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Daniela Romano, Rocio Condor, Mario Contaldi, Riccardo De Lauretis,
Eleonora Di Cristofaro, Domenico Gaudioso, Barbara Gonella, Marina Vitullo

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Annual Report for submission under the UN Framework Convention on Climate Change and the European Union's Greenhouse Gas Monitoring Mechanism

AUTHORS

Rocio Condor (agriculture), Mario Contaldi (energy), Riccardo De Lauretis (energy, industrial processes), Eleonora Di Cristofaro (solvent and other product use) Domenico Gaudioso (industrial processes, waste), Barbara Gonella (industrial processes, waste), Daniela Romano (general coordination and editing, cross cutting issues), Marina Vitullo (land use, land use change and forestry)

Contact:
Riccardo De Lauretis
telephone +39 0650072543
fax +39 0650072657
e-mail delauretis@apat.it

APAT- Agency for the Protection of the Environment and for Technical Services
Environmental Pressures Unit
Via V. Brancati, 48 - 00144 Rome - ITALY

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EXECUTIVE SUMMARY

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

The United Nations Framework Convention on Climate Change (FCCC) was ratified by Italy in the year 1994 through law no.65 of 15/01/1994. As a Party to the Convention, Italy is committed to develop, publish and regularly update national emission inventories of greenhouse gases (GHGs) as well as to formulate, implement, publish and regularly update programmes addressing anthropogenic GHG emissions.
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 a 8% reduction within the period 2008-2012, in comparison with 1990 levels. For Italy, the EU burden sharing 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 with the 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.
The Kyoto Protocol finally entered into force in February 2005.
In order to establish compliance with national and international commitments, the national GHG emission inventory is compiled and communicated annually to the competent institutions 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. An annual 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 1 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 as well as estimation procedures, including all the basic data needed to carry out the final estimates, are requested in order 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 availability of new information. 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 for the year 2003, including the entire time series 1990-2003.
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 and other related documents can be found at the website http://www.sinanet.apat.it/site/it-IT/Data_Service/Tipologie/Dati/.

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 change, increased by 11.6% between the base year and 2003 (from 510 to 570 million CO_2 equivalent tons), while the national Kyoto target is a reduction of 6.5% as compared the base year levels by the period 2008-2012.

The most important greenhouse gas, CO_2, which accounted for 85.5% of total emissions in CO_2 equivalent in 2003, showed an increase of 13.2% between 1990 and 2003. In the energy sector, in particular, emissions in 2003 were 14.2% greater than in 1990.

CH_4 and N_2O emissions were equal to 6.1% and 7.4%, respectively, of the total CO_2 equivalent greenhouse gas emissions in 2003. CH_4 emissions decreased by 9.6% from 1990 to 2003, while N_2O increased by 6.1%.

Other greenhouse gases, HFCs, PFCs and SF_6, ranged from 0.3% to 1% of total emissions; at present, variations in these gases are not relevant to reaching the objectives for emissions reduction.

Table ES.1 illustrates the national trend of greenhouse gases for 1990-2003, expressed in CO_2 equivalent terms, by substance and category.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
GREENHOUSE GAS EMISSIONS	CO_2 equivalent (Gg)													
Net CO_2 emissions/ removals	369,752.09	347,343.91	350,338.62	359,646.86	335,700.02	360,859.13	349,329.99	362,660.89	372,197.82	371,040.27	385,746.46	386,503.29	375,622.18	405,381.94
CO_2 emissions (without LUCF)	430,635.79	430,495.57	429,474.73	424,411.88	417,250.73	446,659.92	438,857.66	443,122.08	452,983.52	460,271.54	467,548.23	472,005.00	471,401.88	487,281.90
CH_4	38,319.71	38,971.34	37,823.64	38,030.09	38,037.79	38,293.56	38,211.82	38,471.27	38,328.10	38,466.02	38,050.72	37,145.04	35,852.68	34,637.28
N_2O	39,924.14	41,164.37	40,613.86	40,871.23	39,828.34	41,025.27	40,774.95	42,010.19	41,837.52	42,877.30	42,994.77	43,000.28	43,005.39	42,353.46
HFCs	351.00	355.43	358.78	355.42	481.90	671.29	450.17	755.33	1,180.96	1,451.82	2,005.50	2,758.80	3,560.52	4,575.46
PFCs	1,807.65	1,422.87	798.94	630.85	354.77	336.71	243.39	252.08	270.43	258.00	345.85	452.37	413.58	493.56
SF_6	332.92	356.39	358.26	370.40	415.66	601.45	682.56	728.64	604.81	404.51	493.43	795.34	738.35	485.94
Total (with net CO_2 emissions/ removals)	**450,487.51**	**429,614.31**	**430,292.10**	**439,904.84**	**414,818.48**	**441,787.42**	**429,692.87**	**444,878.39**	**454,419.64**	**454,497.92**	**469,636.73**	**470,655.12**	**459,192.69**	**487,927.63**
Total (without CO_2 from LUCF)	**511,371.22**	**512,765.97**	**509,428.21**	**504,669.86**	**496,369.18**	**527,588.21**	**519,220.55**	**525,339.58**	**535,205.34**	**543,729.19**	**551,438.49**	**556,156.84**	**554,972.40**	**569,827.59**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
GREENHOUSE GAS SOURCE AND SINK	CO_2 equivalent (Gg)													
1. Energy	418,964.45	419,069.03	417,401.18	414,934.95	408,191.11	436,004.87	430,316.30	434,274.06	444,319.86	451,530.22	457,825.06	461,681.51	461,520.65	476,888.49
2. Industrial Processes	35,613.97	35,252.97	34,644.74	31,587.78	30,319.23	33,660.28	31,040.59	31,876.13	32,500.36	33,305.08	35,709.20	37,476.54	37,664.68	39,210.33
3. Solvent and Other Product Use	2,543.53	2,486.09	2,407.87	2,353.48	2,279.29	2,251.94	2,357.61	2,362.40	2,451.27	2,434.65	2,401.50	2,276.30	2,250.29	2,180.40
4. Agriculture	40,618.04	41,877.49	41,610.38	41,928.80	41,480.06	41,395.48	41,191.39	42,279.48	41,590.71	41,874.74	40,981.46	40,334.33	40,176.07	38,747.07
5. Land-Use Change and Forestry	-60,726.31	-83,111.42	-79,069.58	-64,603.72	-81,490.08	-85,777.03	-89,512.49	-80,379.59	-80,710.02	-89,200.01	-81,705.93	-85,440.93	-95,745.64	-81,828.39
6. Waste	13,473.84	14,040.16	13,297.50	13,703.54	14,038.88	14,251.89	14,299.48	14,465.91	14,267.46	14,553.25	14,425.44	14,327.37	13,326.64	12,729.74
7. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table ES.1. Total greenhouse gas emissions in CO_2 equivalent

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

Table ES.2 provides an overview of the CO2 equivalent emission trends by IPCC source category.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Source category	CO_2 equivalent (Gg)													
1A. Energy: fuel combustion	**409,164**	**409,516**	**407,958**	**405,568**	**399,254**	**427,424**	**422,039**	**425,819**	**435,886**	**443,922**	**450,089**	**454,296**	**454,553**	**469,302**
CO_2: 1. Energy Industries	134,951	129,450	129,292	124,264	125,962	139,974	135,167	136,392	146,567	143,251	150,409	153,465	159,502	160,883
CO_2: 2. Manufacturing Industries and Construction	84,969	82,568	80,320	81,483	83,019	87,904	84,576	87,919	81,174	86,463	89,044	85,426	79,890	85,035
CO_2: 3. Transport	101,858	104,350	108,671	110,396	110,223	112,023	113,192	114,919	118,732	119,987	120,452	122,793	124,907	126,015
CO_2: 4. Other Sectors	76,262	81,834	78,370	78,099	68,864	75,643	77,386	74,704	77,636	81,701	77,933	80,579	77,911	84,162
CO_2: 5. Other	1,041	1,192	1,276	1,443	1,455	1,436	1,178	1,222	1,036	1,107	806	354	314	660
CH_4	1,548	1,619	1,683	1,684	1,732	1,820	1,822	1,861	1,726	1,797	1,726	1,647	1,617	1,713
N_2O	8,534	8,504	8,346	8,199	7,999	8,625	8,719	8,802	9,014	9,616	9,719	10,032	10,412	10,833
1B2. Energy: fugitives from oil & gas	**9,801**	**9,553**	**9,443**	**9,367**	**8,938**	**8,581**	**8,277**	**8,455**	**8,434**	**7,608**	**7,736**	**7,385**	**6,968**	**7,587**
CO_2	3,048	2,990	2,926	3,084	2,913	2,843	2,692	2,875	2,768	2,091	2,298	2,182	1,928	2,499
CH_4	6,753	6,563	6,517	6,283	6,024	5,737	5,585	5,581	5,666	5,517	5,439	5,203	5,040	5,087
2. Industrial processes	**35,614**	**35,253**	**34,645**	**31,588**	**30,319**	**33,660**	**31,041**	**31,876**	**32,500**	**33,305**	**35,709**	**37,477**	**37,665**	**39,210**
CO_2	26,266	25,887	26,432	23,497	22,733	24,789	22,701	23,123	23,321	23,862	24,997	25,610	25,428	26,536
CH_4	108	104	101	102	106	113	63	68	65	64	63	60	57	58
N_2O	6,748	7,128	6,595	6,632	6,228	7,150	6,901	6,950	7,058	7,264	7,804	7,801	7,467	7,061
HFCs	351	355	359	355	482	671	450	755	1,181	1,452	2,005	2,759	3,561	4,575
PFCs	1,808	1,423	799	631	355	337	243	252	270	258	346	452	414	494
SF_6	333	356	358	370	416	601	683	729	605	405	493	795	738	486
3. Solvent and other product use	**2,544**	**2,486**	**2,408**	**2,353**	**2,279**	**2,252**	**2,358**	**2,362**	**2,451**	**2,435**	**2,402**	**2,276**	**2,250**	**2,180**
CO_2	1,747	1,736	1,660	1,595	1,532	1,496	1,457	1,462	1,412	1,417	1,391	1,361	1,337	1,324
N_2O	796	750	748	758	747	756	901	901	1,039	1,017	1,011	915	913	857
4. Agriculture	**40,618**	**41,877**	**41,610**	**41,929**	**41,480**	**41,395**	**41,191**	**42,279**	**41,591**	**41,875**	**40,981**	**40,334**	**40,176**	**38,747**
CH_4: Enteric fermentation	12,341	12,734	12,380	12,255	12,295	12,476	12,478	12,545	12,481	12,513	12,249	11,750	11,645	10,933
CH_4: Manure management	4,026	4,064	3,916	3,906	3,803	3,882	3,906	3,900	3,938	3,978	3,863	3,950	3,922	3,821
CH_4: Rice Cultivation	1,539	1,474	1,545	1,655	1,685	1,709	1,696	1,663	1,590	1,577	1,574	1,554	1,562	1,562
CH_4: Field Burning of Agricultural Residues	13	14	14	13	13	13	13	12	14	13	12	11	13	11
N_2O: Manure management	3,829	3,932	3,843	3,802	3,820	3,985	4,037	4,089	4,156	4,206	4,050	4,204	4,177	3,972
N_2O: Agriculture soils	18,866	19,655	19,908	20,293	19,860	19,327	19,056	20,067	19,407	19,584	19,229	18,861	18,854	18,444
N_2O: Field Burning of Agricultural Residues	4	4	4	4	4	4	4	4	4	4	4	4	4	4
5A. Land-use change and forestry	**-60,726**	**-83,111**	**-79,070**	**-64,604**	**-81,490**	**-85,777**	**-89,512**	**-80,380**	**-80,710**	**-89,200**	**-81,706**	**-85,441**	**-95,746**	**-81,828**
CO_2	-60,884	-83,152	-79,136	-64,765	-81,551	-85,801	-89,528	-80,461	-80,786	-89,231	-81,802	-85,502	-95,780	-81,900
CH_4	143	37	60	151	61	27	22	74	86	42	87	55	31	65
N_2O	15	4	6	10	0	-4	-7	8	-11	-11	9	6	3	7
6. Waste	**13,474**	**14,040**	**13,298**	**13,704**	**14,039**	**14,252**	**14,299**	**14,466**	**14,267**	**14,553**	**14,425**	**14,327**	**13,327**	**12,730**
CO_2	493	490	528	551	551	553	508	508	336	392	219	235	185	168
CH_4	11,849	12,363	11,607	11,980	12,318	12,516	12,626	12,768	12,762	12,965	13,038	12,915	11,967	11,387
N_2O	1,131	1,188	1,163	1,173	1,171	1,183	1,165	1,190	1,170	1,196	1,169	1,177	1,175	1,175
TOTAL EMISSIONS	***511,371***	***512,766***	***509,428***	***504,670***	***496,369***	***527,588***	***519,221***	***525,340***	***535,205***	***543,729***	***551,438***	***556,157***	***554,972***	***569,828***

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

The energy sector is the largest contributor to national total GHG emissions with a share, in 2003, of 84% out of the total GHG emissions. Emissions from the energy sector increased by about 13.8% from 1990 to 2003. Substances with the highest increase rates are CO_2, whose levels increased by 14% from 1990 to 2003 and accounts for 96.4% of the total in the energy sector, and N_2O which shows an increase of 22% but its share out of the total is only 2.2%; CH_4, on the other hand, shows a decrease of 18% from 1990 to 2003 but it is not relevant on total emissions, accounting only for 1.4%. Specifically, in terms of total CO_2 equivalent, the most significant increase is observed in the transport and energy industries sectors, about 25% and 19% from 1990 to 2003, respectively; these sectors, altogether, account for 62% of total energy emissions.

For the industrial processes sector, emissions show a total increase of 13% from the base year to 2003. Specifically, by substance, CH_4 decreased by 46%, but it accounts only for 0.1%, while N_2O, whose levels share 18% of total industrial emissions, raised up to 28%. A considerable increase is observed in F-gas emissions (about 245%) and the level of these gases on total emissions is 14%.
In contrast, emissions from the solvent and other use sector, which refer to CO_2 and N_2O emissions except for gases other than greenhouse, decreased by 12% from 1990 to 2003. The reduction is mainly to be attributed to a decrease by 24% in CO_2 emissions, which account for 59% of the sector. The most relevant reduction affected both the paint application sector (-18%), which accounts for 48%, and other use of solvents in related activities (-24%), such as domestic solvent use other than painting, printing industries, vehicle dewaxing, which account for 38%. Emissions from metal decreasing and dry cleaning activities, also decreased (-57%) but account for only 5%.
The level of N_2O emissions, on the other hand, increased by 15% from 1990 to 2003.
For agriculture, emissions refer to CH_4 and N_2O levels, which account, in 2003, for 42% and 58% of the sector, respectively. The decrease observed in the total emissions (-5%) is mostly due to the decrease of CH_4 emissions from enteric fermentation (-11%), which account for 28%, and to a minor decrease in emissions from agricultural soils (-2%), which account for most of the sectoral emissions.
Finally, emissions from the waste sector decreased by 5.5% from 1990 to 2003 due to the reduction in the waste incineration sector (-27%), which account for 4% of waste emissions, as well as those from solid waste disposal (-6%) which account for 76%.
The most important greenhouse gas in this sector is CH_4 which accounts for 90% of the sectoral emissions and shows a decrease of 4% from 1990 to 2003. N_2O levels increased by 4% whereas CO_2 decreased by 66%; these gases account for 9% and 1%, respectively.

ES.4. Other information

In Table ES.3 emission trends of NO_X, CO, NMVOC and SO_2 from 1990 to 2003 are summarised.

Indirect greenhouse gases and SO_2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Emissions in ktons														
NO_X	1,947	2,000	2,019	1,921	1,840	1,808	1,732	1,654	1,553	1,456	1,378	1,367	1,276	1,260
CO	7,150	7,451	7,654	7,602	7,380	7,144	6,846	6,602	6,191	5,907	5,225	5,131	4,519	4,430
NMVOC	2,032	2,093	2,150	2,112	2,050	2,023	1,972	1,909	1,803	1,714	1,544	1,456	1,346	1,311
SO_2	1,795	1,677	1,578	1,477	1,388	1,320	1,209	1,133	995	899	753	708	632	506

Table ES.3. Total emissions of indirect greenhouse gases and SO_2 (1990-2003)

All gases show a significant reduction in 2003 as compared to 1990 levels. The highest reduction is observed for SO_2 (-72%), while CO emissions reduced by 38% and NO_X and NMVOC levels showed a decrease by about 35%.

SOMMARIO (ITALIAN)

Nel documento “Italian Greenhouse Gas Inventory 1990-2003. National Inventory Report 2005” 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 (UNFCC) e del Meccanismo di Monitoraggio dei Gas Serra dell’Unione Europea.
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 chiave, *key sources*, e dell’incertezza ad esse associata, le referenze delle metodologie di stima e le fonti dei dati di base e dei fattori di emissione utilizzati per le stime, una descrizione del sistema di *Quality Assurance/Quality Control* a cui è soggetto l’inventario e le attività di verifica effettuate sui dati.
Il *National Inventory Report* facilita, inoltre, i processi internazionali di revisione a cui le stime di emissione dei gas serra sono sottoposte al fine di verificarne la rispondenza alle proprietà di trasparenza, consistenza, comparabilità, completezza e accuratezza nella realizzazione dell’inventario, richieste esplicitamente dalle Convenzioni suddette. Nel caso in cui durante il processo di review vengano 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 www.unfccc.int.
I dati di emissione della serie storica italiana sono disponibili sul sito web http://www.sinanet.apat.it/site/it-IT/Data_Service/Tipologie/Dati/.
Da una analisi di sintesi della serie storica dei dati di emissione dal 1990 al 2003, si evidenzia che le emissioni nazionali totali dei sei gas serra, espresse in CO_2 equivalente, sono aumentate del 12% nel 2003 rispetto all’anno base (corrispondente al 1990 per CO_2, CH_4 e N_2O ed al 1995 per HFC, PFC e SF_6), 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 2003 superiori del 13% rispetto al 1990, mentre le emissioni relative al solo settore energetico sono aumentate del 14.2%. Le emissioni di metano e di protossido di azoto sono pari rispettivamente a circa il 6% e l’7% del totale e presentano andamenti in diminuzione per il metano (-9.6%) e in crescita (+6.1%) per il protossido di azoto. Gli altri gas-serra, HFC, PFC e SF_6, hanno un peso complessivo intorno all’1% sul totale delle emissioni; le emissioni di questi ultimi gas sono in forte crescita per quanto riguarda gli HFCs ed in diminuzione per gli altri due. Anche se al momento non rilevanti ai fini del raggiungimento degli obiettivi di riduzione delle emissioni, il forte *trend* di crescita li renderà sempre più importanti nei prossimi anni.

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. 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 to formulate, implement, publish and regularly update programmes addressing anthropogenic GHG emissions. Specifically, Italy ratified the convention through law no.65 of 15/1/1994.

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 a 8% reduction within the period 2008-2012, in comparison with 1990 levels. For Italy, the EU burden sharing has established a reduction objective of 6.5% in the commitment period, in comparison with 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. The Kyoto Protocol finally entered into force in February 2005.

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; EMEP/CORINAIR, 2001).

Detailed information on emission figures as well as estimation procedures, including all the basic data needed to carry out the final estimates, are requested in order 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 the availability of new information. 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 for the year 2003, including the entire time series 1990-2003.
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 and other related documents can be found on the website http://www.sinanet.apat.it/site/it-IT/Data_Service/Tipologie/Dati/.

1.2 Description of the institutional arrangement for inventory preparation

Italy is undertaking the actions to develop a national emission inventory system, National System, which involves and attributes specific roles and responsibilities to the different institutions which should collect and communicate basic data necessarily and timely for the GHG inventory compilation. 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 UNFCC 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 (280/2004/EC) 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.
Up to now, the Agency for the Protection of the Environment and for Technical Services (APAT) is recognized by the competent Ministries and Administrations, as responsible for the compilation of the National Air Emission Inventory through the collection, elaboration and diffusion of data. In particular, as National Reference Centre of the European Environment Agency (EEA), APAT is required to prepare the national atmospheric emission inventory in order to ensure compliance with international commitments concerning the protection of the environment (Framework Convention on Climate Change, Convention on Long Range Transboundary Air Pollution, European Directives on emission ceilings).
The Italian greenhouse gas inventory is compiled and updated annually by the Agency and officially communicated to the Secretariat of the Framework Convention on Climate Change and to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism, after endorsement by the Ministry for the Environment and Territory.
Although there is not an official National System in place, different institutions responsible for statistical data flow and publication are part of a National Statistical System (SISTAN) and therefore are asked periodically to update statistics; in spite of that, problems regarding timeliness and lack of transparency still occur. In the next months, APAT, on behalf of the Ministry for the Environment and Territory, will draft a plan for the establishment of a robust national system (building on the base of SISTAN), with a sound legal basis at a later stage.

1.3 Brief description of the process of inventory preparation

Data collection and timely availability are the main difficulties faced by Italy, up to now, which do not allow the submission of the emission inventory within the time scheduled. In fact, several sectoral statistics are available with significant delay: for instance, energy statistics and fuel consumption are published at the end of the year, or even later, and some industrial production statistics as well as agriculture and forestry statistics are published even two years later. Moreover, data are not always available with the necessary details and the use of proxy variables and indicators, even if overcoming these difficulties, would introduce further uncertainties in the estimates. At this aim, ad hoc expert panel, i.e transport, land use change and forestry, have been instituted on a voluntary basis in order to improve the completeness and transparency of the inventory. Generally, the basic data needed for the preparation of the GHG inventory are energy statistics published by the Ministry of Production Activities (MAP) in the National Energy Balance (BEN), statistics on industrial and agricultural production published by the National Statistics Institute (ISTAT), statistics on transportation provided by the Ministry of Transportation, and data supplied directly by the relevant professional associations.

Emission factors and methodologies used in the estimation process are consistent with the IPCC Good Practice Guidance and supported by national experiences and circumstances. Final decisions are up to inventory experts, taking into account all the information available.

As far as industrial sources are concerned, emission data collected through the National Pollutant Emission Register (EPER) are taken into account as a verification of emission inventory estimates. According to the Italian Decree of 23 November 2001, data from the Italian EPER are validated and communicated by APAT to the Ministry of the Environment and the Territory and to the European Community within October of the current year for the previous year. These data are not used directly for the compilation of the inventory because industries communicate emission values only if they exceed specific thresholds; furthermore, basic data such as fuel consumption are not communicated and in some cases production are not split by product but considered as an overall figure. Anyway, EPER 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 some sectoral emissions.

In addition, estimates are checked and verified also taking into account figures reported by industries in their annual environmental reports.

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 UNFCC Secretariat filling in the CRF files. The process takes over annually; in the year t final emissions are calculated for the year t-2: in case of methodological changes or additional information, emissions are recalculated from the year 1990 onwards.

All the 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 Agency.

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 specific chapters. In Table 1.1 a summary of the activity data and the sources used in the inventory compilation is reported.
Methodologies are consistent with the Revised 1996 IPCC Guidelines, IPCC Good Practice Guidance and EMEP-CORINAIR Emission Inventory Guidebook (IPCC, 1997; IPCC, 2000; IPCC, 2003; EMEP/CORINAIR 2001); national emission factors are used as well as default emission factors from international guidebooks (IPCC, CORINAIR, EPA), in case national data are not available. The development of national methodologies is supported by background documents, even though not always available in English.

Table 1.1 Activity data and sources for the Italian National Emission Inventory

SECTOR	ACTIVITY DATA	SOURCE
1 Energy 1A1 Energy Industries	Fuel use	Energy Balance - Ministry of Production Activities Major national electricity producers
1A2 Manufacturing Industries and Construction	Fuel use	Energy Balance - Ministry of Production Activities Major National Industry Corporation.
1A3 Transport	Fuel use Number of vehicles Aircraft landing and take-off cycles and maritime activities	Energy Balance - Ministry of Production Activities Statistical Yearbooks - National Statistical System Statistical Yearbooks - Ministry of Transportation
1A4 Residential-public-commercial sector	Fuel use	Energy Balance - Ministry of Production Activities
1B Fugitive Emissions from Fuel	Amount of fuel treated, stored, distributed	Energy Balance - Ministry of Production Activities Statistical Yearbooks - Ministry of Transportation Major National Industry Corporation.
2 Industrial processes	Production data	National Statistical Yearbooks- National Statistics Institute International Statistical Yearbooks-UN
3 Solvent Use	Amount of solvent use	National Environmental Publications - Sectoral industrial associations International Statistical Yearbooks - UN
4 Agriculture	Production data Number of animals Fertiliser consumption	Statistical Yearbooks - National Statistics Institute
5 Land use change and forestry	Forest and soil surfaces Amount of biomass Biomass burnt Biomass growth	Statistical Yearbooks - National Statistics Institute State Forestry Corps National and Regional Forestry Inventory Universities and research institutes
6 Waste	Amount of waste	Agency for the Protection of the Environment and for Technical Services-National Waste Observatory

Specific sector analyses are committed to ad hoc research teams or consultants when in depth investigation is needed and a high uncertainty in the estimates is present.
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 8.

Table 1.2 Methods and emission factors used in the inventory preparation

SUMMARY 3 SUMMARY REPORT FOR METHODS AND EMISSION FACTORS USED

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2		CH_4		N_2O		HFCs		PFCs		SF_6	
	Method applied (1)	Emission factor (2)	Method applied (1)	Emission factor (2)	Method applied (1)	Emission factor (2)	Method applied (1)	Emission factor (2)	Method applied (1)	Emission factor (2)	Method applied (1)	Emission factor (2)
1. Energy												
A. Fuel Combustion												
1. Energy Industries	T3	CS	T1	D	T3	D						
2. Manufacturing Industries and Construction	T1	CS	T2	D	T1	D						
3. Transport	T1, T2, C	CS	T1, T2, C	C, CS	T1, T2, C	C, CS						
4. Other Sectors	T1	CS	T2	C	T1	C						
5. Other	T1	CS	T2	C	T1	C						
B. Fugitive Emissions from Fuels												
1. Solid Fuels			T1	D, C, CS								
2. Oil and Natural Gas	T1	CS	T1, T3	CS								
2. Industrial Processes												
A. Mineral Products	D, T2	CS, PS										
B. Chemical Industry	D	C, PS	D	C, PS	D	D, PS						
C. Metal Production	D	C, CS	D	C, CS					T1, T2	PS	D	PS
D. Other Production												
E. Production of Halocarbons and SF_6							CS	PS	CS	PS	CS	PS
F. Consumption of Halocarbons and SF_6							T1a, CS	D, CS, PS	CS	PS	T1a, CS	CS, PS
G. Other												
3. Solvent and Other Product Use	C	C, CS			CS	CS						
4. Agriculture												
A. Enteric Fermentation			T1, T2	D, CS								
B. Manure Management			T1, T2	D, CS	D	D, CS						
C. Rice Cultivation			T2	CS								
D. Agricultural Soils					D	D, CS						
E. Prescribed Burning of Savannas												
F. Field Burning of Agricultural Residues			D	D	D	D						
G. Other												
5. Land-Use Change and Forestry												
A. Changes in Forest and Other Woody Biomass Stocks	T1, T2	D, CS										
B. Forest and Grassland Conversion												
C. Abandonment of Managed Lands												
D. CO_2 Emissions and Removals from Soil												
E. Other	T1, T2	D, CS	T1, T3	D, CS	T1, T3	D, CS						
6. Waste												
A. Solid Waste Disposal on Land			T2	D, CS								
B. Wastewater Handling			D	D	D	D, C						
C. Waste Incineration	D	CS	D	C	D	CS						
D. Other			CS	CS								
7. Other (please specify)												

(1) Use the following notation keys to specify the method applied: D (IPCC default), RA (Reference Approach), T1 (IPCC Tier 1), T1a, T1b, T1c (IPCC Tier 1a, Tier 1b and Tier 1c, respectively), T2 (IPCC Tier 2), T3 (IPCC Tier 3), C (CORINAIR), CS (Country Specific). If using more than one method, enumerate the relevant methods. Explanations of any modifications to the default IPCC methods, as well as information on the proper use of methods per source category where more than one method is indicated, and explanations on the country specific methods, should be provided in the documentation box of the relevant Sectoral background data table.
(2) Use the following notation keys to specify the emission factors used: D (IPCC default), C (CORINAIR), CS (Country Specific), PS (Plant Specific). Where a mix of emission factors has been used, use different notations in one cell with further explanation in the documentation box of the relevant Sectoral background data table.

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

In general, basic statistics for estimating emissions from the energy sector are fuel consumption published in the Energy Balance and provided by the Ministry of Production Activities. Additional information for electricity production is provided by the major national electricity producers and for the industry sector by the major national industry corporation. On the other hand, for the transport sector, 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 Statistics Institute and the Ministry of Transportation. Other data are communicated by different associations.

For the other sectors, i.e. industrial processes, the annual production is provided by national and international statistical yearbooks; 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 Statistics Institute. For land use change and forestry, forest and soil surfaces are provided by

the National Statistics Institute and the hectares burnt by State Forestry Corps. For waste, the main activity data are provided by the Agency for the Protection of the Environment and for Technical Services and the Waste Observatory.
In case basic data are not available proxy variables are considered in the estimation process; 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 Agency for the Protection of the Environment and for Technical Services.
After each reporting cycle, all database files, spreadsheets and electronic documents are archived so that the documentation and estimates could be traced back during the new year inventory compilation. Technical reports and emission figures are publicly accessible by website http://www.sinanet. apat.it/site/it-IT/Data_Service/Tipologie/Dati/ .

1.5 Brief description of key source categories

A key source analysis has been carried out according to the Tier 1 and Tier 2 methods described in the IPCC Good Practice Guidance (IPCC, 2000). A key source category is defined as an emission source that has a significant influence on a country's GHG inventory in terms of the absolute level of emissions, the trend in emissions, or both. Key source categories are those which, when summed together in descending order of magnitude, add up to over 95% of the total emissions.

Table 1.3 Key source categories by the IPCC Tier 1 and Tier 2 approaches (L=Level, T=Trend)

Key source categories	
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
CO_2 Cement production	L, T2
CH_4 Enteric Fermentation in Domestic Livestock	L, T
CH_4 from Solid waste Disposal Sites	L, T
Direct N_2O Agricultural Soils	L, T
N_2O Adipic Acid	L, T
Indirect N_2O from Nitrogen used in agriculture	L, T
N_2O Stationary combustion	L, T2
HFC, PFC substitutes for ODS	L, T
CO_2 Mobile combustion: Waterborne Navigation	L1, T2
CH_4 Fugitive emissions from Oil and Gas Operations	L, T
N_2O Manure Management	L, T2
CH_4 Manure Management	L, T
N_2O Mobile combustion: Road Vehicles	L, T
CO_2 Mobile combustion: Aircraft	T1
CO_2 Other industrial processes	T1
N_2O Nitric Acid	T1
CO_2 Mobile combustion: Other	T1
CO_2 Fugitive emissions from Oil and Gas Operations	L2, T1
N_2O from animal production	L2, T2
CH_4 Emissions from Wastewater Handling	L2, T2
CH_4 from Rice production	L2
CO_2 Emissions from solvent use	L2, T2
N_2O Emissions from solvent use	T2
CH_4 Stationary combustion	L2
N_2O Emissions from Wastewater Handling	T2

National emissions have been disaggregated, as far as possible, into the categories proposed in the Good Practice Guidance; other categories have been added to reflect specific national circumstances. Both level and trend analysis has been applied. As far as both level and trend emission sources are concerned, 29 key sources were totally individuated. Results are reported in Table 1.3. It should be noted that higher tiers are mostly used for calculating emissions from these sources as requested by the Good Practice Guidance (IPCC, 2000).

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

A specific QA/QC system is being developed in the framework of the establishment of the National System, but QA/QC techniques and different verification procedures are already applied as part of the inventory estimation process.

The Italian Atmospheric Emission Inventory and the Italian Greenhouse Gas Inventory are compiled and maintained by the Agency for the Protection of the Environment and for Technical Services which is the Inventory Agency responsible for data submission. The whole inventory is compiled by the agency; 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.

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* control activities related to completeness, consistency in the time series and correctness in the sum of sub-categories, specific quality control activities regard the accurate check of figures and documentation of those cases where methodological and data changes result in recalculations. Particular attention is also paid to the archiving and storing of all inventory data, supporting information, inventory records as well as all the reference documents.

Data entries are checked several times during the compilation of the inventory; special attention is paid to sources which show significant changes from a year to another or new sources. Final checks involve a consistency check on the whole time series. When revisions of estimation methodologies are applied, emissions are recalculated for the entire time series as a matter of course.

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, while all information and documentation are stored at the Agency so as to be consulted whenever needed. After each reporting cycle, all database files, spreadsheets and electronic documents are archived and documentation and estimates could be consulted during the new year inventory compilation.

Quality assurance procedures regard some verification activities of the inventory as a whole and at sectoral level. Drawbacks derive, in particular, from the communication of data to different institutions and/or at local level. 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 Yearbook published by the Agency; they are also published

by the Ministry of Environment in the Report on the State of the Environment and communicated to the National Institute of Statistics to be published in their Environmental Statistics Yearbooks and used in the framework of the EUROSTAT NAMEA Project.
Comparisons of national activity data with data from international databases are usually carried out in order to find out the main differences and an explanation to them; this results in a better understanding and detail of the basic data. Such a comparison has mainly regarded data for the agriculture and industrial processes sectors. The results are reported in the specific chapters. Additional comparisons of emission estimates from industrial sectors with those published by the industry itself in the Environmental reports are carried out annually in order to assess the quality and the uncertainty of the estimates.
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, a study was carried out by Ecofys. 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).
The quality of the inventory has also improved by the organization and participation in sector specific workshops. Furthermore, follow-up processes are set up in the framework of the WGI under the EC Monitoring Mechanism, which has up to now addressed to the improvement of methodologies in the waste sector as well methodologies to estimate emissions from international bunkers. Regarding this last point, national methodologies used to estimate emissions from aviation and marine bunkers were explained by the different countries at a specific European workshop on bunker fuels which involved the International Energy Agency and EUROCONTROL. The workshop aimed at comparing methodologies and discussed the most common problems among countries which is the split of fuel into domestic and international. For the waste sector, a workshop was held on methodologies to estimate emissions and projections from different countries. The European Topic Center on Resource and Waste Management was also involved and documentation is available on the website at the ETC/ACC web site: http://air-climate.eionet.eu.int/meetings/past_html.
International reviews also contribute to improve the inventory and identify areas where further improvements are needed. Specifically, the Italian GHG inventory was subjected to a centralised review by the UNFCC Secretariat; in response recalculation tables for all years have been provided and source not previously estimated have been included.
A specific procedure undertaken for improving the inventory regards the establishment of national expert panels (specifically, in road transport, land use change and forestry and energy production sectors) which involve, on a voluntary basis, different institutions, local agencies and industrial associations which cooperate for improving activity data and emission factors accuracy.

Specific activities relating to improvements of the inventory and QA/QC carried out in the last year were:

- *Waste Sector Emissions Review.* A revision of emissions from solid waste disposal on land, specifically a study on the average degradable organic carbon on the basis of the waste composition in Italy and on the landfill gas recovery system in Italy has been carried out.
- *Solvent and Other Product Use*. N_2O emissions from the use of N_2O for anaesthesia and from aerosol cans were estimated on account of new information made available from the Italian manufacturers and distributors association of N_2O products and the Italian Association of Aerosol Producers.
- *Energy Balance Verification.* The task force of energy and inventory experts (Ministry of

Production Activities, ENEA and APAT) established to examine differences in basic data between the CRF and the joint EUROSTAT/IEA/UNECE questionnaire submissions and to improve the details of the National Energy Balance finalised its study and reported the results in the document "Energy data harmonization for CO_2 emission calculations: the Italian case" (ENEA/MAP/APAT, 2004).

- *Road Transport Emissions Review.* The Italian Expert Panel on Transport, which includes experts from Research Institutes, Universities, Industrial Associations, Local Authorities, Ministries and Public Authorities, has continued its work on the improvement and assessment of emission estimations from road transport. Specifically, this year the group was organised in sub-groups according to different subjects of interest. There has been a considerable improvement on the details of basic data to be used within the COPERT model, both in terms of availability and timeliness. Studies of the expert panel group as well as presentations held in different meetings can be found on the website www.inventaria.sinanet.apat.it/ept.
- *MeditAIRaneo Project.* A three years project involving the Inventory Reference Centres of the European Mediterranean Countries (Italy, Spain, France, Greece, Portugal) started at the end of the year 2000. The aim was to examine in details emissions that are specific and/or typical of the Mediterranean Countries. Four different studies on air emissions from vegetation, agriculture, solvent use and urban road transport in Mediterranean areas were funded by APAT, some of which are still in progress. Common objectives are analysis of methodologies and emission factors used by Mediterranean countries for estimating emissions, individuation of Mediterranean peculiarities, in comparison with other European countries, such as climate, technologies, industrial management, identification of methodological points which need in-depth examination and uncertainty assessment. An Italian case study is also planned for each of the four projects. By 2006, all the projects will be concluded and the results will be used in the national inventory to improve country-specific emission factors.
- Data from the Italian Pollutant Emission Register (EPER) from some industrial sectors were used as a check and comparison with the estimates carried out at national level. In particular, this regards the production of non-ferrous metals, chemical productions such as nitric and sulphuric acid, and the production of iron and steel.
- At the national level, a lot of meetings with industry representatives were held in the process of implementing the emission trading directive; this resulted in a better understanding of some processes and the improvement of national emission factors and activity data. Specifically, this was the case of emissions from refineries, production of lime and cement, iron and steel, primary aluminium, bricks and tiles. For these sectors, the first database from the Emission Trading Scheme was analysed.
- *Local inventories*. A study on the top-down approach to the preparation of local inventories was conducted and Italian emissions for different local areas were derived. The results were checked out by regional and local environmental agencies and authorities in order to find out the main weak points and contribute with information available to characterise the local environment, this contributing as well as a feedback to the improvement of the national inventory. Final estimates and the detailed methodologies followed for each SNAP sector to carry out emission figures are published in a technical report (Liburdi et al., 2004).

Further improvements in 2005 will concern: the analysis of sectoral industrial data from the Italian Emission Trading Scheme database, specifically for the iron and steel and cement sectors; on going work jointly with the industrial association to improve N_2O emission estimates from the solvent and

other product use sector; a revision of the factors and parameters for the estimation of CH_4 emissions from enteric fermentation taking into consideration the results from MediterAIRaneo project.

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

The IPCC Good Practice Guidance (IPCC, 2000) defines the Tier 1 and Tier 2 approaches to estimating uncertainties in national greenhouse gas inventories. At the moment, quantitative estimates of the uncertainties for the Italian GHG inventory are calculated using a Tier 1 approach, which provides a simplified calculation based on the error propagation equations, whilst a Tier 2 approach, corresponding to the application of Monte Carlo analysis, will be applied in the next submissions. With this regard, a specific study on the comparison of different methodologies which can be used to evaluate uncertainty of emissions was finalised (Romano et al., 2004).
The results of the Tier 1 approach are shown in Annex 1. Emission sources are disaggregated into a detailed level and uncertainties are then estimated for these categories.
The Tier 1 approach suggests an uncertainty of 3.2% in the combined GWP total emissions in 2003. The analysis also estimates an uncertainty of 2.4% in the trend between 1990 and 2003.
For the LULUCF sector, the Tier 1 approach has also been applied, which results in a value of uncertainty equal to 71% for the year 2003, whereas the uncertainty for the trend is estimated to be 30%.

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.
Table 1.4 summarizes the sectoral coverage of the GHG emissions in the Italian inventory.

Table 1.4 Completeness of the Italian GHG inventory

TABLE 7 OVERVIEW TABLE [1] FOR NATIONAL GREENHOUSE GAS INVENTORIES - COMPLETENESS AND QUALITY OF ESTIMATES

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2		CH_4		N_2O		HFCs		PFCs		SF_6		NO_x		CO		NMVOC		SO_2	
	estimate	quality	estimate	quality	estimate	quality	estimate	quality	estimate	quality	estimate	quality	estimate	quality	estimate	quality	estimate	quality	estimate	quality
Total National Emissions and Removals																				
1 Energy																				
A. Fuel Combustion Activities																				
Reference Approach	ALL	H																		
Sectoral Approach																				
1. Energy Industries	ALL	H											ALL	H	ALL	M	ALL	H	ALL	H
2. Manufacturing Industries and Construction	ALL	H	ALL	M	ALL	M							ALL	H	ALL	M	ALL	H	ALL	H
3. Transport	ALL	H	ALL	M	ALL	M							ALL	H	ALL	M	ALL	H	ALL	H
4. Other Sectors	ALL	H	ALL	M	ALL	M							ALL	H	ALL	M	ALL	H	ALL	H
5. Other	ALL	H	ALL	M	ALL	M							ALL	H	ALL	M	ALL	H	ALL	H
B. Fugitive Emissions from Fuels																				
1. Solid Fuels	NO		ALL	M	NO															
2. Oil and Natural Gas	ALL	M	ALL	H	NO								ALL	H	ALL	M	ALL	H	ALL	M
2 Industrial Processes																				
A. Mineral Products	ALL	M	NO		NO								NO		NO		ALL	H	ALL	M
B. Chemical Industry	ALL	M	ALL	M	ALL	M	NO		NO				ALL	H	ALL	M	ALL	H	ALL	M
C. Metal Production	ALL	M	ALL	M	NO				ALL	H	ALL	H	ALL	H	ALL	M	ALL	H	ALL	M
D. Other Production	ALL	M											ALL	H	NO		ALL	H	ALL	M
E. Production of Halocarbons and SF_6							ALL	M	ALL	H	ALL	H								
F. Consumption of Halocarbons and SF_6																				
Banked [2]							ALL	M	NE		ALL	H								
Actual [2]							ALL	M	ALL	H	ALL	H								
G. Other	NO		NO		NO		NO		NO		NO		NO		NO		NO		NO	
3 Solvent and Other Product Use	ALL	H			ALL	H							NO		NO		ALL	H	NO	
4 Agriculture																				
A. Enteric Fermentation			ALL	H																
B. Manure Management			ALL	H	ALL	H											ALL	H		
C. Rice Cultivation			ALL	H													NO			
D. Agricultural Soils	NO		NO		ALL	H											NO			
E. Prescribed Burning of Savannas			NO		NO								NO		NO		NO		NO	
F. Field Burning of Agricultural Residues			ALL	M	ALL	M							ALL	H	ALL	M	ALL	H	NO	
G. Other			NO		NO								NO		NO		NO		NO	
5 Land-Use Change and Forestry																				
A. Changes in Forest and Other Woody Biomass Stocks	ALL	H																		
B. Forest and Grassland Conversion	NO		NO		NO								NO		NO		NO		NO	
C. Abandonment of Managed Lands	ALL	M																		
D. CO_2 Emissions and Removals from Soil																				
E. Other	ALL	M	ALL	M	ALL	M							ALL	H	ALL	M	ALL	H	ALL	M
6 Waste																				
A. Solid Waste Disposal on Land	NO		ALL	M											NO		ALL	H		
B. Wastewater Handling			ALL	M	ALL	M							NO		NO		NO			
C. Waste Incineration	ALL	M	ALL	M	ALL	M							ALL	H	ALL	M	ALL	H	ALL	M
D. Other	NO		ALL	M	NO								NO		NO		ALL	H	NO	
7 Other (please specify)	NO		NO		NO		NO		NO		NO		NO		NO		NO		NO	
Memo Items:																				
International Bunkers																				
Aviation	ALL	H	ALL	M	ALL	M							ALL	H	ALL	M	ALL	H	ALL	H
Marine	ALL	H	ALL	M	ALL	M							ALL	H	ALL	M	ALL	H	ALL	H
Multilateral Operations	NE		NE		NE								NE		NE		NE		NE	
CO_2 Emissions from Biomass	ALL	H																		

(1) This table is intended to be used by Parties to summarise their own assessment of completeness (e.g. partial, full estimate, not estimated) and quality (High, medium, low) of major source/sink inventory estimates. The latter could be understood as a qualitative assessment of the uncertainty of the estimates. This table might change once the IPCC completes its work on managing uncertainties of GHG inventories. The title of the table may deviate consistency with the current table in the IPCC Guidelines.

