arr/ita.pdf (last access 04/04/2011).

15.2 ENERGY [CRF sector 1]

ACI, several years. Annuario statistico. Automobile Club d'Italia, Roma.
http://www.aci.it/index.php?id=54 (last access 04/04/2011).

ADEME, 2005. Recherche et développement: histoires de réussites. Agence de l'Environnement et de la Maîtrise de l'Energie, 2005.

AEEG, several years. Qualità del servizio gas. Autorità per l'energia elettrica e il gas. http://www.autorita.energia.it/it/dati/dati_statistiche.htm (last access 04/04/2011).

AISCAT, several years. Aiscat in cifre. Data and reports available on website at:
http://www.aiscat.it/pubb_cifre.htm?ck=1&sub=3&idl=4&nome=pubblicazioni&nome_sub=aiscat%20in%20cifre (last access 04/04/2011).

ANCMA, several years. Data available on website at: http://www.ancma.it/it/publishing.asp (last access 04/04/2011).

ANPA, 2001. Redazione di inventari nazionali delle emissioni in atmosfera nei settori del trasporto aereo e marittimo e delle emissioni biogeniche. Rapporto finale. Gennaio 2001.

APAT, 2003 [a]. Indicatori e modelli settoriali finalizzati alla preparazione di inventari delle emissioni del sistema energetico nazionale nel breve e medio periodo. Tricarico A., Rapporto Tecnico N° 01/2003.

APAT, 2003 [b]. Analisi dei fattori di emissione di CO_2 dal settore dei trasporti. Ilacqua M., Contaldi M., Rapporti n° 28/2003.

ASSOCARTA, several years. Rapporto Ambientale dell'industria cartaria italiana. Also available on the website http://www.assocarta.it (last access 04/04/2011).

CONFETRA, several years. Il trasporto merci su strada in Italia. Data and reports available on website at: http://www.confetra.it/it/centrostudi/statistiche.htm (last access 04/04/2011).

Contaldi M., 1999. Inventario delle emissioni di metano da uso gas naturale. ANPA, internal document.

EC, 2009. Proposal for a Commission Decision amending Decision 2007/589/EC as regards the inclusion of monitoring and reporting guidelines for emissions and tonne-kilometre data from aviario activities. Commission of the European Communities, 2009 (draft).

EDISON, several years. Rendiconto ambientale e della sicurezza.

EEA, 2000. COPERT III, Computer Programme to Calculate Emissions from Road Transport - Methodology and Emission Factors, European Environment Agency, Technical report No 49, November 2000.

EEA, 2007. COPERT 4, Computer programme to calculate emissions from road transport. European Environment Agency, December 2007. http://lat.eng.auth.gr/copert/docs.htm

EEA, 2010. COPERT 4, Computer programme to calculate emissions from road transport. European Environment Agency, March 2010. http://lat.eng.auth.gr/copert/ (last access 04/04/2011).

EEA, 2010. COPERT 4, Computer programme to calculate emissions from road transport. European Environment Agency, October 2010. http://lat.eng.auth.gr/copert/ (last access 04/04/2011).

EMEP/CORINAIR, 2007. Atmospheric Emission Inventory Guidebook. Technical report No 16/2007.

EMEP/EEA, 2009. Air Pollutant Emission Inventory Guidebook. EEA. Technical report No 9/2009.

ENAC/MINT, several years. Annuario Statistico. Ente Nazionale per l'Aviazione Civile, Ministero delle Infrastrutture e dei Trasporti.

ENEA, several years. Rapporto Energia Ambiente. Ente per le Nuove tecnologie, l'Energia e l'Ambiente, Roma.

ENEL, several years. Dati statistici sull'energia elettrica in Italia. ENEL.

ENI, several years [a]. La congiuntura economica ed energetica. ENI.

ENI, several years [b]. Health Safety Environment report. ENI.

Frustaci F., 1999. Metodi di stima ed analisi delle emissioni inquinanti degli off-road. Thesis in Statistics.

Giordano R., 2007. Trasporto merci: criticità attuali e potenziali sviluppi nel contesto europeo. National road transporters central commitee.

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Centre, Meteorological Office, Bracknell, UK.

IPCC, 2000. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. IPCC National Greenhouse Gas Inventories Programme, Technical Support Unit, Hayama, Kanagawa, Japan.

IPCC 2006, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds).Published: IGES, Japan

ISTAT, 2009. Personal comunication.

ISTAT, several years [a]. Annuario Statistico Italiano. Istituto Nazionale di Statistica.

ISTAT, several years [b]. Trasporto merci su strada. Istituto Nazionale di Statistica. http://www.istat.it/dati/dataset/20070109_00/ (last access 04/04/2011).

Kouridis C., Gkatzoflias D., Kioutsioukis I., Ntziachristos L., Pastorello C., Dilara P., 2010. Uncertainty Estimates and Guidance for Road Transport Emission Calculations, European Commission, Joint Research Centre, Institute for Environment and Sustainability, 2010, http://www.emisia.com/docs/COPERT%20uncertainty.pdf (last access 04/04/2011).

MINT, several years. Conto Nazionale delle Infrastrutture e dei Trasporti (CNT). Ministero delle Infrastrutture e dei Trasporti. http://www.mit.gov.it/mit/site.php?o=vc&lm=2&id_cat=148 (last access 04/04/2011).

MSE, several years [a]. Bilancio Energetico Nazionale (BEN). Ministero delle Attività Produttive, Direzione Generale delle Fonti di Energia ed industrie di base. http://dgerm.sviluppoeconomico.gov.it/dgerm/ben.asp (last access 04/04/2011).

MSE, several years [b]. Bollettino Petrolifero Trimestrale (BPT). Ministero delle Attività Produttive.

Patel M.K., Tosato G.C., 1997. Understanding Non-energy Use and Carbon Storage in Italy in the Context of the Greenhouse Gas Issue.

Riva A., 1997. Methodology for methane emission inventory from SNAM transmission system. Snam Spa Italy.

Romano D., Gaudioso D., De Lauretis R., 1999. Aircraft Emissions: a comparison of methodologies based on different data availability. Environmental Monitoring and Assessment. Vol. 56 pp. 51-74.

Techne, 2009. Stima delle emissioni in atmosfera nel settore del trasporto aereo e marittimo. Final report. TECHNE Consulting, March 2009.

Terna, several years. Dati statistici sugli impianti e la produzione di energia elettrica in Italia. Gestore Rete Trasmissione Nazionale. www.terna.it (last access 04/04/2011).

Trozzi C., Vaccaro R., De Lauretis R., Romano D., 2002 [a]. Air pollutant emissions estimate from global air traffic in airport and in cruise: methodology and case study. Presented at Transport and Air Pollution 2002.

Trozzi C., Vaccaro R., De Lauretis R., 2002 [b]. Air pollutant emissions estimate from global ship traffic in port and in cruise: methodology and case study. Presented at Transport and Air Pollution 2002.

UNFCCC, 2007. Report of the individual review of the greenhouse gas inventory of Italy submitted in 2006. FCCC/ARR/2006/ITA. UNFCCC, 11 December 2007.

UNFCCC, 2009. Report of the individual review of the greenhouse gas inventories of Italy submitted in 2007 and 2008. FCCC/ARR/2008/ITA. UNFCCC, 16 January 2009.

UP, several years. Previsioni di domanda energetica e petrolifera in Italia. Unione Petrolifera.

15.3 INDUSTRIAL PROCESSES [CRF sector 2]

A2A, several years. Bilancio di Sostenibilità. A2A.

ACEA, 2004. Personal Communication. ACEA.

ACEA, several years. Bilancio di Sostenibilità. ACEA

AEM, several years. Rapporto Ambientale. AEM.

AITEC, 2004. Posizione dell’industria cementiera in merito al Piano Nazionale di Allocazione delle emissioni di gas ad effetto serra. Roma 19/03/2004.

AITEC, several years. L’industria Italiana del Cemento. Associazione italiana tecnico economica del cemento.

ALCOA, 2004. Primary Aluminium in Italy. ALCOA.

ALCOA, several years. Personal Communication. ALCOA.

ALCOA, 2010. Personal Communication. ALCOA.

ANDIL, 2000. Primo rapporto ambientale dell’industria italiana dei laterizi. Assolaterizi, Associazione nazionale degli industriali dei laterizi.

ANDIL, several years. Indagine conoscitiva sui laterizi. Assolaterizi, Associazione nazionale degli industriali dei laterizi.

ANIE, several years. Personal Communication. ANIE Federazione.

APAT, 2003. Il ciclo industriale dell’acciaio da forno elettrico. Agenzia per la Protezione dell’Ambiente e per i servizi tecnici, Rapporti 38/2003.

ASSOMET, several years. I metalli non ferrosi in Italia. Associazione nazionale industrie metalli non ferrosi.

ASSOPIASTRELLE, 2004. L’industria italiana delle piastrelle di ceramica e la Direttiva 2003/87.

ASSOPIASTRELLE, several years. Indagine statistica nazionale. Industria italiana delle piastrelle di ceramica. Assopiastrelle, Associazione nazionale dei produttori di piastrelle di ceramica e di materiali refrattari.

ASSURE, 2005. Personal Communication. European Association for Responsible Use of HFCs in Fire Fighting.

Boehringer Ingelheim, several years. Personal Communication. Boehringer Ingelheim Istituto De Angeli.

CAGEMA, 2005. Politiche e misure per la riduzione delle emissioni di gas serra: il settore della calce. Associazione dell’industria italiana della calce, del gesso e delle malte.

CARBITALIA SPA, 2009, Personal Communication

Chiesi Farmaceutici, several years. Personal Communication. Chiesi Farmaceutici S.p.A.

CNH, several years. Personal Communication. Case New Holland.

Coferc, 2008. F-Gas EC Reporting.

CTN/ACE, 2000. Rassegna delle informazioni disponibili sulle emissioni di diossine e furani dal settore siderurgico e della metallurgia ferrosa. A cura di Pasquale Spezzano.

EC, 2006. Regulation n. 842/2006 of the European Parliament and of the Council of 17 May 2006 on certain fluorinated greenhouse gases.

ECOFYS, 2009. Sectoral Emission Reduction Potentials and Economic Costs for Climate Change (SERPEC-CC) – Industry and Refineries Sector, Martijn Overgaag (Ecofys), Robert Harmsen (Ecofys), Andreas Schmitz (JRC-IPTS). October 2009.

EDIPOWER, 2003. Rapporto Ambientale 2003. EDIPOWER.

EDIPOWER, 2007. Rapporto di Sostenibilità 2007. EDIPOWER.

EDIPOWER, 2009. Rapporto di Sostenibilità 2008. EDIPOWER.

EDISON, 2009. Bilancio di Sostenibilità 2008, EDISON.

EDISON, several years. Bilancio Ambientale. EDISON.

EMEP/CORINAIR, 2007. Atmospheric Emission Inventory Guidebook. Technical report No 16/2007.

ENDESA, 2004. Personal Communication. ENDESA.

ENDESA, several years [a]. Rapporto ambiente e sicurezza. ENDESA.

ENDESA, several years [b]. Rapporto di sostenibilità. ENDESA.

ENEL, several years. Rapporto ambientale. ENEL.

ENIRISORSE, several years. Statistiche metalli non ferrosi. ENIRISORSE.

FEDERACCIAI, 2004. Personal Communication.

FEDERACCIAI, 2008. Rapporto ambientale Federacciai 2007

FEDERACCIAI, several years. La siderurgia in cifre. Federazione Imprese Siderurgiche Italiane.

FEDERCHIMICA, several years. La chimica in cifre. Federazione Nazionale dell'Industria Chimica.

FIAT, several years. Personal Communication.

General Gas, several years. F-Gas EC Reporting.

GSK, several years. Personal Communication. GlaxoSmithKline S.p.A.

IAI, 2003. The Aluminium Sector Greenhouse Gas Protocol (Addendum to the WBCSD/WRI Greenhouse Gas Protocol). Greenhouse Gas Emission Monitoring and Reporting by the Aluminium Industry. International Aluminium Institute, May 2003.

IAI, 2006. The Aluminium Sector Greenhouse Gas Protocol (Addendum to the WBCSD/WRI Greenhouse Gas Protocol). Greenhouse Gas Emission Monitoring and Reporting by the Aluminium Industry. International Aluminium Institute, October 2006.

ILVA, 2006. Analisi ambientale iniziale. Rev. 2, March 2006. IPPC permitting process.

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Centre, Meteorological Office, Bracknell, UK.

IPCC, 2000. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. IPCC National Greenhouse Gas Inventories Programme, Technical Support Unit, Hayama, Kanagawa, Japan.

IPCC, 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

IPPC, 2001. Best Available Techniques Reference Document on the Production of Iron and Steel. Integrated Pollution Prevention and Control. European Commission. December 2001.

ISPESL, 2005. Profilo di rischio e soluzioni. Metallurgia. Produzione ferroleghe. Edited by A. Borroni

ISTAT, 2003. Bollettino mensile di statistica.

ISTAT, several years. Annuario Statistico Italiano. Istituto Nazionale di Statistica.

Italghisa, 2011. Personal communication

IVECO, several years. Personal Communication.

Lusofarmaco, several years. Personal Communication. Istituto Luso Farmaco d'Italia S.p.A.

Magnesium products of Italy, several years. Personal Communication. Meridian Technologies Inc. - Magnesium Products of Italy.

Mariel, several years. F-Gas EC Reporting.

Menarini, several years. Personal Communication. Industrie farmaceutiche riunite.

MICRON, several years. Personal Communication. Micron Technology Italia S.r.l.

Norsk Hydro, several years. Personal Communication.

Numonyx, several years. Personal Communication. Numonyx Italy S.r.l.

Polimeri, several years. Personal Communication. Polimeri Europa S.p.A.

Radici Chimica, 1993. Progetto CORINAIR. Produzione acido adipico: descrizione del processo utilizzato da Radici Chimica. Radici Group, Novara.

Radici Chimica, several years. Personal Communication.

Safety Hi Tech, 2008. Personal Communication. Safety Hi Tech S.r.l.

Safety Hi Tech, several years. F-Gas EC Reporting.

Sanofi Aventis, several years. Personal Communication. Sanofi Aventis Italia.

Sinteco, several years. F-Gas EC Reporting.

Siteb, several years. Rassegna del bitume.

Solvay, 2003. Bilancio di Sostenibilità Solvay 2002. Solvay Solexis S.p.A.

Solvay, 2008. Personal Communication. Solvay Fluor Italia.

Solvay Fluor Italia, several years. F-Gas EC Reporting.

Solvay, several years. Personal Communication. Solvay Solexis S.p.A.

Sotacarbo, 2004. Progetto integrato miniera centrale. Studio di fattibilità sito di Portovesme.

ST Microelectronics, several years. Personal Communication. ST Microelectronics.

Syndial, several years. Personal Communication. Syndial S.p.A. – Attività diversificate

Synthesis Chimica, several years. F-Gas EC Reporting.

Tazzetti, several years. F-Gas EC Reporting.

TERNA, several years. Rapporto di Sostenibilità. TERNA.

Trench Italia, several years. F-Gas EC Reporting.

UN, several years. Industrial Commodity Statistics Yearbook. United Nation.

UNFCCC, 2007. Report of the review of the initial report of Italy. FCCC/IRR/2007/ITA 10 December 2007.

UNFCCC, 2009. Report of the individual review of the greenhouse gas inventories of Italy submitted in 2007 and 2008. FCCC/ARR/2008/ITA 16 January 2009.

UNFCCC, 2010. Report of the individual review of the greenhouse gas inventories of Italy submitted in 2010. FCCC/ARR/2010/ITA 22 November 2010.

UNRAE, several years. Personal Communication. Unione Nazionale Rappresentanti Autoveicoli Esteri.

USEPA, 1997. “Compilation of Air Pollutant Emission Factors”. AP-42, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. October 1997.

USGS, several years. Mineral yearbook. Ferroalloys.

YARA, 2007. Technical documentations from IPPC permit issuing process.

YARA, several years. Personal Communication.

15.4 SOLVENT AND OTHER PRODUCT USE [CRF sector 3]

AIA, several years [a]. Personal Communication. Associazione Italiana Aerosol.

AIA, several years [b]. Relazioni annuali sulla produzione italiana aerosol. Associazione Italiana Aerosol.

Assocasa, several years. Personal Communication.

Assogastecnici, several years. Personal Communication.

AVISA, several years. Personal Communication.

Benndorf R., 1999. Situation in Deutschland. ACCC-Workshop ‘N2O und das Kyoto-Ziel’, Umweltbundesamt (Berlin), Wien.

Co.Da.P., 2005. Personal Communication.

EC, 1999. Council Directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations. Official Journal of the European Communities 29 March 1999.

EC, 2002. Screening study to identify reduction in VOC emissions due to the restrictions in the VOC content of products. Final Report of the European Commission, February 2002.

EC, 2004. Directive 2004/42/EC of the European Parliament and of the Council of 21 April 2004 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in decorative paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC. Official Journal of the European Communities 30 April 2004.

EEA, 1997. CORINAIR 94 Summary Report, Report to the European Environment Agency from the European Topic Centre on Air Emission.

EMEP/CORINAIR, 2007. Atmospheric Emission Inventory Guidebook. Technical report No 16/2007.

EMEP/CORINAIR, 2008. Atmospheric Emission Inventory Guidebook. Draft.

ENEA/USLRMA, 1995. Lavanderie a secco.

FAO, several years. Food balance. http://faostat.fao.org (last access 04/04/2011).

FIAT, several years. Rendiconto Ambientale. Gruppo Fiat.

Folchi R., Zordan E., 2004. Il mercato degli esplosivi in Italia. Costruzioni, 28/1/2004.

GIADA, 2006. Progetto Giada and Personal Communication. ARPA Veneto – Provincia di Vicenza.

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Centre, Meteorological Office, Bracknell, UK.

ISTAT, several years [a]. Annuario Statistico Italiano.

ISTAT, several years [b]. Bollettino mensile di statistica.

ISTAT, several years [c]. http://www.istat.it (last access 04/04/2011).

ISTAT, several years [d]. Personal communication.

Offredi P., several years. Professione Verniciatore del Legno. Personal communication.

Regione Campania, 2005. Inventario regionale delle emissioni di inquinanti dell’aria della Regione Campania, marzo 2005.

Regione Toscana, 2001. Inventario regionale delle sorgenti di emissione in aria ambiente, febbraio 2001.

TECHNE, 1998. Personal communication.

TECHNE, 2004. Progetto MeditAiraneo. Rassegna dei fattori di emissione nazionali ed internazionali relativamente al settore solventi. Rapporto Finale, novembre 2004.

TECHNE, 2008. Fattori di emissione per l’utilizzo di solventi. Rapporto Finale, marzo 2008.

UNIPRO, several years. Rapporto Annuale - Consumi cosmetici in Italia.

Vetrella G., 1994. Strategie ottimali per la riduzione delle emissioni di composti organici volatili. Thesis in Statistics.

15.5 AGRICULTURE [CRF sector 4]

ADBPO, 1994. Piano delle direttive e degli interventi urgenti per la lotta all'eutrofizzazione delle acque interne e del mare Adriatico. Autorità di bacino del fiume Po. Parma - Italia.

ADBPO, 2001. Progetto di Piano stralcio per il controllo dell'Eutrofizzazione (PsE).Autorità di bacino del fiume Po. Relazione generale. Parma - Italia.

AIA, 2010. Controlli della produttività del latte in Italia - Statistiche Ufficiali - Anno 2009. Associazione Italiana Allevatori. Italia. http://www.aia.it/bollettino/bollettino.htm (last access 04/04/2011).

ANPA-ONR, 2001. I rifiuti del comparto agro-alimentare, Studio di settore. Agenzia Nazionale per la Protezione dell'Ambiente. Rapporto n. 11/2001. Roma –Italia.

APAT, 2004[a]. Linee guida per l'utilizzazione agronomica degli effluenti di allevamento, Fase 2 Effluenti zootecnici, Risultati di una indagine campionaria sulle caratteristiche degli effluenti di allevamento, a cura di CRPA. Reggio Emilia – Italia.

APAT, 2004[b]. Linee guida per l'utilizzazione agronomica degli effluenti di allevamento, Fase 2 Effluenti zootecnici, Risultati di una indagine campionaria sulle tipologie di stabulazione e di stoccaggio, a cura di CRPA. Reggio Emilia – Italia.

APAT, 2005. Methodologies used in Italy for the estimation of air emission in the agriculture sector. Technical report 64/2005. Rome - Italy.

ASSONAPA, 2006. Database of goat and sheep animal consistency and breeds. Associazione Nazionale della Pastorizia Ufficio Centrale dei Libri Genealogici e dei Registri Anagrafici, Italy. http://www.assonapa.com/ (last access 04/04/2011).

Baldoni R., Giardini L., 1989. Coltivazione erbacee. Editor Patron, p 1072. Bologna, Italia.

Barile, V.L., 2005. Improving reproductive efficiency in female buffaloes. Livest. Prod. Sci. 92, 83–194.

Bonazzi G., Crovetto M., Della Casa G., Schiavon S., Sirri F., 2005, Evaluation of Nitrogen and Phosphorus in Livestock manure: Southern Europe (Italy). In Workshop: Nutrients in livestock manure, Bruxelles, 14 February 2005.

Borgioli E., 1981. Nutrizione e alimentazione degli animali domestici. Edagricole, p. 464.

Butterbach-Bahl K., Papen H., Rennenberg H., 1997. Impact of rice transport through cultivars on methane emission from rice paddy fields. Plant, Cell and Environment. 20:1175-1183.

CESTAAT, 1988. Impieghi dei sottoprodotti agricoli ed agroindustriali, Vol. 1. Centro Studi sull'Agricoltura, l'Ambiente e il Territorio, p. 311.

Cóndor G.R., Vitullo, M., De Lauretis, R., 2005. Contribution of ISTAT statistics to the National Air Emission Inventory of the Agriculture sector. In: Convegno "AGRISTAT - Statistiche Agricole" 30 - 31 Maggio 2005. Florence - Italy.

Cóndor R.D. 2006. Agricoltura. Oral presentation "Cambiamenti Climatici e inquinamento atmosferico. L'inventario nazionale delle emissioni come strumento di conoscenza e verifica dello stato dell'ambiente", 23-24 October 2006 Rome - Italy. http://www.apat.gov.it/site/_files/Doc_emissioni/RocioCondor.pdf (last access 04/04/2011).

Cóndor, R.D., De Lauretis, R. 2007. Agriculture air emission inventory in Italy: synergies among conventions and directives. In: Ammonia Conference abstract book. Ed. G.J. Monteny, E. Hartung, M. van den Top, D. Starmans. Wageningen Academic Publishers. 19-21 March 2007, Ede - The Netherlands.

Cóndor, R.D., De Lauretis, R., Lupotto, E., Greppi, D., Cavigiolo S. 2007[a]. Methane emission inventory for the rice cultivation sector in Italy. In: Proceeding of the Fourth Temperate Rice Conference". Ed. S. Bocchi, A. Ferrero, A. Porro. 25-28 June Novara –Italy.

Cóndor, R.D., Vitullo, M. De Lauretis, 2007[b]. Emissioni ed assorbimenti di gas serra dai settore Agricoltura e Uso del Suolo e Foreste in Italia. Dipartimento Stato dell'Ambiente e Metrologia Ambientale, APAT. Poster presented *"Conferenza Nazionale sui Cambiamenti Climatici 2007"*. 12-13 September, Rome - Italy. http://www.apat.gov.it/site/_files/CNCC2007Sintesilavori.pdf (last access 04/04/2011).

Cóndor, R.D., Valli L., De Rosa G., Di Francia A., De Lauretis R. 2008[a]. Estimation of the methane emission factor for the Italian Mediterranean buffalo. International Journal of Animal Biosciences 2:1247-1253.

Cóndor R., De Lauretis R., Romano D., Vitullo M. 2008[b]. Inventario nazionale delle emissioni di particolato e principali fonti di emissione. In: Atti 3° Convegno Nazionale sul Particolato Atmosferico. Il particolato atmosferico: la conoscenza per l'informazione e le e le strategie di intervento Bari 6-8 Ottobre, Italia.

Cóndor, R.D., Cristofaro, E. De Lauretis, R. 2008[c]. Agricoltura: inventario nazionale delle emissioni e disaggregazione provinciale. Istituto superiore per la protezione e la ricerca ambientale, ISPRA Rapporto tecnico 85/2008. Roma, Italia. http://www.apat.gov.it/site/it-IT/APAT/Pubblicazioni/Rapporti/Documento/rapporto_85_2008.html (last access 04/04/2011).

Cóndor, R.D., De Lauretis, R. 2009. I gas serra prodotti dall'agricoltura. L'Informatore Agrario 34/2009.

Cóndor, R.D., Vitullo, M. 2010. Emissioni di gas serra dall'agricoltura, selvicoltura ed altri usi del suolo in Italia. Agriregionieuropa Anno 6, Numero 21 Giugno 2010. http://agriregionieuropa.univpm.it/pdf.php?id_articolo=619 (last access 04/04/2011).

Cóndor, R.D., 2011. Procedura per la preparazione, caricamento e *reporting* dell'inventario nazionale delle emissioni 1990-2009, le emissioni provvisorie del 2010 e gli scenari emissivi del 2015 e 2020 settore: Agricoltura. Internal report ISPRA. Rome, Italy.

Confalonieri R., Bocchi S. 2005. Evaluation of CropSyst for simulating the yield of flooded rice in northern Italy. European Journal of Agronomy. 2005, 23, 315 – 326.

Consorzio per la tutela del formaggio Mozzarella di Bufala Campana, 2002. Modello di Regolamento per la gestione igienica ed alimentare dell'allevamento bufalino in relazione alla produzione della mozzarella di bufala campana DOP. Edit. Consorzio per la tutela del formaggio mozzarella di bufala campana (Campana Mozzarella Consortium).

CRPA, 1993. Manuale per la gestione e utilizzazione agronomica dei reflui zootecnici. Regione Emilia Romagna, Assessorato agricoltura.

CRPA, 1996. Biogas e cogenerazione nell'allevamento suino. Manuale pratico. ENEL, Direzione studi e ricerche, Centro ricerche ambiente e materiali. Milano – Italia.

CRPA, 1997 [a]. Piani Regionali di Risanamento e tutela della qualità dell'aria. Quadro delle azioni degli enti locali per il settore zootecnico delle aree padane. Allegato 2. Relazione di dettaglio sulla metodologia adottata per la quantificazione delle emissioni di metano. Febbraio 1997.

CRPA, 1997 [b]. Piani Regionali di Risanamento e tutela della qualità dell'aria. Quadro delle azioni degli enti locali per il settore zootecnico delle aree padane. Relazione di dettaglio sulla metodologia adottata per la quantificazione delle emissioni di protossido di azoto. Settembre 1997.

CRPA, 2000. Aggiornamento dell'inventario delle emissioni in atmosfera di ammoniaca, metano e protossido di azoto dal comparto agricolo. Centro Ricerche Produzioni Animali. Gennaio 2000.

CRPA, 2004[a]. L'alimentazione della vacca da latte. Edizioni L'Informatore Agrario. Terza edizione, Centro Ricerche Produzioni Animali.

CRPA, 2004[b]. Personal communication, expert in dairy cattle feeding from the Research Centre on Animal Production (CRPA), Maria Teresa Pacchioli.

CRPA, 2004[c]. Personal communication, expert in greenhouse gases emissions from the agriculture sector from the Research Centre on Animal Production (CRPA), Laura Valli.

CRPA, 2005. Personal communication, working group with experts in animal feeding from the Research Centre on Animal Production (CRPA), Maria Teresa Pacchioli and Paola Vecchia.

CRPA, 2006[a]. Progetto MeditAIRaneo: settore Agricoltura. Relazione finale. Technical report on the framework of the MeditAIRaneo project for the Agriculture sector, Reggio Emilia - Italia.

CRPA, 2006[b], Predisposizione di scenari di emissione finalizzati alla progettazione di interventi per la riduzione delle emissioni nazionali di ammoniaca ed alla valutazione di misure e di progetti per la tutela della qualità dell'aria a livello regionale. Final report. Reggio Emilia – Italy.

CRPA, 2008. Le scelte politiche energetico-ambientali lanciano il biogas. L'Informatore Agrario 3/2008, p.28-32.

CRPA, 2009. Valutazione dell'entità delle emissioni ammoniacali derivanti dall'applicazione al suolo dei fertilizzanti, delle loro possibilità di riduzione e individuazione degli elementi per un monitoraggio statistico delle tecniche di applicazione utilizzate. Final report. Reggio Emilia – Italy.

CRPA, 2010. Personal communication - experts Laura Valli and Maria Teresa Pacchioli from the Research Centre on Animal Production (expert consultation on N excretion and national production systems). Reggio Emilia, Italy.

CRPA/AIEL, 2008. Energia dal biogas prodotto da effluenti zootecnici, biomasse dedicate e di scarto. Ed. Associazione Italiana Energie Ambientali (AIEL).

CRPA/CNR, 1992. Indagine sugli scarti organici in Emilia Romagna.

Dan J., Krüger M., Frenzel P., Conrad R., 2001. Effect of a late season urea fertilization on methane emission from a rice field in Italy. Agri. Ecos. Env. 83: 191–199.

Dannenberg S., Conrad R, 1999. Effect of rice plants on methane production and rhizospheric metabolism in paddy soil. Biogeochemistry 45: 53–71.

De Corso, E. 2008. World fertilizer market between food crisis and global economy simulations with partial equilibrium models”. Tesi di laurea. Facolta’ di Agraria, Universita’ Cattolica del Sacro Cuore. 98p.

De Roest and Speroni, 2005. Il bilancio dell’azoto negli allevamenti di latte. Agricoltura. Marzo 2005, 112-114.

De Rosa, M., Trabalzi, F., 2004. Technological innovation among buffalo breeders of southern lazio, Italy. Agricoltura Mediterranea. Vol. 134, 58-67.

ENEA, 1994. Personal communication, expert in agriculture sector. Ente nazionale per l'energia, l'ambiente e le nuove tecnologie (ENEA), Andrea Sonnino.

ENEA, 2006. Valutazione della possibilità di sostituzione dell'urea con altri fertilizzanti azotati. Final report. Rome, Italy.

ENR, 2010. Personal communication with *Ente Nazionale Risi* (ENR), Enrico Losi. Information available on rice surface, rice surface by variety and time of cultivation.

EUROSTAT, 2007[a]. Farm structure in Italy – 2005. Statistics in Focus Agriculture and Fisheries 22/2007 Product KS-SF-07-022 European Comunities.

EUROSTAT, 2007[b]. Agriculture. Main statistics 2005-2006. Product Ks-ED-07-002-En-C. European Comunities.

FAO, 2011. FAOSTAT, the FAO Statistical Database, http://faostat.fao.org/ (last access 04/04/2011).

Ferrero A., Nguyen N.V., 2004. Constraints and opportunities for the sustainable development of rice-based production systems in Europe. In proceedings: FAO Rice Conference, 12-13 February 2004, FAO, Rome, Italy.

Gazzetta Ufficiale della Repubblica Italiana, 2006. Criteri e norme tecniche generali per la disciplina regionale dell’utilizzazione agronomica degli effluenti di allevamento e di acque reflue di cui all’articolo 38 del decreto legislativo 11 maggio 1999 N. 152. G.U. n. 109 del 12/05/06 - Suppl. Ordinario n.120. Ministero delle Politiche Agricole e Forestali. Italy. http://www.guritel.it/icons/freepdf/SGFREE/2006/05/12/SG109.pdf (last access 04/04/2011).

Giardini L., 1983. Agronomia Generale, Patron, Bologna.

Greco, M., Martino, L. 2001. The agricultural statistical system in Italy. In: Conference on Agricultural and Environmental Application, Rome 4-8 June. Italy 46-461pp

Gruber, L. & Pötsch, E. M., 2006. Calculation of nitrogen excretion of dairy cows in Austria. Die Bodenkultur, 2006, Vol. 57, Heft 1- 4, Vienna. http://www.boku.ac.at/diebodenkultur/volltexte/band-57/heft-2/gruber.pdf (last access 04/04/2011).

Holter J.B., Young A.J., 1992. Methane prediction in dry and lactating holstein cows, Journal of Dairy Science, 8(75), pp. 2165-2175.

Holzapfel-Pschorn A., Seiler W., 1986. Methane emission during a cultivation period from an Italian Rice Paddy. Journal of Geophysical Research Vol. 91 Nº D11 11,803-11,814.

Husted S., 1993. An open chamber technique for determination of methane emission from stored livestock manure. Atmospheric Environment 11 (27).

Husted S., 1994. Seasonal variation in methane emissions from stored slurry and solid manures, J. Env. Qual. 23, pp. 585-592.

INEA, 2010. Italian Agriculture in Figures 2010. National Institute of Agricultural Economics, INEA http://www.inea.it/public/pdf_articoli/1396.pdf (last access 04/04/2011).

Infascelli, F., 2003. Nuove acquisizioni sulla nutrizione e sull'alimentazione della bufala. In: II Congresso Nazionale sull'Allevamento del Bufalo Monterotondo - Roma, pp. 1-18.

INRA, 1988. Alimentation des bovines, ovins et caprins, Paris, p.471.

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Centre, Meteorological Office, Bracknell, UK.

IPCC, 2000. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. IPCC National Greenhouse Gas Inventories Programme, Technical Support Unit, Hayama, Kanagawa, Japan.

IPCC, 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

ISPRA, 2008 [a]. Serie storiche dal 1980 al 2006 delle emissioni nazionali di inquinanti atmosferici, Rete del Sistema Informativo Nazionale Ambientale - SINANET. Istituto Superiore per la Protezione e la Ricerca Ambientale. http://www.sinanet.isprambiente.it/it/sinanet/serie_storiche_emissioni/NFR%20/view.

ISPRA, 2008 [b]. Database della disaggregazione a livello provinciale dell'Inventario nazionale delle emissioni:1990-1995-2000-2005. Istituto Superiore per la Protezione e la Ricerca Ambientale, ISPRA. http://www.sinanet.apat.it/it/inventaria/disaggregazione_prov2005/ (last access 04/04/2011).

ISPRA, 2009. La disaggregazione a livello provinciale dell'inventario nazionale delle emissioni. Anni 1990-1995-2000-2005. ISPRA, 92/2009. http://www.apat.gov.it/site/it-IT/APAT/Pubblicazioni/Rapporti/Documento/rapporti_92_2009.html (last access 04/04/2011).

ISPRA, 2011. Quality Assurance/Quality Control plan for the Italian Inventory. Year 2011.

ISTAT, 1991. Caratteristiche strutturali delle aziende agricole, fascicoli provinciali, 4° Censimento generale dell'Agricoltura (20 ottobre 1990-22 febbraio 1991), Roma – Italia.

ISTAT, 2003. 5º Censimento Generale dell'Agricoltura. Caratteristiche strutturali delle aziende agricole. Fascicolo Nazionale: dati regionali, provinciali e comunali. Istituto Nazionale di Statistica, Roma - Italia.

ISTAT, 2004. Personal communication, expert in agriculture statistics- fertilizers from the National Institute of Statistics (ISTAT), Mario Adua.

ISTAT, 2006 [a]. Struttura e produzioni delle aziende agricole Anno 2005. Statistiche in breve (27 dicembre 2006). Statistiche Servizio Agricoltura – Allevamenti e pesca. Istituto Nazionale di Statistica, Roma – Italia. http://www.istat.it/salastampa/comunicati/non_calendario/20061227_00/testointegrale.pdf (last access 04/04/2011).

ISTAT, 2006[b]. Personal communication, expert in agriculture statistics from the National Institute of Statistics (ISTAT), Giampaola Bellini.

ISTAT, 2007[a]. Farm and structure survey from 2005. Information on the number of animals at a provincial level. Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, 2007[b]. Annuario Statistico Italiano 2007- Capitolo 13 Agricoltura. Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, 2007[c]. Personal communication with N. Mattaliano. E-mail request for elaboration SPA 2003 data on burning residues -cereals. Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, 2007[d]. Personal communication with F. Piersimoni. Update of data on livestock collected on 1 December for the year 2001. Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, 2007[e]. "Indagine sulla struttura e produzione delle aziende agricole. Anno 2005". Prodotto DCSSD1.1.1. Rapporto di qualità su SPA 2005. Istituto Nazionale di Statistica, Roma – Italia.

ISTAT, 2008[a]. Struttura e produzioni delle aziende agricole. Anno 2007 (03 Dicembre 2008). Istituto Nazionale di Statistica, Roma – Italia. http://www.istat.it/salastampa/comunicati/non_calendario/20081203_00/testointegrale20081203.pdf (last access 04/04/2011).

ISTAT, 2008[b]. Indagine sulla struttura e produzione delle aziende agricole. Anno 2007. Rapporto sulla Qualità. Istituto Nazionale di Statistica, Roma - Italia.

ISTAT, 2010. Personal communication with C. Manzi: E-mail request of rabbit production data for 2008. Request was forward to ISMEA who provided an updated time series of rabbit production. Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, 2011[a]. Dati annuali sulla consistenza del bestiame, periodo di riferimento 2009. Statistiche Servizio Agricoltura – Allevamenti e pesca. Istituto Nazionale di Statistica, Roma – Italia. http://agri.istat.it/jsp/Introduzione.jsp (last access 04/04/2011).

ISTAT, 2011[b]. Dati annuali e mensili sul settore lattiero caseario, periodo di riferimento 2009. Statistiche Servizio Agricoltura – Allevamenti e pesca. Istituto Nazionale di Statistica, Roma – Italia. http://agri.istat.it/jsp/Introduzione.jsp (last access 04/04/2011).

ISTAT, 2011[c]. Dati congiunturali sui mezzi di produzione 2009. Istituto Nazionale di Statistica, Roma –Italia. http://agri.istat.it/jsp/Introduzione.jsp (last access 04/04/2011).

ISTAT, 2011[d]. Dati congiunturali sulle coltivazioni 2009. Istituto Nazionale di Statistica, Roma – Italia. http://agri.istat.it/jsp/Introduzione.jsp (last access 04/04/2011).

ISTAT, 2011[e]. Personal communication with R. Moro: E-mail request for last updated information on agricultural surface and production year 2009. Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, several years [a]. Statistiche dell'agricoltura, zootecnia e mezzi di produzione – Annuari (1990-1993), Istituto Nazionale di Statistica, Roma – Italia.

ISTAT, several years [b]. Statistiche dell'agricoltura – Annuari (1994-2000), Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, several years [c]. Struttura e produzioni delle aziende agricole – Informazione (1995-1999), Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, several years [d]. Statistiche sulla pesca e zootecnia – Informazione (1998-2001), Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, several years [e]. Statistiche sulla pesca, caccia e zootecnia – Informazione (1996-1997), Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, several years [f]. Annuario Statistico Italiano - Annuario (1990; 1993-1994; 1997-2003), Istituto Nazionale di Statistica, Roma –Italia.

Kruger M., Frenzel P., Kemnitz D., Conrad R., 2005. Activity, structure and dynamics of the methanogenic archaeal community in a flooded Italian rice field. FEMS Microbiology Ecology 51: 323–331.

Leip, A. Bocchi, S. 2007. Contribution of rice production to greenhouse gas emissions in Europe. In: Proceeding of the Fourth Temperate Rice Conference". Ed. S.Bocchi, A. Ferrero, A. Porro. 25-28 June Novara –Italy.

Leip, A., S. Russo, K.A. Smith, F. Conen, and G. Bidoglio, 2002. Rice cultivation by direct drilling and delayed flooding reduces methane emissions. In: van Ham et al. (eds): Non-CO2 Greenhouse Gases (NCGG-3): Scientific understanding, control options and policy aspects. p. 457-458.

Lupotto E., Greppi D., Cavigiolo S., 2005. Personal communication, group of experts in rice paddy cultivation and agronomic practices from the C.R.A. – Experimental Institute of Cereal Research – Rice Research Section of Vercelli (Consiglio per la Ricerca e sperimentazione in Agricoltura, Istituto sperimentale per la Cerealicoltura, Sezione specializzata per la Risicoltura) Italia.

Mannini P., 2004. Risparmio idrico/metodi e sistemi irrigui. La sommersione. In: Supplementi di Agricoltura 18. Le buone pratiche agricole per risparmiare acqua. Assessorato Agricoltura, Ambiente e Sviluppo Sostenibile, Regione Emilia Romagna. pp.154-157. http://www.ermesagricoltura.it/var/portale_agricoltura/storage/file/supp18154_1244543172.pdf.

Marik T., Fischer H., Conen F., Smith K., 2002. Seasonal variations in stable carbon and hydrogen isotope ratios in methane from rice fields. Global Biogeochemical Cycles, vol. 16, Nº4

Masucci, F., Di Francia, A., Gioffrè, F., Zullo, A., Proto, V., 1999. Prediction of digestibility in buffalo. In: XIII ASPA Congress, Piacenza (Italy) 21-24 June 345-347.

Masucci, F., Di Francia, A., Proto, V., 1997. In vivo digestibility, rate of particulate passage and dry matter rumen degradability in buffaloes and sheep. In: V World Buffalo Congress, Caserta (Italy) 13-16 October, 296-301.

MATTM, 2007. Fourth National Communication under the UN Framework Convention on Climate Change Italy, November 2007. http://unfccc.int/resource/docs/natc/itanc4.pdf (last access 04/04/2011).

MATTM, 2009. Fifth National Communication under the UN Framework Convention on Climate Change Italy December 2009. http://unfccc.int/resource/docs/natc/ita_nc5.pdf (last access 04/04/2011).

MATTM, 2010. Personal communication with Marco Porrega: E-mail request for sewage sludge applied to agricultural soils in Italy. *Ministero dell'Ambiente e della Tutela del Territorio e del Mare*, Roma –Italia.

Mordenti A., Pacchioli M.T., Della Casa, G. 1997. Production and nutrition techniques in the control of meat quality in heavy pigs. XXXII International Symposium on Animal Production: Advances in Technology, Accuracy and Management Milano, 29th September –1st October 1997. pag 81.

NRC, 1984. Nutrient Requirements of beef cattle- Sixth revised Edition. Not. Ac. Press, Washington.

NRC, 1988. Nutrient Requirements of swine - Ninth revised Edition. Not. Ac. Press, Washington.

NRC, 2001. Nutrient Requirements of dairy cattle Ninth edition, Nat. Acad. Press, Washington, D.C. USA.

OSSLATTE, 2001. Annuario del latte, Edizione 2001. Capitolo 3: La produzione di latte secondo l'ISTAT e l'AIA, Osservatorio sul mercato dei prodotti lattiero-caseari del latte.

OSSLATTE/ISMEA, 2003. Il mercato del latte, rapporto 2003. Capitolo 3: La struttura degli allevamenti e la produzione di latte secondo l'ISTAT. Osservatorio sul mercato dei prodotti lattiero-caseari del latte e l'Istituto di Servizi per il Mercato Agricolo ed Alimentare.

Perelli, M., 2007. Prezzi dei prodotti agricoli e fertilizzazione. Fertilizzanti Maggio 2007. Anno IX N3. 10-13pp.

PROINCARNE, 2005. Personal communication, expert in goat and sheep breeding. Associazione Produttori Carni Bovine dell'Emilia Romagna, Stefano Ronchi.

Regione Emilia Romagna, 2004 L. R. 28/98 – P.S.A. 2001 - N. PROG. 3 TAB. B3 - Bilancio dell'azoto nelle specie di interesse zootecnico, Relazione finale, a cura di C.R.P.A., September 2004, Reggio Emilia, Italy.

Regione Emilia Romagna, 2005. Disciplinari di produzione integrata 2005 Norme tecniche di coltura - Tecnica agronomica - Colture erbacee – RISO. Direzione Agricoltura, Regione Emilia Romagna.

Roy R., Detlef Kluber H., Conrad R., 1997. Early initiation of methane production in anoxic rice soil despite the presence of oxidants. FEMS Microbiology Ecology 24:311-320.

Russo S., 1976. Influenza dell'interramento della paglia su crescita e produzione del riso. Rivista Il Riso Anno XXV Nº 1 p19-36.

Russo S., 1988. L'interramento delle paglie come fattore di fertilità e di risparmio energetico. In proceedings: 10º Convegno Internazionale sulla Risicoltura. Vercelli 16-18 Novembre 1998, Vercelli, Italy.

Russo S., 1993. Prove di concimazione con azoto frazionato in risaia. L'informatore Agrario 8/93 p 87-94.

Russo S., 1994. Semina interrata con sommersione ritardata: un'alternativa all'impianto della risaia tradizionale. L'informatore Agrario 12/94 p 39-46.

Russo S., 2001. Concimazione più sostenibile in risaia e concimi organo-minerali. L'informatore Agrario 10/2001 p 23-26.

Russo S., Ferrari G., Raso G., 1990. Ricerche sull'efficienza dell'azoto con la somministrazione frazionata. L'informatore Agrario p 27-29.

Safley L.M., Casada M.E., Woodbury J., Roos K.F., 1992. Global methane emissions from livestock and poultry manure. USEPA, Washington D.C., EPA/400/191/048.

Sauvant D., 1995. Les émission de méthane par les ruminants: processus, modélisation, quantification et spatialisation. Le dossier de l'environnement de l'INRA, 10 pp. 7-15.