Note: To fill in the table use the notation keys as given in the IPCC Guidelines (Volume 1, Reporting Instructions, Tables 7.1).

Sectoral and background tables of CRF sheets are complete as far as the details of basic information are available. For instance, for emissions from the military sector, sources are not distinguished between stationary and mobile but only mobile emissions are reported separately; stationary emissions are, on the other hand, included in commercial/institutional sector (1.A.4.a).

As compared to the last year submission, CH_4 emissions from waste incineration both for biogenic and plastics and other non-biogenic waste and N_2O emissions from other solvent use have been estimated. Potential emissions of PFCs are not estimated because no information on import-export is available at the moment. Multilateral operations emissions are not estimated because no activity data are available.

For fugitive emissions, CH_4 emissions from oil exploration and venting are included in those from oil production because no detailed information is available. Emissions from transport and distribution of oil result as not occurring or negligible. CH_4 emissions from gas exploration are also included in those from production while other leakage emissions are included in distribution emission estimates. Further investigation will be carried out closely with industry about these figures. CH_4

emissions from gas venting are included with natural gas under 1.B.2.b, production, as not separately supplied by the relevant industries. For industrial processes, emissions from soda ash use are included in glass and paper production emissions because the use of soda is part of that specific production process.

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 1990-2003 are reported in Annex 7 in Tables A7.1- A7.5.
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. In agreement with the Convention on Climate Change, the National Greenhouse Gas Inventory is communicated through compilation of the Common Reporting Format.
Total greenhouse gas emissions, in CO_2 equivalent, excluding emissions and removals of CO_2 from land use change, have increased by 11.4% between 1990 and 2003, varying from 511 to 570 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.
The most important greenhouse gas, CO_2, which accounts for 85.5% of total emissions in CO_2 equivalent, shows an increase by 13.2% between 1990 and 2003. In the energy sector, in particular, emissions in 2003 are 13.1% greater than in 1990.
CH_4 and N_2O emissions are equal, respectively, to 6.1% and 7.4% of the total CO_2 equivalent greenhouse gas emissions. CH_4 emissions have fallen by 9.6% from 1990 to 2003, while N_2O has increased by 6.1%.
Other greenhouse gases, HFCs, PFCs and SF_6, range from 0.3% to 1% of total emissions; at present, variations in these gases are not relevant to reaching the emission reduction objectives. Figure 2.1 illustrates the national trend of greenhouse gases for 1990-2003, expressed in CO_2 equivalent terms and by substance; CO_2 emissions do not include emissions and removals from land use change.

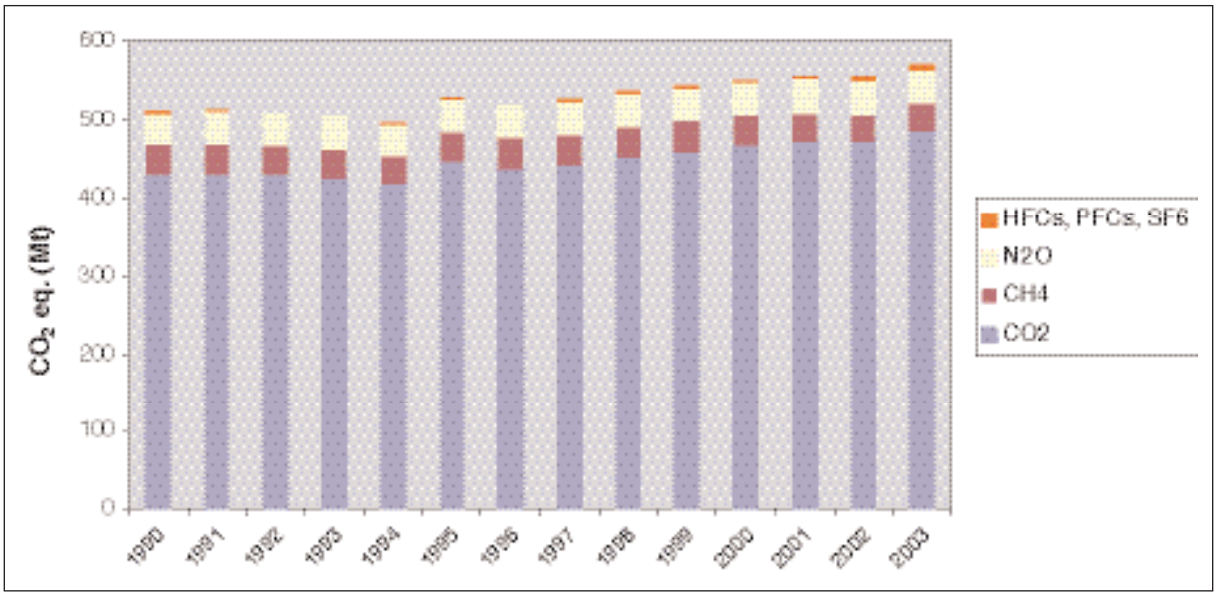

Figure 2.1 National greenhouse gas emissions from 1990 to 2003

The share of the different sectors in terms of total emissions remains nearly unvaried over the period 1990-2003. Specifically for the year 2003, the greatest part of the total greenhouse gas emissions is to be attributed to the energy sector, with a percentage of 84%, followed by agriculture and industrial processes, both accounting for 7% of total emissions, waste and use of solvents. Figure 2.2 shows the total greenhouse gas emissions subdivided by sector.

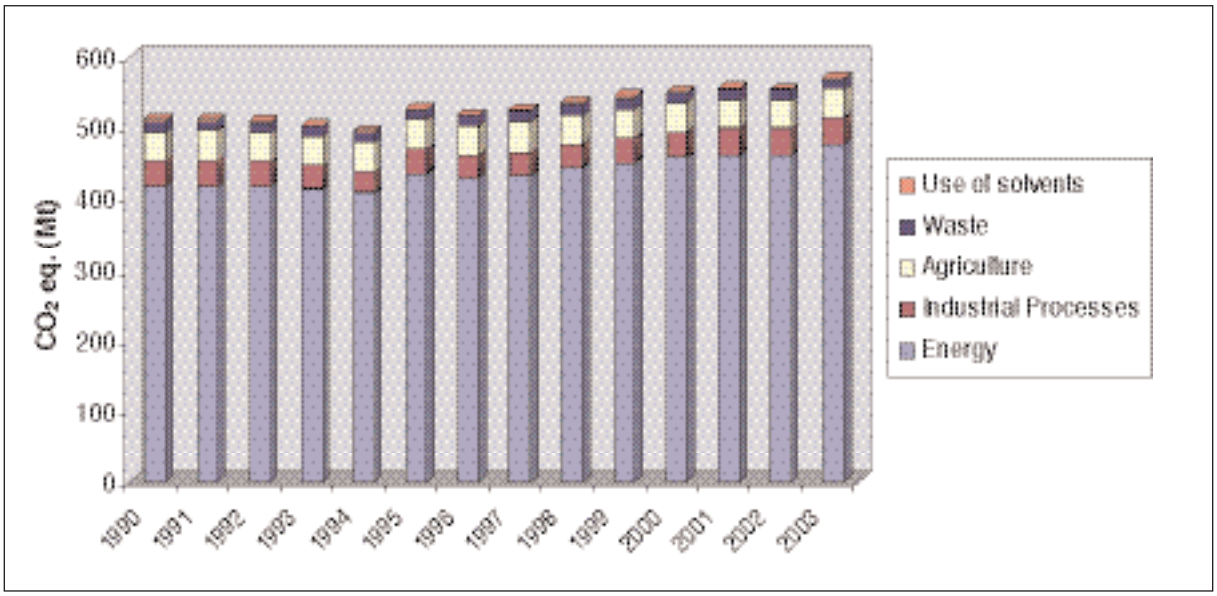

Figure 2.2 Greenhouse gas emissions from 1990 to 2003 by sector

2.2 Description and interpretation of emission trends by gas

2.2.1 Carbon dioxide emissions

CO_2 emissions, excluding emissions and removals from land use change and forestry, have increased by approximately 13% from 1990 to 2003, ranging from 431 to 487 million tons.
The most relevant emissions derive from the energy industries (33%) and transportation (26%). Manufacturing and construction industries and non-industrial combustion account for 17% each, while the remaining emissions derive from industrial processes (5%) and other sectors (1%). The performance of CO_2 emissions by sector is shown in Figure 2.3.

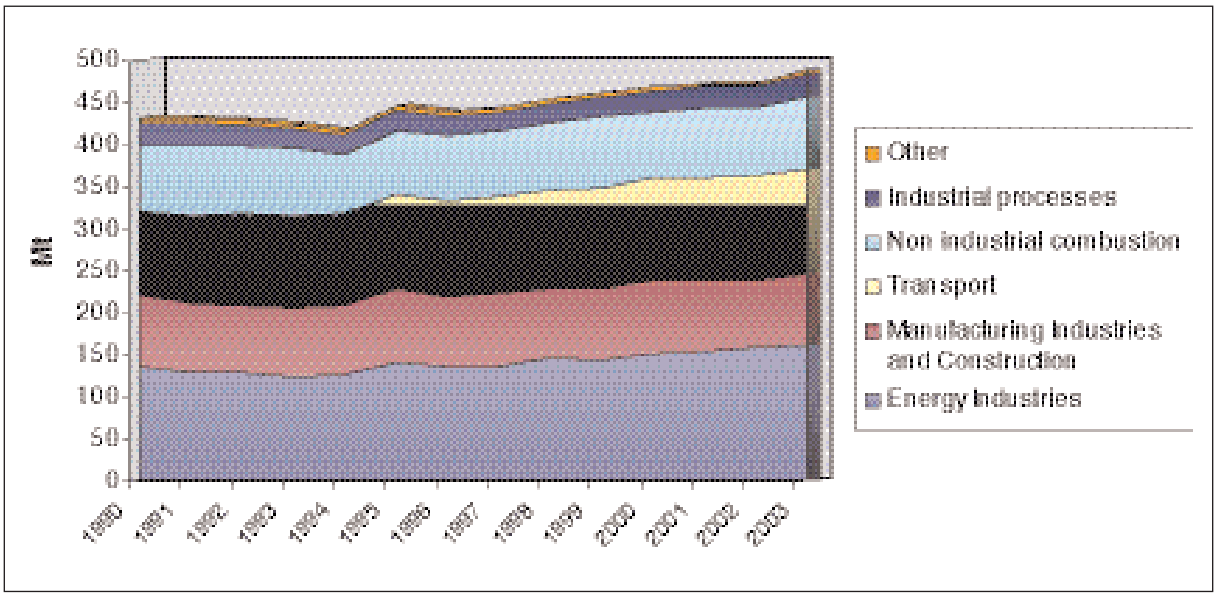

Figure 2.3 National emissions of CO_2 by sector from 1990 to 2003

The main sectors responsible for the increase of CO_2 emissions are transport and energy industries; in particular, emissions from transport have increased by 24% from 1990 to 2003 while those from energy industries by 19%. Non industrial combustion emissions have increased by 10%, minor increases are also observed for the industrial processes and manufacturing industries and construction, whereas emissions in the 'Other' sector, mostly fugitive emissions from oil and natural gas and emissions from solvent and other product use, reduced by 24%.

Figure 2.4 illustrates the performance of the following economic and energy indicators:
• Gross Domestic Product (GDP) at market prices as of 1995 (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, with a decoupling between the curves 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 stopped in 2002, due to the increase of coal consumption in power plants. In the last year, in spite of the decrease in the GDP level, emissions continue to follow the positive trend.

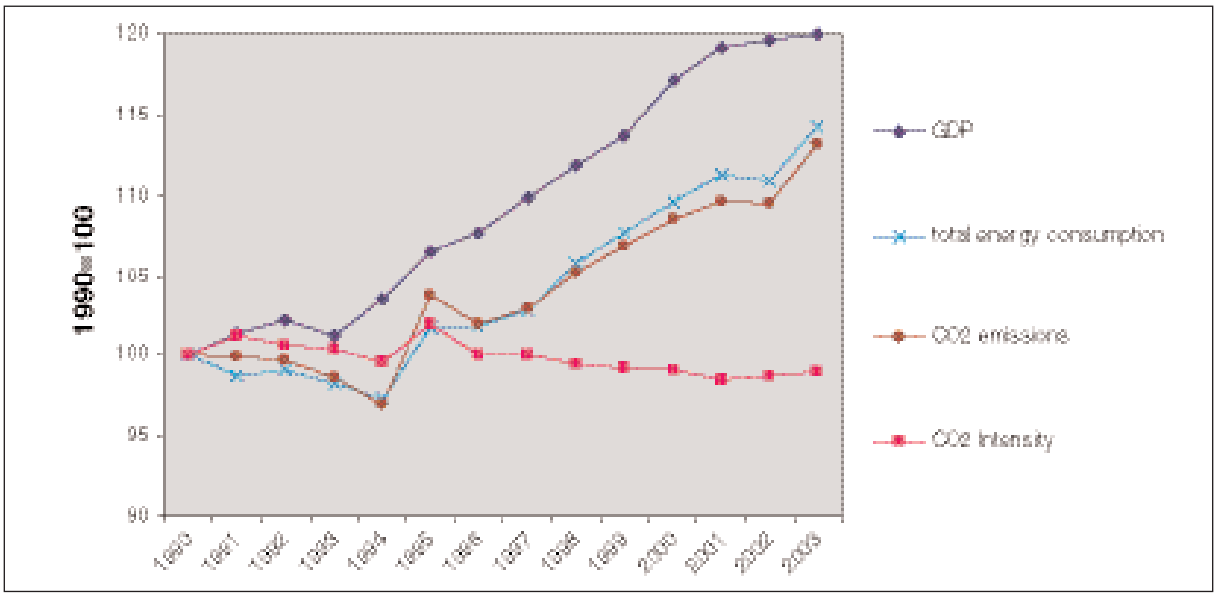

Figure 2.4 Energy-related and economic indicators and CO_2 emissions

2.2.2 Methane emissions

Methane emissions in 2003 represent 6.1% of total greenhouse gases, equal to 34.6 Mt in CO_2 equivalent, and show a decrease of approximately 3 Mt compared to 1990.

CH_4 emissions are mainly originated from the agricultural sector, which accounts for 47% of total methane emissions, as well as to the management of waste (32.9%) and to energy (19.6%).

Emissions in the agricultural sector regard mainly the breeding of animals and rice cultivation. The agriculture sector shows a decrease of emissions equal to 8.9% as compared to 1990.

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 small decrease in emission levels (-0.4% compared to 1990).

In terms of CH_4 emissions in the energy sector, the reduction (-18%) is the result of two different factors; on the one hand there has been a considerable reduction in emissions caused by leakage from the extraction and distribution of fossil fuels, due to the gradual replacement of natural-gas distribution networks; at the same time, combustion emissions in the road transport sector have decreased on account of the new vehicle-fleet, whereas, in the civil sector, they increased, as the result of increasing use of methane in heating systems.

Figure 2.5 shows the emission figures by sector.

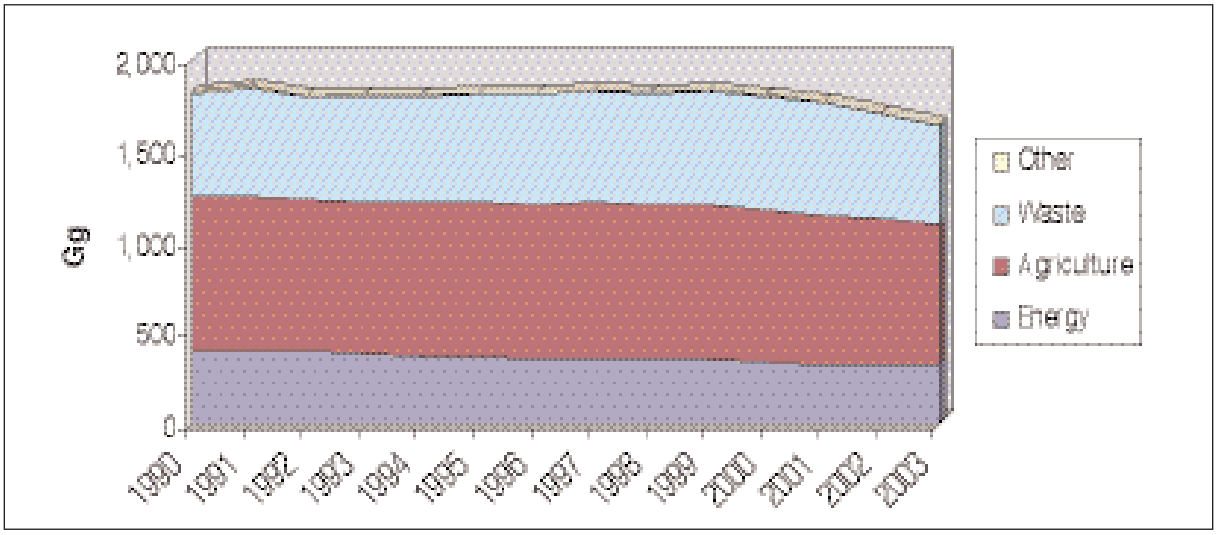

Figure 2.5 National CH_4 emissions by sector from 1990 to 2003

2.2.3 Nitrous oxide emissions

In 2003 nitrous oxide emissions represent 7.4% of total greenhouse gases, with a growth rate of 6.1% between 1990 and 2003, from 39.9 to 42.4 CO_2 equivalent Mt.

The major source of N_2O emissions is the agricultural sector (52.9%), 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 1.2% during the period 1990-2003.

Emissions in the energy-use sector (25.6% of the total) show an increase by approximately 27% from 1990 to 2003; this growth can be traced primarily to the road transport sector and 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.

The production of nitric acid, which has decreased in recent years, and of adipic acid, whose levels have grown, account totally for 16.7% of total emissions.

Other emissions in the waste sector primarily regard the processing of industrial and domestic waste-water.

Figure 2.6 shows national emission figures by sector.

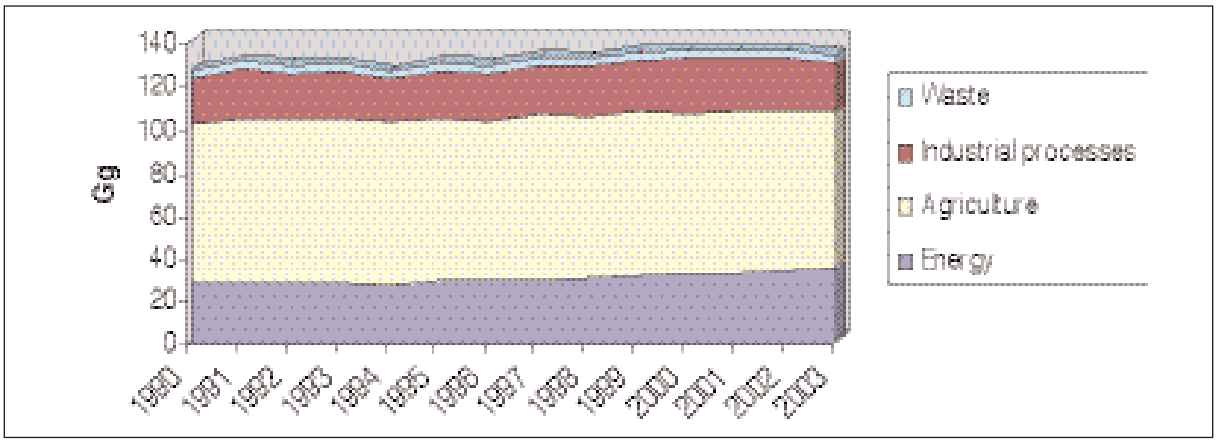

Figure 2.6 National N_2O emissions by sector from 1990 to 2003

2.2.4 Fluorinated gas emissions

Italy has set 1995 as the base year for reduction in the emissions of the fluorinated gases covered by the Kyoto Protocol, that's HFCs, PFCs and SF_6. Taken altogether, the emissions of fluorinated gases represent 0.97% of total greenhouse gases in CO_2 equivalent in 2003, and they show an increase of 245% between 1995 and 2003. This increase is the result of different features for different gases.
HFCs, for instance, have increased considerably from 1995 to 2003, from 0.7 to 4.6 CO_2 equivalent Mt. 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 replacements for gases that destroy the ozone layer and to the greater use of air conditioners in automobiles.
Emissions of PFCs have risen by approximately 47% from 1995 to 2003. The level of these emissions in 2003 is 0.3 Mt in CO_2 equivalent, and it can be traced in equal proportion to the use of the gases in the production of aluminium and in the production of semiconductors. 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 0.5 Mt in CO_2 equivalent in 2003, with a decrease of 19% compared to 1995. Out of the SF_6 emissions, 28% can be traced to the use of gas in magnesium foundries, 60% to the gas contained in electrical equipments. The rest of the emissions results from the gas use in the production of semiconductors. The gas use both in magnesium foundries has been on the rise in recent years, unlike the figures for the gas contained in electrical equipments, which have fallen.
The National Inventory of fluorinated gases has largely improved in terms of the sources and the gases identified. Further in-depth examination and controls are required but higher methods have been applied and some difficulties in procuring activity data from the industry overcome. Nevertheless, uncertainty still regards some activity data which are considered of strategic economic importance and therefore kept confidential.

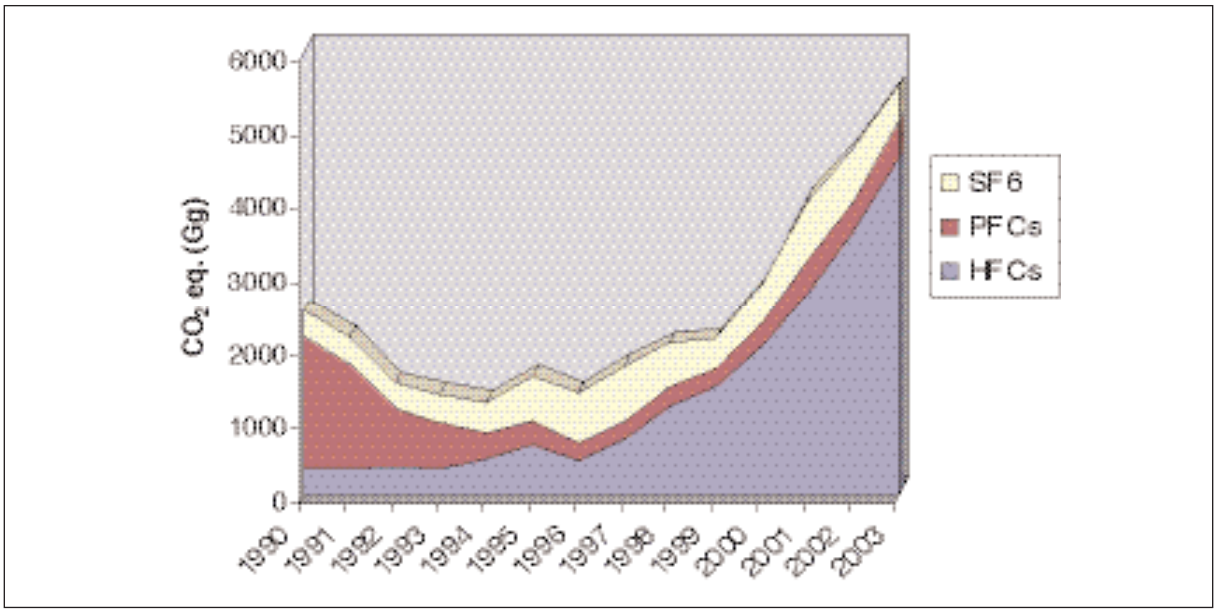

Figure 2.7 National emissions of fluorinated gases by sector from 1990 to 2003

2.3 Description and interpretation of emission trends by source

2.3.1 Energy

Emissions in CO_2 equivalent from the energy sector are reported in Table 2.1 and Figure 2.8.

Table 2.1 Total emissions in CO_2 equivalent from the energy sector by source (1990-2003)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
							Gg							
Total emissions														
CO_2 eq	**418,964**	**419,099**	**417,559**	**415,082**	**408,391**	**435,379**	**430,223**	**434,191**	**444,108**	**450,928**	**457,723**	**461,368**	**461,141**	**476,467**
Fuel Combustion (Sectoral Approach)	409,164	409,516	407,958	405,568	399,254	427,424	422,039	425,819	435,886	443,922	450,089	454,296	454,553	469,302
Energy Industries	*136,951*	*131,357*	*131,112*	*125,971*	*127,716*	*141,962*	*137,095*	*138,322*	*148,426*	*145,109*	*152,329*	*155,505*	*161,817*	*163,382*
Manufacturing Industries and Construction	*86,730*	*84,320*	*82,080*	*83,141*	*84,671*	*89,599*	*86,235*	*89,608*	*82,851*	*88,152*	*90,800*	*87,191*	*81,657*	*86,854*
Transport	*104,357*	*106,909*	*111,351*	*113,170*	*113,148*	*115,146*	*116,509*	*118,376*	*122,487*	*123,988*	*124,487*	*126,844*	*129,220*	*130,400*
Other Sectors	*80,011*	*85,661*	*82,061*	*81,752*	*72,181*	*79,211*	*80,962*	*78,221*	*81,031*	*85,518*	*81,622*	*84,391*	*81,536*	*87,964*
Other	*1,114*	*1,269*	*1,355*	*1,533*	*1,537*	*1,507*	*1,238*	*1,292*	*1,092*	*1,154*	*851*	*365*	*322*	*701*
Fugitive Emissions from Fuels	9,801	9,553	9,443	9,367	8,938	8,581	8,277	8,455	8,434	7,608	7,736	7,385	6,968	7,587
Solid Fuels	*122*	*112*	*112*	*82*	*71*	*65*	*60*	*60*	*55*	*53*	*73*	*81*	*78*	*95*
Oil and Natural Gas	*9,679*	*9,441*	*9,331*	*9,285*	*8,866*	*8,516*	*8,217*	*8,396*	*8,378*	*7,556*	*7,663*	*7,304*	*6,890*	*7,492*

An upward trend is noted from 1990 to 2003. Substances with the highest increase rate are CO_2, whose levels have increased by 14.2% from 1990 to 2003 and account for 96% of the total, and N_2O which shows an increase of 22% but its share out of the total is only 2%; CH_4, on the other hand, shows a decrease of 18.1% from 1990 to 2003 but this is not relevant on total emissions, accounting only for 1%.
Totally emissions from this sector increase by 13.7% from 1990 to 2003.
Details on these figures are described in the specific chapter.
It should be noted that the most significant increase, in terms of total CO_2 equivalent, is observed in the transport and energy industries sectors, about 25% and 19.3%, respectively, from 1990 to 2003; these sectors, altogether, account for more than 60% of total emissions.

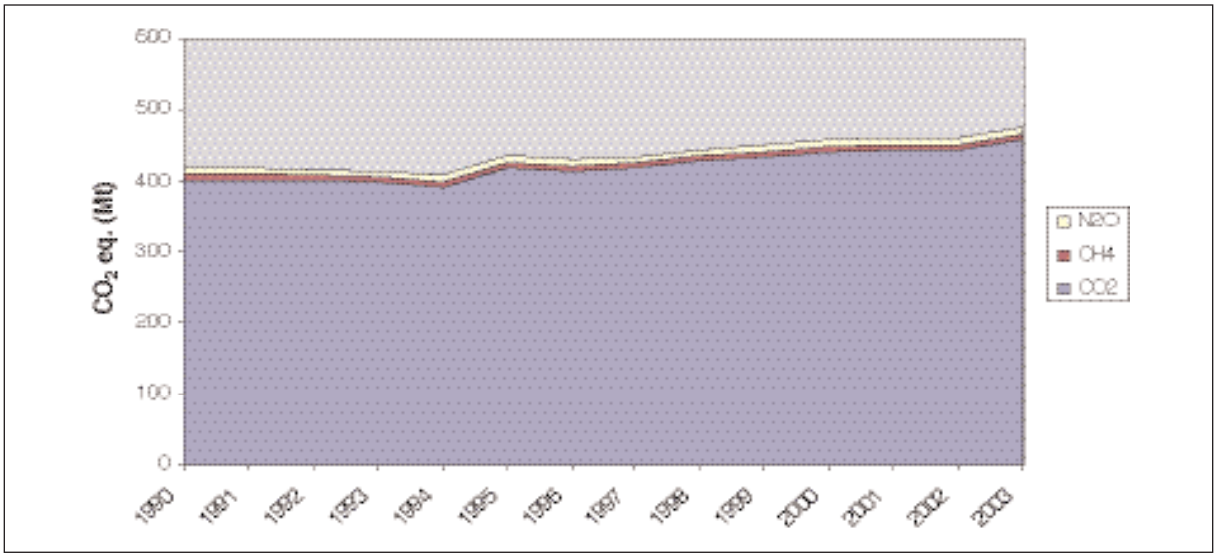

Figure 2.8 Trend of total emissions in CO_2 equivalent from the energy sector by gas (1990-2003)

2.3.2 Industrial processes

Emission trends from industrial processes are reported in Table 2.2 and Figure 2.9.
Total emission levels, in CO_2 equivalent, show an increase of 19%, from the base year to 2003. Taking into account emissions by substance, CO_2 and N_2O levels increased by 1% and 5%, respectively; these two substances account altogether for about 86% of the total emissions from industrial processes. A considerable increase is observed in F-gas emissions (245%) and the share of these gases on the total emissions is 14%.
Details for industrial processes emissions can be found in the specific chapter.

Table 2.2 Total emissions in CO_2 equivalent from industrial processes sector by gas (1990-2003)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
							Gg							
Total emissions														
CO_2 eq	**35,614**	**35,253**	**34,645**	**31,588**	**30,319**	**33,660**	**31,041**	**31,876**	**32,500**	**33,305**	**35,709**	**37,477**	**37,665**	**39,210**
CO2	26,266	25,887	26,432	23,497	22,733	24,789	22,701	23,123	23,321	23,862	24,997	25,610	25,428	26,536
CH4	108	104	101	102	106	113	63	68	65	64	63	60	57	58
N2O	6,748	7,128	6,595	6,632	6,228	7,150	6,901	6,950	7,058	7,264	7,804	7,801	7,467	7,061
HFCS	351	355	359	355	482	671	450	755	1,181	1,452	2,005	2,759	3,561	4,575
PFCS	1,808	1,423	799	631	355	337	243	252	270	258	346	452	414	494
SF6	333	356	358	370	416	601	683	729	605	405	493	795	738	486

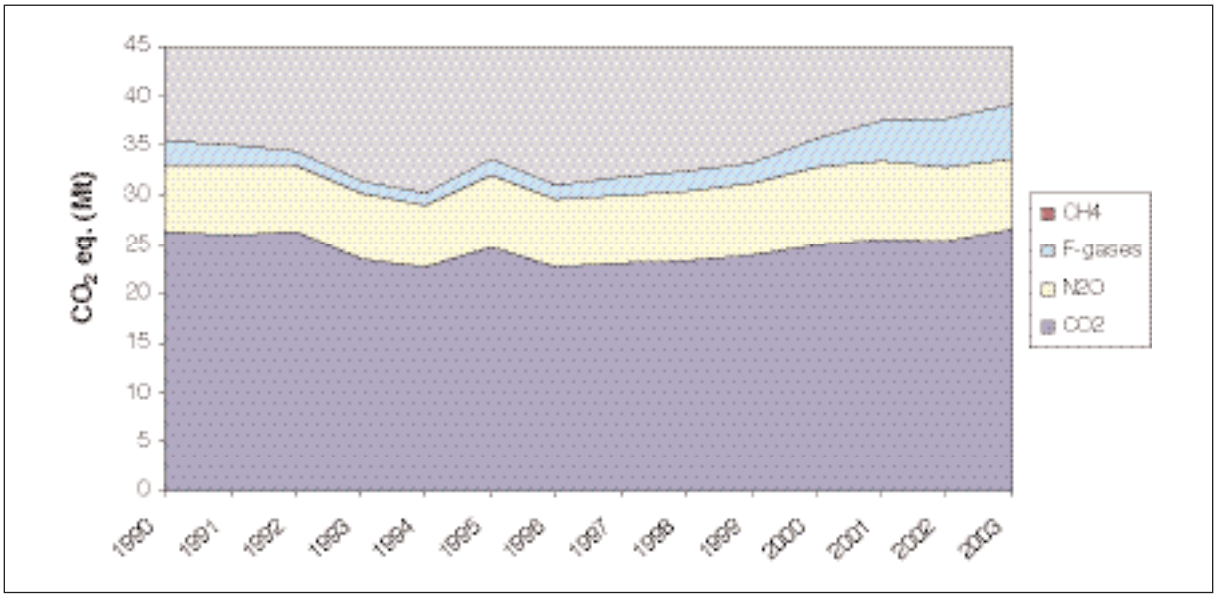

Figure 2.9 Trend of total emissions in CO_2 equivalent from industrial processes by gas (1990-2003)

2.3.3 Solvent and other product use

Emissions from the solvent and other product use sector refer to CO_2 and N_2O, except for gases other than greenhouse.
A considerable amount of emissions from this sector is, in fact, also to be attributed to NMVOC. The share of CO_2 emissions, in this sector, is 61% out of the total; the decrease by 28% from 1990 to 2003 is to be attributed to different sources. Emission levels from paint application sector, which

accounts for 52% of total CO_2 emissions from this sector, decreased by 18%; emissions from other use of solvents in related activities, such as domestic solvent use other than painting, printing industries, vehicle dewaxing, which account for 42% of the total, show a decrease of 24%. Finally, emissions from metal decreasing and dry cleaning activities, decreased by 57% but they account for only 6% of the total.

In 2003, solvent use is responsible for 0.3% of the total CO_2 emissions (not considering CO_2 from LUCF) and 37.2% of the total NMVOC emissions, and represents the second source of anthropogenic NMVOC national emissions.

The N_2O emissions, in 2003, represent about 2% of the total N_2O national emissions.

Emissions from paint application and other use of solvents for NMVOC and CO_2 are more than 80% and 90% of the total in the sector respectively.

From 1990 to 1995, a constant level of N_2O emissions is observed, afterwards from 1995 to 1998 emissions increased by 37%. From 1999, there appears to be a reduction in N_2O emissions, due to a decrease in the anaesthetic use of N_2O, that has been replaced by halogen gas.

Further details about this sector can be found in the specific chapter.

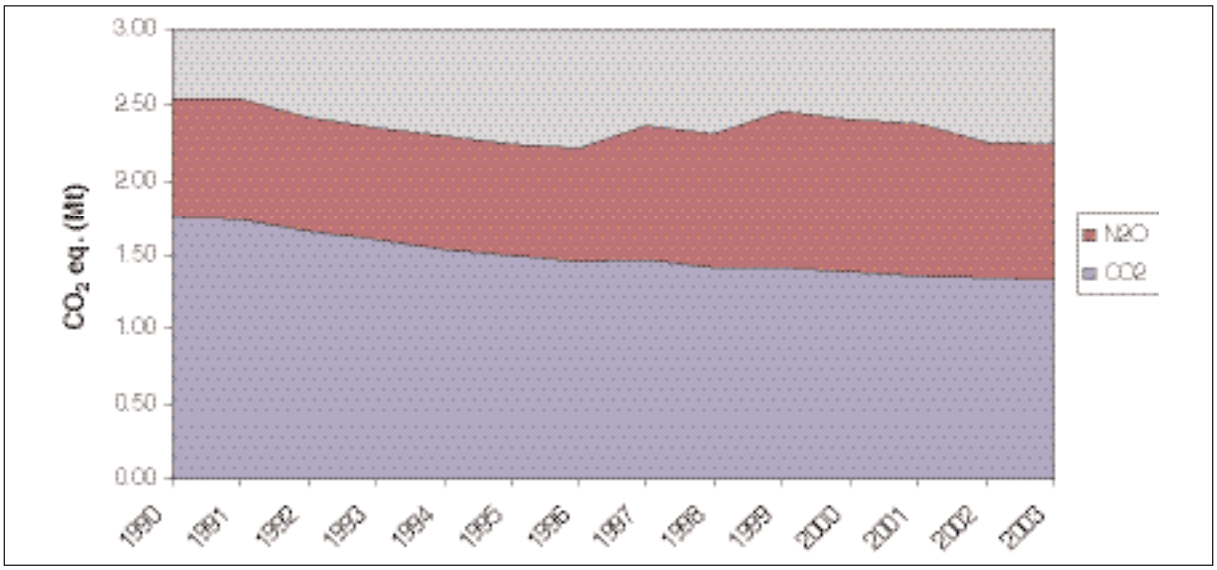

Figure 2.10 Trend of total emissions in CO_2 equivalent from the solvent and other product use sector (1990-2003)

2.3.4 Agriculture

Emissions from the agriculture sector are reported in Table 2.3 and Figure 2.11.

Table 2.3 Total emissions in CO2 equivalent from the agricultural sector by source (1990-2003)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
							Gg							
Total emissions														
CO_2 eq	**40,618**	**41,877**	**41,610**	**41,929**	**41,480**	**41,395**	**41,191**	**42,279**	**41,591**	**41,875**	**40,981**	**40,334**	**40,176**	**38,747**
Enteric Fermentation	12,341	12,734	12,380	12,255	12,295	12,476	12,478	12,545	12,481	12,513	12,249	11,750	11,645	10,933
Manure Management	7,855	7,997	7,759	7,708	7,622	7,867	7,943	7,989	8,094	8,184	7,913	8,154	8,099	7,793
Rice Cultivation	1,539	1,474	1,545	1,655	1,685	1,709	1,696	1,663	1,590	1,577	1,574	1,554	1,562	1,562
Agricultural Soils	18,866	19,655	19,908	20,293	19,860	19,327	19,056	20,067	19,407	19,584	19,229	18,861	18,854	18,444
Field Burning of Agricultural Residues	17	19	18	17	18	17	18	16	18	17	16	15	17	15

Emissions refer to CH_4 and N_2O levels, which account for 42% and 58% of the total emission of the sector, respectively. The small decrease observed in the total emissions (-5%) is mostly due to the decrease of CH_4 emissions from enteric fermentation (-11%) which account for 28% of the total emissions. Detailed comments can be found in the specific chapter.

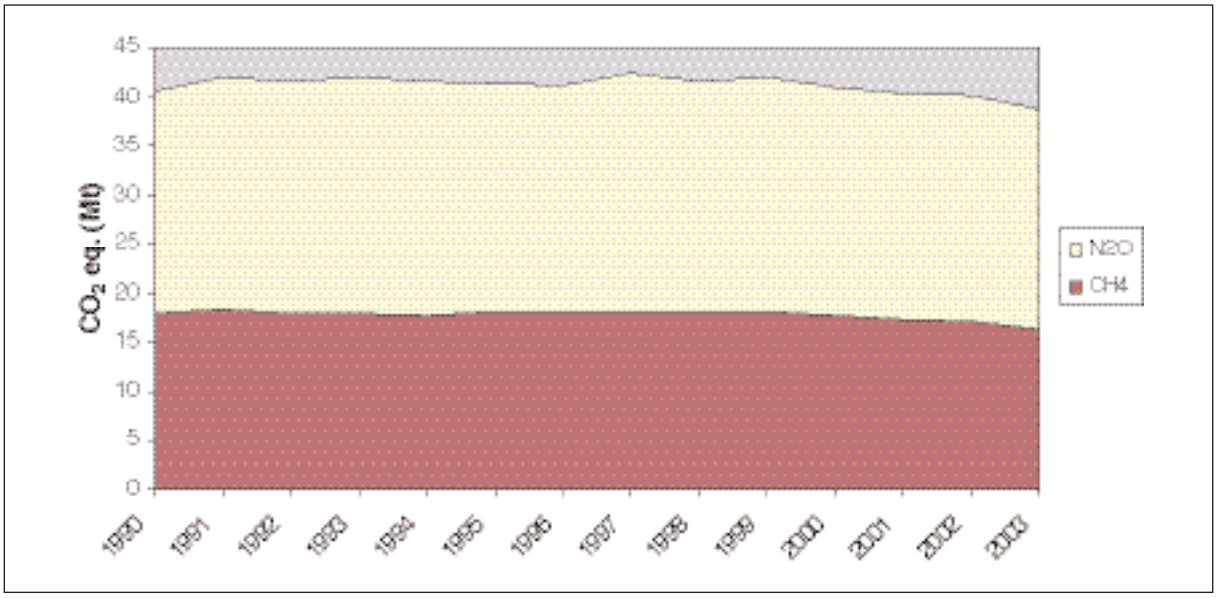

Figure 2.11 Trend of total emissions in CO_2 equivalent from agriculture (1990-2003)

2.3.5 Waste

Emissions from the waste sector are shown in Table 2.4 and Figure 2.12.
Total emissions in CO_2 equivalent decreased by 5.5% from 1990 to 2003. The decrease is mostly due to the decrease in emissions from waste incineration (-27%), which account for 4% of the total, as well as those from solid waste disposal (-6%) which account for 76%.
Considering emissions by gas, the most important greenhouse gas is CH_4 which accounts for 90% of the total and shows a decrease of 4% from 1990 to 2003. N_2O levels have increased by 4% while CO_2 decreased by 66%; these gases account for 9% and 1%, respectively. Further details can be found in the specific chapter.

Table 2.4 Total emissions in CO_2 equivalent from the waste sector by source (1990-2003)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
							Gg							
Total emissions														
CO_2 eq	**13,474**	**14,040**	**13,298**	**13,704**	**14,039**	**14,252**	**14,299**	**14,466**	**14,267**	**14,553**	**14,425**	**14,327**	**13,327**	**12,730**
Solid Waste Disposal on Land	10,348	10,683	9,981	10,313	10,666	10,855	10,998	11,071	11,098	11,253	11,358	11,199	10,266	9,690
Waste-water Handling	2,384	2,407	2,423	2,446	2,452	2,439	2,452	2,474	2,471	2,464	2,486	2,498	2,493	2,494
Waste Incineration	741	950	893	944	920	957	849	920	698	834	579	628	564	542
Other	0	0	0	0	0	0	0	1	1	1	2	3	3	4

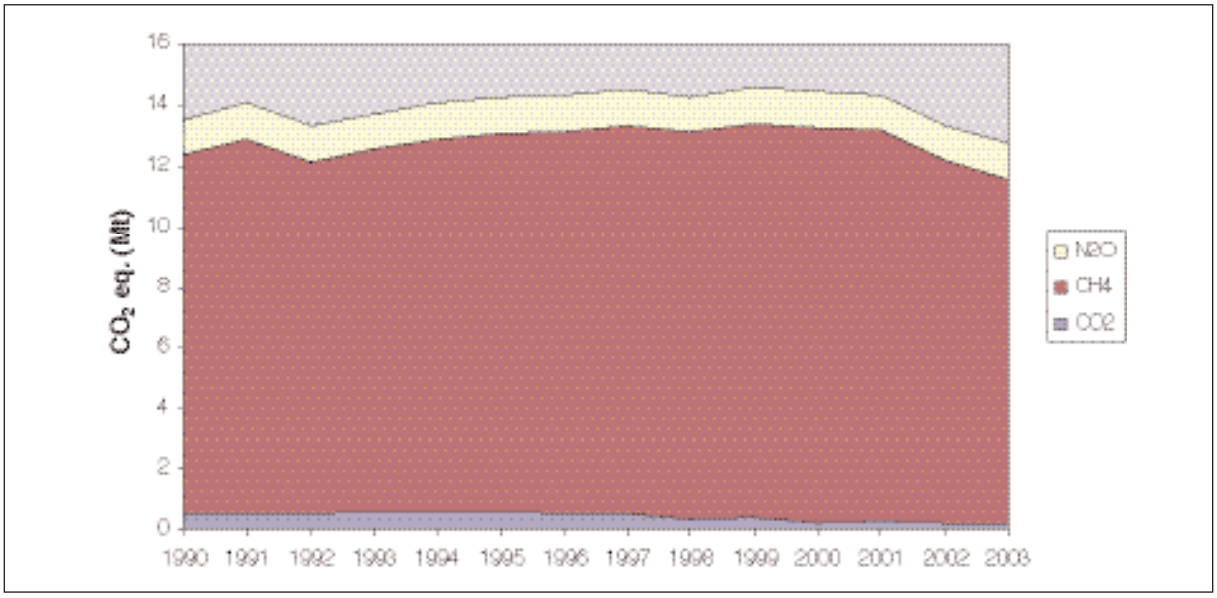

Figure 2.12 Trend of total emissions in CO_2 equivalent from waste (1990-2003)

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 2003 are presented in Table 2.5 and Figure 2.13.

Table 2.5 Total emissions for indirect greenhouse gases and SO_2 (1990-2003)

Indirect greenhouse gases and SO_2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
							kt							
NO_X	1,947	2,000	2,019	1,921	1,840	1,808	1,732	1,654	1,553	1,456	1,378	1,367	1,276	1,260
CO	7,150	7,451	7,654	7,602	7,380	7,144	6,846	6,602	6,191	5,907	5,225	5,131	4,519	4,430
NMVOC	2,032	2,093	2,150	2,112	2,050	2,023	1,972	1,909	1,803	1,714	1,544	1,456	1,346	1,311
SO_2	1,795	1,677	1,578	1,477	1,388	1,320	1,209	1,133	995	899	753	708	632	506

All gases show a significant reduction in 2003 as compared to 1990 levels. The highest reduction is observed for SO_2 (-72%), CO levels have reduced by 38%, while NO_X and NMVOC show a decrease by about 35%. 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 2001/81/EC Directive.

The most relevant reductions occurred as a consequence of the Directive 75/716/EC and following 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.

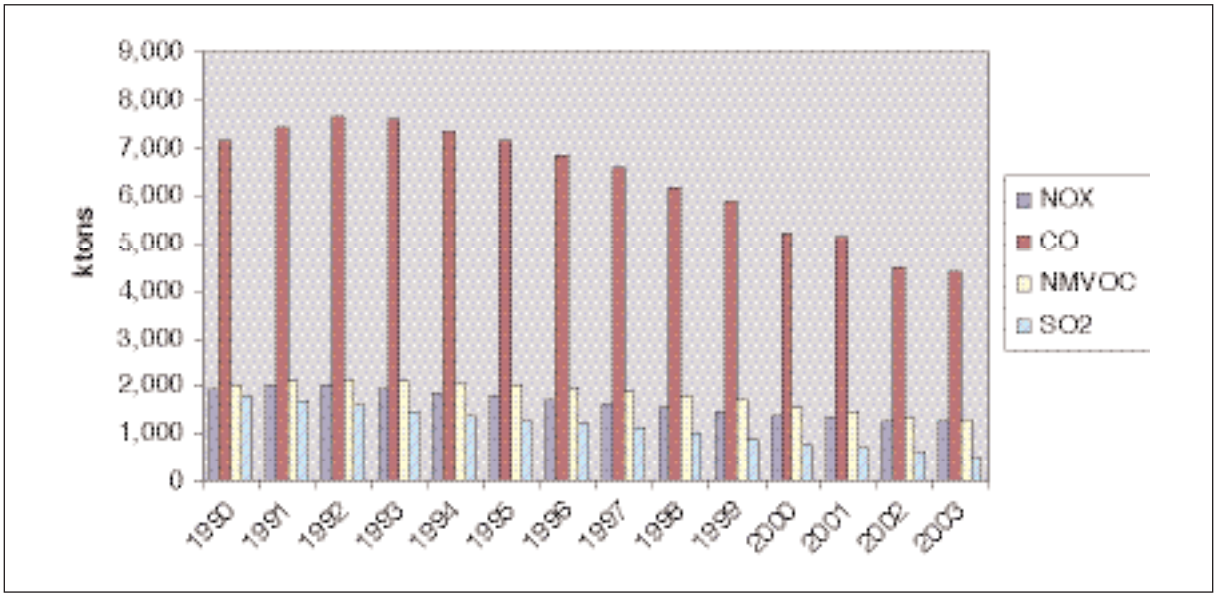

Figure 2.13 Trend of total emissions for indirect greenhouse gases and SO_2 (1990-2003)

3. ENERGY [CRF SECTOR 1]

3.1 Introduction

The aim of this section is to describe in detail the methodology used to estimate the emissions arising from fuel combustion for energy. These sources correspond to IPCC Tables 1A.
Emission inventory is prepared using the 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 great number of publications and it is needed to evaluate emissions of methane and nitrous oxide. Those emissions are related to the actual physical conditions of the combustion process and to environmental conditions.
There is little continuous monitoring of emissions performed in Italy; hence information is rarely available on actual emissions over a specific period of time from an individual emission source. Therefore, the majority of emissions is estimated from other 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:

$$\text{Total Emission} = \text{Emission Factor} \times \text{Activity Statistic}$$

Emission factors are typically derived from measurements on a number of representative sources and the resulting factor applied to the whole country.
For certain sectors, emissions data are available for individual sites. Hence the emission for a particular sector can be calculated as the sum of the emissions from these point sources. That is:

$$\text{Emission} = \Sigma \text{ Point Source Emissions}$$

However, it is necessary to carry out an estimate of the fuel consumption associated with these point sources, so that the emissions from non-point sources can be estimated from fuel consumption data without double counting. In general the point source approach is only applied to emissions of indirect greenhouse gases for well defined point sources (eg, power stations, cement kilns, refineries). Direct greenhouse gas emissions and most non-industrial sources are estimated using emission factors.

3.2 Key sources

Key source analysis for the 2003 inventory has identified 12 categories with the Tier 2 approach 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 underlining data of most key source categories. In Table 3.1 the relevant key sources are listed making reference to the section of the text where they are quoted.
With reference to Table 3.1, half of the key sources (n. 1, 2, 3, 5, 10 and 12) are linked to stationary combustion and to the same set of energy data: to the energy sector CRF table 1.A.1, to the

industrial sector, table 1.A.2 and to the civil sector 1.A.4a and .4b. Four out of 6 key sources refer to CO_2 emissions. All those sectors refer to the national energy balance (MAP, 2005 [a]) for the basic energy data and the distribution between various subsectors, even if more accurate data can be found in GRTN database (GRTN, 2005) for the electricity production sector. Evolution of energy consumptions/emissions is linked to the activity data of each sector, refer to para 3.4, 3.5 and 3.7 for the detailed analysis of those sectors. Electricity production is the most "dynamic" sector and most of the emissions increase from 1990 to 2003, for CO_2, N_2O and CH_4, is due to the increase of thermoelectric production, see Tables 3.2, 3.4 and 3.9 for more details.
Another consistent group of four key sources (n. 4, 6, 8 and 9, see Table 3.1) are referred to 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. Refer to para 3.6, transport, for an accurate analysis of those key sources. Also this sector shows a remarkable increase in emissions, CO_2, in particular from air transport and road transport, as can be seen in Table 3.1 and 3.19, respectively. The evolution of N_2O emissions is linked to technological changes occurred in the period.
Finally, the last group of two key sources refers to oil and gas operations. Also 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 APAT by operators, see para 3.11.

Table 3.1 Energy related key sources and relevant section

	ENERGY RELATED KEY SOURCE CATEGORIES, TIER 2	Relevant paragraph	Notes
1	CO_2 stationary combustion liquid fuels	3.4, 3.5 and 3.7	Table 3.9
2	CO_2 stationary combustion solid fuels	3.4, 3.5 and 3.7	Table 3.9
3	CO_2 stationary combustion gaseous fuels	3.4, 3.5 and 3.7	Table 3.9
4	CO_2 Mobile combustion: Road Vehicles	3.6 and 3.6.3	Tables 3.18, 3.19
5	N_2O stationary combustion	3.4, 3.5 and 3.7	Table 3.9
6	CO_2 Mobile combustion: Waterborne Navigation	3.6.4	Table 3.24
7	CH_4 Fugitive emissions from Oil and Gas Operations	3.11	Table 3.28
8	N_2O Mobile combustion: Road Vehicles	3.6 and 3.6.3	Tables 3.18, 3.19
9	CO_2 Mobile combustion: Aircraft	3.6.1	Table 3.14
10	CO_2 Other industrial processes	3.5	Table 3.9
11	CO_2 Fugitive emissions from Oil and Gas Operations	3.11	Table 3.28
12	CH_4 Stationary combustion	3.4, 3.5 and 3.7	Table 3.9

3.3 Methodology for estimation of emissions from combustion

For the pollutants and sources discussed in this section, emissions result from the combustion of fuel. The activity statistics used to calculate emissions are fuel consumptions provided in the national energy balance ((MAP, 2005 [a])), GRTN (GRTN, 2005) for the power sector and some additional data sources to characterise the technologies used at sectoral level, quoted in the relevant sections.
Emissions are calculated using sector specific spreadsheets according to 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 pollutants estimated in this way 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)
• sulphur dioxide (SO_2)

The sources covered by this methodology are:
• Electricity (power plants and Industrial producers)
• Refineries (Combustion)
• Chemical and petrochemical industries (Combustion)
• Construction industries (roof tiles, bricks)
• Other industries (c) metal works factories, food, textiles, others)
• Road Transport
• Coastal Shipping
• Railways
• Aircraft
• Domestic
• Commercial
• Public Service
• Fishing
• Agriculture

The fuels covered are listed in Table 3.2, 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 should be appropriate for Italy. Most of the emission factors have been cross checked 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 factors with the IPCC ones was carried out and 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.
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 showed a significant variation around the year 2000 due to the reformulation of gasoline and diesel to comply with the EU directive, see section 3.10 for details;
– the most important imported fuels, natural gas, fuel oil and coal show no negligible 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 section 3.10 for details.

The Ministry of Production Activities (Ministero delle Attività Produttive, MAP) publishes annually energy balances (MAP, 2005 [a]) of fuels used in Italy. These balances 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 a copy of the 2003 data is attached, the full time series is available on the website https://dgerm.attivitaproduttive.gov.it/dgerm/.
Additionally to fossil fuel, the national energy balance (BEN) 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, 2005) 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 GHG gasses and other pollutants are included. CORINAIR methodology (EMEP/CORINAIR, 2001) includes emissions from the combustion of wood in the industrial and domestic sectors as well as the combustion of biomass in agriculture.
The inventory reports 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 feedstocks" raw "Productions", see Annex 5, Table A5.1- National energy balance, year 2003, Primary fuels. These data are not used to calculate emissions, in both reference and sectoral approach.
For most of the combustion source categories, emissions are estimated from fuel consumption data reported in the BEN and 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 3.7
• Iron & Steel (Combustion, Blast Furnaces, Sinter Plant): See Annex 4
• Petrochemical industries (Combustion): See Annex 4
• Other combustion with contact industries: glass and tiles: See Annex 4
• Other industries (Metal works factories, food, textiles, others)
• Ammonia Feedstock (natural gas only): See Annex 4
• Ammonia (Combustion) (natural gas only): See Annex 4
• Cement (Combustion): See Annex 4
• Lime Production (non-decarbonising): See Annex 4

Thus the inventory 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 sections indicated. 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 BEN.
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";

– iron and steel auto-generation is included in section 1.A.1c.
Those reports are based on GRTN (GRTN, 2005) estimates of fuel used for steam generation connected with electricity production.

3.4 Energy industries

3.4.1 Electricity production

The source of the data 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 (GRTN), a public enterprise that runs the high voltage transmission grid. For the period 1990-1998 the same data were published by ENEL (ENEL, several years), the former electricity monopoly. The time series is available since 1963.
In these publications the 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 bigger installation 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 5 groups that do not allow for a precise evaluation of the carbon content. In Table 3.2 a copy of the time series 1990-2003 is reported.
For the purpose of calculating GHG emissions, the detailed list of fuels used was delivered to APAT by GRTN for the years 2001, 2002 and 2003; data for the year 2000 are not available. The detailed list is confidential and only the output of the simulation model used to calculate emissions for all years from 2000 to 2003 at the aggregated level of Table 3.2 can be reported (see Annex 2).
At national level other statistics on the fuel used for electricity production do exist, the most remarkable being the National Energy Balance (BEN), published annually. Moreover the UP (Unione Petrolifera, Oil companies association) and ENI, the former national oil company, regularly publish data on this issue. In the past, up to the year 1998, also the association of the industrial electricity producers (UNAPACE) published production data with the associated fuel consumption.

Table 3.2 Time series of power sector production by fuel, kt or 10^6 m^3

	1990	1995	1999	2000	2001	2002	2003
National coal	58	-	96	Solids	Solids	Solids	Solids
Imported coal	10,724	8,216	8,378				
Lignite	1,501	380	62	9,633	11,445	13,088	14,252
Natural gas, m^3	9,731	11,277	19,766	22,334	21,930	22,362	25,534
BOF(steel converter) gas, m^3	509	633	536	Coal	Coal	Coal	Coal
Blast furnace gas, m^3	6,804	6,428	8,611	gases	gases	gases	gases
Coke gas, m^3	693	540	660	8,690	9,785	10,034	10,479
Light distillate	5	6	12	oil	oil	oil	oil
Diesel oil	303	184	560	products	products	products	products
Heavy fuel oil	21,798	25,355	17,511				
Refinery gas	211	378	409				
Petroleum coke	186	189	216				
Orimulsion	-	-	1,688	19,352	17,186	17,694	14,993
Gases from chemical processes	444	803	1,155	Others	Others	Others	Others
Tar	2	-	-				
Heat recovered from Pyrite	146	3	-			mc=769	mc=857
Other fuels	344	697	1,819	5,153	9,175	t=10,686	t=12,588

Source: GRTN, 2005

Both BEN and GRTN 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 GRTN data arises from the following reasons:

– BEN data are prepared on the basis of GRTN reports to IEA, so both data sets come from the same source;
– Before to be published inside BEN, GRTN 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 GRTN reports and the physical quantities are changed to avoid discrepancies; the resulting information cannot be cross checked with detailed plant data (collected for the point source evaluation) based on the physical quantities;
– up to the year 1999, the types of fuel used were much more detailed in GRTN database: in BEN the 17 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;
– activity data for "BOF converter gas" are not reported in BEN up to 1999, from year 2000 they are added up to the blast furnace gas;
– finally, the two data sets are never the same, even considering the total energy values of fuels or the produced electricity, there are always small differences, less than 1% -see Annex 2 for details- that increase the already sizable discrepancy between the reference approach and the detailed approach.

In Annex 2 there are summary tables where the differences between BEN and ENEL/GRTN data are detailed by primary fuel for four years: 1990, 1995, 1999-2003. The year 1999 is added because in the year 2000 the reported data are quite poor, as already mentioned.
The other two statistical publications quoted before, UP (UP, 2005) and ENI (ENI, 2005), have direct access to fuel consumption data from the associated companies, but both rely on GRTN data for the complete picture. Data from those two sources are used for cross checking and estimation of point source emissions.

To estimate the CO_2 emissions, and also N_2O and CH_4 emissions, a rather complex calculation sheet is used, see APAT, (APAT, 2003 [a], in Italian) for description. 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. For each year, a run estimates the fuel consumed by each plant type, the pollutant emissions and GHG emissions.
The energy data used for the years 1990, 1995, 1999-2003 are reported in Annex 2. The emission factors used are listed in Table 3.7.
The model reports the consumption and GHG emission data according to primary source (oil, coal, natural gas) so that they can be inserted in the CRF. 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 industrial sector section, tables 1.A.1.b/c and 1.A.2 .
The following Table 3.3 shows an intermediate part of the process, with all energy and emissions summarized by fuel and split in the two main categories of producers: public services and industrial producers for the year 2003. In the period 1990-1997 all the industrial producers energy/emission data were reported in the CRF tables according to the industrial sector (refineries, steel plants, chemical plants and others). From 1998 onwards the expansion of the industrial cogeneration of electricity and the split of the 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 .

Table 3.3 Power sector, Energy/CO_2 emissions in CRF format, year 2003

	TJ	C, Kt	CO_2, Kt - Gg
For table 1.A.1, a. Public Electricity and Heat Production			
Liquid fuels	5.68996E+05	11946	43772.3
Solid fuels	3.72086E+05	9494	34787.2
Natural gas	8.04862E+05	12145	44499.3
Refinery gases	1.674E+04	329	1206.6
Coal gases	1.001E+04	128	467.9
Biomass	4.3172E+04		
Other fuels	1.481E+03	38	138.5
Total	**1.8174E+06**	**34080**	**124872**
Industrial producers (Table 1.A.1, a-b-c) and auto-producers, to table "1.A.2 Manufacturing Industries"			
Liquid fuels	8.8386E+03	197	723
Solid fuels	5.7E+00	0	1
Natural gas	8.90074E+04	1343	4921
Refinery gases	5.2813E+03	104	381
Other refinery products	5.7703E+04	1263	4627
Coal gases	3.7969E+04	2780	10187.8
Biomass	0	0	0
Other fuels	2.977E+02	8	28
Total	**1.99E+05**	**5695**	**20868**
General total	**2.0165E+06**	**39775**	**145740**

In Table 3.4 the time series of the total CO_2 emissions deriving from electricity generation activities is reported, including total electricity produced and specific CO_2 emissions for the total production and for the thermoelectric production only. It is clearly showed that although the specific carbon content of the KWh generated in Italy has constantly improved over time the total emissions are growing due to the even bigger increase of electricity production over time. Specific thermoelectric emissions are nearly stable from the year 1999 to 2002 because efficiency increases have been

balanced by a growing coal share. In 2003 a remarkable improvement is reported in specific emissions of thermoelectric production, due to the entry into service of more efficient plants, but not in total production due to the reduction of hydroelectric production.

Table 3.4 Time series of CO_2 emissions from electricity production

	1990	1995	1999	2000	2001	2002	2003
Total electricity produced (gross)	216.9	241.5	265.7	276.6	279.0	284.4	293.9
Total CO_2 emitted, Mt	124.2	132.9	133.4	140.5	138.0	144.5	145.7
g CO_2 / kwh of gross thermo-electric production	696	680	643	645	639	637	614
g CO_2 / kwh of total gross production	572	550	501	508	495	508	494

3.4.2 Refineries

The consumption data used come from BEN (MAP, 2005 [a]), the same data are also reported by UP (UP, 2005).
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.
All the fuel used in boilers and processes, the refinery "losses" and the possible losses of crude oil and all distributed fuels that are due to statistical discrepancies are considered to calculate emissions. Both refinery losses and fuel lost in the distribution network are considered as real but not accounted for in the individual end uses sectors.
Part of refinery losses, flares, are reported in CRF table 1.B.2.a and c, using IPCC emission factors, the other emissions are reported in CRF table 1.A.1.b. From 2002 particular attention has been paid to avoid double counting of the CO_2 emissions checking if the individual refineries report sheets already include losses in the energy balances. It is planned to further investigate this aspect as soon as the new comprehensive reporting requirements of the IPPC directive are routinely used. Additional investigation is also planned to find out the fuel used for steam production, part of which presently seems to be allocated to the general industry.
IPCC Tier 2 emission factors and national emission factors are used, refer to Table 3.7. In Table 3.5 a sample calculation for the year 2003 is reported, with energy and emission data. In Table 3.6 GHG emissions in the years 1990, 1995, 2000-2003 are reported.

Table 3.5 Refineries, CO_2 emission calculation, year 2003

	Consumption, TJ			CO_2 Emissions, kt		
REFINERIES	Petroleum coke	Ref. gas	Liquid fuels	Petroleum coke	Ref. gas	Liquid fuels
			34,419			2,497
	24,240	103,730	97,246	2,418	6,440	7,345
TOTAL			259,635			18,699

Table 3.6 Refineries, GHG emission time series

	1990	1995	2000	2001	2002	2003
CO_2 emissions, Mt	18.3	18.8	17.6	19.8	18.8	18.7
CH_4 emissions, kt	0.88	0.72	0.63	0.76	0.74	0.73
N_2O emissions, kt	0.99	1.03	0.73	0.84	0.78	0.73
Refinery, total, Mt CO_2 eq	18.7	19.2	17.9	20.1	19.1	18.9

3.4.3 Manufacture of Solid Fuels and Other Energy Industries

In Italy all the iron and steel plants are integrated, so there is no separated reporting for the different part of the process. A few coke and "manufactured gas" producing plants where existing in the early nineties and they have been reported here. Only one 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 steel plant sites (using coal gases and other fuels).

3.5 Manufacturing industries and construction

Energy consumption for this sector is reported in the BEN, reference Annex 5, Tables A5.9 and A5.10, in physical units. 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 the industrial processes listed in para 3.3, with the exception of coal (see Annex 3). The balance of fuel is assumed as used in boilers and heaters and the emissions are estimated with the emission factors listed in Table 3.7. These factors already contain the correction for the fraction of carbon oxidised (IPCC default values).

Table 3.7 Emission Factors for Power, Industry and Civil sector

	t CO_2 / TJ	t CO_2 / t	t CO_2 / tep
Liquid fuels			
Crude oil	72.549	3.035	3.035
Jet kerosene	70.735	3.078	2.959
Petroleum Coke	99.755	3.464	4.174
Orimulsion	77.733	2.177	3.252
TAR	80.189	3.120	3.355
Gaseous fuels			
Natural gas (dry) 2003 average	55.287	1.950 (smc)	2.313
Solid fuels			
Steam coal, 2003 average	93.478	2.370	3.911
"sub-bituminous" coal	96.234	2.557	4.026
Lignite	99.106	1.037	4.147
Coke	105.929	3.102	4.432
Biomass			
Solid Biomass		(1.124)	(4.495)
National emission factors			
Derived Gases	t CO_2 / TJ		t CO_2 / tep
Refinery Gas	62.080	3.120	2.60
Coke Gas	41.900	0.380	1.753
Blast furnace – oxygen converter Gas	261.711	1.30	10.950
Fossil fuels, national data			
Fuel oil , 2003 average	76.695	3.177	3.209
Coking coal	95.702	2.963	4.004
Petrol, 1990-99	68.631	3.015	2.872
Petrol, test data, 2000-03	71.145	3.109	2.977
Gas oil, 1990-99	73.274	3.127	3.066
Gas oil, engines, test data, 2000-03	73.153	3.138	3.061
Gas oil, heating, test data, 2000-03	73.693	1.410	3.083
LPG, 1990-99, IPCC	62.392	2.872	2.610
LPG, test data, 2000-03	64.936	2.994	2.717

3.5.1 Estimation of carbon content of coals used in industry

The preliminary use of the CRF software underlined an unbalance of emissions in the solid fuel rows above 20%. A detailed verification pointed out to an already known fact: 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 extensive recovery of coal gases from blast furnaces and coke ovens for electricity generation, a specific national circumstance of Italy.
To avoid the double counting a 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. The detailed procedure is described in Annex 3, here we underline that a balance is made between the input coals 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.

3.5.2 Time series

In the following Table 3.8, GHG emissions connected to the use of fossil fuels, process emissions excluded, in the years 1990, 1995 and 2000-2003 are reported. Industrial emissions do show a remarkable reduction from 1990 to 1995, then the data are more stable, with oscillation connected to economic cycles. In Table 3.9 the emissions of energy industries (para 3.4), manufacturing industries (para 3.5) and other sectors (para 3.7) are summarized according to key sources categories.

Table 3.8 Manufacturing industry, GHG emission time series

	1990	1995	2000	2001	2002	2003
CO_2 emissions, kt	80,657	76,419	81,028	78,340	75,527	78,215
CH_4 emissions, t	14,936	14,730	14,343	14,217	13,710	13,973
N_2O emissions, t	3,325	2,678	3,264	3,204	3,148	3,348
Industry, total, kt CO_2 eq	82,001	77,559	82,341	79,632	76,791	79,547

Table 3.9 Stationary combustion, GHG emissions in 1990 and 2003

		1990	2003
CO_2 stationary combustion liquid fuels	kt	153,097	124,462
CO_2 stationary combustion solid fuels	kt	58,021	61,629
CO_2 stationary combustion gaseous fuels	kt	85,065	143,988
CH_4 stationary combustion	t	770	1,096
CO_2 Other industrial processes	kt	3,643	2,435
N_2O stationary combustion	t	6,740	7,025

3.6 Transport

This sector is the one that shows the most pronounced increase in emissions over time, reflecting an increase in fuel consumption.
The mobility demand and particularly the road transportation share have always increased in the time period from 1990 to 2003.

The historical time series of CO_2, CH_4 and N_2O emissions is reported in Table 3.10.
The emissions in the table comprise all the emissions reported in table 1.A.3 of CRF.
Emission estimates are discussed below for each sub sector.
Increase in N_2O emissions is related to the expansion of the car fleet equipped with exhaust gasses catalytic converters.
On the contrary, methane emissions are quite stable, due to the combined effect of technological improvements that limit VOCs from tail pipe and evaporative emissions and the expansion in petrol consumption.
It has to be underlined that in Italy there is a remarkable fleet of motorbikes and mopeds (about 9.1 millions vehicles in 2003) that are using petrol and are not subject to tight VOC emissions control yet.

Table 3.10 GHG emissions for the transport sector

		1990	1995	2000	2001	2002	2003
CO_2	Mt	101.9	112.1	120.4	122.8	124.9	126.0
CH_4	Mt	0.77	0.95	0.84	0.71	0.65	0.83
N_2O	Mt	1.72	2.17	3.19	3.33	3.66	4.37
Total, Mt CO_2 eq.	Mt	104.4	115.2	124.4	126.9	129.2	131.2

3.6.1 Aviation

The IPCC requires the estimation of emissions for 1A3ai International Aviation and 1A3aii Domestic Aviation, including figures both from the cruise phase of the flight and the landing and take-off cycles (LTO). According to the methodologies described in the IPCC Good Practice Guidance (IPCC, 1997) and in the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2001), a method was devised based on the following assumptions and information:

(i) Total inland deliveries of aviation spirit and aviation turbine fuel to air transport are provided in the national energy balance BEN (MAP, 2005 [a]), see Annex 5, Table A5.10. This figure is the best approximation of aviation fuel consumption available and it covers international and domestic but not the split between domestic and international;

(ii) Data on annual arrivals and departures of domestic and international landing and take-off cycles at Italian airports are reported by different sources: National Statistics Institute in the statistics yearbooks (ISTAT, several years), Ministry of Transport in the national transport statistics yearbooks (MINT, 2004) and the Italian civil aviation in the national aviation statistics yearbooks (ENAC/MINT, 2004);

(iii) Total consumption for military aviation is given in the petrochemical bulletin (MAP, 2005 [b]) by fuel. Emissions from military aircraft are reported under 1A5 Other.

(iv) Emission factors and consumption factors for LTO cycles and cruise phases are derived by the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2001), considering national specificities. These specificities derive from the results of a specific study which, taking into account detailed information on the Italian air fleet and the origin-destination flights for the year 1999, calculated default national values for both domestic and international flights (Romano et al., 1999; ANPA, 2001; Trozzi et al., 2002 [a]) on the basis of the emission and consumption factors reported in the EMEP/CORINAIR guidebook. National average emissions and consumption factors were therefore calculated for LTO cycles and cruise both for domestic and international flights.

To carry out national estimates for greenhouse gases and other pollutants in the Italian inventory, consumptions are calculated for the complete time series using the average consumption factors multiplied by the number of flights for LTO, both domestic and international, and for domestic cruise; on the other hand, consumptions for international cruise are derived by difference from the total fuel consumption reported in the national energy balance and the above estimated values.
The current methodology may overestimate emissions from aircraft for the last years. This is because default factors used pertain to older models and the distribution of the international flights between European and extra-European flights has changed from 1999 with an increase of the shortest distances. Currently the use of a more detailed model for estimating aircraft emissions is under consideration, provided the availability of more data on the flights by national and European civil aviation control authorities.
Data on domestic and international aircraft movements from 1990 to 2003 are shown in Table 3.11 where domestic flights are those entirely within Italy. Emission factors are reported in Table 3.12 and Table 3.13. Total fuel consumptions both domestic and international are reported by LTO and cruise in Table 3.14. GHG domestic emissions from the aviation sector are summarised in Table 3.15. Emissions from international aviation are reported for information only and are not included in national totals.
Military aviation emissions cannot be estimated in this way since LTO data are not available. Therefore emissions are calculated by multiplying military fuel consumption data for the EMEP/CORINAIR default emission factors shown in Table 3.13. These factors are appropriate for military aircrafts.

Table 3.11 Aircraft Movement Data (LTO cycles)

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
Domestic flights	186,446	199,585	223,801	242,053	263,263	303,280	319,963	303,354	315,010	325,179
International flights	139,733	184,233	206,586	223,434	243,012	268,947	303,747	315,736	293,365	325,755

Source: ISTAT, several years; ENAC/MINT, 2004

Table 3.12 CO_2 and SO_2 emission factors for Aviation (kg/t) 1990-2003

	CO_2 [a]	SO_2
Aviation Turbine Fuel	859	1.0
Aviation Spirit	865	1.0

a Emission factor as kg carbon/t.

Table 3.13 Non- CO_2 Emission Factors for Aviation

	Units	CH_4	N_2O	NO_x	CO	NMVOC	Fuel
Domestic LTO	kg/LTO	0.168	0.1	7.913	7.163	1.580	647.6
International LTO	kg/LTO	0.354	0.3	10.840	11.608	3.334	878.4
Domestic Cruise	kg/t fuel	0.048	0.048	14.653	1.617	0.448	-
International Cruise	kg/t fuel	0.058	0.011	15.040	1.241	0.546	-
Aircraft Military [a]	kg/t fuel	0.400	0.2	15.800	126.0	3.600	-

a EMEP/CORINAIR, 2001

Table 3.14 Aviation fuel consumptions, domestic and international flights

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
					kt					
Domestic LTO	132	135	151	163	177	205	218	208	216	226
International LTO	123	162	181	196	213	236	267	277	258	286
Domestic cruise	387	414	464	502	546	629	664	629	654	675
International cruise	1,214	1,661	1,773	1,796	1,952	2,139	2,279	2,014	2,002	2,330

Source: APAT elaborations

Table 3.15 GHG emissions from domestic aviation

		1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
CO_2 Mobile combustion: Aircraft	Mt	1,581	1,675	1,876	2,027	2,206	2,545	2,689	2,554	2,651	2,745
CH_4 Mobile combustion: Aircraft	t	50	53	60	65	70	81	85	81	79	87
N_2O Mobile combustion: Aircraft	t	37	40	45	48	53	61	64	61	60	65

Source: APAT elaborations

3.6.2 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 1A1a Public Electricity.
Emissions from diesel trains are reported under the IPCC category 1A3c Railways. These estimates are based on the gas oil consumption for railways reported in BEN (MAP, 2005 [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, 2001). The emission factors shown in Table 3.16 are aggregate factors so that all factors are reported on the common basis of fuel consumption.

Table 3.16 Railway Emission Factors (kt/Mt)

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Diesel train	857	0.14	1.2	40.5	4.9	3.6	2.8

Source: EMEP/CORINAIR, 2001

3.6.3 Road Transport

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.

3.6.3.1 Fuel-based emissions
Emissions of carbon dioxide and sulphur dioxide from road transport are calculated from the consumption of petrol, diesel, LPG and natural gas and the carbon - sulphur content of the fuels consumed. Consumption data for the fuel consumed by road transport in the Italy are taken from the BEN (MAP, 2005 [a]), refer to 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 3.17.

Values for SO_2 vary annually as the sulphur-content of fuels change and are shown in UP (UP, 2005). These factors already contain the correction for the fraction of carbon oxidised.

Table 3.17 Fuel-Based Emission Factors for Road Transport

National emission factors	t CO_2 / TJ	t CO_2 / t
Mtbe	73.121	-
Petrol, 1990-'99, IPCC OECD[a]	68.631	3.015
Petrol, test data, 2000-03[b]	71.145	3.109
Gasoil, 1990-'99, IPCC OECD[a]	73.274	3.127
Gasoil, engines, test data, 2000-03[b]	73.153	3.137
LPG, 1990-'99, IPCC[a]	62.392	2.872
LPG, test data, 2000-03[b]	64.936	2.994
Natural gas (dry) 2003	55.287	-
Fuel oil , 2003 average	76.702	-

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 APAT (APAT, 2003 [b])

Emissions of CO_2 and SO_2 can be broken down by vehicle type based on estimated fuel consumption factors and traffic data in a manner similar to the traffic-based emissions described below for other pollutants. The 2003 inventory used fuel consumption factors expressed as g fuel per kilometre for each vehicle type and average speed calculated from the emission functions and speed-coefficients provided by COPERT III (EEA, 2000).
Fuel consumption calculated from these functions are shown in Table 3.18 for each vehicle type, emission regulation and road type in Italy. A normalisation procedure was used to ensure that the breakdown of petrol 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). Evaporative emissions are not shown in the table.

Table 3.18 Average fuel consumption and mileage for main vehicle categories and road type, year 2003

SNAP CODE	Sub sector	Type of fuel	Tons of fuel consumed	Mileage, KM_KVEH
070101	PC Hway	diesel	2,531,174	43,344,544
070101	PC Hway	petrol	2,966,082	53,583,501
070101	PC Hway	lpg	366,512	6,163,643
070102	PC rur	diesel	3,176,849	72,676,712
070102	PC rur	petrol	4,263,721	99,884,196
070102	PC rur	lpg	369,549	8,218,190
070103	PC urb	diesel	1,817,067	18,763,006
070103	PC urb	petrol	6,292,743	68,621,426
070103	PC urb	lpg	472,956	6,163,643
070201	LDV Hway	diesel	887,540	9,987,121
070201	LDV Hway	petrol	54,761	822,041
070202	LDV rur	diesel	1,680,957	27,464,584
070202	LDV rur	petrol	148,764	2,260,613
070203	LDV urb	diesel	1,429,574	12,483,902
070203	LDV urb	petrol	166,026	1,027,551
070301	HDV Hway	diesel	4,806,804	21,559,720
070301	HDV Hway	petrol	1,252	7,585
070302	HDV rur	diesel	2,875,600	14,796,958
070302	HDV rur	petrol	3,413	22,755
070303	HDV urb	diesel	1,605,294	5,129,406
070303	HDV urb	petrol	1,707	7,585
070400	mopeds	petrol	565,239	17,067,496
070501	Moto Hway	petrol	44,426	1,259,664
070502	Moto rur	petrol	238,599	8,817,644
070503	Moto urb	petrol	450,868	15,115,962
Total				515,249,446

Source: APAT 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; biodisel included in diesel

The following Table 3.19 summarizes the time series of GHG emissions from road transport, highlighting the evolution of this fast growing source.

Table 3.19 GHG emissions from road transport

		1990	1995	2000	2001	2002	2003
CO_2	Mt	93,994	104,153	110,316	113,022	115,125	116,569
CH_4	kt	744	911	807	685	622	800
N_2O	kt	1,608	2,057	3,064	3,206	3,534	4,151

3.6.3.2 Traffic-based emissions

Emissions of the pollutants 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 APAT on data released from Ministry of Transport (MINT, 2004). 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 III (EEA, 2000). This source provides emission functions and coefficients relating emission factor (in g/km) to average speed for each vehicle type and Euro emission standard derived by fitting experimental measurements to some polynomial functional form. 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- 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 the COPERT III methodology, in brief the emissions from motor vehicles fall into three different types which are each calculated in a different manner. These are hot exhaust emissions, cold-start emissions and, for NMVOC, 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, the type of fuel its engine runs on, the driving profile of the vehicle on a journey and the emission regulations which applied when the vehicle was first registered as this defines the type of technology the vehicle is equipped with which effects emissions.
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 the 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, work has shown that for modelling vehicle emissions for an inventory covering a road network on a 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, 2000). 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:
• Petrol cars
• Diesel cars
• Petrol 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
• Motorcycles

Detailed data on the national fleet composition can be found in yearly report from ACI (ACI, 2004). In the following Tables 3.20, 3.21 and 3.22 detailed data on the relevant vehicles in the circulating fleet between 1990 and 2003 are reported, subdivided according to the main emission regulations that applied when the vehicle was sold.

Table 3.20 Petrol cars technological evolution: circulating extraurban fleet calculated as stock data multiplied by effective mileage

	1990	1995	2000	2003
Older than 20 years, PRE ECE	0.005	0.007		
1972 -1977, ECE 15.00/.01	0.142	0.017	0.009	0.009
1978 -1986, ECE 15.02/.03	0.277	0.178	0.039	0.007
1987 -1989, ECE 15.04	0.159	0.103	0.061	0.034
1990 - 1992, ECE 15.04	0.417	0.388	0.264	0.182
91/441/EC, from 1/1/93, euro 1	0.000	0.308	0.218	0.189
94/12/ EC, from 1-1-97, euro 2		0.000	0.410	0.298
98/69/EC, from 1/1/2001, euro 3				0.282
Totals	1.000	1.000	1.000	1.000

Source: APAT elaborations on ACI data

Table 3.21 Diesel cars technological evolution: circulating extra-urban fleet calculated as stock data multiplied by effective mileage

	1990	1995	2000	2003
Older than 15 years, PRE ECE	0.006	0.009	-	-
1972 -1977, ECE 15.00/.01	0.008	0.000	0.009	0.019
1978 -1985, ECE 15.02/.03	0.248	0.103	-	-
1985-1989, ECE 15.04	0.359	0.285	0.053	-
1990 - 1992, ECE 15.04	0.378	0.390	0.109	0.052
91/441/EC, from 1/1/93, euro 1	0.000	0.213	0.127	0.088
94/12/ EC, from 1-1-97 , euro 2	-	-	0.702	0.348
98/69/EC, from 1/1/2001, euro 3	-	-	-	0.421
Totals	1.000	1.000	1.000	1.000

Source: APAT elaborations on ACI data

Table 3.22 Trucks technological evolution: circulating fleet for light duty

	1990	1995	2000	2003
pre -1985	0.60	0.32	0.18	0.09
1985-1989, Dir 88/77/EWG	0.29	0.26	0.17	0.13
1990 - 1992	0.11	0.21	0.14	0.11
1/gen/93 - 31/dic/95	-	0.10	0.07	0.06
from 1/1/96, Dir. 91/542 EEC, euro I	-	0.10	0.19	0.15
from 1/1/97, Dir. 91/542 EEC, euro II	-	-	0.25	0.25
from 1/1/2001, Dir. 99/96, euro III	-	-	-	0.21
Totals	1.00	1.00	1.00	1.00

Source: APAT elaborations on ACI data

Average emission factors are calculated for average speeds on three specified types of roads and combined with the number of vehicle kilometres travelled by each type of vehicle on each of these road types:

- Urban
- Rural
- Motorway

APAT estimates total annual vehicle kilometres for the road network in Italy by vehicle type, see Table 3.23, on the basis of data from various sources:

– Ministry of Transport (MINT, 2004) 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;
– local authorities for built-up areas (urban).

Table 3.23 Evolution of fleet consistency and mileage

	1990	1995	2000	2003
All passenger vehicles, total mileage (10^9 veh-km/y)	339	394	431	466
Car fleet (10^6)	27.7	31.0	32.9	34.3
Goods transport, total mileage (10^9 veh-km/y)	66	68	74	76
Truck fleet (10^6), including LDV	3.0	3.2	3.6	3.8

Source: APAT elaborations

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 petrol 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 petrol fuel vapour from the tank and fuel delivery system in vehicles constitute a significant fraction of total NMVOC emissions from road transport. The procedure for estimating evaporative emissions of NMVOCs takes account of changes in ambient temperature and fuel volatility.

3.6.4 Navigation

This source category includes all emissions from fuels delivered to water-borne navigation.
Emissions of the Italian inventory from the navigation sector are carried out according to the CORINAIR methodology which provides estimates from Coastal Shipping, Fishing, Naval Shipping and International Marine. Coastal Shipping has been mapped onto 1A3dii National Navigation and Fishing onto 1A4ciii Fishing (EMEP/CORINAIR, 2001).
The emissions reported under Coastal Shipping, Naval Shipping and Fishing are estimated according to the base combustion datasheet using the emission factors given in Table 3.17.
The CORINAIR category International Marine is the same as the IPCC category 1A.3i International Marine. The methodology developed to estimate emissions is based on the following information and assumptions:

- Total deliveries of fuel oil, gas oil and marine diesel oil to marine transport are given in national energy balance (MAP, 2005 [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;
- Emission factors and consumption factors for national and international traffic derive from the results of a specific study which, taking into account detailed information on the Italian marine fleet and the origin-destination matrix for the year 1999, calculated default national values (ANPA, 2001; Trozzi et al., 2002 [b]) on the basis of emission factors reported in the EMEP/CORINAIR guidebook. National emissions were also divided into harbour activities and national cruise;
- National consumptions are estimated using the consumption factors provided by the study whereas consumption for international cruise is derived by difference from the total fuel consumption reported in the national energy balance and the above estimated values.

In Table 3.24 the time series resulting from the above described methodology is shown. The data include the quantities of marine fuels reported by the national energy balance for domestic use, estimate of fuels used in the national harbours or for travel within two Italian destinations and the resulting bunker fuels used for international travels. Carbon dioxide emissions relevant to the national total are also reported.

Table 3.24 Marine fuel consumptions in domestic and international travels. CO_2 emissions from domestic navigation

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
				kt						
Fuels used for domestic travels	778	706	802	843	888	859	875	871	851	861
Estimate of fuel in ports (dom+int ships)	748	693	794	824	868	844	864	860	841	851
Estimate of fuel in international bunkers	1,398	1,286	911	975	982	982	1,224	1,388	1,585	1,781
CO_2 Mobile combustion: Waterborne Navigation	5,419	5,112	5,745	5,957	6,240	6,093	6,223	6,215	6,085	6,148

Source: APAT elaborations

Emission estimates from 1A.3i International Marine are reported for information only and are not included in national totals.

3.7 Other sectors

The estimation procedure follows that of the base combustion data sheet, emissions are estimated from the energy consumption data and the emission factor illustrated in Table 3.7.
The category Other sectors comprises emissions from agriculture, fisheries, residential, commercial and others. The national energy balance (refer to 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) 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 subdivided on the basis of the estimations reported by ENEA in its annual energy report (ENEA, 2005).
Emissions from 1A.4b Residential and 1A.4c 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 para 3.7.2. Emissions from fishing vessels are estimated from fuel consumption data (MAP, 2005 [a]) and emission factors are shown in Table 3.7.

3.7.1 Other combustion

Emissions from military aircraft and naval vessels are reported under 1A.5b Mobile. The method of estimation is discussed in para 3.6.1 and 3.6.4.
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 para 3.7.2.

3.7.2 Other off-road sources

This category covers 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 combine 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, 2001):
• 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.
The estimates are calculated using a modification of the methodology given in EMEP/CORINAIR (EMEP/CORINAIR, 2001). 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 petrol engined 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

The 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, 2001), 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, 2001). 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 1990-2003 for each of the main categories:

A. Agricultural power units: Data on gas oil consumption were taken from ENEA (ENEA, 2005). The consumption of petrol was estimated using the population method for 1995 without correction. Time series is reconstructed in relation to the fuel use in agriculture.
B. Industrial off-road: The construction component of the gas oil consumption was calculated from the Ministry of Production Activities data (MAP, 2005 [a]) on building and construction. 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: Petrol 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 petrol consumption increased markedly but is still only a tiny proportion of total petrol sales.

3.8 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, 3.6.1 and 3.6.4 .
The methodology implements the IPCC guidelines according to the available statistical data.