Schütz H., Holzapfel-Pschorn A., Conrad R., Rennenberg H., Seiler W., 1989 [a]. A 3-year continuous record on the influence of daytime, season and fertilizer treatment on methane emission rates from an Italian rice padd., Journal of. Geophysical Research 94, D13, pp. 16405-16415.

Schütz H., Seiler W.,Conrad R., 1989 [b]. Processes involved in formation and emission of methane in rice paddies. Biogeochemistry, 7, pp. 33-53.

Spanu A., 2006. Personal communication, expert in rice cultivation from Università degli Studi di Sassari, Sardegna - Italy.

Spanu A., Murtas A., Ledda L., Ballone F., 2004. Confronto tra varietà di riso sottoposte a irrigazione turnata. L'informatore Agrario 18/2004 p 61-62.

Spanu A., Pruneddu G., 1996. The influence of irrigation volumes on sprinkler-irrigated rice (Oryza sativa) production. Agricoltura Mediterranea, Vol 126, 377-382.

Steed Jr. J., Hashimoto A.G., 1995. Methane emissions from typical manure management systems, Bioresource Technology 50 pp. 123-130.

TERNA, 2011. National production data from biogas, year 2009. http://www.terna.it/default/Home/SISTEMA_ELETTRICO/statistiche/dati_statistici.aspx (last access 04/04/2011).

Tinarelli, A., 1973. La coltivazione del riso Editorial Edagricole, First edition p. 425.

Tinarelli, A., 1986. Il riso. Editorail Edagricole, Second edition p. 426.

Tinarelli, A., 2005. Personal communication, Italian expert in rice cultivation – Antonio Tinarelli, participated in the working group with the Experimental Institute of Cereal Research – Rice Research Section of Vercelli, Italia.

Tossato S., Regis F. 2002. Collana monografica di manuali naturalistico-agronomici, con riferimento alle principali colture geneticamente modificate. Volume 6. Il Riso. Agenzia Regionale per la Protezione Ambientale Piemonte (ARPA Piemonte), Piemonte, Italy.

UCEA, 2010. Temperature data, Ufficio Centrale di Ecologia Agraria.

UNA, 2011. Poultry production information from 2009. Le carne avicole e le uova. *Unione Nazionale Avicoltura.* http://www.unionenazionaleavicoltura.it/ (last access 04/04/2011).

UNFCCC, 2004. Report of the Individual review of the GHG Inventory submitted in the year 2004 (4 March 2005). http://unfccc.int/files/national_reports/annex_i_ghg_inventories/inventory_review_reports/application/pdf/2004_irr_centralized_review_italy.pdf (last access 04/04/2011).

UNFCCC, 2005. Report of the individual review of the greenhouse gas inventory of Italy submitted in 2005 (24 November 2005). http://unfccc.int/resource/docs/2005/arr/ita.pdf (last access 04/04/2011).

UNFCCC, 2007. Report of the review of the initial report of Italy (FCCC/IRR/2007/ITA; 10 December 2007. http://unfccc.int/resource/docs/2007/irr/ita.pdf (last access 04/04/2011).

UNFCCC, 2009. Report of the individual review of the greenhouse gas inventories of Italy submitted in 2007 and 2008 (FCCC/ARR/2008/ITA; 16 January 2009). http://unfccc.int/resource/docs/2009/arr/ita.pdf (last access 04/04/2011).

UNFCCC, 2010[a]. Report of the individual review of the greenhouse gas inventories of Italy submitted in 2009 (FCCC/ARR/2009/ITA; 12 February 2010). http://unfccc.int/resource/docs/2010/arr/ita.pdf (last access 04/04/2011).

UNFCCC, 2010[b]. Report of the individual review of the greenhouse gas inventories of Italy submitted in 2010 (FCCC/ARR/2010/ITA; 22 November 2010). http://unfccc.int/resource/docs/2010/arr/ita2.pdf (last access 04/04/2011).

Valli L., Cóndor R., De Lauretis R. 2004. MeditAIRanean Project: Agriculture sector. In: The quality of greenhouse gas emission inventories for agricultural soils. Report on the Expert Meeting on improving the quality of GHG emissions inventories for Category 4D. Joint Research Centre, 21-22 October, 2004. http://afoludata.jrc.ec.europa.eu/events/expmeetcat4d_2004/N2O.EMISSIONSfromAGRICULTURE.2005.pdf (last access 04/04/2011).

Wassmann, R. 2005. Personal communication, expert in methane from rice paddies (Forschungszentrum Karlsruhe IMK-IFU, Garmisch-Partenkirchen, Germany). E-mail communication received on 16/08/2005.

Weber S., Lueders T., Friedrich M.W., Conrad R., 2001. Methanogenic populations involved in the degradation of rice straw in anoxic paddy soil. FEMS Microbiology Ecology 38:11-20.

Xiccato G., Schiavon S., Gallo L., Bailoni L., Bittante G., 2005. Nitrogen excretion in dairy cow, beef and veal cattle, pig, and rabbit farms in Northern Italy. Ital. J.Anim.Sci. Vol. 4 (Suppl.), 103-111.

Yan X., Yagi K., Akiyama H., Akimoto H., 2005. Statistical analysis of the major variables controlling methane emission from rice fields. Global Change Biology (2005) 11, 1131–1141.

Zavattaro L., Romani M., Sacco D., Bassanino M., C.Grignani, 2004. Fertilization management of paddy fields in Piedmont (NW Italy) and its effects on the soil and water quality. In proceedings: Challenges and opportunities for sustainable rice-based production systems. Torino, Italy 13-15 September 2004.

Zicarelli, L., 2001. Evoluzione dell'allevamento bufalino in Italia. In Proc. I Congresso Nazionale sull'Allevamento del Bufalo Eboli, Salerno, Italy, pp. 1-19.

15.6 LAND USE, LAND USE CHANGE AND FORESTRY [CRF sector 5]

Adams, W.A. 1973. The effect of organic matter on the bulk and true densities of some uncultivated podzolic soils. J. Soil Sci. 24:10–17.

APAT, 2004. Corine (Coordination of Information on the Environment) Land Cover Programme. URL: http://www.clc2000.sinanet.apat.it/ (last access 04/04/2011).

APAT - ARPA Lombardia, 2007. Stima dei consumi di legna da ardere per riscaldamento ed uso domestico in Italia, Rapporto Finale.

ARPA Lombardia - Regione Lombardia, 2011 [a]. INEMAR, Inventario emissioni in atmosfera. Emissioni in Lombardia nel 2008 - revisione pubblica

ARPA Lombardia - Regione Lombardia, 2011 [b] – Personal Communication by Federico Antognazza

Batjes, 1996. Total carbon and nitrogen in the soils of the world. Eur. J. Soil Sci. 47: 151-163.

Benedetti A., Pompili L., Nisini L., 2004. Ruolo attivo dell’agricoltura nei processi di mitigazione del cambiamento climatico globale. Rapporto del progetto Climagri-Cambiamenti climatici e agricoltura, – CRA- Istituto Sperimentale per la Nutrizione delle Piante.

BioSoil, 2011. BioSoil-Soil project - http://biosoil.jrc.ec.europa.eu/; http://forest.jrc.ec.europa.eu/contracts/biosoil (last access 04/04/2011). Project performed under Regulation (EC) n. 2152/2003 on forest monitoring and environment interactions in the Community (Forest Focus). Coordination: CONECOFOR division, National Forest Service (CFS). Technical and scientific work contracted to research institution and university departments. Personal communication by Giorgio Matteucci (National Research Council of Italy, Institute for Agroenvironmental and Forest Biology), Stefano Carnicelli (University of Florence), Roberto Comolli (University of Milan Bicocca), Gloria Falsone (University of Turin), Giorgio Poggio (National Research Council of Italy, Institute for Ecosystem Studies), Simona Vingiani (University of Naples-I).

Bovio G., 1996. Stima della biomassa bruciata e della CO_2 prodotta da incendi boschivi in Italia. Schweizerische Zeitschrift für Forstwesen-Journal Forestier Suisse, 147, 4.

Ceccanti B., Doni S., Macci C., Cercignani G., Masciandaro G., 2008. Characterization of stable humic–enzyme complexes of different soil ecosystems through analytical isoelectric focussing technique (IEF), Soil Biology & Biochemistry 40 (2008) 2174–2177.

CESTAAT, 1988. Impieghi dei sottoprodotti agricoli ed agroindustriali, Vol. 1. Centro Studi sull'Agricoltura, l'Ambiente e il Territorio, p. 311.

Corona P, Giuliarelli D, Lamonaca A, Mattioli W, Tonti D, Chirici G, Marchetti M, 2007. Confronto sperimentale tra superfici a ceduo tagliate a raso osservate mediante immagini satellitari ad alta risoluzione e tagliate riscontrate amministrativamente. Forest@ 4 (3): 324-332. URL: http://www.sisef.it (last access 04/04/2011).

CRPA, 1997. Piani Regionali di Risanamento e tutela della qualità dell'aria. Quadro delle azioni degli enti locali per il settore zootecnico delle aree padane. Relazione di dettaglio sulla metodologia adottata per la quantificazione delle emissioni di protossido di azoto. Settembre 1997.

CRPA, 2009. Progetto Salvaguardia e valorizzazione del prato stabile irriguo in area Parmigiano-Reggiano attraverso l'ottimizzazione della risorsa idrica e azotata, Personal communication.

Davidson E.A., Ackerman I.L., 1993. Changes in soil carbon inventory following cultivation of previously untilled soil. Biogeochemistry 20, pp. 161–194.

Del Gardo I., Six J., Peressotti A., Cotrufo M.F., 2003. Assessing the impact of land-use change on soil C sequestration in agricultural soils by means of organic matter fractionation and stable C isotopes. Global Change Biology (2003) 9, 1204–1213.

ERSAF, 2008. Stock di carbonio nei suoli regionali. Progetto Kyoto-Ricerca sui cambiamenti climatici e il controllo dei gas serra in Lombardia - GS3.

FAO, 2004 [a]. Global Forest Resources Assessment Update 2005, Specification of National Reporting Tables for FRA 2005, Forest Resources Assessment Programme. Food and Agriculture Organization of the United Nations.

FAO, 2004 [b]. Global Forest Resources Assessment 2005. Global Forest Resources Assessment 2005 – Italy – Country Report , UN/ECE- FAO, submitted. Food and Agriculture Organization of the United Nations.

FAO, 2005. FAOSTAT database. URL: http://faostat.fao.org/ (last access 04/04/2011). Food and Agriculture Organization of the United Nations.

Federici S, Vitullo M, Tulipano S, De Lauretis R, Seufert G, 2008. An approach to estimate carbon stocks change in forest carbon pools under the UNFCCC: the Italian case. iForest 1: 86-95 URL: http://www.sisef.it/iforest/ (last access 04/04/2011).

Francaviglia R., Aromolo R., Benedetti A., Beni C., Biondi F.A., Dell'Abate M.T., Figliolia A., Mecella G., Pompili L., 2006. Qualità funzionali alla conservazione della fertilità integrale dei suoli. Rapporto del Progetto Conservazione e valorizzazione della risorsa suolo: definizione delle qualità del suolo ai fini della gestione agricola e forestale ecocompatibile – CRA- Istituto Sperimentale per la Nutrizione delle Piante.

FutMon: Life+ LIFE07/D/000218 project for the "Further Development and Implementation of an EU-level Forest Monitoring System"; http://www.futmon.org/ (last access 04/04/2011). Personal communication by Patrizia Gasparini (CRA – MPF - Unità di ricerca per il Monitoraggio e la Pianificazione forestale).

Gardi C, Stefano Brenna, Silvia Solaro et al, 2007 "The Carbon Sequestration Potential of Soils: Some Data from Northern Italian Regions" Ital. J. Agron. 2:163-170.

Giordano G., 1980. Tecnologia del legno. Hoepli. Milano.

Guo L.B., Giffort R.M., 2002. Soil carbon stocks and land-use change: a meta analysis. Global Change Biology 8, pp. 345-360.

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Office, Bracknell, UK.

IPCC, 2003. Good Practice Guidance for Land Use, Land-Use Change and Forestry. IPCC Technical Support Unit, Kanagawa, Japan.

IPCC, 2006. Guidelines for National Greenhouse Gas Inventories. IPCC Technical Support Unit, Kanagawa, Japan.

IPLA 2007, Realizzazione della parte piemontese della Carta dei Suoli nazionale a scala 1:250.000, Personal communication.

ISAFA, 2004. RiselvItalia Project, Personal communication.

ISPRA, 2011 [a]. National Greenhouse Gas Inventory System in Italy. April 2011.

ISPRA, 2011 [b]. Quality Assurance/Quality Control plan for the Italian Emission Inventory. Year 2011.

ISTAT, several years [a]. Statistiche forestali. Istituto Nazionale di statistica, Roma.

ISTAT, several years [b]. Statistiche dell'agricoltura. Istituto Nazionale di statistica, Roma.

ISTAT, several years [c]. Annuario Statistico Italiano. Istituto Nazionale di statistica, Roma.

Janssen P. H. M., Heuberger P.S.C., 1995. Calibration of process oriented models. Ecological Modelling 83 pp. 55-66.

JRC, 2004. Pilot Project to test and learn harmonisation of reporting of EU member states under the UNFCCC on Land Use change and Forestry (LUCF). Joint Research Centre IES.

La Mantia T, Oddo G, Rühl J, Furnari G, Scalenghe R, 2007. Variazione degli stock di carbonio in seguito ai processi di abbandono dei coltivi: il caso studio dell'isola di Pantelleria (TP). Forest@ 4 (1): 102-109. URL: http://www.sisef.it/ (last access 04/04/2011).

Lagomarsino A., Moscatelli M.C., Di Tizio A., Mancinelli R., Grego S., Marinari S., 2009. Soil biochemical indicators as a tool to assess the short-term impact of agricultural management on changes in organic C in a Mediterranean environment. Ecological indicators 9 (2009) 518–527.

Lugato E., Berti A., 2008. Potential carbon sequestration in a cultivated soil under different climate change scenarios: A modelling approach for evaluating promising management practices in north-east Italy. Agriculture, Ecosystems and Environment 128 (2008) 97–103.

MAF/ISAFA, 1988. Inventario Forestale Nazionale. Sintesi metodologica e risultati. Ministero dell'Agricoltura e delle foreste. Istituto Sperimentale per l'assestamento forestale e per l'Alpicoltura, Trento.

MAF/ISAFA, 2004. Inventario nazionale delle foreste e del carbonio, preliminary results. Personal communication. Ministero dell'Agricoltura e delle foreste. Istituto Sperimentale per l'assestamento forestale e per l'Alpicoltura, Trento.

MAMB, 1992. Inventario delle zone umide del territorio italiano (a cura di G. De Maria, Servizio Conservazione Natura, Ministero dell'ambiente e del territorio).

Martiniello P., 2007. Biochemical parameters in a Mediterranean soil as effected by wheat–forage rotation and irrigation. Europ. J. Agronomy 26 (2007) 198–208.

Masciandaro G., Ceccanti B., 1999. Assessing soil quality in different agro-ecosystems through biochemical and chemico-structural properties of humic substances. Soil & Tillage Research 51 (1999) 129-137.

MATT, 2002. Third National Communication under the UN Framework Convention on Climate Change. Ministry for the Environment and Territory. October 2002.

Monaco Stefano, Hatch D. J., Sacco D., Bertora C., Grignania C., 2008. Changes in chemical and biochemical soil properties induced by 11-yr repeated additions of different organic materials in maize-based forage systems. Soil Biology & Biochemistry 40 (2008) 608–615.

Olson J.S., 1963. Energy storage and the balance of producers and decomposers in ecological systems. Ecology 44 (2), pp. 322-331.

Perucci p., Monaci E., Onofri A., Dischetti C., Casacci C., 2008. Changes in physico-chemical and biochemical parameters of soil following addition of wood ash: A field experiment. Europ. J. Agronomy 28 (2008) 155–161.

Petrella F., Piazzi M. 2006 – Carbonio nei suoli degli ecosistemi semi-naturali piemontesi. Sherwood N.123, June 2006.

Post W.M., Kwon K.C., 2000. Soil carbon sequestration and land-use change: processes and potential. Global Change Biology 6, pp. 317-327.

Puglisi E., Fragoulis G., Del Re A.A.M., Spaccini R., Piccolo A., Gigliotti G., Said-Pullicino D., Trevisan M., 2008. Carbon deposition in soil rhizosphere following amendments with compost and its soluble fractions, as evaluated by combined soil–plant rhizobox and reporter gene systems. Chemosphere 73 (2008) 1292–1299.

Ramsar, 2005. The Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat http://www.ramsar.org/ (last access 04/04/2011). United Nations Educational, Scientific and Cultural Organization (UNESCO).

Rawls W.J., Brakensiek, D.L. 1985. Prediction of soil water properties for hydrologic modelling, in Proceedings of Symposium on Watershed Management, ASCE, pp. 293-299.

Reeder J.D., Schuman G.E., Bowman R.A., 1998. Soil C and N changes on conservation reserve program lands in the Central Great Plains. Soil & Tillage Research 47, pp. 339-349.

Schulze E-D (ed.), 2000. Carbon and nitrogen cycling in European forest ecosystems, Ecological Studies 142, 500 pp + CD, Springer: Berlin, Heidelberg, New York.

Tabacchi G, De Natale F, Di Cosmo L, Floris A, Gagliano C, Gasparini P, Genchi L, Scrinzi G, Tosi V. 2007. Le stime di superficie 2005 – Parte 1. Inventario Nazionale delle Foreste e dei Serbatoi Forestali di Carbonio. MiPAF - Corpo Forestale dello Stato - Ispettorato Generale, CRA - ISAFA, TN. :1-413, versione 2.

Tabacchi G., De Natale F. and Gasperini P. Coerenza ed entità delle statistiche forestali - Stime degli assorbimenti netti di carbonio nelle foreste italiane, Sherwood n.165/2010.

Triberti L., Nastri A., Giordani G., Comellini F., Baldoni G, Toderi G., 2008. Can mineral and organic fertilization help sequestrate carbon dioxide in cropland? Europ. J. Agronomy 29 (2008) 13–20.

UNECE – FAO, Timber Committee, 2008 - Italian statement on potential wood supply, communication by national correspondent, March 2008.

UNFCCC, 2005. Report of the individual review of the greenhouse gas inventory of Italy submitted in 2005 (24 November 2005). URL: http://unfccc.int/resource/docs/2005/arr/ita.pdf (last access 04/04/2011).

UNFCCC, 2007. Report of the review of the initial report of Italy. FCCC/IRR/2007/ITA. UNFCCC, 10 December 2007. URL: http://unfccc.int/resource/docs/2007/arr/ita.pdf (last access 04/04/2011).

UNFCCC, 2010. Report of the individual review of the greenhouse gas inventory of Italy submitted in 2010 (22 November 2010). URL: http://unfccc.int/documentation/documents/advanced_search/items/3594.php?rec=j&priref=600006054#beg (last access 04/04/2011).

Viaroli P., Gardi C., 2004. Censimento e caratterizzazione pedologica e vegetazionale dei "Prati Stabili" presenti nel Parco Regionale Fluviale del Taro. Relazione tecnica - Università degli Studi di Parma - Dipartimento di Scienze Ambientali.

Waring RH, Running SW (1998). Forest ecosystems, analysis at multiple scales. Academic Press, New York, USA.

Xiloyannis C., 2007. La valutazione del contenuto e composizione del carbonio organico del suolo di sistemi agricoli. Relazione tecnica - Università degli Studi della Basilicata - Dipartimento di Scienze dei sistemi colturali, forestali e dell'ambiente.

15.7 WASTE [CRF sector 6]

Acaia et al., 2004. Emissioni atmosferiche da discariche di rifiuti in Lombardia: stato attuale e scenari tecnologici di riduzione. RS – Rifiuti Solidi vol. XVIII n. 2, pp. 93-112.

AMA-Comune di Roma, 1996. Nuovo impianto per l'incenerimento dei rifiuti ospedalieri. Rapporto AMA.

Andreottola G., Cossu R., 1988. Modello matematico di produzione del biogas in uno scarico controllato. RS – Rifiuti Solidi vol. II n. 6, pp. 473-483.

ANPA, 1998. Il sistema ANPA di contabilità dei rifiuti, prime elaborazioni dei dati. Agenzia Nazionale per la Protezione dell'Ambiente.

ANPA, 2001. Guida alla progettazione dei sistemi di collettamento e depurazione delle acque reflue urbane. Agenzia Nazionale per la Protezione dell'Ambiente. Rapporto n. 1/2001.

ANPA-FLORYS, 2000. Industria conciaria, Studio di settore. Agenzia Nazionale per la Protezione dell'Ambiente.

ANPA-FLORYS, 2001. Industria della carta e cartone, Studio di settore. Agenzia Nazionale per la Protezione dell'Ambiente.

ANPA-ONR, 1999 [a]. Primo Rapporto sui rifiuti speciali. Agenzia Nazionale per la Protezione dell'Ambiente.

ANPA-ONR, 1999 [b]. Secondo Rapporto sui Rifiuti Urbani e sugli Imballaggi e rifiuti di imballaggio. Agenzia Nazionale per la Protezione dell'Ambiente.

ANPA-ONR, 2001. I rifiuti del comparto agro-alimentare, Studio di settore. Agenzia Nazionale per la Protezione dell'Ambiente. Rapporto n. 11/2001.

APAT, 2002. Annuario dei dati ambientali. Agenzia per la Protezione dell'Ambiente e per i servizi Tecnici. Rapporto n. 7/2002.

APAT-ONR, several years. Rapporto Rifiuti. Agenzia per la Protezione dell'Ambiente e per i servizi Tecnici.

ApS, 1997. Technical Paper. Azienda Po Sangone.

Asja, 2003. Dichiarazione Ambientale 2003. Asja Ambiente Italia S.p.A., 2003.

Assobirra, several years. Rapporti Annuali e Dati Statistici. Also available on the website http://www.assobirra.it (last access 04/04/2011).

Assocarta, several years. Rapporto Ambientale dell'industria cartaria italiana. Also available on the website http://www.assocarta.it (last access 04/04/2011).

AUSITRA-Assoambiente, 1995. Impianti di trattamento dei rifiuti solidi urbani e assimilabili. Indagine a cura di Merzagora W., Ferrari S.P.

Borgioli E., 1981. Nutrizione e alimentazione degli animali domestici. Ed Agricole, p. 464.

CESTAAT, 1988. Impieghi dei sottoprodotti agricoli ed agroindustriali, Vol. 1. Centro Studi sull'Agricoltura, l'Ambiente e il Territorio, edizione fuori commercio, p. 311.

CNR, 1980. Indagine sui Rifiuti Solidi Urbani in Italia. Consiglio Nazionale delle Ricerche, Progetto Finalizzato Energetica.

Colombari et al., 1998. Le emissioni di metano dalle discariche di rifiuti in Italia: stima e scenari futuri. ENEA RT/AMB/98/30.

Colombo, 2001. Nuovo Colombo, Manuale dell'Ingegnere, Vol. 3, 83^ma^ edizione. Hoepli editore.

COOU, several years, Consorzio Olii Usati, also available on the web-site http://www.coou.it (last access 04/04/2011).

COVIRI, 2005. Relazione annuale al parlamento sullo stato dei servizi idrici, Anno 2005. Autorità di vigilanza sulle risorse idriche e sui rifuti.

De Poli F., Pasqualini S., 1991. Landfill gas: the Italian situation. ENEA, atti del convegno Sardinia 91, Third International Landfill Symposium.

De Stefanis P. et al., 1998. Gestione dei rifiuti ad effetto serra. ENEA-CNR, atti della Conferenza Nazionale Energia e Ambiente, Rome 25-18 November 1998.

De Stefanis P., 1999. Personal communication.

Decree of President of the Republic 10 September 1982, n.915. Attuazione delle direttive 75/442/CEE relativa ai rifiuti e 76/403/CEE relativa ai rifiuti tossici e nocivi. G.U. 15 dicembre 1982, n. 343, S.O.

EC, 1975. Council Directive 1975/442/EC. Council Directive 75/442/EC of 15 July 1975 on waste framework. Official Journal of the European Communities 25 July 1975.

EC, 1976. Council Directive 1976/403/EC. Council Directive 76/403/EC of 6 April 1976 on treatment and disposal of PCBs and PCTs. Official Journal of the European Communities 26 April 1976.

EC, 1978. Council Directive 1978/319/EC. Council Directive 78/319/EC of 20 March 1978 on toxic and dangerous waste. Official Journal of the European Communities 31 March 1978.

EC, 1986. Council Directive 86/278/EC. Council Directive 86/278/EC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture. Official Journal of the European Communities 4 July 1986.

EC, 1999. Council Directive 1999/31/EC. Council Directive 99/31/EC of 26 April 1999 on the landfill of waste. Official Journal of the European Communities 16 July 1999.

Ecomondo, 2006. Conference Proceedings, 10^{th} International Trade Fair on Material and Energy Recovery and Sustainable Development, Rimini 8 – 10 november 2006.

EEA, 2005. Waste management in Europe and the Landfill Directive. Background paper from the ETC/RWM to the ETC/ACC workshop ‘Inventories and Projections of Greenhouse Gas Emissions from Waste’, European Environment Agency, April 2005.

EMEP/CORINAIR, 2007. Atmospheric Emission Inventory Guidebook. Technical report No 16/2007.

EMEP/EEA, 2009. Air Pollutant Emission Inventory Guidebook. Technical report No 9/2009.

ENI S.p.A. 2001. Rapporto Salute Sicurezza Ambiente.

FAO, several years. Food balance, available on the website http://faostat.fao.org (last access 04/04/2011).

Favoino E., Cortellini L., 2001. Composting and biological treatment in southern European countries: an overview. Conference Proceedings Soil and Biowaste in Southern Europe. Rome 18-19 January, 2001.

Favoino E., Girò F., 2001. An assessment of effective, optimised schemes for source separation of organic waste in Mediterranean districts. Conference Proceedings Soil and Biowaste in Southern Europe. Rome 18-19 January, 2001.

FEDERAMBIENTE, 1992. Analisi dei principali sistemi di smaltimento dei rifiuti solidi urbani.

FEDERAMBIENTE, 1998. Impianti di smaltimento: analisi sui termocombustori RSU – prima edizione. Indagine a cura di Motawi A.

FEDERAMBIENTE, 2001. Impianti di smaltimento: analisi sui termoutilizzatori RU. Indagine a cura di Morabito L., GEA n. 5/2001.

FEDERCHIMICA, several years. Rapporto Responsible Care. Federazione Nazionale dell'Industria Chimica.

Ferrari G., 1996. I rifiuti città per città. GEA, July 1996.

Finn L., Spencer R., 1997. Managing biofilters for consistent odor and VOC treatment. Biocycle, January 1997 Vol. 38 Iss.1.

Gaudioso et al., 1993. Emissioni in atmosfera dalle discariche di rifiuti in Italia. RS, Rifiuti Solidi vol. VII n. 5, Sept.-Oct. 1993.

Ham, R.K., 1979. Predicting gas generation from landfills. Waste Age, 11, 50.

Hogg D., 2001. Biological treatment of waste: a solution for tomorrow. ISWA Beacon Conference.

IPCC, 1995. IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Manual, Reporting Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Centre, Meteorological Office, Bracknell, UK.

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Centre, Meteorological Office, Bracknell, UK.

IPCC, 2000. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. IPCC National Greenhouse Gas Inventories Programme, Technical Support Unit, Hayama, Kanagawa, Japan.

IPCC, 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

IRSA-CNR, 1998. Personal Communication.

ISPRA, several years. Rapporto Rifiuti 2008. Istituto Superiore per la Protezione e la Ricerca Ambientale.

ISPRA, 2010. Personal Communication.

ISTAT, 1987. Approvvigionamento idrico, fognature e impianti di depurazione in Italia – anno 1987. Collana d'informazione n. 20, ed. 1991.

ISTAT, 1991. Statistiche ambientali 1991. Istituto nazionale di statistica.

ISTAT, 1993. Statistiche ambientali 1993. Istituto nazionale di statistica.

ISTAT, 1998 [a]. Il processo di depurazione e la qualità delle acque reflue urbane. Indagine sugli impianti di depurazione delle acque reflue urbane, anno 1993. Istituto nazionale di statistica.

ISTAT, 1998 [b]. Caratteristiche strutturali degli impianti di depurazione delle acque reflue urbane. Indagine sugli impianti di depurazione delle acque reflue urbane, anno 1993. Istituto nazionale di statistica.

ISTAT, 2004. Sistema di Indagini sulle Acque, SIA – anno 1999. Istituto nazionale di statistica, also available at website http://acqua.istat.it.

ISTAT, several years [a]. Annuario Statistico. Istituto Nazionale di Statistica.

ISTAT, several years [b]. Bollettino mensile di statistica. Istituto Nazionale di Statistica.

ISTAT, several years [c]. Information available on the website http://www.istat.it (last access 04/04/2011).

Law Decree 30 December 2008, n.208. Misure straordinarie in materia di risporse idriche e protezione dell'ambiente. G.U. 31 dicembre 2008, n. 304, S.O.

Legislative Decree 11 May 1999, n. 152. Disposizioni sulla tutela delle acque dall'inquinamento e recepimento della direttiva 91/271/CEE concernente il trattamento delle acque reflue urbane e della direttiva 91/676/CEE relativa alla protezione delle acque dall'inquinamento provocato dai nitrati provenienti da fonti agricole. G.U. 29 maggio 1999, n. 124, S.O.

Legislative Decree 13 January 2003, n. 36. Attuazione della direttiva 1999/31/EC relativa alle discariche di rifiuti. G.U. 12 marzo 2003, n. 59 – S.O. 40/L.

Legislative Decree 5 February 1997, n. 22. Attuazione delle direttive 91/156/CEE sui rifiuti 91/698/CEE sui rifiuti pericolosi e 94/62/CEE sugli imballaggi e sui rifiuti di imballaggio. G.U. 15 febbraio 1997, n. 38, S.O.

Masotti L., 1996. Depurazione delle acque. Edizioni Calderoni.

MATTM, 2005. Personal Communication.

MATTM, 2010. Personal Communication.

MATTM, several years. RSA - Rapporto sullo stato dell'ambiente 1989, 1992, 1997, 2001. Ministero dell'Ambiente e della Tutela del Territorio e del Mare.

Metcalf and Eddy, 1991. Wastewater engineering: treatment, disposal and reuse. Mc Graw Hill, third edition.

Ministerial Decree 12 July 1990. Linee Guida per il contenimento delle emissioni inquinanti degli impianti industriali e la fissazione dei valori minimi di emissione. G.U. 30 luglio 1990, n. 176.

Ministerial Decree 19 November 1997, n. 503. Regolamento recante norme per l'attuazione delle Direttive 89/369/CEE e 89/429/CEE concernenti la prevenzione dell'inquinamento atmosferico provocato dagli impianti di incenerimento dei rifiuti urbani e la disciplina delle emissioni e delle condizioni di combustione degli impianti di incenerimento di rifiuti urbani, di rifiuti speciali non pericolosi, nonché di taluni rifiuti sanitari. G.U. 29 gennaio 1998, n. 23.

Morselli L., 1998. L'incenerimento dei rifiuti, ricognizione sulla realtà regionale. Università degli Studi di Bologna, Dipartimento di chimica industriale e dei materiali e Regione Emilia Romagna, Assessorato Territorio, Programmazione e Ambiente.

Muntoni A., Polettini A., 2002. Modelli di produzione del biogas - limiti di applicazione e sensitività. Conference proceedings, Università degli Studi di Roma La Sapienza "Gestione del biogas da discarica: controllo, recupero e monitoraggio. Rome, December 2002.

Provincia di Roma, 2008. Documento di indirizzo per la riduzione della produzione di rifiuti urbani e l'implementazione delle raccolte differenziate nel territorio della provincia di Roma. Dipartimento Ambiente della Provincia di Roma, 12 febbraio 2008.

Regione Calabria, 2002. Piano regionale di gestione rifiuti. Supplemento straordinario al Bollettino Ufficiale Regione Calabria 30 novembre 2002, n. 22.

Regione Emilia Romagna, 2009. La gestione dei rifiuti in Emilia Romagna. Regione Emilia Romagna – ARPA Emilia Romagna, Report 2009.

Regione Piemonte, 2007. L'evoluzione merceologica dei Rifiuti Urbani: la storia e le prospettive. Recycling Prix proceedings. Turin, October 2007.

Regione Sicilia, 2004. Programma regionale per la riduzione dei rifiuti biodegradabili da avviare in discarica. Ordinanza 25 marzo 2004, n. 323 del Commissario delegato per l'emergenza rifiuti e la tutela delle acque in Sicilia.

Regione Umbria, 2007. Programma regionale per la riduzione dei rifiuti biodegradabili da avviare in discarica. Bollettino Ufficiale Regione Umbria 31 gennaio 2007, n. 5.

Regione Veneto, 2006. Programma regionale per la riduzione dei rifiuti biodegradabili da avviare in discarica. Bollettino Ufficiale Regione Veneto 21 luglio 2006, n. 65.

SEFIT, 2010. Personal Communication.

Tecneco, 1972. Indagine Nazionale sullo smaltimento dei Rifiuti Solidi Urbani. Dispense 1995 Prof. Liuzzo, Università degli Studi di Roma "La Sapienza".

TERNA, several years. Dati statistici sull'energia elettrica in Italia. Rete Elettrica Nazionale.

UNIC, several years. Rapporto Ambientale. Unione Nazionale Industria Conciaria.

UP, several years. Statistiche economiche, energetiche e petrolifere. Unione Petrolifera.

US EPA, 1990. Air emissions Species Manual, vol. I: Volatile Organic Compound Species Profiles, Second Edition. EPA-450/2-90-001a (United States Environmental Protection Agency – Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711), January 1990.

15.8 Information on minimization of adverse impacts in accordance with Article 3, paragraph 14

Boyd et al., 2009. Reforming the CDM for sustainable development: lessons learned and policy futures. Environmental Science & Policy 12: 820-831.

Brooks J, Filipski M, Jonasson E, Taylor JE, 2010. Modelling the distributional impacts of agricultural policies in developing countries: the development policy evaluation model (DEVPEM). In: Proceedings The 84th Annual Conference of the Agricultural Economics Society Edinburgh, 29th-3st March 2010. 32p. http://ageconsearch.umn.edu/bitstream/91961/2/121brooks_philipski_jonasson_taylor.pdf (last access 04/04/2011).

Carbon Finance, 2011. Italian Carbon Fund Project Portfolio. http://wbcarbonfinance.org/Router.cfm?Page=ICF&FID=9710&ItemID=9710&ft=Projects (accessed 04/02/2011).

CCBA, 2011. Climate, Community and Biodiversity Project Design Standards. Second Edition. Climate, Community & Biodiversity Alliance. http://www.climate-standards.org/standards/pdf/ccb_standards_second_edition_december_2008.pdf (last access 04/04/2011).

Cha K, Lim A, Hur T., (2008). Eco-efficiency approach for global warming in the context of Kyoto Mechanism. Ecological Economics 67: 274 –280.

Cóndor et al. (2010). Multicriteria Decision Aid to support Multilateral Environmental Agreements in assessing international forestry projects. International Environmental Agreements: Politics, Law and Economics DOI 10.1007/s10784-010-9125-7.

DGCS, 2009. Piano programmatico nazionale per l'efficacia degli aiuti. Approvato dal Comitato Direzionale nella seduta del 14/7/09. Ministry of Foreign Affairs. http://www.cooperazioneallosviluppo.esteri.it/pdgcs/italiano/DGCS/uffici/ufficioI/aid_effectiveness.html (last access 04/04/2011).

DGCS, 2011. *Cooperazione Italiana allo sviluppo*. Database of world-wide projects. Directorate General for Development Cooperation, Ministry of Foreign Affairs. http://www.cooperazioneallosviluppo.esteri.it/pdgcs/italiano/iniziative/AreeTematiche.asp (last access 04/04/2011).

Endesa Carbono, 2010. Personal communication, Claudia Monsalve/Lorenzo Eguren – *CDM expert* (29/03/2010).

ENEL, 2010. Environment Report 2009. http://www.enel.com/en-GB/sustainability/environment/policy/environmental_report/index.aspx (last access 04/04/2011).

ENI, 2010. Bilancio di sostenibilità 2009. http://www.eni.com/it_IT/sostenibilita/sost-bilancio-sostenibilita/sost-bilancio-sostenibilita.shtml (last access 04/04/2011).

European Commission, 2008. Legislative proposals following the Communication on the 'Health Check' in the Common Agricultural Policy. Brussels, SEC(2008) 1885/2. http://ec.europa.eu/governance/impact/ia_carried_out/docs/ia_2008/sec_2008_1885_2_en.pdf (last access 04/04/2011).

European Commission, 2009[a]. Impact Assessment Guidelines, 15 January 2009 (SEC(2009)92). http://ec.europa.eu/governance/impact/commission_guidelines/docs/iag_2009_en.pdf (last access 04/04/2011).

European Commission, 2009[b]. Fifth national communication from the European Community under the UN Framework Convention on Climate Change. http://unfccc.int/resource/docs/natc/ec_nc5.pdf (last access 04/04/2011).

European Commission, 2010[a]. List of impact assessments. http://ec.europa.eu/governance/impact/ia_carried_out/cia_2010_en.htm (last access 04/04/2011).

European Commission, 2010[b]. Annual European Community Greenhouse Gas Inventory 1990–2008 and Inventory Report 2010 Submission to the UNFCCC Secretariat.

Evans, M., Legro, S., Popovi I. (2000) The climate for joint implementation: case studies from Russia, Ukraine, and Poland. Mitigation and Adaptation Strategies for Global Change **5:** 319–336.

Firsova, A., Taplin, R. 2008. A Review of Kyoto Protocol Adoption in Russia: Joint Implementation Focus. Transition Studies Review 15(3) 480 – 498.

Gold Standard, 2011. Annex I Guidance on Sustainability Assessment. http://cdmgoldstandard.org/fileadmin/editors/files/6_GS_technical_docs/GSv2.1/Annex_I.pdf (last access 04/04/2011).

Hallam, D. 2010. International Investment in Developing Country Agriculture – Issues and Challenges. Agriregionieuropa Anno 6, Numero 20 Marzo 2010. http://agriregionieuropa.univpm.it/dettart.php?id_articolo=580 (last access 04/04/2011).

ISPRA, 2011[a]. Personal communication with Dr. Mario Contaldi, Lead Author of Chapter 5 – Projections and effects of policies and measures from the Fifth National Communication (28/02/2011).

ISPRA, 2011[b]. Personal communication with Dr. Domenico Gaudioso, Head of the Climate Change Unit at ISPRA (12/01/2011).

MAE, 2010[a]. Personal communication, Alfredo Guillet/Giorgio Grussu, DGCS/Central Technical Unit of the Ministry of Foreign Affairs (31/03/2010)

MAE, 2010[b]. Personal communication, Giancarlo Palma, DGCS/ Central Technical Unit of the Ministry of Foreign Affairs (31/04/2010).

MAE, 2010[c]. La cooperazione Italiana allo sviluppo nel Triennio 2011-2013. Linee – guida e indirizzi di programmazione. Ministry of Foreign Affairs. http://www.cooperazioneallosviluppo.esteri.it/pdgcs/italiano/LineeGuida/LineeGuida.html (last access 04/04/2011).

MAE, 2010[d]. La valutazione in itinere ed ex post dell'aiuto Pubblico allo sviluppo attuato dal Ministero degli Affari Esteri. Direzione Generale per la Cooperaazione allo Sviluppo. Linee Guida. Giugno 2010. Ministry of Foreign Affairs. http://www.cooperazioneallosviluppo.esteri.it/pdgcs/italiano/LineeGuida/pdf/Linee_Guida_Valutazione.pdf (last access 04/04/2011).

MAE, 2010[e]. Linee guida della DGCS sulla Cooperazione decentrata, Marzo 2010. Ministry of Foreign Affairs. http://www.cooperazioneallosviluppo.esteri.it/pdgcs/italiano/LineeGuida/pdf/Linee_guida_Decentrata.pdf (last access 04/04/2011).

MATTM, 2007. Fourth National Communication under the UN Framework Convention on Climate Change Italy. http://unfccc.int/resource/docs/natc/itanc4.pdf (last access 04/04/2011).

MATTM, 2009. Fifth National Communication under the UN Framework Convention on Climate Change Italy. http://unfccc.int/resource/docs/natc/ita_nc5.pdf (last access 04/04/2011).

MATTM, 2010[a]. Personal communication, Vanessa Leonardi, CDM expert, Department for Sustainable Development, Climate Change and Energy, Ministry for the Environment, Land and Sea (01/04/2010).

MATTM, 2010[b]. Italian Guidelines and Procedures for approving Art.6 Projects, including the consideration of stakeholders' comments (Joint Implementation activities). http://ji.unfccc.int/UserManagement/FileStorage/YYYGL2ACBT50HBDKU65X56RU0UKG8W (last access 04/04/2011).

MATTM, 2011[a]. Clima. I meccanismi flessibili del Protocollo di Kyoto. Ministry for the Environment, Land and Sea. http://www.minambiente.it/home_it/menu.html?mp=/menu/menu_attivita/&m=Clima.html|I_Meccanismi_flessibili_del_Protocollo_di_.html (last access 04/04/2011).

MATTM, 2011[b]. Personal communication, Vanessa Leonardi, CDM expert, Department for Sustainable Development, Climate Change and Energy, Ministry for the Environment, Land and Sea (02/03/2011).

MINAM, 2010. Personal communication, Laura Reyes – CDM expert, *Dirección General de Cambio Climático, Desertificación y Recursos Hídricos, Ministerio del Ambiente del Peru* (22/03/2010).

Nussbaumer, P. 2009. On the contribution of labelled Certified Emission Reductions to sustainable development: A multi-criteria evaluation of CDM projects. Energy Policy 37: 91–101.

OECD, 2008. DAC Principles for Evaluation of Development Assistance - Development Assistance Committee. http://www.oecd.org/dataoecd/31/12/2755284.pdf (last access 04/04/2011).

OECD, 2009. Development Assistance Committee peer review of Italy. http://www.oecd.org/dataoecd/54/59/44403908.pdf (last access 04/04/2011).

OECD, 2011. Statistical Annex of the Development Co-operation Report. http://www.oecd.org/document/9/0,3746,en_2649_34447_1893129_1_1_1_1,00.html (last access 04/04/2011).

OICS, 2011. Web site of the Interregional Observatory for Development Cooperation [Osservatorio Interregionale Cooperazione Sviluppo]. http://www.oics.it/ (last access 04/04/2011).

Oikonomou, V., van der Gaast, W. 2008. Integrating Joint Implementation Projects for Energy Efficiency on the Built Environment with White Certificates in The Netherlands. Mitigation and Adaptation Strategies for Global Change 13:61–85.

Olsen, K.H. 2007. The clean development mechanism's contribution to sustainable development: a review of the literature. Climatic Change 84, 59–73.

Olsen, K.H. & Fenhann J. 2008. Sustainable development benefits of clean development mechanism projects A new methodology for sustainability assessment based on text analysis of the project design documents submitted for validation. Energy Policy 36: 2819– 2830.

Palm, M., Ostwald M., Berndes G., Ravindranath, N.H. 2009. Application of Clean Development Mechanism to forest plantation projects and rural development in India. J. Applied Geography 29(1): 2-11.

Schmidhuber, J. (2009). *La dieta europea Evoluzione, valutazione e impatto della Pac*. Gruppo 2013 Working Paper N◦ 11 Luglio 2009. http://www.gruppo2013.it/working-paper/Documents/La%20dieta%20europea,%20Wp%20n11%20-%20luglio%2009.pdf (last access 04/04/2011).

Seres S., Haites E., Murphy K. 2009. Analysis of technology transfer in CDM projects: An update. Energy Policy 37: 4919–4926.

Sirohi, S. 2007. CDM: Is it a 'win–win' strategy for rural poverty alleviation in India? Climatic Change 84:91–110

Streimikiene, D., Mikalauskiene A. 2007. Application of flexible Kyoto mechanisms for renewable energy projects in Baltic states. Renewable and Sustainable Energy Reviews 11: 753–775.

Sutter,Ch. 2003.Sustainability Check-Up for CDM Projects. How to asses the sustainability under the Kyoto Protocol. Wissenschaftlicher Verlag, Berlin. http://www.up.ethz.ch/publications/documents/Sutter_2003_Sustainability_Check-Up_for_CDM_Projects__e-book_.pdf (last access 04/04/2011).

Sutter Ch., Parreño, J.C. 2007. Does the current Clean Development Mechanism (CDM) deliver its sustainable development claim? An analysis of officially registered CDM projects. Climatic Change 84:75–90.

UNEP, 2011. Personal communication Dr. Joergen Fenhann from UNEP Risø Centre - Risø National Laboratory for Sustainable Energy. Email request database CDM projects and Gold Standard validation (16/02/2011).

UNFCCC, 2002. Report of the Conference of the Parties on its seventh session, held at Marrakesh from 29 October to 10 November 2001. Addendum. Part two: action taken by the Conference of the Parties. Annex. Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol. I Reporting supplementary information under Article 7, Paragraph 1. H. Minimization of adverse impacts in accordance with Article 3, paragraph 14. (FCCC/CP/2001/13/Add.3; 21 January 2002). http://unfccc.int/resource/docs/cop7/13a03.pdf (last access 04/04/2011).