3.9 Feedstock and non-energy use of fuels

In Table 3.25 and 3.26 detailed data on petrochemical and other non-energy use for the year 2003 are given.
Data are based on a rather detailed yearly report available by MAP. The report summarize answers from a detailed questionnaire that all operator in Italy prepare monthly. The data are more detailed than those normally available by international statistics and refer to:
– input to plants (gross input);
– quantities of fuels returned to the marked (with possibility to estimate the net input);
– fuels used internally for combustion;
– quantities stored in products.

In the energy balances only the input and output quantities from the petrochemical plants are reported, so it may be that the output quantity is greater than the input quantity, due from internal transformation. Therefore it is possible to have negative values for some products mainly gasoline, refinery gas, fuel oil.
With this data it is possible to estimate the quantities of fuels stored in product in percentage on net

and gross petrochemical input, see Table 3.25 for details by product and Table 3.27 for the overall figure. The data of Table 3.27 are reported also as a note in CRF table 1.A(d). As can be seen from the value reported for the year 2003 there is a huge 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 as reported in table 1-5 and the fuels reported as "petrochemical input" in Table 3.25. The resulting estimate of about 7,143 kt of products for the year 2003, is more than 35% bigger than the quantities reported, 5,286 kt, see Table 3.25 .

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 3.26, 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 result if the calculation is based on national data or IPCC default values, see the table for details.

Table 3.25 Petrochemical, detailed data from MAP, year 2003 (MAP, personal communication)

FUEL TYPE	Petroch. Input kt	Returns to refinery/ market kt	Internal consumption /losses kt	Quantity stored in products kt	% on gross input	% on net input	Emission factor (IPCC) t C / t
LPG	431	441	39.2	-89.2	-21%	892%	0.8137
Refinery gas	180	113	816.6	-1566.6	-870%	-2338%	0.8549
Virgin naphtha	5,005	8.2	0	4,996.8	100%	100%	0.8703
Gasoline	1,065	1914	0	-839	-79%	99%	0.8467
Kerosene	867	599.4		274.6	32%	103%	0.8485
Gasoil	1,095	165.8	0	928.2	85%	100%	0.8569
Fuel oil	249	62.0	907.7	-720.7	-289%	-385%	0.8678
Petroleum coke	0	0	0	0			0.955
Others (feedstock)	96	122.7	12.2	-46.9	-49%	176%	0.8368
Losses			68	-68			0.8368
Natural gas	0	0		0			0.7280
total	8,988	3,426.0	1,775.7	2,869.3	32%	52%	

Table 3.26 Other non energy uses, year 2003, MAP 2005[a]

NON ENERGY FROM REFINERIES	Quantity stored in products kt	Energy content IPCC '96	Emission factor t C / t	Total energy content with IPCC values TJ	With BEN values TJ
tar	141	30.97	0.7988	4.4	4.4
bitumen	3,265	40.19	0.8841	131.2	123.0
lubricants	1,296	40.19	0.8038	36.5	36.4
recovered lubric. oils	0	40.19	0.8038	0.0	0.0
paraffin	40	40.19	0.8368	1.6	1.0
others (benzene, others)	872	40.19	0.8368	35.0	21.7
Totals	5,473.0			204.3	182.1

(include estimation of minor inconsistencies between BEN and CRF data)

Table 3.27 Other non energy uses, year 2003

BREAKDOWN OF TOTAL PETROCHEMICAL FLOW					
		Petroch. Input	Returns to refin./market	Internal consumption / losses	Quantity stored in products
ALL ENERGY CARRIERS, kt		8,988	3,426.0	1,775.6	2,869.3
	% of total input		38.1%	19.8%	31.9%
	% of net input			31.9%	51.6%

3.10 Country specific issues

3.10.1 National energy balance

Italian energy statistics are based mainly on BEN, National Energy Balance, that is annually edited by MAP. This report is quite reliable, by international standards, and it may be useful to summarize here 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 Production Activities, 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; those excise duties are differentiated between products and between 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;
– from the point of view of energy consumption information this system produces highly reliable data: BEN is always based on registered quantities of energy consumption, 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 are estimates; anyway it is nearly all imported and it is used by a limited number of operators; all of them are monitored on a monthly basis by the Ministry of Production Activities.

3.10.2 National emission factors

Monitoring of the carbon content of the fuels used nationally is an ongoing activity at APAT. 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 Tables 3.7 and 3.17.
The specific procedure followed for each primary fuel (natural gas, oil, coal) is reported in Annex 6.

3.11 Fugitive emissions from solid fuels, oil and natural gas

Fugitive emissions in this source category originate from the production and transformation of solid fuels, the production of oil and gas, the transmission and distribution of gas and from oil refining. Trends in fugitive emissions are summarised in Table 3.28.
Totally, fugitive emissions, in CO_2 equivalent, account for 1.5% out of the total emissions in the energy sector. Both CH_4 and CO_2 emissions show a reduction from 1990 to 2003 by 25% and 18%, respectively.

Table 3.28 Fugitive emissions from oil and gas 1990-2003 (Gg CO2 eq.)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
CO_2														
Solid fuels	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil and natural gas	3,048	2,990	2,926	3,084	2,913	2,843	2,692	2,875	2,768	2,091	2,298	2,182	1,928	2,499
CH4														
Solid fuels	122	112	112	82	71	65	60	60	55	53	73	81	78	95
Oil and natural gas	6,631	6,451	6,405	6,201	5,953	5,673	5,524	5,521	5,611	5,464	5,366	5,122	4,962	4,993

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

Key-source identification in the fugitive sector with the IPCC Tier1 and Tier2 approaches

1B2	CH_4	Fugitive emissions from oil and gas operations	Key (L, T)
1B2	CO_2	Fugitive emissions from oil and gas operations	Key (L2, T1)

Specifically, methane emissions from oil and gas operations is a key source according to the level and trend assessment both Tier 1 and Tier 2. CO_2 emissions from oil and gas operations is also a key source for the level, Tier 2, and trend assessment, Tier 1. The uncertainty in methane 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.
Fugitive emissions from solid fuels, reported in 1.B.1, are not relevant. In fact, CH_4 emissions from coal mining refer only to two mines, one underground producing lignite and the other surface producing coal, with very low production in the last ten years; CH_4 emissions from solid fuel transformation refer to the coke production from the iron and steel industry, also decreasing in the last years. CO_2 emissions from 1.B.1 are not occurring. The uncertainty in methane emissions from coal mining and handling is estimated to be 300% as combination of 3% and 300% for activity data and emission factors, respectively.
Fugitive CO_2 emissions reported in 1.B.2 refer to fugitive emissions in refineries during petroleum production processes, such as fluid catalytic cracking, and in flaring. CO_2 emissions from other activities in 1.B.2 do not occur.
CH_4 emissions reported in 1.B.2 derive mainly from the transmission in pipelines and distribution of natural gas and decrease in the last years in account of the gradual substitution of old pipelines.
For the completeness of the CRF tables pertaining to these emissions, in particular 1.B.2, the rationale beyond the values reported and not reported is explained below.
CH_4 fugitive emissions from oil exploration are included in those from production because no detailed information is available. Emissions from transport and distribution of oil result as not

occurring or negligible. CH_4 emissions from gas exploration are also included in those from production while other leakage emissions are included in distribution emission estimates. Further investigation will be carried out with industry about these figures.
CH_4 emissions from gas venting are included in production, respectively for oil under 1.B.2.a and natural gas under 1.B.2.b, as not separately supplied by the relevant industries.
A summary of the completeness of CH_4 fugitive emissions is shown in the following Table 3.29.

Table 3.29 Completeness of CH_4 fugitive emissions

1.B. 2.a. Oil		
i. Exploration	CH_4	Included in 1.B.2.a production
1.B.2.b. Natural Gas		
i. Exploration	CH_4	Included in 1.B.2.b production
iii. Other leakage	CH_4	Included in 1.B.2.b distribution
1.B. 2.c. Venting		
i. Oil	CH_4	Included in 1.B.2.a production
ii. Gas	CH_4	Included in 1.B.2.b production

4. INDUSTRIAL PROCESSES [CRF SECTOR 2]

4.1 Overview of sector

Included in this category are by-products or fugitive emissions which originate from industrial processes. 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 1A2. All greenhouse gases as well as CO, NO_x, NMVOC and SO_2 emissions are estimated.
In 2003 industrial processes account for 5.4% of CO_2 emissions, 0.2% of CH_4, 16.7% of N_2O, 100% of PFCs, HFCs and SF_6. In term of CO_2 equivalent, industrial processes share 6.9% 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 2003, while CO_2 emissions from chemical and metal industry reduced sharply.

Table 4.1 Trend in greenhouse gas emissions from the industrial process sector, 1990-2003

Gas/subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
CO_2 (Gg)														
2A. Mineral Products	21,875	21,737	22,500	20,094	19,602	21,479	19,697	20,032	20,249	21,045	21,923	22,664	22,575	23,483
2B. Chemical Industry	2,186	2,089	2,051	1,461	1,197	1,223	962	1,035	1,041	958	1,062	1,034	1,082	1,243
2C. Metal Production	2,205	2,060	1,881	1,941	1,934	2,087	2,042	2,056	2,032	1,859	2,013	1,911	1,772	1,810
CH_4 (Gg)														
2B. Chemical Industry	2.45	2.43	2.40	2.28	2.49	2.65	0.60	0.62	0.59	0.59	0.40	0.33	0.33	0.31
2C. Metal Production	2.71	2.51	2.43	2.59	2.58	2.71	2.39	2.61	2.52	2.46	2.61	2.51	2.37	2.46
N_2O (Gg)														
2B. Chemical Industry	21.77	22.99	21.28	21.39	20.09	23.06	22.26	22.42	22.77	23.43	25.18	25.16	24.09	22.78
HFCs	351	355	359	355	482	671	450	755	1,181	1,452	2,005	2,759	3,561	4,575
PFCs	1,808	1,423	799	631	355	337	243	252	270	258	346	452	414	494
SF_6	333	356	358	370	416	601	683	729	605	405	493	795	738	486

Five key sources have been identified for this sector, for level and trend assessment, using both the Tier 1 and Tier 2 approaches. The results are reported in the following box.

Key-source identification in the industrial processes sector with the IPCC Tier1 and Tier2 approaches

2A	CO_2	Emissions from cement production	Key (L, T2)
2F	HFC, PFC	Emissions from substitutes for ODS	Key (L, T)
2B	N_2O	Emissions from adipic acid	Key (L, T)
2B	N_2O	Emissions from nitric acid	Key (T1)
2A	CO_2	Emissions from other industrial processes	Key (T1)

CO_2 emissions from cement production are included in category 2A; N_2O emissions from adipic acid and nitric acid refer both to 2B; CO_2 emissions from other industrial processes include soda ash and glass production (2A), ammonia and other chemical production emissions (2B), aluminium and ferroalloys production (2C); HFC and PFC consumption as substitutes for Ozone Depleting Substances are included in 2F. Methane emissions from the sector are not key sources.

4.2 Mineral products (2A)

4.2.1 Source category description

In this sector the main source of emissions is CO_2 from cement production (2A1) which is, as already mentioned, a key source and accounts for 3% of the total national emissions.
Limestone and dolomite use accounts for 0.58% of the total national emissions.
CO_2 emissions also occur from processes where lime is produced and account for 0.37% of the total national emissions.
CO_2 emissions from decarbonising in glass production have been estimated and reported in other.
CO_2 emissions from soda ash production are also included in this category.
Asphalt roofing and road paving with asphalt activities contribute only with NMVOC emissions.

4.2.2 Methodological issues

IPCC Guidelines and Good Practice Guidance are used to estimate emissions (IPCC, 1997; IPCC, 2000).
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), by the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2001) or by other international Guidebooks (USEPA, 1997).
CO_2 emissions from cement production are estimated by the IPCC Tier 2 approach. Activity data comprise data on clinker production provided by ISTAT (ISTAT, several years). Activity data have been revised from 1990 onwards; the production of hydraulic lime is not included anymore, after a clarification with the Italian Cement Association (AITEC), because it is already accounted for in the clinker production values. Emission factors have also been updated, for the whole time series, taking in account the information provided by the plants and by the Italian Cement Association (AITEC, 2003; AITEC, 2004; AITEC, 2005) in the framework of the European emission registry (EPER) 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. The resulting emission factor for cement production is equal to 540 kg CO2/ton clinker, based on the average CaO content in the clinker and taking in account the contribute of carbonates and additives. The emission factor has been suggested to the operators by AITEC (AITEC, 2004) on the basis of a tool provided by the World Business Council for Sustainable Development and available on the website http://www.ghgprotocol.org/standard/tools.htm.
CO_2 emissions from limestone and dolomite use are related to the use of limestone and dolomite in bricks, tiles and ceramic production and iron and steel production. Emission factors are derived by bricks and ceramic industry (ANDIL, 2000; ANDIL, 2004; ASSOPIASTRELLE, 2004;

ASSOPIASTRELLE, 2005) and iron and steel association (FEDERACCIAI, 2004) and they have been supplied in the framework of the European emissions trading scheme.
CO_2 emissions from soda ash production have been estimated on account of information available on the Solvay process (Solvay, 2003), whereas those from soda ash use are included both in glass and paper production.
CO_2 emissions from lime and glass production and NMVOC emissions from asphalt roofing and road paving have been estimated by production activity data (ISTAT, several years) and default emission factors (IPCC, 1997; EMEP/CORINAIR, 2001).

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, as the combination of 3% and 10% for activity data and emission factor, respectively.
The emission trend is related to the production which is stable.

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 have been compared with data reported in the national EPER registry.

4.2.5. Source-specific recalculations

On account of new information available by the relevant industrial associations and by the plants, especially in the framework of the European emissions trading scheme, the time series of some activity data and emission factors have been recalculated. Specifically, the recalculation of activity data has regarded the clinker production values. Besides the usual update of data for the last two years, the overall revision of production data has regarded the subtraction of the hydraulic lime produced by cement plants, because already accounted for in the clinker production data. As mentioned above emission factor also has been updated. The time series of activity data and the emission recalculations are shown in Table 4.2.

Table 4.2 Production activity data for clinker (kt) and recalculations of CO_2 (Gg) in the cement production sector 1990-2002

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2004 submission													
Activity data (clinker+hydr. lime)	31,655	31,488	32,854	28,310	27,708	30,424	27,868	28,249	28,779	30,227	31,347	32,343	32,235
CO_2 emissions	16,052	15,968	16,660	14,356	14,051	15,428	14,132	14,325	14,594	15,328	15,896	16,401	16,347
2005 submission													
Activity data (clinker)	29,786	29,497	30,878	26,438	25,923	28,778	26,292	26,753	27,328	28,717	29,816	30,893	30,770
CO_2 emissions	16,084	15,928	16,674	14,277	13,999	15,540	14,198	14,447	14,757	15,507	16,101	16,682	16,616
Δ emissions (%)	*0.2*	*-0.2*	*0.1*	*-0.6*	*-0.4*	*0.7*	*0.5*	*0.8*	*1.1*	*1.2*	*1.3*	*1.7*	*1.6*

CO_2 emission factors for glass and lime production so as for limestone and dolomite use in brick and tiles production have been updated on the basis of production plants information supplied in the

framework of the Emissions Trading Scheme. For the 2A sector, recalculations result in an increase of emissions for the whole time series from 0,7% in 1990 to 2.3% in 2002. The time series of emissions recalculated are shown in Table 4.3.

Table 4.3 Recalculations of CO_2 emissions (Gg) in the mineral products sector 1990-2002

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2004 submission													
CO_2 emissions (2A)	21,713	21,645	22,349	20,035	19,512	21,222	19,488	19,768	19,938	20,718	21,612	22,184	22,077
2005 submission													
CO_2 emissions (2A)	21,875	21,737	22,500	20,094	19,602	21,479	19,697	20,032	20,249	21,045	21,923	22,664	22,575
Δ emissions (%)	*0.7*	*0.4*	*0.7*	*0.3*	*0.5*	*1.2*	*1.1*	*1.3*	*1.6*	*1.6*	*1.4*	*2.2*	*2.3*

4.2.6. Source-specific planned improvements

Emission factors and activity data will be improved by a detailed sectoral analysis of the national EPER and Emissions Trading data for the cement production sector.

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.
Emissions from adipic acid production are supplied and referenced by the Italian producer (Radici Chimica, 1993; Radici Chimica, 2005). Specifically, for N_2O, adipic acid is a key source at level and trend assessment, both with the Tier 1 and Tier 2 approach. These emissions account for 15.2% of total N_2O emissions in 2003. CO_2 emissions from this source are also estimated and reported in the CRF under other chemical industry.
N_2O emissions from nitric acid production is also a key source, at trend assessment with the Tier 1 approach. In fact, these emissions show a relevant decrease in the last years as a consequence of the reduction in production.
The sharp decreasing trend of CO_2 emissions from ammonia is the main contributor to the assessment of "CO_2 from other Industrial Processes" as a key source for trend with the Tier 1 approach and it is due to the reduction in ammonia production.
The time series of production data related to ammonia, nitric and adipic acids are reported in the following Table 4.4.

Table 4.4 Production of ammonia, nitric acid and adipic acid (kt) from 1990 to 2003

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Ammonia	1,455	1,392	1,358	885	612	592	397	446	409	367	414	430	474	578
Nitric acid	1,037	988	937	725	532	588	545	560	480	432	556	527	536	554
Adipic acid	49	54	50	55	55	64	62	62	65	68	71	75	74	69

4.3.2. Methodological issues

Italian production figures and emission estimates for adipic acid have been provided by the process

operator (Radici Chimica, 2005) for the whole time series. N_2O emissions from adipic acid production (2B3) have been estimated using the default IPCC emission factor equal to 0.30 kg N_2O/kg adipic acid produced because no abatement technology is present on the production plants.
With regard to nitric acid production (2B2), emissions have been recalculated on the basis of a detailed analysis of information reported in the framework of the national EPER registry; production figures are published in the national statistical yearbooks (ISTAT, several years), while the N_2O emission factors have been calculated from 2001, as a weighted average of EFs supplied by the production plants in the EPER registry. For the years 1990-2000 the default IPCC emission factors for medium pressure plants has been used, and refers to the average emission factor supplied by Norsk Hydro (Norsk Hydro, 2005), equal to 6.75 kg N_2O/tonne nitric acid. In the '90s, the reduction of N_2O emissions should be a consequence of the introduction of abatement technology, specifically NSCR, to reduce NO_X emissions. NO_X emission factors for nitric acid production have been reduced by more than 70% from 1990 to 2003.
Ammonia production data are published in the international industrial statistical yearbooks (UN, several years) and they have been checked with information reported in the national EPER registry. CO_2 emission factors have been recalculated on the basis of information reported by the production plants for 2002 and 2003 in the framework of the national EPER registry and the value is equal to 1.175 t CO_2/t ammonia production. This value has been used for the whole time series in consideration that no modifications to the production plants occurred over the period. 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.
CO_2 emissions from carbon black production process have been estimated, and reported in the CRF under other chemical industry, on the basis of information supplied by the Italian production plants in the framework of the EPER registry and the European emissions trading scheme. Average implied emission factor is equal to 2.33 t CO_2/t carbon black production.

4.3.3 Uncertainty and time-series consistency

The uncertainty in N_2O emissions from adipic and nitric acid production and in CO_2 emissions from other industrial processes is estimated 10.4%, for each activity, as combination of uncertainties equal to 3% and 10% for activity data and emission factors, respectively.
Adipic acid emission trend are directly related to the production while nitric acid emissions are related to a reduction in production, to the closure of the old technology plants and to the introduction of abatement technology to reduce NO_X emissions. Adipic acid production is increasing whereas nitric acid production and emissions show a decrease in the last years.
Total CO_2 emissions from chemical production have decreased as a result of a relevant reduction in ammonia production.

4.3.4. Source-specific QA/QC and verification

Emissions from adipic, nitric acid, ammonia and other chemical industry production have been checked with the relevant process operators and with data reported to the national EPER registry.

4.3.5. Source-specific recalculations

On account of new information available by industry, N_2O and CO_2 emissions have been recalculated for the whole time series. The recalculation accounts for an increase of 16.1% and 0.1% in N_2O emissions for 1990 and 2002, respectively; for CO_2 emissions recalculations result in a decrease of 2.3% in 1990 and an increase of 96.2% in 2002. Total recalculation for the chemical industry category (2B) results in the increase of CO_2 equivalent emissions of 10.8% and 5.8% for 1990 and 2002, respectively.
The time series of CO_2 equivalent emission recalculations is reported in Table 4.5.

Table 4.5 Recalculations of CO_2 equivalent (Gg) emissions in the chemical production sector 1990-2002

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2004 submission													
CO_2 eq. (2B)	8,112	8,413	7,943	7,391	6,770	7,625	7,113	7,230	7,360	7,531	8,040	8,384	8,084
2005 submission													
CO_2 eq. (2B)	8,986	9,268	8,697	8,141	7,477	8,428	7,876	7,998	8,111	8,235	8,874	8,841	8,556
Δ emissions (%)	*10.8*	*10.2*	*9.5*	*10.1*	*10.4*	*10.5*	*10.7*	*10.6*	*10.2*	*9.4*	*10.4*	*5.5*	*5.8*

4.3.6. Source-specific planned improvements

Emission factors and activity data will be improved by collecting more information from the operators about N_2O emission trends for nitric acid production, especially for the years 1990-2000.

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”, all identified as non-key sources.
CO_2 emissions from steel production refer to basic oxygen furnaces and electric furnaces.
For the steel production from arc furnaces, the amount of steel recycled is about 15,000 kilotonnes.
CO_2 emissions from pig iron, sinter and coke production are not relevant and by the way they are estimated and included in the combustion processes (1A2a).
CH_4 emissions from steel production are estimated on the basis of emission factors derived from the IPPC “Bref Report” and the EMEP/CORINAIR “Guidebook” and refer to Basic Oxygen furnace, Electric furnaces and Rolling mills. Therefore values are entered in “Other”.
CH_4 emissions from coke production are fugitive emissions during solid fuel transformation and have been reported in Table 1B1b of the CRF.
The share of CO_2 emissions from metal production accounts, in the year 2003, for 0.4% of the national total CO_2 emissions, and 6.8% of the total CO_2 from industrial processes.
The share of CH_4 emissions out of the total is not relevant and N_2O emissions do not occur.
The share of F-gas emissions from metal production out of the national total F-gas levels was 8.9% in the base-year 1995 and less than 5% (0.06% of the national total greenhouse gas emissions) in the year 2003.

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) and industrial reports and emission factors used are those reported in the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2001), in sectoral studies (ANPA, 2000; CTN/ACE, 2000) or supplied directly by industry.
CH_4 emissions from steel production, reported in "Other", have been estimated on the basis of emission factors derived from the IPPC specific BREF Report (available at http://eippcb.jrc.es) and the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2001) and refer to basic oxygen furnace, electric furnaces and rolling mills.
For the estimation of PFC emissions from aluminium production, both IPCC Tier 1 and Tier 2 methods are used. These emissions, specifically CF_4 and C_2F_6, have been calculated on the basis of the information provided by the national primary aluminium producer, with reference to the document drawn up by International Aluminium Institute (IAI, 2003) and the IPCC Good Practice Guidance (IPCC, 2000).
The Tier 1 has been used to calculate PFC emissions relating to the entire period 1990-1999. As from the year 2000, the more accurate Tier 2 method has been followed, based on default technology specific slope and overvoltage coefficients.
As concerns the Tier 1 methodology, the emission factors for CF_4 and C_2F_6 were provided, whereas for the Tier 2 site specific values and, where they were not available, default coefficients were provided. In the following tables (Tables 4.6, 4.7, 4.8, 4.9) the EFs and the default parameters used are reported; site specific values are confidential but they have been supplied to the inventory team.

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

	Technology specific emissions (kg CF_4 / t Al)		
	1990 - 1993	**1994 - 1997**	**1998 - 2000**
Center Work Prebake	0.4	0.3	0.2
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
Horizontal Stud Søderberg	0.7	0.6	0.6

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

	Technology multiplier factor
Center Work Prebake	0.17
Point Fed Prebake	0.17
Side Work Prebake	0.24
Vertical Stud Søderberg	0.06
Horizontal Stud Søderberg	0.09

Table 4.8 Coefficients used for estimation with the Tier 2 methodology by plant

	Baked Anode Properties (weight percent)		
	Sulphur	**Ash**	**Impurities**
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 with the Tier 2 methodology by plant

	Pitch content in green anodes (weight%)	Hydrogen content in pitch (weight%)	Recovered tar (kg/t BAP)	Packing coke consumption (t Pcc/ t BAP)	Sulphur content of packing coke (weight%)	Ash content of packing coke (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

At present in Italy there are two primary aluminium production plants, which use a prebake technology with point feeding (CWPB), characterised by low emissions. These plants have been progressively upgraded from a Side Work Prebake technology to Point Fed Prebake technology; three old plants with Side Work Prebake technology and Vertical Stud Søderberg technology stopped operation in 1991 and 1992.
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 which operates the only magnesium foundry located in Italy (Magnesium products of Italy, 2005). The plant started its activity in September 1995.

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 4.10 the emission trend of F-gases per compound from metal production is given.

Table 4.10 Actual emissions of F-gases per compound from metal production in Gg CO_2eq (1990-2003)

COMPOUND	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
CF_4 (PFC-14)	1,289.2	115.6	119.9	122.0	122.8	122.0	168.1	198.1	168.1	234.1
C_2F_6 (PFC-16)	384.1	27.8	28.8	29.4	29.5	29.3	30.6	36.0	30.6	42.6
Total PFC emissions from aluminium production	*1,673.4*	*143.4*	*148.7*	*151.4*	*152.3*	*151.3*	*198.7*	*234.1*	*198.6*	*276.7*
Total SF_6 emissions from magnesium foundries	*0.0*	*0.0*	*12.0*	*15.5*	*23.9*	*35.9*	*172.1*	*449.9*	*400.1*	*135.5*
Total F-gas emissions from metal production	1,673.4	143.4	160.6	166.9	176.2	187.2	370.8	684.0	598.7	412.2

The decreasing of SF_6 consumption in the magnesium foundry in 2003 is due to the abandonment of recycling plant and the optimisation of mixing parameters.

4.4.4 Source-specific QA/QC and verification

Emissions from aluminium production are checked with the relevant process operators.

4.4.5 Source-specific recalculations

No recalculation has been done.

4.4.6. Source-specific planned improvements

The consistency of the PFC emissions from aluminium production will be verified, as two different methodologies have been used on account of the information provided by the industry.

4.5 Other production (2D)

4.5.1. Source category description

Only indirect gas 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. gasification of water) 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 beverage included in the previous submissions have been removed since they are 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.

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, “HFC-23 emissions from HCFC-22 manufacture” and “Fugitive emissions”, identified as non-key sources.
The share of emissions of F-gases from the production of halocarbons and SF_6 in the national total of F-gases was 43.2% in the base-year 1995 and 0.4% in 2003; the share in the national total greenhouse gas emissions was 0.16% in the base-year and 0.005% in 2003.

4.6.2 Methodological issues

For source category ”HFC-23 emissions from HCFC-22 manufacture”, the IPCC Tier 2 method is used, based on plant-level data communicated by the national producer (Solvay-Solexis, 2005); since 1996, data are adjusted for HCFC-22 destruction.
Also for source category “Fugitive emissions”, emission estimates are based on plant-level data communicated by the national producer (Solvay-Solexis, 2005).

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. In Table 4.11 an overview of the emissions from production of halocarbons and SF_6 is given for the 1990-2003 period, per compound.

HFC-23 emissions from HCFC-22 had already been drastically reduced in 1988 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.
PFC and SF_6 emissions are constant from 1990 to 1995 and from 1996 to 1998, reducing to zero from 1999 due to the installation of the thermal afterburner mentioned above. PFC are by-product emissions, whereas SF_6 production stopped from the 1st of January 2005.
As concerns fugitive emissions, emissions of HFC-134a have been cut in 1999 thanks to a rationalisation in the new production facility located in Porto Marghera, whereas HFC-125 and HFC-143 released as by-products from the production of HFC-134a have been recovered and commercialised.

Table 4.11 Actual emissions of F-gases per compound from production of halocarbons and SF_6 in Gg CO_2eq (1990-2003)

COMPOUND	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
HFC 23	351.0	351.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total HFC 23 emissions from HCFC 22 manufacture	*351.0*	*351.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
HFC 125	0.0	28.0	22.4	98.0	56.0	5.6	2.8	5.6	5.6	11.2
HFC 134a	0.0	39.0	41.6	52.0	65.0	15.6	15.6	15.6	15.6	7.8
HFC 143a	0.0	22.8	22.8	30.4	38.0	3.8	3.8	3.8	0.0	3.8
HFC 227ea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CF_4	97.5	97.5	32.5	32.5	32.5	0.0	0.0	0.0	0.0	0.0
PFC C2÷C3	36.8	36.8	9.2	9.2	9.2	0.0	0.0	0.0	0.0	0.0
SF_6	119.5	119.5	47.8	47.8	47.8	0.0	0.0	0.0	0.0	0.0
Total F gas fugitive emissions	*253.8*	*343.6*	*176.3*	*269.9*	*248.5*	*25.0*	*22.2*	*25.0*	*21.2*	*22.8*
Total F-gas emissions from production of halocarbons and SF_6	604.8	694.6	176.3	269.9	248.5	25.0	22.2	25.0	21.2	22.8

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 source 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 sources. The share of emissions of F-gases from the consumption of halocarbons and SF_6 in the national total of F-gases was 47.9% in the base-year 1995 and 94.6% in 2003; the share in the national total greenhouse gas emissions was 0.17% in the base-year and 1.1% in 2003.

4.7.2. Methodological issues

The type of methods used to calculate emissions of F-gases 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 3b

Basic data have been supplied by industry: specifically, for the air conditioning equipment the national motor company and the agent's union of foreign motor-cars vehicles has provided the yearly consumptions (FIAT, 2005; IVECO, 2005; UNRAE, 2005); pharmaceutical industry has provided aerosols/metered dose inhaler data (AVENTIS, 2005; Boehringer Ingelheim Italia, 2005; Chiesi Farmaceutici, 2005; GSK, 2005; LUSOFARMACO, 2005; Menarini, 2005); the semiconductor manufacturing industry has supplied consumption data for four national plants (ST Microelectronics, 2005; MICRON, 2005); finally, for the sub-source fire extinguishers, the European Association for Responsible Use of HFCs in Fire Fighting have been contacted (ASSURE, 2005).
SF_6 emissions from electrical equipment from 1990 to 1994 have been estimated according to IPCC Tier 2a approach. SF_6 leaks from installed equipment have been estimated on the basis of the total amount of sulphur hexafluoride accumulated and of average leakage rates; leakage data published in environmental reports have also been used for major electricity producers (ANIE, 2005).
IPCC Tier 1a method has been used to calculate potential emissions, using production, import, export and destruction data provided by the national producer (ANIE, 2005).

4.7.3. Uncertainty and time-series consistency

The combined uncertainty in F-gas emissions from HFC, PFC emissions from 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 11.1% in annual emissions, 5% and 10% concerning respectively activity data and emission factors.
In Table 4.12 an overview of the emissions from consumption of halocarbons and SF_6 is given for the 1990-2003 period, per compound. In Table 4.13 an overview of the potential emissions is given for the 1990-2003 period, per compound. Concerning PCF potential emissions, there is no information on import/export, whereas the production is zero (Solvay-Solexis, 2005).

Table 4.12 Actual F-gas emissions per compound from the consumption of halocarbons and SF_6 in Gg CO_2eq (1990-2003)

Compound	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
HFC 23	0.00	1.58	2.30	3.03	3.77	4.51	5.27	6.03	6.80	7.58
HFC 32	0.00	0.00	0.19	0.51	12.10	21.33	50.33	93.13	146.71	229.91
HFC 125	0.00	1.85	10.81	24.34	96.19	178.34	381.68	671.68	1,029.60	1,527.51
HFC 134	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC 134a	0.00	224.33	333.00	508.06	785.79	945.18	1,136.80	1,365.13	1,586.36	1,740.10
HFC 143a	0.00	2.74	15.51	34.39	63.67	125.29	234.94	381.18	556.46	757.56
Total HFC emissions from refrigeration and air conditioning equipment	*0.00*	*230.49*	*361.81*	*570.33*	*961.52*	*1,274.66*	*1,809.02*	*2,517.16*	*3,325.93*	*4,262.67*
HFC 134a emissions from foam blowing	0.00	0.00	0.00	0.00	31.27	36.29	41.09	45.68	51.62	57.70
HFC 227ea emissions from fire extinguishers	0.00	0.00	1.56	4.60	11.54	15.33	19.64	25.91	31.86	37.52
HFC 134a emissions from aerosols/metered dose inhalers	0.00	0.00	0.00	0.00	0.00	80.63	108.37	137.62	123.71	186.21
Total HFC emissions from ODS substitutes	*0.00*	*0.00*	*1.56*	*4.60*	*42.81*	*132.25*	*169.10*	*209.21*	*207.20*	*281.43*
HFC 23	0.00	0.00	0.00	0.00	17.61	19.86	5.12	7.42	6.19	8.57
HFC 134a	0.00	0.00	0.00	0.00	0.03	0.05	0.05	0.01	0.00	0.00
CF_4	0.00	24.43	21.94	24.43	27.20	40.94	64.81	107.81	106.17	117.11
C_2F_6	0.00	34.57	31.06	34.57	49.17	65.59	81.98	99.12	108.01	97.68
C_4F_8	0.00	0.00	0.00	0.00	0.04	0.15	0.37	11.30	0.77	2.04
SF_6	0.00	0.00	0.00	0.00	55.57	62.14	20.91	49.40	53.30	60.46
Total PFC, HFC, SF_6 emissions from semiconductor manufacturing	*0.00*	*59.00*	*53.00*	*59.00*	*149.62*	*188.74*	*173.25*	*275.06*	*274.44*	*285.86*
SF_6 emissions from electrical equipment	*213.42*	*481.95*	*622.81*	*665.30*	*477.54*	*306.52*	*300.44*	*296.05*	*284.96*	*289.97*
Total F-gas emissions from consumption of halocarbons and SF_6	**213.42**	**771.45**	**1,039.17**	**1,299.23**	**1,631.49**	**1,902.16**	**2,451.81**	**3,297.47**	**4,092.53**	**5,119.92**

Table 4.13 Potential F-gas emissions per compound from the consumption of halocarbons and SF6, (1990-2003), in Gg CO_2eq

Compound	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
HFC 32	0.00	0.00	0.00	0.00	0.00	0.00	10.40	3.25	-5.20	29.25
HFC 125	0.00	148.40	-36.40	47.60	-109.20	260.40	268.80	1.671.60	803.60	-123.20
HFC 134a	0.00	1,739.40	2,059.20	1,886.30	4,101.50	3,367.00	2,107.30	4,371.90	2,960.10	4,551.30
HFC 143a	0.00	11.40	45.60	-11.40	60.80	266.00	68.40	258.40	79.80	547.20
HFC 227ea	0.00	0.00	0.00	0.00	2.90	40.60	72.50	133.40	89.90	0.00
SF_6	3,752.30	3,675.82	3,451.16	4,612.70	11,495.90	3,465.50	3,919.60	5,903.30	3,689.20	3,211.20
Total F-gases	**3,752.30**	**5,575.02**	**5,519.56**	**6,535.20**	**15,551.90**	**7,399.50**	**6,447.00**	**12,341.85**	**7,617.40**	**8,215.75**

4.7.4. Source-specific recalculations

In Table 4.14 the comparison between total estimation recalculated and previous estimation of the sector is given in percentages from 1990 to 2002, for every gases. Only the percentages different from zero have been reported.

Table 4.14 Comparison between recalculated and previous F-gas emissions from the consumption of halocarbons and SF_6 per gas in percentage (1990-2002)

Compound	1990	1995	1996	1997	1998	1999	2000	2001	2002
HFC 23	-	-	-	-	-	-	-	-	-
HFC 32	-	-	-	-	-	-	-	-	-
HFC 125	-	-	-	-	-	-	-	-	-
HFC 134	-	-	-	-	-	-	-	-100.00%	-100.00%
HFC 134a	-	-	-	-	-	-	-	-	-2.20%
HFC 143a	-	-	-	-	-	-	-	-	-
Total HFC emissions from refrigeration and air conditioning equipment									
HFC 134a emissions from foam blowing	-	-	-	-	-	-	-	-	-
HFC 227ea emissions from fire extinguishers	-	-	-99.00%	-99.02%	-99.02%	-99.05%	-99.07%	-99.08%	-99.10%
HFC 134a emissions from aerosols/metered dose inhalers	-	-	-	-	-	-	-	-	-
Total HFC emissions from ODS substitutes									
HFC 23	-	-	-	-	-	-	-	-	-
HFC 134a	-	-	-	-	-	-	-	-	-
CF_4	-	-	-	-	-	-	-	-	-
C_2F_6	-	-	-	-	-	-	-	-	-
C_4F_8	-	-	-	-	-	-	-	-	-
SF_6	-	-	-	-	-	-	-	-	-
Total PFC, HFC, SF6 emissions from semiconductor manufacturing									
SF_6 emissions from electrical equipment	-	-	-	-	-	-	-	-	-7.13%
Total F-gas emissions from consumption of halocarbons and SF_6									

Regarding HFC-134, a double counting has been corrected; HFC-134 emissions reported in previous submissions for truck's air conditioning equipment were already included in HFC-134a emissions communicated by the national industry IVECO.

The differences for 2002 for SF_6 emissions from electrical equipment and HFC-134a from air conditioning system are due to an erroneous calculation referring to the last submission.

The most relevant recalculation, in terms of emission, concerns HFC-227ea from fire extinguishers, where the EF has been corrected.

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, have been estimated.
N_2O emissions have been included in the submission of this year. 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 used for whipped cream. The entire time series from 1990 to 2003 has been reconstructed.
In 2003, solvent use is responsible for 0.3% of the total CO_2 emissions (not considering CO_2 from LUCF) and 37.2% of total NMVOC emissions, and represents the second source of anthropogenic NMVOC national emissions.
N_2O emissions, in 2003, represent about 2% of the total N_2O national emissions.
The trends of NMVOC, CO_2 and N_2O emissions are summarised in Table 5.1. Emissions from paint application and other use of solvents for NMVOC and CO_2 are more than 80% and 90%, respectively, of the total in the sector.
From 1990 to 1995, a constant level of N_2O emissions is observed, afterwards from 1995 to 1998 emissions increased by 37%. From 1999, there appears to be a reduction in N_2O emissions, due to a decrease in the anaesthetic use of N_2O, that has been replaced by halogen gas.

Table 5.1 Trend in NMVOC, CO_2 and N_2O emissions from the solvent use sector 1990-2003 (Gg)

Gas/subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NMVOC														
3A. Paint Application	270.09	265.53	264.79	255.56	255.11	254.61	245.67	245.02	229.94	229.27	227.38	230.65	227.39	222.29
3B. Degreasing and dry cleaning	56.66	52.98	50.72	43.20	37.05	34.12	31.92	30.22	28.59	27.12	26.40	25.70	25.02	24.36
3C. Chemical products	56.70	57.79	60.45	55.16	58.69	59.98	61.80	62.48	62.67	62.69	67.71	65.18	64.06	63.32
3D. Other	233.76	238.49	217.09	213.10	199.35	191.27	189.81	193.64	194.60	198.26	192.43	180.25	176.57	177.99
CO_2														
3A. Paint Application	841.87	827.67	825.36	796.58	795.19	793.62	765.77	763.71	716.74	714.64	708.74	718.94	708.77	692.88
3B. Degreasing and dry cleaning	176.62	165.15	158.09	134.65	115.48	106.34	99.50	94.20	89.12	84.52	82.27	80.09	77.98	75.93
3D. Other	728.62	743.38	676.68	664.25	621.36	596.20	591.64	603.59	606.56	617.99	599.79	561.83	550.36	554.79
N_2O														
3D. Other (use of N_2O for anaesthesia and N_2O from aerosol cans)	2.57	2.42	2.41	2.45	2.41	2.44	2.91	2.91	3.35	3.28	3.26	2.95	2.95	2.76

CO_2 emissions from solvent use is a key source in the Tier 2 analysis both for level and trend assessment, especially because of the high level of uncertainty in the estimates and a strong

reduction of emissions in these years. On the other hand, N_2O emissions from solvent use is a key source in the Tier 2 analysis for trend assessment, especially because of the high level of uncertainty in the activity data and the increase of emission levels. The results are reported in the following box.

Key-source identification for solvent and other use with the IPCC Tier1 and Tier2 approaches

3A-3D	CO_2	Indirect emissions from solvent use and other product use	Key (L2, T2)
3D	N_2O	Emissions from uses of N_2O in anaesthesia and aerosol cans	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, has been 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 have been 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 and from aerosol cans (3D) have been estimated. Emissions of N_2O from fire extinguishers do not occur.
Emissions of N_2O from other use of N_2O (3D) have not been estimated because no information on activity data and emission factors is available at present.

5.3 Methodological issues

Emissions of NMVOC from solvent use have been estimated according to the CORINAIR methodology with a bottom-up approach, applying both national and international emission factors (Vetrella, 1994; EMEP/CORINAIR, 2001). All the activities in the Selected Nomenclature for Air Pollutant classification (SNAP97) have been estimated.
Country specific emission factors provided by several accredited sources have been used extensively, in particular for paint application (Professione Verniciatore del Legno, several years; GRUPPO FIAT, 2004), solvent use in dry cleaning (ENEA/USLRMA, 1995), solvent use in textile finishing and in the tanning industries (TECHNE, 1998). 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.
The conversion of NMVOC emissions into CO_2 emissions has been carried out considering specific factor calculated on the basis of molecular weights and suggested by the European Environmental Agency for the CORINAIR project (EEA, 1997), except for emissions from the 3C sub-sector to avoid double-counting as suggested in the Common Reporting Format.
Emissions of N_2O have been estimated taking into account information made 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 2003 (ASSOGASTECNICI, 2005).

For previous years, data have been estimated by the number of surgical beds published by national statistics (ISTAT, several years). The Italian Association of Aerosol Producers (AIA – ASSOCIAZIONE ITALIANA AEROSOL [a] and [b], 2005) has provided data on the annual production of aerosol cans.
It is assumed that all of N_2O used will eventually be released to the atmosphere, therefore the emission factor for anaesthesia is 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).
N_2O emissions have been calculated multiplying activity data, total quantity of N_2O used for anaesthesia and total aerosol cans products, 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 factors.
The decrease in NMVOC emission levels from 1990 to 2003 is about 20% due to the reduction of emissions especially in degreasing and dry cleaning and in other use of solvents. The European Directive (EC, 1999) regarding NMVOC emission reduction in this sector entered into force in Italy in January 2004, establishing a reduction of the solvent content in products. Figure 5.1 shows emission trends from 1991 to 2003 with respect to 1990 by sub-sectors.
From 1990 to 2003, emissions from the use of N_2O increased by about 8%.

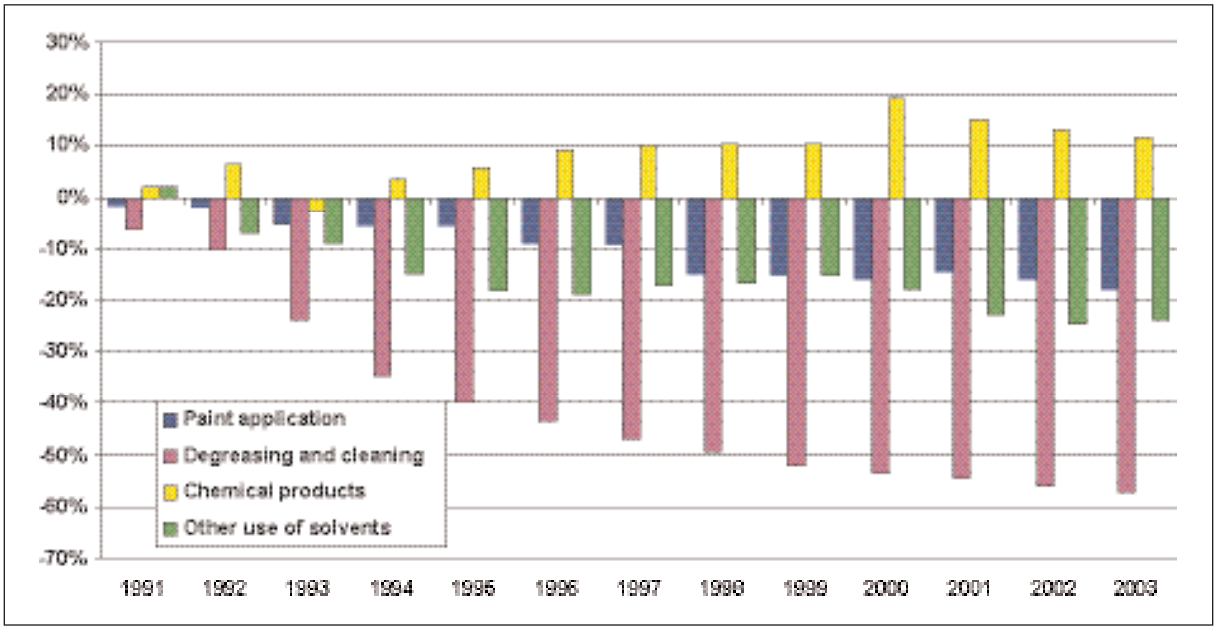

Figure 5.1 Trend of NMVOC emissions from 1991 to 2003 as compared to 1990 (%)

5.5 Source-specific QA/QC and verification

In 2003, 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) have been updated with data acquired by the National Statistics Institute (ISTAT [a], [b], [c], several years), industrial associations (AVISA, 2005) and international organization (FAO, several years).
In the framework of the MeditAiraneo project, APAT commissioned to the Techne Consulting 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.
In this year submission moreover, N_2O emissions from the use of this gas in anaesthesia application and in aerosol cans have been estimated.

5.6 Source-specific recalculations

Source-specific recalculations are equal, on average, to 3% of the total NMVOC levels in the sector. Specifically, for the years 1997-2002, there has been a revision of emissions from fat edible and non edible oil extraction and application of glues and adhesives. In general, the higher level is due to the updating of activity data time series.
The recalculation for CO_2 and N_2O emission levels, in terms of CO_2 equivalent, is high and, on average, equal to 64% because N_2O emissions have been estimated and reported in this year submission.

Table 5.2 Trend of recalculations of CO_2, CO_2/ N_2O and NMVOC emissions 1990-2002 (%)

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CO_2	0.8	0.7	1.9	2.1	1.6	1.6	2.0	3.0	3.9	4.9	4.6	7.7	7.8
CO_2/N_2O													
NMVOC	46.7	44.2	47.8	50.6	51.2	52.9	65.0	66.5	80.3	80.2	80.6	80.2	81.3
	0.4	0.3	1.6	2.0	1.7	1.7	2.3	3.6	3.8	4.7	4.7	7.4	7.4

5.7 Source-specific planned improvements

A revision of emission factors and activity data on the basis of information by industrial associations for some activities, such as domestic solvent use, will be carried out.

6. AGRICULTURE [CRF SECTOR 4]

6.1 Overview of sector

The agriculture sector in the Italian inventory includes five source categories: enteric fermentation (4A), manure management (4B), rice cultivation (4C), agriculture soils (4D) and field burning of agriculture residues (4F) and the estimation of methane (CH_4) and nitrous oxide (N_2O). 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.
In 2003, the agriculture sector has been the dominant national source for methane and nitrous oxide emissions, accounting for 47.8% (777.47 Gg CH_4) and 54.1% (72.32 Gg N_2O) of total national emissions, respectively. Emission trends for the agriculture sector, for methane and nitrous oxide gases, expressed in Gg, are summarised in Table 6.1. Methane emissions from enteric fermentation and nitrous oxide emissions from direct agriculture soils are the most relevant source categories in this sector; and their individual share in national total greenhouse gas emissions, in CO_2 equivalent, is 1.9% and 2.9%, respectively.

Table 6.1 Trend in greenhouse gas emissions from the agriculture sector, 1990-2003 (Gg)

Categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
$\underline{CH_4}$							Gg							
4A. Enteric Fermentation	587.68	606.39	589.54	583.59	585.50	594.09	594.21	597.37	594.35	595.84	583.31	559.53	554.51	520.63
4B. Manure management	191.70	193.53	186.46	186.02	181.09	184.88	185.99	185.72	187.53	189.44	183.97	188.08	186.75	181.94
4C. Rice cultivation	73.26	70.17	73.58	78.81	80.24	81.36	80.78	79.18	75.73	75.08	74.93	74.01	74.36	74.36
4F. 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	0.58	0.53	0.60	0.54
$\underline{N_2O}$							Gg							
4B. Manure management	12.35	12.69	12.40	12.26	12.32	12.85	13.02	13.19	13.41	13.57	13.07	13.56	13.48	12.81
4D. Agriculture soils	60.86	63.40	64.22	65.46	64.06	62.34	61.47	64.73	62.60	63.17	62.03	60.84	60.82	59.50
4F. 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	0.01	0.01	0.01	0.01

In 2003, methane emissions from enteric fermentation and nitrous oxide from agricultural soils, both direct and indirect emissions, are ranked among the top-10 level key sources; methane emissions from enteric fermentation are also ranked among the top-10 trend key sources.
In the following box, according to a level and/or trend assessment (*IPCC Tier 1 and Tier 2 approaches*), key and non-key sources from the agriculture sector are shown. Methane emissions from enteric fermentation, manure management and rice cultivation, as well as nitrous oxide emissions from manure management and agricultural soils, direct, indirect and from animal production, have been identified as key sources.

Key-source identification in the agriculture sector with the IPCC Tier1 and Tier2 approaches

4A	CH_4	Emissions from enteric fermentation	Key (L, T)
4B	CH_4	Emissions from manure management	Key (L, T)
4B	N_2O	Emissions from manure management	Key (L, T2)
4C	CH_4	Emissions from rice cultivation	Key (L2)
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, T)
4F	CH_4	Emissions from field burning of agriculture residues	Non-key
4F	N_2O	Emissions from field burning of agriculture residues	Non-key

As emission factors and activity data are the main parameters for the calculation of emissions, there are some general aspects, which are important to be mentioned. In general, emission factors used for the estimation of emissions in agriculture reflect specific national characteristics, in some cases also IPCC default emission factors have been used. Improvements in estimations are due to more detailed information on activity data or parameters available from the national agriculture statistics. By the time of the preparation of the emission inventory, some activity data for 2003 were not available, therefore estimations have been carried out on the basis of times series; these data will be updated in the next submission. Recommendations from the Centralized Review have been taken into consideration (FCCC/WEB/IRI/2004/ITA[1]).

6.2. Enteric fermentation (4A)

6.2.1 Source category description

As mentioned previously, methane emissions from enteric fermentation is a major key source, both in terms of level and trend for Tier 1 and Tier 2 approaches.
In 2003, methane emissions from enteric fermentation were 520.63 Gg, which represent 67% of methane emissions for the agriculture sector (68.9% in 1990) and 31.6% for total methane emissions (32.2% in 1990). Methane emissions from this source mainly consist of cattle emissions, with 189.83 Gg for dairy cattle and 228.71 Gg for non-dairy cattle, representing 36.5% (42.3% in 1990) and 43.9% (40.6% in 1990) of enteric fermentation, respectively.
For enteric fermentation, 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.

6.2.2. Methodological issues

Methane emissions from enteric fermentation are estimated by defining an emission factor for each livestock category multiplied by the population of the same category. Data for each livestock category are collected from the National Institute of Statistics (ISTAT, several years [a], [b], [c], [g],

[1] Italy, Report of the Individual review of the GHG Inventory submitted in the year 2004 –Agriculture sector (4 March 2005).

[h]), and are based on specific national surveys (milk production[2], farm structure and production[3]), and from a general agriculture census carried out each 10 years (ISTAT, 2000).
All livestock categories provided by ISTAT are classified according to the type of production, slaughter or breeding, and the age of animals. Only for rabbits, activity data for 1990 have been collected from ISTAT agriculture census, and for the years 1991-2003, activity data from brood-rabbits and other rabbits have been reconstructed on the basis of meat production.
Methane emissions from enteric fermentation for dairy cattle are estimated using Tier 2 approach, as suggested in the Good Practice Guidance (IPCC, 2000).
Parameters used for the calculation of time series emission factors are presented in the following box.

Parameters for the calculation of dairy cattle emission factors from enteric fermentation

Parameters	Value	Reference
Average weight (kg)	650	CRPA, 2000
Coefficient NEm (dairy cattle)	0,335	NRC, 2001; IPCC, 2000
Pasture (%)	10	CRPA, 2000
Weight gain (kg/day)	0,051	CRPA, 2004 [b]
Fat content in milk (%)	3.59-3.71	ISTAT, several years [a], [b], [d], [e]
Hours of work per day	0	CRPA, 2000
Portion of cows giving birth	0.92-0.98	AIA, 2001
Milk production (kg/head/day)	13.4-17.4	ISTAT, several years [a], [b], [c] [d], [e], [h]
Digestibility of feed (%)	65	CRPA, 2004 [b]
Methane conversion rate (%)	5.2-5.5	CRPA, 2000
MJ/kg methane	55.65	IPCC, 2000

During the years, variation of dairy cattle emission factor has been attributed to new or updated specific national parameters, such as fat content in milk, portion of cows giving birth, milk production and methane conversion factor; parameters and feeding characteristics are described in national publications (CRPA, 2004[a]). In particular, average milk production yield is composed by milk used for dairy production and consumption (*latte munto*[4]) and milk used for calves feeding (*alimentazione dei bestiami poppato dai redi-mammella*[5]); their contribution to national milk production fluctuates during the years. An in depth review of different statistical sources for the milk production (OSSLATTE, 2001; OSSLATTE/ISMEA, 2002; OSSLATTE/ISMEA, 2003; AIA/ISMEA/ OSSLATTE, 2003; OSSLATTE/ISMEA, 2004) has been done. The methane conversion rate, based on the energetic concentration of the ration, is progressively reduced, according to expert judgement, due to an increase of efficiency on ingested food (CRPA, 2000). Data for fat content of milk, portion of cows giving birth, milk production and methane conversion factor are presented in Table 6.2.

[2] *Indagine annuale sul settore lattiero-caseraio*, survey done each year to industries that treat and transforms milk (dairy factories, milk centres and centres for the collection of milk).
[3] *Indagine sulla s**truttura** e produzione delle aziende agricole*, survey done each two years in agricultural farms.
[4] *Latte munto*, composed of milk delivered to dairy factories, direct sales, farm cheese, home consumption and feed.
[5] *Alimentazione dei bestiami poppato dai redi-mammella*, milk which is suckled from calves.

Table 6.2 Parameters used for the estimation of CH_4 enteric fermentation emissions for dairy cattle, 1990-2003

	Fat content in milk (%)	Portion of cows giving birth	Methane conversion rate (%)	Milk production yield (kg/head/d)
1990	3.59	0.98	5.5%	13.38
1991	3.59	0.97	5.5%	14.87
1992	3.59	0.96	5.5%	15.91
1993	3.63	0.96	5.5%	15.70
1994	3.64	0.96	5.4%	16.57
1995	3.64	0.94	5.4%	16.76
1996	3.65	0.95	5.3%	17.24
1997	3.66	0.94	5.3%	17.43
1998	3.71	0.93	5.3%	17.34
1999	3.69	0.92	5.2%	17.28
2000	3.65	0.93	5.2%	17.39
2001	3.65	0.92	5.2%	16.55
2002	3.65	0.92	5.2%	16.18
2003	3.65	0.92	5.2%	16.99

Resulting dairy cattle emission factors (EF) are presented in Table 6.5. In 2003, EF was estimated to be 99.86 kg CH_4/head/year; EF proposed by the IPCC is equal to 100 kg CH_4/head/year (IPCC, 1997).
For non-dairy cattle, methane emissions from enteric fermentation are estimated with Tier 2 approach (IPCC, 2000), defining emission factors with country-specific data. Emission factors are estimated for disaggregated livestock categories, as shown in Table 6.3, and are based on dry matter intake (kg/head/day) calculated as percentage of live weight (INRA, 1988; NRC, 1984; NRC, 1988; Borgioli, 1981; Holter and Young, 1992; Sauvant, 1995; CRPA, 2000). Dry matter intake is converted to gross energy (MJ/head/day) using 18.45 MJ/kg dry matter (IPCC, 2000). Emission factors for each category have been calculated by using equation 4.14 from the Good Practice Guidance (IPCC, 2000). Parameters used for the estimation of non-dairy cattle emission factor are shown in Table 6.4.
National characteristics of Italian breeding are reflected in emission factors and are related to the classification age of the animals and dry matter intake. Implied non-dairy cattle emission factors are presented in Table 6.5. They include all cattle categories except for dairy cattle. In 2003, emission factor was estimated to be 48.35 kg CH_4/head/year; EF proposed by IPCC is 48 kg CH_4/head/year (IPCC, 1997).

Table 6.3 Age class distribution of non-dairy cattle, 1990-2003

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	
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	386.000	1.694.000	26.986	629.014	721.000	164.000	83.000	480.000	39.000	625.000	4.848.000
2002	410.000	1.794.000	25.176	586.824	723.000	160.000	98.000	431.000	53.000	588.000	4.869.000
2003	466.000	1.557.000	31.799	741.201	718.000	178.000	89.000	449.000	51.000	449.000	4.730.000

Table 6.4 Main parameters for non-dairy cattle CH_4 emission estimations, 1990-2003

	<1 year		1-2 years Males		1-2 years Females		>2 years Males	>2 years Females		
Parameters	for slaughter	Others	breeding	for slaughter	breeding	for slaughter	all	breeding	for slaughter	others
Average weight (kg)	0	190	550	450	450	450	900	550	550	750
Percentage weight ingested	0	2.6	1.9	2.1	2.1	2.1	1.9	2.1	2.1	1.9
Dry matter intake (kg/head/day)	0	4.8	10.6	9.4	9.5	9.4	17.1	11.5	11.5	14.3
Gross Energy (Mj /head/day)	0	89.4	194.8	173.5	174.3	173.5	315.5	212.2	212.2	262.9
CH_4 conversion (%)	0	4	4.5	4	6	4	6	6	6	6

A tier 1 approach using IPCC default emission factors was used to estimate methane emissions from swine, sheep, goats, horses, mules and asses (IPCC, 1997). According, to country specific characteristics in Italy, rabbits have also been considered; methane emissions from rabbits were estimated using a country-specific emission factor suggested by the Research Centre on Animal Production (*Centro Ricerche Produzioni Animali*, CRPA). Daily dry matter intake for brood-rabbits and rabbits are 0.13 kg/day and 0.11 kg/day, respectively, and it has been assumed 0.6% as methane conversion rate (CRPA, 2004[c]).
Emission factors from 1990 to 2003 for all livestock categories, dairy cattle, non-dairy cattle, buffalo, swine, sheep, goats, horses, mules and asses, and other (rabbit) are presented in Table 6.5.

Table 6.5 Average methane emission factors for enteric fermentation (kg CH_4/head/yr), 1990-2003

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sheep	Goat	Horses	Mules and asses	Swine	Other: Rabbit
1990	94.11	46.64	55	8	5	18	10	1.5	0.08
1991	98.74	49.72	55	8	5	18	10	1.5	0.08
1992	101.96	50.00	55	8	5	18	10	1.5	0.08
1993	101.55	50.09	55	8	5	18	10	1.5	0.08
1994	102.49	51.60	55	8	5	18	10	1.5	0.08
1995	103.00	50.11	55	8	5	18	10	1.5	0.08
1996	102.66	50.46	55	8	5	18	10	1.5	0.08
1997	103.29	51.06	55	8	5	18	10	1.5	0.08
1998	103.33	50.24	55	8	5	18	10	1.5	0.08
1999	101.01	50.68	55	8	5	18	10	1.5	0.08
2000	101.07	49.87	55	8	5	18	10	1.5	0.08
2001	98.54	50.57	55	8	5	18	10	1.5	0.08
2002	97.44	49.40	55	8	5	18	10	1.5	0.08
2003	99.86	48.35	55	8	5	18	10	1.5	0.08

6.2.3. Uncertainty and time-series consistency

Uncertainty of methane emissions from enteric fermentation is estimated to be 28% for annual emissions, as a combination of 20% of uncertainty for both activity data and emission factors.
In 2003, livestock methane emissions from enteric fermentation were 11.4% (520.63 Gg) lower than in 1990 (587.68 Gg) while from 1990 to 2003 dairy cattle livestock have decreased by 28%, from 2,600,000 to 1,900,000, and non-dairy cattle by 7%, from 5,100,000 to 4,700,000. The

decrease in cattle number is tending to drive down livestock emissions, particularly as emissions per head from cattle are 10 times that per head of sheep or goat. Additionally, cattle contributes with 79-84% to the total methane emissions in this category, sheep with 11-15% and the rest of livestock categories with 5-7%. In Table 6.6, enteric fermentation methane emission trends from 1990 to 2003 are presented.

Table 6.6 Trend in CH_4 emissions from enteric fermentation 1990-2003 (Gg)

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sheep	Goats	Horse	Other equines	Sows	Other swine	Rabbit	TOTAL
1990	248.608	238.371	4.707	69.914	6.295	5.181	0.839	0.976	11.633	1.157	**587.681**
1991	231.011	277.562	3.964	67.177	6.305	5.654	0.663	1.067	11.756	1.233	**606.392**
1992	218.844	271.275	5.061	67.684	6.777	5.685	0.569	1.037	11.330	1.274	**589.537**
1993	215.186	266.579	5.310	69.356	7.044	5.819	0.494	1.054	11.468	1.284	**583.595**
1994	206.203	266.091	5.588	79.713	8.290	5.832	0.431	1.016	11.019	1.313	**585.496**
1995	214.218	260.040	8.162	85.344	6.865	5.666	0.378	1.035	11.056	1.329	**594.094**
1996	213.562	256.999	9.436	87.548	7.096	5.617	0.341	1.089	11.167	1.354	**594.210**
1997	214.680	260.163	8.882	87.150	6.755	5.634	0.300	1.040	11.399	1.368	**597.371**
1998	218.655	251.894	10.245	87.154	6.655	5.595	0.296	1.061	11.422	1.375	**594.354**
1999	214.694	255.239	11.026	88.134	6.987	5.440	0.296	1.037	11.584	1.400	**595.837**
2000	208.706	248.774	10.560	88.712	6.875	5.537	0.296	1.062	11.399	1.388	**583.308**
2001	212.262	245.156	10.560	66.488	5.125	5.537	0.296	1.076	11.601	1.425	**559.525**
2002	214.262	240.543	9.790	65.104	4.940	5.634	0.296	1.056	11.444	1.437	**554.506**
2003	189.828	228.707	12.650	63.616	4.805	5.634	0.296	1.104	12.563	1.423	**520.626**

6.2.4. Source-specific QA/QC and verification

Specific activities from the MeditAIRanean project for the agriculture sector are mainly focused on the assessment of critical points and uncertainties, evaluation of basic activity data and emission factors. The project is considering specific peculiarities of the European Mediterranean Region taking into account parameters for the calculation of emissions such as climate, technologies, industrial management, livestock breeding, etc. Currently, the project has started with an in depth analysis of emission factors and methodologies of categories with higher contribution of emissions in the agriculture sector (Valli et al., 2004). The work is still in progress and results will be used for the future submissions.

6.2.5. Source-specific recalculations

Recalculations in the dairy cattle category are due to the update of parameters used for the estimation of the emission factor. These parameters are: weight gain, fat content of milk, portion of cows giving birth, milk production, digestibility of feed and methane conversion rate (see Table 6.2).
In Table 6.7 new and old dairy cattle emission factors from 2004 and 2005 submissions are presented.
The new emission factors are higher from 3% to 17% than those used in the previous submission.

6.2.6. Source-specific planned improvements

In the framework of MeditAIRanean project, further inputs are expected for future submissions.

Table 6.7 Dairy cattle, average methane emission factors for enteric fermentation (kg/head/year), 1990-2003

Year	Emission factor 2004 submission	Emission factor 2005 submission
1990	88.72	94.11
1991	95.60	98.74
1992	95.36	101.96
1993	91.32	101.55
1994	98.32	102.49
1995	94.27	103.00
1996	93.30	102.66
1997	91.43	103.29
1998	89.26	103.33
1999	86.18	101.01
2000	86.26	101.07
2001	84.44	98.54
2002	84.44	97.44
2003		99.86

6.3 Manure management (4B)

6.3.1 Source category description

As mentioned above, methane and nitrous oxide emissions from manure management are key sources. Methane emissions are key source at level and trend assessment, both Tier 1 and Tier 2, while nitrous oxide emissions are key sources at level, both Tier 1 and Tier 2, and Tier 2 trend assessment.
In 2003, methane emissions from manure management were 181.94 Gg, which represents 23.4% of methane emissions for the agriculture sector (22.5% in 1990) and 11% for total methane emissions (10.5% in 1990). Methane emissions from this source mainly consist of cattle, equal to 88.32 Gg, and swine emissions, 70.68 Gg, which represent 48.5% (55.1% in 1990) and 38.8% (35.1% in 1990) of manure management methane emissions, respectively.
In 2003, nitrous oxide emissions from manure management were 12.81 Gg, which represents 17.7% of N_2O emissions for the agriculture sector (16.9% in 1990) and 9.4% for total nitrous oxide emissions (9.6% in 1990). Nitrous oxide emissions from this source mainly consist of the solid storage source with 11.52 Gg, which accounts for 90% of manure management emissions.

6.3.2 Methodological issues

Methane emission factors for manure management have been calculated for cattle, buffalo and swine with IPCC Tier 2 approach. Cattle and buffalo emission factors have been calculated for the years 1990 and 1995 at regional level and on a monthly basis as described below and indicated as Method 1. For later years, average emission factors calculated on a regional basis have been used and applied to the whole time series with a simplified methodology (Method 2).
For all livestock categories, as mentioned before (section 6.2.2) activity data have been collected from ISTAT. For the specific case of rabbit, activity data have been reconstructed on the basis of a livestock production index.

Methane emissions (cattle and buffalo)
Method 1: Regional basis
Estimates of methane emissions from manure management, drawn up on a regional basis, depend on the specific manure management practices and environmental conditions (Safley et al., 1992; Steed and Hashimoto, 1995; Husted, 1994), specifically on the following factors: average regional monthly temperatures (UCEA, 2005), amount of slurry and solid manure produced per livestock category (CRPA, 1993) and management techniques for the application of slurry and solid manure for agricultural purposes in Italy.
For cattle and buffalo, the estimation of the emission factor starts with the calculation of a *methane emission rate* (g CH_4/m^3/day), obtained from an equation presented by Husted, and which is different for slurry (Husted, 1994) and solid manure (Husted, 1993). The methane emission rate has been transformed to g/ m^3/month. Equations used are presented below (CRPA, 1997[a]):
For slurry:

$$CH_4\ (g/m^3/day) = e^{(0.68+0.12*\text{average regional monthly temperature})}$$

For solid manure:

$$CH_4\ (g/m^3/day) = e^{(-2,3+0,1*\ \text{monthly storage temperature})}$$

The monthly storage temperature from the solid manure is estimated according to the following equation (Husted, 1994):

$$\text{T solid manure storage} = 6,7086e^{0,1014t\ (°C)\ (\text{average regional monthly temperature})}$$

For temperatures below 10°C emissions are considered negligible.
The volume of slurry and solid manure produced per livestock category has been calculated (m^3/head) with the average production of slurry and solid manure per livestock category per day (m^3/head/day) 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]). Emission factors for slurry and solid manure (g CH_4/head/month) are obtained with methane emission rates and the volume of slurry and solid manure produced. Only for slurry a correction factor is applied, because it considers the characteristic of slurry volatile solids content in Italy. Emission factors obtained at this level are calculated for each month; therefore the annual emission factor for each livestock category will be the sum of slurry and solid manure emission factor for all months (kg CH_4/head/year).

Method 2: National basis
Methane emission factors for manure management, on a national basis, have also been calculated for slurry and solid manure; different cattle and buffalo categories as well as values of slurry and solid manure production and volatile solid content have been considered (see Table 6.8).
The implied emission factors for dairy cattle, non-dairy cattle and buffalo are the average of the different category emission factors weighted with the livestock.
In 2003, emission factors presented for dairy cattle and non-dairy cattle are 20.05 kg CH_4/head/year and 10.62 kg CH_4/head/year, respectively. Emission factor from non-dairy cattle includes: calf, cattle, female cattle and other dairy cattle. IPCC default emissions factors for cool temperature are 14 kg CH_4/head/year and 6 kg CH_4/head/year, respectively.

Table 6.8 Methane manure management emission factors for cattle and buffalo in 2003

Livestock category	Slurry (kg CH_4/head/yr)	Manure (kg CH_4/head/year)	CH_4 manure management for cattle (kg CH_4/head/year)
Calf (*vitellini*)	4.761	0	4.761
Cattle (*bovini*)	5.386	3.146	8.531
Female cattle (*bovine*)	5.512	4.786	10.299
Dairy cattle (*vacche da latte*)	11.973	8.084	20.057
Female buffalo (*bufale*)	9.511	9.289	18.800
Other buffalo (*bufalini*)	3.465	3.001	6.465
Other dairy cattle (*altre vacche*)	11.464	9.952	21.416

For buffalo, an average emission factor that includes two categories presented by ISTAT, female dairy buffalo (*bufale*) and other buffalo, which includes young buffalo (*altri bufalini*), has been estimated. In 2003, implied emission factor for buffalo has been 14.95 kg CH_4/head/year, as reported in the CRF, which represents a weighted average between female dairy buffalo and other buffalo. Emission factor for female dairy buffalo (18.8 kg CH_4/head/year) is close to the value estimated for dairy cattle (20.06 kg CH_4head/year); emissions per head for both categories (dairy cattle and female dairy buffalo) are higher as compared with other livestock categories.

Methane emissions (swine)

For the estimation of swine methane emissions a country-specific methane emission rate has been determined experimentally at the Research Centre on Animal Production (CRPA, 1996). The estimation of the emission factor considers the structure of the storage for slurry (tank and lagoons), type of breeding and seasonal production of biogas. Different parameters have been considered: livestock, average weight for fattening swine and sows, methane emission rate which has been determined experimentally and a reduction of emissions by 8% for covered storage structures. 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]). In Table 6.9 country-specific characteristics from swine breeding are presented as well as emission factors used.

In 2003, emission factor for sows including piglets is equal to 20.75 kg CH_4head/yr and for other swine is equal to 8.22 kg CH_4/head/yr. Implied emission factor (IEF) from the CRF is equal to 7.76 kg CH_4/head/year because it refers to the total number of swine including piglets.

The fundamental characteristics 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. Additionally, other two specific characteristics have to be considered: feeding in order to obtain high quality meat and the concentration of Italian pig production, which is limited to a small area (Lombardia, Emilia-Romagna, Piemonte and Veneto), representing 75% of national swine resources. All this peculiarities of Italian swine production influenced methane emission factors for manure management as well as nitrogen excretion factors used for estimating nitrous oxide emissions (Mordenti et al., 1997; CRPA, 2000).

Table 6.9 Methane manure management parameters and emission factors for swine in 2003

Livestock category	Average weight (kg)	Breed live weight (t)	Methane emission rate (nl CH_4/100 kg live weight)	Emission factor (kg CH_4/head/yr)
Other swine	**83**	**557.850**	**14.965**	**8.22**
20-50 kg	35	63.665		
50-80 kg	65	103.025		
80-110 kg	95	143.355		
110 kg and more	135	243.405		
Boar	200	4.400		
Sow	**160**	**134.130**	**17.155**	**20.75**
Piglets	10	16.370		
Sow	160	117.760		

Methane emission factors used for calculating other livestock categories from manure management are those proposed by IPCC; according to the yearly average temperature in Italy (13 °C), emission factors chosen belong to the "cold" climatic region (IPCC, 1997).

Nitrous oxide emissions

Nitrous oxide emissions have been estimated by using equation 4.18 from IPCC in the Good Practice Guidance (IPCC, 2000). For estimations, different parameters have been used such as number of livestock species, country-specific nitrogen excretion rates per livestock category (CRPA, 2000), fraction of total annual excretion per livestock category related to a manure management system, and emission factors for manure management systems (IPCC, 1997).

Annual nitrogen excretion rates have been estimated by livestock categories and are defined by the livestock population characteristics in Italy on the basis of recent European literature (Smith and Frost, 2000; Smith et al., 2000; Jongbloed et al., 1999) as described by the Research Centre on Animal Production (CRPA, 2000). The fraction of total annual excretion for each livestock category and manure management system has been estimated by CRPA (CRPA, 1997[b]; CRPA, 2000).

Liquid system, solid storage and other management systems (chicken-dung drying process system) have been considered according to their significance and major application in Italy; emission factors used are 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 (IPCC, 1997; IPCC, 2000). When estimating emissions from manure management, the amount relating to manure excreted while grazing is subtracted and reported in "Agricultural soils" under soil emissions - animal production (see Table 6.10).

Table 6.10 Average weight and nitrogen excretions from the different livestock catories in 2003

Livestock category	Average weight (kg)	N excretedHousing *(Ricoveri)* (kg/head/yr)	N excreted Grazing (*Pascolo*) (kg/head/yr)	TOTAL Nitrogen excreted (kg/head/yr)
Non-dairy cattle	387.0	42.6	2.2	44.8
Buffalo	517.6	73.0	7.9	80.9
Dairy cattle	650.0	98.0	10.6	108.6
Other swine	82.8	12.7	0	12.7
Sow (include piglets)	160.0	25.9	0	25.9
Sheep	46.0	1.6	14.6	16.2
Goat	42.4	1.6	14.6	16.2
Horses, mules and asses	528.4	20.0	30.0	50.0
Poultry	1.8	1	0	0.6
Rabbit	1.6	0.6	0	0.6

6.3.3. Uncertainty and time-series consistency

Uncertainty of methane and nitrous oxide emissions from manure management is estimated equal to 102% for annual emissions, as a combination of 20% and 100% for activity data and emissions factor, respectively.

In 2003, livestock methane emissions from manure management were 5.1% (181.94 Gg CH_4) lower than in 1990 (191.70 Gg CH_4). From 1990 to 2003, dairy and non-dairy cattle livestock has decreased by 28% and 7%, respectively, whereas swine increased by 8.4%. Therefore, manure management emissions are driven down mainly because of the reduction in number of cattle, taking into account that cattle contribution to manure management methane emissions are 48.5% while swine contributes for 38.8% in 2003.

In Table 6.11, methane emissions from manure management are presented.

Table 6.11 Trend in CH_4 emissions due to manure management, 1990-2003 (Gg)

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sheep	Goat	Horse	Other equines	Poultry	Swine	Rabbit	TOTAL
1990	52.957	52.591	1.273	1.901	0.183	0.426	0.071	13.822	67.293	1.187	191.704
1991	46.898	60.118	1.046	1.826	0.183	0.465	0.056	13.801	67.869	1.266	193.528
1992	43.027	58.998	1.323	1.840	0.197	0.467	0.048	13.771	65.483	1.307	186.461
1993	42.477	58.189	1.373	1.886	0.204	0.478	0.042	13.815	66.235	1.318	186.017
1994	40.331	56.813	1.438	2.167	0.240	0.479	0.036	14.242	63.996	1.348	181.09
1995	41.692	57.134	2.231	2.320	0.199	0.466	0.032	14.672	64.767	1.364	184.877
1996	41.703	56.989	2.573	2.380	0.206	0.462	0.029	14.571	65.685	1.390	185.988
1997	41.664	57.111	2.418	2.370	0.196	0.463	0.025	14.869	65.205	1.404	185.725
1998	42.421	56.394	2.824	2.370	0.193	0.460	0.025	15.848	65.588	1.411	187.534
1999	42.610	57.004	3.054	2.396	0.203	0.447	0.025	15.674	66.593	1.436	189.442
2000	41.395	54.963	2.836	2.412	0.199	0.455	0.025	14.089	66.167	1.425	183.966
2001	43.179	54.167	2.877	1.808	0.149	0.455	0.025	16.677	67.283	1.462	188.082
2002	44.081	53.707	2.695	1.770	0.143	0.463	0.025	16.392	66.003	1.475	186.754
2003	38.108	50.214	3.439	1.730	0.139	0.463	0.025	15.679	70.679	1.460	181.936

In 2003, nitrous oxide emissions from manure management were 3.6% (12.81Gg N_2O) higher than in 1990 (12.35 Gg N_2O). Major contribution to total nitrous oxide emissions are given by the solid storage category with 89.9%, followed by "other" with 6.9% and 3.2% from liquid systems. It has been assumed that chicken-dung drying process system ("other" emissions) has been widely used from 1995 (CRPA, 1997[b], CRPA, 2000). In Table 6.12 nitrous oxide emissions from manure management for the different manure management systems are presented.

Table 6.12 Trend in N_2O emissions due to manure management, 1990-2003 (Gg)

Year	Liquid system	Solid storage	Other	TOTAL
1990	0.454	11.898	0.000	12.351
1991	0.459	12.227	0.000	12.685
1992	0.444	11.953	0.000	12.397
1993	0.440	11.824	0.000	12.264
1994	0.433	11.888	0.000	12.321
1995	0.438	12.327	0.089	12.854
1996	0.432	12.426	0.166	13.024
1997	0.430	12.507	0.251	13.189
1998	0.431	12.555	0.420	13.406
1999	0.430	12.609	0.529	13.568
2000	0.414	12.094	0.557	13.065
2001	0.413	12.373	0.776	13.563
2002	0.409	12.223	0.844	13.475
2003	0.405	11.521	0.887	12.814

6.3.4. Source-specific QA/QC and verification

Specific activities from the MeditAIRanean project for the agriculture sector are mainly focused on the assessment of critical points and uncertainties, evaluation of basic activity data and emission factors. The project is considering specific peculiarities of the European Mediterranean Region taking into account parameters for the calculation of emissions such as climate, technologies, industrial management livestock breeding, etc. Some of the peculiarities related with Italian swine production have already been described in section 6.3.2.
The work is still in progress and results will be used in future submissions.

6.3.5. Source-specific recalculations

No specific recalculation has been carried out with exception of the updating of some basic data for 2001 and 2002.

6.3.6. Source-specific planned improvements

In the framework of MeditAIRanean project, further inputs are expected for the next submission.

6.4. Rice cultivation (4C)

6.4.1. Source category description

Methane emissions from rice cultivation are a level key source assessed with the Tier 2 approach. For rice cultivation only methane emissions are estimated, other greenhouse gases do not occur and nitrous oxide from fertilisation during cultivation is estimated and reported in “Agricultural soils” under direct soil emissions - synthetic fertilizers.
In 2003, methane emissions from rice cultivation were 74.36 Gg, which represents 9.6% of emissions for the agriculture sector (8.6% in 1990) and 4.5% for total methane emissions (4.0% in 1990).
According to specific characteristics of rice cultivation in Italy, methane emissions from rice cultivation are estimated only for an irrigated regime, other categories suggested by IPCC (rainfed, deep water and “other”) are not present.

6.4.2. Methodological issues

Methane emissions from rice cultivation have been calculated following IPCC Good Practise Guidance, equation 4.42 (IPCC, 2000); adjusted seasonally integrated emission factor and annual harvested area cultivated under specific conditions have been used. Cultivated surface data have been collected from the National Institute of Statistics.
For estimating the seasonally integrated emission factor, a specific study on Italian paddies was carried out in 2000 (Tani, 2000); therefore country-specific characteristics of rice cultivation have been used.
In Italy rice cropping occurs exclusively in flat fields with one harvest per year. Therefore harvested surfaces coincide with cropped and harvested surfaces, differing from tropical countries where

more than one harvest per year is possible. Moreover the particularly expensive crop establishment excludes the possibility of non harvested cropped fields.
Field water regime is man managed, following the theoretical continuously flooded agronomic technique, which involves overflowing of rice paddies with 15-25 centimetres of water usually from April-May to August.
For the period of the field submersion, the following assumptions are made: two or three water drainage periods, lasting from 2 to 4 days each, occur in 85% of rice paddies; a clearly uninterrupted submersion in 13-14%; about one month delayed submersion in 1-2%. In the Po valley (except for the Milan rice paddies area) drainage periods are usually short, scarce or non existent. In the Milan area, but mainly in the South of Italy and in the islands where water is scarce, more than three drainage periods per year may occur, sometimes longer than 4 days (Russo and Nardi, 1996; Spanu and Pruneddu, 1996).
Mineral fertilisation is always used and, seldom, manure. Usually fertilisers are surface applied, without deep incorporation. Organic fertilisers used are litters, commercial products and manure. Rice straws are often burned in the field, otherwise reincorporated into the soil (50% in both cases has been assumed); when buried, little quantities of nitrogen are also added. The above-mentioned applications are usually used in two or three periods, the first of which always before sowing, that is on dry soil, and the others during the growing season.
On the basis of the information reported above, in Italy estimations of methane emissions consider rice cultivation with an irrigated regime, which includes continuous flooded, intermittently flooded-single aeration and intermittently flooded-multiple aeration regimes.
Seasonally integrated emission factor has been adjusted with the following parameters: seasonally integrated emission factor for continuously flooded fields without organic fertilisers (33g $CH_4/m^2 \cdot year$**)**, scaling factor to account for the differences in ecosystem and water management regime (range 0.5-1), scaling factor which varies for both types and amount of amendment applied (1.5), and the scaling factor for soil type (IPCC default =1). The seasonally integrated emission factor used (33 g $CH_4/m^2.year$**)** has been increased by 20% taking into account post harvest emissions; therefore it becomes 39.6 g $CH_4/m^2 \cdot year$ (Wassmann et al., 1994). In Table 6.13, all parameters used for the estimation of methane emissions from rice cultivation are presented.

Table 6.13. Parameters used for estimating methane emissions from rice cultivation

Rice cultivation water regimes	Scaling factor to account for the differences in ecosystem and water management regime	Scaling factor for organic amendment	Seasonally integrated emission factor (g $CH_4/m^2.year$)	Adjusted seasonally integrated emission factor (g $CH_4/m^2.year$)
Continuous flooded	1	1.5	39.6	59.40
Intermittently flooded				
Single aeration	0.75	1.5	39.6	44.55
Multiple aeration	0.5	1.5	39.6	29.70

A coefficient equal to 0.5 has been attributed to “Irrigated, intermittently flooded - multiple aeration”, which was considered as representative even the short and modest drainage periods in the Po valley or longer periods in the South of Italy. For “Irrigated, intermittently flooded - single aeration” a value of 0.75 was attributed in consideration that one month or more delayed field submersions are responsible for about 25% of emission reduction with respect to continuous floods. This value has been deduced from Schütz results, assuming that the flooding delay generates a proportional reduction of the emissions (Schütz et al., 1989 [a]).

Assuming that the area involved in rice straw and other organic matter amendments is about 50% of the total, the scaling factor of 2 has been applied, thus the final average increment factor is 1.5 (Schütz et al.,1989 [a], Yagi and Minami, 1990).
Field measurements of methane emission rates were performed in rice paddies of the Italian Rice Research Institute (*Istituto Sperimentale per la Cerealicoltura, Sezione Specializzata per la Risicoltura*). During the experiments diurnal variation as well seasonal variation of methane emissions rates were verified. Average seasonal methane emission rates from unfertilised rice paddies are based in more than 600 individual measurements of methane emission rates (per vegetation period) obtained from 1983-1986, and vary between 0.16 and 0.38 g CH_4/m^2day, with a mean value of 0.28 g CH_4/m^2day. Lowest values were obtained in 1985, when the average CH_4 emission rate did not exceed 0.16 g CH_4/m^2day. Additionally, diurnal and seasonal variations were positively correlated with soil temperature at 1 to 15-cm depth, indicating that the process leading to methane emissions are located mainly in the upper soil. The final emission factor chosen for estimating methane emissions from rice cultivation is equal to 33 g/m^2 CH_4 yr and is derived from research studies (Schütz et al.,1989 [a], [b]).

6.4.3. Uncertainty and time-series consistency

Uncertainty of emissions from rice cultivation has been estimated equal to 40% as a combination of 3% and 40% for activity data and emissions factor, respectively.
In 2003, methane emissions from rice cultivation were 1.5% (74.364 Gg CH_4) higher than in 1990 (73.264 Gg CH_4). The main driving force for methane emissions is the harvested area from rice cultivation, which has increased by 1.5%, from 215,442 ha/year in 1990 to 218,675 ha/year in 2003. Higher values of methane emissions are present in 1994 (80.24 Gg), 1995 (81.36 Gg) and 1996 (80.78 Gg) and are also related to an increase in harvested area of 235,951 ha/year, 239,259 ha/year and 237,551 ha/year, respectively.
In Table 6.14, methane emissions from rice cultivation and harvested area are presented.

Table 6.14 Harvested area and methane emissions from rice cultivation, 1990-2003 (Gg)

	Harvested area ($10^9 m^2$/yr)	Methane emissions (Gg)
1990	2.154	73.26
1991	2.063	70.17
1992	2.164	73.58
1993	2.317	78.81
1994	2.360	80.24
1995	2.393	81.36
1996	2.376	80.78
1997	2.328	79.18
1998	2.227	75.73
1999	2.208	75.08
2000	2.203	74.93
2001	2.176	74.01
2002	2.187	74.36
2003	2.187	74.36

Lack of experimental data and of knowledge about the occurrence and duration of drainage periods in Italy is the major cause of uncertainty. The assumption of the same water regime surfaces

assessment for all previous years introduces another important uncertainty in the results. Further possible improvements in estimates by carrying out provincial estimations on the basis of the relation between emissions and temperature would be limited since the largest Italian rice production is in the Po valley, more than 98% of the total, where monthly temperatures of the rice paddies are similar.

6.4.4 Source-specific QA/QC and verification

This source category is covered by the general QA/QC procedures.

6.4.5 Source-specific recalculations

No major recalculations have been carried out.

6.4.6 Source-specific planned improvements

In the framework of MeditAIRanean project, further inputs to refine the estimation are expected for the future submissions.

6.5. Agriculture soils (4D)

6.5.1. Source category description

Direct and indirect nitrous oxide emissions from agricultural soils are key sources at level and trend assessment, both with Tier 1 and Tier 2 approaches, while animal production is key source at level and trend assessment with the Tier 2 approach, taking in account the uncertainty. In 2003, nitrous oxide emissions from agricultural soils were 59.50 Gg, which represents 82.3% of emissions for the agriculture sector (83.1% in 1990) and 43.5% for total nitrous oxide emissions (47.3% in 1990). Nitrous oxide emissions from this source mainly consisted of direct soil emissions, 28.29 Gg, and indirect soil emissions, 25.78 Gg, which represents together the 90.9% of total agricultural soil emissions (90.1% in 1990).
In Italy, agricultural soil emissions are estimated for direct and indirect soils and animal production. For direct soil emissions all sources have been 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 have been 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.