UNFCCC, 2007. Report of the review of the initial report of Italy. http://unfccc.int/resource/docs/2007/irr/ita.pdf (last access 04/04/2011).

UNFCCC, 2011[a]. Clean Development web site. http://cdm.unfccc.int/index.html (accessed 16/02/2011).

UNFCCC, 2011[b]. Joint Implementation web site. http://ji.unfccc.int/index.html (accessed 16/02/2011).

15.9 KP-LULUCF

BioSoil, 2011. BioSoil-Soil project – http://biosoil.jrc.ec.europa.eu/; http://forest.jrc.ec.europa.eu/contracts/biosoil (last access 04/04/2011). Project performed under Regulation (EC) n. 2152/2003 on forest monitoring and environment interactions in the Community (Forest Focus). Coordination: CONECOFOR division, National Forest Service (CFS). Technical and scientific work contracted to research institution and university departments. Personal communication by Giorgio Matteucci (National Research Council of Italy, Institute for Agroenvironmental and Forest Biology), Stefano Carnicelli (University of Florence), Roberto Comolli (University of Milan Bicocca), Gloria Falsone (University of Turin), Giorgio Poggio (National Research Council of Italy, Institute for Ecosystem Studies), Simona Vingiani (University of Naples-I).

Bovio G., 1996. Stima della biomassa bruciata e della CO_2 prodotta da incendi boschivi in Italia. Schweizerische Zeitschrift für Forstwesen-Journal Forestier Suisse, 147, 4.

FAO, 2004 [a]. Global Forest Resources Assessment Update 2005, Specification of National Reporting Tables for FRA 2005, Forest Resources Assessment Programme. Food and Agriculture Organization of the United Nations.

FAO, 2004 [b]. Global Forest Resources Assessment 2005. Global Forest Resources Assessment 2005 – Italy – Country Report , UN/ECE- FAO, submitted. Food and Agriculture Organization of the United Nations.

Federici S, Vitullo M, Tulipano S, De Lauretis R, Seufert G, 2008. An approach to estimate carbon stocks change in forest carbon pools under the UNFCCC: the Italian case. iForest 1: 86-95 URL: http://www.sisef.it/iforest/ (last access 04/04/2011).

FutMon: Life+ LIFE07/D/000218 project for the "Further Development and Implementation of an EU-level Forest Monitoring System"; http://www.futmon.org/ (last access 04/04/2011). Personal communication by Patrizia Gasparini (CRA – MPF - Unità di ricerca per il Monitoraggio e la Pianificazione forestale).

Giordano G., 1980. Tecnologia del legno. Hoepli. Milano.

Guo L.B., Giffort R.M., 2002. Soil carbon stocks and land-use change: a meta analysis. Global Change Biology 8, pp. 345-360.

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Office, Bracknell, UK.

IPCC, 2003. Good Practice Guidance for Land Use, Land-Use Change and Forestry. IPCC Technical Support Unit, Kanagawa, Japan.

IPCC, 2006. Guidelines for National Greenhouse Gas Inventories. IPCC Technical Support Unit, Kanagawa, Japan.

ISAFA, 2004. RiselvItalia Project, Personal communication.

ISTAT, several years [a]. Statistiche forestali. Istituto Nazionale di statistica, Roma.

ISTAT, several years [b]. Statistiche dell'agricoltura. Istituto Nazionale di statistica, Roma.

ISTAT, several years [c]. Annuario Statistico Italiano. Istituto Nazionale di statistica, Roma.

MAF/ISAFA, 1988. Inventario Forestale Nazionale. Sintesi metodologica e risultati. Ministero dell'Agricoltura e delle foreste. Istituto Sperimentale per l'assestamento forestale e per l'Alpicoltura, Trento.

MAF/ISAFA, 2004. Inventario nazionale delle foreste e del carbonio, preliminary results. Personal communication. Ministero dell'Agricoltura e delle foreste. Istituto Sperimentale per l'assestamento forestale e per l'Alpicoltura, Trento.

Schulze E-D (ed.), 2000. Carbon and nitrogen cycling in European forest ecosystems, Ecological Studies 142, 500 pp + CD, Springer: Berlin, Heidelberg, New York.

Tabacchi G, De Natale F, Di Cosmo L, Floris A, Gagliano C, Gasparini P, Genchi L, Scrinzi G, Tosi V. 2007. Le stime di superficie 2005 – Parte 1. Inventario Nazionale delle Foreste e dei Serbatoi Forestali di Carbonio. MiPAF - Corpo Forestale dello Stato - Ispettorato Generale, CRA - ISAFA, TN. :1-413, versione 2.

UNFCCC, 2005. Report of the individual review of the greenhouse gas inventory of Italy submitted in 2005 (24 November 2005). URL: http://unfccc.int/resource/docs/2005/arr/ita.pdf (last access 04/04/2011).

UNFCCC, 2007. Report of the review of the initial report of Italy. FCCC/IRR/2007/ITA. UNFCCC, 10 December 2007. URL: http://unfccc.int/resource/docs/2007/arr/ita.pdf (last access 04/04/2011).

UNFCCC, 2010. Report of the individual review of the greenhouse gas inventory of Italy submitted in 2010 (22 November 2010). URL: http://unfccc.int/documentation/documents/advanced_search/items/3594.php?rec=j&priref=600006054#beg (last access 04/04/2011).

Università della Tuscia, Università del Molise. 2009. IUTI: Classification system and photo interpretation methods for the Italian Land Use Inventory.

15.10 ANNEX 1

IPCC, 2000. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. IPCC National Greenhouse Gas Inventories Programme, Technical Support Unit, Hayama, Kanagawa, Japan.

IPCC, 2003. Good Practice Guidance for Land Use, Land-Use Change and Forestry. IPCC Technical Support Unit, Kanagawa, Japan.

IPCC, 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

UNFCCC, 2010. Report of the individual review of the greenhouse gas inventory of Italy submitted in 2010. FCCC/ARR/2010/ITA (22 November 2010). URL: http://unfccc.int/documentation/documents/advanced_search/items/3594.php?rec=j&priref=600006054#beg (last access 04/04/2011).

15.11 ANNEX 2

APAT, 2003. Indicatori e modelli settoriali finalizzati alla preparazione di inventari delle emissioni del sistema energetico nazionale nel breve e medio periodo. Tricarico A., Rapporto Tecnico N° 01/2003.

ENEL, several years. Dati statistici sull’energia elettrica in Italia. ENEL.

ENI, several years. La congiuntura economica ed energetica. ENI.

MSE, several years. Bilancio Energetico Nazionale (BEN). Ministero dello Sviluppo Economico, Direzione Generale delle Fonti di Energia ed industrie di base, URL: http://dgerm.sviluppoeconomico.gov.it/dgerm/ben.asp (last access 04/04/2011).

TERNA, several years. Dati statistici sull’energia elettrica in Italia. Rete Elettrica Nazionale.

UNAPACE, several years. Data from the association of industrial electricity producers. Available:http://www.assoelettrica.it/

UP, several years. Statistiche economiche, energetiche e petrolifere. Unione Petrolifera.

15.12 ANNEX 3

MSE, several years. Bilancio Energetico Nazionale (BEN). Ministero dello Sviluppo Economico, Direzione Generale delle Fonti di Energia ed industrie di base, also available on website http://dgerm.sviluppoeconomico.gov.it/dgerm/ben.asp (last access 04/04/2011).

TERNA, several years. Dati statistici sull’energia elettrica in Italia. Rete Elettrica Nazionale.

15.13 ANNEX 4

ENEA, 2002 [a]. Calcolo delle emissioni di CO_2 dal settore energetico, metodo di riferimento IPCC. Contaldi M., La Motta S.

ENEA, 2002 [b]. Calcolo delle emissioni di CO_2, reference approach - manuale d’uso per la compilazione del foglio elettronico 1a(b) e 1a(d) del common reference framework (CRF). La Motta S. and Ancona P., Ente per le Nuove tecnologie, l’Energia e l’Ambiente.

ENEA, several years. Rapporto Energia Ambiente. Ente per le Nuove tecnologie, l’Energia e l’Ambiente, Roma.

ENEL, several years. Environmental Report. ENEL. www.enel.it (last access 04/04/2011).

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Centre, Meteorological Office, Bracknell, UK.

MSE, several years [a]. Bilancio Energetico Nazionale (BEN). Ministero dello Sviluppo Economico, Direzione Generale delle Fonti di Energia ed industrie di base, also available on website http://dgerm.sviluppoeconomico.gov.it/dgerm/ben.asp (last access 04/04/2011).

MSE, several years [b]. Bollettino Petrolifero Trimestrale (BPT). Ministero dello Sviluppo Economico.

15.14 ANNEX 5

MSE, several years. Bilancio Energetico Nazionale (BEN). Ministero dello Sviluppo Economico, Direzione Generale delle Fonti di Energia ed industrie di base, also available on website http://dgerm.sviluppoeconomico.gov.it/dgerm/ben.asp (last access 04/04/2011).

15.15 ANNEX 6

APAT, 2003. Analisi dei fattori di emissione di CO_2 dal settore dei trasporti. Ilacqua M., Contaldi M., Rapporti n° 28/2003.

EEA, 2010. COPERT 4, Computer programme to calculate emissions from road transport. European Environment Agency, March 2010. http://lat.eng.auth.gr/copert/.

EMEP/CORINAIR, 2007. Atmospheric Emission Inventory Guidebook. Technical report No 16/2007.

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Centre, Meteorological Office, Bracknell, UK.

IPCC, 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

MSE, several years [a]. Bilancio Energetico Nazionale (BEN). Ministero dello Sviluppo Economico, Direzione Generale delle Fonti di Energia ed industrie di base, also available on website http://dgerm.sviluppoeconomico.gov.it/dgerm/ben.asp (last access 04/04/2011).

MSE, several years [b]. Bollettino Petrolifero Trimestrale (BPT). Ministero dello Sviluppo Economico.

Snam Rete Gas, several years. Bilancio di sostenibilità.

TERNA, several years. Dati statistici sull’energia elettrica in Italia. Rete Elettrica Nazionale.

15.16 ANNEX 7

Cóndor, R.D., Cristofaro, E. De Lauretis, R. 2008. Agricoltura: inventario nazionale delle emissioni e disaggregazione provinciale. Istituto superiore per la protezione e la ricerca ambientale, ISPRA Rapporto tecnico 85/2008. Roma, Italia. http://www.apat.gov.it/site/it-IT/APAT/Pubblicazioni/Rapporti/Documento/rapporto_85_2008.html (last access 04/04/2011).

IPCC, 2000. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. IPCC National Greenhouse Gas Inventories Programme, Technical Support Unit, Hayama, Kanagawa, Japan.

MATTM, 2010. Personal communication with Marco Porrega: E-mail request for sewage sludge applied to agricultural soils in Italy. *Ministero dell'Ambiente e della Tutela del Territorio e del Mare*, Roma –Italia.

TERNA, 2010. National production data from biogas, year 2008. http://www.terna.it/default/Home/SISTEMA_ELETTRICO/statistiche/dati_statistici.aspx (last access 04/04/2011).

TERNA, 2011. National production data from biogas, year 2009. http://www.terna.it/default/Home/SISTEMA_ELETTRICO/statistiche/dati_statistici.aspx (last access 04/04/2011).

UNFCCC, 2009. Report of the individual review of the greenhouse gas inventories of Italy submitted in 2007 and 2008 (FCCC/ARR/2008/ITA; 16 January 2009). http://unfccc.int/resource/docs/2009/arr/ita.pdf (last access 04/04/2011).

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, these updated guidelines have been followed to implement the key category and uncertainty analyses.

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 2009, 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, 19 sources were individuated according to Approach 1, whereas 15 sources were carried out by Approach 2. Including the LULUCF sector in the analysis, 24 categories were selected jointly by the Approach 1 and Approach 2.

For the year 2009, 17 sources were individuated by the Approach 1 accounting for 95% of the total emissions, without LULUCF; for the trend 14 key sources were selected. Jointly for the Approach 1, both level and trend, 21 key categories were totally individuated.

Repeating the *key category* analysis for the full inventory including the LULUCF sector, 20 categories were individuated accounting for 95% of the total emissions and removals in 2009, and 16 key categories in trend assessment. Jointly for the Approach 1, both level and trend, 24 key categories were totally individuated.

The application of the Approach 2 to the 2009 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 increased to 17 with differences with respect to the previous list.

The application of the Approach 2 including the LULUCF categories results in 17 key categories, for the year 2009, accounting for the 90% of the total levels with uncertainty; for the trend analysis including LULUCF categories, the results were 12 key categories. Jointly for both the level and trend, 18 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:

$$\text{Category Level Assessment} = \frac{|\text{Source or Sink Category Estimate}|}{\text{Total Contribution}}$$

$$L_{x,t} = \left|E_{x,t}\right| \Big/ \sum_y \left|E_{y,t}\right|$$

where

$L_{x,t}$ = level assessment for source or sink *x* in year *t*;

$\left|E_{x,t}\right|$ = absolute value of emission and removal estimate of source or sink category *x* in year *t*;

$\sum_y \left|E_{y,t}\right|$ = 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:

$$\text{Category Trend Assessment} = (\text{Source or Sink Category Level Assessment}) \cdot |\text{Source or Sink Category Trend - Total Trend}|$$

$$T_{x,t} = \left|E_{x,0}\right| \Big/ \sum_y \left|E_{y,0}\right| \cdot \left| \left[\left(E_{x,t} - E_{x,0}\right) \Big/ \left|E_{x,0}\right| \right] - \left[\left(E_t - E_0\right) \Big/ \sum_y \left|E_{y,0}\right| \right] \right|$$

where

$T_{x,t}$ = trend assessment, which is the contribution of the source or sink category trend to the overall inventory trend;

$\left|E_{x,0}\right|$ = absolute value of emission and removal estimate of source or sink category *x* in the base year (year *0*);

$\sum_y \left|E_{y,0}\right|$ = 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:

$$T_{x,t} = \left| E_{x,t} \middle/ \left| E_{x,0} \right| \right|$$

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 2009 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.

CATEGORIES	2009 CO_2 eq	Level assessment	Cumulative Percentage
CO2 stationary combustion gaseous fuels	148,999	0.303	0.30
CO2 Mobile combustion: Road Vehicles	109,906	0.224	0.53
CO2 stationary combustion liquid fuels	72,096	0.147	0.67
CO2 stationary combustion solid fuels	49,286	0.100	0.77
CO2 Cement production	13,454	0.027	0.80
CH4 from Solid waste Disposal Sites	12,741	0.026	0.83
CH4 Enteric Fermentation in Domestic Livestock	10,779	0.022	0.85
HFC, PFC substitutes for ODS	8,167	0.017	0.87
Direct N2O Agricultural Soils	7,354	0.015	0.88
Indirect N2O from Nitrogen used in agriculture	6,564	0.013	0.89
CH4 Fugitive emissions from Oil and Gas Operations	4,906	0.010	0.90
CO2 Mobile combustion: Waterborne Navigation	4,762	0.010	0.91
CO2 stationary combustion other fuels	4,520	0.009	0.92
N2O Manure Management	3,762	0.008	0.93
N2O stationary combustion	3,550	0.007	0.94
CH4 Manure Management	2,886	0.006	0.94
CH4 Emissions from Wastewater Handling	2,723	0.006	0.95
CO2 Mobile combustion: Aircraft	2,197	0.004	0.95
CO2 Fugitive emissions from Oil and Gas Operations	2,170	0.004	0.96
N2O Emissions from Wastewater Handling	1,964	0.004	0.96
CO2 Mobile combustion: Other	1,853	0.004	0.97
CO2 Lime production	1,689	0.003	0.97
CO2 Limestone and Dolomite Use	1,651	0.003	0.97
CO2 Other industrial processes	1,593	0.003	0.98
CH4 from Rice production	1,579	0.003	0.98
N2O from animal production	1,541	0.003	0.98
CO2 Emissions from solvent use	1,191	0.002	0.99
CH4 stationary combustion	981	0.002	0.99
N2O Mobile combustion: Road Vehicles	980	0.002	0.99
CO2 Iron and Steel production	901	0.002	0.99
N2O Adipic Acid	748	0.002	0.99
CO2 Ammonia production	695	0.001	0.99
N2O Emissions from solvent use	671	0.001	1.00
N2O Nitric Acid	382	0.001	1.00
SF6 Electrical Equipment	367	0.001	1.00
CH4 Mobile combustion: Road Vehicles	285	0.001	1.00
CH4 Emissions from Waste Incineration	285	0.001	1.00
CO2 Emissions from Waste Incineration	250	0.001	1.00
PFC Aluminium production	146	0.000	1.00
N2O Emissions from Waste Incineration	126	0.000	1.00
N2O Mobile combustion: Other	111	0.000	1.00
PFC, HFC, SF6 Semiconductor manufacturing	100	0.000	1.00
CH4 Fugitive emissions from Coal Mining and Handling	45	0.000	1.00
CH4 Industrial Processes	39	0.000	1.00
N2O Mobile combustion: Waterborne Navigation	35	0.000	1.00
CH4 Mobile combustion: Waterborne Navigation	27	0.000	1.00
N2O Mobile combustion: Aircraft	19	0.000	1.00
CH4 Agricultural Residue Burning	13	0.000	1.00
N2O Fugitive emissions from Oil and Gas Operations	12	0.000	1.00
SF6 Magnesium production	9.2	0.000	1.00
CH4 Emissions from Other Waste	4.4	0.000	1.00
N2O Agricultural Residue Burning	4.0	0.000	1.00
CH4 Mobile combustion: Other	2.5	0.000	1.00
CH4 Mobile combustion: Aircraft	1.4	0.000	1.00

Table A1.1 Results of the key category analysis without LULUCF. Approach 1 Level assessment, year 2009

CATEGORIES	Contribution to trend (%)	Cumulative Percentage
CO2 stationary combustion liquid fuels	0.350	0.35
CO2 stationary combustion gaseous fuels	0.329	0.68
CO2 Mobile combustion: Road Vehicles	0.103	0.78
HFC, PFC substitutes for ODS	0.039	0.82
CO2 stationary combustion solid fuels	0.033	0.85
N2O Adipic Acid	0.017	0.87
CO2 stationary combustion other fuels	0.014	0.88
CO2 Iron and Steel production	0.010	0.89
CH4 Fugitive emissions from Oil and Gas Operations	0.010	0.90
CO2 Ammonia production	0.009	0.91
CO2 Cement production	0.008	0.92
Direct N2O Agricultural Soils	0.008	0.93
CH4 from Solid waste Disposal Sites	0.008	0.94
N2O Nitric Acid	0.008	0.95
PFC Aluminium production	0.007	0.95
Indirect N2O from Nitrogen used in agriculture	0.005	0.96
CO2 Fugitive emissions from Oil and Gas Operations	0.005	0.96
CH4 Emissions from Wastewater Handling	0.004	0.97
CO2 Limestone and Dolomite Use	0.004	0.97
CH4 Enteric Fermentation in Domestic Livestock	0.004	0.97
CO2 Mobile combustion: Aircraft	0.003	0.98
CH4 Manure Management	0.002	0.98
CH4 Mobile combustion: Road Vehicles	0.002	0.98
CH4 stationary combustion	0.002	0.98
CO2 Mobile combustion: Waterborne Navigation	0.002	0.98
CO2 Emissions from solvent use	0.002	0.99
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.002	0.99
N2O stationary combustion	0.001	0.99
CO2 Emissions from Waste Incineration	0.001	0.99
CO2 Lime production	0.001	0.99
N2O Mobile combustion: Road Vehicles	0.001	0.99
N2O Emissions from Wastewater Handling	0.001	0.99
SF6 Electrical Equipment	0.001	0.99
CO2 Other industrial processes	0.001	1.00
CH4 Emissions from Waste Incineration	0.001	1.00
SF6 Production of SF6	0.001	1.00
N2O from animal production	0.000	1.00
CH4 from Rice production	0.000	1.00
PFC, HFC, SF6 Semiconductor manufacturing	0.000	1.00
N2O Emissions from solvent use	0.000	1.00
CH4 Fugitive emissions from Coal Mining and Handling	0.000	1.00
CH4 Industrial Processes	0.000	1.00
CO2 Mobile combustion: Other	0.000	1.00
N2O Manure Management	0.000	1.00
N2O Emissions from Waste Incineration	0.000	1.00
N2O Mobile combustion: Other	0.000	1.00
N2O Other industrial processes	0.000	1.00
SF6 Magnesium production	0.000	1.00
N2O Mobile combustion: Aircraft	0.000	1.00
CH4 Emissions from Other Waste	0.000	1.00
N2O Mobile combustion: Waterborne Navigation	0.000	1.00
CH4 Mobile combustion: Other	0.000	1.00
CH4 Mobile combustion: Waterborne Navigation	0.000	1.00
CH4 Mobile combustion: Aircraft	0.000	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.000	1.00
N2O Agricultural Residue Burning	0.000	1.00
CH4 Agricultural Residue Burning	0.000	1.00

Table A1.2 Results of the key category analysis without LULUCF. Approach 1 Trend assessment, 1990- 2009

CATEGORIES	2009 CO_2 eq	Level assessment	Cumulative Percentage
CO2 stationary combustion gaseous fuels	148,998.86	0.251	0.25
CO2 Mobile combustion: Road Vehicles	109,905.63	0.185	0.44
CO2 stationary combustion liquid fuels	72,096.33	0.122	0.56
CO2 Forest land remaining Forest Land	-65,040.14	0.110	0.67
CO2 stationary combustion solid fuels	49,286.42	0.083	0.75
CO2 Cement production	13,453.89	0.023	0.77
CO2 Land converted to Grassland	-12,788.14	0.022	0.80
CH4 from Solid waste Disposal Sites	12,741.31	0.021	0.82
CO2 Cropland remaining Cropland	-12,299.41	0.021	0.84
CH4 Enteric Fermentation in Domestic Livestock	10,779.27	0.018	0.86
HFC, PFC substitutes for ODS	8,166.95	0.014	0.87
Direct N2O Agricultural Soils	7,354.13	0.012	0.88
CO2 Grassland remaining Grassland	-6,729.89	0.011	0.89
Indirect N2O from Nitrogen used in agriculture	6,563.69	0.011	0.90
CH4 Fugitive emissions from Oil and Gas Operations	4,905.69	0.008	0.91
CO2 Mobile combustion: Waterborne Navigation	4,762.45	0.008	0.92
CO2 stationary combustion other fuels	4,519.96	0.008	0.93
N2O Manure Management	3,762.03	0.006	0.93
N2O stationary combustion	3,550.07	0.006	0.94
CO2 Land converted to Settlements	3,515.81	0.006	0.95
CH4 Manure Management	2,885.55	0.005	0.95
CH4 Emissions from Wastewater Handling	2,723.09	0.005	0.96
CO2 Mobile combustion: Aircraft	2,197.18	0.004	0.96
CO2 Fugitive emissions from Oil and Gas Operations	2,170.10	0.004	0.96
N2O Emissions from Wastewater Handling	1,964.37	0.003	0.97
CO2 Mobile combustion: Other	1,852.55	0.003	0.97
CO2 Lime production	1,689.36	0.003	0.97
CO2 Limestone and Dolomite Use	1,651.03	0.003	0.98
CO2 Other industrial processes	1,592.66	0.003	0.98
CH4 from Rice production	1,578.66	0.003	0.98
N2O from animal production	1,541.24	0.003	0.98
CO2 Land converted to Forest Land	-1,389.69	0.002	0.99
CO2 Emissions from solvent use	1,190.58	0.002	0.99
CH4 stationary combustion	981.27	0.002	0.99
N2O Mobile combustion: Road Vehicles	979.73	0.002	0.99
CO2 Iron and Steel production	900.67	0.002	0.99
N2O Adipic Acid	748.03	0.001	0.99
CO2 Ammonia production	694.83	0.001	0.99
N2O Emissions from solvent use	671.01	0.001	1.00
N2O Nitric Acid	381.61	0.001	1.00
SF6 Electrical Equipment	367.03	0.001	1.00
CH4 Mobile combustion: Road Vehicles	285.50	0.000	1.00
CH4 Emissions from Waste Incineration	285.48	0.000	1.00
CO2 Emissions from Waste Incineration	249.90	0.000	1.00
PFC Aluminium production	145.61	0.000	1.00
N2O Emissions from Waste Incineration	125.58	0.000	1.00
N2O Mobile combustion: Other	110.79	0.000	1.00
PFC, HFC, SF6 Semiconductor manufacturing	99.58	0.000	1.00
CH4 Forest land remaining Forest Land	54.91	0.000	1.00
CH4 Fugitive emissions from Coal Mining and Handling	44.58	0.000	1.00
CH4 Industrial Processes	39.11	0.000	1.00
N2O Mobile combustion: Waterborne Navigation	34.59	0.000	1.00
CH4 Mobile combustion: Waterborne Navigation	26.67	0.000	1.00
N2O Mobile combustion: Aircraft	19.06	0.000	1.00
CH4 Agricultural Residue Burning	12.53	0.000	1.00
N2O Fugitive emissions from Oil and Gas Operations	11.84	0.000	1.00
SF6 Magnesium production	9.18	0.000	1.00
N2O Forest land remaining Forest Land	5.57	0.000	1.00
CH4 Emissions from Other Waste	4.42	0.000	1.00
N2O Agricultural Residue Burning	4.01	0.000	1.00
CH4 Mobile combustion: Other	2.53	0.000	1.00
CH4 Mobile combustion: Aircraft	1.38	0.000	1.00

Table A1.3 Results of the key category analysis with LULUCF. Approach 1 Level assessment, year 2009

CATEGORIES	Contribution to trend (%)	Cumulative Percentage
CO2 stationary combustion gaseous fuels	0.305	0.31
CO2 stationary combustion liquid fuels	0.247	0.55
CO2 Mobile combustion: Road Vehicles	0.117	0.67
CO2 Forest land remaining Forest Land	0.076	0.75
CO2 Land converted to Grassland	0.052	0.80
CO2 Cropland remaining Cropland	0.042	0.84
HFC, PFC substitutes for ODS	0.033	0.87
N2O Adipic Acid	0.013	0.89
CO2 stationary combustion other fuels	0.012	0.90
CO2 Grassland remaining Grassland	0.009	0.91
CO2 stationary combustion solid fuels	0.009	0.92
CO2 Iron and Steel production	0.007	0.92
CO2 Ammonia production	0.007	0.93
N2O Nitric Acid	0.006	0.94
CH4 Fugitive emissions from Oil and Gas Operations	0.006	0.94
CO2 Land converted to Settlements	0.005	0.95
PFC Aluminium production	0.005	0.95
CH4 Emissions from Wastewater Handling	0.004	0.96
Direct N2O Agricultural Soils	0.004	0.96
CO2 Land converted to Cropland	0.004	0.96
CO2 Mobile combustion: Aircraft	0.003	0.97
CO2 Fugitive emissions from Oil and Gas Operations	0.003	0.97
N2O stationary combustion	0.002	0.97
CO2 Limestone and Dolomite Use	0.002	0.97
CO2 Land converted to Forest Land	0.002	0.98
Indirect N2O from Nitrogen used in agriculture	0.002	0.98
CO2 Cement production	0.002	0.98
CH4 from Solid waste Disposal Sites	0.002	0.98
CH4 stationary combustion	0.002	0.98
N2O Emissions from Wastewater Handling	0.002	0.99
N2O Manure Management	0.001	0.99
CH4 Mobile combustion: Road Vehicles	0.001	0.99
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.001	0.99
N2O Mobile combustion: Road Vehicles	0.001	0.99
CO2 Emissions from solvent use	0.001	0.99
CH4 from Rice production	0.001	0.99
CH4 Enteric Fermentation in Domestic Livestock	0.001	0.99
CO2 Emissions from Waste Incineration	0.001	0.99
CO2 Mobile combustion: Other	0.001	0.99
SF6 Electrical Equipment	0.001	1.00
CH4 Emissions from Waste Incineration	0.001	1.00
CH4 Manure Management	0.000	1.00
N2O Land converted to Cropland	0.000	1.00
SF6 Production of SF6	0.000	1.00
PFC, HFC, SF6 Semiconductor manufacturing	0.000	1.00
CO2 Lime production	0.000	1.00
CH4 Forest land remaining Forest Land	0.000	1.00
CO2 Mobile combustion: Waterborne Navigation	0.000	1.00
CH4 Fugitive emissions from Coal Mining and Handling	0.000	1.00
CH4 Industrial Processes	0.000	1.00
N2O Emissions from Waste Incineration	0.000	1.00
N2O from animal production	0.000	1.00
N2O Emissions from solvent use	0.000	1.00
N2O Other industrial processes	0.000	1.00
SF6 Magnesium production	0.000	1.00
N2O Forest land remaining Forest Land	0.000	1.00
N2O Mobile combustion: Aircraft	0.000	1.00
CH4 Emissions from Other Waste	0.000	1.00
CO2 Other industrial processes	0.000	1.00
N2O Mobile combustion: Other	0.000	1.00
CH4 Mobile combustion: Other	0.000	1.00
CH4 Mobile combustion: Waterborne Navigation	0.000	1.00
CH4 Agricultural Residue Burning	0.000	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.000	1.00
CH4 Mobile combustion: Aircraft	0.000	1.00
N2O Agricultural Residue Burning	0.000	1.00
N2O Mobile combustion: Waterborne Navigation	0.000	1.00

A1.4 Results of the key category analysis with LULUCF. Approach 1 Trend assessment, 1990-2009

The application of Approach 1, excluding LULUCF categories, gives as a result 17 key sources accounting for the 95% of the total levels; when applying the trend analysis, excluding LULUCF categories, the key sources decreased to 14 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 20 key categories (sources and sinks), whereas 16 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 2009 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 2009, excluding the LULUCF sector.
Details on the method used for LULUCF are described in the relevant chapter, 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.

		Emissions		Uncertainty				Sensitivity		Uncertainty in trend		
IPCC category	Gas	1990	2009	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.										
CO2 stationary combustion liquid fuels	CO2	153,467	72,096	3%	3%	0.042	0.000	0.140	0.139	0.004	0.006	0.000
CO2 stationary combustion solid fuels	CO2	59,348	49,286	3%	3%	0.042	0.000	0.013	0.095	0.000	0.004	0.000
CO2 stationary combustion gaseous fuels	CO2	85,066	148,999	3%	3%	0.042	0.000	0.132	0.287	0.004	0.012	0.000
CO2 stationary combustion other fuels	CO2	1,779	4,520	3%	3%	0.042	0.000	0.005	0.009	0.000	0.000	0.000
CH4 stationary combustion	CH4	647	981	3%	50%	0.501	0.000	0.001	0.002	0.000	0.000	0.000
N2O stationary combustion	N2O	3,445	3,550	3%	50%	0.501	0.000	0.001	0.007	0.000	0.000	0.000
CO2 Mobile combustion: Road Vehicles	CO2	93,387	109,906	3%	3%	0.042	0.000	0.041	0.212	0.001	0.009	0.000
CH4 Mobile combustion: Road Vehicles	CH4	694	285	3%	40%	0.401	0.000	0.001	0.001	0.000	0.000	0.000
N2O Mobile combustion: Road Vehicles	N2O	789	980	3%	50%	0.501	0.000	0.000	0.002	0.000	0.000	0.000
CO2 Mobile combustion: Waterborne Navigation	CO2	5,420	4,762	3%	3%	0.042	0.000	0.001	0.009	0.000	0.000	0.000
CH4 Mobile combustion: Waterborne Navigation	CH4	29	27	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Waterborne Navigation	N2O	39	35	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion: Aircraft	CO2	1,613	2,197	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	1,853	3%	5%	0.058	0.000	0.000	0.004	0.000	0.000	0.000
CH4 Mobile combustion: Other	CH4	5	3	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Other	N2O	131	111	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	122	45	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	2,170	3%	25%	0.252	0.000	0.002	0.004	0.000	0.000	0.000
CH4 Fugitive emissions from Oil and Gas Operations	CH4	7,298	4,906	3%	25%	0.252	0.000	0.004	0.009	0.001	0.000	0.000
N2O Fugitive emissions from Oil and Gas Operations	N2O	12	12	3%	25%	0.252	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Cement production	CO2	16,084	13,454	3%	10%	0.104	0.000	0.003	0.026	0.000	0.001	0.000
CO2 Lime production	CO2	2,042	1,689	3%	10%	0.104	0.000	0.000	0.003	0.000	0.000	0.000
CO2 Limestone and Dolomite Use	CO2	2,540	1,651	3%	10%	0.104	0.000	0.001	0.003	0.000	0.000	0.000
CO2 Iron and Steel production	CO2	3,124	901	3%	10%	0.104	0.000	0.004	0.002	0.000	0.000	0.000

Table A1.5 Results of the uncertainty analysis excluding LULUCF (Approach 1). Year 2009 (continued)

		Emissions		Uncertainty				Sensitivity		Uncertainty in trend		
IPCC category	Gas	1990	2009	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.										
CO2 Ammonia production	CO2	2,765	695	3%	10%	0.104	0.000	0.004	0.001	0.000	0.000	0.000
CO2 Other industrial processes	CO2	1,842	1,593	3%	10%	0.104	0.000	0.000	0.003	0.000	0.000	0.000
N2O Adipic Acid	N2O	4,579	748	3%	10%	0.104	0.000	0.007	0.001	0.001	0.000	0.000
N2O Nitric Acid	N2O	2,086	382	3%	10%	0.104	0.000	0.003	0.001	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	39	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
PFC Aluminium production	PFC	1,673	146	5%	10%	0.112	0.000	0.003	0.000	0.000	0.000	0.000
SF6 Magnesium production	SF6	0	9	5%	5%	0.071	0.000	0.000	0.000	0.000	0.000	0.000
SF6 Electrical Equipment	SF6	213	367	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	100	30%	50%	0.583	0.000	0.000	0.000	0.000	0.000	0.000
HFC, PFC substitutes for ODS	HFC	134	8,167	30%	50%	0.583	0.000	0.015	0.016	0.008	0.007	0.000
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	HFC	351	0	5%	10%	0.112	0.000	0.001	0.000	0.000	0.000	0.000
CH4 Enteric Fermentation in Domestic Livestock	CH4	12,179	10,779	20%	20%	0.283	0.000	0.001	0.021	0.000	0.006	0.000
CH4 Manure Management	CH4	3,462	2,886	20%	100%	1.020	0.000	0.001	0.006	0.001	0.002	0.000
N2O Manure Management	N2O	3,921	3,762	20%	100%	1.020	0.000	0.000	0.007	0.000	0.002	0.000
CH4 Agricultural Residue Burning	CH4	13	13	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
N2O Agricultural Residue Burning	N2O	4	4	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
Direct N2O Agricultural Soils	N2O	9,605	7,354	20%	100%	1.020	0.000	0.003	0.014	0.003	0.004	0.000
Indirect N2O from Nitrogen used in agriculture	N2O	8,140	6,564	20%	100%	1.020	0.000	0.002	0.013	0.002	0.004	0.000
CH4 from Rice production	CH4	1,562	1,579	3%	20%	0.202	0.000	0.000	0.003	0.000	0.000	0.000
N2O from animal production	N2O	1,736	1,541	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	12,741	20%	30%	0.361	0.000	0.003	0.025	0.001	0.007	0.000
CH4 Emissions from Wastewater Handling	CH4	1,990	2,723	100%	30%	1.044	0.000	0.002	0.005	0.000	0.007	0.000
N2O Emissions from Wastewater Handling	N2O	1,832	1,964	30%	30%	0.424	0.000	0.000	0.004	0.000	0.002	0.000
CO2 Emissions from Waste Incineration	CO2	537	250	5%	25%	0.255	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 2009 (continued)

IPCC category	Gas	Emissions 1990	2009	Uncertainty AD	EF	Combined	Contribution to variance	Sensitivity Type A	Type B	Uncertainty in trend introduced by EF uncertainty	introduced by AD uncertainty	in total national emissions
		Gg CO2 eq.										
CH4 Emissions from Waste Incineration	CH4	161	285	5%	20%	0.206	0.000	0.000	0.001	0.000	0.000	0.000
N2O Emissions from Waste Incineration	N2O	88	126	5%	100%	1.001	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Emissions from Other Waste	CH4	0	4	10%	100%	1.005	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Emissions from solvent use	CO2	1,643	1,191	30%	50%	0.583	0.000	0.001	0.002	0.000	0.001	0.000
N2O Emissions from solvent use	N2O	812	671	50%	10%	0.510	0.000	0.000	0.001	0.000	0.001	0.000
TOTAL		**519,157**	**491,120**				**0.001**					**0.001**
						Percentage uncertainty in total inventory	**3%**				**Trend uncertainty**	**2%**

Table A1.5 Results of the uncertainty analysis excluding LULUCF (Approach 1). Year 2009

IPCC Category	Gas	Emissions 1990	2009	Uncertainty AD	EF	Combined uncertainty	Contribution to variance 2009	Sensitivity Type A	Type B	Trend uncertainty in LULUCF emissions introduced by EF	in LULUCF emissions introduced by AD	in total LULUCF emissions
		Gg CO_2 eq										
A. Forest Land	CO_2	-41,701	-55,960	*23%*	*43%*	49%	12%	4%	90%	2%	30%	9%
B. Cropland	CO_2	-18,949	-12,453	*75%*	*75%*	106%	2%	27%	20%	20%	21%	8%
C. Grassland	CO_2	-3,954	-13,570	*75%*	*75%*	106%	5%	22%	31%	16%	33%	14%
D. Wetlands	CO_2	0	0			0%	0%	0%	0%	0%	0%	0%
E. Settlements	CO_2	2,526	2,495	*75%*	*75%*	106%	0%	1%	6%	0%	6%	0%
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		**-62,077**	**-79,488**				**19%**					**35%**
						Percentage uncertainty	**43%**				**Trend uncertainty**	**59%**

[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 A1.6 Results of the uncertainty analysis for the LULUCF sector – CO_2 (Approach 1)

IPCC Category	Gas	Emissions 1990	2009	Uncertainty AD	EF	Combined uncertainty	Contribution to variance 2009	Sensitivity Type A	Type B	Trend uncertainty in LULUCF emissions introduced by EF uncertainty	emissions introduced by AD uncertainty	in total LULUCF emissions
		Gg CO_2 eq										
A. Forest Land	CO_2 eq	-41,540	-62,969	*23%*	*43%*	49%	11%	1%	102%	0%	34%	11%
B. Cropland	CO_2 eq	-18,828	-12,928	*75%*	*75%*	106%	2%	25%	21%	19%	22%	8%
C. Grassland	CO_2 eq	-3,954	-20,391	*75%*	*75%*	106%	5%	23%	33%	18%	35%	15%
D. Wetlands	CO_2 eq	0	0			0%	0%	0%	0%	0%	0%	0%
E. Settlements	CO_2 eq	2,526	3,460	*75%*	*75%*	106%	0%	1%	6%	0%	6%	0%
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		**-61,795**	**-92,828**				**19%**					**35%**
						Percentage uncertainty	**43%**				**Trend uncertainty**	**60%**

Table A1.7 Results of the uncertainty analysis for the LULUCF sector – CO_2, CH_4, N_2O (Approach 1)

		Emissions		Uncertainty				Sensitivity		Uncertainty in trend		
IPCC category	**Gas**	**1990**	**2009**	**AD**	**EF**	**Combined**	**Contribution to variance**	**Type A**	**Type B**	**introduced by EF uncertainty**	**introduced by AD uncertainty**	**in total national emissions**
		Gg	**Gg**									
CO_2 stationary combustion liquid fuels	CO_2	153,467	72,096	3%	3%	0.042	0.000	0.133	0.158	0.004	0.007	0.000
CO_2 stationary combustion solid fuels	CO_2	59,348	49,286	3%	3%	0.042	0.000	0.005	0.108	0.000	0.005	0.000
CO_2 stationary combustion gaseous fuels	CO_2	85,066	148,999	3%	3%	0.042	0.000	0.164	0.326	0.005	0.014	0.000
CO_2 stationary combustion other fuels	CO_2	1,779	4,520	3%	3%	0.042	0.000	0.007	0.010	0.000	0.000	0.000
CH_4 stationary combustion	CH_4	647	981	3%	50%	0.501	0.000	0.001	0.002	0.000	0.000	0.000
N_2O stationary combustion	N_2O	3,445	3,550	3%	50%	0.501	0.000	0.001	0.008	0.001	0.000	0.000
CO_2 Mobile combustion: Road Vehicles	CO_2	93,387	109,906	3%	3%	0.042	0.000	0.063	0.240	0.002	0.010	0.000
CH_4 Mobile combustion: Road Vehicles	CH_4	694	285	3%	40%	0.401	0.000	0.001	0.001	0.000	0.000	0.000
N_2O Mobile combustion: Road Vehicles	N_2O	789	980	3%	50%	0.501	0.000	0.001	0.002	0.000	0.000	0.000
CO_2 Mobile combustion: Waterborne Navigation	CO_2	5,420	4,762	3%	3%	0.042	0.000	0.000	0.010	0.000	0.000	0.000
CH_4 Mobile combustion: Waterborne Navigation	CH_4	29	27	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N_2O Mobile combustion: Waterborne Navigation	N_2O	39	35	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CO_2 Mobile combustion: Aircraft	CO_2	1,613	2,197	3%	3%	0.042	0.000	0.002	0.005	0.000	0.000	0.000
CH_4 Mobile combustion: Aircraft	CH_4	1	1	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N_2O Mobile combustion: Aircraft	N_2O	14	19	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CO_2 Mobile combustion: Other	CO_2	1,894	1,853	3%	5%	0.058	0.000	0.000	0.004	0.000	0.000	0.000
CH_4 Mobile combustion: Other	CH_4	5	3	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N_2O Mobile combustion: Other	N_2O	131	111	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CH_4 Fugitive emissions from Coal Mining and Handling	CH_4	122	45	3%	200%	2.000	0.000	0.000	0.000	0.000	0.000	0.000
CO_2 Fugitive emissions from Oil and Gas Operations	CO_2	3,344	2,170	3%	25%	0.252	0.000	0.002	0.005	0.000	0.000	0.000
CH_4 Fugitive emissions from Oil and Gas Operations	CH_4	7,298	4,906	3%	25%	0.252	0.000	0.003	0.011	0.001	0.000	0.000
N_2O Fugitive emissions from Oil and Gas Operations	N_2O	12	12	3%	25%	0.252	0.000	0.000	0.000	0.000	0.000	0.000
CO_2 Cement production	CO_2	16,084	13,454	3%	10%	0.104	0.000	0.001	0.029	0.000	0.001	0.000
CO_2 Lime production	CO_2	2,042	1,689	3%	10%	0.104	0.000	0.000	0.004	0.000	0.000	0.000
CO_2 Limestone and Dolomite Use	CO_2	2,540	1,651	3%	10%	0.104	0.000	0.001	0.004	0.000	0.000	0.000
CO_2 Iron and Steel production	CO_2	3,124	901	3%	10%	0.104	0.000	0.004	0.002	0.000	0.000	0.000
CO_2 Ammonia production	CO_2	2,765	695	3%	10%	0.104	0.000	0.004	0.002	0.000	0.000	0.000
CO_2 Other industrial processes	CO_2	1,842	1,593	3%	10%	0.104	0.000	0.000	0.003	0.000	0.000	0.000
N_2O Adipic Acid	N_2O	4,579	748	3%	10%	0.104	0.000	0.007	0.002	0.001	0.000	0.000
N_2O Nitric Acid	N_2O	2,086	382	3%	10%	0.104	0.000	0.003	0.001	0.000	0.000	0.000
N_2O Other industrial processes	N_2O	11	0	3%	10%	0.104	0.000	0.000	0.000	0.000	0.000	0.000

Table A1.8 Results of the uncertainty analysis including LULUCF (Approach 1). Year 2009 (continued)

		Emissions		Uncertainty				Sensitivity		Uncertainty in trend		
IPCC category	Gas	1990	2009	AD	EF	Combined	Contribution to variance	Type A	Type B	introduced by EF uncertainty	introduced by AD uncertainty	in total national emissions
		Gg	Gg									
CH4 Industrial Processes	CH4	108	39	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
PFC Aluminium production	PFC	1,673	146	5%	10%	0.112	0.000	0.003	0.000	0.000	0.000	0.000
SF6 Magnesium production	SF6	0	9	5%	5%	0.071	0.000	0.000	0.000	0.000	0.000	0.000
SF6 Electrical Equipment	SF6	213	367	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-I	0	100	30%	50%	0.583	0.000	0.000	0.000	0.000	0.000	0.000
HFC, PFC substitutes for ODS	HFC	134	8,167	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	0	5%	10%	0.112	0.000	0.001	0.000	0.000	0.000	0.000
CH4 Enteric Fermentation in Domestic Livestock	CH4	12,179	10,779	20%	20%	0.283	0.000	0.000	0.024	0.000	0.007	0.000
CH4 Manure Management	CH4	3,462	2,886	20%	100%	1.020	0.000	0.000	0.006	0.000	0.002	0.000
N2O Manure Management	N2O	3,921	3,762	20%	100%	1.020	0.000	0.001	0.008	0.001	0.002	0.000
CH4 Agricultural Residue Burning	CH4	13	13	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
N2O Agricultural Residue Burning	N2O	4	4	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
Direct N2O Agricultural Soils	N2O	9,605	7,354	20%	100%	1.020	0.000	0.002	0.016	0.002	0.005	0.000
Indirect N2O from Nitrogen used in agriculture	N2O	8,140	6,564	20%	100%	1.020	0.000	0.001	0.014	0.001	0.004	0.000
CH4 from Rice production	CH4	1,562	1,579	3%	20%	0.202	0.000	0.000	0.003	0.000	0.000	0.000
N2O from animal production	N2O	1,736	1,541	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	12,741	20%	30%	0.361	0.000	0.001	0.028	0.000	0.008	0.000
CH4 Emissions from Wastewater Handling	CH4	1,990	2,723	100%	30%	1.044	0.000	0.002	0.006	0.001	0.008	0.000
N2O Emissions from Wastewater Handling	N2O	1,832	1,964	30%	30%	0.424	0.000	0.001	0.004	0.000	0.002	0.000
CO2 Emissions from Waste Incineration	CO2	537	250	5%	25%	0.255	0.000	0.000	0.001	0.000	0.000	0.000
CH4 Emissions from Waste Incineration	CH4	161	285	5%	20%	0.206	0.000	0.000	0.001	0.000	0.000	0.000
N2O Emissions from Waste Incineration	N2O	88	126	5%	100%	1.001	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Emissions from Other Waste	CH4	0	4	10%	100%	1.005	0.000	0.000	0.000	0.000	0.000	0.000

Table A1.8 Results of the uncertainty analysis including LULUCF (Approach 1). Year 2009 (continued)

IPCC category	Gas	Emissions 1990	Emissions 2009	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	Gg									
CO2 Emissions from solvent use	CO2	1,643	1,191	30%	50%	0.583	0.000	0.001	0.003	0.000	0.001	0.000
N2O Emissions from solvent use	N2O	812	671	50%	10%	0.510	0.000	0.000	0.001	0.000	0.001	0.000
CO2 Forest land remaining Forest Land	CO2	-40,919	-65,040	23%	43%	0.490	0.006	0.065	0.142	0.028	0.047	0.003
CH4 Forest land remaining Forest Land	CH4	146	55	23%	43%	0.490	0.000	0.000	0.000	0.000	0.000	0.000
N2O Forest land remaining Forest Land	N2O	15	6	23%	43%	0.490	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Cropland remaining Cropland	CO2	-19,977	-12,299	75%	75%	1.061	0.001	0.011	0.027	0.008	0.029	0.001
CO2 Land converted to Forest Land	CO2	-782	-1,390	75%	75%	1.061	0.000	0.002	0.003	0.001	0.003	0.000
CO2 Land converted to Cropland	CO2	1,028	0	75%	75%	1.061	0.000	0.002	0.000	0.001	0.000	0.000
CO2 Grassland remaining Grassland	CO2	-3,954	-6,730	75%	75%	1.061	0.000	0.007	0.015	0.005	0.016	0.000
CO2 Land converted to Grassland	CO2	0	-12,788	75%	75%	1.061	0.001	0.028	0.028	0.021	0.030	0.001
N2O Land converted to Cropland	N2O	121	0	75%	75%	1.061	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Land converted to Settlements	CO2	2,526	3,516	75%	75%	1.061	0.000	0.003	0.008	0.002	0.008	0.000
TOTAL		**457,362**	**396,449**				**0.011**					**0.006**
						Percertage uncertainty in total inventory	**10%**				**Trend uncertainty**	**8.0%**

Table A1.8 Results of the uncertainty analysis including LULUCF (Approach 1). Year 2009

Emission sources of the Italian inventory are disaggregated into a detailed level, 57 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 67 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 7.6%.

In 2009, the results of Approach 1 suggest an uncertainty of 3.4% in the combined GWP total emissions. The analysis also estimates an uncertainty of 2.5 % in the trend between 1990 and 2009.

Specifically, for the LULUCF sector, the uncertainty value resulting from Approach 1 is 33% in the combined GWP total emissions for the year 2009, whereas the uncertainty in the trend is 60%. Uncertainty estimates related to CO_2 total emissions are equal to 35%, for the year 2009, and 47%

in the trend. Details of the figures are shown in Tables A1.6 and A1.7. It should be noted that the uncertainty related to the LULUCF sector has decreased from the previous estimates on account of the improvement in the information available on carbon stock changes.
Including the LULUCF sector in the total uncertainty assessment, Approach 1 shows an uncertainty of 10% in the combined GWP total emissions for the year 2009, whereas the uncertainty in the trend between 1990 and 2009 is equal to 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 2009 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 2009, while in Table A1.10 results, including LULUCF categories, are shown.
The application of Approach 2 to the base year gives as a result 15 key categories accounting for the 90% of the total levels uncertainty. Including the LULUCF categories, 16 key categories result accounting for 90% of the total uncertainty levels.
For the year 2009, 16 key categories accounting for the 90% of the total levels uncertainty were identified; when applying the trend analysis the key categories increased to 17 with differences with respect to the previous list.
The application of Approach 2 to the inventory, including the LULUCF categories, results in 17 key categories which account for the 90% of the total levels uncertainty; for the trend analysis, with LULUCF, the number of key categories decreases to 12 with differences with respect to the previous list.

CATEGORIES	Share	Uncertainty	L*U	Level assessment with uncertainty	Cumulative Percentage
Direct N2O Agricultural Soils	0.01	1.0198	0.0153	0.1167	0.12
Indirect N2O from Nitrogen used in agriculture	0.01	1.0198	0.0136	0.1042	0.22
CO2 stationary combustion gaseous fuels	0.30	0.0424	0.0129	0.0984	0.32
HFC, PFC substitutes for ODS	0.02	0.5831	0.0097	0.0741	0.39
CO2 Mobile combustion: Road Vehicles	0.22	0.0424	0.0095	0.0726	0.47
CH4 from Solid waste Disposal Sites	0.03	0.3606	0.0094	0.0715	0.54
N2O Manure Management	0.01	1.0198	0.0078	0.0597	0.60
CO2 stationary combustion liquid fuels	0.15	0.0424	0.0062	0.0476	0.64
CH4 Enteric Fermentation in Domestic Livestock	0.02	0.2828	0.0062	0.0475	0.69
CH4 Manure Management	0.01	1.0198	0.0060	0.0458	0.74
CH4 Emissions from Wastewater Handling	0.01	1.0440	0.0058	0.0443	0.78
CO2 stationary combustion solid fuels	0.10	0.0424	0.0043	0.0326	0.81
N2O stationary combustion	0.01	0.5009	0.0036	0.0277	0.84
N2O from animal production	0.00	1.0198	0.0032	0.0245	0.87
CO2 Cement production	0.03	0.1044	0.0029	0.0219	0.89
CH4 Fugitive emissions from Oil and Gas Operations	0.01	0.2518	0.0025	0.0192	0.91
N2O Emissions from Wastewater Handling	0.00	0.4243	0.0017	0.0130	0.92
CO2 Emissions from solvent use	0.00	0.5831	0.0014	0.0108	0.93
CO2 Fugitive emissions from Oil and Gas Operations	0.00	0.2518	0.0011	0.0085	0.94
CH4 stationary combustion	0.00	0.5009	0.0010	0.0077	0.95
N2O Mobile combustion: Road Vehicles	0.00	0.5009	0.0010	0.0076	0.96
N2O Emissions from solvent use	0.00	0.5099	0.0007	0.0053	0.96
CH4 from Rice production	0.00	0.2022	0.0007	0.0050	0.97
CO2 Mobile combustion: Waterborne Navigation	0.01	0.0424	0.0004	0.0031	0.97
CO2 stationary combustion other fuels	0.01	0.0424	0.0004	0.0030	0.97
CO2 Lime production	0.00	0.1044	0.0004	0.0027	0.97
CO2 Limestone and Dolomite Use	0.00	0.1044	0.0004	0.0027	0.98
CO2 Other industrial processes	0.00	0.1044	0.0003	0.0026	0.98
N2O Emissions from Waste Incineration	0.00	1.0012	0.0003	0.0020	0.98
CH4 Mobile combustion: Road Vehicles	0.00	0.4011	0.0002	0.0018	0.98
N2O Mobile combustion: Other	0.00	1.0004	0.0002	0.0017	0.99
CO2 Mobile combustion: Other	0.00	0.0583	0.0002	0.0017	0.99
CO2 Iron and Steel production	0.00	0.1044	0.0002	0.0015	0.99
CO2 Mobile combustion: Aircraft	0.00	0.0424	0.0002	0.0015	0.99
CH4 Fugitive emissions from Coal Mining and Handling	0.00	2.0002	0.0002	0.0014	0.99
N2O Adipic Acid	0.00	0.1044	0.0002	0.0012	0.99
CO2 Ammonia production	0.00	0.1044	0.0001	0.0011	0.99
CO2 Emissions from Waste Incineration	0.00	0.2550	0.0001	0.0010	1.00
CH4 Emissions from Waste Incineration	0.00	0.2062	0.0001	0.0009	1.00
PFC, HFC, SF6 Semiconductor manufacturing	0.00	0.5831	0.0001	0.0009	1.00
SF6 Electrical Equipment	0.00	0.1118	0.0001	0.0006	1.00
N2O Nitric Acid	0.00	0.1044	0.0001	0.0006	1.00
N2O Mobile combustion: Waterborne Navigation	0.00	1.0004	0.0001	0.0005	1.00
CH4 Industrial Processes	0.00	0.5009	0.0000	0.0003	1.00
N2O Mobile combustion: Aircraft	0.00	1.0004	0.0000	0.0003	1.00
PFC Aluminium production	0.00	0.1118	0.0000	0.0003	1.00
CH4 Mobile combustion: Waterborne Navigation	0.00	0.5009	0.0000	0.0002	1.00
CH4 Agricultural Residue Burning	0.00	0.5385	0.0000	0.0001	1.00
CH4 Emissions from Other Waste	0.00	1.0050	0.0000	0.0001	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.00	0.2518	0.0000	0.0000	1.00
N2O Agricultural Residue Burning	0.00	0.5385	0.0000	0.0000	1.00
CH4 Mobile combustion: Other	0.00	0.5009	0.0000	0.0000	1.00
CH4 Mobile combustion: Aircraft	0.00	0.5009	0.0000	0.0000	1.00
SF6 Magnesium production	0.00	0.0707	0.0000	0.0000	1.00

Table A1.9 Results of the key category analysis without LULUCF. Approach 2 Level assessment, year 2009

CATEGORIES	Trend assessment	Uncertainty	T*U	Relative trend assessment with uncertainty	Cumulative Percentage
HFC, PFC substitutes for ODS	0.0155	0.5831	0.0090	0.225	0.22
CO2 stationary combustion liquid fuels	0.1408	0.0424	0.0060	0.149	0.37
CO2 stationary combustion gaseous fuels	0.1320	0.0424	0.0056	0.139	0.51
Direct N2O Agricultural Soils	0.0033	1.0198	0.0034	0.085	0.60
Indirect N2O from Nitrogen used in agriculture	0.0022	1.0198	0.0022	0.056	0.65
CO2 Mobile combustion: Road Vehicles	0.0415	0.0424	0.0018	0.044	0.70
CH4 Emissions from Wastewater Handling	0.0016	1.0440	0.0017	0.042	0.74
CH4 from Solid waste Disposal Sites	0.0033	0.3606	0.0012	0.029	0.77
CH4 Fugitive emissions from Oil and Gas Operations	0.0038	0.2518	0.0010	0.024	0.79
CH4 Manure Management	0.0008	1.0198	0.0008	0.019	0.81
N2O Adipic Acid	0.0069	0.1044	0.0007	0.018	0.83
CO2 stationary combustion solid fuels	0.0132	0.0424	0.0006	0.014	0.84
CO2 Fugitive emissions from Oil and Gas Operations	0.0019	0.2518	0.0005	0.012	0.86
CO2 Iron and Steel production	0.0040	0.1044	0.0004	0.010	0.87
CO2 Emissions from solvent use	0.0007	0.5831	0.0004	0.010	0.88
CH4 Enteric Fermentation in Domestic Livestock	0.0014	0.2828	0.0004	0.010	0.89
CO2 Ammonia production	0.0037	0.1044	0.0004	0.010	0.90
CH4 stationary combustion	0.0007	0.5009	0.0004	0.009	0.90
CO2 Cement production	0.0034	0.1044	0.0004	0.009	0.91
N2O Nitric Acid	0.0031	0.1044	0.0003	0.008	0.92
PFC Aluminium production	0.0028	0.1118	0.0003	0.008	0.93
CH4 Mobile combustion: Road Vehicles	0.0007	0.4011	0.0003	0.007	0.94
N2O stationary combustion	0.0006	0.5009	0.0003	0.007	0.94
CH4 Fugitive emissions from Coal Mining and Handling	0.0001	2.0002	0.0003	0.007	0.95
CO2 stationary combustion other fuels	0.0055	0.0424	0.0002	0.006	0.96
N2O Mobile combustion: Road Vehicles	0.0005	0.5009	0.0002	0.006	0.96
N2O from animal production	0.0002	1.0198	0.0002	0.005	0.97
N2O Emissions from Wastewater Handling	0.0004	0.4243	0.0002	0.005	0.97
CO2 Limestone and Dolomite Use	0.0014	0.1044	0.0002	0.004	0.97
CO2 Emissions from Waste Incineration	0.0005	0.2550	0.0001	0.003	0.98
PFC, HFC, SF6 Semiconductor manufacturing	0.0002	0.5831	0.0001	0.003	0.98
N2O Manure Management	0.0001	1.0198	0.0001	0.003	0.98
N2O Emissions from solvent use	0.0002	0.5099	0.0001	0.002	0.99
N2O Emissions from Waste Incineration	0.0001	1.0012	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
CH4 Industrial Processes	0.0001	0.5009	0.0001	0.002	0.99
CO2 Mobile combustion: Aircraft	0.0013	0.0424	0.0001	0.001	0.99
CH4 Emissions from Waste Incineration	0.0003	0.2062	0.0001	0.001	0.99
CO2 Lime production	0.0005	0.1044	0.0000	0.001	0.99
CH4 from Rice production	0.0002	0.2022	0.0000	0.001	1.00
SF6 Electrical Equipment	0.0003	0.1118	0.0000	0.001	1.00
CO2 Other industrial processes	0.0003	0.1044	0.0000	0.001	1.00
CO2 Mobile combustion: Waterborne Navigation	0.0007	0.0424	0.0000	0.001	1.00
N2O Mobile combustion: Other	0.0000	1.0004	0.0000	0.001	1.00
SF6 Production of SF6	0.0002	0.1118	0.0000	0.001	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
CO2 Mobile combustion: Other	0.0001	0.0583	0.0000	0.000	1.00
N2O Mobile combustion: Waterborne Navigation	0.0000	1.0004	0.0000	0.000	1.00
N2O Other industrial processes	0.0000	0.1044	0.0000	0.000	1.00
CH4 Mobile combustion: Other	0.0000	0.5009	0.0000	0.000	1.00
SF6 Magnesium production	0.0000	0.0707	0.0000	0.000	1.00
CH4 Mobile combustion: Waterborne Navigation	0.0000	0.5009	0.0000	0.000	1.00
CH4 Mobile combustion: Aircraft	0.0000	0.5009	0.0000	0.000	1.00
N2O Agricultural Residue Burning	0.0000	0.5385	0.0000	0.000	1.00
CH4 Agricultural Residue Burning	0.0000	0.5385	0.0000	0.000	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.0000	0.2518	0.0000	0.000	1.00

Table A1.10 Results of the key category analysis without LULUCF. Approach 2 Trend assessment, 1990- 2009

CATEGORIES	Share	Uncertainty	L*U	Level assessment with uncertainty	Cumulative Percentage
CO2 Forest land remaining Forest Land	0.11	0.4904	0.0538	0.2361	0.24
CO2 Land converted to Grassland	0.02	1.0607	0.0229	0.1004	0.34
CO2 Cropland remaining Cropland	0.02	1.0607	0.0220	0.0965	0.43
Direct N2O Agricultural Soils	0.01	1.0198	0.0126	0.0555	0.49
CO2 Grassland remaining Grassland	0.01	1.0607	0.0120	0.0528	0.54
Indirect N2O from Nitrogen used in agriculture	0.01	1.0198	0.0113	0.0495	0.59
CO2 stationary combustion gaseous fuels	0.25	0.0424	0.0107	0.0468	0.64
HFC, PFC substitutes for ODS	0.01	0.5831	0.0080	0.0352	0.67
CO2 Mobile combustion: Road Vehicles	0.19	0.0424	0.0079	0.0345	0.71
CH4 from Solid waste Disposal Sites	0.02	0.3606	0.0077	0.0340	0.74
N2O Manure Management	0.01	1.0198	0.0065	0.0284	0.77
CO2 Land converted to Settlements	0.01	1.0607	0.0063	0.0276	0.80
CO2 stationary combustion liquid fuels	0.12	0.0424	0.0052	0.0226	0.82
CH4 Enteric Fermentation in Domestic Livestock	0.02	0.2828	0.0051	0.0226	0.84
CH4 Manure Management	0.00	1.0198	0.0050	0.0218	0.86
CH4 Emissions from Wastewater Handling	0.00	1.0440	0.0048	0.0210	0.89
CO2 stationary combustion solid fuels	0.08	0.0424	0.0035	0.0155	0.90
N2O stationary combustion	0.01	0.5009	0.0030	0.0132	0.91
N2O from animal production	0.00	1.0198	0.0027	0.0116	0.93
CO2 Land converted to Forest Land	0.00	1.0607	0.0025	0.0109	0.94
CO2 Cement production	0.02	0.1044	0.0024	0.0104	0.95
CH4 Fugitive emissions from Oil and Gas Operations	0.01	0.2518	0.0021	0.0091	0.96
N2O Emissions from Wastewater Handling	0.00	0.4243	0.0014	0.0062	0.96
CO2 Emissions from solvent use	0.00	0.5831	0.0012	0.0051	0.97
CO2 Fugitive emissions from Oil and Gas Operations	0.00	0.2518	0.0009	0.0040	0.97
CH4 stationary combustion	0.00	0.5009	0.0008	0.0036	0.98
N2O Mobile combustion: Road Vehicles	0.00	0.5009	0.0008	0.0036	0.98
N2O Emissions from solvent use	0.00	0.5099	0.0006	0.0025	0.98
CH4 from Rice production	0.00	0.2022	0.0005	0.0024	0.98
CO2 Mobile combustion: Waterborne Navigation	0.01	0.0424	0.0003	0.0015	0.99
CO2 stationary combustion other fuels	0.01	0.0424	0.0003	0.0014	0.99
CO2 Lime production	0.00	0.1044	0.0003	0.0013	0.99
CO2 Limestone and Dolomite Use	0.00	0.1044	0.0003	0.0013	0.99
CO2 Other industrial processes	0.00	0.1044	0.0003	0.0012	0.99
N2O Emissions from Waste Incineration	0.00	1.0012	0.0002	0.0009	0.99
CH4 Mobile combustion: Road Vehicles	0.00	0.4011	0.0002	0.0008	0.99
N2O Mobile combustion: Other	0.00	1.0004	0.0002	0.0008	0.99
CO2 Mobile combustion: Other	0.00	0.0583	0.0002	0.0008	0.99
CO2 Iron and Steel production	0.00	0.1044	0.0002	0.0007	0.99
CO2 Mobile combustion: Aircraft	0.00	0.0424	0.0002	0.0007	1.00
CH4 Fugitive emissions from Coal Mining and Handling	0.00	2.0002	0.0002	0.0007	1.00
N2O Adipic Acid	0.00	0.1044	0.0001	0.0006	1.00
CO2 Ammonia production	0.00	0.1044	0.0001	0.0005	1.00
CO2 Emissions from Waste Incineration	0.00	0.2550	0.0001	0.0005	1.00
CH4 Emissions from Waste Incineration	0.00	0.2062	0.0001	0.0004	1.00
PFC, HFC, SF6 Semiconductor manufacturing	0.00	0.5831	0.0001	0.0004	1.00
SF6 Electrical Equipment	0.00	0.1118	0.0001	0.0003	1.00
N2O Nitric Acid	0.00	0.1044	0.0001	0.0003	1.00
N2O Mobile combustion: Waterborne Navigation	0.00	1.0004	0.0001	0.0003	1.00
CH4 Forest land remaining Forest Land	0.00	0.4904	0.0000	0.0002	1.00
CH4 Industrial Processes	0.00	0.5009	0.0000	0.0001	1.00
N2O Mobile combustion: Aircraft	0.00	1.0004	0.0000	0.0001	1.00
PFC Aluminium production	0.00	0.1118	0.0000	0.0001	1.00
CH4 Mobile combustion: Waterborne Navigation	0.00	0.5009	0.0000	0.0001	1.00
CH4 Agricultural Residue Burning	0.00	0.5385	0.0000	0.0000	1.00
CH4 Emissions from Other Waste	0.00	1.0050	0.0000	0.0000	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.00	0.2518	0.0000	0.0000	1.00
N2O Forest land remaining Forest Land	0.00	0.4904	0.0000	0.0000	1.00
N2O Agricultural Residue Burning	0.00	0.5385	0.0000	0.0000	1.00
CH4 Mobile combustion: Other	0.00	0.5009	0.0000	0.0000	1.00
CH4 Mobile combustion: Aircraft	0.00	0.5009	0.0000	0.0000	1.00
SF6 Magnesium production	0.00	0.0707	0.0000	0.0000	1.00
N2O Other industrial processes	0.00	0.1044	0.0000	0.0000	1.00
SF6 Production of SF6	0.00	0.1118	0.0000	0.0000	1.00

Table A1.11 Results of the key category analysis with LULUCF. Approach 2 Level assessment, year 2009

CATEGORIES	Trend assessment	Uncertainty	T*U	Relative trend assessment with uncertainty	Cumulative Percentage
CO2 Land converted to Grassland	0.0217	1.0607	0.0230	0.24	0.24
CO2 Cropland remaining Cropland	0.0176	1.0607	0.0186	0.19	0.43
CO2 Forest land remaining Forest Land	0.0317	0.4904	0.0156	0.16	0.59
HFC, PFC substitutes for ODS	0.0137	0.5831	0.0080	0.08	0.67
CO2 stationary combustion gaseous fuels	0.1279	0.0424	0.0054	0.06	0.72
CO2 stationary combustion liquid fuels	0.1035	0.0424	0.0044	0.04	0.77
CO2 Grassland remaining Grassland	0.0038	1.0607	0.0041	0.04	0.81
CO2 Land converted to Settlements	0.0023	1.0607	0.0024	0.02	0.83
CO2 Mobile combustion: Road Vehicles	0.0492	0.0424	0.0021	0.02	0.85
CH4 Emissions from Wastewater Handling	0.0017	1.0440	0.0018	0.02	0.87
Direct N2O Agricultural Soils	0.0017	1.0198	0.0017	0.02	0.89
CO2 Land converted to Cropland	0.0015	1.0607	0.0016	0.02	0.91
CO2 Land converted to Forest Land	0.0009	1.0607	0.0009	0.01	0.92
Indirect N2O from Nitrogen used in agriculture	0.0008	1.0198	0.0009	0.01	0.92
N2O Manure Management	0.0006	1.0198	0.0006	0.01	0.93
CH4 Fugitive emissions from Oil and Gas Operations	0.0024	0.2518	0.0006	0.01	0.94
N2O Adipic Acid	0.0055	0.1044	0.0006	0.01	0.94
N2O stationary combustion	0.0010	0.5009	0.0005	0.00	0.95
CH4 stationary combustion	0.0007	0.5009	0.0004	0.00	0.95
CO2 Iron and Steel production	0.0031	0.1044	0.0003	0.00	0.95
CO2 Fugitive emissions from Oil and Gas Operations	0.0012	0.2518	0.0003	0.00	0.96
CO2 Ammonia production	0.0029	0.1044	0.0003	0.00	0.96
CH4 from Solid waste Disposal Sites	0.0008	0.3606	0.0003	0.00	0.96
N2O Emissions from Wastewater Handling	0.0006	0.4243	0.0003	0.00	0.97
N2O Nitric Acid	0.0024	0.1044	0.0003	0.00	0.97
N2O Mobile combustion: Road Vehicles	0.0005	0.5009	0.0003	0.00	0.97
PFC Aluminium production	0.0022	0.1118	0.0002	0.00	0.97
CO2 Emissions from solvent use	0.0004	0.5831	0.0002	0.00	0.98
CH4 Mobile combustion: Road Vehicles	0.0005	0.4011	0.0002	0.00	0.98
CO2 stationary combustion other fuels	0.0051	0.0424	0.0002	0.00	0.98
CH4 Fugitive emissions from Coal Mining and Handling	0.0001	2.0002	0.0002	0.00	0.98
CH4 Manure Management	0.0002	1.0198	0.0002	0.00	0.98
N2O Land converted to Cropland	0.0002	1.0607	0.0002	0.00	0.99
CO2 stationary combustion solid fuels	0.0037	0.0424	0.0002	0.00	0.99
CH4 Enteric Fermentation in Domestic Livestock	0.0004	0.2828	0.0001	0.00	0.99
PFC, HFC, SF6 Semiconductor manufacturing	0.0002	0.5831	0.0001	0.00	0.99
CO2 Limestone and Dolomite Use	0.0009	0.1044	0.0001	0.00	0.99
CO2 Emissions from Waste Incineration	0.0004	0.2550	0.0001	0.00	0.99
CO2 Cement production	0.0008	0.1044	0.0001	0.00	0.99
N2O Emissions from Waste Incineration	0.0001	1.0012	0.0001	0.00	0.99
CH4 from Rice production	0.0004	0.2022	0.0001	0.00	0.99
N2O from animal production	0.0001	1.0198	0.0001	0.00	1.00
CH4 Forest land remaining Forest Land	0.0001	0.4904	0.0001	0.00	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.0005	0.1118	0.0001	0.00	1.00
CO2 Mobile combustion: Aircraft	0.0014	0.0424	0.0001	0.00	1.00
CH4 Emissions from Waste Incineration	0.0002	0.2062	0.0001	0.00	1.00
CH4 Industrial Processes	0.0001	0.5009	0.0000	0.00	1.00
SF6 Electrical Equipment	0.0003	0.1118	0.0000	0.00	1.00
N2O Emissions from solvent use	0.0001	0.5099	0.0000	0.00	1.00
CO2 Mobile combustion: Other	0.0004	0.0583	0.0000	0.00	1.00
SF6 Production of SF6	0.0002	0.1118	0.0000	0.00	1.00
CO2 Lime production	0.0001	0.1044	0.0000	0.00	1.00
N2O Mobile combustion: Aircraft	0.0000	1.0004	0.0000	0.00	1.00
CH4 Emissions from Other Waste	0.0000	1.0050	0.0000	0.00	1.00
N2O Forest land remaining Forest Land	0.0000	0.4904	0.0000	0.00	1.00
CO2 Mobile combustion: Waterborne Navigation	0.0001	0.0424	0.0000	0.00	1.00
N2O Mobile combustion: Other	0.0000	1.0004	0.0000	0.00	1.00
N2O Other industrial processes	0.0000	0.1044	0.0000	0.00	1.00
CH4 Mobile combustion: Other	0.0000	0.5009	0.0000	0.00	1.00
SF6 Magnesium production	0.0000	0.0707	0.0000	0.00	1.00
CH4 Mobile combustion: Waterborne Navigation	0.0000	0.5009	0.0000	0.00	1.00
CH4 Agricultural Residue Burning	0.0000	0.5385	0.0000	0.00	1.00
CH4 Mobile combustion: Aircraft	0.0000	0.5009	0.0000	0.00	1.00
CO2 Other industrial processes	0.0000	0.1044	0.0000	0.00	1.00
N2O Mobile combustion: Waterborne Navigation	0.0000	1.0004	0.0000	0.00	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.0000	0.2518	0.0000	0.00	1.00
N2O Agricultural Residue Burning	0.0000	0.5385	0.0000	0.00	1.00

Table A1.12 Results of the key category analysis with LULUCF. Approach 2 Trend assessment, 1990- 2009

CATEGORIES	Share	Uncertainty	L*U	Level assessment with uncertainty	Cumulative Percentage
Direct N2O Agricultural Soils	0.02	1.0198	0.0189	0.1437	0.14
Indirect N2O from Nitrogen used in agriculture	0.02	1.0198	0.0160	0.1218	0.27
CO2 stationary combustion liquid fuels	0.30	0.0424	0.0125	0.0955	0.36
CH4 from Solid waste Disposal Sites	0.03	0.3606	0.0106	0.0807	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	0.0581	0.56
CO2 stationary combustion gaseous fuels	0.16	0.0424	0.0070	0.0530	0.61
CH4 Manure Management	0.01	1.0198	0.0068	0.0518	0.66
CH4 Enteric Fermentation in Domestic Livestock	0.02	0.2828	0.0066	0.0505	0.71
CO2 stationary combustion solid fuels	0.11	0.0424	0.0049	0.0369	0.75
CH4 Emissions from Wastewater Handling	0.00	1.0440	0.0040	0.0305	0.78
CH4 Fugitive emissions from Oil and Gas Operations	0.01	0.2518	0.0035	0.0270	0.81
N2O from animal production	0.00	1.0198	0.0034	0.0260	0.83
N2O stationary combustion	0.01	0.5009	0.0033	0.0253	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	0.0141	0.90
CO2 Fugitive emissions from Oil and Gas Operations	0.01	0.2518	0.0016	0.0124	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 Emissions from solvent use	0.00	0.5099	0.0008	0.0061	0.94
N2O Mobile combustion: Road Vehicles	0.00	0.5009	0.0008	0.0058	0.94
CO2 Iron and Steel production	0.01	0.1044	0.0006	0.0048	0.95
CH4 stationary combustion	0.00	0.5009	0.0006	0.0048	0.95
CH4 from Rice production	0.00	0.2022	0.0006	0.0046	0.96
CO2 Ammonia production	0.01	0.1044	0.0006	0.0042	0.96
CH4 Mobile combustion: Road Vehicles	0.00	0.4011	0.0005	0.0041	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	0.0036	0.97
CO2 Mobile combustion: Waterborne Navigation	0.01	0.0424	0.0004	0.0034	0.97
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	0.0028	0.98
PFC Aluminium production	0.00	0.1118	0.0004	0.0027	0.99
CO2 Emissions from Waste Incineration	0.00	0.2550	0.0003	0.0020	0.99
N2O Mobile combustion: Other	0.00	1.0004	0.0003	0.0019	0.99
CO2 Mobile combustion: Other	0.00	0.0583	0.0002	0.0016	0.99
N2O Emissions from Waste Incineration	0.00	1.0012	0.0002	0.0013	0.99
HFC, PFC substitutes for ODS	0.00	0.5831	0.0002	0.0011	0.99
CO2 stationary combustion other fuels	0.00	0.0424	0.0001	0.0011	1.00
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
CH4 Emissions from Waste Incineration	0.00	0.2062	0.0001	0.0005	1.00
SF6 Electrical Equipment	0.00	0.1118	0.0000	0.0004	1.00
CH4 Mobile combustion: Waterborne Navigation	0.00	0.5009	0.0000	0.0002	1.00
N2O Mobile combustion: Aircraft	0.00	1.0004	0.0000	0.0002	1.00
SF6 Production of SF6	0.00	0.1118	0.0000	0.0002	1.00
CH4 Agricultural Residue Burning	0.00	0.5385	0.0000	0.0001	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.00	0.2518	0.0000	0.0000	1.00
CH4 Mobile combustion: Other	0.00	0.5009	0.0000	0.0000	1.00
N2O Agricultural Residue Burning	0.00	0.5385	0.0000	0.0000	1.00
N2O Other industrial processes	0.00	0.1044	0.0000	0.0000	1.00
CH4 Mobile combustion: Aircraft	0.00	0.5009	0.0000	0.0000	1.00
CH4 Emissions from Other Waste	0.00	1.0050	0.0000	0.0000	1.00

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
CO2 Cropland remaining Cropland	0.03	1.0607	0.0360	0.1790	0.18
CO2 Forest land remaining Forest Land	0.07	0.4904	0.0341	0.1695	0.35
Direct N2O Agricultural Soils	0.02	1.0198	0.0166	0.0827	0.43
Indirect N2O from Nitrogen used in agriculture	0.01	1.0198	0.0141	0.0701	0.50
CO2 stationary combustion liquid fuels	0.26	0.0424	0.0111	0.0550	0.56
CH4 from Solid waste Disposal Sites	0.03	0.3606	0.0093	0.0465	0.60
CO2 Grassland remaining Grassland	0.01	1.0607	0.0071	0.0354	0.64
N2O Manure Management	0.01	1.0198	0.0068	0.0338	0.67
CO2 Mobile combustion: Road Vehicles	0.16	0.0424	0.0067	0.0335	0.71
CO2 stationary combustion gaseous fuels	0.14	0.0424	0.0061	0.0305	0.74
CH4 Manure Management	0.01	1.0198	0.0060	0.0298	0.77
CH4 Enteric Fermentation in Domestic Livestock	0.02	0.2828	0.0059	0.0291	0.79
CO2 Land converted to Settlements	0.00	1.0607	0.0046	0.0226	0.82
CO2 stationary combustion solid fuels	0.10	0.0424	0.0043	0.0213	0.84
CH4 Emissions from Wastewater Handling	0.00	1.0440	0.0035	0.0175	0.86
CH4 Fugitive emissions from Oil and Gas Operations	0.01	0.2518	0.0031	0.0155	0.87
N2O from animal production	0.00	1.0198	0.0030	0.0150	0.89
N2O stationary combustion	0.01	0.5009	0.0029	0.0146	0.90
CO2 Cement production	0.03	0.1044	0.0029	0.0142	0.92
CO2 Land converted to Cropland	0.00	1.0607	0.0019	0.0092	0.92
CO2 Emissions from solvent use	0.00	0.5831	0.0016	0.0081	0.93
CO2 Fugitive emissions from Oil and Gas Operations	0.01	0.2518	0.0014	0.0071	0.94
CO2 Land converted to Forest Land	0.00	1.0607	0.0014	0.0070	0.95
N2O Emissions from Wastewater Handling	0.00	0.4243	0.0013	0.0066	0.95
N2O Adipic Acid	0.01	0.1044	0.0008	0.0040	0.96
N2O Emissions from solvent use	0.00	0.5099	0.0007	0.0035	0.96
N2O Mobile combustion: Road Vehicles	0.00	0.5009	0.0007	0.0033	0.96
CO2 Iron and Steel production	0.01	0.1044	0.0006	0.0028	0.97
CH4 stationary combustion	0.00	0.5009	0.0006	0.0027	0.97
CH4 from Rice production	0.00	0.2022	0.0005	0.0027	0.97
CO2 Ammonia production	0.00	0.1044	0.0005	0.0024	0.97
CH4 Mobile combustion: Road Vehicles	0.00	0.4011	0.0005	0.0024	0.98
CO2 Limestone and Dolomite Use	0.00	0.1044	0.0005	0.0022	0.98
CH4 Fugitive emissions from Coal Mining and Handling	0.00	2.0002	0.0004	0.0021	0.98
CO2 Mobile combustion: Waterborne Navigation	0.01	0.0424	0.0004	0.0019	0.98
N2O Nitric Acid	0.00	0.1044	0.0004	0.0018	0.99
CO2 Lime production	0.00	0.1044	0.0004	0.0018	0.99
CO2 Other industrial processes	0.00	0.1044	0.0003	0.0016	0.99
PFC Aluminium production	0.00	0.1118	0.0003	0.0016	0.99
CO2 Emissions from Waste Incineration	0.00	0.2550	0.0002	0.0012	0.99
N2O Mobile combustion: Other	0.00	1.0004	0.0002	0.0011	0.99
N2O Land converted to Cropland	0.00	1.0607	0.0002	0.0011	0.99
CO2 Mobile combustion: Other	0.00	0.0583	0.0002	0.0009	0.99
N2O Emissions from Waste Incineration	0.00	1.0012	0.0001	0.0007	1.00
HFC, PFC substitutes for ODS	0.00	0.5831	0.0001	0.0007	1.00
CO2 stationary combustion other fuels	0.00	0.0424	0.0001	0.0006	1.00
CH4 Forest land remaining Forest Land	0.00	0.4904	0.0001	0.0006	1.00
CO2 Mobile combustion: Aircraft	0.00	0.0424	0.0001	0.0006	1.00
CH4 Industrial Processes	0.00	0.5009	0.0001	0.0005	1.00
N2O Mobile combustion: Waterborne Navigation	0.00	1.0004	0.0001	0.0003	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.00	0.1118	0.0001	0.0003	1.00
CH4 Emissions from Waste Incineration	0.00	0.2062	0.0001	0.0003	1.00
SF6 Electrical Equipment	0.00	0.1118	0.0000	0.0002	1.00
CH4 Mobile combustion: Waterborne Navigation	0.00	0.5009	0.0000	0.0001	1.00
N2O Mobile combustion: Aircraft	0.00	1.0004	0.0000	0.0001	1.00
SF6 Production of SF6	0.00	0.1118	0.0000	0.0001	1.00
N2O Forest land remaining Forest Land	0.00	0.4904	0.0000	0.0001	1.00
CH4 Agricultural Residue Burning	0.00	0.5385	0.0000	0.0001	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.00	0.2518	0.0000	0.0000	1.00
CH4 Mobile combustion: Other	0.00	0.5009	0.0000	0.0000	1.00
N2O Agricultural Residue Burning	0.00	0.5385	0.0000	0.0000	1.00
N2O Other industrial processes	0.00	0.1044	0.0000	0.0000	1.00
CH4 Mobile combustion: Aircraft	0.00	0.5009	0.0000	0.0000	1.00
CH4 Emissions from Other Waste	0.00	1.0050	0.0000	0.0000	1.00

Table A1.14 Results of the key category analysis with LULUCF. Approach 2 Level assessment, year 1990

A1.5 Uncertainty assessment (IPCC Approach 2)

Following the recommendation of the last review report (UNFCCC, 2010) regarding the application of a full Approach 2 uncertainty analysis for at least one inventory year, Montecarlo has been applied to some of the key categories of the Italian inventory. The analysis will be extended to the complete inventory in the next submission. 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.

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
Waste	CH_4 from Solid waste Disposal Sites	L	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

Table A1.15 Comparison between uncertainty assessment by Approach 1 and Approach 2

A summary of the results is described in the following by category.

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.

	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**

Table A1.16 Statistics of the Montecarlo analysis for CO_2 emissions from stationary combustion of liquid fuels, year 2009

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.1.

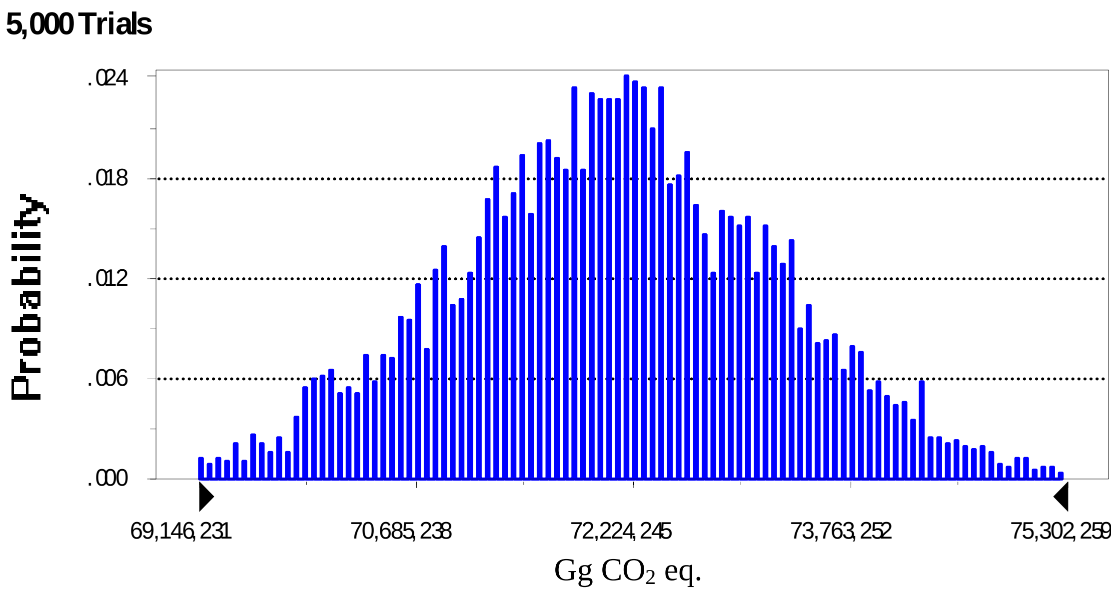


Figure A1.1 Probability density function resulting from Montecarlo analysis for CO_2 emissions from stationary combustion of liquid fuels, year 2009

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.

	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**

Table A1.17 Statistics of the Montecarlo analysis for CO_2 emissions from stationary combustion of solid fuels, year 2009

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.2.

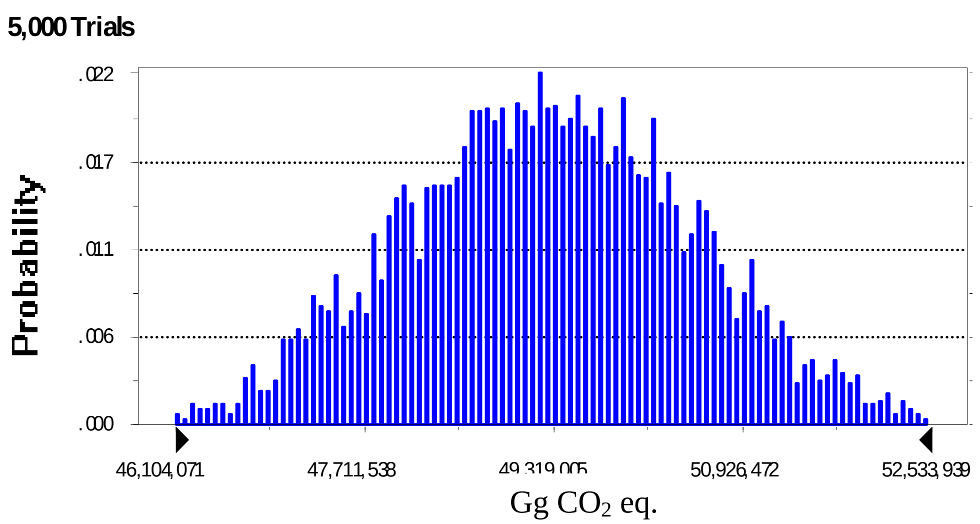


Figure A1.2 Probability density function resulting from Montecarlo analysis for CO_2 emissions from stationary combustion of solid fuels, year 2009

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.

	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**

Table A1.18 Statistics of the Montecarlo analysis for CO_2 emissions from stationary combustion of gaseous fuels, year 2009

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.3.

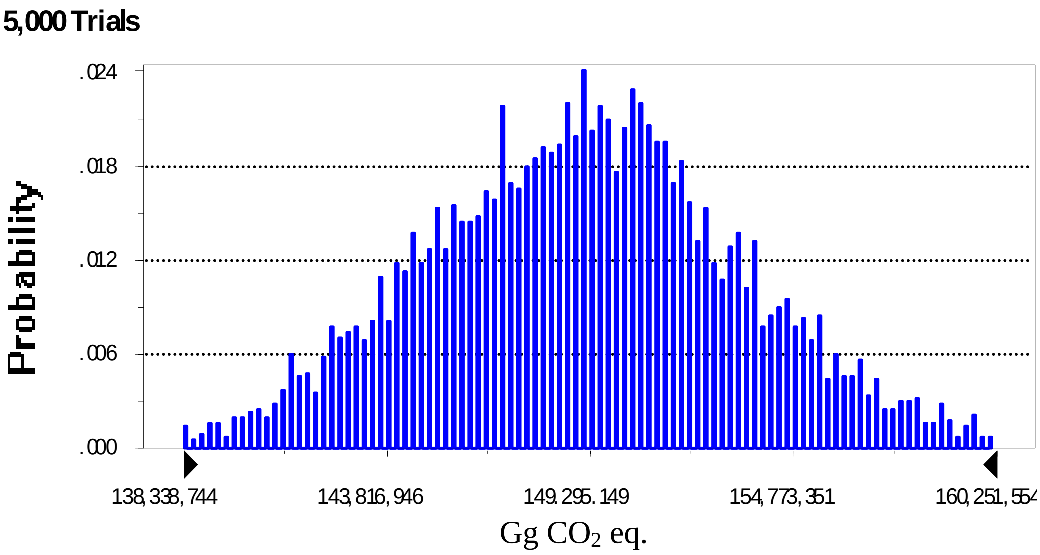


Figure A1.3 Probability density function resulting from Montecarlo analysis for CO_2 emissions from stationary combustion of gaseous fuels**, year 2009**

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[60] "Uncertainty estimates and guidance for road transport emission calculations" performed by EMISIA[61] 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.

[60] 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
[61] EMISIA: www.emisia.com

	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**

Table A1.19 Statistics of the Montecarlo analysis for GHG emissions from Mobile combustion: Road Vehicles, year 2005

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.