6.5.2. Methodological issues

Methodologies used for estimating nitrous oxide emissions from “Agricultural soils” follow the IPCC approach. Emission factors suggested by IPCC (IPCC, 1997) and by the Research Centre on Animal Production (CRPA, 1997[b]; CRPA, 2000) have been used; activity data have been collected from different sources. A summary of data used and their sources for estimations of nitrous oxide emissions is presented in the following box:

Data used for estimating agricultural soil emissions

Data	Reference
Fertilizer distributed (t/yr)	ISTAT, several years [b]
Nitrogen content (%)	ISTAT, several years [b]
N excretion (kg/head/yr)	CRPA, 2000
Cultivated surface (ha/yr)	ISTAT, several years [b], [c], [f]
Annual crop production (t/yr)	ISTAT, several years [b], [c], [f]
N fixed by type of species (kg N/ha)	Erdamn,1959 in Giardini, 1983
Residue/crop product ratio by crop type	CESTAAT, 1988
Crop residue production (t dry matter/ha/yr)	CRPA/CNR, 1992
Dry matter content by crop type	CRPA/CNR, 1992
Protein content in dry matter by crop type	CESTAAT, 1988
Livestock data	ISTAT, several years [b], [c], [g]

For estimating nitrous oxide direct soil emissions, the IPCC approach has been followed, some modifications have been included because of country-specific peculiarities (IPCC, 1997; IPCC, 2000); emissions related to the F_{SN}, $F_{AM,}$ F_{CR}, F_{BN} and F_{OS} amounts have been estimated, then N_2O-N emissions have been calculated on the basis of IPCC emission factors (IPCC, 2000) and converted to N_2O emissions multiplying by coefficient 44/28; therefore in order to obtain the total direct soil emissions they have been added. Animal production emissions have been estimated according to the methodology described in section 6.3.2, for the manure management. Indirect emissions have been estimated using methodologies suggested by IPCC (IPCC, 1997).
For direct emissions from agricultural soils the following parameters have been estimated:
• Synthetic fertilizers (F_{SN})
• Animal waste applied to soil (F_{AM})
• N-fixing crops (F_{BN})
• Crop residues (F_{CR})
• Cultivation of histosols (F_{os})

The total use of synthetic fertilizer (expressed in t N/year) has been estimated for all years and for each type of fertilizer. Calculation of synthetic fertilizer use (F_{SN}**)** is obtained by multiplying the total use of fertilizer by (1- $FRAC_{GASF}$), where $FRAC_{GASF}$ is the fraction of total synthetic fertilizer nitrogen that is emitted as NO_x +NH_3. In Italy, $FRAC_{GASF}$ has been calculated for all time series on the basis of N-NH_3 and N-NO_x emission estimations from fertilised soils. Nitrous oxide emissions for synthetic fertilizers were obtained by multiplying F_{SN} with emission factor 0.0125 kg N-N_2O/kg N (IPCC, 1997). In Table 6.15, fertilizers distribution, nitrogen content (%) and total use of fertilizer are presented. In 2003, the total use of synthetic fertilizers has been equal to 824,649 t N, while F_{SN} has been equal to 745,417 t N.

Table 6.15 Total use of synthetic fertilizer, t N/yr in 2003

Type of fertilizers	Fertilizers distributed (t/yr)	Nitrogen content (%)	Total use of synthetic fertilizers (t N/yr)
Ammonium sulphate	127,728	20.8%	26,550
Calcium cianamide	13,895	19.8%	2,751
Ammonium nitrate < 27%	332,377	28.2%	93,689
Ammonium nitrate > 27%	243,564	28.2%	68,654
Calcium nitrate	70,426	15.4%	10,844
Urea + others	881,602	43.5%	383,934
Phosphate nitrogen	469,265	18.1%	85,079
Potassium nitrogen	65,176	15.5%	10,105
NPK nitrogen	867,754	12.5%	108,358
Organic mineral	355,366	9.8%	34,684
TOTAL	**3,427,152**		**824,649**

The manure nitrogen used as fertiliser in Italy, corrected for NH_3 and NO_x emissions and excluding manure produced during grazing (kg N/yr) has been calculated with the IPCC methodology (IPCC, 1997) and country-specific N excretion values suggested by the Research Centre on Animal Production have been considered. Final F_{AM} (t/yr) value has been estimated by summing all F_{AM} for each livestock category multiplied by the number of animals and emissions are calculated with the emission factor 0.0125 kg N-N_2O/kgN (IPCC, 1997). In Table 6.16 N excreted by livestock category and F_{AM} values are presented. In 2003 the F_{AM} has been equal to 394,878 t N.

Table 6.16 Total N excretion by livestock category and F_{AM} in 2003

	TOTAL N excreted (t N/yr)	F_{AM} (t N/yr)
Non-dairy cattle	211,850	125,040
Buffalo	18,596	10,662
Dairy cattle	206,481	116,388
Other swine	85,383	49,639
Sow	19,055	10,864
Sheep	128,822	4,340
Goat	15,568	524
Horse	17,128	4,474
Broilers	46,724	29,100
Hens	35,295	18,823
Others Poultry	29,477	18,706
Other (rabbit)	11,091	6,318
TOTAL	**825,472**	**394,878**

Nitrogen input from N-fixing crops (F_{BN}, kg N/year) has been calculated with a country-specific methodology according to peculiarities in Italy, which considers not only N-fixing crops but also legumes forage. F_{BN} has been calculated with two parameters: cultivated surface and nitrogen fixed per hectare (Erdamn 1959 in Giardini, 1983). Emissions are finally multiplied by the emission factor 0.0125 kg N_N_2O/kgN (IPCC, 1997). In Table 6.17, N-fixing species cultivated in Italy are presented. In 2003, F_{BN} has been equal to 175,133 t N.

Table 6.17. Parameters used for estimating N-fixed from crops (2003)

	Cultivated surface (ha)	Nitrogen fixed (kg N/ha/yr)	TOTAL N fixed (t N/yr)
Bean, fresh seed (*fagiolo*)	23,720	40	949
Bean, dry seed (*fagiolo*)	9,180	40	367
Broad bean, fresh seed (*fava*)	9,736	40	389
Broad bean, dry seed (*fava*)	44,098	40	1,764
Pea, fresh seed (*pisello*)	11,478	50	574
Pea, dry seed (*pisello*)	9,771	72	704
Chickpea (*cece*)	5,694	40	228
Lentil (*lenticchia*)	1,745	40	70
Tare (*veccia*)	6,500	80	520
Lupin (*lupino*)	3,000	40	120
soya bean (*soia)*	152,052	58	8,819
Alfalfa (*erba medica)*	767,678	194	148,930
Clover grass (*trifoglio)*	113,594	103	11,700
TOTAL	**1,158,246**		**175,133**

For the estimation of nitrogen input from crop residues (F_{CR}), also a country-specific methodology has been used according to national characteristics. The total amount of crop residues has been estimated (t dry matter/year) for all crops, and the following parameters have been used: annual crop production (t/year), residue/crop product ratio, and dry matter content by type of crop (%); when using cultivated surface (ha) activity data, only the crop residue production (t dry matter/ha/year) parameter has been used for estimating the total amount of crop residues.
The nitrogen content from cereals, legumes, tubers and roots and legumes forages crop residues (t N/year) has been estimated by multiplying the total amount of crop residue by 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 in dry matter by type of crop. The nitrogen content has been obtained dividing the protein content in dry matter by 6.25. F_{CR} is obtained by adding the nitrogen content from all crop residues. In 2003, F_{CR} has been equal to 119,273 t N. Emissions are obtained by multiplying the nitrogen content from crop residues with the emission factor 0.0125 kg N-N_2O/kg N (IPCC, 1997).
In Italy, the area of organic soils cultivated annually (histosols) is estimated to be 9,000 hectares (CRPA, 1997[b]); this value is then multiplied by 8 kg N-N_2O/hectare/year as suggested by the Good Practice Guidance (IPCC, 2000). The data for surface area, reproduced in the national soil map of the year 1961, have been supplied by the Experimental Institute for the study and protection of soil from Florence (ISSDS). These values have been verified with related data for Emilia Romagna region, where this type of soil is most prevalent.
As mentioned in section 6.3.2, when estimating nitrous oxide emissions from manure management, the amount relating to manure excreted while grazing is subtracted and reported in "Agricultural soils" under animal production**.** In Table 6.10, N excreted - housing (kg/head/year) used for estimations are presented. Final nitrous oxide emissions are estimated with the total N excreted from grazing (include all livestock categories), the number of animals, and the emission factor 0.02 kg N_2O-N/kg N excreted (IPCC, 1997).

For indirect emissions from agricultural soils the following parameters have been estimated:
• Atmospheric deposition.
• Nitrogen leaching and run-off.
The estimation of nitrous oxide emissions due to atmospheric deposition of NH_3 and NO_x has followed IPCC approach (IPCC, 1997). Parameters which have been used are: total use of synthetic fertilizer, t N/year (see Table 6.15), $FRAC_{GASF}$ emission factor; total N excreted by livestock (kg/head/year), $FRAC_{GASM}$ emission factor and emission factor 0.01 kg N_2O-N per kg NH_3-N + NO_x-N emitted (IPCC, 1997; IPCC, 2000). $FRAC_{GASM}$ has been calculated for all time series and livestock categories because national N excreted values are available (CRPA, 2000).
The estimation of nitrous oxide emissions due nitrogen leaching and run-off has also followed IPCC approach (IPCC, 1997). Parameters which have been used are: total use of synthetic fertilizer, t N/yr (see Table 6.15), total N excreted by livestock (kg/head/year), $FRAC_{LEACH}$ emission factor 0.3 N/kg nitrogen of fertiliser or manure and the emission factor 0.025 Kg N_2O-N per kg nitrogen leaching/run-off (IPCC, 1997; IPCC, 2000).

6.5.3 Uncertainty and time-series consistency

Uncertainty for nitrous oxide emissions from agricultural soils (direct soil emissions, indirect soil

emissions and animal production) is equal to 102%, as combination of 20% and 100% for activity data and emission factor, respectively. In 2003, nitrous oxide emissions from agricultural soils were 2.2% (59.50 Gg N_2O) lower than in 1990 (60.86 Gg N_2O). Major contributions come from direct soil emissions (28.29 Gg) and indirect soil emissions (25.78 Gg), with 47.6% and 43.3%, respectively. In a detailed analysis, N_2O from nitrogen leaching and run-off has the highest contribution with respect to total agricultural soil emissions with 19.45 Gg N_2O in 2003 (32.7%); also emissions from synthetic fertilizers have a high contribution with respect to total N_2O emissions. N_2O emissions from leaching and run-off are related to the nitrogen content in fertilizers and animal wastes; therefore, emissions are mainly related to the use of fertilizers in the country as well as the variation in livestock number (see Table 6.18).

Table 6.18 Nitrous oxide emission trends from Agricultural soils, 1990-2003 (Gg)

Year	Direct Soil Emissions	Animal Production	Indirect Soil emissions	TOTAL
1990	29.43	6.02	25.41	60.86
1991	30.79	5.93	26.68	63.40
1992	31.26	5.96	27.00	64.22
1993	31.65	6.06	27.75	65.46
1994	30.16	6.76	27.14	64.06
1995	28.86	6.94	26.54	62.34
1996	28.27	7.11	26.09	61.47
1997	30.20	7.06	27.48	64.73
1998	28.98	7.06	26.56	62.60
1999	29.09	7.15	26.93	63.17
2000	28.51	7.15	26.37	62.03
2001	28.89	5.73	26.23	60.84
2002	28.98	5.62	26.22	60.82
2003	28.29	5.42	25.78	59.50

6.5.4 Source-specific QA/QC and verification

Synthetic fertilisers and their nitrogen content have been compared with the international FAO agriculture database statistics (FAO, 2005). In Table 6.19, national and FAO time series of total N applied are reported. Differences between national data and FAO database are related to the difference in data elaboration (ISTAT, 2004). Differences could be attributed to different factors. First, national data are more disaggregated by substance than FAO data and the national N content is considered for each substance, see Table 6.15, while FAO utilises default values. Besides, differences could also derive from different products classification.

Table 6.19 Total annual N in fertiliser applied from 1990 to 2003 (tonnes)

Year	National data	FAO database
1990	757 509	857 000
1991	837 402	906 000
1992	884 121	909 000
1993	945 290	918 000
1994	875 536	882 000
1995	797 500	875 000
1996	756 057	876 000
1997	856 945	855 000
1998	774 707	845 000
1999	791 982	868 000
2000	785 594	828 000
2001	808 963	773 161
2002	819 352	785 314
2003	824 649	Not available

6.5.5 Source-specific recalculations

No major recalculations have been done for the agricultural soils category; activity data for last years have been updated.

6.5.6 Source-specific planned improvements

In the framework of MeditAIRanean project, further inputs are expected for the next submission.

6.6 Field burning of agriculture residues (4F)

6.6.1 Source category description

Methane and nitrous oxide emissions from field burning agriculture residues are not key sources. In 2003, methane emissions from this source were 0.54 Gg, which only represents 0.1% of emissions for the agriculture sector (0.07% in 1990); nitrous oxide emissions were 0.01 Gg, which represents 0.02% of emissions for the agriculture.

6.6.2 Methodological issues

Emissions from field burning of agriculture residues have been calculated with a country-specific methodology. IPCC suggestions for parameter calculation have been considered (amount of residues produce, the amount of dry residues, the total biomass burned, and the total carbon and nitrogen released). Activity data used for estimating burning of agriculture residues have been summarised in the following box.

Data used for estimating field burning of agriculture residues emission (2003)

Data	Reference
Annual crop production	ISTAT, several years [b]; [f]
Removable residues/product ratio	CESTAAT, 1988
Fixed residues/removable residues ratio	ENEA, 1994
Fraction of dry matter in residues	CESTAAT, 1988; Borgioli, 1981; CRPA/CNR, 1992; IPCC, 1997
Fraction of the field where "fixed" residues are burned	CESTAAT, 1988; IPCC,1997; ANPA-ONR, 2001
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

Emissions from burning of agriculture residues, both fixed and removable, have been estimated with the same methodology but reported in two different sectors; emissions from fixed residues, 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 6C category, waste incineration, in the waste sector.
In the following, the methodology for estimating emissions is described; it refers to fixed residues burnt but the same steps are followed to calculate emissions from removable residues burnt reported in the waste sector.
The methodology for estimating methane emissions has considered different parameters:

a) Amount of "fixed" burnable residues[6] (t), calculated with the annual crop production, the removable residues/product ratio, and the "fixed" residue/removable residues ratio.
b) Amount of dry residues in the "fixed" residue[7] (t dry matter), calculated with the amount of burnable residues and the fraction of dry matter.
c) Amount of "fixed" dry residues oxidized[8] (t dry matter), calculated with the amount of dry residues in the "fixed" residues, fraction of the field where "fixed" residues are burned, and the fraction of residues oxidized during burning.
d) Amount of carbon from stubble burning release in air[9] (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[10] (t C-CH_4), calculated with the amount of carbon from stubble burning release in air and the default emissions rate for C-CH_4, equal to 0.005 (IPCC, 1997).

In 2003, final methane emissions from on field burning of agriculture residues (0.54 Gg CH_4) are estimated by multiplying the C-CH_4 value (0.4043 Gg C-CH_4) with the coefficient 16/12. In Table 6.20 parameters used for the estimation of methane emissions from on field burning of agriculture residues are presented.

For estimating nitrous oxide emissions, the same amount of "fixed" dry residue oxidized described above has been used; further parameters are:

[6] Quantità di residuo "fisso" bruciabile (produzione totale) (ton)
[7] Quantità di residuo secco nel residuo "fisso" (ton di sostanza secca)
[8] Quantità residuo secco "fisso" ossidato (ton di sost. secca)
[9] Quantità di carbonio rilasciato in aria dalla combustione delle stoppie (tonnellate di carbonio)
[10] Emissione di C-CH4 dalla combustione delle stoppie (tonnellate di C-CH4)

a) Amount of nitrogen from stubble burning release in air[11] (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[12] (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 2003, final nitrous oxide emissions from on field burning of agriculture residues (0.012 Gg N_2O) are estimated by multiplying the N-N_2O value (0.0074 Gg N) with the coefficient 44/28. In Table 6.21 parameters used for the estimation of methane emissions from field burning of agriculture residues are presented.

Table 6.20 Parameters used for the estimation of methane emissions from agriculture residues (2003)

Crop	Harvested annual 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*)	6,229	1,075	917	80	39	194.8
Rye (*segale*)	7	1.2	1.0	0.09	0.03	0.2
Barley (*orzo*)	1,021	204	175	16	6	29.1
Oats (*avena*)	306	54	46	4	2	8.3
Rice (*riso*)	1,402	235	176	79	33	164.3
Maize (*granoturco)*	8,702	870	363	0	0	0
Sorghum (*sorgo da granella*)	158	55	46	4	2	7.7
TOTAL	17,827	2,494	1,723	184	81	404.3

Table 6.21 Parameters used for the estimation of nitrous oxide from agriculture residues (2003)

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*)	80	0.03	0.05	0.385	2.7
Rye (*segale*)	0.09	0.036	0.06	0.001	0
Barley (*orzo*)	16	0.037	0.06	0.093	0.7
Oats (*avena*)	4	0.04	0.06	0.027	0.2
Rice (*riso*)	79	0.041	0.07	0.520	3.6
Maize (*granoturco)*	0	0	0.07	0	0
Sorghum (*sorgo da granella*)	4	0.037	0.06	0.024	0.2
TOTAL	184			1.050	7.4

6.6.3 Uncertainty and time-series consistency

Uncertainty for methane and nitrous oxide 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 2003, methane emissions from field burning of agriculture residues were 13.5% (0.54 Gg CH_4)

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

lower than in 1990 (0.62 Gg CH_4). Nitrous oxide emissions were 0.01 Gg N_2O, as mentioned before, and are the same for all time series (see Table 6.22). Variation in time series is related to cereal production by crops.

Table 6.22 Methane and nitrous oxide emission trends from field burning of agriculture residues, between 1990 and 2003 (Gg)

Year	Methane emissions	Nitrous oxide emissions
1990	0.62	0.013
1991	0.68	0.014
1992	0.66	0.014
1993	0.64	0.013
1994	0.64	0.013
1995	0.62	0.013
1996	0.64	0.013
1997	0.57	0.012
1998	0.64	0.013
1999	0.62	0.013
2000	0.58	0.012
2001	0.53	0.011
2002	0.60	0.013
2003	0.54	0.012

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 forests. The sector is responsible for 81.9 Mt of CO_2 removals from the atmosphere in 2003.
The 2003 IPCC Good Practice Guidance for LULUCF have 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 2003 are shown in Figure 7.1:

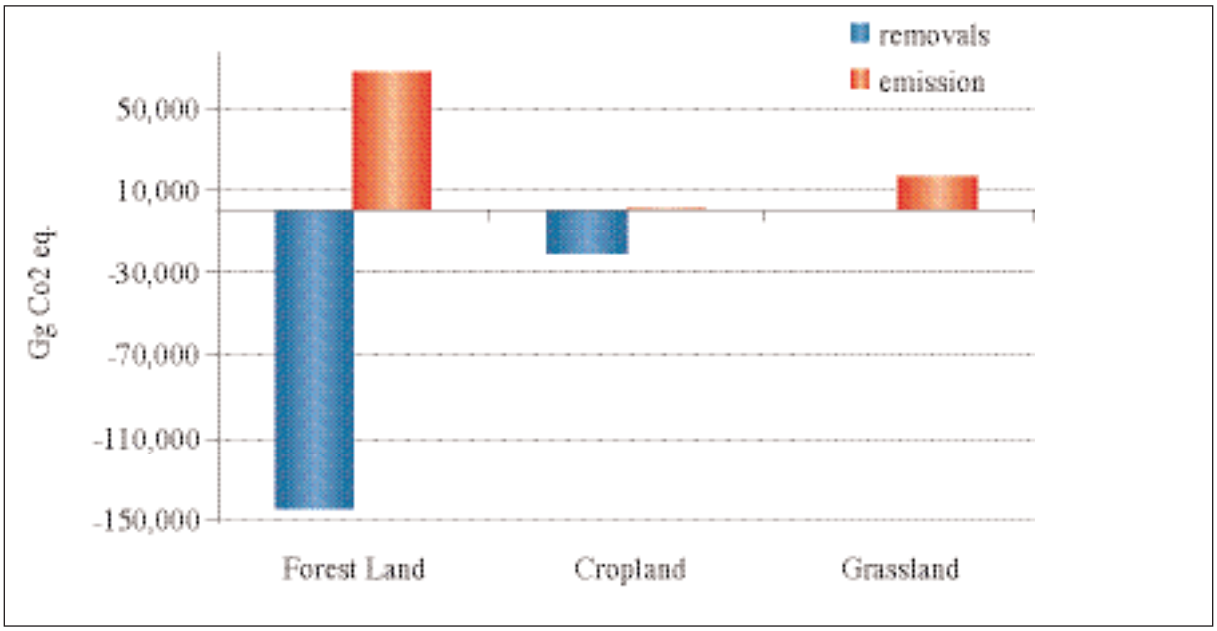

Figure 7.1 Greenhouse gas removals and emissions in LULUCF sector in 2003 [Gg CO_2 eq.]

In Table 7.1 emission and removal time series is reported.

Table 7.1 Trend in greenhouse gas emissions from the LULUCF sector 1990-2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
CO_2 (2)	-60,883.79	-83,151.66	-79,136.11	-64,765.02	-81,559.71	-85,866.79	-89,527.68	-80,461.18	-80,785.70	-89,231.27	-81,801.57	-85,981.72	-95,779.70	-81,899.96
A. Forest Land	-58,286.36	-80,271.84	-76,793.48	-61,773.41	-78,482.86	-83,326.03	-86,777.41	-78,716.23	-76,464.31	-84,161.14	-78,079.57	-82,080.93	-91,456.32	-80,044.43
B. Cropland	-20,225.03	-19,926.86	-19,756.22	-19,593.46	-19,386.47	-18,758.98	-19,169.37	-19,731.85	-21,577.69	-22,508.48	-20,950.58	-20,913.23	-20,677.54	-19,723.73
C. Grassland	16,173.36	15,582.95	15,946.87	16,601.87	16,088.12	16,379.19	16,519.30	16,494.58	17,250.49	17,498.35	17,238.18	17,213.96	16,887.09	16,395.30
D. Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Settlements	1,454.93	1,466.09	1,466.73	0.00	0.00	0.00	0.00	1,472.37	0.00	0.00	0.00	5,328.05	1,467.07	1,472.90
F. Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CH_4	6.80	1.74	2.88	7.18	2.90	1.30	1.06	3.53	4.11	2.02	4.14	2.63	1.47	3.09
A. Forest Land	6.80	1.74	2.88	7.18	2.90	1.30	1.06	3.53	4.11	2.02	4.14	2.63	1.47	3.09
B. Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F. Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N_2O	0.05	0.01	0.02	0.03	0.00	-0.01	-0.02	0.02	-0.03	-0.04	0.02	0.02	0.01	0.02
A. Forest Land	0.05	0.01	0.02	0.05	0.02	0.01	0.01	0.02	0.03	0.01	0.03	0.02	0.01	0.02
B. Cropland	0.00	0.00	0.00	-0.02	-0.02	-0.02	-0.03	0.00	-0.06	-0.05	-0.01	0.00	0.00	0.00
C. Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F. Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Land Use, Land-Use Change and Forestry (2) (Gg CO_2 equivalent)	-60,728	-83,112	-79,069	-64,666	-81,459	-85,777	-89,512	-80,381	-80,709	-89,201	-81,709	-85,849	-95,766	-81,829

For the land use conversion, land use change matrices have been used; the matrices have permit to point out the average areas of transition land, separately for each initial and final land use (i.e. forest land, grassland, etc.).
In the following Table 7.2, the land use matrices are reported, while the methodological issues relating to the different land uses are given in the respective category paragraphs.

Table 7.2 Land use change matrices for the years 1990-2003

		1989						
		Forest	Grassland	Cropland	Wetland	Settlements	Other Land	Initial sum
	1990	9,145	7,809	10,895	57	1,340	887	30,134
1990	Forest	**9,145**						*9,145*
	Grassland	118	7,691	0		0		*7,809*
	Cropland		46	**10,841**		8		*10,895*
	Wetland				**57**			*57*
	Settlements					**1,340**		*1,340*
	Other Land						**887**	*887*
	Final sum	*9,263*	*7,738*	*10,841*	*57*	*1,348*	*887*	30,134

		1990						
		Forest	Grassland	Cropland	Wetland	Settlements	Other Land	Initial sum
	1991	9,263	7,738	10,841	57	1,348	887	30,134
1991	Forest	**9,263**						*9,263*
	Grassland	118	7,620	0		0		*7,738*
	Cropland		24	**10,808**		8		*10,841*
	Wetland				**57**			*57*
	Settlements					**1,348**		*1,348*
	Other Land						**887**	*887*
	Final sum	*9,380*	*7,644*	*10,808*	*57*	*1,356*	*887*	30,134

		1991						
		Forest	Grassland	Cropland	Wetland	Settlements	Other Land	Initial sum
	1992	9,380	7,644	10,808	57	1,356	887	30,134
1992	Forest	**9,380**						*9,380*
	Grassland	118	7,527	0		0		*7,644*
	Cropland		23	**10,777**		8		*10,808*
	Wetland				**57**			*57*
	Settlements					**1,356**		*1,356*
	Other Land						**887**	*887*
	Final sum	*9,498*	*7,549*	*10,777*	*57*	*1,365*	*887*	30,134

		1992						
		Forest	Grassland	Cropland	Wetland	Settlements	Other Land	Initial sum
	1993	9,498	7,549	10,777	57	1,365	887	30,134
1993	Forest	**9,498**						*9,498*
	Grassland	118	7,382	41		8		*7,549*
	Cropland		0	**10,777**		0		*10,777*
	Wetland				**57**			*57*
	Settlements					**1,365**		*1,365*
	Other Land						**887**	*887*
	Final sum	*9,616*	*7,382*	*10,818*	*57*	*1,373*	*887*	30,134

		1993						
		Forest	Grassland	Cropland	Wetland	Settlements	Other Land	*Initial sum*
	1994	*9,616*	*7,382*	*10,818*	*57*	*1,373*	*887*	*30,134*
1994	Forest	**9,616**						*9,616*
	Grassland	118	**7,202**	54		8		*7,382*
	Cropland		0	**10,818**		0		*10,818*
	Wetland				**57**			*57*
	Settlements					**1,373**		*1,373*
	Other Land						**887**	*887*
	Final sum	*9,733*	*7,202*	*10,873*	*57*	*1,381*	*887*	30,134

		1994						
		Forest	Grassland	Cropland	Wetland	Settlements	Other Land	*Initial sum*
	1995	*9,733*	*7,210*	*10,873*	*57*	*1,381*	*887*	*30,134*
1995	Forest	**9,733**						*9,733*
	Grassland	118	**7,022**	54		8		*7,202*
	Cropland		0	**10,873**		0		*10,873*
	Wetland				**57**			*57*
	Settlements					**1,381**		*1,381*
	Other Land						**887**	*887*
	Final sum	*9,851*	*7,022*	*10,927*	*57*	*1,389*	*887*	30,134

		1995						
		Forest	Grassland	Cropland	Wetland	Settlements	Other Land	*Initial sum*
	1996	*9,851*	*7,022*	*10,927*	*57*	*1,389*	*887*	*30,134*
1996	Forest	**9,851**						*9,851*
	Grassland	118	**6,817**	79		8		*7,022*
	Cropland		0	**10,927**		0		*10,927*
	Wetland				**57**			*57*
	Settlements					**1,389**		*1,389*
	Other Land						**887**	*887*
	Final sum	*9,968*	*6,817*	*11,006*	*57*	*1,398*	*887*	30,134

		1996						
		Forest	Grassland	Cropland	Wetland	Settlements	Other Land	*Initial sum*
	1997	*9,968*	*6,817*	*11,006*	*57*	*1,396*	*887*	*30,134*
1997	Forest	**9,968**						*9,968*
	Grassland	118	**6,700**	0		0		*6,817*
	Cropland		25	**10,973**		8		*11,006*
	Wetland				**57**			*57*
	Settlements					**1,398**		*1,398*
	Other Land						**887**	*887*
	Final sum	*10,086*	*6,724*	*10,973*	*57*	*1,406*	*887*	30,134

		1997						
		Forest	Grassland	Cropland	Wetland	Settlements	Other Land	*Initial sum*
	1998	*10,086*	*6,724*	*10,973*	*57*	*1,406*	*887*	*30,134*
1998	Forest	**10,086**						*10,086*
	Grassland	118	**6,434**	164		8		*6,724*
	Cropland		0	**10,973**		0		*10,973*
	Wetland				**57**			*57*
	Settlements					**1,406**		*1,406*
	Other Land						**887**	*887*
	Final sum	*10,203*	*6,434*	*11,137*	*57*	*1,414*	*887*	30,134

1998

1999	Forest	Grassland	Cropland	Wetland	Settlements	Other Land	Initial sum
	10,203	6,434	11,137	57	1,414	887	30,134
Forest	**10,203**						10,203
Grassland	118	**6,176**	132		8		6,434
Cropland		0	**11,137**		0		11,137
Wetland				**57**			57
Settlements					**1,414**		1,414
Other Land						**887**	887
Final sum	10,321	6,176	11,269	57	1,422	887	30,134

1999

2000	Forest	Grassland	Cropland	Wetland	Settlements	Other Land	Initial sum
	10,321	6,176	11,269	57	1,422	887	30,134
Forest	**10,321**						10,321
Grassland	118	**6,036**	15		8		6,176
Cropland		0	**11,269**		0		11,269
Wetland				**57**			57
Settlements					**1,422**		1,422
Other Land						**887**	887
Final sum	10,438	6,036	11,284	57	1,431	887	30,134

2000

2001	Forest	Grassland	Cropland	Wetland	Settlements	Other Land	Initial sum
	10,438	6,036	11,284	57	1,431	887	30,134
Forest	**10,438**						10,438
Grassland	118	**5,897**	0		2 1		6,036
Cropland		118	**11,137**		29		11,284
Wetland				**57**			57
Settlements					**1,431**		1,431
Other Land						**887**	887
Final sum	10,556	6,015	11,137	57	1,461	887	30,134

2001

2002	Forest	Grassland	Cropland	Wetland	Settlements	Other Land	Initial sum
	10,556	6,057	11,137	57	1,439	887	30,134
Forest	**10,556**						10,556
Grassland	118	**5,940**	0		0		6,057
Cropland		65	**11,064**		8		11,137
Wetland				**57**			57
Settlements					**1,439**		1,439
Other Land						**887**	887
Final sum	10,674	6,004	11,064	57	1,447	887	30,134

2002

2003	Forest	Grassland	Cropland	Wetland	Settlements	Other Land	Initial sum
	10,674	6,004	11,064	57	1,447	887	30,134
Forest	**10,674**						10,674
Grassland	118	**5,887**	0		0		6,004
Cropland		98	**10,967**		8		11,064
Wetland				**57**			57
Settlements					**1,447**		1,447
Other Land						**887**	887
Final sum	10,791	5,985	10,957	57	1,455	887	30,134

Recalculations of emissions and removals have been carried out on the basis of the new IPCC Good Practice Guidance for LULUCF (IPCC, 2003). Strong deviations from the precedent sectoral estimates occurred, due to the severe changes in the 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).
Quality control activities have been undertaken in order to assure completeness and consistency in the time series and correctness in the sum of sub-categories; where possible, activity data comparison among different sources (FAO database[13], ISTAT data[14]) have 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.

7.2 Forest Land (5A)

7.2.1 Source category 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.
Net carbon stocks change by land converted in forest land, for the living biomass, dead organic matter and soils sectors, is included in the assessment of carbon stocks change in living biomass, dead organic matter and soils for forest land remaining forest land.
Forest land removals share 68% of total CO_2 LULUCF emissions and removals, in particular the living biomass removals represent 45%, while the removals from dead organic matter and soils stand for 7% and 48% of total forest land CO_2 removals, respectively.

7.2.2 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., 2005), 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.
Model input data for the forest area, per region and inventory typologies[15], were the First Italian National Forest Inventory (IFN) data and the Second Italian National Forest Inventory data.

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[13] FAO, 2005. FAOSTAT, http://faostat.fao.org
[14] ISTAT, several years [a], [b], [c]
[15] The inventory typologies are classified in 4 main categories: Stands, Coppices, Plantations and Protective Forests. The typologies for each category 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.*

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. Preliminary results of the first inventory phase, consisting in interpretation of orthophotos, were used as input data for the model. This source of information refers to the 2002 (MAF/ISAFA, 2004).
The estimation for 1990 was calculated through a linear interpolation between the 1985 and 2002 data. By assuming that the defined trend may well represent the near future, it was possible to extrapolate data for 2003.
Additional source of information is the National Statistics Institute (ISTAT), which provides annual data on forest area extent. Unfortunately the forest definition adopted by ISTAT implies a minimum cover density of 50% and a minimum forest extent of 0.5 hectares. This leads to an underestimation of the actual forest resources, as less dense formations are not considered. This is the reason why such an important set of historical data was not used to estimate and forecast the forest area extent for the requested years.
To estimate the growing stock of Italian forest, from 1990 to 2003, 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[16], 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.

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 derived Richards function and

[16] 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. The independent variable, x, represents the growing stock of the stand, while the dependent variable y is the correspondent increment computed with the Richards function - first derivative.

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

where the general constrain for the parameters are the following:

$$a, k > 0 \quad -1 \le v \le \infty \quad v \ne 0$$

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).

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 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 0.00117, for deciduous forest, according to the GPG (IPCC, 2003).
The rate of draining and grazing, applied to the protective forest, has been estimated as 3%.
The total commercial harvested wood, for construction and energy purposes, has been obtained from national statistics (ISTAT, several years [a]) even if data on biomass removed in commercial harvest published by ISTAT are probably underestimated, particularly concerning fuelwood consumption (Ciccarese et al., 1999). Data of wood use for construction and energy purposes, reported in m^3, are disaggregated at NUT2 level, in sectoral statistics (ISTAT, several years [a]) or at NUT1 level for coppices and high forests, in the national statistics (ISTAT, several years [c]). These figures have been subtracted, as losses, to the growing stock volume, as abovementioned.
Carbon amount released by forest fires was included in the overall assessment of the carbon stocks change. The amount of burned growing stock related to the burned area has been derived by the growing stock of the specific forest typology, weighted with the fraction having, as numerator, the specific typology surface and, as denominator, the total surface of the category (i.e. *stands, coppices, plantations, protective forests*). The assessed growing stock has, finally, been subtracted to the total growing stock, as aforesaid, considering all the computed biomass oxidised.
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.
Once estimated the growing stock, the amount of aboveground tree biomass (dry matter) belowground biomass (dry matter) and dead mass (dry matter), from 1990 to 2003, can be assessed.
With regard to the aboveground biomass:
1. starting from the 1985 growing stock data, reported in the IFN, the amount of aboveground tree biomass [t dry matter] was calculated, for each forest typology, with 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 for the conversions of volume to aboveground tree biomass (ISAFA, 2004)
WBD = Wood Basic Density [t d.m. m^{-3}]
A = total area referred to a specific forest typology (MATT/ISAFA, 1988) [ha]

The BEF were derived for each forest typology and wood basic density values were different for the main tree species.

2. starting from 1985, for each year, the current increment per hectare [m^3 ha^{-1}] is computed with the derivative Richards function, 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, 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 tree biomass [t dry matter] for each forest typology, for each year, starting from the 1986.

In the following Table 7.3 biomass expansion factors for the conversions of volume to aboveground tree biomass and wood basic densities are reported:

Table 7.3 Biomass Expansion Factors and Wood Basic Densities

	Inventory typology	**BEF** *aboveground biomass / growing stock*	**Wood Basic Density** *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
	partial total	*1.35*	*0.51*
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
	partial total	*1.39*	*0.56*
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
	partial total	*1.36*	*0.40*
protective	rupicolous forest	1.44	0.52
	riparian forest	1.39	0.41
	shrublands	1.49	0.63
	partial total	*1.46*	*0.56*
	Total	**1.38**	**0.53**

Using the preliminary results of the *RiselvItalia Project* carried out by ISAFA (ISAFA, 2004), belowground biomass was estimated applying a BEF to the growing stock. The belowground biomass is computed, as:

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

where:
GS = volume of growing stock [m^3 ha^{-1}]
BEF = Biomass Expansion Factors for the conversions of volume to belowground biomass
WBD = Wood Basic Density [t d.m. m^{-3}]
A = total area referred to a specific forest typology [ha]
Also in this case, the BEFs and WBDs were derived for each forest typology:

Table 7.4 Biomass Expansion Factors and Wood Basic Densities

	Inventory typology	**BEF** *belowground biomass / growing stock*	**Wood Basic Density** *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
	partial total	*0.28*	*0.50*
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
	partial total	*0.27*	*0.57*
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
	others	0.28	0.48
	partial total	*0.25*	*0.40*
protective	rupicolous forest	0.42	0.52
	riparian forest	0.23	0.41
	shrublands	0.62	0.63
	partial total	*0.50*	*0.58*
	Total	*0.30*	*0.54*

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 biomass was estimated applying a dead mass expansion factor (DEF[17]) of 20%, as the only available national information refers to dead standing trees in high forest stands.
The dead mass [t dry matter] is:

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

where:
GS = volume of growing stock [m^3 ha^{-1}]
BEF = Biomass Expansion Factors for the conversions of volume to aboveground tree biomass
WBD = Wood Basic Density [t d.m. m^{-3}]
DEF = Dead mass expansion factor
A = total area referred to a specific forest typology [ha]

The total litter carbon amount is estimated from the aboveground carbon amount with linear relations, deduced from national CONECOFOR Programme data (Corpo Forestale, 2005; Cutini, 2002), per forestry use, stands (resinous, broadleaves, mixed stands) and coppices.
In Table 7.5 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:

Table 7.5 Relations litter - aboveground carbon per ha

	Inventory typology	Relation litter – aboveground C per ha
stands	norway spruce	$y = 0.0145 \cdot x + 1.4798$
	silver fir	$y = 0.0145 \cdot x + 1.4798$
	larches	$y = 0.0145 \cdot x + 1.4798$
	mountain pines	$y = 0.0145 \cdot x + 1.4798$
	mediterranean pines	$y = 0.0145 \cdot x + 1.4798$
	other conifers	$y = 0.0145 \cdot x + 1.4798$
	european beech	$y = -0.0086 \cdot x + 4.7466$
	turkey oak	$y = -0.0086 \cdot x + 4.7466$
	other oaks	$y = -0.0086 \cdot x + 4.7466$
	other broadleaves	$y = -0.0086 \cdot x + 4.7466$
coppices	european beech	$y = -0.014 \cdot x + 4.8826$
	sweet chestnut	$y = -0.014 \cdot x + 4.8826$
	hornbeams	$y = -0.014 \cdot x + 4.8826$
	other oaks	$y = -0.014 \cdot x + 4.8826$
	turkey oak	$y = -0.014 \cdot x + 4.8826$
	evergreen oaks	$y = -0.014 \cdot x + 4.8826$
	other broadleaves	$y = -0.014 \cdot x + 4.8826$
	conifers	$y = 0.0145 \cdot x + 1.4798$
plantations	eucalyptuses coppices	$y = -0.014 \cdot x + 4.8826$
	other broadleaves coppices	$y = -0.014 \cdot x + 4.8826$
	poplars stands	$y = -0.0086 \cdot x + 4.7466$
	other broadleaves stands	$y = -0.0086 \cdot x + 4.7466$
	conifers stands	$y = 0.0145 \cdot x + 1.4798$
	others	$y = -0.0039 \cdot x + 3.9468$
protective	rupicolous forest	$y = -0.0039 \cdot x + 3.9468$
	riparian forest	$y = -0.0086 \cdot x + 4.7466$
	shrublands	$y = -0.014 \cdot x + 4.8826$

[17] In accordance with the FAO –GFRA Update 2005 Specification of National Reporting Tables for FRA 2005 (FAO, 2004 [a])

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, deduced from national CONECOFOR Programme data (Corpo Forestale, 2005; Cutini, 2002), per forestry use – stands (resinous, broadleaves, mixed stands) and coppices. In Table 7.6 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:

Table 7.6 Relations soil - aboveground carbon per ha

	Inventory typology	Relation soil – aboveground C per ha
stands	norway spruce	$y = 0.4041 \cdot x + 57.874$
	silver fir	$y = 0.4041 \cdot x + 57.874$
	larches	$y = 0.4041 \cdot x + 57.874$
	mountain pines	$y = 0.4041 \cdot x + 57.874$
	mediterranean pines	$y = 0.4041 \cdot x + 57.874$
	other conifers	$y = 0.4041 \cdot x + 57.874$
	european beech	$y = 0.4041 \cdot x + 57.874$
	turkey oak	$y = 0.4041 \cdot x + 57.874$
	other oaks	$y = 0.4041 \cdot x + 57.874$
	other broadleaves	$y = 0.4041 \cdot x + 57.874$
coppices	european beech	$y = 0.3922 \cdot x + 65.356$
	sweet chestnut	$y = -0.014 \cdot x + 4.8826$
	hornbeams	$y = -0.014 \cdot x + 4.8826$
	other oaks	$y = -0.014 \cdot x + 4.8826$
	turkey oak	$y = -0.014 \cdot x + 4.8826$
	evergreen oaks	$y = -0.014 \cdot x + 4.8826$
	other broadleaves	$y = -0.014 \cdot x + 4.8826$
	conifers	$y = 0.4041 \cdot x + 57.874$
plantations	eucalyptuses coppices	$y = 0.3922 \cdot x + 65.356$
	other broadleaves coppices	$y = 0.3922 \cdot x + 65.356$
	poplars stands	$y = 0.9843 \cdot x + 5.0746$
	other broadleaves stands	$y = 0.9843 \cdot x + 5.0746$
	conifers stands	$y = 0.4041 \cdot x + 57.874$
	others,	$y = 0.7647 \cdot x + 33.668$
protective	rupicolous forest	$y = 0.7647 \cdot x + 33.668$
	riparian forest	$y = 0.9843 \cdot x + 5.0746$
	shrublands	$y = 0.3922 \cdot x + 65.356$

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 is included in table 5.A.1 of the CRF, i.e. forest land remaining forest land.

CO_2 emissions due to wildfires in forest land remaining forest land are included in table 5.A.1, carbon stocks change in living biomass, decrease.

7.2.3 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 year 1990–2003, the Tier 1 Approach 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 the table 7.7 the relations for assessing the overall uncertainties associated to the carbon pools have been reported:

Table 7.7 Relations for assessing uncertainties of the C pools

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	$E_{BG_{1985}}=\sqrt{E_{NFI}^2+E_{BEF_2}^2+E_{BD}^2+E_{CF}^2}$
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	$E_{S_{1985}}=\sqrt{E_{SS_{1985}}^2+E_{SR_5}^2}$

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 stands for the uncertainty related to the expansion factor 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 CONECOFOR Programme (Corpo Forestale, 2005). 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 7.8, the values of carbon stocks in the five pools, for the 1985, and the abovementioned uncertainties are reported:

Table 7.8 Carbon stocks and uncertainties for the year 1985

Carbon stocks t CO_2 eq. ha^{-1}	*Aboveground biomass*	V_{AG}	128.3
	Belowground biomass	V_{BG}	29.6
	Dead mass	V_D	19.4
	Litter	V_L	14.5
	Soil	V_S	205.6
Uncertainty	*Growing stock*	E_{NFI}	3.2%
	BEF_1	E_{BEF1}	30%
	BEF_2	E_{BEF2}	30%
	DEF	E_{DEF}	30%
	Litter (stock + regression)	E_L	45%
	Soil (stock + regression)	E_S	152%
	Basic Density	E_{BD}	30%
	C Conversion Factor	E_{CF}	2%

The uncertainties related to the carbon pools and the overall uncertainty for 1985 has been computed and shown in Table 7.9, using the relations in Table 7.7.