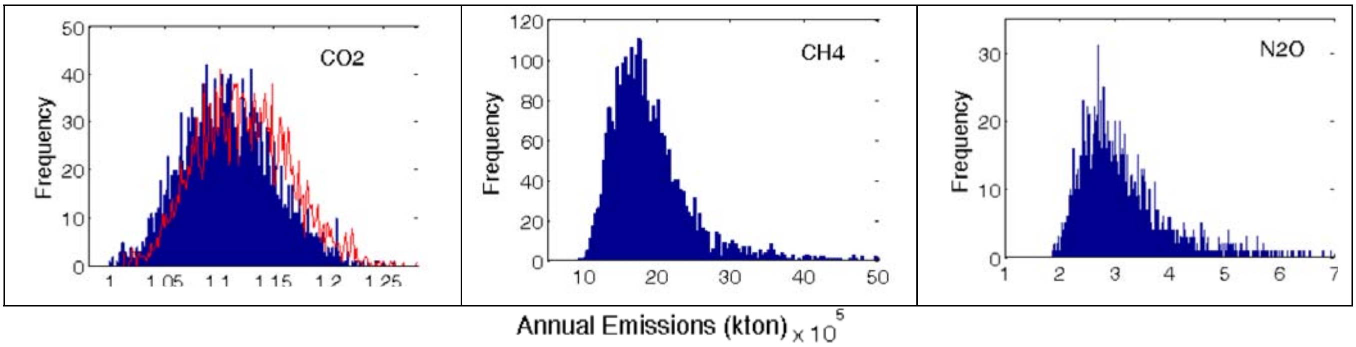


Figure A1.4 Probability density function resulting from Montecarlo analysis for CO_2, CH_4 and N_2O emissions from Mobile combustion: Road Vehicles, year 2005 (Kouridis et al., 2010)

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.

	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**

Table A1.20 Statistics of the Montecarlo analysis for CO_2 emissions from cement production, year 2009

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.5.

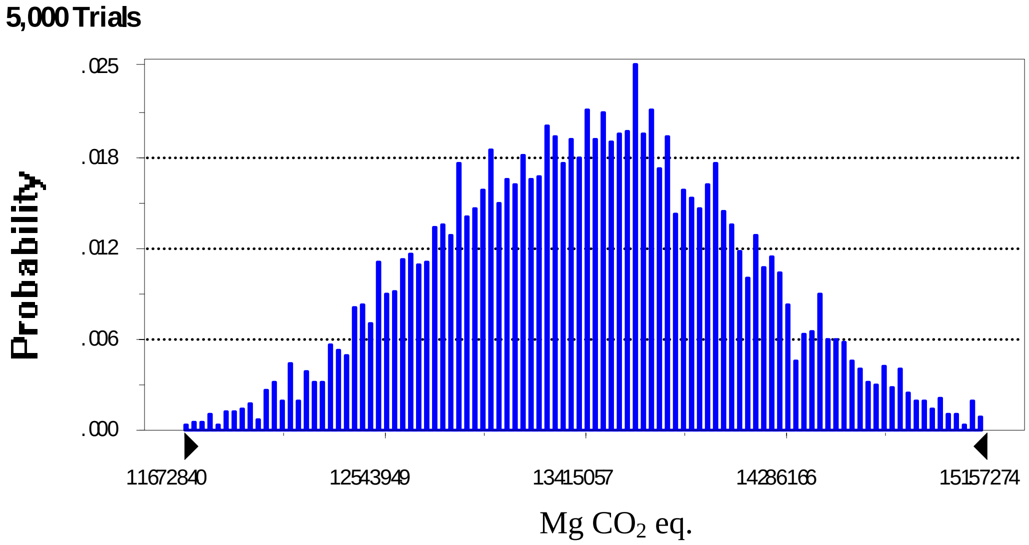


Figure A1.5 Probability density function resulting from Montecarlo analysis for CO_2 emissions from cement production, year 2009

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.

	Value
Trials	5000
Mean	4904
Median	4903
Standard Deviation	427
Range Minimum	3027
Range Maximum	6532
Uncertainty (%)	**17.40**

Table A1.21 Statistics of the Montecarlo analysis for CH_4 from fugitive emissions, year 2009

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.6.

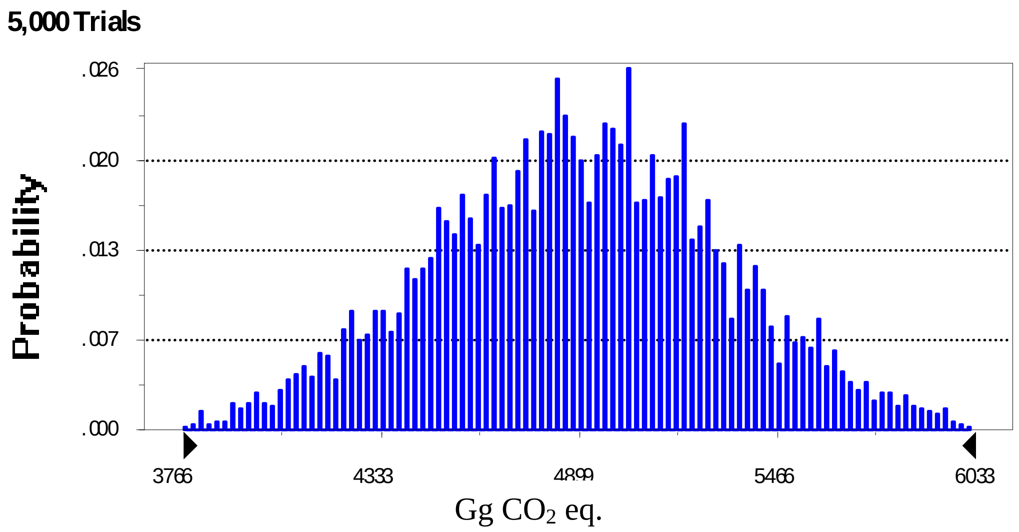


Figure A1.6 Probability density function resulting from Montecarlo analysis for CH_4 from fugitive emissions, year 2009

Agricolture: 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.

	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**

Table A1.22 Statistics of the Montecarlo analysis for CH_4 emissions from enteric fermentation, year 2009

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.7.

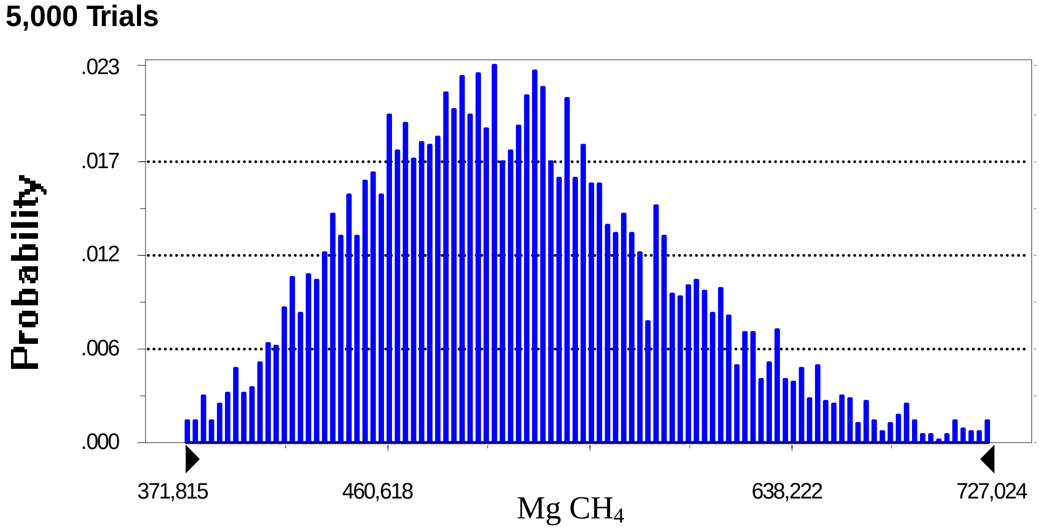


Figure A1.7 Probability density function resulting from Montecarlo analysis for CH_4 emissions from enteric fermentation, year 2009

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 A1.23 a description of the statistics resulting from the Montecarlo analysis is shown.

	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**

Table A1.23 Statistics of the Montecarlo analysis for CO_2 emissions and removals from Forest Land remaining Forest Land, year 2009

In Table A1.24 the results of the uncertainty assessment for the different subcategories are reported, related to the 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**

Table A1.24 Uncertainties assessed for the different subcategories, year 2009

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.8.

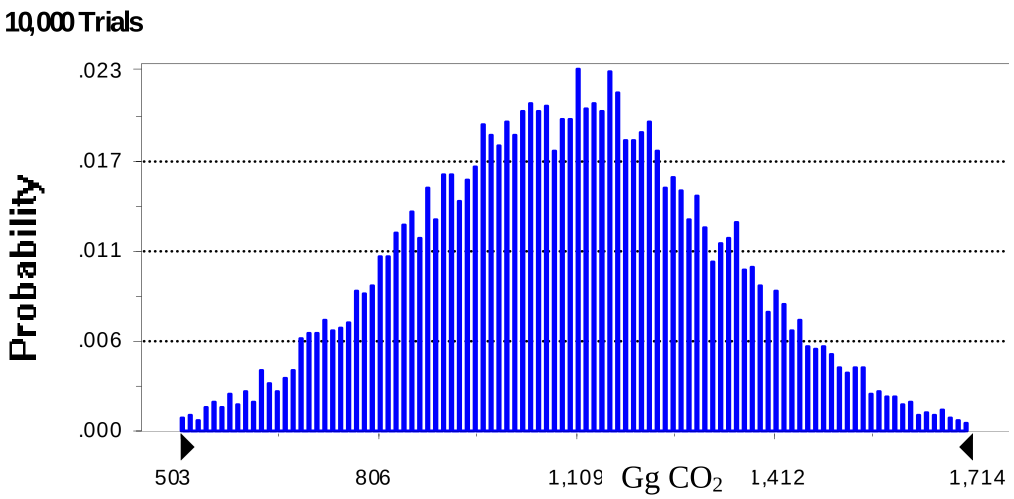


Figure A1.8 Probability density function resulting from Montecarlo analysis for the CO_2 emissions and removals from Forest Land remaining Forest Land category, year 2009

In the Table A.1.25 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.

Uncertainty	**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**

Table A1.25 Comparison between uncertainty assessment with Approach 1 and Approach 2

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 A1.26 a description of the statistics resulting from the Montecarlo analysis is shown.

			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**

Table A1.26 Statistics of the Montecarlo analysis for Land converting to Forest Land, year 2009

The probability function resulting from the Montecarlo assessment is shown in Figure A1.9.

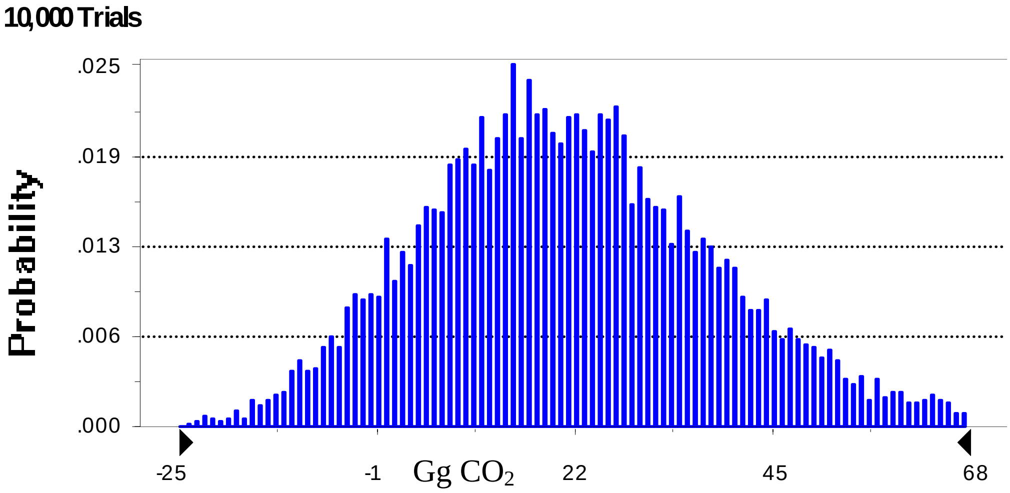


Figure A1.9 Probability density function resulting from Montecarlo analysis for the Land converting to Forest Land, year 2009

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 A1.27 a description of the statistics resulting from the Montecarlo analysis is shown.

			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**

Table A1.27 Statistics of the Montecarlo analysis for CO_2 emissions and removals from Cropland remaining Cropland, year 2009

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.10.

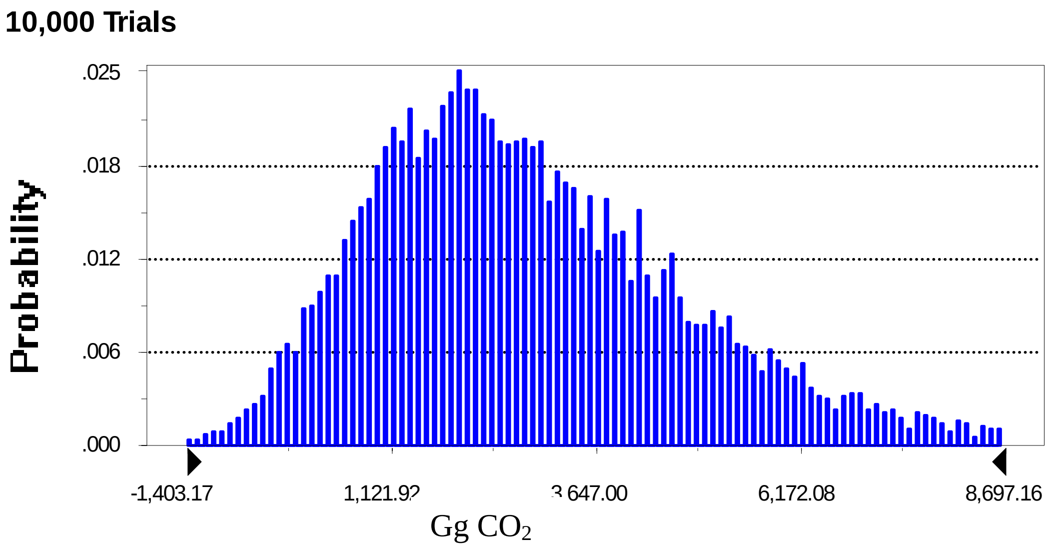


Figure A1.10 Probability density function resulting from Montecarlo analysis for the CO_2 emissions and removals from Cropland remaining Cropland, year 2009

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 A1.28 a description of the statistics resulting from the Montecarlo analysis is shown.

	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**

Table A1.28 Statistics of the Montecarlo analysis for CO_2 emissions and removals from *Land converting to Cropland*, year 2009

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.11.

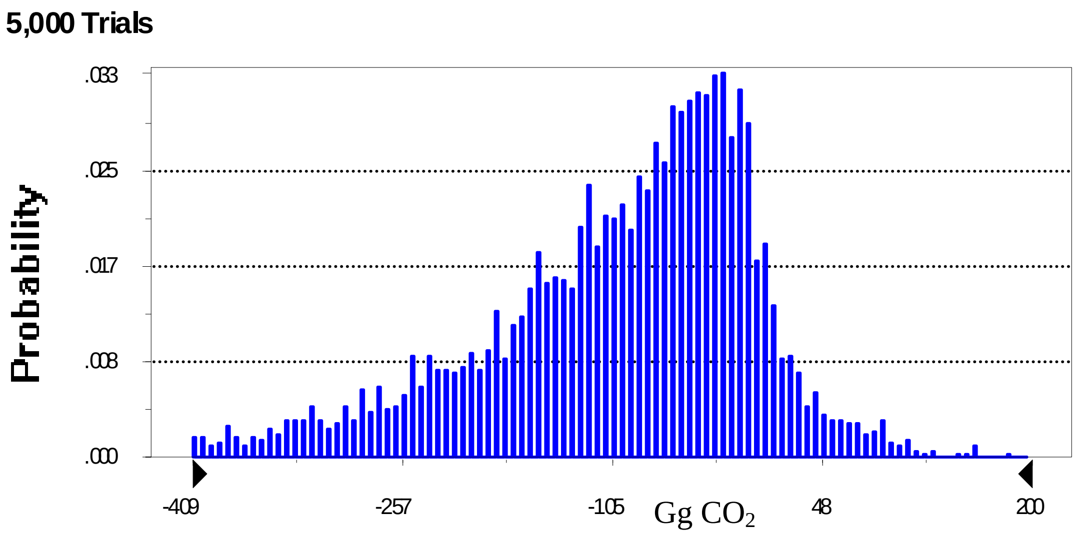


Figure A1.11 Probability density function resulting from Montecarlo analysis for CO_2 emissions and removals from Land converting to Cropland, year 2009

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 A1.29 a description of the statistics resulting from the Montecarlo analysis is shown.

	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**

Table A1.29 Statistics of the Montecarlo analysis for CO_2 emissions and removals from Grassland remaining Grassland, year 2009

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.12.

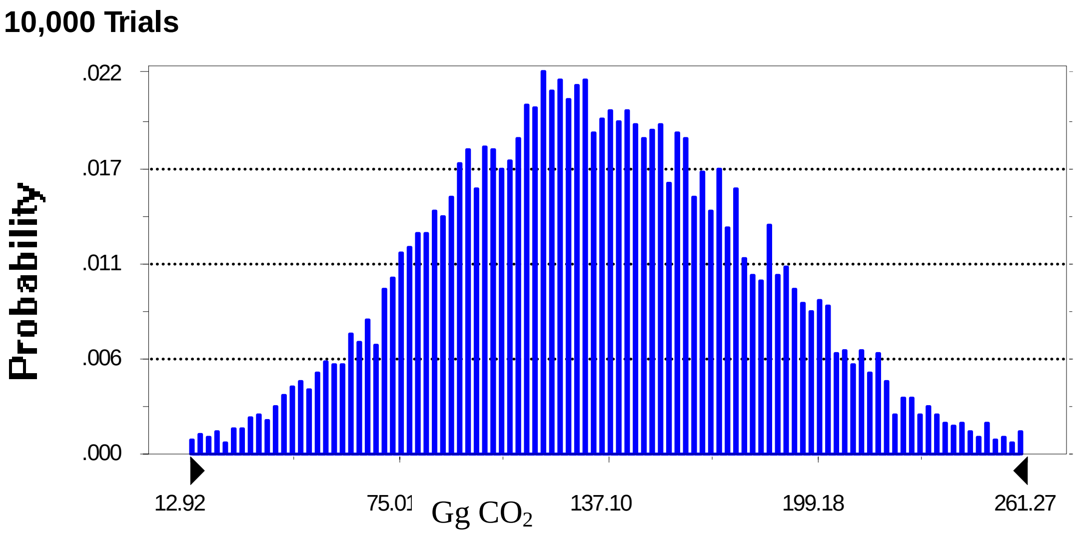


Figure A1.12 Probability density function resulting from Montecarlo analysis for CO_2 emissions and removals from Grassland remaining Grassland, year 2009

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 A1.30 a description of the statistics resulting from the Montecarlo analysis is shown.

	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**

Table A1.30 Statistics of the Montecarlo analysis for CO_2 emissions and removals from Land converting to Grassland, year 2009

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.13.

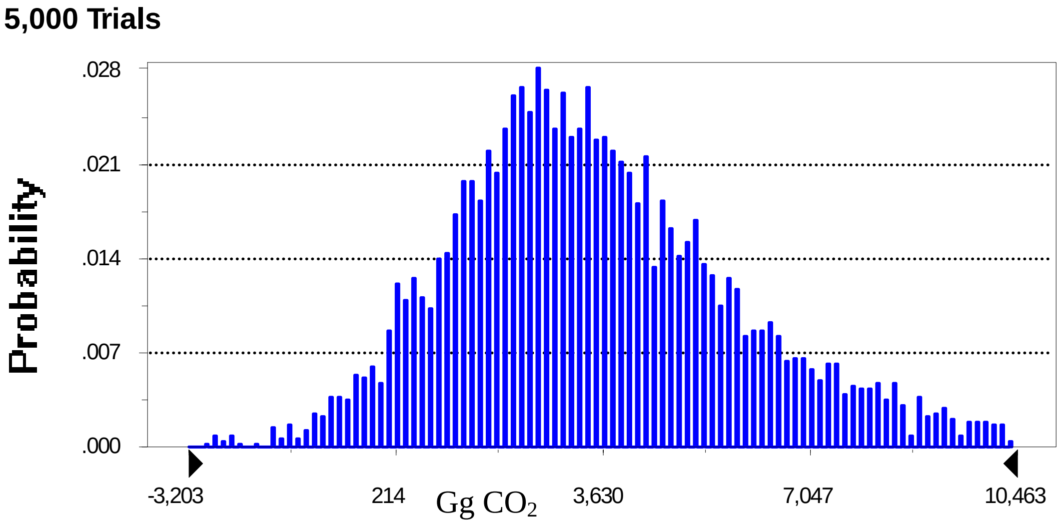


Figure A1.13 Probability density function resulting from Montecarlo analysis for the CO_2 emissions and removals from Land converting to Grassland, year 2009

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 A1.31 a description of the statistics resulting from the Montecarlo analysis is shown.

	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**

Table A1.31 Statistics of the Montecarlo analysis for CO_2 emissions from Land converting to Settlements, year 2009

In Table A1.32 the results of the uncertainty assessment for the different subcategories are reported, related to the year 2009.

Uncertainty	**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**

Table A1.32 Uncertainties assessed for the different subcategories, year 2009

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.14.

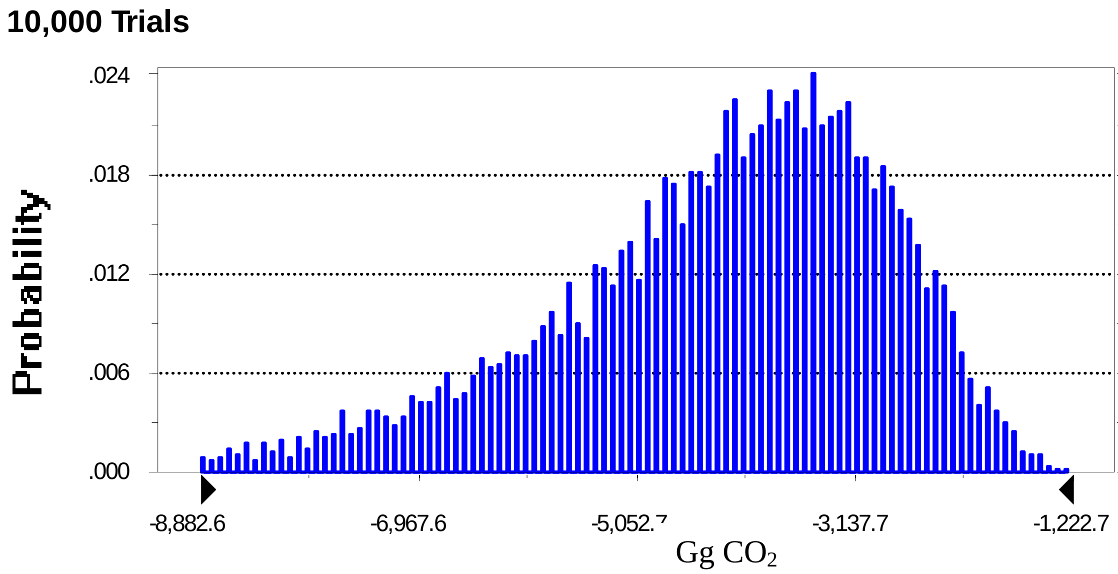


Figure A1.14 Probability density function resulting from Montecarlo analysis for the CO_2 emissions from Land converting to Settlements, year 2009

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 A1.33 a description of the statistics resulting from the Montecarlo analysis is shown.

	Value
Trials	5000
Mean	595,157
Median	595,893
Standard Deviation	37,423
Range Minimum	469,077
Range Maximum	728,751
Uncertainty (%)	**12.58**

Table A1.33 Statistics of the Montecarlo analysis for Solis waste disposal on land category, year 2009

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.15.

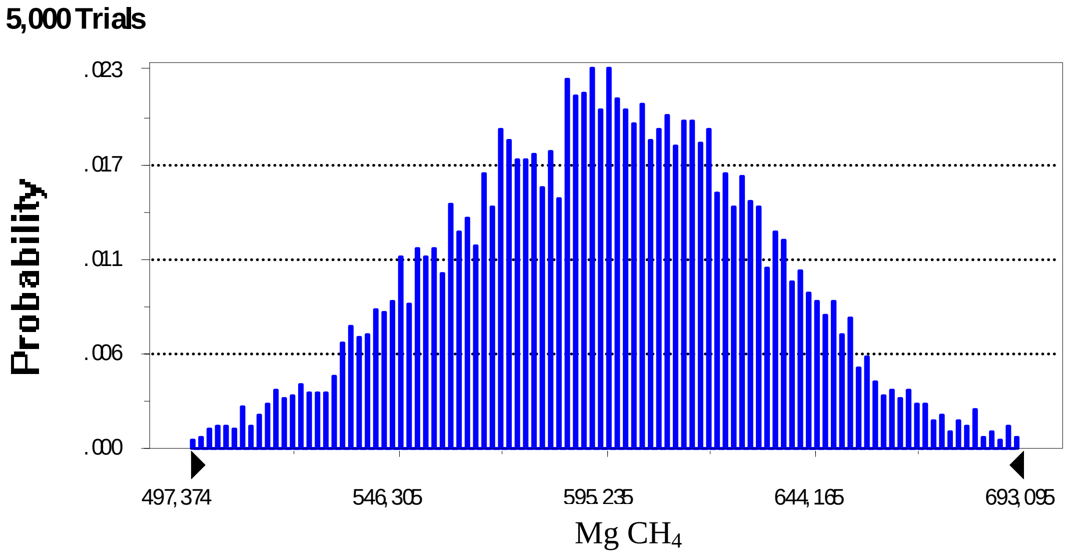


Figure A1.15 Probability density function resulting from Montecarlo analysis for the Solis waste disposal on land category, year 2009

ANNEX 2: ENERGY CONSUMPTION FOR POWER GENERATION

A2.1 Source category description

The main source of data on fuel consumption for the production of electricity 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. The base 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 biggest 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.

	1990	1995	2000	2005	2006	2007	2008	2009
national coal	58	-	Solids	Solids	Solids	Solids	Solids	Solids
imported coal	10,724	8,216	9,633	16,253	16,587	16,886	16,878	15,218
lignite	1,501	380						
Natural gas, m^3	9,731	11,277	22,334	30,544	31,381	33,957	33,706	28,634
BOF(steel converter) gas, m^3	509	633	Coal	Coal	Coal	Coal	Coal	Coal
Blast furnace gas, m^3	6,804	6,428	gases	gases	gases	gases	gases	gases
Coke gas, m^3	693	540	8,690	12,104	13,131	11,353	10,648	6,661
Light distillate	5	6	oil	oil	oil	oil	oil	oil
Diesel oil	303	184	products	products	products	products	products	products
Heavy fuel oil	21,798	25,355	19,352	7,941	7,629	5,292	4,366	3,715
Refinery gas	211	378						
Petroleum coke	186	189						
Orimulsion	-	-						
Gases from chemical processes	444	803	Others	Others	Others	Others	Others	Others
Tar	2	-		Mm^3=978	Mm^3=1,321	Mm^3=1,423	Mm^3=1,414	Mm^3=1,289
Heat recovered from Pyrite	146	3		Gg=15,460	Gg=16,253	Gg=17,490	Gg=16,520	Gg=14,789
Other fuels	344	697	5,153					

Source: Terna, several years

Table A2.1 Time series of power sector production by fuel, Gg or Mm^3

Figures reported in the table show that natural gas has substituted oil products, from 1990 to 2009, becoming the main fuel for electricity production while coal consumption has slightly 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. In 2008 the list of the fuels used to estimate emissions was expanded by Terna, up to 34 different types. 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 been changed (see previous reports).
The detailed information is confidential and only the output of the simulation model applied to calculate emissions for the year 2009, 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, 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 being published 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, 34 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, 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 from 17 to 12 adds rounding errors and this may cause the small difference between the production of electricity of the two sources, 0.2% in 2009. The difference in the energy consumption value is negligible in 2009, thanks to the continuing efforts to improve the comparability of statistical data.

Table A2.2 reports the differences between the national energy balance and Terna data for 2009. For the other years, differences are explainded 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.

Fuels	**Terna**			**BEN**		
	GWe, gross	Gg / Mm^3	Pj	GWe, gross	Gg/ Mm^3	Pj
Coal	39,745.1	15,218	385.1	39,744.2	14,493	385.0
Coke oven gas	1,268.3	600	11.2	1,238.4	613	10.9
Blast furnace gas	2,248.4	5,786	19.7	2,034.9	5,239	19.5
Oxi converter gas	184.1	276	1.8	184.0		1.8
total derived gases	3,700.8	6,662	32.7	3,457.3	5,852	32.3
Coal	**43,445.9**		**417.7**	**43,201.4**		**417.3**
Light distillates	2.4	1	0.02	161.6	27	1.2
Light fuel oil	854.3	196	9.3	695.3	191	8.2
Fuel oil - high sulfur content	12,495.5	3,112	124.3	14,211.6	2,757	113.0
Fuel oil - low sulfur content				7,694.2	1,688	69.2
Refinery gas	1,911.4	269	16.2	1,823.3	311	15.6
Petroleum coke	617.3	172	4.9	617.4	140	4.8
Oriemulsion	0.0	0	0.0			
total fuel oil	*15,878.1*		*154.8*	*25,203.5*	*4,398*	*212.1*
Gas from chemical proc.	610.1	631	5.0	1,502.0	716	8.6
Heavy residuals/ tar	9,324.9	6,373	57.3			
Others	101.4		1.1			
total residual	*10,008.2*		*63.5*	*1,502.0*		*8.6*
Oil+residuals	**25,886.3**		**218.2**	**26,705.5**		**220.6**
Natural gas	**147,270.1**	28,634	**994.5**	**147,269.8**	29,022	**994.5**
Biofuels	1,447.8	295	10.9			
Biogas	1,741.2	1,263	17.6			
Biomass	2,827.9	3,043	36.6	6,010.5	6,221	65.0
Municipal waste	3,416.4	4,449	54.8	3,237.2	4,992	52.2
Grand total	**226,035.6**		**1,750.3**	**226,424.4**		**1,749.6**
Terna /BEN differences				-0.2%		0.0%

Source: ISPRA elaborations

Table A2.2 Energy consumption for electricity production, year 2009

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, so it is possible to use almost any data available at national level. 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 2009. 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.

	TJ	C, Gg	CO_2, Gg
For Table 1.A.1, a. Public Electricity and Heat Production			
Liquid fuels	134,771	2,804	10,275
Solid fuels	385,048	9,897	36,263
Natural gas	952,253	14,847	54,400
Refinery gases	14,051	238	872
Coal gases	9,681	124	455
Biomass	92,593	2,659	9,743
Other fuels (incl.waste)	27,383	716	2,622
Total	**1,615,780**	**28,626**	**104,888**
Industrial producers (Table 1.A.1, a-b-c) and auto-producers,			
to table "1.A.2 Manufacturing Industries "			
Liquid fuels	3,789	82	302
Solid fuels	3	0	0
Natural gas	42,235	659	2,413
Refinery gases	2,139	36	133
Other refinery products	58,521	1,549	5,677
Coal gases	22,972	1,678	6,148
Biomass			
Other fuels (incl.waste)	5,002	355	1,302
Total	**134,663**	**4,360**	**15,974**
General total	**1,750,443**	**32,985**	**120,862**

Source: ISPRA elaborations

Table A2.3 Power sector, Energy/CO_2 emissions in CRF format, year 2009

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.

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 2009 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 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 of 2007 and 2008 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 2009 the decrease is even more accentuated because of the economic recession.

	1990	1995	2000	2005	2006	2007	2008	2009
Total electricity produced (gross), TWh	216.9	241.5	276.6	303.7	314.1	313.9	319.1	292.6
Total CO_2 emitted, Mt	128.5	135.7	140.5	146.4	148.7	144.2	143.1	120.9
g CO_2 / kwh of gross thermo-electric production	720	693	645	596	578	553	559	545
g CO_2 / kwh of total gross production	592	562	508	482	474	459	448	413

Source: ISPRA elaborations

Table A2.4 Time series of CO_2 emissions from electricity production

The trend of CO_2 emissions per thermoelectric production are the result of an increase due to a growing coal share and reductions due to the entry into service of more efficient combined cycle plants. The downward trend takes 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

There has been an overall recalculation of emissions from the sector due to the update based on detailed Terna report for the year 2009 and data collected from the EU ETS scheme. In particular, the recalculations refer to CO_2 emission factors for the years 2005-2008 for coal and 2008 for natural gas. Coal CO_2 emission factor has been updated taking into account the information supplied by the plants in the framework of the EU ETS scheme for the same years. Natural gas CO_2 emission factor has been updated for change of imported gas parameters. The recalculations affected only slightly the time series from 2005 to 2008 with differences ranging from -1.2% to -0.2%, with respect to 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 fact 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 section.
Another specific national circumstance is the concentration of steel works, since the year 2005, in two sites, 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.
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 standard 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 2009, 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 first box from top of the table we can see the quantities of coke, coke gas and blast furnace gas uses by the different sectors. In the second box are reported the quantities of the same energy carriers that are self-used, used for the production of coke or wasted.
Then in the final part of the table, the two coloured groups of cells report the verification of the input-output of two processes, coke ovens and blast furnaces. The input –output is generally balanced for all the considered years; the small differences can be explained by statistical discrepancies. The following data are just memo summary of the quantities of fuels imported or exported by the system.

coke	coke gas	blast furnace gas	NOTES
4,793			For blast furnace
0	2,606	4,715	For electricity production
13,764	0	73	For steel industries
128	0	0	For other industries use
0	0		For domestic use
18,685	2,606	4,788	Total consumption
400	194	6	Consumption for production of secondary fuels
-1	-1	0	Losses of transformation
19,084	2,799	4,794	Total consumption + losses and prod.
Energy balance, coke ovens		**Energy balance, blast furnace gas**	
69		-588.5	Difference in energy consumption
0.3%		-12.3%	Unbalance in %
23,828			Coke oven output
1,288			Transformation losses, coke ovens
1,014			non energy use
26,129			sub total
26,129			Coking coal input to coke ovens
7,049			Blast furnace coal input
-2,013			import + stock change

Table A3.1 Energy balance, 2009, Tcal

In Table A3.2, in the first two boxes from the top the same energy data of Table A3.1 valuated for their carbon content are reported, according to the standard emission factors reported in Table 3.12 of the NIR. In the coloured cells the balance of carbon inputs and outputs of two processes coke oven and blast furnaces are shown.
So in the end the methodology actually foresees as a first step the calculation of the total carbon inputs (imported fuels plus standard IPCC emission factors), see table A3.2 column "total according to BEN". A second step foresees the use for the electric sector of the value directly calculated from the coal gasses used and the calculation of a "balance" quantity for blast furnaces, see column "total used for CRF" in Table A3.2. 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 resulting carbon quantities are correct but, when reported in the CRF format, they seem to be produced using very low emission factors for coal produced CO_2, near to the natural gas emission factor, for the steel making process and quite high carbon emissions for the coal used to produce electricity.

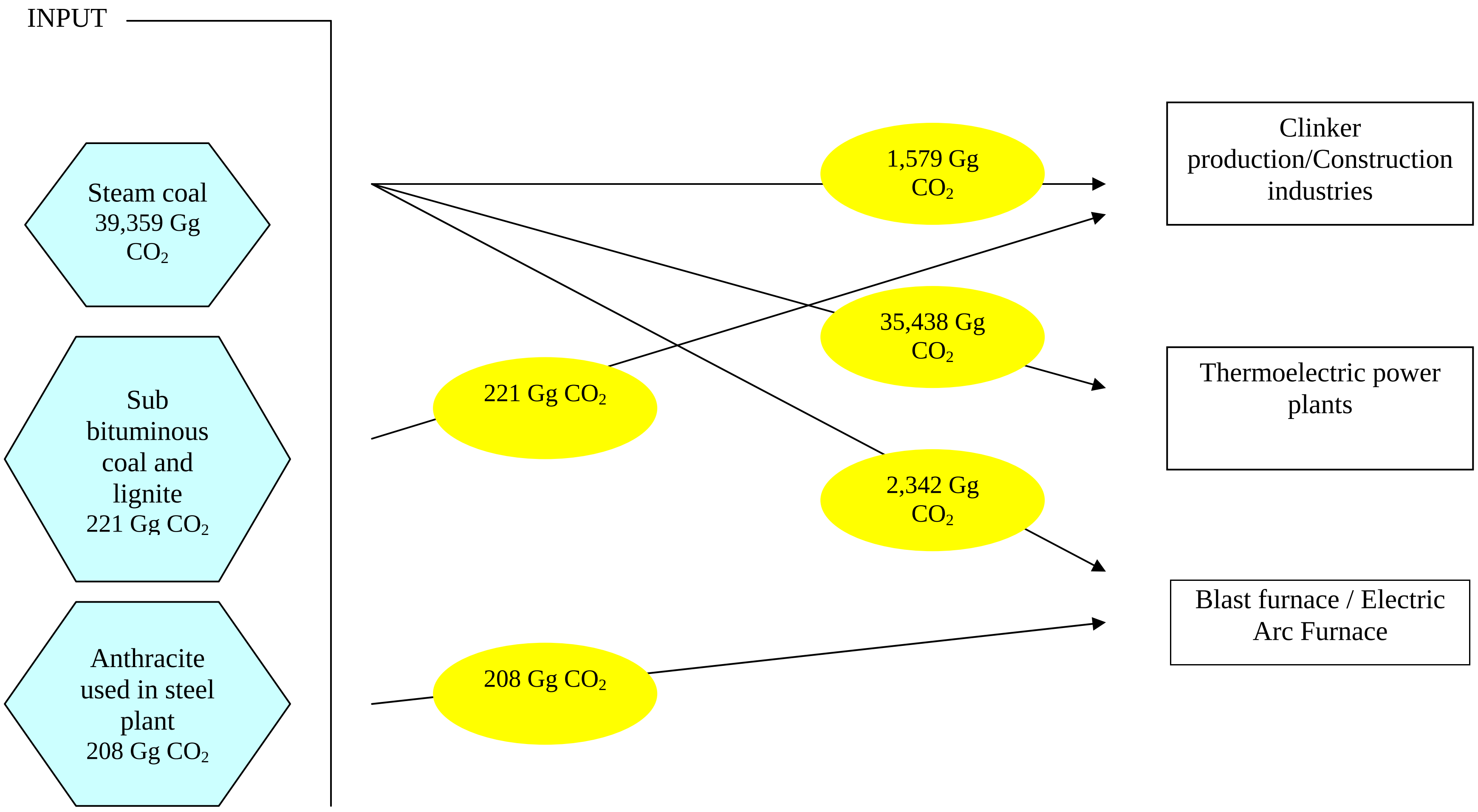
Further investigations are planned, with a verification of the carbon content of the imported coals and of the coal gasses produced at various stages of the process, coke gas, blast furnace gas and BOF gas. Additional information from the operators on fuel consumptions and average emission factors is submitted in the framework of the EU ETS scheme and it is used to verify our calculation and CO_2 emissions at plant level.
On the basis of the analysis of these data and comparison with figures reported in the National Energy Balance, in the 2010 submission coking coal consumptions due to losses during the transformation process in cookeries, and their related emissions, have been reallocated from the 1.A.2.a sector, iron and steel, to the 1.A.1.c sector, manufacture of solid fuels and other energy industries.

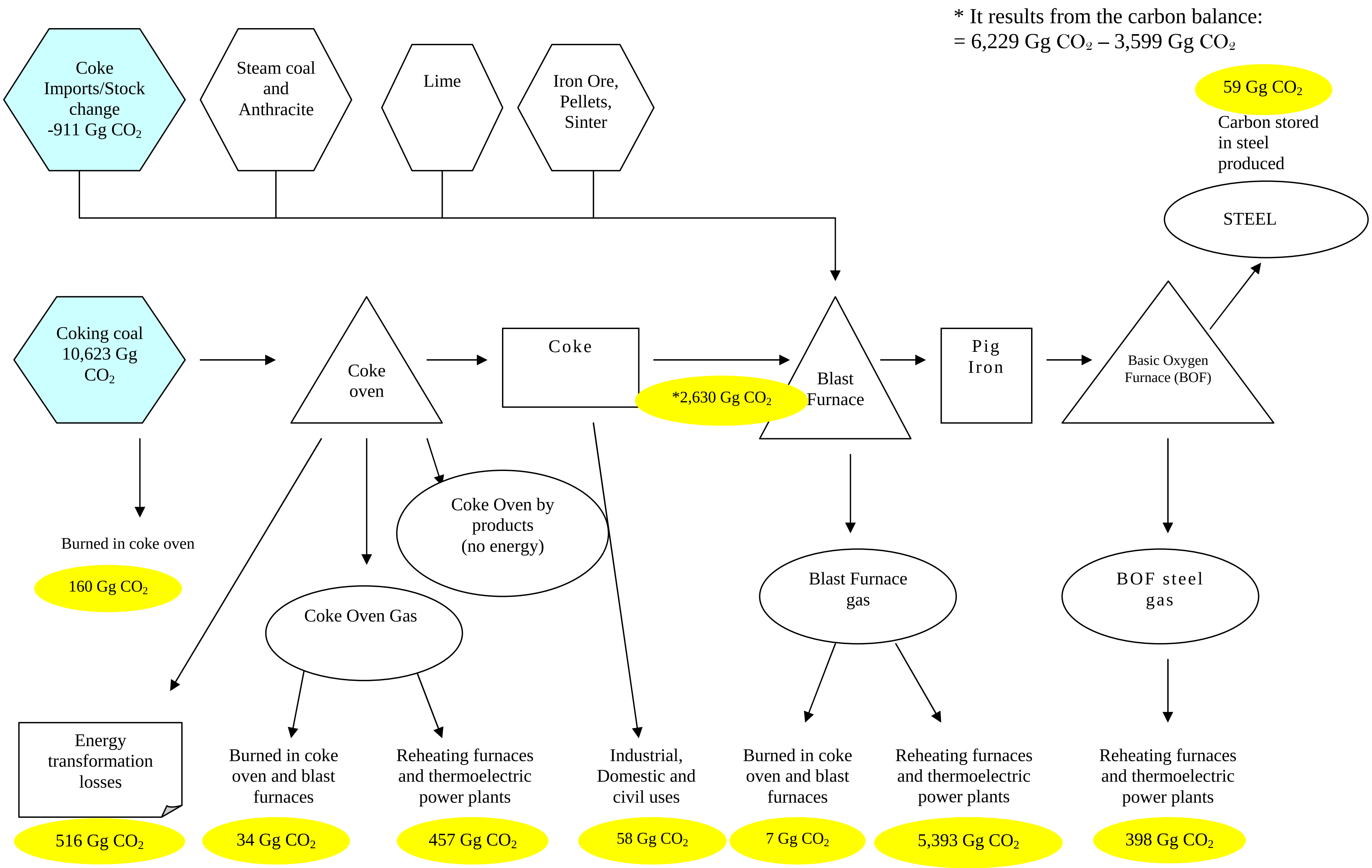
coke	coke gas	Blast furnace gas + oxi gas	NOTES	Total according to BEN	Total used for CRF
2.12			From blast furnace (no direct emissions, transformed in coal gasses)	2.12	
0.00	0.51	4.77	From electricity prod.	5.76	6.60
6.10	0.00	0.08	From steel industries	6.18	5.30
0.06	0.00	0.00	From other industries use	0.06	0.06
0.00	0.00		From domestic use	0.00	
8.28	0.51	4.86	Total emissions, final uses	14.13	11.96
0.15	0.04	0.01	Consumption for production of secondary fuels	0.20	
0.00	0.00	0.00	Losses of transformation	0.00	
8.44	0.55	4.86	Total consumption + losses and prod.	14.33	
Carbon balance, coke ovens		**Carbon balance, blast furnace**			
0.3		0.1	Difference in physical emissions		
4%		1%	Unbalance in %		
Emissions					
9.54			Carbon in produced coke		
0.52			Transformation losses		
0.41			non energy use	0.41	0.41
10.13			Coal input to coke ovens		
3.13			Coal input to blast furnace		
-0.89			Coke import + stock change		
12.36			Total carbon input		12.36

Table A3.2 Carbon balance, 2009, Mt CO_2

The flowchart of carbon - cycle for the year 2009 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 yellow. 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 2009. The amount of carbon stored in steel produced was estimated and subtracted from the balance to avoid the subsequent overestimation of CO_2.

CO_2 emission calculation
Year 2009




* It results from the carbon balance:
= 6,229 Gg CO₂ – 3,599 Gg CO₂
Coke Imports/Stock change -911 Gg CO2
Steam coal and Anthracite
Lime
Iron Ore, Pellets, Sinter
59 Gg CO2
Carbon stored in steel produced
STEEL
Coking coal 10,623 Gg CO2
Coke oven
Coke
*2,630 Gg CO2
Blast Furnace
Pig Iron
Basic Oxygen Furnace (BOF)
Burned in coke oven
160 Gg CO2
Coke Oven by products (no energy)
Coke Oven Gas
Blast Furnace gas
BOF steel gas
Energy transformation losses
516 Gg CO2
Burned in coke oven and blast furnaces
34 Gg CO2
Reheating furnaces and thermoelectric power plants
457 Gg CO2
Industrial, Domestic and civil uses
58 Gg CO2
Burned in coke oven and blast furnaces
7 Gg CO2
Reheating furnaces and thermoelectric power plants
5,393 Gg CO2
Reheating furnaces and thermoelectric power plants
398 Gg CO2

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 2008 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 and production;
2) natural gas data import;
3) import-export data of petrol, aviation fuel, other kerosene, diesel, fuel oil, LPG and virgin naphtha;
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 2003 because it is explicitly excluded by the IPCC methodology.

From 2004 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[62];

6) all coal data are available in BEN, coke import-export included;
7) total natural gas import-export balance reflects BEN estimate (energy section), but the detailed quantities coming from different countries (relevant for the carbon emission factors estimate, see paragraph 3.8) are from foreign trade statistics or "Rete Gas", the national gas grid monopoly, fiscal budgets; the estimated quantities of natural gas used by various sectors show not negligible variations from source to source, with particular reference to the underground stocked quantities; when available we use the estimates of AEEG (Authority for electricity and gas) for consumption of the distribution / storage system and BEN for final consumption;
8) from 1990 to 2009 biomass consumption data are those reported in the BEN; it is well known that other estimates show much bigger, up to 50% more, quantities of used biomass, for example ENEA (ENEA, several years); but the same source quotes BEN biomass consumption estimates as official statistics up to the year 2009 pending further investigations; the inventory follows the same methodology.

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
- Waste incineration
- Non-Fuel industrial processes

---

[62] The feedstock production data refers to petrochemical feedstock and other fuel streams coming back to the refineries from the internal market. Those quantities do not contain additional carbon inputs but because those quantities 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 2004 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.

First of all, the IPCC Reference total can be compared with the IPCC Table 1A total. Results show the IPCC Reference totals are between 0-4 percent lower than the comparable ‘bottom up’ totals. The highest difference between the two approaches is observed in 1999 and is equal to 3.3%; 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.
Differences between emissions estimated by the reference and sectoral approach are reported in Table A4.1.

	1990	1995	2000	2005	2006	2007	2008	2009
Sectoral approach	402.0	414.8	435.1	459.4	454.6	444.9	437.2	393.6
Reference approach	395.7	406.2	424.8	452.2	448.9	436.9	434.4	394.8
Δ %	-1.56%	-2.09%	-2.36%	-1.55%	-1.25%	-1.80%	-0.65%	0.29

Table A4.1 Reference and sectoral approach CO_2 emission estimates 1990-2009 (Mt) and percentage differences

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, instead 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. An investigation is planned as soon as resources become available.
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 specific methodology for estimate carbon content of liquid fuel imports is at the moment only planned.

ANNEX 5: NATIONAL ENERGY BALANCE, YEAR 2009

The following table reproduces the part expressed in amount of energy consumed of the National Energy Balance (BEN) of the year 2009 (MSE, several years).

The complete balance, containing the physical quantities as well as the amount of energy and a consistent time series from the year 1998 onwards, is also available on the website: http://dgerm.sviluppoeconomico.gov.it/dgerm/.

Sectors and fuel definition have been translated here in English, but, of course, the tables on Internet are in Italian language. Definitions are very similar to their English equivalents so this should not be an obstacle to independent verifications of energy data sources for previous years.

The national energy balance is comprised of two “sets” of tables: from page 2 to page 10 the energy vectors are represented in physical quantities (Gg or Mm^3) while from page 12 to page 20 they are expressed in energy equivalents (10^9 kcal).
Recalling what already said in Annex 2 related to the BEN reporting methodology (that prefers to use always the same lower heat value for each primary fuel in various years, to better follow the variable energy content of each shipment), we make reference here to the second set of tables. 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 (non reproduced here) is an “adjusted” quantity of Gg or Mm^3. This process is routinely applied for 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. Experience on the measure of the actual energy content of fuels shows minor variations from one to another year, 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 we use fuel from four main different sources: Russia, Netherlands, Algeria and national production. From 2003-2004 onwards 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 has recently been changed. From 2004 onwards, the price makes reference to the energy content of natural gas and the metered physical quantities of gas delivered to all final customers are 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.

So for the estimations of liquid fuels used in the civil and transportation sector the most reliable data is the physical quantity and this is used to calculate emissions, using updated data for the emission factors, estimated from samples of marketed fuels.
For this reason we attach also the copies of tables, page 8 and 9 of BEN (see Tables A5.9-10), mirror sheet of the tables, page 18 and 19 of BEN (see 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 2009, Primary fuels, 10^9 kcal

BALANCE	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**	**Wood**	**Biomass (f)**	**Biodiesel**	**TOTAL PRIMARY SOURCES**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Conversion factor (b)	*7,400*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*	*2,200*	*2,500*	*2,500*	*2,500*	*8,900*	
1. PRODUCTIONS (c)	0	457	0	0	2.48	65.626	45.51	25.97	108.103	11.752	15.883	12.48	18.151	15.553	7.102	329.067
2. IMPORTS	23.71	102.807	725	18	0	567.158	762.97	63.4	0	0	0	0	8.825	0	4.139	1.533.752
3. EXPORTS						1.024	3750	19250					63	0	792	24.879
4. Stock changes (d)	-2.819	337	-370	0	0	-7.256	1.25	330	0	0	0	0	0	0	-142	-8.67
5. TOTAL RESOURCES	**26.529**	**102.927**	**1.095**	**18**	**2.48**	**639.017**	**803.48**	**69.79**	**108.103**	**11.752**	**15.883**	**12.48**	**26.913**	**15.553**	**10.591**	**1.846.611**
6. Transformations (Enclosure 1/a)	26.129	92.028		0	2.479	237.69	873.27	0	108.103	11.752	15.883	12.48	1.938	15.553	0	1.397.305
7. Consumptions and Losses (Encl.2/a)	400	0	0	0	1	10.934	0	0	0	0	0	0	0	0	0	11.335
8. Final Consumptions (Enclosure 3/a)	0	10.899	1.095	18	0	390.393	0	0				0	24.975	0	10.591	437.971
a) Agriculture	0	0	0	0	0	1.417	0	0	0	0	0	0	2.498	0	0	3.915
b) Industry	0	10.899	1.051	18	0	118.519		0				0	3.745	0	0	134.232
c) Services						6.011		0					0	0	10.591	16.602
d) Domestic and civil uses			44	0		258.779		0					18.733	0	0	277.556
Total (a+b+c+d)	**0**	**10.899**	**1.095**	**18**	**0**	**384.726**		**0**				**0**	**24.975**	**0**	**10.591**	**432.304**
e) Non energy uses						5.667	0	0	0	0	0	0	0	0	0	5.667

BALANCE	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**	**Wood**	**Biomass (f)**	**Biodiesel**	**TOTAL PRIMARY SOURCES**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Conversion factor (b)	*7,400*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*	*2,200*	*2,500*	*2,500*	*2,500*	*8,900*	
TOTAL ENERGY CONSUMPTIONS (7+8)	**400**	**10.899**	**1.095**	**18**	**1**	**401.327**	**0**	**0**	**0**	**0**		**0**	**24.975**	**0**	**10.591**	**449.306**
9. Non energy final uses																
10. BUNKERS																
12. TOTAL USES	**26.529**	**102.927**	**1.095**	**18**	**2.48**	**639.017**	**873.27**	**0**	**108.103**	**11.752**	**15.883**	**12.48**	**26.913**	**15.553**	**10.591**	**1.846.611**

(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 petrolchimical 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 2009, Secondary fuels, 10^9kcal

BALANCE	SECONDARY SOURCES																		
	Electric Energy	**Char- coal**	**Coke**	**Coke oven gas**	**Blast furnace Gas (g)**	**Non energy use of coal products**	**Gas works Gas**	**L. P. G.**	**Refinery gas (h)**	**Light Distillates (naphtha)**	**Gasoline**	**Jet fuel**	**Kerosene**	**Gas Oil / Diesel Oil**	**Residual Oil, HS (i)**	**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)	*0,86*	*7,500*	*7,513*	*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*	*6,170*	
1. PRODUCTIONS (c)	247.969	969	20.699	2.801	4.794	1.339	0	20.548	40.044	28.34	195.752	31.72	2.678	378.757	(g) 72.128	49.333	10.624	37.1	1.145.595
2. IMPORTS	40.481	570	0					20.218	0	20.353	1.901	8.195	1.524	20.349	(h) 6.115	12.711	21.871	3.313	157.601
3. EXPORTS	1.816	15	2.074			311		4.301		6.458	81.134	1.955	773	94.248	19.669	11.211	1.054	18.084	243.103
4. Stock changes (d)		0	-60					561		-156	1.691	-437	-155	-4.304	-666	-1.147	-1.278	-2.098	-8.049
5. TOTAL RESOURCES	**286.634**	**1.524**	**18.685**	**2.801**	**4.794**	**1.028**	**0**	**35.904**	**40.044**	**42.391**	**114.828**	**38.397**	**3.584**	**309.162**	**59.24**	**51.98**	**32.719**	**24.427**	**1.068.142**
6. Transformations (Encl.1/a)			4.793	2.606	(c) 4.715	0		0	3.732	284	0	0	0	1.952	27.019	16.542	1.158	0	62.801
7. Consumptions and Losses (Encl.2/a)	37.22	0	0	193	6	0	0	473	26.46	164	62	0	0	159	6.83	9.949	8.57	205	90.24
8. Final Consumptions (Encl.3/a)	249.414	1.524	13.892	0	73	1.029	0	35.431	9.852	41.943	114.766	38.397	3.584	301.359	6.908	16.228	22.991	3.208	881.331
a) Agriculture	4.859							660	0	0	116	0	0	23.297	0	0	0	0	28.932
b) Industry	98.32	195	13.892	0	73		0	2.948	2.016	0	273	125	10	3.426	5.105	12.74	22.991	3.208	165.322
c) Services	39.128							12.089			110.996	38.272	0	241.771	0	0	0	0	442.256

BALANCE	SECONDARY SOURCES																		
	Electric Energy	**Char- coal**	**Coke**	**Coke oven gas**	**Blast furnace Gas (g)**	**Non energy use of coal products**	**Gas works Gas**	**L. P. G.**	**Refinery gas (h)**	**Light Distillates (naphtha)**	**Gasoline**	**Jet fuel**	**Kerosene**	**Gas Oil / Diesel Oil**	**Residual Oil, HS (i)**	**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)	*0,86*	*7,500*	*7,513*	*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*	*6,170*	
d) Domestic and civil uses	107.107	1.329	0				0	19.734	0	0	0		93	23.195	0	862	0	0	152.32
Total (a+b+c+d)	**249.414**	**1.524**	**13.892**	**0**	**73**	**0**	**0**	**35.431**	**2.016**	**0**	**111.385**	**38.397**	**103**	**291.689**	**5.105**	**13.602**	**22.991**	**3.208**	**788.83**
e) No energetic uses				0		1.029		0	7.836	41.943	3.381	0	3.481	9.67	1.803	2.626	0	20.732	92.501
TOTAL ENERGY CONSUMPTIONS (7+8)	**286.634**	**1.524**	**13.892**	**193**	**79**	**1.029**	**0**	**35.904**	**36.312**	**42.107**	**114.828**	**38.397**	**3.584**	**301.518**	**13.738**	**26.177**	**31.561**	**3.413**	**950.89**
9. Non energy final uses		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20.731	20.731
10. BUNKERS		0	0	0	0	0	0	0	0	0	0	0	0	5.692	18.483	9.261	0	283	33.719
12. TOTAL USES	**286.634**	**1.524**	**18.685**	**2.801**	**4.794**	**1.028**	**0**	**35.904**	**40.044**	**42.391**	**114.828**	**38.397**	**3.584**	**309.162**	**59.24**	**51.98**	**32.719**	**24.427**	**1.068.142**

(h) - Including residuals gas of chemical processes

Table A5.3 -National Energy Balance, year 2009, 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*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*	*2,200*	*2,500*	*2,500*	
1) INPUT QUANTITY														
a) Charcoal pit													1.938	1.938
b) Coking	26.129													26.129
c) Town gas Workshop														
d) Blast furnaces														
e) Petroleum refineries							873.270							956.000
f) Hydroelectric power plants									108.103					108.103
g) Geothermal power plants										11.752				11.752
h) Thermoelectric power plants		92.028			2.479	237.690						12.480	15.553	360.230
i) Wind / Photovoltaic power plants						-					15.883			15.883
TOTAL	**26.129**	**92.028**			**2.479**	**237.690**	**873.270**		**108.103**	**11.752**	**15.883**	**12.480**	**17.491**	**1.397.305**
2) OUTPUT QUANTITY														
A) Obtained sources														
a) Charcoal pit													970	970
b) Coking	23.828													23.828

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*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*	*2,200*	*2,500*	*2,500*	
c) Town gas Workshop														
d) Blast furnaces														
e) Petroleum refineries							829.930							829.930
f) Hydroelectric power plants								42.258						42.258
g) Geothermal power plants									4.594					4.594
h) Thermoelectric power plants		34180			1.450	126.652						2.784	5.169	170.235
i) Wind / Photovoltaic power plants											6.209			6.209
Sub-Total A	**23.828**	**34.180**			**1.450**	**126.652**	**829.930**		**42.258**	**4.594**	**6.209**	**2.784**	**6.139**	**1.078.024**
B) Losses of transformation														
a) Charcoal pit													968	968
b) Coking	1.288													1.288
c) Town gas Workshop														
d) Blast furnaces														
e) Petroleum refineries							6.240							6.240
f) Hydroelectric power plants									65.845					65.845

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*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*	*2,200*	*2,500*	*2,500*	
g) Geothermal power plants										7.158				7.158
h) Thermoelectric power plants		57.848			1.029	111.038						9.696	10.384	189.995
i) Wind / Photovoltaic power plants											9.674			9.674
Sub-Total B	**1.288**	**57.848**			**1.029**	**111.038**	**6.240**		**65.845**	**7.158**	**9.674**	**9.696**	**11.352**	**281.168**
C) Non energy products														
a) Coke ovens (c)	1.013													1.013
b) Town Gas Workshop														
c) Petroleum refineries (d)							37.100							37.100
Sub-Total C	**1.013**						**37.100**							**38.113**
TOTAL A+B+C	**26.129**	**92.028**			**2.479**	**237.690**	**873.270**		**108.103**	**11.752**	**15.883**	**12.480**	**17.491**	**1.397.305**

(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 2009, 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*	*7,513*	*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*	*6,170*	
1) INPUT QUANTITY																			
a) Charcoal pit																			
b) Coking																			
c) Town gas Workshop																			
d) Blast furnaces			4.794																4.794
e) Petroleum refineries																			
f) Hydroelectr.power plants																			
g) Geothermal power plants																			
h) Thermoelectr. power plants				2.606	4.715				3.732	284				1.952	27.019	16.542	1.158		58.008
i) Wind / Photovoltaic power plants																			
TOTAL			**4.794**	**2.606**	**4.715**				**3.732**	**284**				**1.952**	**27.019**	**16.542**	**1.158**		**62.802**
2) OUTPUT QUANTITY																			
A) Obtained sources																			
a) Charcoal pit																			

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*	*7,513*	*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*	*6,170*	
b) Coking																			
c) Town gas Workshop																			
d) Blast furnaces			4.794																4.794
e) Petroleum refineries																			
f) Hydroelectric power plants																			
g) Geothermal power plants																			
h) Thermoelectric power plants				1.065	1.934				1.568	139				598	12.222	6.617	531		24.674
i) Wind / Photovoltaic power plants																			
Sub-Total A			**4.794**	**1.065**	**1.934**				**1.568**	**139**				**598**	**12.222**	**6.617**	**531**		**29.468**
B) Losses of transformation																			
a) Charcoal pit																			
b) Coking																			
c) Town gas Workshop																			
d) Blast furnaces																			
e) Petroleum refineries																			
f) Hydroelectric																			

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*	*7,513*	*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*	*6,170*	
power plants																			
g) Geothermal power plants																			
h) Thermoelectric power plants				1.541	2.781				2.164	145				1.354	14.797	9.925	627		33.334
i) Wind / Photovoltaic power plants																			
Sub-Total B				1.541	2.781				2.164	145				1.354	14.797	9.925	627		33.334
C) Non energy products																			
a) Coking																			
b) Town Gas Workshop																			
c) Petroleum refineries																			
Sub-Total C																			
TOTAL A+B+C			**4.794**	**2.606**	**4.715**				**3.732**	**284**				**1.952**	**27.019**	**16.542**	**1.158**		**62.802**

Table A5.5 -National Energy Balance, year 2009, 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*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*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						3.137								3.137
f) Natural gas liquids														
g) Crude oil														
h) Hydraulic Energy														
i) Geothermal Energy														
Sub-total						**3.137**								**3.137**
2) Consumptions for production														
of secondary sources (c)														
a) Charcoal pit														
b) Coke ovens	400													400
c) Town Gas Workshop														
d) Blast furnaces														
e) Petroleum refineries						4.079								4.079
f) Hydraulic power plants														

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*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*			*2,500*	
g) Geothermal power plants														
h) Thermoelectric power plants														
i) Nuclear power plants														
Sub-total	**400**					**4.079**								**4.479**
3) Consumptions and Losses of														
transport and distribution						3.718								3.718
4) Differences :														
- Statistics														
- of conversion					1									1
TOTAL (1+2+3+4)	**400**				**1**	**10.934**								**11.335**

(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

(d) Excluding losses of transformation considered in the balance of transformations

Table A5.6 -National Energy Balance, year 2009, 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*	*7,513*	*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*	*6,170*	
1) Consumptions for production																			
of primary sources						1													1
a) Biomass																			
b) Coal	36																		36
c) Lignite	2																		2
d) Nuclear fuels	5																		5
e) Natural Gas	294																		294
f) Natural gas liquids																			
g) Crude oil																			
h) Hydraulic Energy	1.284	(d)																	1.284
i) Geothermal Energy	-																		-
Sub-total	**1.621**																		**1.622**
2) Consumptions for production																			
of secondary sources (c)																			
a) Charcoal pit																			
b) Coke ovens	65			194	6														265
c) Town Gas Workshop	221																		221

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*	*7,513*	*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*	*6,170*	
d) Blast furnaces																			
e) Petroleum refineries	5.077							473	26.460	166	63			163	6.830	9.946	8.566	204	57.948
f) Hydraulic power plants	515																		515
g) Geothermal power plants	280																		280
h) Thermoelectric power plants	9.074																		9.074
i) Wind / Photovoltaic power plants	50																		
Sub-total	**15.282**			**194**	**6**			**473**	**26.460**	**166**	**63**			**163**	**6.830**	**9.946**	**8.566**	**204**	**68.303**
3) Consumptions and Losses of	20.317																		20.317
transport and distribution																			
4) Differences :																			
- Statistics	-																		
- of conversion			-1	-1		-1				-2	-1			-4		3	4	1	-2
TOTAL (1+2+3+4)	**37.220**		**-1**	**193**	**6**			**473**	**26.460**	**164**	**62**			**159**	**6.830**	**9.949**	**8.570**	**205**	**90.240**

Table A5.7 -National Energy Balance, year 2009, 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*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*	*2,200*	*2,500*	*2,500*	*8,900*	
1) AGRICULTURE AND FISHING															
I- Agriculture						1.417							2.498		3.915
II- Fishing															
Sub-Total						**1.417**							**2.498**		**3.915**
2) INDUSTRY															
I- Iron and steel industry		6.509	540			13.243									20.292
II- Other industry		4.390	511	18		105.276							3.745		113.940
a) Mining industry						369									369
b) Non-Ferrous Metals			44			3.563									3.607
c) Metal works factories						17.035									17.035
d) Food Processing, Beverages						14.087									14.087
e) Textile and clothing						6.962									6.962
f) Construction industries (cement, bricks)		4.390	444	18		5.823							3.745		14.420
g) Glass and pottery						17.527									17.527
h) Chemical			23			20.811									20.834
i) Petrochemical															
l) Pulp, paper and print						14.382									14.382

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*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*	*2,200*	*2,500*	*2,500*	*8,900*	
m) Other industries						4.717									4.717
n) Building and civil works															
Sub-Total		**10.8994**	**1.051**	**18**		**118.519**							**3.745**		**134.232**
3) SERVICES															
I - Railways															
II - Navigation															
III - Road transportation						6.011								10.591	16.602
IV - Civil aviation															
V - Other transportation															
VI - Public Service															
Sub-Total						**6.011**								**10.591**	**16.602**
4) DOMESTIC AND COMMERCIAL USES			44			258.779							18.733		277.556
TOTAL (1+2+3+4)		**10.899**	**1.095**	**18**		**384.726**							**24.976**	**10.591**	**432.305**
5) NON ENERGY USE (b)															
I - Chemical industry															
II - Petrochemical						5.667									5.667
III - Agriculture															
IV - Other sectors															
Sub-Total						**5.667**									**5.667**

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*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*	*2,200*	*2,500*	*2,500*	*8,900*	
TOTAL (1+2+3+4+5)		**10.899**	**1.095**	**18**		**390.393**							**24.976**	**10.591**	**437.972**

(a) - Lower heat value has been adopted for all fuels

(b) - Non energy uses of energetic sources

Table A5.8-National Energy Balance, year 2009, 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*	*7,513*	*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*	*6,170*	
1) AGRICULTURE AND FISHING																			
I- Agriculture	4.859							638			105			21.063					26.665
II- Fishing								22			11			2.234					2.267
Sub-Total	**4.859**							**660**			**116**			**23.297**					**28.932**
2) INDUSTRY																			
I- Iron and steel industry	13.529		13.764		73			198						61	647	392	8		28.672
II- Other industry	84.791	195	128					2750	2.016		273	125	10	3.365	4.458	12.348	22.983	3.208	136.650
a) Mining industry	822							22						163	137	10			1.154
b) Non-Ferrous Metals	4.346		15					143						51		343			4.898
c) Metal works factories	19.553							605			273	125	10	1.132	1.058	1.480			24.236
d) Food Processing, Beverages	10.800	150						330						408	1.421	2.391			15.500
e) Textile and clothing	5.642							132						347	10	951			7.082
f) Construction industries (cement, bricks)	6.077		75					660						337	529	372	22.908	3.208	34.166
g) Glass and	3.997							550						122		1.764			6.433

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*	*7,513*	*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*	*6,170*	
pottery																			
h) Chemical	16.987	45	15					33						163		1.019	75		18.337
i) Petrochemical	1.435							132	2.016						392	2.891			6.866
l) Pulp, paper and print	8.064							66						163		1.098			9.391
m) Other industries	5.513		23					66						122	568	372			6.664
n) Building and civil works	1.555							11						357					1.923
Sub-Total	98.320	195	13.892		**73**			2.948	2.016		273	125	10	3.426	5.105	12.740	22.991	3.208	165.322
3) SERVICES																			
I - Railways	4.733													612					5.345
II - Navigation	34													2.234					2.268
III - Road transportation	4.124							12.056			110.628			236.477					363.285
IV - Civil aviation	168										179	37.149							37.496
V - Other transportation	20.440																		20.440
VI - Public Service	9.629							33			189	1.123		2.448					13.422
Sub-Total	**39.128**							**12.089**			**110.996**	**38.272**		**241.771**					**442.256**
4) DOMESTIC AND COMMERCIAL	107.107	1.329						19.734					93	23.195		862			152.320

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*	*7,513*	*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*	*6,170*	
USES																			
TOTAL (1+2+3+4)	**249.414**	**1.524**	**13.892**		**73**			**35.431**	**2.016**		**111.385**	**38.397**	**103**	**291.689**	**5.105**	**13.602**	**22.991**	**3.208**	**788.830**
5) NON ENERGY USE (b)																			
I - Chemical industry																			
II - Petrochemical									7.836	41.943	3.381		3.481	9.670	1.803	2.626		154	70.894
III - Agriculture						111													111
IV - Other sectors						918												20.578	21.496
Sub-Total						**1.029**			**7.836**	**41.943**	**3.381**		**3.481**	**9.670**	**1.803**	**2.626**		**20.732**	**92.501**
TOTAL (1+2+3+4+5)	**249.414**	**1.524**	**13.892**		**73**	**1.029**		**35.431**	**9.852**	**41.943**	**114.766**	**38.397**	**3.584**	**301.359**	**6.908**	**16.228**	**22.991**	**23.940**	**881.331**

Table A5.9 -National Energy Balance, year 2009, 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						173							999	
II- Fishing														
Sub-Total	**0**	**0**	**0**	**0**	**0**	**173**	**0**	**0**	**0**	**0**			**999**	
2) INDUSTRY														
I- Iron and steel industry		1.025	73			1.617								
II- Other industry	0	691	69	7		12.854	0		0	0		0	1.498	
a) Mining industry						45								
b) Non-Ferrous Metals			6			435								
c) Metal works factories						2.080								
d) Food Processing, Beverages						1.720								
e) Textile and clothing						850								
f) Construction industries (cement, bricks)		691	60	7		711							1.498	
g) Glass and pottery						2.140								
h) Chemical			3			2.541								
i) Petrochemical						0								
l) Pulp, paper and print						1.756								
m) Other industries						576								
n) Building and civil works														
Sub-Total	**0**	**1.716**	**142**	**7**	**0**	**14.471**	**0**	**0**	**0**	**0**		**0**	**1.498**	
3) SERVICES														
I - Railways														

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	
II - Navigation														
III - Road transportation						734							(b) 1.190	
IV - Civil aviation														
V - Other transportation														
VI - Public Service														
Sub-Total	**0**	**0**	**0**	**0**		**734**	**0**	**0**	**0**	**0**			**1.190**	
4) DOMESTIC AND COMMERCIAL USES			6			31.597							(b) 7.493	
TOTAL (1+2+3+4)	**0**	**1.716**	**148**	**7**		**46.975**	**0**	**0**	**0**	**0**			**11.180**	
5) NON ENERGY USE (a)														
I - Chemical industry														
II - Petrochemical						692								
III - Agriculture														
IV - Other sectors														
Sub-Total	**0**	**0**	**0**	**0**		**692**	**0**	**0**	**0**	**0**			**-**	
TOTAL (1+2+3+4+5)	**0**	**1.716**	**148**	**7**		**47.667**	**0**	**0**	**0**	**0**			**11.180**	

(a) - Non energy uses of energetic sources

(b) - Biodiesel for road transport and for domestic and commercial uses

Table A5.10 -National Energy Balance, year 2009, 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	5.650							58			10			2.065					
II- Fishing								2			1			219					
Sub-Total	**5.650**	**0**	**0**	**0**	**0**		**0**	**60**	**0**	**0**	**11**	**0**	**0**	**2.284**	**0**	**0**	**0**	**0**	
2) INDUSTRY																			
I- Iron and steel industry	15.731		1.832		81			18						6	66	40	1		
II- Other industry	98.594	26	17	0	0	0	0	250	168	0	26	12	1	330	455	1.260	2.769	520	
a) Mining industry	956							2						16	14	1			
b) Non-Ferrous Metals	5.053		2					13						5	35	0			
c) Metal works factories	22.736							55			26	12	1	111	108	151			
d) Food Processing, Beverages	12.558	20						30						40	145	244			
e) Textile and clothing	6.560							12						34	1	97			
f) Construction industries (cement, bricks)	7.066		10					60						33	54	38	2.760	520	
g) Glass and pottery	4.648							50						12	0	180			
h) Chemical	19.753	6	2					3						16	0	104	9		
i) Petrochemical	1.669							12	168					0	40	295			
l) Pulp, paper and	9.376							6						16	0	112			

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	
print																			
m) Other industries	6.411		3					6						12	58	38			
n) Building and civil works	1.808							1						35					
Sub-Total	**114.325**	**26**	**1.849**	**0**	**81**	**0**	**0**	**268**	**168**	**0**	**26**	**12**	**1**	**336**	**521**	**1.300**	**2.770**	**520**	
3) SERVICES																			
I - Railways	5.504													60					
II - Navigation	41													219					
III - Road transportation	4.795							1.096			(b) 10.536		23.184						
IV - Civil aviation	196										17	3.572							
V - Other transportation	23.766																		
VI - Public Service	11.196							(a) 3			18	108		(a) 240					
Sub-Total	**45.498**	**0**	**0**	**0**	**0**	**0**	**0**	**1.099**	**0**	**0**	**10.571**	**3.680**	**0**	**23.703**	**0**	**0**	**0**	**0**	
4) DOMESTIC AND COMMERCIAL USES	124.543	177						1.794					9	2.274		88			
TOTAL (1+2+3+4)	**290.016**	**203**	**1.849**	**0**	**81**	**0**	**0**	**3.221**	**168**	**0**	**10.608**	**3.692**	**10**	**28.597**	**521**	**1.388**	**2.770**	**520**	
5) NON ENERGY USE																			
I - Chemical industry																			
II - Petrochemical									653	4.033	322	0	338	948	184	268	0	25	

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	
III - Agriculture						15													
IV - Other sectors						124												3.335	
Sub-Total	**-**	**0**	**0**	**0**	**0**	**139**	**0**	**0**	**653**	**4.033**	**322**	**0**	**338**	**948**	**184**	**268**	**0**	**3.360**	
TOTAL (1+2+3+4+5)	**290.016**	**203**	**1.849**	**0**	**81**	**139**	**0**	**3.221**	**821**	**4.033**	**10.930**	**3.692**	**348**	**29.545**	**705**	**1.656**	**2.770**	**3.880**	

(c) 48 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 factors did imply a methodological revision to estimate the average national EF. Additionally the new 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 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 2010 submission the average emission factor for the 2008 has been updated. As shown in the table, the ranges of national EFs are within the lower and upper threshold of the IPCC 2006 guidelines.

	$t\ CO_2$ / TJ (stechiometric)	$t\ CO_2$ / TJ	$t\ CO_2 / 10^3$ std cubic mt	$t\ CO_2$ / 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	56.048	55.768	1.958	2.333
Natural gas, 2009, with 8190 lhv	57.415	57.128	1.958	2.390

Source: ISPRA elaborations

Table A6.1 Natural gas carbon emission factors

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 data is published yearly by Terna. Operator's data are used to verify the calculation results. Weighted average lhv of the imported / produced natural gas in 2008 is 8362 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 consider 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 have no influence if the EF is referred to cubic meters. The total amount of carbon emitted by

natural gas in Italy in 2008 and 2009 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, national production

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 of the European Environment Agency (EEA, 2010).
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.

	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 2000-2009	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 2000-2009	73.153	3.138	3.061
Gas oil, heating, experimental averages 2000-2009	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	64.350	3.000	2.692
LPG, experimental averages	64.936	2.994	2.717

Source: ISPRA elaborations

Table A6.2 Fuels, national production, carbon emission factors, with oxidation factor equal to 0.99

A6.3 Fuel oil, imported and produced

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.

	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

Source: ISPRA elaborations

Table A6.3 Fuel oil, average of national and imported products, carbon emission factors

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 imports

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 2009 in Table A6.4.

Country	Coking coal	Coke	Steam coal	Lignite	Other	Total Coal	Pet-Coke
BULGARIA	26,107	0	0	0	0	26,107	0
CYPRUS	0	0	327,846	0	0	327,846	0
FRANCE	0	49	0	71	256	376	0
GERMANY	0	0	191	7,035	256	7,482	0
LITHUANIA	0	0	0	0	3,156	3,156	0
SPAIN	0	0	1,116,929	0	0	1,116,929	14,126
TOTAL EU	**26,107**	**49**	**1,444,966**	**7,106**	**3,668**	**1,481,896**	**14,126**
ARGENTINA	0	0	0	0	0	0	41,988
AUSTRALIA	733,271	0	305,511	0	0	1,038,782	0
CANADA	422,656	0	0	0	0	422,656	0
COLOMBIA	0	0	2,305,449	0	0	2,305,449	0
GEORGIA	0	0	20,047	0	0	20,047	0
INDONESIA	0	0	6,555,143	0	0	6,555,143	0
RUSSIA	45,601	0	848,151	0	24,083	917,835	0
SOUTH AFRICA	0	0	4,053,731	0	0	4,053,731	0
UCRAINA	0	0	347,281	0	60,847	408,128	0
Former SOVIET UNION	0	0	0	0	10,285	10,285	0
U.S.A.	1,921,765	1	199,711	0	0	2,121,477	1,671,384
VENEZUELA	0	0	110,112	0	0	110,112	151,708
TOTAL NON-EU	**3,123,293**	**1**	**14,745,136**	**0**	**95,215**	**17,963,645**	**1,865,080**
TOTAL	**3,149,400**	**50**	**16,190,102**	**7,106**	**98,883**	**19,445,541**	**1,879,206**

Source: MSE, several years [b]

Table A6.4 – Coal imported by country in 2009 (Mg)

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 the table A6.5 updated coal EF 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".

In 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 emission trading scheme has been carried out. In consideration that these data refer 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 for the years 2005-2009. The resulting figures are lower than the previous estimates calculated on the basis of carbon content of coal imports.

	t CO2 / TJ (stechiometric)	t CO2 / TJ (with oxidation factor 0.98)	t CO2 / t	t CO2 / toe
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

Source: ISPRA elaborations

Table A6.5 – Coal, average carbon emission factors

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)

Following suggestions from the UNFCCC ERT 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 (UNFCCC, 2009). Information on the equations used for estimating the different net energy (NE_m, NE_g, etc.) is described in IPCC Good Practice (IPCC, 2000).

	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	0.10	33.52	0.00	3.97	0.51	0.31	**235.77**
1991	40.75	0.35	0.10	37.71	0.00	3.96	0.51	0.31	**248.30**
1992	40.75	0.35	0.10	40.42	0.00	3.91	0.51	0.31	**256.30**
1993	40.75	0.35	0.10	40.25	0.00	3.89	0.51	0.31	**255.70**
1994	40.75	0.35	0.10	42.53	0.00	3.92	0.51	0.31	**262.63**
1995	40.75	0.35	0.10	43.38	0.00	3.86	0.51	0.31	**264.99**
1996	40.75	0.35	0.10	44.66	0.00	3.86	0.51	0.31	**268.84**
1997	40.75	0.35	0.10	45.46	0.00	3.85	0.51	0.31	**271.18**
1998	40.75	0.35	0.10	45.25	0.00	3.79	0.51	0.31	**270.40**
1999	40.75	0.35	0.10	45.17	0.00	3.75	0.51	0.31	**270.00**
2000	40.75	0.35	0.10	44.31	0.00	3.78	0.51	0.31	**267.52**
2001	40.75	0.35	0.10	43.74	0.00	3.73	0.51	0.31	**265.67**
2002	40.75	0.35	0.10	47.60	0.00	3.72	0.51	0.31	**277.19**
2003	40.75	0.35	0.10	47.57	0.00	3.72	0.51	0.31	**277.10**
2004	40.75	0.35	0.10	49.68	0.00	3.66	0.51	0.31	**283.26**
2005	40.75	0.35	0.10	50.84	0.00	3.71	0.51	0.31	**286.88**
2006	40.75	0.35	0.10	51.17	0.00	3.67	0.51	0.31	**287.76**
2007	40.75	0.35	0.10	51.15	0.00	3.65	0.51	0.31	**287.62**
2008	40.75	0.35	0.10	52.43	0.00	3.65	0.51	0.31	**291.48**
2009	40.75	0.35	0.10	51.00	0.00	3.67	0.51	0.31	**287.24**

Source: ISPRA elaborations

Table A.7.1 Parameters used for the Tier 2 approach - dairy cattle

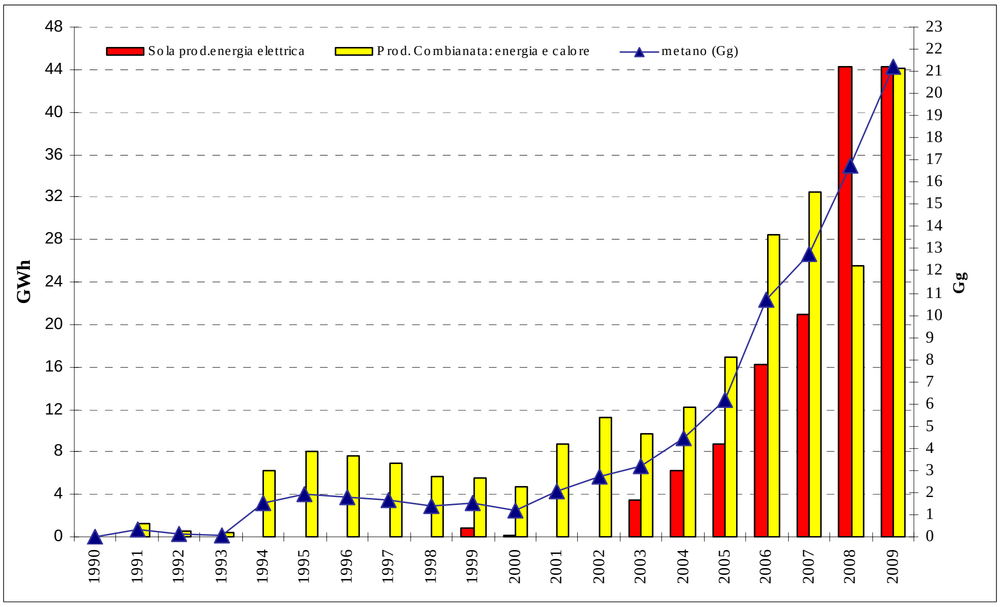
A7.2 Manure management (4B)

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, 2011). 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/TG. A representation of the time series is presented in the following Table A.7.2 and Figure A.7.1.

Year	**BIOGAS** Only for electricity production (GWh)	Combined: For electricity +heat production (GWh)	**TOTAL** Gross production (GWh)	**Methane (Gg)**
1990	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**

Source: ISPRA elaboration on TERNA data

Table A.7.2 Time series of gross production of biogas from animal manure



Source: adapted from Cóndor et al. 2008

Figure A7.1 Time series of gross production of biogas from animal manure

A7.3 Agricultural soils (4D)

In this section parameters used for estimating direct and indirect N_2O emissions from sewage sludge applied to soils are presented.

Year	Total amount sewage sludge for agriculture (t dry matter)	N content (%)	N sewage sludge (t)
1990	98.164	5.0	4,875
1991	102.840	5.0	5,107
1992	94.675	5.0	4,702
1993	90.039	5.0	4,472
1994	127.505	5.0	6,332
1995	157.512	5.0	7,823
1996	174.505	5.0	8,667
1997	217.747	5.0	10,814
1998	194.314	5.3	10,292
1999	215.024	4.0	8,706
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

Source: ISPRA elaboration from MATTM (2010)

Figure A7.3 Time series of sewage sludge activity data

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 2009, submitted in 2011, 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 2009 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

Inventory 2009 Submission 2011 v1.2

CO_2

(Part 1 of 2)

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	**405.318,37**	**404.844,89**	**403.899,86**	**400.559,80**	**394.483,05**	**418.017,59**	**413.995,55**	**418.069,70**	**429.353,65**	**434.738,14**
A. Fuel Combustion (Sectoral Approach)	401.974,82	401.577,77	400.685,54	397.177,43	391.254,39	414.840,01	410.958,07	414.824,05	426.232,93	432.331,21
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	86.479,86	83.759,99	82.236,54	82.756,34	83.924,12	86.023,25	84.125,85	86.956,96	80.648,13	82.680,98
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	76.676,86	82.248,15	78.809,30	78.491,90	69.314,51	76.090,33	77.936,90	75.254,68	78.337,61	82.959,85
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	3.343,55	3.267,12	3.214,31	3.382,37	3.228,66	3.177,58	3.037,47	3.245,66	3.120,72	2.406,93
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2. Oil and Natural Gas	3.343,55	3.267,12	3.214,31	3.382,37	3.228,66	3.177,58	3.037,47	3.245,66	3.120,72	2.406,93
2. Industrial Processes	**28.396,70**	**27.952,28**	**28.500,37**	**25.239,40**	**24.162,58**	**25.995,34**	**23.449,24**	**23.573,12**	**23.599,05**	**23.728,65**
A. Mineral Products	21.265,07	21.217,10	22.028,62	19.572,71	19.079,17	20.933,49	19.241,19	19.485,80	19.741,04	20.549,22
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	1.642,80	1.628,14	1.629,14	1.577,88	1.504,86	1.463,35	1.405,30	1.416,58	1.332,27	1.336,49
4. Agriculture										

TABLE 10 EMISSION TRENDS

CO_2

(Part 1 of 2)

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)
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)	**-62.077,34**	**-76.309,79**	**-75.562,07**	**-58.838,30**	**-75.505,73**	**-79.962,66**	**-88.197,78**	**-75.178,09**	**-73.189,79**	**-79.488,21**
A. Forest Land	-41.700,85	-58.823,30	-57.114,05	-42.774,56	-57.390,39	-61.755,91	-61.205,09	-50.633,95	-48.722,63	-55.960,49
B. Cropland	-18.948,73	-14.769,75	-16.159,12	-15.277,57	-15.491,33	-14.436,35	-15.820,50	-14.090,88	-14.650,05	-12.452,64
C. Grassland	-3.954,11	-5.237,44	-4.810,89	-3.308,20	-5.147,31	-6.295,37	-13.661,38	-12.944,36	-12.309,95	-13.570,27
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	2.526,35	2.520,70	2.521,99	2.522,03	2.523,31	2.524,97	2.489,18	2.491,11	2.492,84	2.495,18
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	**536,90**	**562,22**	**562,44**	**521,18**	**524,10**	**483,02**	**472,13**	**507,76**	**504,42**	**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	536,90	562,22	562,44	521,18	524,10	483,02	472,13	507,76	504,42	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**

TABLE 10 EMISSION TRENDS

CO_2

(Part 1 of 2)

Inventory 2009
Submission 2011 v1.2
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)
Total CO_2 emissions including net CO_2 from LULUCF	**373.817,42**	**358.677,73**	**359.029,72**	**369.059,95**	**345.168,85**	**365.996,63**	**351.124,44**	**368.389,07**	**381.599,60**	**380.708,53**
Total CO_2 emissions excluding net CO_2 from LULUCF	**435.894,77**	**434.987,52**	**434.591,79**	**427.898,25**	**420.674,58**	**445.959,30**	**439.322,22**	**443.567,16**	**454.789,39**	**460.196,74**
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	5.243,86	5.962,78	6.286,98	6.209,51	7.215,92	7.076,58	7.063,49	7.702,89	7.574,50	8.899,16

Table A8.1.1.2 CO_2 emissions trends, CRF year 2009 (years 2000 – 2009)

TABLE 10 EMISSION TRENDS

CO_2

(Part 2 of 2)

Inventory 2009
Submission
2011 v1.2

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**437.683,71**	**442.800,45**	**445.105,45**	**459.799,16**	**461.848,16**	**461.495,38**	**456.746,57**	**447.051,46**	**439.473,15**	**395.789,48**	**-2,35**
A. Fuel Combustion (Sectoral Approach)	435.095,88	440.357,64	442.840,53	456.959,46	459.693,91	459.378,44	454.552,91	444.870,69	437.208,82	393.619,38	-2,08
1. Energy Industries	151.893,98	154.498,04	161.400,59	161.982,20	159.962,44	160.133,46	161.509,95	161.139,98	157.278,47	132.368,27	-3,03
2. Manufacturing Industries and Construction	83.698,84	81.954,63	78.206,02	83.596,04	84.477,90	80.392,39	78.958,40	75.730,87	72.784,78	56.432,54	-34,74
3. Transport	120.100,81	122.177,89	124.138,07	125.097,18	127.081,10	125.824,54	127.145,29	127.209,38	122.251,97	117.873,47	16,40
4. Other Sectors	78.596,14	81.373,15	78.782,28	85.623,88	87.081,49	91.830,36	85.957,65	79.894,26	84.155,82	86.100,76	12,29
5. Other	806,10	353,94	313,56	660,15	1.090,98	1.197,69	981,61	896,19	737,77	844,34	-19,31
B. Fugitive Emissions from Fuels	2.587,83	2.442,81	2.264,92	2.839,69	2.154,25	2.116,94	2.193,67	2.180,77	2.264,33	2.170,10	-35,10
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
2. Oil and Natural Gas	2.587,83	2.442,81	2.264,92	2.839,69	2.154,25	2.116,94	2.193,67	2.180,77	2.264,33	2.170,10	-35,10
2. Industrial Processes	**24.508,58**	**25.309,67**	**25.286,60**	**26.389,89**	**27.218,57**	**27.063,50**	**27.081,51**	**27.618,14**	**25.010,40**	**19.982,44**	**-29,63**
A. Mineral Products	21.393,00	22.247,37	22.298,88	23.158,16	23.710,01	23.357,91	23.412,29	23.934,38	21.646,85	17.497,98	-17,71
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	-63,81
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	-66,30
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
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	0,00
3. Solvent and Other Product Use	1.275,92	1.286,13	1.290,29	1.295,50	1.299,51	1.315,43	1.332,55	1.316,24	1.270,83	1.190,58	-27,53
4. Agriculture											

TABLE 10 EMISSION TRENDS
CO_2
(Part 2 of 2)