Table 7.9 Uncertainties for the year 1985

Aboveground biomass	E_{AG}	42.59%
Belowground biomass	E_{BG}	42.59%
Dead mass	E_D	52.10%
Litter	E_L	45.09%
Soil	E_S	152.05%
Overall uncertainty	$\mathbf{E_{1985}}$	**88.49%**

The overall uncertainty related to the 1985 (the year of the first National Forest Inventory) has been propagated through the years, till 2003, following Tier 1 approach. The equation for the estimates of the 1986 overall uncertainty is shown:

$$E_{1986} = \frac{\sqrt{\left(E_{AG_{1985}} \cdot V_{AG_{1985}}\right)^2 + \left(E_{BG_{1985}} \cdot V_{BG_{1985}}\right)^2 + \left(E_{D_{1985}} \cdot V_{D_{1985}}\right)^2 + \left(E_{L_{1985}} \cdot V_{L_{1985}}\right)^2 + \left(E_{S_{1985}} \cdot V_{S_{1985}}\right)^2}}{\left|V_{AG_{1985}} + V_{BG_{1985}} + V_{D_{1985}} + V_{L_{1985}} + V_{S_{1985}}\right|}$$

The abovementioned relation is similar to the equation for 1985 uncertainty, apart from the terms linked to aboveground biomass: the biomass increment has been computed with the methodology described in 7.2.2. Methodological issues with reference to the forest land remaining forest land. Therefore the equation for the estimate of the aboveground biomass uncertainty is:

$$E_{AG_{1986}} = \frac{\sqrt{\left(\frac{\sqrt{\left(E_{NFI} \cdot V_{NFI}\right)^2 + \left(E_I \cdot V_I\right)^2 + \left(E_H \cdot V_H\right)^2 + \left(E_F \cdot V_F\right)^2 + \left(E_O \cdot V_O\right)^2 + \left(E_M \cdot V_M\right)^2}}{\left|V_{NFI} + V_I + \left(-V_H\right) + \left(-V_F\right) + \left(-V_O\right) + \left(-V_{MOR}\right)\right|}\right)^2 + E_{BEF_L}^2 + E_{BD}^2 + E_{CF}^2}}{\left|V_{AG_{1985}} + V_{BG_{1985}} + V_{D_{1985}} + V_{L_{1985}} + V_{S_{1985}}\right|}$$

In Table 7.10 the quantities and related uncertainties required from the equation for the estimate of the overall aboveground biomass uncertainty are reported:

Table 7.10 Uncertainties for the aboveground biomass for the year 1986

Growing stock uncertainty (NFI 1985)	E_{NFI}	3.2%
Current increment (Richards)[18]	E_{NFI}	51.6%
Harvest[19]	E_{H}	30%
Fire[20]	E_{F}	30%
Drain and grazing	E_{D}	30%
Mortality	E_{M}	30%
BEF_1	E_{BEF1}	30%
BEF_2	E_{BEF2}	30%
DEF	E_{DEF}	30%
Litter (stock + regression)	E_{L}	45%
Soil (stock + regression)	E_{S}	152%
Basic Density	E_{BD}	30%
C Conversion Factor	E_{CF}	2%

The uncertainties related to the carbon pools and the overall uncertainty for 1986 are shown in Table 7.11:

Table 7.11 Uncertainties for the year 1986

Aboveground biomass	E_{AG}	42.68%
Belowground biomass	E_{BG}	42.68%
Dead mass	E_{D}	52.17%
Litter	E_{L}	45.09%
Soil	E_{S}	152.05%
Overall uncertainty	E_{1985}	88.32%

Following Tier 1 approach and the abovementioned methodology, the overall uncertainty in the estimates produced by the described model has been quantified; in Table 7.12 the uncertainties of the 1990-2003 period are reported:

Table 7.12 Overall uncertainties 1985 - 2003

1985	88.49%
1986	88.32%
1987	91.65%
1988	91.82%
1989	91.69%
1990	91.62%
1991	91.45%
1992	91.21%
1993	91.12%
1994	90.96%
1995	90.70%
1996	90.46%
1997	90.26%
1998	90.12%
1999	89.92%
2000	89.74%
2001	89.54%
2002	89.27%
2003	89.10%

[18] The current increment is estimated by the derived Richards function (see 7.2.2. Methodological issues - *Forest Land remaining Forest Land*); 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
[19] Good Practice Guidance default value (IPCC, 2003)
[20] Good Practice Guidance default value (IPCC, 2003)

The overall uncertainty in the model estimates between 1990 and 2003 has been assessed with the following relation:

$$E_{1990-2003} = \frac{\sqrt{\left(E_{1990} \cdot V_{1990}\right)^2 + \left(E_{2003} \cdot V_{2003}\right)^2}}{\left|V_{1990} + V_{2003}\right|}$$

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 1990–2003 is equal to 63.88%. The table reporting the uncertainties referring to all the categories (Forest Land, Cropland, Grassland, Wetlands, Settlements, Other Land) is shown in Annex 1.

7.2.4 Source-specific planned improvements

The final result of the new forest inventory, available in 2006, will allow a more precise evaluation of the estimated time series, in order to reduce the related uncertainty.
Improvements will be also related to the outcome of European research projects on carbon stock inventories in Europe. Specifically for Italy, two projects are in progress: INFOCARB- Carbon fluxes and Pools in Forest Ecosystems and Progetto Kyoto which should estimate the carbon amount in the Lombardy region. Details of the projects can be found at the website links: http://www.cealp.it/, http://www.flanet.org/ricerca/kyoto.asp.
Further improvements will be related to the estimate of the emissions/removals due to the area converted in forest land, currently included in the estimate of the forest land remaining forest land.
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 the next submissions an upgrade of the used model is foreseen 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.

7.3 Cropland (5B)

7.3.1 Source category 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 16.7% of total CO_2 LULUCF emissions and removals, in particular the living biomass removals represent 95%, while the emissions from soils stand for 5% of total cropland CO_2 emissions and removals.

7.3.2 Methodological issues

Cropland remaining Cropland
Cropland includes all annual and perennial crops; the change in biomass has been estimated only for

perennial woody crops, since, for annual crops, increase in biomass stocks in a single year is assumed equal to biomass losses from harvest and mortality in that same year. Therefore activity data for cropland remaining cropland concerns only perennial woody crops.
The 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 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. This is the reason why no biomass carbon loss is estimated, since no data about biomass clearing, in wooden cropland, are available.
Net changes in cropland C stocks obtained are equal to 5.741 Tg C for 1990, and 5.699 Tg C for 2003.

In the GPG, carbon stocks for soils are measured to a default depth of 30cm and do not include C in surface residue, i.e. dead organic matter, or changes in inorganic carbon, for Tier1 and Tier2 methods.
Changes in carbon stocks in mineral soils in total cropland have been estimated following changes in management that impact soil carbon content. Previous 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. According to the indications of national experts, the carbon content of one hectare of land, at the default depth of 30cm, has been estimated as equal to 44,5 ± 10 t (Ciccarese *et al.*, 2000).
Default stock change factors, factor for land use (F_{LU}), factor for management (F_{MG}), and input factor (F_I), have been selected among the relative stock change factors for different management activities on cropland, given in GPG, Table 3.3.4 (IPCC, 2003).
In the subsequent table the used stock change factors are shown:

Table 7.13 Stock change factors for cropland management

	F_{LU}	F_{MG}	F_I
Cropland	0.82	1.0	1.0

With the stock change factors the soil carbon stock [t C] for the inventory year [SOC_0] and the previous 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 the GPG default, in 20 years. 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).
Net changes in soil C stocks obtained are equal to -0.222 Tg C for 1990, and -0.32 Tg C for 2003.
No CO_2 emissions from organic soils or from application of carbonate containing lime or dolomite to agricultural soils have occurred.

Land converted to Cropland

In accordance with the GPG methodology, estimates of carbon stock change in living biomass and soils have been provided, since there is not sufficient information to estimate carbon stock change in dead organic matter pool.

N_2O emissions arising from the conversion of land to cropland have been also estimated, and reported in the Common Reporting Format 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 in Italian case, to cropland, during each year, from 1990 to 2003, has been estimated through the construction of the land use change matrices, one for each year; the matrices allow to point out the average areas of transition land separately for each initial and final land use (i.e. forest land, grassland, etc.). 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 7.2, conversion of lands into cropland has taken place only in a few years during the period 1990- 2003. C emissions [Gg C] due to change in carbon stocks in living biomass in land converted to cropland, are reported in Table 7.14:

Table 7.14 Change in carbon stock in living biomass in land converted to cropland

Year	Conversion Area *k ha*	$\Delta C_{\text{converted land}}$ *Gg C*
1990	-	-
1991	-	-
1992	-	-
1993	41	53.45
1994	54	70.82
1995	54	70.82
1996	79	102.27
1997	-	-
1998	164	213.74
1999	132	171.67
2000	15	18.97
2001	-	-
2002	-	-
2003	-	-

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. According to the indications of national experts, the carbon content of one hectare of grassland or cropland, at the default depth of 30cm has been estimated as equal to 44,5 ± 10t (Ciccarese *et al.*, 2000).
As above mentioned, only conversion from grassland to cropland has occurred in the Italian territory; different stock change factors (F_{LU}, F_{MG}, F_I) have been used for the different management activities on grassland, initial land use, and cropland, final land use.
With the stock change factors, the cropland soil carbon stock [t C] for the inventory year [SOC_0] and the grassland 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 the GPG default, in 20 years. 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 7.15.
No CO_2 emissions from organic soils or from application of carbonate containing lime or dolomite to agricultural soils have occurred.

7.3.3 Source-specific planned improvements

Improvements will concern the implementation of the estimate of carbon change in cropland biomass at a higher disaggregate 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.

Table 7.15 Change in carbon stock in soil in land converted to cropland

Year	Conversion Area	Carbon stock
	k ha	*Gg C yr^{-1}*
1990	-	-
1991	-	-
1992	-	-
1993	41	-11.9
1994	54	-15.8
1995	54	-15.8
1996	79	-22.8
1997	-	-
1998	164	-47.6
1999	132	-38.2
2000	15	-4.2
2001	-	-
2002	-	-
2003	-	-

7.4 Grassland (5C)

7.4.1 Source category 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 emissions share 13.9% of absolute CO_2 LULUCF emissions and removals, in particular the living biomass emissions represent 4%, while the emissions from soils stand for 96% of total grassland CO_2 emissions.

7.4.2 Methodological issues

Grassland remaining Grassland
Forage crops, permanent pastures, and lands once used for agriculture purposes, but in fact set-aside since 1970 has been considered as grasslands.
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, while estimate on carbon stocks changes in soils has been provided. In accordance to the GPG no data regarding the dead organic matter pool have been provided, since not enough information is available.
Changes in carbon stocks in mineral soils in total grassland have been estimated following changes in management that impact soil carbon content. Previous soil carbon stock [$SOC_{(0-T)}$] and soil carbon stock in the inventory year [SOC_0] for the grassland area have been estimated from the reference carbon stocks. According to the indications of national experts, the carbon content of one hectare of land with a soil depth of 30cm can be estimated as equal to 44,5 ± 10t (Ciccarese *et al.*, 2000).
For the two grassland systems (forage crops and permanent pasture, set-aside lands) a set of default stock change factors (F_{LU}, F_{MG}, F_I) has been chosen among the relative stock change factors for grassland management given in GPG, Table 3.4.5 (IPCC, 2003), taking into account the land use, the different level of degradation and the applied input to lands. The land use stock change factor (F_{LU}) for the so-called set aside lands has been derived, according to the indications of national experts, from Table 3.4.5 of the GPG (IPCC, 2003).
In the following table the used stock change factors are shown:

Table 7.16 Stock change factors for grassland management

Grassland system	F_{LU}	F_{MG}	F_I
Forage crops and permanent pasture	1.0	0.95	1.0
Grassland from set aside lands	0.82	1.0	0.92

With the stock change factors the soil carbon stock [t C] for the inventory year [SOC_0] and the previous 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 the GPG default, in 20 years.
The annual change in carbon stocks in mineral soils has been, at last, assessed as described in the equation 3.4.8 of the GPG. Net changes in soil C stocks obtained are equal to 4.341 Tg C for 1990, and 4.322 Tg C for 2003.
No CO_2 emissions from organic soils or from application of carbonate containing lime have occurred.

Land converted to Grassland

In accordance with the GPG methodology, estimate of carbon stocks change in living biomass and soils have been provided, since there is not sufficient information to estimate carbon stocks change in dead organic matter pool. Only conversion from cropland to grassland has occurred.

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.

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 in Italian case, to grassland during each year, from 1990 to 2003, has been pointed out, for each initial and final land use, through the use of the land use change matrices, one for each year.

The GPG equation 3.4.13 (IPCC, 2003) has been used to estimate the change in carbon stocks, resulting from the land use change. Concerning Italian territory, only conversion from cropland to grassland has occurred; therefore the default biomass carbon stocks present on land converted to grassland, as dry matter, as supplied by Table 3.4.9 of the GPG for warm temperate – dry, have been used, equal to 6.1 t d.m. ha^{-1}. Since, according to national expert judgement, it has been assumed that lands in conversion to grassland are mostly annual crops, carbon stocks in biomass immediately before conversion have been obtained by the default values reported in the Table 3.3.8 of the GPG, for annual cropland.

As pointed out above in the land use matrices, see Table 7.2, the conversion of lands into grassland have taken place only in a few years during the period 1990-2003. C emissions [Gg C] due to change in carbon stocks in living biomass in land converted to grassland, are reported in Table 7.17:

Table 7.17 Change in carbon stock in living biomass in land converted to grassland

Year	Conversion Area	C_{before}	ΔC_{growth}	ΔC
	k ha	*t C ha-1 yr-1*	*t C ha-1*	*Gg C*
1990	46	5	3.05	-90.2
1991	24	5	3.05	-47.4
1992	23	5	3.05	-43.9
1993	-	5	3.05	-
1994	-	5	3.05	-
1995	-	5	3.05	-
1996	-	5	3.05	-
1997	25	5	3.05	-48.2
1998	-	5	3.05	-
1999	-	5	3.05	-
2000	-	5	3.05	-
2001	118	5	3.05	-229.2
2002	65	5	3.05	-126.2
2003	98	5	3.05	-191.9

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. According to the indications of national

experts, the carbon content of one hectare of grassland or cropland, at the default depth of 30cm, has been estimated as equal to 44,5 ± 10t (Ciccarese *et al.*, 2000).
As above mentioned, only conversion cropland to grassland has occurred in the Italian territory; different stock change factors (F_{LU}, F_{MG}, F_I) have been used for the for diverse management activities on cropland, initial land us, and grassland, final land use.
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 the GPG default, in 20 years. 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 7.18:

Table 7.18 Change in carbon stock in soil

Year	Conversion Area	Carbon stock
	k ha	*Gg C yr^{-1}*
1990	46	20.1
1991	24	10.6
1992	23	9.8
1993	-	-
1994	-	-
1995	-	-
1996	-	-
1997	25	10.8
1998	-	-
1999	-	-
2000	-	-
2001	118	51.2
2002	65	28.2
2003	98	42.8

7.4.3 Source-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, to obtain a more accurate estimate of the carbon stocks change.

7.5 Wetlands (5D)

7.5.1 Source category description

Under this category, activity data from wetlands remaining wetlands are reported.

7.5.2 Methodological issues

Lands covered or saturated by water, all or part of year, which harmonize with the definitions of the Ramsar Convention on Wetlands[21] have been included in this category (MAMB, 1992). No data

[21] Ramsar Convention on Wetlands: http://www.ramsar.org/ (Ramsar, 2005)

were available on flooded lands, therefore reservoirs or water bodies regulated by human activities have not been considered. Concerning land converted to wetland, during the period 1990-2003, no land has been in transition to wetlands.

7.5.3 Source-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 Source category description

Under this category, activity data from settlements and from land converted to settlements are reported; CO_2 emissions, from living biomass, from land converted in settlements have been also reported. Settlements emissions share 1.25% of total CO_2 LULUCF emissions and removals.

7.6.2 Methodological issues

Up to now there is a lack of data concerning urban tree formations. Therefore it is not possible to give estimates on the carbon stocks changes in living biomass, dead organic matter and soil for this category. Therefore only activity data have been reported. Settlements time series has been developed through a linear interpolation between the 1990 and 2000 data, obtained by the Corine Land Cover[22] maps, relatively to the class "*Artificial surfaces*". By assuming that the defined trend may well be represent the near future, it was possible to extrapolate data for the years 2001-2003.

Land converted to Settlements
The average area of land undergoing a transition from non-settlements to settlements during each year, from 1990 to 2003, has been estimated with the land use change matrices that have also permitted to specify the initial and final land use. 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 the table 7.2, only conversions from grassland and cropland to settlements have occurred in the 1990-2003 period. Concerning grassland converted to settlements, no change in carbon stocks has been computed, as in Tier 1 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:

[22] Corine Land Cover, http://www.clc2000.sinanet.apat.it/cartanetclc2000/ (APAT, 2004)

Table 7.19 Stock change factors for cropland

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

As indicated in the land use matrices of Table 7.2, the conversion of lands into settlements have taken place only in a few years during the period 1990-2003. In Table 7.20 C emissions [Gg C] due to change in carbon stocks in living biomass in cropland (annual and perennial) converted to settlements are reported:

Table 7.20 Change in carbon stocks in living biomass in cropland converted to settlements

year	annual crops to settlements		perennial woody crops to settlements		*Total Carbon stock*
	Conversion Area	*Carbon stock*	*Conversion Area*	*Carbon stock*	
	k ha	*Gg C*	*k ha*	*Gg C*	*Gg C*
1990	2.08	-10.4	6.18	-389.1	-399.5
1991	2.08	-10.4	6.18	-389.5	-399.8
1992	2.07	-10.4	6.18	-389.6	-400.0
1993	-	-	-	-	-
1994	-	-	-	-	-
1995	-	-	-	-	-
1996	-	-	-	-	-
1997	2.05	-10.2	6.21	-391.3	-401.6
1998	-	-	-	-	-
1999	-	-	-	-	-
2000	-	-	-	-	-
2001	7.40	-37.0	22.05	-1388.8	-1425.8
2002	2.07	-10.4	6.19	-389.7	-400.1
2003	2.05	-10.2	6.21	-391.5	-401.7

7.6.3 Source-specific planned improvements

Further investigation will be made to obtain additional statistics about settlements, comparing the added information with the time series developed from Corine Land Cover data (APAT, 2004). 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 and soils 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))

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 Source category description

Under this category, N_2O emissions from disturbance of soils associated with land-use conversion to cropland, 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 2003, has been estimated with the land use change matrices; as abovementioned, 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 7.21 N_2O emissions resulting from the disturbance associated with land-use conversion to cropland are reported:

Table 7.21 N_2O emissions from land-use conversion to cropland

Year	Conversion Area *k ha*	Carbon stock *Gg C yr^{-1}*	$N_{net\text{-}min}$ *kt Nyr^{-1}*	$N_2O_{net\text{-}min}$-N *kt N_2O-N yr^{-1}*	N_2O emissions *Gg N_20 yr^{-1}*
1990	-	-	-	-	-
1991	-	-	-	-	-
1992	-	-	-	-	-
1993	41	-11.9	-0.8	-0.010	-0.016
1994	54	-15.8	-1.1	-0.013	-0.021
1995	54	-15.8	-1.1	-0.013	-0.021
1996	79	-22.8	-1.5	-0.019	-0.030
1997	-	-	-	-	-
1998	164	-47.6	-3.2	-0.040	-0.062
1999	132	-38.2	-2.5	-0.032	-0.050
2000	15	-4.2	-0.3	-0.004	-0.006
2001	-	-	-	-	-
2002	-	-	-	-	-
2003	-	-	-	-	-

7.11 Carbon emissions from agricultural lime application (5(IV))

Carbon emissions from agricultural lime application are no estimated, since no lime application is occurring.

7.12 Biomass Burning (5(V))

7.12.1 Source category 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.

7.12.2 Methodological issues

In Italy, in consideration of national regulations, 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, has been estimated following the methodology reported in paragraph 7.2.2.
IPCC method was followed for CH_4 and N_2O emissions, multiplying the amount of C released from 1990 to 2003, calculated on the basis of regional parameters (Bovio, 1996), by the emission factors suggested in the IPCC guidelines (IPCC, 1997).

7.12.3 Source-specific planned improvements

Further investigations will be made to acquire data on grassland fires, in order to provide estimate of CO_2 emissions.

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 2.2% (and was 2.6% in the base year 1990).
The trends in greenhouse gas emissions from the waste sector are 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; in fact these emissions rank among the top-10 key level and key trend sources.
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 categories 1A2 (Manufacturing industries and construction) and 1A4a (according to the IPCC reporting guidelines).
Under 6D, CH_4 and NMVOC emissions from compost production are reported.

Table 8.1 Trend in greenhouse gas emissions from the waste sector 1990-2003 (Gg)

GAS/SUBSOURCE	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
CO_2										
6C. Waste incineration	493.33	552.57	508.48	507.76	335.73	392.09	218.75	235.06	184.89	167.70
CH_4										
6A. Solid waste disposal on land	492.76	516.92	523.72	527.18	528.46	535.86	540.86	533.29	488.87	461.44
6B. Wastewater handling	63.83	66.15	66.61	67.52	67.43	67.05	68.01	68.66	68.30	68.18
6C. Waste incineration	7.65	12.91	10.90	13.24	11.75	14.38	11.87	12.93	12.53	12.43
6D. Other (compost production)	0.01	0.02	0.02	0.05	0.06	0.07	0.10	0.12	0.16	0.18
N_2O										
6B. Wastewater handling	3.37	3.39	3.40	3.41	3.40	3.41	3.41	3.41	3.42	3.43
6C. Waste incineration	0.28	0.43	0.36	0.43	0.37	0.45	0.36	0.39	0.37	0.37

From the following box, in which the 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 according to both level and trend assessment, calculated with Tier 1 e Tier 2; methane emission from wastewater handling is a key source at level and trend assessment, when taking into account uncertainty; finally, nitrous oxide emission from wastewater handling is a key source at trend assessment including uncertainty.

Key-source identification in the waste sector using the IPCC Tier 1 and 2 approach

6A	CH_4	Emissions from solid waste disposal sites	Key (L, T)
6B	CH_4	Emissions from wastewater handling	Key (L2, T2)
6B	N_2O	Emissions from wastewater handling	Key (T2)
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

As mentioned above, methane from landfills is a major key source, both in terms of level and trend. Its share of CH_4 emissions in the national greenhouse total is presently 1.7% (and was 2% in the base year 1990).
The main parameters that influence the estimation of emissions from landfills are, apart of course 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, which could influence the emission estimates.
From 2000, municipal solid wastes are disposed only into managed landfills, due to the enforcement of regulations.
The Landfill European Directive (EC, 1999), that has been transposed by the Legislative Decree 13 January 2003 n. 36, will applied definitely to the Italian landfill the next July. Until this deadline, the classification of landfill refers to the old national legislation (Decision 27 July 1984), that is very close to the new one.
The municipal solid wastes are disposed into the 1st category landfills, whereas the inert wastes are disposed into the 2nd category, type A, landfills; other industrial wastes with different toxicity are disposed into the 2nd category, type B and C, and into the 3rd category landfills. Methane emissions are expected from 1st category landfills, as results from law's disposition, that force only this category having a collecting gas system, due to biodegradability of wastes disposed.
For this reason, only 1st category landfills have been considered for the estimation of methane emissions.
For the year 2003, the 1st category landfills in Italy are 487, that dispose 21,112 Mt of wastes.

8.2.2. Methodological issues

In order to calculate CH_4 emissions from all the landfill sites in Italy, the assumption was made that all the landfills started operation in 1975 and the same parameters have been considered in order to apply the First Order Decay Model (although characteristics of individual sites can vary substantially). Thus, the IPCC Tier 2 methodology has been followed for the emission estimation.
Since CH_4 emissions from landfills are a key source (see above), the present methodology does comply with the IPCC Good Practice Guidance (IPCC, 2000).
Apart from municipal solid waste, sludge from urban wastewater handling plants has also been considered. The share of waste disposed of into uncontrolled landfills, which was 52.7% in 1975,

gradually decreases, thanks to the enforcement of new regulations as reported above, and it has been assumed equal to 0 in the year 2000, although emissions are released due to the waste disposed in the past years. The unmanaged sites have been considered 50% deep and 50% shallow.

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).

On the basis of data available on waste composition (Ferrari, 1996), the moisture content, the organic carbon content and the fraction of biodegradable organic carbon for each waste stream (Andreottola and Cossu, 1988), the DOC contents for each waste typology and the methane generation potential values (L_0) have been generated.
The fraction of DOC dissimilated and the MCF are IPCC default values. The MCF value for unmanaged landfill results as average of the default IPCC values reported for deep and shallow sites.
It is assumed that landfill gas composition is 50% carbon dioxide and 50% methane.
In the following Table 8.2, national parameters are reported; the main difference between national and IPCC DOC values refers to paper and textiles.

Table 8.2 Parameters used to calculate the fraction of DOC and consequently the methane generation potential

	National	*National*	*National*	*National*	*National*	*IPCC*
	Waste composition by weight (KgMSWi/100Kg wet RSU)	**Moisture Content**	**Organic Carbon content (KgC/Kg dry MSW)**	**Fraction of Biodegradable Organic Carbon**	**DOC (KgC/100Kg wet MSW)**	**DOC (KgC/100Kg wet MSW)**
Food	26.31	60%	0.48	80%	4.04	3.95
Garden and park	4.48	50%	0.48	70%	0.75	1.05
Paper	30.13	8%	0.44	50%	6.10	12.05
Textiles	5.13	10%	0.55	20%	0.51	2.05
Wood and straw	-	20%	0.50	50%		
Σ					**11.40**	**19.10**
	IPCC	*National*	*IPCC*	*IPCC*	*National*	*National*
	MCF	**DOC (KgC/100Kg wet MSW)**	**DOC_f**	**F**	**L_0 ($KgCH_4$/ tMSW)**	**L_0 (m^3CH_4/ tMSW)**
Managed	1	11.40	50%	50%	38.00	51.35
Unmanaged	0.6	11.40	50%	50%	22.80	30.81

On the basis of encouragements of the centralized review of the 2004 GHG inventory Italy's submission, the maximum methane generation rate constant of 0.4 per year has been revised. The new value (k = 0.26) has been calculated making a weighted average of the single k values calculated for each rapidly, moderately and slowly biodegradable fractions, on the basis of their percentage within the waste composition, as reported in Table 8.3. National half life values are suggested by Andreottola and Cossu (Andreottola and Cossu, 1988).

Table 8.3 Half-life values and methane generation rate constant correlated, both national and IPCC values

	National	*National*	*IPCC*	*IPCC*
	Half life	**Methane generation rate constant**	**Half life**	**Methane generation rate constant**
Rapidly biodegradable	1 year	0.69	3 year	0.23
Moderately biodegradable	5 years	0.14	14 years	0.05
Slowly biodegradable	15 years	0.05	23 years	0.03
Average	**2.66 years**	**0.26**		

Concerning NMVOC emissions, 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).

8.2.3 Uncertainty and time-series consistency

The combined uncertainty in CH_4 emissions from solid waste disposal sites is estimated to be 36.1% in annual emissions, 20% and 30%, respectively, for activity data and emission factors, as suggested by the IPCC Good Practice Guidance (IPCC, 2000).
Due to importance of the sub-sector, the time series of activity data is also reported (Table 8.4), followed by the CH_4 emission trend (Table 8.5).

Table 8.4 Activity Data Solid Waste Disposal on Land, 1990-2003 (Gg)

Activity Data	**1990**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
MSW Production (Gg)	22,231	25,780	25,960	26,605	26,847	28,364	28,959	29,409	29,864	30,038
MSW Landfilled (%)	91.1%	85.5%	83.3%	80.0%	77.4%	76.7%	75.7%	68.0%	63.1%	59.9%
- in managed landfills	62,1%	70,6%	72,1%	73,0%	73,9%	74,8%	75,7%	68,0%	63,1%	59,9%
Sewage Sludge Landfilled (Gg)	2,763	3,476	3,465	3,351	3,494	3,474	3,170	3,194	3,022	3,116
Total MSW to landfills (Gg)	**23,023**	**25,520**	**25,088**	**24,626**	**24,261**	**25,219**	**25,087**	**23,197**	**21,870**	**21,112**

Table 8.5 Methane produced, recovered and CH_4 and NMVOC net emissions, 1990-2003 (Gg)

Emissions	**1990**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Managed Landfills										
Methane produced	441.84	628.14	653.50	677.51	700.27	728.17	752.68	757.03	750.20	739.12
Methane recovered	24.42	166.056	170.94	175.824	180.708	185.592	190.476	192.58	227.47	240.90
CH_4 net emissions	370.79	410.47	428.66	445.65	461.53	481.97	499.41	501.40	464.34	442.57
NMVOC net emissions	4.88	5.41	5.65	5.87	6.08	6.35	6.58	6.60	6.12	5.83
Unmanaged Landfills										
Methane produced	123.57	107.86	96.32	82.61	67.81	54.60	42.00	32.31	24.86	19.12
Methane recovered	0	0	0	0	0	0	0	0	0	0
CH_4 net emissions	121.97	106.46	95.07	81.53	66.93	53.89	41.46	31.89	24.53	18.87
NMVOC net emissions	1.61	1.40	1.25	1.07	0.88	0.71	0.55	0.42	0.32	0.25

8.2.4 Source-specific QA/QC and verification

A comparison of the national emission factors and parameters used for the estimation with the default IPCC values has been done (see Tables 8.2 and 8.3). The main difference refers to the average degradable organic carbon in the waste and depends on the Italian waste composition.
The values used to calculate the DOC content and the methane generation rate constant have been

compared with those reported in a survey by the Hydraulic Department of the University of Rome "La Sapienza" (Muntoni and Polettini, 2002).
A verification on methane recovered time series has been done, on the basis of a new available national survey (Acaia et al., 2004). Concerning CH_4 recovering, figures have been estimated on the basis of data on landfill gas flared available for 1991-1992-1993 (De Poli and Pasqualini, 1997) and data on energy recovered from landfill gas published yearly from 1990 by the Italian Independent System Operator (GRTN, 2003). A recent research (Acaia et al., 2004) for Lombardy Region on landfill gas recovered (both flared and energy use) has been used to verify the average percentage of landfill gas recovered at landfill sites; additionally, data on methane recovered for some disposal sites have been provided by Asja Company, one of the leaders in Italy in the management of landfills, for the years 2001 and 2002 (Asja, 2003).

8.2.5 Source-specific recalculations

The methane generation rate constant k that appears 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 t1/2). 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 slower decay rates are associated with dry site conditions and slowly degradable waste such as wood or paper.
On the basis of encouragements of the centralized review of the 2004 GHG inventory Italy's submission, the maximum methane generation rate constant of 0.4 per year has been revised. The new value (k = 0.26) has been calculated on the basis of the national waste composition and the national 'half-life' values, for the rapidly, moderately and slowly biodegradable matter.
As reported above, sludge from urban wastewater handling plants has also been considered. The whole time series have been revised: sludge disposed in landfill sites has been estimated from the equivalent inhabitants treated in wastewater treatment plants, distinguished in primary and secondary plants (MATT, 1989; ISTAT, 1991; ISTAT, 1993; ISTAT, 1998 [a], [b]), applying the specific per capita sludge production (Masotti, 1996; ANPA, 2001; ApS, 1997); the total amount of sludge per year could be treated by incineration or composting, or once digested could be disposed to soil for agricultural purpose or to landfills (ISTAT, 1998 [a], [b]; De Stefanis et al., 1998).
Other minor modification concerning the oxidation factor has been done, due to an error in the last submission.
A comparison with the previous estimation, in percentage terms, is reported in Table 8.6.

Table 8.6 Differences in percentages between time series reported in the updated time series and 2004 submission

	1990	1995	1996	1997	1998	1999	2000	2001	2002
Managed Landfills									
Methane produced	19.9%	20.1%	19.9%	20.2%	21.5%	23.6%	23.0%	19.3%	18.4%
Methane recovered	0%	0 %	0%	0 %	0%	0 %	0%	-1.4%	13.6%
CH_4 net emissions	9.2%	16.5%	16.1%	16.4%	18.2%	21.1%	20.1%	15.7%	8.6%
NMVOC net emissions	9.2%	16.5%	16.1%	16.4%	18.2%	21.1%	20.1%	15.7%	8.6%
Unmanaged Landfills									
Methane produced	6.6%	1.4%	2.2%	2.1%	3.5%	10.3%	15.6%	32.7%	52.3%
Methane recovered	-	-	-	-	-	-	-	-	-
CH_4 net emissions	6.6%	1.4%	2.2%	2.1%	3.5%	10.3%	15.6%	32.7%	52.3%
NMVOC net emissions	6.6%	1.4%	2.2%	2.1%	3.5%	10.3%	15.6%	32.7%	52.3%

8.2.6 Source-specific planned improvements

Improvements are expected due to the entering in force of the landfill directive (EC, 1999). The application of the Directive could implement the availability of data regarding the main parameters influencing the estimation of emission from landfills: the waste composition, the fraction of methane in the landfill gas and the amount of landfill gas collected and treated.

8.3 Wastewater handling (6B)

8.3.1 Source category description

In Italy wastewater handling is managed mainly using aerobic treatment plants, where the complete-mix activated sludge process is more frequently designed. It is assumed that domestic and commercial wastewaters are treated 100% aerobically, whereas industrial wastewaters are treated 85% aerobically and 15% anaerobically.
Consequently, there are no CH_4 emissions from the treatment of domestic and commercial wastewaters, but only N_2O emissions from human sewage. Since there are not further N_2O emissions, they are reported exclusively in human sewage.
CH_4 emissions from sludge generated by Domestic and Commercial Wastewater treatment have been calculated; the stabilization of sludge, both in domestic and industrial wastewater treatment plants, occurs in aerobic or anaerobic reactors; whereas anaerobic digestion is used, the reactors are of course covered and provided of gas recovery. A percentage from 2 to 5% of domestic and commercial wastewater is treated in Imhoff tanks, where the digestion of sludge occurs anaerobically without gas recovery. Therefore, very few emissions from sludge disposal does occur.

8.3.2 Methodological issues

As concerns N_2O emissions, 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 protein and emission factor (EF_6) default values 0.01 kg N-N_2O/kg N produced have been used, whereas the value 60 g/capita◊d of protein intake have been used, as indicate in a survey by the National Research Centre on Nutrition (INRAN, 1997).
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 are available so the default value of 0.25 kg CH_4/kg DC, suggested in the IPCC Good Practice Guidance (IPCC, 2000), has been used for the whole time series.
As recommended by the Good Practice Guidance (IPCC, 2000) for key source categories, data have been collected for several industrial sectors (food and beverage, paper and pulp, organic chemicals, refineries, iron and steel, textile, leather industry). National data have been used in the calculation of the total amount of both COD produced and wastewater output for: refineries (UP, 2004), organic chemicals (FEDERCHIMICA, several years) pulp & paper sector (ANPA-FLORYS, 2001; Assocarta, several years), beer (Assobirra, several years), wine, milk and sugar sectors (ANPA-

ONR, 2001 [a]), and leather sector (ANPA-FLORYS, 2000; UNIC, 2003). Production data have been provided by the National Statistic Institute (ISTAT, 2004 [a], [b]).
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).
A recent survey conducted by the National Statistic Institute (ISTAT, 2004 [c]) 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], [b]).
On the basis of the equivalent inhabitants treated in Imhoff tanks, the organic loading 60 g BOD_5/capita·d, 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 BOD_5, CH_4 emissions have been calculated.

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% respectively for activity data and emission factor uncertainty, coming from the IPCC Good Practice Guidance (IPCC, 2000). The uncertainty in N_2O emission 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 8.7; as previously noted only the 15% of industrial flows are treated anaerobically.
CH_4 emission trend for industrial wastewater handling for different sectors is shown in Table 8.8, whereas the emission trend for N_2O emissions both from industrial wastewater handling and human sewage is shown in Table 8.9.
Concerning CH_4 emissions from industrial wastewater, neither wastewater flow nor average COD value change much over time, therefore emissions are stable. The following COD values, expressed in grams per litre for 2003, have been used: 0.1 g/l (Iron and steel); 3.0 g/l (Organic chemicals); 3.61 g/l (Food and beverages); 0.07 g/l (Pulp and paper); 1.0 g/l (Textile industry); 3.60 g/l (Leather industry). Data on organic load for oil refinery is available only as total annual amount.

Table 8.7 Total industrial wastewater production by sector, 1990-2003 (1000 m^3)

Wastewater production (1000 m^3)	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
Iron and steel	9,534	7,778	7,443	7,829	7,788	7,485	6,756	7,244	6,098	5,741
Oil refinery	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Organic chemicals	210,936	212,317	212,717	213,850	213,987	214,336	215,049	214,670	214,525	214,744
Food and beverage	170,621	168,998	172,447	171,635	171,386	175,134	175,808	178,031	176,564	175,903
Pulp and paper	369,059	398,864	410,949	417,892	394,071	407,185	380,693	319,644	332,901	336,044
Textile industry	108,460	103,047	103,480	105,449	104,416	95,672	101,572	100,120	93,714	86,021
Leather industry	23,623	25,002	26,519	26,755	26,376	24,428	27,218	25,580	24,875	24,927
Total	892,233	916,007	933,556	943,410	918,025	924,241	907,096	845,289	848,676	843,380

Table 8.8 CH_4 emissions from anaerobic industrial wastewater treatment, 1990-2003 (Gg)

CH_4 Emissions (Gg)	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
Iron and steel	0.036	0.029	0.028	0.029	0.029	0.028	0.025	0.027	0.023	0.022
Oil refinery	5.850	5.625	5.000	4.800	4.925	4.580	4.250	4.750	4.750	4.750
Organic chemicals	23.794	23.911	23.938	24.044	24.043	24.104	24.173	24.205	24.210	24.196
Food and beverage	22.022	21.200	21.597	22.035	21.484	21.944	22.684	23.351	23.437	23.785
Pulp and paper	0.903	0.976	0.964	0.998	1.027	1.079	1.037	0.870	0.906	0.915
Textile industry	4.067	3.864	3.881	3.954	3.916	3.588	3.809	3.755	3.514	3.226
Leather industry	3.192	3.378	3.583	3.615	3.564	3.301	3.678	3.456	3.361	3.368
Total	59.86	58.98	58.99	59.47	58.99	58.62	59.66	60.41	60.20	60.26

Table 8.9 N_2O emissions from industrial wastewater handling and human sewage, 1990-2003 (Gg)

N_2O Emissions (Gg)	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
Industrial Wastewater	0.223	0.229	0.233	0.236	0.230	0.231	0.227	0.211	0.212	0.211
Human Sewage	3.144	3.157	3.164	3.170	3.172	3.176	3.185	3.194	3.204	3.215
Total	3.37	3.39	3.40	3.41	3.40	3.41	3.41	3.41	3.42	3.43

8.3.4 Source-specific QA/QC and verification

This source category is covered by the general QA/QC procedures. 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).

8.3.5 Source-specific recalculations

Estimation of CH_4 emissions from sludge generated by Domestic and Commercial Wastewater treatment have been implemented this year, on the basis of national information on anaerobic sludge treatment system. As reported above, a recent survey conducted by the National Statistical Institute (ISTAT, 2004 [c]) 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], [b]).
The CH_4 emission trend from sludge generated by Domestic and Commercial Wastewater treatment, together with equivalent inhabitants treated in Imhoff tank and consequently the organic loading per year, is reported in Table 8.10, whereas a comparison with the previous estimation of the total methane for wastewater handling, in percentage terms, is reported in Table 8.11.

Table 8.10 CH_4 emissions from sludge generated by Domestic and Commercial Wastewater treatment, 1990-2003 (Gg)

Domestic and Commercial Sludge	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
Equivalent inhabitants treated in Imhoff tanks (10^3 milions)	1,005	1,818	1,933	2,042	2,142	2,139	2,119	2,091	2,054	2,008
Organic loading in sludge (tons/year)	6,606	11,942	12,701	13,414	14,073	14,050	13,924	13,739	13,496	13,193
CH_4 emissions (Gg)	3.96	7.17	7.62	8.05	8.44	8.43	8.35	8.24	8.10	7.92

Table 8.11 Differences in percentages between CH_4 emissions from Wastewater Handling reported the updated time series and the 2004 submission

Wastewater Handling	1990	1995	1996	1997	1998	1999	2000	2001	2002
Total CH_4 emissions	6.62%	12.15%	12.92%	13.53%	14.31%	14.38%	14.00%	13.65%	13.45%

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 plant are used exclusively for industrial and sanitary waste, both hazardous and not, and for the combustion waste oils, whereas there are few plants that treat residual waste from waste treatments, as well as sewage sludge.
As mentioned above, emissions from waste incineration facilities with energy recovery are reported under categories 1A2 (Manufacturing industries and construction) and 1A4a (Combustion activity, commercial/institutional sector), whereas emissions from other types of waste incineration facilities are reported under category 6C (Waste incineration). For 2003, the 70.5% of the incineration plants, both for the disposal of MSW and for the disposal of other industrial wastes are provided of energy recovering system.
A complete data base of the incineration plants is now available, updated with the information reported in the yearly report on waste production and management published by APAT (APAT-ONR, 2004).
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

As concern GHG emissions from incinerators, the methodology reported in the IPCC Good Practice Guidance (IPCC, 2000) has been used, combined with that reported in the CORINAIR Guidebook (EMEP/CORINAIR, 2001). In fact, a single emission factor for each pollutant has been used combined with plant specific waste activity data.
The emissions have been determined for each type of waste: municipal, industrial, hospital, sewage sludge and waste oils.
A complete data base of these plants has been built, on the basis of various available sources relating to the period of the entire time series, extrapolating data for the years for which there was no available information (MATT, several years; ANPA-ONR, 1999 [a]; ANPA-ONR, 2001 [b]; APAT-

ONR, 2002; APAT-ONR, 2003; APAT-ONR, 2004; APAT, 2002; ANPA-ONR, 1999 [b]; AUSITRA-Assoambiente, 1995; Morselli, 1998; FEDERAMBIENTE, 1998; FEDERAMBIENTE, 2001; AMA-Comune di Roma, 1996; Ambiente, 2001; COOU, 2005).
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 of course 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.
Specifically:

1. for municipal waste, emission data from a large sample of Italian incinerators were used (these plants represent around 50% in terms of the quantities of waste disposed of annually);
2. for industrial waste and waste oil, reference was made to the allowed levels in the authorisation for the management of a group of incinerators taken as a sample;
3. for hospital waste, which is usually disposed of alongside municipal waste, the emission factors used for industrial waste were also used;
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 12th July 1990.

With regard to municipal waste, 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.
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 included.
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 in account the amount of crop produced, the ratio of removable residue in the crop, 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. The methodology is the same used to calculate emissions from residues burned on fields, reported 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, accounting the first for the 99%, as compared to the whole emissions from waste incineration, and N_2O emissions for a little bit less. 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, when available (CESTAAT, 1988; Borgioli, 1981).

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% in annual emissions, 5% and 25% concerning respectively activity data and emission factors. As

regard N_2O and CH_4 emissions, the combined uncertainty is estimated to be about 100% and 20.6% in annual emissions.
The emission trend for CO_2 emissions from each type of waste incinerators is shown in Table 8.12 both for plants without energy recovery, reported under 6C, and plants with energy recovery, reported under 1A. In the Table 8.13 N_2O and CH_4 emissions are summarized. In the period 1990-2003, total emissions increased by 35%; but whereas emissions from plants with energy recovery have more than doubled, emissions from plants without energy recovery decreased by 66%.