Inventory 2009
Submission 2011 v1.2

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
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)	**-78.984,29**	**-86.970,90**	**-92.865,98**	**-83.690,10**	**-88.013,40**	**-90.584,83**	**-96.998,23**	**-73.527,01**	**-92.878,70**	**-94.731,45**	**52,60**
A. Forest Land	-54.421,54	-62.527,07	-67.628,47	-59.125,32	-65.373,26	-66.659,53	-67.150,67	-45.816,80	-63.019,48	-66.429,83	59,30
B. Cropland	-14.116,39	-13.629,93	-14.088,59	-13.743,45	-11.451,21	-12.611,44	-12.820,76	-13.151,53	-12.928,38	-12.299,41	-35,09
C. Grassland	-12.943,76	-14.171,00	-14.514,02	-14.193,94	-14.569,61	-14.702,82	-20.430,49	-17.975,96	-20.390,56	-19.518,02	393,61
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
E. Settlements	2.497,40	3.357,10	3.365,11	3.372,60	3.380,67	3.388,96	3.403,69	3.417,28	3.459,72	3.515,81	39,17
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
6. Waste	**201,57**	**222,26**	**244,97**	**215,76**	**199,23**	**244,69**	**267,49**	**240,20**	**249,88**	**249,90**	**-53,46**
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	0,00
B. Waste-water Handling											
C. Waste Incineration	201,57	222,26	244,97	215,76	199,23	244,69	267,49	240,20	249,88	249,90	-53,46
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00

TABLE 10 EMISSION TRENDS

CO_2

(Part 2 of 2)

Inventory 2009
Submission
2011 v1.2

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0,00**
Total CO_2 emissions including net CO_2 from LULUCF	**384.685,49**	**382.647,61**	**379.061,33**	**404.010,20**	**402.552,06**	**399.534,16**	**388.429,91**	**402.699,03**	**373.125,56**	**322.480,95**	**-13,73**
Total CO_2 emissions excluding net CO_2 from LULUCF	**463.669,78**	**469.618,50**	**471.927,30**	**487.700,31**	**490.565,47**	**490.118,99**	**485.428,13**	**476.226,04**	**466.004,25**	**417.212,41**	**-4,29**
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**	**89,78**
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	115,54
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	65,35
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
CO_2 Emissions from Biomass	9.384,36	10.345,58	9.984,85	12.045,57	14.453,09	14.081,40	15.059,44	17.222,51	20.001,52	22.637,02	331,69

Table A8.1.2.1 CH_4 emission trends, CRF year 2009 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

CH_4

(Part 1 of 2)

Inventory 2009
Submission 2011 v1.2

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	418,84	419,94	424,99	419,59	410,83	399,92	392,12	390,96	394,05	383,44
A. Fuel Combustion (Sectoral Approach)	65,52	68,56	71,19	71,31	71,58	72,21	69,69	70,24	69,16	67,97
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	34,52	36,44	38,96	40,35	38,85	38,32	36,79	35,22	34,32	31,43
4. Other Sectors	14,73	16,33	16,95	15,98	17,54	18,01	17,82	19,56	19,72	22,04
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	353,33	351,38	353,80	348,28	339,25	327,71	322,44	320,72	324,89	315,47
1. Solid Fuels	5,79	5,33	5,31	3,90	3,39	3,07	2,88	2,85	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	322,26	312,95
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	**819,80**	**829,39**	**807,99**	**805,18**	**807,07**	**820,15**	**821,62**	**823,14**	**816,91**	**823,22**

TABLE 10 EMISSION TRENDS

CH_4

(Part 1 of 2)

Inventory 2009
Submission 2011 v1.2
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)
A. Enteric Fermentation	579,93	592,81	574,81	568,74	573,87	584,15	586,80	589,39	585,33	591,84
B. Manure Management	164,86	164,82	158,67	158,32	153,34	156,48	156,90	156,26	157,94	159,48
C. Rice Cultivation	74,39	71,09	73,86	77,48	79,22	78,90	77,27	76,91	72,99	71,27
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	0,68	0,66	0,64	0,64	0,62	0,64	0,57	0,64	0,62
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**6,96**	**2,13**	**3,16**	**8,01**	**3,33**	**1,50**	**1,43**	**4,44**	**5,10**	**2,83**
A. Forest Land	6,96	2,13	3,16	8,01	3,33	1,50	1,43	4,44	5,10	2,83
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
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	**828,79**	**881,83**	**831,23**	**830,01**	**855,16**	**876,11**	**913,33**	**940,50**	**940,71**	**955,23**
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	7,65	14,78	11,61	12,61	11,81	12,91	10,89	13,24	11,76	14,38
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**

TABLE 10 EMISSION TRENDS

CH_4

(Part 1 of 2)

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)
Total CH_4 emissions including CH_4 from LULUCF	**2.079,55**	**2.138,24**	**2.072,20**	**2.067,65**	**2.081,45**	**2.103,03**	**2.131,50**	**2.162,26**	**2.159,87**	**2.167,76**
Total CH_4 emissions excluding CH_4 from LULUCF	**2.072,59**	**2.136,11**	**2.069,04**	**2.059,64**	**2.078,12**	**2.101,53**	**2.130,07**	**2.157,82**	**2.154,77**	**2.164,93**
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 2009 (years 2000 – 2009)

TABLE 10 EMISSION TRENDS

CH_4

(Part 2 of 2)

Inventory 2009
Submission 2011
v1.2

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	370,05	351,31	345,18	338,97	332,40	328,96	303,22	300,84	303,82	297,51	-28,97
A. Fuel Combustion (Sectoral Approach)	64,16	62,33	57,75	57,84	59,36	57,07	57,71	62,11	62,23	61,78	-5,70
1. Energy Industries	6,85	5,95	5,92	6,14	6,21	6,34	6,17	5,72	5,65	5,15	-44,40
2. Manufacturing Industries and Construction	5,72	5,79	5,69	5,83	5,76	6,28	6,24	6,53	6,25	4,18	-38,75
3. Transport	28,65	26,69	24,86	22,90	20,72	18,76	17,73	16,71	15,64	14,98	-56,61
4. Other Sectors	22,81	23,82	21,21	22,87	26,53	25,53	27,45	33,04	34,63	37,40	153,88
5. Other	0,13	0,09	0,07	0,10	0,14	0,16	0,13	0,11	0,07	0,07	-57,82
B. Fugitive Emissions from Fuels	305,89	288,98	287,44	281,13	273,05	271,90	245,51	238,73	241,59	235,73	-33,28
1. Solid Fuels	3,48	3,85	3,72	4,50	3,05	3,27	2,56	4,00	3,45	2,12	-63,33
2. Oil and Natural Gas	302,41	285,13	283,72	276,62	270,00	268,62	242,94	234,73	238,13	233,60	-32,78
2. Industrial Processes	**3,01**	**2,83**	**2,71**	**2,77**	**2,91**	**3,06**	**3,14**	**3,08**	**2,91**	**1,86**	**-63,90**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
B. Chemical Industry	0,40	0,33	0,33	0,31	0,33	0,33	0,32	0,34	0,30	0,28	-88,60
C. Metal Production	2,61	2,50	2,38	2,46	2,58	2,72	2,81	2,75	2,61	1,58	-41,55
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	0,00
3. Solvent and Other Product Use											

TABLE 10 EMISSION TRENDS
CH_4
(Part 2 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
4. Agriculture	**801,77**	**765,53**	**748,91**	**751,65**	**739,75**	**736,90**	**721,12**	**743,50**	**728,16**	**726,48**	**-11,38**
A. Enteric Fermentation	579,30	540,01	525,27	526,52	515,89	516,24	506,01	524,93	520,04	513,30	-11,49
B. Manure Management	156,10	159,19	155,42	154,89	150,14	149,93	144,20	145,43	140,99	137,41	-16,65
C. Rice Cultivation	65,80	65,80	67,63	69,69	73,05	70,11	70,32	72,52	66,48	75,17	1,06
D. Agricultural Soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
F. Field Burning of Agricultural Residues	0,58	0,53	0,60	0,55	0,67	0,62	0,60	0,61	0,65	0,60	-4,27
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
5. Land Use, Land-Use Change and Forestry	**4,02**	**2,64**	**1,47**	**3,08**	**1,82**	**1,83**	**1,46**	**9,37**	**2,20**	**2,61**	**-62,45**
A. Forest Land	4,02	2,64	1,47	3,08	1,82	1,83	1,46	9,37	2,20	2,61	-62,45
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
6. Waste	**998,92**	**999,72**	**978,24**	**936,36**	**889,24**	**882,79**	**851,29**	**819,77**	**779,66**	**750,20**	**-9,48**
A. Solid Waste Disposal on Land	874,15	869,64	844,96	800,29	746,31	738,78	707,20	675,89	636,40	606,73	-16,47
B. Waste-water Handling	112,73	116,97	120,53	123,05	126,55	129,67	130,40	130,77	129,62	129,67	36,84
C. Waste Incineration	11,94	12,98	12,59	12,85	16,20	14,14	13,47	12,89	13,43	13,59	77,76

TABLE 10 EMISSION TRENDS

CH_4

(Part 2 of 2)

Inventory 2009
Submission 2011
v1.2

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
D. Other	0,10	0,12	0,16	0,18	0,18	0,20	0,21	0,22	0,21	0,21	1.872,62
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0,00**
Total CH_4 emissions including CH_4 from LULUCF	**2.177,77**	**2.122,03**	**2.076,52**	**2.032,83**	**1.966,12**	**1.953,55**	**1.880,22**	**1.876,56**	**1.816,74**	**1.778,67**	**-14,47**
Total CH_4 emissions excluding CH_4 from LULUCF	**2.173,75**	**2.119,39**	**2.075,05**	**2.029,75**	**1.964,30**	**1.951,71**	**1.878,77**	**1.867,19**	**1.814,54**	**1.776,05**	**-14,31**
Memo Items:											
International Bunkers	0,51	0,58	0,65	0,74	0,80	0,83	0,88	0,87	0,93	0,81	73,59
Aviation	0,11	0,12	0,12	0,14	0,15	0,17	0,17	0,13	0,12	0,12	149,22
Marine	0,40	0,46	0,53	0,60	0,65	0,66	0,71	0,74	0,81	0,69	65,19
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
CO_2 Emissions from Biomass											

Table A8.1.3.1 N_2O emission trends, CRF year 2009 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS
N_2O
(Part 1 of 2)

Inventory 2009
Submission 2011 v1.2
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	**14,29**	**14,25**	**14,53**	**14,61**	**15,05**	**16,01**	**16,39**	**16,62**	**16,76**	**16,99**
A. Fuel Combustion (Sectoral Approach)	14,25	14,21	14,49	14,57	15,01	15,97	16,35	16,58	16,71	16,95
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	2,91	3,06	3,27	3,54	4,13	4,69	5,20	5,40	5,42	5,58
4. Other Sectors	4,52	4,44	4,53	4,78	4,66	4,88	4,94	4,89	4,99	5,13
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	**75,51**	**77,43**	**77,22**	**78,38**	**76,62**	**74,88**	**73,95**	**77,31**	**75,36**	**76,10**
A. Enteric Fermentation										
B. Manure Management	12,65	12,63	12,09	11,98	11,93	12,20	12,34	12,44	12,70	12,89

TABLE 10 EMISSION TRENDS

N_2O

(Part 1 of 2)

Inventory 2009
Submission 2011 v1.2
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)
C. Rice Cultivation										
D. Agricultural Soils	62,84	64,79	65,12	66,39	64,67	62,66	61,60	64,86	62,65	63,20
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
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**0,44**	**0,03**	**0,04**	**0,07**	**0,04**	**0,02**	**0,01**	**0,03**	**0,04**	**0,02**
A. Forest Land	0,05	0,01	0,02	0,06	0,02	0,01	0,01	0,03	0,04	0,02
B. Cropland	0,39	0,01	0,01	0,01	0,01	0,01	NO	NO	NO	NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
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	**6,19**	**6,47**	**6,32**	**6,20**	**6,18**	**6,16**	**6,25**	**6,29**	**6,40**	**6,64**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	5,91	5,98	5,92	5,78	5,79	5,74	5,89	5,86	6,02	6,18
C. Waste Incineration	0,28	0,49	0,40	0,42	0,40	0,42	0,36	0,43	0,39	0,45
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	**120,59**	**123,45**	**121,68**	**123,40**	**120,71**	**122,91**	**122,22**	**126,00**	**125,01**	**126,64**
Total N_2O emissions excluding N_2O from LULUCF	**120,15**	**123,42**	**121,64**	**123,34**	**120,67**	**122,89**	**122,21**	**125,97**	**124,98**	**126,62**

TABLE 10 EMISSION TRENDS
N_2O
(Part 1 of 2)

Inventory 2009
Submission 2011 v1.2
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)
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 2009 (years 2000 – 2009)

TABLE 10 EMISSION TRENDS

N_2O

(Part 2 of 2)

Inventory 2009
Submission 2011
v1.2

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**17,13**	**17,30**	**17,13**	**17,42**	**17,85**	**16,56**	**16,76**	**16,61**	**15,96**	**15,18**	**6,22**
A. Fuel Combustion (Sectoral Approach)	17,09	17,26	17,09	17,38	17,80	16,52	16,72	16,57	15,92	15,14	6,24
1. Energy Industries	1,67	1,75	1,82	1,84	1,91	1,90	1,89	1,87	1,85	1,65	-0,76
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	-19,27
3. Transport	5,50	5,44	5,32	5,06	5,00	3,66	3,94	3,89	3,57	3,45	18,49
4. Other Sectors	5,11	5,30	5,15	5,42	5,59	5,64	5,60	5,60	5,66	5,82	28,77
5. Other	0,14	0,03	0,02	0,13	0,28	0,29	0,24	0,23	0,20	0,24	6,09
B. Fugitive Emissions from Fuels	0,04	0,04	0,04	0,04	0,04	0,05	0,04	0,04	0,04	0,04	-3,72
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
2. Oil and Natural Gas	0,04	0,04	0,04	0,04	0,04	0,05	0,04	0,04	0,04	0,04	-3,72
2. Industrial Processes	**25,54**	**26,55**	**25,49**	**24,38**	**27,24**	**25,03**	**8,54**	**6,10**	**3,44**	**3,64**	**-83,08**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
B. Chemical Industry	25,54	26,55	25,49	24,38	27,24	25,03	8,54	6,10	3,44	3,64	-83,08
C. Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
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	0,00
3. Solvent and Other Product Use	3,31	3,00	3,00	2,81	2,73	2,66	2,61	2,54	2,35	2,16	-17,39
4. Agriculture	**74,86**	**74,30**	**73,15**	**72,49**	**72,34**	**70,37**	**69,52**	**69,99**	**66,64**	**62,02**	**-17,87**

TABLE 10 EMISSION TRENDS
N_2O
(Part 2 of 2)

Inventory 2009
Submission 2011
v1.2

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
A. Enteric Fermentation											
B. Manure Management	12,46	12,91	12,42	12,33	11,98	11,96	11,61	12,19	12,18	12,14	-4,06
C. Rice Cultivation											
D. Agricultural Soils	62,39	61,38	60,72	60,15	60,34	58,39	57,89	57,79	54,45	49,87	-20,65
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
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	-0,44
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
5. Land Use, Land-Use Change and Forestry	**0,03**	**0,02**	**0,01**	**0,02**	**0,01**	**0,01**	**0,01**	**0,06**	**0,02**	**0,02**	**-95,90**
A. Forest Land	0,03	0,02	0,01	0,02	0,01	0,01	0,01	0,06	0,02	0,02	-62,45
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	-100,00
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
6. Waste	**6,57**	**6,44**	**6,43**	**6,41**	**6,63**	**6,57**	**6,55**	**6,57**	**6,74**	**6,74**	**8,86**
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	6,34	7,23
C. Waste Incineration	0,36	0,39	0,38	0,38	0,47	0,42	0,40	0,38	0,40	0,41	42,80
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0,00**

TABLE 10 EMISSION TRENDS

N_2O

(Part 2 of 2)

Inventory 2009
Submission 2011
v1.2

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Total N_2O emissions including N_2O from LULUCF	**127,44**	**127,61**	**125,20**	**123,52**	**126,78**	**121,20**	**103,99**	**101,88**	**95,14**	**89,77**	**-25,56**
Total N_2O emissions excluding N_2O from LULUCF	**127,41**	**127,60**	**125,19**	**123,50**	**126,77**	**121,19**	**103,98**	**101,81**	**95,13**	**89,75**	**-25,30**
Memo Items:											
International Bunkers	**0,35**	**0,36**	**0,35**	**0,37**	**0,38**	**0,39**	**0,41**	**0,44**	**0,45**	**0,41**	**75,10**
Aviation	0,25	0,24	0,21	0,21	0,21	0,21	0,22	0,24	0,24	0,22	84,36
Marine	0,11	0,12	0,14	0,16	0,17	0,18	0,19	0,20	0,21	0,18	65,19
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
CO_2 Emissions from Biomass											

Table A8.1.4.1 HFC, PFC and SF_6 emission trends, CRF year 2009 (1990 – 1999)

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 1 of 2)

Inventory 2009
Submission 2011 v1.2
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**	**671,29**	**450,33**	**755,74**	**1.181,72**	**1.523,65**
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	0,02	0,05
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	0,01	0,04	0,05	0,08
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	0,68	0,85
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	0,01	0,02	0,03	0,03
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)	**1.807,65**	**1.451,54**	**849,56**	**707,47**	**476,84**	**490,80**	**243,39**	**252,08**	**270,43**	**258,00**
CF_4	0,21	0,17	0,10	0,08	0,06	0,06	0,03	0,03	0,03	0,03
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

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 1 of 2)

Inventory 2009
Submission 2011 v1.2
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)
c-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
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 2009 (2000 – 2009)

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 2 of 2)

Inventory 2009
Submission 2011
v1.2

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Emissions of HFCs[(3)] - (Gg CO_2 equivalent)	**1.985,67**	**2.549,75**	**3.191,29**	**3.901,91**	**4.635,03**	**5.400,56**	**6.106,19**	**6.855,26**	**7.512,98**	**8.172,52**	**2.228,35**
HFC-23	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-91,40
HFC-32	0,08	0,12	0,17	0,23	0,29	0,36	0,43	0,49	0,55	0,60	100,00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-125	0,13	0,20	0,28	0,38	0,48	0,59	0,69	0,79	0,89	0,98	100,00
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-134a	1,01	1,19	1,31	1,50	1,67	1,83	1,96	2,14	2,26	2,40	100,00
HFC-152a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-143a	0,06	0,08	0,11	0,15	0,19	0,24	0,28	0,32	0,36	0,40	100,00
HFC-227ea	0,01	0,01	0,01	0,02	0,02	0,03	0,03	0,04	0,05	0,05	100,00
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
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	0,00
Emissions of PFCs[(3)] - (Gg CO_2 equivalent)	**345,37**	**450,68**	**423,27**	**497,00**	**347,52**	**353,94**	**283,67**	**287,10**	**200,59**	**217,81**	**-87,95**
CF_4	0,04	0,05	0,04	0,05	0,04	0,04	0,03	0,04	0,02	0,03	-87,97
C_2F_6	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,00	0,00	0,00	-92,26
C_3F_8	NA,NO	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00

TABLE 10 EMISSION TRENDS
HFCs, PFCs and SF_6
(Part 2 of 2)

Inventory 2009
Submission 2011
v1.2

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
c-C_4F_8	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
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	0,00
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**	**19,55**
SF_6	0,02	0,03	0,03	0,02	0,02	0,02	0,02	0,02	0,02	0,02	19,55

Table A8.1.5.1 Total emission trends, CRF year 2009 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS SUMMARY (Part 1 of 2)

Inventory 2009
Submission 2011 v1.2
ITALY

GREENHOUSE GAS EMISSIONS	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)
CO_2 emissions including net CO_2 from LULUCF	373.817,42	358.677,73	359.029,72	369.059,95	345.168,85	365.996,63	351.124,44	368.389,07	381.599,60	380.708,53
CO_2 emissions excluding net CO_2 from LULUCF	435.894,77	434.987,52	434.591,79	427.898,25	420.674,58	445.959,30	439.322,22	443.567,16	454.789,39	460.196,74
CH_4 emissions including CH_4 from LULUCF	43.670,65	44.903,02	43.516,15	43.420,61	43.710,45	44.163,56	44.761,44	45.407,46	45.357,36	45.522,94
CH_4 emissions excluding CH_4 from LULUCF	43.524,41	44.858,26	43.449,83	43.252,46	43.640,59	44.132,06	44.731,40	45.314,14	45.250,17	45.463,55
N_2O emissions including N_2O from LULUCF	37.381,94	38.270,45	37.720,19	38.255,32	37.420,27	38.103,11	37.888,09	39.059,71	38.754,33	39.257,69
N_2O emissions excluding N_2O from LULUCF	37.245,92	38.261,73	37.709,28	38.234,08	37.409,00	38.095,74	37.885,04	39.050,24	38.743,45	39.251,66
HFCs	351,00	355,43	358,78	355,42	481,90	671,29	450,33	755,74	1.181,72	1.523,65
PFCs	1.807,65	1.451,54	849,56	707,47	476,84	490,80	243,39	252,08	270,43	258,00
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)	**457.361,60**	**444.014,56**	**441.832,66**	**452.169,17**	**427.673,97**	**450.026,86**	**435.150,24**	**454.592,69**	**467.768,25**	**467.675,32**
Total (excluding LULUCF)	**519.156,67**	**520.270,88**	**517.317,51**	**510.818,07**	**503.098,57**	**529.950,65**	**523.314,94**	**529.667,99**	**540.839,97**	**547.098,12**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)
1. Energy	418.544,70	418.079,85	417.327,74	413.901,35	407.776,02	431.380,14	427.311,56	431.433,16	442.823,27	448.058,17
2. Industrial Processes	37.673,04	37.290,46	36.712,22	33.487,14	31.954,73	35.110,72	31.913,32	32.440,11	32.869,66	33.281,66
3. Solvent and Other Product Use	2.455,02	2.393,84	2.392,69	2.351,69	2.267,92	2.234,94	2.321,81	2.333,28	2.386,93	2.369,79
4. Agriculture	40.622,55	41.419,85	40.907,11	41.205,38	40.700,97	40.435,25	40.179,19	41.252,87	40.516,13	40.877,73
5. Land Use, Land-Use Change and Forestry(5)	-61.795,08	-76.256,32	-75.484,84	-58.648,90	-75.424,60	-79.923,79	-88.164,69	-75.075,30	-73.071,72	-79.422,79
6. Waste	19.861,36	21.086,88	19.977,75	19.872,51	20.398,94	20.789,60	21.589,05	22.208,57	22.243,97	22.510,77
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)(5)	**457.361,60**	**444.014,56**	**441.832,66**	**452.169,17**	**427.673,97**	**450.026,86**	**435.150,24**	**454.592,69**	**467.768,25**	**467.675,32**

Table A8.1.5.2 Total emission trends, CRF year 2009 (years 2000 – 2009)

TABLE 10 EMISSION TRENDS SUMMARY (Part 2 of 2)

Inventory 2009
Submission 2011 v1.2
ITALY

GREENHOUSE GAS EMISSIONS	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change from base to latest reported year
	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	(%)
CO_2 emissions including net CO_2 from LULUCF	384.685,49	382.647,61	379.061,33	404.010,20	402.552,06	399.534,16	388.429,91	402.699,03	373.125,56	322.480,95	-13,73
CO_2 emissions excluding net CO_2 from LULUCF	463.669,78	469.618,50	471.927,30	487.700,31	490.565,47	490.118,99	485.428,13	476.226,04	466.004,25	417.212,41	-4,29
CH_4 emissions including CH_4 from LULUCF	45.733,25	44.562,69	43.606,88	42.689,47	41.288,57	41.024,46	39.484,72	39.407,77	38.151,63	37.351,97	-14,47
CH_4 emissions excluding CH_4 from LULUCF	45.648,74	44.507,24	43.575,95	42.624,70	41.250,30	40.985,94	39.454,10	39.211,02	38.105,44	37.297,06	-14,31
N_2O emissions including N_2O from LULUCF	39.505,92	39.560,44	38.813,40	38.292,59	39.303,02	37.572,16	32.236,36	31.581,95	29.494,79	27.827,34	-25,56
N_2O emissions excluding N_2O from LULUCF	39.497,34	39.554,82	38.810,26	38.286,01	39.299,13	37.568,25	32.233,26	31.561,99	29.490,10	27.821,77	-25,30
HFCs	1.985,67	2.549,75	3.191,29	3.901,91	4.635,03	5.400,56	6.106,19	6.855,26	7.512,98	8.172,52	2.228,35
PFCs	345,37	450,68	423,27	497,00	347,52	353,94	283,67	287,10	200,59	217,81	-87,95
SF_6	493,43	795,34	739,72	467,56	502,14	465,39	405,87	427,55	435,53	398,02	19,55
Total (including LULUCF)	**472.749,13**	**470.566,50**	**465.835,89**	**489.858,73**	**488.628,34**	**484.350,67**	**466.946,71**	**481.258,66**	**448.921,08**	**396.448,61**	**-13,32**
Total (excluding LULUCF)	**551.640,35**	**557.476,32**	**558.667,80**	**573.477,48**	**576.599,59**	**574.893,07**	**563.911,21**	**554.568,96**	**541.748,90**	**491.119,58**	**-5,40**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change from base to latest reported year
	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	(%)
1. Energy	450.764,03	455.540,11	457.663,98	472.317,60	474.361,68	473.538,38	468.310,67	458.519,07	450.802,25	406.743,19	-2,82
2. Industrial Processes	35.314,64	37.396,87	37.599,45	38.871,47	41.207,37	41.107,89	36.589,63	37.143,57	34.286,18	29.939,54	-20,53
3. Solvent and Other Product Use	2.302,43	2.217,38	2.219,27	2.168,11	2.144,38	2.138,88	2.140,88	2.104,25	1.998,10	1.861,59	-24,17
4. Agriculture	40.043,90	39.110,07	38.404,33	38.255,15	37.959,06	37.288,75	36.694,88	37.310,62	35.949,71	34.481,12	-15,12
5. Land Use, Land-Use Change and Forestry[(5)]	-78.891,21	-86.909,82	-92.831,91	-83.618,76	-87.971,25	-90.542,40	-96.964,50	-73.310,29	-92.827,82	-94.670,97	53,20
6. Waste	23.215,36	23.211,90	22.780,77	21.865,15	20.927,10	20.819,18	20.175,16	19.491,45	18.712,66	18.094,14	-8,90
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
Total (including LULUCF)[(5)]	**472.749,13**	**470.566,50**	**465.835,89**	**489.858,73**	**488.628,34**	**484.350,67**	**466.946,71**	**481.258,66**	**448.921,08**	**396.448,61**	**-13,32**

A8.2 Supplementary information under Article 7, paragraph 1

A8.2.1 KP-LULUCF

Table A8.2.1.1 Table NIR1. Summary Table

TABLE NIR 1. 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	R	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

Table NIR 2. LAND TRANSITION MATRIX

Areas and changes in areas between the previous and the current inventory year (1), (2), (3)

From previous inventory year / To current inventory		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	1,387.23	NO						1,387.23
	Deforestation		12.28						12.28
Article 3.4 activities	Forest Management (if elected)		0.72	7,450.57					7,451.29
	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)		77.89	0.00	0.00	0.00	0.00	0.00	21,204.92	21,282.81
Total area at the end of the current inventory year		1,465.12	13.00	7,450.57	0.00	0.00	0.00	21,204.92	30,133.60

Table A8.2.1.3 Table NIR2. Land Transition Matrix - 2009

Table NIR 2. LAND TRANSITION MATRIX

Areas and changes in areas between the previous and the current inventory year (1), (2), (3)

To current inventory / From previous inventory year		Article 3.3 activities		Article 3.4 activities				Other (5)	Total area at the beginning of the current inventory year(6)
		Afforestation and Reforestation	Deforestation	Forest Management (if elected)	Cropland Management (if elected)	Grazing Land Management (if elected)	Revegetation (if elected)		
		(kha)							
Article 3.3 activities	Afforestation and Reforestation	1,465.12	NO						1,465.12
	Deforestation		13.00						13.00
Article 3.4 activities	Forest Management (if elected)		0.72	7,450.57					7,451.29
	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)		78.48	0.00	0.00	0.00	0.00	0.00	21,125.71	21,204.19
Total area at the end of the current inventory year		1,543.60	13.72	7,450.57	0.00	0.00	0.00	21,125.71	30,133.60

Table A8.2.1.4 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	CO2	Forest land remaining forest land	Yes	no	no

Table A8.2.1.5 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 2011 v1.2

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				**-5,940.33**
A.1. Afforestation and Reforestation [(7)]	-6,346.52	0.78	0.01	-6,328.57
A.1.1. Units of land not harvested since the beginning of the commitment period	-6,346.52	0.78	0.01	-6,328.57
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA
A.2. Deforestation	388.24	NA	NA	388.24
B. Article 3.4 activities				**-51,120.26**
B.1. Forest Management (if elected)	-51,162.15	1.81	0.01	-51,120.26
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 A8.2.1.6 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 2011 v1.2

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				**-6,320.27**
A.1. Afforestation and Reforestation (7)	-6,730.54	0.78	0.01	-6,710.22
A.1.1. Units of land not harvested since the beginning of the commitment period	-6,730.54	0.78	0.01	-6,710.22
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA
A.2. Deforestation	389.95	NA	NA	389.95
B. Article 3.4 activities				**-48,451.18**
B.1. Forest Management (if elected)	-48,493.52	1.83	0.01	-48,451.18
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	2011
Reported year	2010
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	2,22E+09	NO	NO	7411755	NO	NO
Entity holding accounts	2,11E+08	NO	NO	20312441	NO	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	NO	NO	NO	NO	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	2,43E+09	NO	NO	27724196	NO	NO

Table A8.2.2.2.a Annual internal transactions

Party	Italy
Submission year	2011
Reported year	2010
Commitment period	1

Table 2 (a). Annual internal transactions

	Additions						Subtractions					
	Unit type						Unit type					
Transaction 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	NO	NO	NO
Sub-total		NO	NO				NO	NO	NO	NO	NO	NO

	Retirement					
	Unit type					
Transaction 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	2011
Reported year	2010
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												
CDM	NO	NO	NO	2765793	NO	NO	NO	NO	NO	NO	NO	NO
AT	3622958	2158	NO	NO	NO	NO	989500	NO	NO	40961	NO	NO
BE	1365001	NO	NO	25000	NO	NO	679673	NO	NO	NO	NO	NO
BG	2059694	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CZ	3834293	NO	NO	NO	NO	NO	668366	NO	NO	NO	NO	NO
DK	40456901	50000	NO	1348000	NO	NO	6249814	50000	NO	451000	NO	NO
EE	300000	NO	NO	NO	NO	NO	214000	NO	NO	NO	NO	NO
FI	NO	NO	NO	NO	NO	NO	266672	NO	NO	NO	NO	NO
FR	11274497	NO	NO	2235966	NO	NO	38672115	900000	NO	1337926	NO	NO
DE	1724558	8501	NO	1842631	NO	NO	11407182	NO	NO	43230	NO	NO
GR	501899	NO	NO	61000	NO	NO	293399	NO	NO	61000	NO	NO
HU	59500	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
IE	19800	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
JP	NO	NO	NO	NO	NO	NO	NO	NO	NO	999999	NO	NO
LV	NO	NO	NO	NO	NO	NO	10000	NO	NO	NO	NO	NO
LI	25143881	NO	NO	NO	NO	NO	7011461	NO	NO	NO	NO	NO
NL	35315377	NO	NO	347981	NO	NO	25509439	NO	NO	160804	NO	NO

	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	AAUs	ERUs	AAUs	ERUs	AAUs	ERUs	AAUs	ERUs	AAUs	ERUs
Transfers and acquisitions												
PL	1687202	NO	NO	NO	NO	NO	437202	NO	NO	NO	NO	NO
PT	394001	NO	NO	NO	NO	NO	3	NO	NO	NO	NO	NO
RO	7293004	NO	NO	NO	NO	NO	1099004	NO	NO	NO	NO	NO
SK	453004	NO	NO	NO	NO	NO	773887	NO	NO	100	NO	NO
SI	NO	NO	NO	1379	NO	NO	9179	NO	NO	NO	NO	NO
ES	8273560	NO	NO	4149520	NO	NO	2270438	NO	NO	1030000	NO	NO
SE	1585200	NO	NO	NO	NO	NO	834452	NO	NO	NO	NO	NO
CH	NO	200000	NO	418148	NO	NO	NO	100000	NO	323918	NO	NO
GB	37369888	1079347	NO	7448230	NO	NO	95382910	NO	NO	9044294	NO	NO
Sub-total	1,83E+08	1340006	NO	20643648	NO	NO	1,93E+08	1050000	NO	13493232	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)	1,83E+08	1340006	NO	20643648	NO	NO	1,93E+08	1050000	NO	13493232	NO	NO

Table A8.2.2.3 Expiry, cancellation and replacement

Party	Italy
Submission year	2011
Reported year	2010
Commitment period	1

Table 3. Expiry, cancellation and replacement

Transaction or event type	Expiry, cancellation and requirement to replace		Replacement					
	Unit type		Unit 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	2011
Reported year	2010
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	2,19E+09	287848	NO	15698709	NO	NO
Entity holding accounts	2,31E+08	2158	NO	19175903	NO	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	NO	NO	NO	NO	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	2,42E+09	290006	NO	34874612	NO	NO

Table A8.2.2.5.a Summary information on additions and subtractions

Party	Italy
Submission year	2011
Reported year	2010
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								
Sub-total	2,42E+09	NO		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)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	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	2,23E+08	1340006	NO	62712431	NO	NO	2,23E+08	1050000	NO	27837819	NO	NO
Total	2,64E+09	1340006	NO	62712431	NO	NO	2,23E+08	1050000	NO	27837819	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)	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	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	NO	NO	NO	NO	NO	NO

A8.2.3 National registry

A8.2.3.1 Changes to national registry

No relevant changes to the national registry have been made during 2010.

A8.2.3.2 Reports:

i) **list of discrepancies**
list of discrepancies is reported in the separate Annex to this document "SIAR Report 2010-Table R-2"

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 55 registered CDM projects where Italy is involved (as for 17/02/2011)

Title	Host Parties	Other Parties	Impacts assessment
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. Ltd., 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	-
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 (d)	**Italy**, 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, 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, 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 (c)	**Italy**, Switzerland	-
Landfill gas recovery and electricity generation at "Mtoni Dumpsite", Dar Es Salaam, Tanzania	United Republic of Tanzania (**)	**Italy**	-
Laizhou Diaolongzui Wind Farm	China (c)	**Italy**	-
Quezon City Controlled Disposal Facility Biogas Emission Reduction Project	Philippines (a)	Switzerland, **Italy**	-
Laguna de Bay Community Waste Management Project: Avoidance of methane production from biomass decay through composting -1	Philippines (a)	Canada, Netherlands, **Italy**, Denmark, Luxembourg, Belgium, Germany, Switzerland, Japan, Norway, Spain	-
Guyana Skeldon Bagasse Cogeneration Project	Guyana (c)	Canada, Netherlands, **Italy**, Denmark, Finland, Luxembourg, Belgium, Germany, Switzerland, Spain	-
Guizhou Zhenyuan Putian Hydropower Station	China (a)	**Italy**	-
Kunming Dongjiao Baishuitang LFG Treatment and Power Generation Project	China (c)	**Italy**	-
Shenyang Laohuchong LFG Power Generation Project	China (c)	**Italy**	-
Expansion Project of Huadian Inner Mongolia Huitengxile Wind Farm	China (c)	**Italy**	-
Moldova Soil Conservation Project	Republic of Moldova(**)(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, Luxembourg, Switzerland, Sweden, Belgium, Japan, Norway, Spain	-
Salta Landfill Gas Capture Project	Argentina (a)	Canada, Netherlands, **Italy**, Denmark, Luxembourg , Switzerland, Sweden, 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)	**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, Luxembourg, Sweden, Germany, Belgium, Japan, Norway, Spain	-

Uganda Nile Basin Reforestation Project No.3	Uganda (d)	**Italy,** Canada, Spain	-
NISCO Converter Gas Recovery and Utilization for Power Generation Project	China (c)	**Italy**	-
Assisted Natural Regeneration of Degraded Lands in Albania	Albania (d)	**Italy**	Cóndor et al. (2010)
Sichuan Mabian Yi Minority Autonomous County Yonglexi Hydropower Station	China (**)	**Italy**	
Yunnan Maguan Mihu River 3rd Level Hydropower Station	China (**)	**Italy**	
Jinping Maocaoping Hydropower Station	China (**)	**Italy**	
Xianggelila Huajiaopo Hydropower Station	China (**)	**Italy**	
Chongqing Wanzhou Xiangjiazui Hydropower Station	China (**)	**Italy**	
Landfill biogas extraction and combustion plant in El Inga I and II landfill (Quito, Ecuador)	Ecuador (**)	**Italy**	
Jinping Maguo River Hydropower Station	China (**)	**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 the 2010 submission; CDCF= Community Development Carbon Fund

ANNEX 9: METHODOLOGIES, DATA SOURCES AND EMISSION FACTORS

This appendix shows a copy of Tables I-1 - I-4 on methodologies, data sources and emission factors used for the Italian inventory communicated to the European Commission under the implementing provisions for the compilation of The European Community Inventory.

Table A9.1 Methods, activity data and emission factors used for the Italian Inventory

ANNEX I

Table for methodologies, data sources and emission factors used by Member States for EC key sources for the purpose of Article 4(1)(b). 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: Community 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	No				No			
Solid fuels	Yes	T3	NS, PS	CS	No				No			
Gaseous fuels	Yes	T3	NS, PS	CS	No				No			
Other fuels	Yes	T3	NS, PS	CS	No				No			
b. Petroleum Refining												
Liquid fuels	Yes	T3	NS, PS	CS	No				No			
Solid fuels	Yes	NA	NA	NA	No				No			
Gaseous fuels	Yes	T3	NS, PS	CS	No				No			
c. Manufacture of Solid Fuels and Other Energy Industries												
Solid fuels	Yes	T3	NS	CS	No				No			
Gaseous fuels	Yes	T3	NS	CS	No				No			
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	CS	No				No			
Solid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
b. Non-Ferrous Metals												
Solid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	No				No				No			
c. Chemicals												
Liquid fuels	Yes	T2	NS	CS	No				No			
Solid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
Other fuels	Yes	T2	NS	CS	No				No			
d. Pulp, Paper and Print												
Liquid fuels	Yes	T2	NS	CS	No				No			
Solid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
e. Food Processing, Beverages and Tobacco												
Liquid fuels	Yes	T2	NS	CS	No				No			
Solid fuels	Yes	NA	NA	NA	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
f. Other *(as specified in table 1.A(a)s2)*												
Liquid fuels	Yes	T2	NS	CS	No				No			
Solid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
Other fuels	Yes	NA	NA	NA	No				No			
3. Transport												
a. Civil Aviation												
Jet kerosene	Yes	T1, T2	NS	CS	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)
b. Road Transportation												
Gasoline	Yes	COPERT IV	NS, AS	CS	Yes	COPERT IV	NS, AS	CS	No			
Diesel oil	Yes	COPERT IV	NS, AS	CS	No				Yes	COPERT IV	NS, AS	CS
LPG	Yes	COPERT IV	NS, AS	CS	No				No			
Other fuels	No				No				No			
c. Railways												
Liquid fuels	Yes	D	NS	CS	No				No			
d. Navigation												
Gas/Diesel oil	Yes	T1, T2	NS	CS	No				No			
Residual Oil	Yes	T1, T2	NS	CS	No				No			
e. Other Transportation *(as specified in table 1.A(a)s3)*												
Gaseous Fuels	Yes	T2	NS	CS	No				No			
4. Other Sectors												
a. Commercial/Institutional												
Liquid fuels	Yes	T2	NS	CS	No				No			
Solid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
b. Residential												
Liquid fuels	Yes	T2	NS	CS	No				No			
Solid fuels	Yes	NA	NA	NA	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
Other fuels	Yes	T2	NS	CS	No				No			
c. Agriculture/Forestry /Fisheries												
Liquid fuels	Yes	T2	NS	CS	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)
Solid fuels	Yes	NA	NA	NA	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
5. Other												
a. Stationary												
Solid fuels	Yes	NA	NA	NA	No				No			
b. Mobile												
Liquid fuels	Yes	T2	NS	CS	No				No			
B. Fugitive Emissions from Fuels												
1. Solid Fuels												
a. Coal Mining	No				Yes	T1	NS	D, CS	No			
b. Solid Fuel Transformation	No				No				No			
c. Other *(as specified in table 1.B.1)*	No				No				No			
2. Oil and Natural Gas												
a. Oil	Yes	T1, T2	NS	D, CS	No				No			
b. Natural Gas	No				Yes	T1, T2	NS	D, CS	No			
c. Venting and Flaring	Yes	T2	NS	CS	No				No			
d. Other *(as specified in table 1.B.2)*	No				No				No			

Table I -2: Community 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	T1	NS	CS,PS	No				No															
3. Limestone and Dolomite Use	Yes	T1	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 *(as specified in table 2(I)A-G)*	No				No				No															
B. Chemical Industry																								
1. Ammonia Production	Yes	T2	NS,PS	CS, PS	No				No				No				No				No			
2. Nitric Acid Production	No				No				Yes	T2	PS	D, PS	No				No				No			
3. Adipic Acid Production	No				No				Yes	T2	PS	D, PS	No				No				No			
4. Carbide Production	No				No				No				No				No				No			
5. Other *(as specified in table 2(I)A-G)*	Yes	T1, T2	NS, PS	D, PS	No				Yes	T1, T2	NS, PS	D, CS, PS	No				No				No			
C. Metal Production																								
1. Iron and Steel Production	Yes	D	NS	C, CS, PS	No				No								No				No			
2. Ferroalloys Production	No				No				No								No				No			
3. Aluminium Production	No				No				No								Yes	T1, T2	PS	PS	No			
4. SF_6 Used in Aluminium and Magnesium Foundries	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)]**
5. Other *(as specified in table 2(I)A-G)*	No				No				No								No				No			
D. Other Production																								
1. Pulp and Paper	No																							
2. Food and Drink	No																							
E. Production of Halocarbons and SF_6																								
1. By-product Emissions													Yes	CS	PS	PS	No				Yes	CS	PS	PS
2. Fugitive Emissions													No				No				No			
3. Other *(as specified in table 2(II)*													Yes	NA	NA	NA	No				No			
F. Consumption of Halocarbons and SF_6																								
1. Refrigeration and Air Conditioning Equipment													Yes	CS	PS	CS	No				No			
2. Foam Blowing													Yes	CS	PS	CS	No				No			
3. Fire Extinguishers													Yes	CS	PS	CS	No				No			
4. Aerosols/ Metered Dose Inhalers													Yes	CS	PS	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 *(as specified in table 2(II)*													No				No				Yes	NA	NA	NA
G. Other																								

Table I -3: Community 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												
A. Paint Application	No								No			
B. Degreasing and Dry Cleaning	No								No			
C. Chemical Products, Manufacture and Processing	No								No			
D. Other	No								No			
4. Agriculture												
A. Enteric Fermentation												
1. Cattle					Yes	T2	NS	CS				
2. Buffalo					No							
3. Sheep					Yes	T1	NS	D				
4. Other					No							
B. Manure Management												
1. Cattle					Yes	T2	NS	CS	No			
2. Buffalo					No				No			
3. Sheep					No				No			
4. Other					No				No			
8. Swine					Yes	T2	NS	CS	No			
13. Solid Storage and Dry Lot					No				Yes	T2	NS	D, CS
C. Rice Cultivation												
D. Agricultural Soils												
1. Direct Soil Emissions	No				No				Yes	T1	NS	D, CS
2. Pasture, range and paddock manure	No				No				Yes	T1	NS	D, CS
3. Indirect Emissions	No				**No**				Yes	T1	NS	D, CS
4. Other *(as specified in table 4.D)*	No				No				No			
E. Prescribed Burning of Savannas					No				No			
F. Field Burning of Agricultural Residues					No				No			
G. Other					No				No			

Table I -4: Community 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	NS	D, 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	Yes	T1	NS	D, CS	No				No			
C. Grassland												
1. Grassland remaining Grassland	Yes	T1	NS	D, CS	No				No			
2. Land converted to Grassland	Yes	T1	NS	D, CS	No				No			
D. Wetlands												
1. Wetlands remaining Wetlands	No				No				No			
2. Land converted to Wetlands	No				No				No			
E. Settlements												
1. Settlements remaining Settlements	No				No				No			
2. Land converted to Settlements	Yes	T1	NS	D, CS	No				No			
F. Other Land												
1. Other Land remaining Other Land					No				No			
2. Land converted to Other Land	Yes	NA	NA	NA	No				No			
G. Other (please specify)												
Harvested Wood Products	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				
3. Other *(as specified in table 6.A)*	No				No							
B. Wastewater Handling												

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. Industrial Wastewater					No				No			
2. Domestic and Commercial Wastewater					Yes	D	NS	D	Yes	D	NS	D
3. Other *(as specified in table 6.B)*					No				No			
C. Waste Incineration												
D. Other	No				No				No			
7. Other (as specified in Summary 1.A)												
Memo Items: (8)												
International Bunkers												
Aviation	No				No				No			
Marine	No				No				No			
CO_2 Emissions from Biomass	No				No				No			

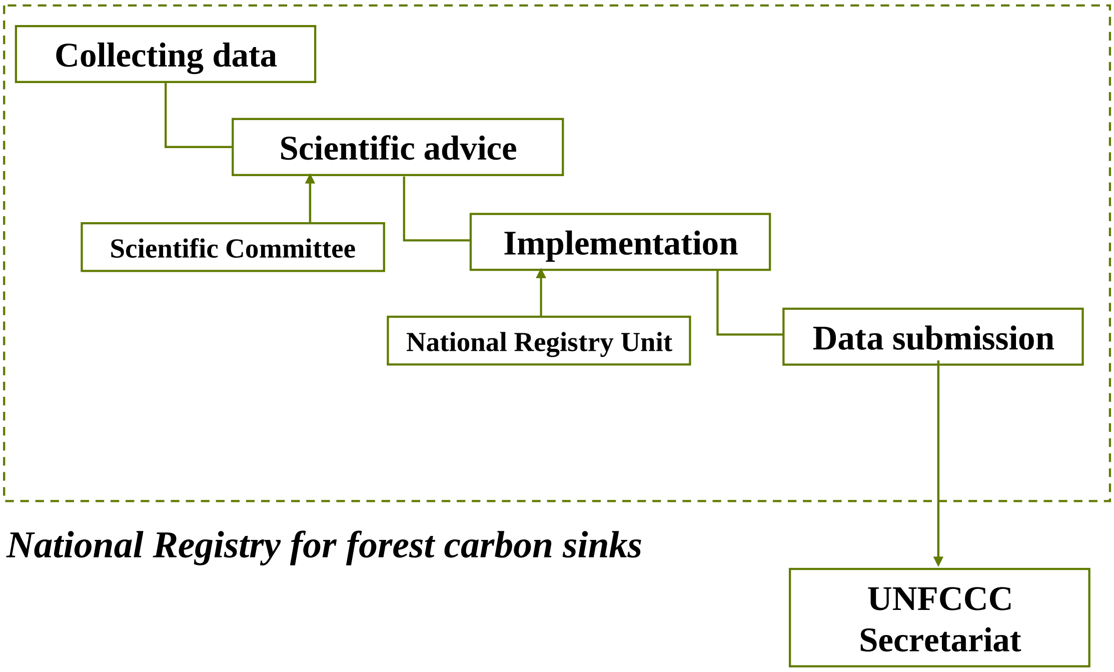
Legend for tables I -1 to I -4

(1) Key sources of the Community. To be completed by Commission/EEA with results from key category analysis from previous inventory submission.			
(2) 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),	**C** (CORINAIR),	**COPERT X** (Copert Model X = Version)
RA (Reference Approach),	**T2** (IPCC Tier 2),	**CS** (Country Specific).	
T1 (IPCC Tier 1),	**T3** (IPCC Tier 3),	**M** (Model)	
If using more than one method within one source category, enumerate the relevant methods. Explanations regarding country-specific 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.			
(3) Use the following notation keys to specify the sources of activity data used :			
NS (national statistics),	**IS** (International statistics),	**AS** (associations, business organizations)	
RS (regional statistics),	**PS** (Plant Specific data).	**Q** (specific questionnaires, surveys)	
If keys above are not appropriate for national circumstances, use additional keys and explain those in the documentation box.			
Where a mix of AD sources has been used, use different notations in one and the same cells with further explanations in the documentation box.			
(4) Use the following notation keys to specify the emission factor used:			
D (IPCC default),	**CS** (Country Specific),		
C (CORINAIR),	**PS** (Plant Specific).		

Where a mix of emission factors has been used, use different notations in one and the same cells with further explanations in the documentation box.										
Documentation box:										
* The full information on methodological issues, such as methods, activity data and emission factors used, can be found in the relevant sector sections of chapter 5 of the NIR. If any additional information is needed										
To understand the content of this table, use this documentation box to provide references to the relevant section of the NIR where further details can be found.										
* Where a mix of methods/ emission factors has been used within one source category, use this documentation box to specify those methods/emission factors for the various sub-sources where they have been applied										
(see also footnotes 2 to 4 to this table).										

ANNEX 10: THE NATIONAL REGISTRY FOR FOREST CARBON SINKS

The so-called "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. 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. A process of validation and verification of IUTI data has been put in place and is expected to supply data useful to update and improve the estimations.
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 will supply 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 (VOLOITALIA[63] and TERRAITALY[64]), land use is classified with a high degree of accuracy and precision, as required by IPCC standards.

Time:
IUTI will annually 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 (1,200,000 sampling points) is uniformly distributed throughout the entire Italian national territory, using a non-aligned systematic statistical model. IUTI will supply data, at NUT2 level, of the investigated variables (i.e. *forest land* category and each subcategory in conversion to and from *forest land*). The analysis of sample plots is being carried on using remote sensed data.

Categories and subcategories:
Land use categories (Table A10.1) are defined according to IPCC Good Practice Guidance for LULUCF:

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**

Table A10.1: IUTI classification system

[63] http://www.cgrit.it/prodotti/voli_italia.html
[64] http://www.terraitaly.it/

Quality assurance:
Data supplied by IUTI will be collected in the so-called "*National Registry for the forest carbon sinks*" of Kyoto Protocol, and have to fulfil quality requirements as stated by the IPCC and UNFCCC guidelines.

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.

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

Table A10.2: Classification hierarchy

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.

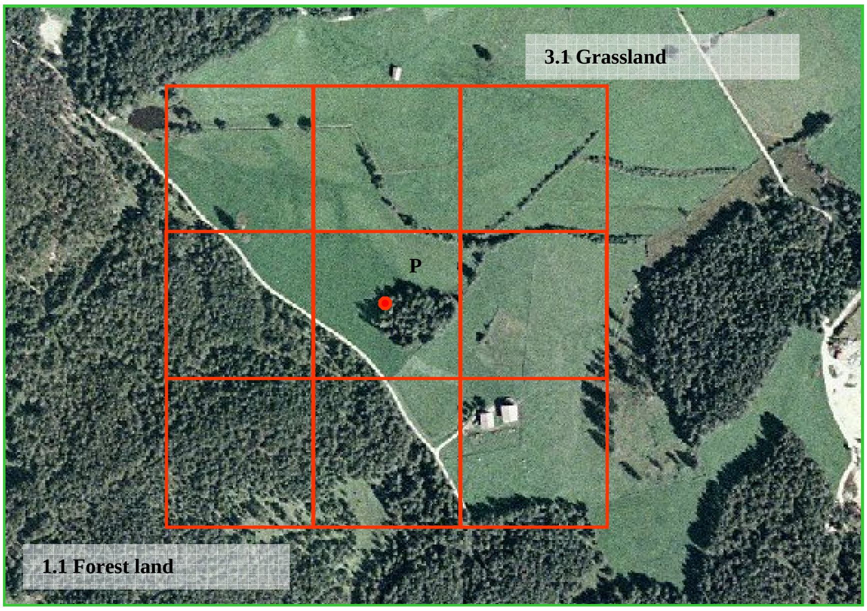


Figure A10.1: Land use classification system - grassland

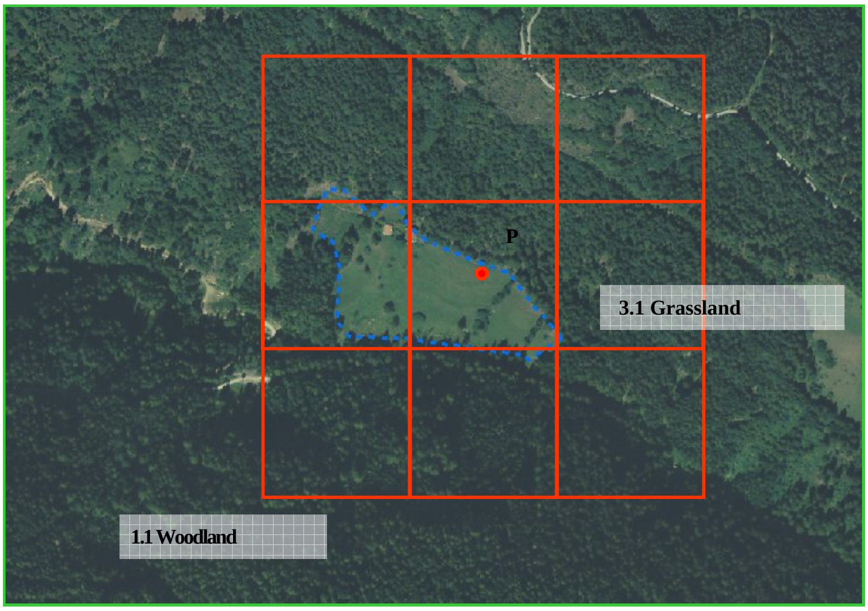


Figure A10.2: Land use classification system - Woodland

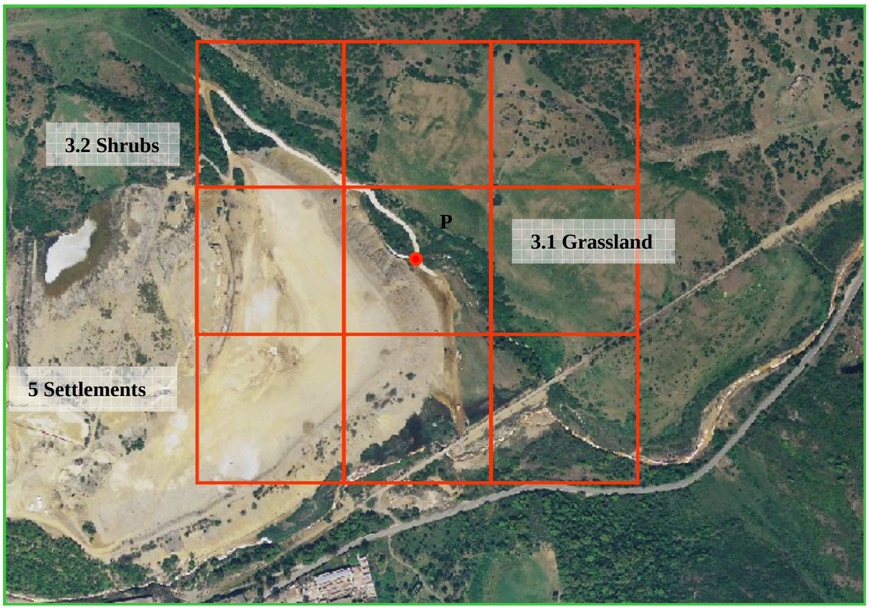


Figure A10.3: Land use classification system – grassland

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 IFN 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 will annually provide 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 will assure the spatial coverage, providing carbon stocks data, at NUT2 level.

Quality assurance:

Data supplied by ISCI will be collected in the so-called "*National Registry for the forest carbon sinks*" of Kyoto Protocol, and have to 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 will annually provide, 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 (because of the strong variability of the forest fires occurrence no interpolation of data is allowed).

Space:

CIFI will cover 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;
- digital terrain model;
- forest-non forest Boolean mask.

Quality assurance:

Data supplied by CIFI will be collected in the so-called "*National Registry for the forest carbon sinks*" of Kyoto Protocol, and have to 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 will annually provide 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 will supply 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 will be collected in the so-called "*National Registry for the forest carbon sinks*" of Kyoto Protocol, and have to fulfil quality requirements as stated by the IPCC and UNFCCC guidelines.

ANNEX 11: THE NATIONAL REGISTRY

The annex gives a description of the Italian Registry during the reporting period, in accordance with the guidelines set down in UNFCCC's Decision 22/CP.8 (Additional sections to be incorporated in the guidelines for the preparation of the information required under Article 7, and in the guidelines for the review of information under Article 8, of the Kyoto Protocol).
All data referring to units holdings and transactions during the year 2010 are reported in the SEF submission; figures are included in tables A8.2.2.1 - A8.2.2.5c.

The information provided below refers to the Italian Registry as it's been until the end of the year 2010. Following a European tender, from January 2011 Italy has continuous agreement with Innofactor Oy which covers hosting and maintenance of the Registry software. The contract also includes any kind of support needed for the Italian Registry.
Due to this major change in the Registry, most procedures have been revised. New technical and operational documentation is currently being prepared for next year submission to the Secretariat to demonstrate proper implementation of the DES and the fulfilment of all Readiness requirements.

A11.1 Description of national registry

Since 2006 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 has since gone live, starting on 28 March 2006.
This registry is an electronic database for the administration of emissions allowances allocated to operators participating to the EU ETS and it's been developed according to the UN Data Exchange Standards document. As a consequence, the registry established under Directive 2003/87/CE can also be used as registry for the administration of Kyoto Protocol units. In fact, the Italian registry for the EU ETS has undergone 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

- SSL connectivity testing (Oct. 26th 2007);
- VPN connectivity testing (Oct. 15th 2007);
- Interoperability test according to Annex H of the UN DES (Nov. the 9th 2007)

and submitted all required information through a complete Readiness questionnaire.
As a result, the Italian registry has fulfilled all of its obligations regarding conformity with the UN Data Exchange Standards. These obligations include having adequate transaction procedures; adequate security measures to prevent and resolve unauthorized manipulations; and adequate measures for data storage and registry recovery. The registry has been therefore 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.

A11.2 Registry Administrator

The Italian Government modified the previous Legislative Decree 216/2006 which enforced Directive 87/2003/CE, by the new Legislative Decree 51 of March 7th 2008. Due to this new Decree, ISPRA (former APAT) is responsible for developing, operating and maintaining the national registry under Directive 2003/87/CE; the Institute performs these tasks under the supervision of the national Competent Authority for the implementation of directive 2003/87/CE, jointly established by the Ministry for Environment, Land and Sea and the Ministry for Economic Development. ISPRA, as Registry Administrator, becomes responsible for the management and functioning of the Registry, including Kyoto Protocol obligations. The reference person is Mr Riccardo Liburdi.

The Decree 51/2008 also establishes that the economic resources for the technical and administrative support of the Registry will be supplied to ISPRA by operators paying a fee for the use of the Registry. The amount of such a fee will 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, six persons have been working for this unit in order to maintain the Registry:

- the Registry Administrator (chief of the unit)
- one IT expert taking care of hardware and software on site, with the support of an external IT supplier giving remote consultancy;
- one Registry Manager in charge of Registry functions and operations, resolution of problems, manual intervention, and coordination with the "Competent Authority";
- three persons dedicated to a first level helpdesk and to administrative tasks (e.g. documentation archiving).

A11.3 Cooperation with other Parties

At present, Italy is also operating its registry under Article 19 of European Directive 2003/87/CE establishing the EU Emission Trading Scheme (EU ETS) and according to Regulation No. 2216/2004 of the European Commission and its later modifications.

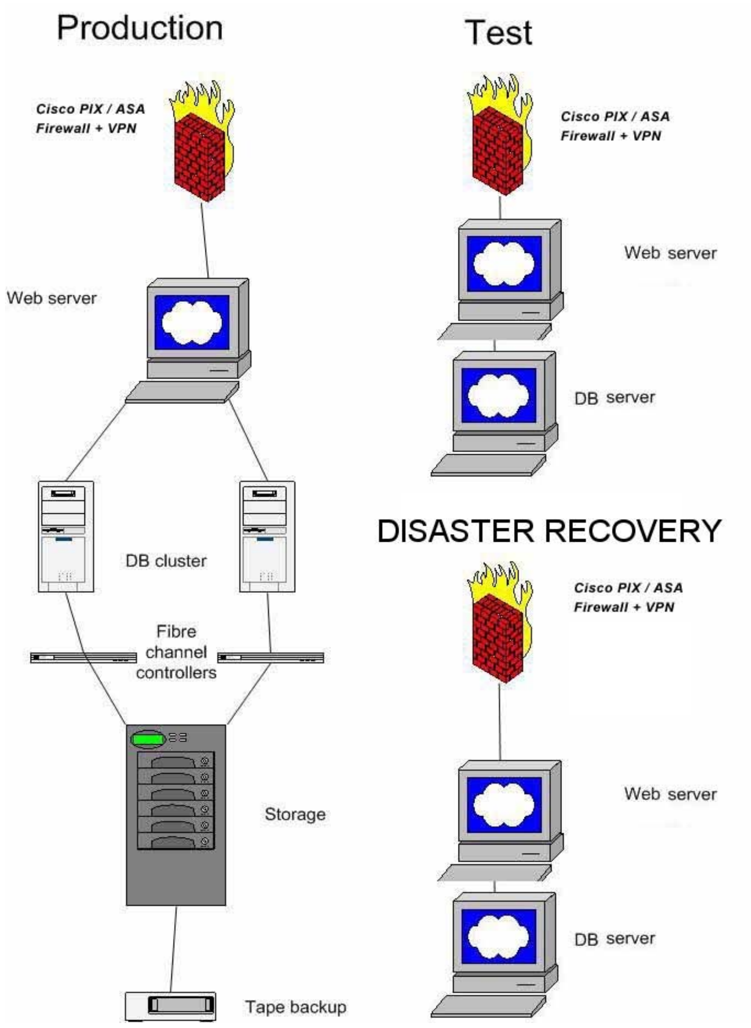
The Italian Registry is currently linked to the national registries of the 27 Member States of the European Union plus Iceland, Liechtenstein and Norway and to the European Commission CITL (Community Independent Transaction Log) by way of the UNFCCC ITL (International Transaction Log).

A11.4 Database structure and capacity of the national registry

The Italian registry is based on the GRETA registry software developed by the provider Greta International Ltd (GIL) and licensed to several EU Member States. The development of the Greta software adheres to the standards specified in the UN Data Exchange Standards. The application has been developed using a 3-tier architecture model and was implemented in ".net" using a Microsoft SQL Server 2000 Enterprise Edition relational database management system with a dedicated data model for supporting registry operations. The SQL license adopted has no access limitations of simultaneous transactions. The application has been hosted on a standard Microsoft environment running IIE server.

In the reporting period the production, test and disaster recovery environments had the following structure (see figure below):

- Production environment: 1 Firewall server + 1 webserver + 2 DB servers in cluster configuration with two controllers fibre channel towards storage unit; the data directory was on the data storage device + 1 Tape Autoloader.
- Test environment: 1 Firewall server + 1 webserver + 1 DB server; same hardware and software configuration as the production web server.
- Disaster Recovery environment: 1 Firewall server (connected through VPN with the firewall of the production environment) + 1 webserver + 1 DB server; same hardware and software configuration as the production environment; physically separated from the production environment (in a different building in a different part of the city of Rome)



The capacity of the storage unit reached up to 600 Gb and the size of an SQL Server Database can be over 1 million Tb. These features, together with fast internet connection and continuous monitoring of capacity indicators, guaranteed high performance of the system

A11.5 Conformity with data exchange standards (DES)

The GRETA registry system has been developed for the EU Emissions Trading Scheme. This scheme requires its Member States' registries to be compliant with the UN Data Exchange Standards specified for the Kyoto Protocol.

In addition, 24 Hour Clean-up, Transaction Status enquiry, Time Synchronisation, Data Logging requirements (including Transaction Log, Reconciliation Log, Internal Audit Log and Message Archive) and the different identifier formats as specified in the UN DES document have been implemented. From February the 7th 2008, however, on both production and test sites a new NTP software has been installed. This software is provided by http://www.meinberg.de/english/sw/ntp.htm and was obtained by compiling version 4.2.4p4 sources of the software supplied by ntp.org.

Formats for account numbers, serial numbers for ERUs, CERs, AAUs, and RMUs, including project identifiers and transaction numbers are as specified in the UN DES Annex F – Definition of Identifiers. The display format is controlled via the registries web configuration file.

Electronical information when transferring ERUs, CERs, AAUs, and/or RMUs to other registries will be transmitted to other registries in the format of the messages specified in the UN DES via the ITL.

Acknowledgement information when acquiring ERUs, CERs, AAUs, and/or RMUs from other national registries or the CDM registry will be transmitted to other registries in the format of the messages specified in the UN DES via the ITL.

Electronical Information when issuing, transferring, acquiring, cancelling and retiring ERUs, CERs, AAUs, and/or RMUs will be transmitted from the national registry to the ITL in the format of the messages specified in the UN DES.

A11.6 Procedures for minimizing and handling of discrepancies

Communications between the National Registry and the ITL is via web-services using XML messages. These web-services, XML message format and the processing sequence are those specified in the UN DES document.

In the EU ETS, to prevent discrepancies between the Registry and the CITL, internal checks (as specified in the UN DES document) have been implemented as far as possible. The same approach has been adopted in the development of the GRETA software for the remaining Kyoto functionalities.

Whenever a possible discrepancy is detected by the internal checks no transaction will be started. Moreover, unit blocks involved in a pending transaction are locked for use in any other transaction and there will be an automatic termination of the transaction that has caused the discrepancy.

In the event of a failure to terminate the transaction, an inconsistency with the ITL or CITL will be detected during the subsequent reconciliation process. The ITL or CITL will then block any transaction involving the related units. The status of the units will then be corrected manually by the Registry Administrator with the help of a manual intervention function. This intervention will be logged automatically in the registry. If no inconsistencies are detected during the next reconciliation process with the ITL or CITL, the related unit will be unblocked so that further transactions with these units will be possible.

A11.7 Prevention of unauthorized manipulations and operator error

ISPRA has always emphasized physical security of server premises in addition to normal access control methods. All servers and backup media are located in secure premises with electronic access control, allowed only to the system administrators.

Personnel have duty of identification when entering the building and a security channel allows monitoring inside the building. When moving servers or backup media between controlled premises, they are never left unattended.

Computers are accessible through username and password and they are automatically locked after 15 minutes of idle time. Employees are required to lock the computers manually whenever leaving the desk.

In the reporting period, the technical measures in place to guarantee security have been:

- reliable hardware
- proven software technology
- all servers protected by firewalls (Cisco ASA units)
- ISPRA firewalls continuously checked for attack attempts
- regular virus scans on all nodes, workstations and servers within their networks (all servers protected with Anti-Virus product updated daily)
- active monitoring of network activity
- secure connection with ITL (VPN, 2way SSL)
- users login using encrypted connection (SSL-128bit)
- OS periodically patched

From the operational point of view, every user of the Registry needs username and password to log-in, which are sent separately. Passwords are of 8 to 15 digits including minimum 1 numbers and minimum 1 alphabet and to change their password every 60 days.
A security matrix manages access rights to Registry for all users so that different functions are restrictively permitted.

Legal and identity documents are accurately checked before opening accounts for legal entities.
Significant attention is placed on verifying the identity of the Organisation legal representative who is signing the nomination of the account primary and secondary authorized representatives.

Procedures and user manual are available to users to prevent operators' error.

A11.8 User interface of the national registry

Public information required by Decision 13/CMP.1 (account information, JI projects in Italy, holdings and transactions of units, authorised legal entities) is available on the Registry homepage at http://www.greta.sinanet.isprambiente.it//.

A support portal, with news, procedures, documentation, is also available for the public at www.greta.sinanet.apat.it.

A11.9 Integrity of data storage and recovery

In the reporting period, a backup plan has been implemented for the production environment, according to the following schedule:

- full backup of the database taken everyday in the storage unit;
- differential backups of new logs taken every hour in the storage unit;
- every week all daily backups recorded on a tape and retained for 2 weeks in a separate location.

Internal backup scheduling system of SQL Server 2000 Enterprise Edition has been used.
Both storage (HP StorageWorks MSA20) and tapes (HP StorageWorks 1/8 Tape Autoloader Ultrium 230) have been kept in secure location with controlled access.
The plan relied on the use of three backup tapes: after being in use for one week, a tape is stored for two weeks, when it is erased and used again. This means that daily backups are available in 14 generations (two weeks).
Backup software's log was checked every weekday. Abnormalities were checked and necessary corrections made.

Moreover, the following disaster recovery plan has been implemented: the synchronization system between the production environment and the disaster recovery environment was carried out every 15 minutes. In case the primary system fell, the synchronization platform would be served by a different connection to the internet with the immediate recovery of all functionalities; the time estimated was just the time needed to update the public DNS caches that should "memorize" the new path towards a different IP address. The ITL would provide the last 15 minutes transaction logs files in order to upgrade the disaster recovery DB and start it. In the meantime, the dedicated personnel would try to resolve as soon as possible the problem on the production platform.
The correct functioning of the disaster recovery platform has been checked once a week.

Reliability of the whole system has been guaranteed by the following stability features:

- power supply from the public power supply network through two separate feeding points;
- uninterruptible power supply on battery basis;
- guarantee of the supply through diesel emergency power aggregate in the event of prolonged failure of the public power supply network;
- all essential hardware components of the server implemented with redundancy (power supply, multiprocessor, hard-disks RAID);
- the database servers operated as a cluster (switchover).

A11.10 Test results

Italy carried out all required steps of the initialization process with the UNFCCC. In particular, Italy successfully performed and passed SSL connectivity tests, VPN connectivity tests, and interoperability tests according to Annex H of the UN DES.
Backup and recovery tests have been performed before the *go-live* of the Registry and the results have been reported as Annex 1, Annex 2 (backup logs) and Annex 3 (restore logs) of the clarifications provided along with the Readiness Questionnaire.

Due to the recent attacks to the registries of the EU ETS, the European Commission required to all Member States security penetration testing which were performed in February-March 2011 on the new hardware infrastructure.
As for performance tests, at the end of January 2011 a new round of tests has been performed due to the upgrade of the Registry software (currently Greta v.5.1.24) and the transfer of the Registry to new hosting premises.

ANNEX 12: OVERVIEW OF THE LAST UNFCCC REVIEW PROCESS

Responses to the main questions raised during the last UNFCCC review process, related to the national inventory submitted in 2010, are described in the following table.

Review report para	Subject	Description	Response
14	Overview – 2. A description of the institutional arrangements for inventory preparation	The present ERT reiterates and refines the recommendations of the previous ERT that Italy apply a full Tier 2 uncertainty analysis for at least one inventory year in one annual submission…	Montecarlo analysis has been applied to the main key categories of the Italian inventory to estimate uncertainty for the year 2009. The study will be extended to the whole inventory for the next year submission.
22	Overview - 3. Follow-up to previous reviews	However, recommendations concerning the prioritization of improvements to its uncertainty analysis, the enhancement of transparency with regard to net carbon stock changes in land converted to forest land, and the further justification of its approach of calculating changes in soil carbon stock in the year following land-use conversions have not been addressed by the Party in its 2010 annual submission.	The prioritization of improvements related to the results of uncertainty analysis lead to the following revision. The activity data related to litter and soil pools have been updated, increasing the number of sampling used and reducing notably the uncertainty related to these pools (litter pool passed from 161% to 101%, while soil pool passed 152% from to 113%).
24 (a)	Overview - 4. Areas for further improvement – Identified by the expert review team	The ERT recommends that Italy implement its planned reallocation of emissions using EU ETS data within the petroleum refining subcategory for the entire time series, ensuring time-series consistency, following the IPCC good practice guidance	The reallocation of emissions using EU ETS data within the petroleum refining subcategory for the entire time series has been implemented
24 (b)	Overview - 4. Areas for further improvement – Identified by the expert review team	The ERT also recommends that Italy report in its next submission the use of reductants in iron and steel production under the industrial processes sector instead of under the energy sector, ensuring that there is no double counting between the two sectors, and that in doing so the Party take account of the quantity of carbon stored in steel produced	The quantity of carbon stored in steel produced has been accounted for in the carbon balance of the iron and steel production ensuring no double counting occurs. The carbon balance methodology does not imply to separate off input between the energy and industrial sectors
24 (c)	Overview - 4. Areas for further improvement – Identified by	The ERT recommends that Italy include more discussion in the NIR as to why the current approach to estimating PFC emissions from aluminium production is conservative	Additional information has been provided in the NIR (paragraph 4.4.2).

	the expert review team		
24 (d)	Overview - 4. Areas for further improvement - Identified by the expert review team	The ERT also strongly recommends that the Party explain the rationale behind and justify (theoretically and/or factually) its approach of accounting for all soil carbon stock changes as a result of a land-use conversion when the conversion takes place instead of spreading those changes across a number of years (20 years is the default period), as this approach might lead to a loss of soil carbon and thus an overestimation of CO_2 removals.	A detailed and transparent description of the rationale used in the estimation process of soil carbon stock changes is provided in NIR (par. 7.1, par. 7.3.4 for land converting to cropland, par. 7.4.4 for land converting to grassland).
27	Energy - Sector overview-Transparency	Transparency in the reporting on oil and natural gas (fugitive emissions) could be improved, as methods have not been clearly described at the activity level; the frequent use of the notation key IE.(included elsewhere), such as for the aggregation of oil and gas exploration and venting under oil and gas production (fugitive emissions), makes it difficult to understand the methods applied.	Additional information has been provided in the NIR as regards the methodology. In order to improve transparency, fugitive emissions from oil extraction have been disaggregated among venting, flaring and production, while emissions from gas extraction have been disaggregated between flaring and production.
32	Energy - Sector overview-CO_2	The ERT noted that the use of EU ETS data for fugitive emissions from oil flaring activities has not resulted in a consistent time series as required by the IPCC good practice guidance. The CO2 implied emission factor (IEF) jumps sharply from 2007 to 2008 from 2,541,500 to 6,338,800 kg CO_2/Mm^3… The ERT recommend that Italy implement its planned reallocation of emissions…	The whole time series has been updated. The reallocation of emissions using EU ETS data within the petroleum refining subcategory for the entire time series has been implemented.
36	Energy-International bunker fuels	Discrepancies exist between CRF tables 1.C and 1.A(b) in relation to residual fuel oil (international marine bunkers) for all years of the time series. … the ERT recommends that it does so in the next submission	The issue of discrepancy has been solved
37	Energy-Feedstock and non-energy use of fuels	The ERT encourages Italy to further clarify its explanation of how it determines the final carbon storage factors that are used in CRF table 1.A(d), in order to improve understanding	Additional information has been provided in the NIR.
38	Energy – Key categories-Stationary combustion:	The ERT recommends that Italy report in its next annual submission the use of reductants in iron and steel production under the industrial processes sector	The quantity of carbon stored in steel produced has been accounted for in the carbon balance of the iron and steel production ensuring no

	solid fuels-CO_2	instead of under the energy sector, ensuring that there is no double-counting between the two sectors.	double counting occurs. The carbon balance methodology does not imply to separate off input between the energy and industrial sectors.
39	Energy – Key categories- Stationary combustion: solid fuels-CO_2	The ERT recommends that, as a part of reallocating the emissions from the use of reductants in iron and steel production to the industrial processes sector, the Party amend its methodology to take account of the quantity of carbon stored in steel produced, in order to avoid a subsequent overestimate of CO_2 in the industrial processes sector.	See previous para
40	Energy – Key categories- Oil and natural gas: liquid fuels . CH_4 and CO_2	The methods used for estimating fugitive emissions from petroleum refining (process emissions resulting from restoration of the catalyst and flaring emissions) are not well documented in the NIR …. The ERT recommends Italy include this information in the category specific section of fugitive emissions in the NIR ….	Additional information has been provided in the NIR.
41	Energy – Key categories- Oil and natural gas: gaseous fuels. CH_4 and CO_2	The CH_4 IEF for natural gas production and processing declined from 2,911.93 kg/Mm^3 gas produced in 1990 to 1,611.10 kg/Mm^3 in 2008, while the CO_2 IEF stayed constant. … The ERT recommends that Italy include this information in the NIR and also provides a discussion on the drivers behind this trend	Additional information has been provided in the NIR.
45	Industrial processes – Adipic acid production – N_2O	…the ERT recommends that Italy further improve transparency by correcting the formula that is reported in the NIR and explaining how this formula is used to check Efs provided by the production plant, and include a description of the emission estimation methodology applied by the production plant that was used by Italy for its 2010 annual submission.	Additional information has been provided in the NIR (paragraph 4.3.2).
46	Industrial processes – Aluminium production – PFCs	…In the case that such data are not available, the previous ERT recommended that Italy enhance the transparency of its inventory by adding more discussion on why the current approach to estimating these emissions is conservative, including a comparison of the IPCC default EFs and the EFs used by Italy for 1990. In addition, if Italy wishes to show that its time series	Additional information has been provided in the NIR (paragraph 4.4.2).

		is conservative by comparing it with a time series using another approach, the previous ERT recommended that Italy use default EFs from the IPCC good practice guidance for this alternate approach. According to its latest annual submission, Italy plans to follow these recommendations for its next submission. The ERT strongly recommends that Italy include the results in its next annual submission.	
47	Industrial processes - Limestone and dolomite use – CO_2	Italy recalculated the emissions from this category to account for the emissions from paper production. However, the ERT noted that recalculations have only been performed for the period 2000-2008. The ERT recommends that Italy apply the recalculation also to the earlier years of the time series (1990-1999) to ensure consistency across the entire time series and the completeness of the coverage of the emission estimate.	The recalculation has been applied also to the earlier years of the time series (1990-1999)
48	Industrial processes - Aluminium production – CO_2	Italy has reported a recalculation of the emissions from this category resulting from an update of the EFs for aluminium production for the period 2002-2008 and the use of a tier 2 method to estimate the emissions in this time period. ... For the period 1990-2001, an EF of 1.55 t CO2/t primary aluminium production was assumed (tier 1); this EF is the average of the EF contained in the Revised 1996 IPCC Guidelines (1.5 t CO2/t primary aluminium production) and the corresponding EF from the 2003 Aluminium Sector Greenhouse Gas Protocol (1.6 t CO2/t primary aluminium production) for the pre-baked anode process. … The ERT recommends that Italy recalculate emissions for the earlier years of the inventory time series, using the tier 2 method and plant-specific data to ensure time-series consistency, and report thereon in its next annual submission, including the impact of the recalculation on the earlier years of the time series. The ERT also recommends that Italy provide improved information relating to the justification of the approach used	Additional information has been provided in the NIR (paragraph 4.4.2) to explain the rationale of using the same emission factor for the period 1990-2001. No detailed information is available from the plant to apply the tier 2 method to this time period.

		by the Party in the NIR and a discussion on the conservativeness of the time series.	
53	Agricultural soils N_2O	Italy uses a tier 1 method and a combination of IPCC default and country-specific EFs to estimate direct and indirect N2O emissions from agricultural soils, which is in line with the IPCC good practice guidance. The ERT reiterates the recommendation made by the previous ERT that Italy report the method used as T1 instead of D in CRF summary table 3.	Italy has incorporated this change in the CRF Reporter for the 2011 submission.
55	Agricultural soils N_2O	The ERT noted that Italy has reported N2O emissions from_sewage sludge under the waste sector. … The ERT recommends that Italy provide in its next NIR sufficient information on the results of this study and the resulting estimation method, and that it provide information on any recalculations undertaken and their impact on the emission trend.	Italy has collected a complete and consistent time series of the activity data (sewage sludge applied to soils) and has estimated nitrous oxide emissions for this source (direct and indirect emissions).
58	Land use, land-use change and forestry - Sector overview	...The ERT encourages the Party to further improve the QA of its LULUCF inventory and to report thereon in its next annual submission.	A detailed description of the improvement carried out is provided in the relevant paragraphs of NIR (i.e. par. 7.2.6 for forest land).
59	Land use, land-use change and forestry - Sector overview	...The ERT noted that the default method of the IPCC good practice guidance for LULUCF assumes that the carbon stock change in soils, following land-use conversion, occurs over the subsequent 20 years. Italy has also mentioned this default value in the NIR but has explained that, based on the above-mentioned scientific studies, it is more relevant to allocate all the emissions or removals to the year following the year in which the land-use conversion took place. The ERT recommends that the Party provide more data and information to support this assumption.	A detailed and transparent description of the rational used in the approach used in the estimation process of soil carbon stock changes is provided in NIR (par. 7.1, par. 7.3.4 for land converting to cropland, par. 7.4.4 for land converting to grassland).
62	Land use, land-use change and forestry - Sector overview	The overall uncertainty of the five forest carbon pools was estimated to be 84.9 per cent. The ERT recommends that Italy prioritize, within this sector, the improvement of the uncertainty analysis for the forest carbon biomass pools. The ERT also recommends that the Party reconsider the mathematical approach	The activity data related to litter and soils pools have been updated, increasing the number of sampling used and reducing notably the uncertainty related to these pools (litter pool passed from 161% to 101%, while soils pool passed from 152% to 113%). Therefore there was

		used to compute the association between carbon stock in living biomass and litter, because the uncertainty values associated with the models currently used are rather large.	a remarkable reduction in the overall uncertainty, that, in 2011, was estimated to be 68.2%.
66	Land use, land-use change and forestry - Forest land remaining forest land - CO_2	The Party has provided a satisfactory validation of the modelling system used for estimation of carbon stock changes. However, the ERT recommends that Italy improve its documentation on the underlying model, including information on equations used (e.g. yearly increase of growing stock per ha).	A detailed and transparent description of modelling system is provided in NIR (par. 7.2.4 for forest land, par. 7.3.4 for plantation and par. 7.4.4 for other wooded land).
67	Land use, land-use change and forestry – Cropland remaining cropland - CO_2	Tier 1 and tier 3 methods were used to calculate carbon stock changes for this category. Changes in litter and soil carbon in mineral soils in plantations were estimated using linear regression with above-ground biomass. The ERT recommends that the Party enhance transparency by providing statistical information about the applied model, in particular coefficients of determination, standard error of the estimate, number of samples, etc., in tables 7.18, 7.19 and 7.20 of the NIR. The ERT appreciates that the Party provided some of this information during the review week upon request, and recommends that the Party include this information in its next annual submission.	The regressions applied to estimate changes in litter and soil carbon in mineral soils have been modified on the basis of the availability of new activity data. A detailed and transparent description of modelling system is provided in NIR (par. 7.2.4 for forest land, par. 7.3.4 for plantation and par. 7.4.4 for other wooded land).
68	Land use, land-use change and forestry – Cropland remaining cropland - CO_2	The ERT noted examples of the use of the notation key “NO” in the reporting of this category in the relevant CRF tables, in particular for net carbon stock changes in organic soils, whereas the NIR includes a description of the relevant estimation methodology. The ERT recommends that the Party check consistency between the NIR and the CRF tables in this regard.	As in the 2010 submission also in 2011 submission activity data and emissions from organic soils have been reported in table 5.B, while methodological issues are described in par. 7.3.4 of NIR.
72	Land use, land-use change and forestry – Cropland remaining cropland - CO_2	The Party has not reported emissions from wildfires or biomass burning on grassland remaining grassland. It is not clear to the ERT whether these activities are indeed “NO”, given that wildfires are affecting forest land in the country and could spread to grassland, particularly shrubland. The ERT recommends, if emissions from wildfires on grassland, cropland and	Further investigation is actually on going as described in par. 7.2.8 of NIR. Up to now there is no evidence of wildfires occurring on grassland or cropland.

		wetlands are already included in the estimates of emissions from forest fires, that the notation keys in the CRF tables be updated. If this is not the case, the ERT recommends that the Party provide further evidence to support the justification that fires are not occurring on land under these other land-use categories.	
75	Land use, land-use change and forestry –Land converted to grassland - CO_2	The Party assumes that changes in carbon stocks occur in the first year after the land-use conversion, rather than considering them over the time period specified by the IPCC good practice guidance for LULUCF (20 years as default). As a result of this assumption, carbon stock changes in mineral soils were estimated as high as 14.12 t C ha^{-1} yearly, which is far higher than biological values and might lead to considerable overestimations of removals in the case of conversion from cropland to grassland. The ERT recommends that the Party revise or further justify this assumption to avoid the possible overestimation of removals.	A detailed and transparent description of the rationale used in the approach used in the estimation process of soil carbon stock changes is provided par.7.4.4 of NIR.
78	Waste – Sector overview - Transparency	The ERT noted from the Party's 2010 annual submission that Italy is undertaking an investigation on waste composition with a view to providing improved information on waste composition, the fraction of CH_4 in landfill gas and the amount of landfill gas collected and treated. Italy has also established a central database that contains information on waste sent to landfill. The ERT welcomes these ongoing improvements and encourages the Party to report on developments in this investigation in its next annual submission.	Emission estimates have been updated on the basis of the results of the study. Detailed descriptions of the improvements concerning activity data and waste composition have been provided in the NIR (paragraph 8.2.2).
80	Waste - Solid waste disposal on land – CH_4 - Transparency	Italy uses the tier 2 method to estimate CH_4 emissions from solid waste disposal on land, using country-specific AD and a combination of country-specific EFs and IPCC default values. The ERT commends Italy for its implementation of the recommendation of the previous ERT in relation to including in the NIR information on how the amount of CH_4 recovered was	Additional explanation has been provided in the NIR (paragraph 8.2.2 – Landfill gas recovered).

		estimated from the amount of energy produced. The ERT encourages Italy to include an explanation of the finding of the energy conversion efficiency factor used to calculate the CH_4 recovered in the NIR of its next annual submission.	
81	Waste - Solid waste disposal on land – CH_4 - Transparency	The ERT noted that tables with emissions data for solid waste disposal on land have been included in the uncertainty and time-series consistency chapter of the NIR. The ERT recommends that these tables be moved to before the uncertainty and time-series consistency chapter in order to improve transparency.	Tables reporting methane and NMVOC emissions have been moved to paragraph 8.2.2
98	Supplementary information required under Article 7.1 of the KP - Activities under Article 3.3, of the KP - Afforestation and reforestation - CO_2	The methods of calculation have been considerably improved; however, they are still not completely transparent. In particular, the ERT noted that the average factor used to identify carbon stock changes in mineral soils due to afforestation is 0.26 Gg/area unit, whereas the factor used in the Party's reporting under the Convention is 4.73 Gg/area unit. The ERT recommends that the same calculation methods be used for the reporting, both under the Convention and the Kyoto Protocol, or otherwise the inconsistency should be explained. In particular, the ERT recommends that the Party describe if the one year stabilization of the carbon stock approach is also being used for estimation of emissions under Article 3, paragraphs 3 and 4, of the Kyoto Protocol.	Computation errors occurred in the previous submission were detected and corrected in the current submission. Concerning the ERT recommendation, details on the method used is given in paragraph 10.3.1.1
99	Supplementary information required under Article 7.1 of the KP - Activities under Article 3.3, of the KP - Afforestation and reforestation - CO_2	The ERT identified inconsistencies in the factors used for the estimation of carbon stock change in living biomass and dead organic matter between the reporting under the Convention and the reporting on KP-LULUCF under Article 3, paragraph 3. The Party informed the ERT during the review that some calculation errors had been identified, but the Party decided not to resubmit data before the review, as there is a plan to completely revise the estimation model used on the basis of the new data coming from the national registry for forest carbon sinks. The ERT recommends that the Party rectify these	Computation errors occurred in the previous submission were detected and corrected in the current submission.

		inconsistencies and report thereon in its next annual submission.	
100	Supplementary information required under Article 7.1 of the KP - Activities under Article 3.3, of the KP – Deforestation - CO_2	The total area deforested since 1990 is 13.0 kha. All forests are assumed to have been converted to settlements. The ERT recommends that the Party provide a more detailed explanation in its next annual submission as to how this assumption is in line with the statistical data used for the estimation of the deforested areas.	A detailed description of assumption used is provided in the NIR (par. 10.2.12). The activity data used, related to deforested area, have been derived from administrative records collected by the National Institute of Statistics.
101	Supplementary information required under Article 7.1 of the KP - Activities under Article 3.3, of the KP – Deforestation - CO2	Deforestation is a net source of emissions, contributing 386.44 Gg CO_2 eq. A conservative approach is used to estimate the carbon stock changes in deforested areas, assuming that all organic carbon existing in the different pools before deforestation is lost. However, it is not clear from the NIR how the initial status of these pools is estimated. The ERT recommends that Italy clarify this methodological issue in its next annual submission.	A detailed description of assumption used is provided in the NIR (par. 10.3.1.1).
102	Supplementary information required under Article 7.1 of the KP - Activities under Article 3.4 of the KP – Forest management - CO_2	... As noted in the Party's reporting under the Convention in the NIR, the uncertainty level of these calculations is high. The ERT encourages the Party to check the estimation method for these uncertainties and aim to reduce uncertainty, as the Party has stated that it will do in the NIR.	A remarkable reduction in the overall uncertainty, estimated in 2011, to be 68.2%, has been reported, resulting from the updating of activity data related to litter and soils pools have been updated, increasing the number of sampling used and reducing notably the uncertainty related to these pools (litter pool passed from 161% to 101%, while soils pool passed 152% from to 113%).
103	Supplementary information required under Article 7.1 of the KP - Activities under Article 3.4 of the KP – Forest management - CO_2	Taking into account that the Party includes forest roads and firebreaks within the area of forest land, the ERT recommends that the Party, in order to enhance transparency, provide in its next NIR an explanation of how the emissions are accounted for in the case of the construction of new forest roads and firebreaks.	A description is provided in the NIR (par. 10.1.1).
107	Information on Kyoto Protocol units – National registry	The national registry has fulfilled the requirements regarding the public availability of information in accordance with chapter II.E of the annex to decision 13/CMP.1.	The requested information has been provided on the registry website.

		However, the ERT reiterates the recommendation contained in the SIAR in relation to the confidentiality of publicly available information, and recommends that Italy provide a clear statement on its website indicating which information required by chapter II.E of the annex to decision 13/CMP.1 is deemed confidential and a citation or reference to the relevant legislation or regulations supporting this confidentiality.	
123	Conclusions and recommendations	In the course of the review, the ERT formulated a number of recommendations relating to the transparency of the information presented in Italy's annual submission. The key recommendations are that Italy: …	See relevant paragraphs