Table 8.12 CO_2 emissions from waste incineration (without and with energy recovery), 1990-2003 (Gg)

SUBSOURCE	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
Incineration of domestic or municipal wastes	124.21	91.71	64.36	85.08	76.21	74.64	46.57	42.75	31.04	17.10
Incineration of industrial wastes (except flaring)	249.20	312.65	301.37	282.69	170.24	254.54	117.85	142.61	107.51	107.06
Incineration of hospital wastes	117.29	146.81	141.49	138.66	88.05	61.79	53.52	49.03	45.91	42.76
Incineration of waste oil	2.63	1.41	1.26	1.33	1.24	1.13	0.82	0.67	0.43	0.77
Waste incineration (6C)	493.33	552.57	508.48	507.76	335.73	392.09	218.75	235.06	184.89	167.70
Manufacturing industries and construction (1A2)	177.9	64.7	49.6	48.8	32.4	31.7	58.1	44.5	40.6	72.4
Commercial/Institutional (1A4a)	323.3	557.9	522.7	535.5	586.2	672.8	792.4	925.3	973.2	1103.6
MSW incineration reported under 1A	501.3	622.6	572.3	584.3	618.6	704.5	850.4	969.9	1013.8	1176.0
Total waste incineration	994.60	1175.12	1080.80	1092.11	954.31	1096.58	1069.17	1204.92	1198.73	1343.72

Table 8.13 N_2O and CH_4 emissions from waste incineration, 1990-2003 (Gg)

GAS/SUBSOURCE	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
N_2O										
Waste incineration (6C)	0.28	0.43	0.36	0.43	0.37	0.45	0.36	0.39	0.37	0.37
MSW incineration reported under 1A	0.15	0.20	0.19	0.19	0.21	0.24	0.28	0.33	0.34	0.40
CH_4										
Waste incineration (6C)	7.65	12.91	10.90	13.24	11.75	14.38	11.87	12.93	12.53	12.43
MSW incineration reported under 1A	0.074	0.118	0.110	0.113	0.122	0.140	0.166	0.193	0.203	0.231

8.4.4 Source-specific QA/QC and verification

This source category is covered by the general QA/QC procedures. For those incineration plants reported in EPER register, a verification on emissions has been carried out.

8.4.5 Source-specific recalculations

For the year 1998, activity data from those incineration plants which treat MSW have been revised, due to a survey on the Italian incineration plants, published in 2001 (FEDERAMBIENTE, 2001). Activity data have been substitute with those calculated within the data base.
For the year 2002, activity data from those incineration plants which treat industrial waste, that were not available, have been published by APAT and so update.

Methane emissions from biogenic, plastic and other non-biogenic wastes, have been calculated.
Moreover, some mistakes for few plants have been detected relating to the split between with or without energy recovery system.
In Table 8.14 differences with GHG emissions reported last year in percentages are reported. As regard CO_2 and N_2O emissions reported in 6C category have been diminished while those reported in 1A category increased.

Table 8.14 Differences in percentages between the updated time series and the 2004 submission

GAS/SUBSOURCE	1990	1995	1996	1997	1998	1999	2000	2001	2002
CO_2									
Waste incineration (6C)	-9.5%	-5.7%	-5.9%	-5.6%	1.6%	-11.0%	-21.7%	-21.2%	-33.9%
MSW incineration reported under 1A	2.4%	1.3%	1.4%	1.3%	1.6%	1.7%	1.8%	1.6%	2.2%
N_2O									
Waste incineration (6C)	-1.4%	-0.6%	-0.7%	-0.6%	0.2%	-0.9%	-1.9%	-1.8%	-2.6%
MSW incineration reported under 1A	2.9%	1.4%	1.4%	1.3%	1.7%	1.7%	1.8%	1.6%	2.2%
CH_4									
Waste incineration (6C)	0.6%	0.3%	0.3%	0.3%	0.3%	0.2%	-0.3%	-0.3%	-0.3%
MSW incineration reported under 1A	3.4%	1.4%	1.5%	1.3%	1.7%	1.8%	1.9%	1.7%	2.3%

8.4.6 Source-specific planned improvements

No specific activities are 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 nearly 17-fold increase from 1990 to 2003 (363,519 tons to 6,090,638 tons).
Information on input waste to composting plants are published yearly by APAT since 1996, including data for 1993 and 1994 (ANPA, 1998; ANPA-ONR, 2001 [b]; APAT-ONR, 2002; APAT-ONR, 2003; APAT-ONR, 2004), while for 1987 and 1995 only data on compost production are available (MATT, 1989; 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 in general a selected waste with better characteristics for landfilling or incinerating system.
It is assumed that the 100% of the input waste to the composting plants from selected waste is treated as compost, while in mechanical-biological treatment plants the 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) .
Since no methodology is provided by the IPCC for these emissions, literature data (Hogg, 2001) has been used for the emission factor, 0.029 g CH4/kg treated waste, equivalent to compost production.
NMVOC emissions have also been estimated: emission factor (51 g NMVOC/kg treated waste) is from international scientific literature too (Finn and Spencer, 1997).
In the Table 8.15 CH_4 and NMVOC emissions are reported.

Table 8.15 CH_4 and NMVOC emissions from compost production, 1990-2003 (Gg)

GAS	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
CH_4										
Compost production (6D)	0.01	0.02	0.02	0.05	0.06	0.07	0.10	0.12	0.16	0.18
NMVOC										
Compost production (6D)	0.02	0.04	0.04	0.08	0.10	0.12	0.17	0.22	0.27	0.31

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 respectively activity data and emission factors.

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 and changes due to error corrections. Revisions apply to the entire time series.
Specifically this year, in addition to the usual updating of activity data, which can also affect information of previous years, methodological revisions have regarded the inclusion of categories not previously estimated.
The complete revised CRFs from 1990 to 2002 has been submitted as well as the CRF for the year 2003 and recalculation tables have been filled in terms of quantity values for each year. Explanatory information on the major recalculations between the 2004 and 2005 submission are reported in Table 9.1.
The revisions that lead to relevant changes in GHG emissions have been already 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 2004 submission and the series reported this year (2005 submission) by gas and sector are shown in Table 9.2. Specifically, by gas, the comparison and differences in emission levels are reported in Table 9.3.
The most relevant changes affected the last year as well as the whole time series.
Improvements in the calculation of emission estimates have led to a recalculation of the entire time series of the national inventory. Considering the total GHG emissions without CO_2 from LUCF, the emission levels of the base year increased by 0.5% in comparison with the last year submission, whereas emissions for the year 2002 showed an increase by 0.2%.
Detailed explanations of these recalculations are provided in the sectoral chapters. In general, the most relevant changes affected F-gas emissions (from 1996), specifically HFCs, due to the revision of the methodologies and new information available. Other important recalculations concerned N_2O for the revision of nitric acid production emissions especially for the base year and CH_4 emissions according to the methodological revisions of emission estimates from enteric fermentation in the agriculture sector and from landfills in the waste sector.

Table 9.1 Explanations of the main recalculations in the 2005 submission (CRF 2003)

TABLE 8(b) RECALCULATION - EXPLANATORY INFORMATION						Italy
(Sheet 1 of 1)						2003
						2005
Specify the sector and source/sink category[1] where changes in estimates have occurred:		GHG	RECALCULATION DUE TO			
			CHANGES IN:			Addition/removal/ replacement of source/sink categories
			Methods [2]	Emission factors [2]	Activity data [2]	
1A4	Other sectors	CH4		EFs for biomass have been corrected		
2A	Mineral products	CO2		EFs have been revised on the basis of new information by industry		
2B	Chemical industry	CO2		Emissions have been recalculated on the basis of new information by industry, specifically CO2 from carbon black has been estimated	Activity data have been revised on the basis of new information by industry	
2F3	Fire extinguishers	HFC227ea		Emission factor has been corrected		
3	Solvent and Other Product Use	N2O	Emissions have been estimated on the basis of information made available by industrial association			N2O emissions from the use of N2O for anaesthesia and from aerosol cans have been estimated
5	LUCF	CO2	The considerable differences in the different categories are due to the remarkable dissimilarity between the old and the new CRFs. The emissions, estimated according the new classification and definition, have been included in the "Other" category			
6A	Solid Waste Disposal	CH4		Emission factors have been revised on the basis of national information on waste composition and half time of DOC taking in account comments from the expert review		CH4 recovered has been reviewed on the basis of information on energy produced from landfill gas available by the national energy manager
6B	Wastewater Handling	CH4	Emissions for the whole time series have been calculated using the IPCC default method on the basis of national information on anaerobic sludge treatment system			CH4 emissions from sludge producing by Domestic and Commercial Wastewater treatment have been calculated
6C	Waste incineration	CO2		Activity data may have changed in the amount of incinerated wastes treated with/without energy recovering due to new information about the plants		
6C	Waste incineration	CH4	Emissions for the whole time series have been calculated using the IPCC default method			CH4 emissions from incineration plants have been estimated
4A	Enteric fermentation	CH4		Emission factor have been revised on the basis of new information	Time series of activity data has been updated	
1B1	Fugitive emissions from solid fuels	CH4		Emission factors have been revised following the Good Practice Guidance		CH4 emissions from post mining activities have been estimated

[1] Enter the identification code of the source/sink category (e.g. 1.B.1) in the first column and the name of the category (e.g. Fugitive Emissions from Solid Fuels) in the second column of the table (see Table 8(a)).

[2] Explain changes in methods, emission factors and activity data that have resulted in recalculation of the estimate of the source/sink as indicated in Table 8(a). Include relevant changes in the assumptions and coefficients under the "Methods" column.

Documentation box: Use the documentation box to report the justifications of the changes as to improvements in the accuracy, completeness and consistency of the inventory

Other minor modifications of the time series or single years as result of basic data updating

Table 9.2 Comparison of the updated time series and the time series submitted in 2004 by gas and sector

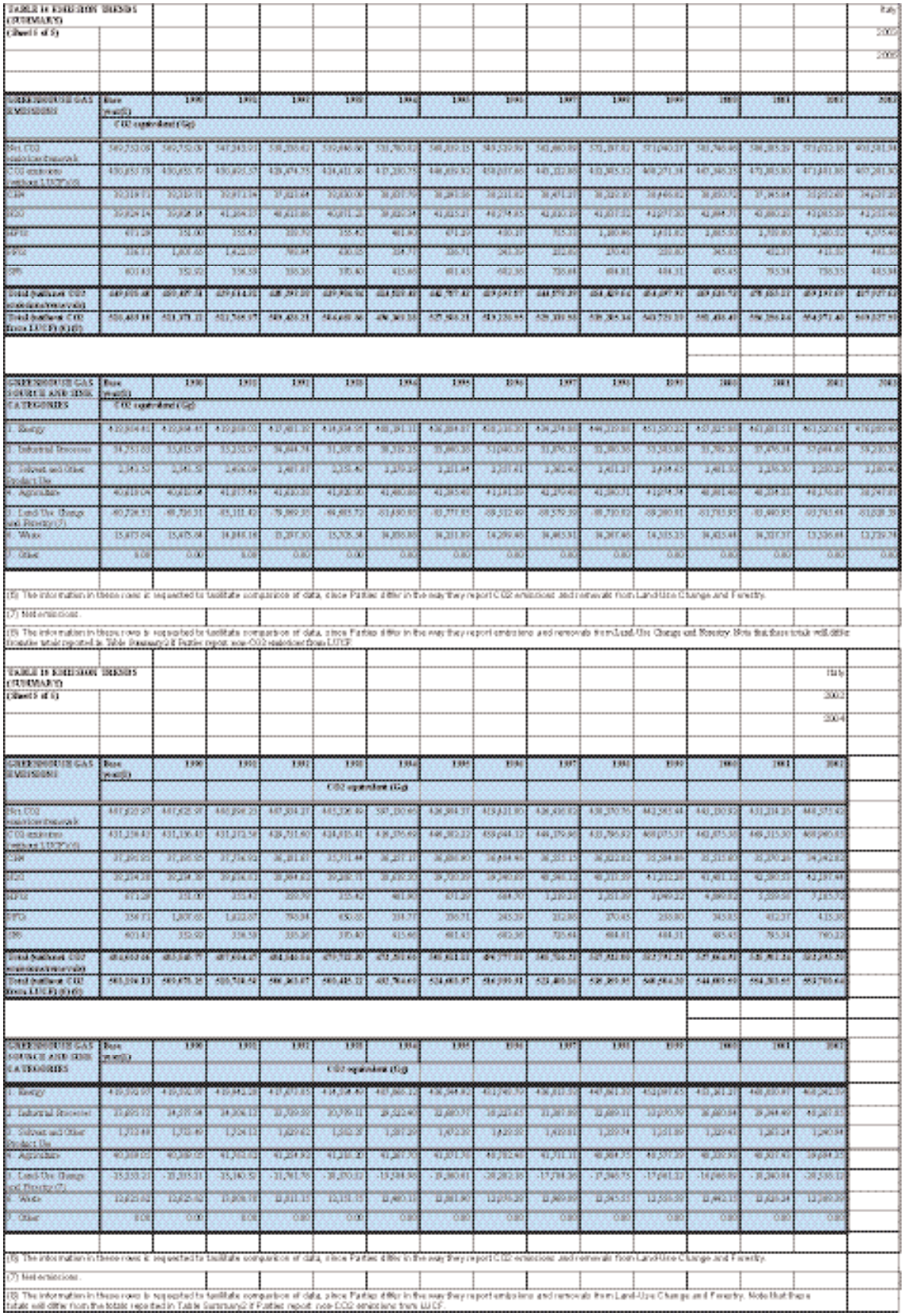

Table 9.3 Differences in time series between 2005 and 2004 submissions due to recalculations

		Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Net CO_2 emissions/removals (Gg CO_2 eq.)	2004 submission	403,624	403,624	403,096	407,934	403,326	397,131	426,984	419,422	426,416	433,371	442,363	445,131	451,214	448,575
	2005 submission	369,752	369,752	343,344	350,339	339,647	335,700	360,859	349,330	362,661	372,198	371,040	385,746	386,503	375,622
Difference		*-8.3%*	*-8.3%*	*-14.9%*	*-14.1%*	*-15.8%*	*-15.5%*	*-15.5%*	*-16.7%*	*-15.0%*	*-14.1%*	*-16.1%*	*-13.3%*	*-14.3%*	*-16.3%*
CO_2 emissions (without LUCF) (Gg CO_2 eq.)	2004 submission	431,156	431,156	431,212	429,752	424,013	416,537	446,382	439,644	444,180	455,197	460,075	462,076	469,215	468,961
	2005 submission	430,636	430,636	430,486	429,435	424,412	417,251	446,660	438,858	443,122	452,984	460,272	467,548	472,005	471,402
Difference		*-0.1%*	*-0.1%*	*-0.2%*	*-0.1%*	*0.1%*	*0.2%*	*0.0%*	*-0.2%*	*-0.2%*	*-0.6%*	*0.0%*	*1.2%*	*0.5%*	*0.5%*
CH$_4$ (Gg CO_2 eq.)	2004 submission	37,196	37,196	37,737	36,102	35,771	36,257	36,837	36,484	36,555	36,023	35,305	35,516	35,370	34,343
	2005 submission	38,320	38,320	38,971	37,824	36,030	38,038	38,294	38,212	38,471	38,328	38,466	38,051	37,145	35,853
Difference		*3.0%*	*3.0%*	*3.3%*	*4.8%*	*6.3%*	*4.9%*	*4.8%*	*4.7%*	*5.2%*	*6.4%*	*8.9%*	*7.1%*	*5.0%*	*4.4%*
N$_2$O (Gg CO_2 eq.)	2004 submission	38,254	38,254	39,037	38,995	39,269	38,619	39,730	39,340	40,546	40,314	41,212	41,481	42,591	42,197
	2005 submission	39,924	39,924	41,164	40,614	40,871	39,828	41,025	40,775	42,010	41,838	42,877	42,995	43,000	43,003
Difference		*4.4%*	*4.4%*	*5.4%*	*4.1%*	*4.1%*	*3.1%*	*3.3%*	*3.6%*	*3.6%*	*3.8%*	*4.0%*	*3.6%*	*1.0%*	*1.9%*
HFCs (Gg CO_2 eq.)	2004 submission	671	351	355	359	353	482	671	805	1,218	2,351	3,049	4,086	5,260	7,106
	2005 submission	671	351	355	359	353	482	671	459	755	1,181	1,452	2,005	2,739	3,361
Difference		*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*-23.0%*	*-38.0%*	*-49.8%*	*-52.4%*	*-51.1%*	*-50.4%*	*-49.9%*
PFCs (Gg CO_2 eq.)	2004 submission	337	1,808	1,423	799	631	353	337	243	252	270	258	346	452	414
	2005 submission	337	1,808	1,423	799	631	355	337	243	252	270	258	346	452	414
Difference		*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*
SF$_6$ (Gg CO_2 eq.)	2004 submission	601	333	356	353	370	416	601	683	729	605	403	493	795	760
	2005 submission	601	333	356	353	370	416	601	683	729	605	405	493	795	738
Difference		*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.6%*	*0.0%*	*0.0%*	*-2.9%*
Total (with net CO_2 emissions/removals) (Gg CO_2 eq.)	2004 submission	484,664	485,546	487,604	484,547	479,723	473,259	505,011	496,731	505,716	517,934	522,192	527,065	535,982	533,395
	2005 submission	449,605	450,488	429,614	430,292	419,903	414,818	441,787	429,693	444,878	454,420	454,496	469,637	470,655	459,193
Difference		*-7.2%*	*-7.2%*	*-11.9%*	*-11.2%*	*-8.5%*	*-12.3%*	*-12.5%*	*-13.5%*	*-12.0%*	*-12.3%*	*-13.1%*	*-10.9%*	*-12.2%*	*-13.9%*
Total (without CO_2 from LUCF) (Gg CO_2 eq.)	2004 submission	508,196	509,078	510,781	506,364	500,413	492,703	524,609	517,000	523,480	535,560	540,504	544,010	554,284	553,781
	2005 submission	510,489	511,371	512,766	509,428	504,670	496,369	527,388	519,221	525,340	535,205	543,729	551,488	556,157	554,972
Difference		*0.5%*	*0.5%*	*0.4%*	*0.6%*	*0.9%*	*0.7%*	*0.5%*	*0.4%*	*0.4%*	*0.0%*	*0.6%*	*1.4%*	*0.3%*	*0.2%*

9.3 Implications for emission trends, including time series consistency

The recalculations, in general, account for an improvement in the overall emission trend and consistency in time series.
In comparison with the time series submitted in 2004, emission levels of the base year, total emissions in CO_2 equivalent without CO_2 emissions from LUCF, increased by 0.5%. Specifically, CH_4 levels have increased by 3% and N_2O by 4.4%. On the contrary, minor changes affected CO_2 emission levels without LUCF, with a decrease by 0.1%, and F-gases for which the revision has no effect on the base year but accounted for from 1996 onwards.
For the year 2002, changes affected positively CO_2 (+0.5%) as well CH_4 and N_2O levels (+4.4% and +1.9%, respectively), whereas F-gas levels show a decrease (-49.9% for HFCs and –2.9% for SF_6).
Due to these recalculations the trend 'base year- year 2002' shows an increase by 8.7% in this year submission, while the increase for the same period was by 9% if considering the previous submission.
Improvements in methodologies used to compile the inventory will guarantee better estimates and minor changes from one year to another for the entire time series.

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 2002 inventory was issued in the year 2004.
Besides the inclusion of 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 applies 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 that have occurred in emission estimates since the last year submission are reported in Table 9.2 and Table 9.3. A more detailed recalculation for the year 2002 is summarised in Table 9.4
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. CH_4 emissions from post mining activities have been estimated. CH_4 emission factors for fugitive emissions, specifically solid fuel, have been revised according to the Good Practice Guidance.
Industrial sector. Most of the relevant recalculations affected the industrial processes sector.
CO_2 and N_2O emissions from mineral products and chemical industry have been revised and recalculated on account of new information made available by industry. In addition, cross-checks with figures reported in the European Pollutant Emission Register for Italy were carried out.
Solvent and other product use sector. N_2O emissions from the use of this gas for anaesthesia and from aerosol cans have been estimated on the basis of new information made available by industry.

Agriculture. CH_4 emission factors for emissions related to enteric fermentation have been revised on the basis of new information.
LULUCF. The entire time series has been recalculated using the new methodology proposed in the Good Practice Guidance for LULUCF (IPCC, 2003).
Waste sector. CH_4 emissions for waste incinerators have been estimated. CH_4 emissions from landfills have been recalculated on the basis of an in depth analysis of basic parameters used for estimation.

Source allocation was improved in the framework of the implementation of the EU emission trading directive, meetings with the industry sector were held. This results in a better understanding of emissions allocation particularly in the refineries, iron and steel, lime and cement and non ferrous metal sectors.

During the compilation of the inventory for the year 2003 an error in F-gas emissions from fire extinguishers has been detected; specifically the emission factor for HFC-227ea has been corrected for the whole time series.

9.4.2 Response to the UNFCCC review process

In 2004 the Italian GHG inventory was subject to the centralized review by the Climate Secretariat on the GHG inventory and NIR submitted in the same year.
In response to the centralized review, recalculation tables for all years have been provided within the submission of the complete set of CRFs 1990-2003. The completeness of the inventory has also improved in the estimation of CH_4 emissions from waste incineration and N_2O emissions from solvent and other product use. 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. Particular attention has been paid to check information and values with the relevant references and to the archiving of all the material used for the 2005 submission.
Figures to draw up uncertainty analysis have been checked with the experts and are consistent with the IPCC Good Practice Guidance.

9.4.3 Planned improvements (e.g., institutional arrangements, inventory preparation)

The main priority will concern the establishment of a National System in order to comply with the additional requirements of the Kyoto protocol and the European Monitoring Mechanism. The implementation of the programme is the responsibility of the Ministry for the Environment and Territory, while practical co-ordination is delegated to APAT.
The first actions which are currently being undertaken are the following:
- elaboration of an inventory QA/QC plan which describes specific QC procedures to be implemented during the inventory development process and facilitate the QA procedures including the establishment of quality objectives;
- official designation of a single national entity with the overall responsibility for the national inventory;
- establishment of processes for the official consideration and approval of the inventory, including any recalculations, prior to its submission;

• basic independent review of the inventory before its submission is also under consideration.
Other specific functions are already part of the good practices followed for the inventory preparation.

Sector specific improvements are identified in the relevant chapters.
Generally, improvements will be related to the availability of new and updated information on emission factors, activity data as well as parameters necessary to carry out the estimates. For the energy and industrial sectors, a depth analysis of data from the European Pollutant Emission Register and the Emissions Trading scheme will be carried out, i.e for cement and iron and steel. For the LULUCF sector, the Corine Land Cover data will be processed.
Finally, the results of the MeditAIRaneo project will led to a better estimation of CH_4 and N_2O emissions from the agriculture sector.
There are only few emission values missing, such as potential PFCs, but at the moment no information is available to fill these gaps.

Table 9.4 Recalculated data of the year 2002

TABLE 9(a) RECALCULATION - RECALCULATED DATA

Recalculated year: 2003

(Sheet 1 of 2)

Italy
2002
2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		CO2			CH4			N2O		
		Previous submission	Latest submission	Difference[1]	Previous submission	Latest submission	Difference[1]	Previous submission	Latest submission	Difference[1]
		CO_2 equivalent (Gg)		(%)	CO_2 equivalent (Gg)		(%)	CO_2 equivalent (Gg)		(%)
Total National Emissions and Removals		**468,575.42**	**395,622.18**	**-16.26**	**34,342.82**	**35,852.68**	**4.40**	**42,197.44**	**41,801.39**	**-1.91**
1 Energy		**440,204.52**	**404,401.65**	**-8.32**	**6,819.35**	**6,657.24**	**-2.37**	**10,388.87**	**10,411.70**	**0.22**
1.A	Fuel Combustion Activities	441,110.29	442,223.86	0.25	1,653.87	1,617.17	-2.22	10,388.87	10,411.70	0.22
1.A.1	Energy Industries	153,150.34	159,301.89	4.02	304.44	278.68	-8.60	1,898.18	1,936.04	1.99
1.A.2	Manufacturing Industries and Construction	84,943.30	79,890.10	-5.95	139.30	143.04	2.68	1,651.23	1,624.30	-1.63
1.A.3	Transport	124,944.01	124,907.10	-0.03	648.82	648.27	-0.08	3,655.66	3,665.12	0.26
1.A.4	Other Sectors	77,338.89	77,911.19	0.74	480.28	445.66	-7.20	3,174.85	3,179.27	0.14
1.A.5	Other	313.56	313.56	0.00	1.32	1.32	0.00	8.96	8.96	0.00
1.B	Fugitive Emissions from Fuels	1,924.29	1,927.99	0.19	5,165.30	5,180.08	0.29	0.00	0.00	0.00
1.B.1	Solid fuel	0.00	0.00	0.00	65.62	78.12	19.05	0.00	0.00	0.00
1.B.2	Oil and Natural Gas	1,924.29	1,927.99	0.19	5,099.68	5,101.97	0.04	0.00	0.00	0.00
2 Industrial Processes		**24,806.89**	**25,428.53**	**2.51**	**118.41**	**46.78**	**-60.49**	**7,466.63**	**7,467.22**	**0.01**
2.A	Mineral Products	22,077.12	22,574.66	2.25	0.00	0.00	0.00	0.00	0.00	0.00
2.B	Chemical Industry	351.31	1,081.36	96.18	63.09	6.93	-89.42	7,466.53	7,467.22	0.01
2.C	Metal Production	1,777.07	1,772.61	-0.25	49.81	49.85	0.04	0.00	0.00	0.00
2.D	Other Production	0.00	0.00	0.00						
2.G	Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Solvent and Other Product Use		**1,240.96**	**1,237.13**	**-3.72**				**0.00**	**913.17**	**100.00**
4 Agriculture		**0.00**	**0.00**	**0.00**	**16,837.44**	**17,100.78**	**1.56**	**23,186.90**	**23,016.26**	**-0.73**
4.A	Enteric Fermentation				11,041.20	11,644.62	5.46			
4.B	Manure Management				3,921.38	3,921.83	0.01	4,168.06	4,177.25	0.21
4.C	Rice Cultivation				1,501.64	1,501.62	0.00			
4.D	Agricultural Soils (2)	0.00	0.00	0.00	0.00	0.00	0.00	18,984.83	18,824.17	-0.85
4.E	Prescribed Burning of Savannas				0.00	0.00	0.00	0.00	0.00	0.00
4.F	Field Burning of Agricultural Residues				12.60	12.63	0.20	3.91	3.92	0.25
4.G	Other				0.00	0.00	0.00	0.00	0.00	0.00
5 Land-Use Change and Forestry (net)(3)		**-30,895.43**	**-36,779.70**	**-19.04**	**24.80**	**30.93**	**24.72**	**2.52**	**3.14**	**24.72**
5.A	Changes in Forest and Other Woody Biomass Stocks	-23,392.23	-30,456.52	-30.20						
5.B	Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.C	Abandonment of Managed Lands	-133.68	0.00	-100.00						
5.D	CO2 Emissions and Removals from Soil	7,232.96	0.00	-100.00						
5.E	Other	0.00	-2,293.38	100.00	24.80	30.93	24.72	2.52	3.14	24.72

(1) Estimate the percentage change due to recalculation with respect to the previous submission [Percentage change = 100% x [(LS-PS)/PS], where LS = Latest submission and PS = Previous submission. All cases of recalculation of the estimate of the source/sink category, should be addressed and explained in Table 8(b) of this common reporting format.
(2) See footnote 4 to Summary 1.A of this common reporting format.
(3) Net CO_2 emissions/removals to be reported.

TABLE 9(a) RECALCULATION - RECALCULATED DATA

Recalculated year: 2003

(Sheet 2 of 2)

Italy
2002
2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		CO2			CH4			N2O		
		Previous submission	Latest submission	Difference[1]	Previous submission	Latest submission	Difference[1]	Previous submission	Latest submission	Difference[1]
		CO_2 equivalent (Gg)		(%)	CO_2 equivalent (Gg)		(%)	CO_2 equivalent (Gg)		(%)
6 Waste		**279.87**	**184.89**	**-33.94**	**10,846.91**	**11,967.83**	**10.34**	**1,082.43**	**1,174.73**	**8.52**
6.A	Solid Waste Disposal on Land	0.00	0.00	0.00	9,318.37	10,268.52	10.17			
6.B	Wastewater Handling				1,280.28	1,458.27	13.91	1,063.93	1,059.00	-0.46
6.C	Waste Incineration	279.87	184.89	-33.94	247.97	240.13	-3.16	18.50	115.73	525.56
6.D	Other	0.00	0.00	0.00	0.30	0.30	0.00	0.00	0.00	0.00
7 Other (please specify)		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
				0.00			0.00			0.00
Memo Items:										
International Bunkers		**11,894.91**	**11,960.81**	**0.55**	**16.17**	**16.63**	**2.82**	**76.49**	**77.19**	**0.91**
Multilateral Operations	M	A	NE		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
CO2 Emissions from Biomass		**11,618.70**	**11,701.24**	**0.71**						

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		HFCs			PFCs			SF_6		
		Previous submission	Latest submission	Difference[1]	Previous submission	Latest submission	Difference[1]	Previous submission	Latest submission	Difference[1]
		CO_2 equivalent (Gg)		(%)	CO_2 equivalent (Gg)		(%)	CO_2 equivalent (Gg)		(%)
Total Actual Emissions		**7,108.78**	**3,998.92**	**-43.89**	**413.88**	**413.88**	**0.00**	**760.22**	**738.19**	**-2.89**
2.C.3	Aluminium Production				198.63	198.63	0.00	400.09	400.09	0.00
2.E	Production of Halocarbons and SF6	25.00	21.20	-15.20	0.00	0.00	0.00	0.00	0.00	0.00
2.F	Consumption of Halocarbons and SF6	7,080.78	3,289.31	-53.55	214.95	214.95	0.00	360.13	338.26	-6.07
	Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potential Emissions from Consumption of HFCs/PFCs and SF_6		**3,928.28**	**3,928.29**	**0.00**	**0.00**	**0.00**	**0.00**	**3,693.69**	**3,688.61**	**0.00**

	Previous submission	Latest submission	Difference[1]
	CO_2 equivalent (Gg)		(%)
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry (3)	553,295.20	489,192.69	-11.59
Total CO_2 Equivalent Emissions without Land-Use Change and Forestry (2)	553,780.64	594,972.40	7.44

10. REFERENCES

References for the main chapters and the annexes are listed here and are organised by chapter and annex.

10.1 INTRODUCTION

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ANNEX 1: KEY SOURCES AND UNCERTAINTY

A1.1 Introduction

The IPCC Good Practice Guidance (IPCC, 2000) recommends as good practice the identification of key source categories in national GHG inventories. A key source 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.
Key source categories therefore are those found in the accumulative 95% of the total annual emissions in the last reported year or belonging to the total trend, when ranked in descending order of magnitude.
The assessment of national key source categories is important because key source categories should receive special consideration in terms of methodological aspects and quality assurance and quality control verification.
Two different approaches are reported in the Good Practice according to whether or not a country has performed an uncertainty analysis of the inventory: the Tier 1 and Tier 2.
When using the Tier 1, key sources categories are identified by means of a pre-determined cumulative emissions threshold, usually fixed at 95% of the total. The threshold is based on an evaluation of several inventories and is aimed at establishing a general level where key source categories should cover up to 90% of inventory uncertainty.
If inventory source-level uncertainties are carried out, the Tier 2 can be used to identify key source categories. The Tier 2 approach is a more detailed analysis that builds on the Tier 1; in fact, the results of the Tier 1 are multiplied by the relative uncertainty of each source category. Key source categories are those that represent 95% of the uncertainty contribution, instead of applying the pre-determined cumulative emissions threshold.
So the factors which make a source a key source are a high contribution to the total, a high contribution to the trend and a high uncertainty.
If both the Tier 1 and Tier 2 are applied it is good practice to use the results of the Tier 2 analysis.
For the Italian inventory, a key source analysis has been carried out according to both the Tier 1 and Tier 2 methods. National emissions have been disaggregated, as far as possible, into the categories proposed in the Good Practice; other categories have been added to reflect specific national circumstances. Both level and trend analysis have been applied.
Summary of the results of the key source analysis is reported in Table 1.3 of chapter 1.
The same categorisation and the same estimates of uncertainty as performed in Table A1. have been used. The table indicates whether a key source arises from the level assessment or the trend assessment.
As far as level emission sources are concerned 23 key sources were individuated accounting for the 95% of the total emission. For the trend, 27 key sources were selected. Jointly for both the level and trend, 29 key sources were totally individuated.

A1.2 Tier 1 key source assessment

As described in the IPCC Good Practice Guidance (IPCC, 2000), the Tier 1 method for identifying key sources categories assesses the impacts of various source categories on the level and the trend of

the national emission inventory. Both level and trend assessment should be applied to an emission GHG inventory.
As concerns the level assessment, the contribution of each source category to the total national inventory level is calculated as follows:

Source Category Level Assessment = Source Category Estimate/Total Estimate

Therefore, key source categories are those which, when summed in descending order of magnitude, add up to over 95% of the total emission.
As far as the trend assessment is concerned, the contribution of each source category's trend can be assessed by the following equation:

Source Category Trend Assessment = Source Category Level Assessment · |(Source Category Trend – Total Trend)|

where the source category trend is the change in the source category emissions over time, computed by subtracting the base year estimate for a generic source category from the current year estimate and dividing by the current 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.
As differences in trend are more significant to the overall inventory level for larger source categories, the results of the trend difference is multiplied by the results of the level assessment to provide appropriate weighting.
Thus, key source categories will be those where the source category trend diverges significantly from the total trend, weighted by the emission level of the source category.
Both level and trend assessment have been carried out for the Italian GHG inventory.
The results of the Tier 1 method are reported in Table A1.1.
As regards the trend assessment, as already mentioned, the equation reported above does not enable quantification in case the emission estimates for the current year are equal to zero. In this case, since it is important to investigate into the trend and the transparency of the estimate, the results of the level assessment or other qualitative criteria can be taken into account. In the Italian inventory this occurs only for SF_6 from the production of SF_6.

Table A1.1 Results of the key sources analysis (Tier1)

TIER 1

CATEGORIES	2003 Gg CO2eq	Level assessment	Cumulative Percentage	CATEGORIES	% Contribution to trend	Cumulative Percentage
CO2 stationary combustion gaseous fuels	143,888	0.25	0.25	CO2 stationary combustion gaseous fuels	0.35	0.35
CO2 stationary combustion liquid fuels	124,462	0.22	0.47	CO2 stationary combustion liquid fuels	0.33	0.68
CO2 Mobile combustion: Road Vehicles	116,346	0.20	0.68	CO2 Mobile combustion: Road Vehicles	0.09	0.77
CO2 stationary combustion solid fuels	61,629	0.11	0.78	HFC, PFC substitutes for ODS	0.03	0.79
CO2 Cement production	17,322	0.03	0.81	CO2 stationary combustion solid fuels	0.02	0.82
CH4 Enteric Fermentation in Domestic Livestock	10,933	0.02	0.83	CH4 Enteric Fermentation in Domestic Livestock	0.02	0.84
CH4 from Solid waste Disposal Sites	9,690	0.02	0.85	CH4 Fugitive emissions from Oil and Gas Operations	0.02	0.85
Direct N2O Agricultural Soils	8,771	0.02	0.87	N2O Mobile combustion: Road Vehicles	0.01	0.87
Indirect N2O from Nitrogen used in agriculture	7,991	0.01	0.88	CH4 from Solid waste Disposal Sites	0.01	0.88
N2O stationary combustion	7,025	0.01	0.89	N2O Nitric Acid	0.01	0.89
N2O Adipic Acid	6,417	0.01	0.90	CO2 Other industrial processes	0.01	0.91
CO2 Mobile combustion: Waterborne Navigation	6,148	0.01	0.91	Direct N2O Agricultural Soils	0.01	0.92
CH4 Fugitive emissions from Oil and Gas Operations	4,993	0.01	0.92	N2O Adipic Acid	0.01	0.93
HFC, PFC substitutes for ODS	4,544	0.01	0.93	CO2 Mobile combustion: Aircraft	0.01	0.93
N2O Manure Management	3,972	0.01	0.94	CO2 Fugitive emissions from Oil and Gas Operations	0.01	0.94
CH4 Manure Management	3,821	0.01	0.94	Indirect N2O from Nitrogen used in agriculture	0.01	0.94
N2O Mobile combustion: Road Vehicles	3,670	0.01	0.95	CO2 Mobile combustion: Other	0.00	0.95
CO2 Limestone and Dolomite Use	3,803	0.01	0.96	CH4 Manure Management	0.00	0.95
CO2 Mobile combustion: Aircraft	2,771	0.00	0.96	CO2 Cement production	0.00	0.96
CO2 Fugitive emissions from Oil and Gas Operations	2,499	0.00	0.97	CO2 Emissions from solvent use	0.00	0.96
CO2 Other industrial processes	2,435	0.00	0.97	CO2 Limestone and Dolomite Use	0.00	0.97
CO2 Lime production	2,092	0.00	0.97	N2O stationary combustion	0.00	0.97
N2O from animal production	1,882	0.00	0.98	HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.00	0.97
CH4 from Rice production	1,562	0.00	0.98	N2O from animal production	0.00	0.98
CH4 Emissions from Wastewater Handling	1,432	0.00	0.98	CO2 Emissions from Waste Incineration	0.00	0.98
CO2 Mobile combustion: Other	1,410	0.00	0.98	N2O Manure Management	0.00	0.98
CO2 Iron and Steel production	1,384	0.00	0.99	CH4 Mobile combustion: Road Vehicles	0.00	0.98
CO2 Emissions from solvent use	1,324	0.00	0.99	SF6 Electrical Equipment	0.00	0.98
CH4 stationary combustion	1,096	0.00	0.99	CH4 stationary combustion	0.00	0.98
N2O Emissions from Wastewater Handling	1,062	0.00	0.99	PFC, HFC, SF6 Semiconductor manufacturing	0.00	0.99
N2O Emissions from solvent use	857	0.00	0.99	CO2 Lime production	0.00	0.99
N2O Nitric Acid	844	0.00	1.00	CH4 from Rice production	0.00	0.99
CH4 Mobile combustion: Road Vehicles	579	0.00	1.00	SF6 Magnesium production	0.00	0.99
SF6 Electrical Equipment	290	0.00	1.00	SF6 Production of SF6	0.00	0.99
PFC, HFC, SF6 Semiconductor manufacturing	286	0.00	1.00	CO2 Iron and Steel production	0.00	0.99
PFC Aluminium production	277	0.00	1.00	PFC Aluminium production	0.00	1.00
CH4 Emissions from Waste Incineration	261	0.00	1.00	N2O Emissions from Wastewater Handling	0.00	1.00
CO2 Emissions from Waste Incineration	168	0.00	1.00	CO2 Mobile combustion: Waterborne Navigation	0.00	1.00
SF6 Magnesium production	136	0.00	1.00	CH4 Emissions from Other Sources (forest fires)	0.00	1.00
N2O Emissions from Waste Incineration	113	0.00	1.00	CH4 Emissions from Waste Incineration	0.00	1.00
CH4 Fugitive emissions from Coal Mining and Handling	95	0.00	1.00	N2O Mobile combustion: Other	0.00	1.00
N2O Mobile combustion: Other	73	0.00	1.00	CH4 Emissions from Wastewater Handling	0.00	1.00
CH4 Emissions from Other Sources (forest fires)	65	0.00	1.00	CH4 Industrial Processes	0.00	1.00
CH4 Industrial Processes	58	0.00	1.00	CH4 Fugitive emissions from Coal Mining and Handling	0.00	1.00
N2O Mobile combustion: Waterborne Navigation	45	0.00	1.00	N2O Emissions from solvent use	0.00	1.00
CH4 Mobile combustion: Waterborne Navigation	33	0.00	1.00	N2O Emissions from Waste Incineration	0.00	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	23	0.00	1.00	N2O Emissions from Other Sources (forest fires)	0.00	1.00
N2O Mobile combustion: Aircraft	20	0.00	1.00	N2O Mobile combustion: Aircraft	0.00	1.00
CH4 Agricultural Residue Burning	11	0.00	1.00	CH4 Emissions from Other Waste	0.00	1.00
N2O Emissions from Other Sources (forest fires)	7	0.00	1.00	CH4 Agricultural Residue Burning	0.00	1.00
CH4 Emissions from Other Waste	4	0.00	1.00	CH4 Mobile combustion: Other	0.00	1.00
N2O Agricultural Residue Burning	4	0.00	1.00	N2O Agricultural Residue Burning	0.00	1.00
CH4 Mobile combustion: Other	3	0.00	1.00	CH4 Mobile combustion: Aircraft	0.00	1.00
CH4 Mobile combustion: Aircraft	2	0.00	1.00	N2O Mobile combustion: Waterborne Navigation	0.00	1.00
SF6 Production of SF6	0	0.00	1.00	CH4 Mobile combustion: Waterborne Navigation	0.00	1.00
N2O from Other agricultural soils (wetlands, waters)	0	0.00	1.00	SF6 Other sources of SF6	0.00	1.00
SF6 Other sources of SF6	0	0.00	1.00	CH4 Savanna Burning	0.00	1.00
N2O Savanna Burning	0	0.00	1.00	N2O Savanna Burning	0.00	1.00
CH4 Savanna Burning	0	0.00	1.00	CH4 from Other agriculture	0.00	1.00
CH4 from Other agriculture	0	0.00	1.00	N2O from Other agricultural soils (wetlands, waters)	0.00	1.00

The application of the Tier 1 gives as a result 17 key sources accounting for the 95% of the total levels uncertainty; when applying the trend analysis the key sources increased to 18 with some differences with respect to the previous list.

A1.3 Uncertainty assessment (IPCC Tier 1)

The Tier 2 method for the identification of key sources implies the assessment of the uncertainty analysis to an emission inventory.
As already mentioned, the IPCC Tier 1 has been applied to the Italian GHG inventory to estimate uncertainties in national greenhouse gas inventories.
The results of the approach are reported in Table A1.2. For the LULUCF sector, emission uncertainties have also been calculated but not included in the national total uncertainty of the inventory. Details on the Tier 1 method used for LULUCF are described in the relevant chapter, chapter 7, the results by category are reported in Table A1.3.

Table A1.2 Results of the uncertainty analysis (Tier1)

Tier 1 Uncertainty calculation and reporting

IPCC Source category	Gas	Base year emissions 1990/1995	Year t emissions 2003	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend, in national emissions introduced by emission factor uncertainty	Uncertainty in trend, in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend, in total national emissions
CO2 stationary combustion: liquid fuels	CO2	153,898	124,482	3%	3%	0.042	0.038	-0.091	0.244	-0.003	0.010	0.011
CO2 stationary combustion: solid fuels	CO2	59,021	61,829	3%	3%	0.042	0.035	-0.086	0.121	0.000	0.005	0.005
CO2 stationary combustion: gaseous fuels	CO2	85,865	143,988	3%	3%	0.042	0.011	0.086	0.282	0.003	0.012	0.012
CH4 stationary combustion	CH4	718	1,896	3%	50%	0.501	0.001	0.000	0.002	0.000	0.000	0.000
N2O stationary combustion	N2O	6,740	7,825	3%	50%	0.501	0.006	-0.001	0.014	0.000	0.001	0.001
CO2 Mobile combustion: Road Vehicles	CO2	93,895	115,248	3%	3%	0.042	0.009	0.022	0.228	0.001	0.010	0.010
CH4 Mobile combustion: Road Vehicles	CH4	747	579	3%	50%	0.104	0.000	0.000	0.001	0.000	0.000	0.000
N2O Mobile combustion: Road Vehicles	N2O	1,912	3,570	3%	50%	0.501	0.003	0.004	0.007	0.002	0.000	0.002
CO2 Mobile combustion: Maritime Navigation	CO2	5,419	5,140	3%	3%	0.042	0.000	0.000	0.010	0.000	0.001	0.001
CH4 Mobile combustion: Maritime Navigation	CH4	29	23	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Maritime Navigation	N2O	39	46	3%	100%	1.808	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion: Aircraft	CO2	1,586	2,711	3%	3%	0.042	0.000	0.002	0.005	0.000	0.000	0.000
CH4 Mobile combustion: Aircraft	CH4	1	2	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Aircraft	N2O	12	26	3%	100%	1.808	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion: Other	CO2	1,880	1,410	3%	5%	0.058	0.000	-0.001	0.003	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	72	3%	100%	1.808	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Fugitive emissions from Coal Mining and Handling	CH4	122	85	3%	300%	3.808	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Fugitive emissions from Oil and Gas Operations	CO2	3,849	2,499	3%	25%	0.252	0.001	-0.002	0.005	0.000	0.000	0.000
CH4 Fugitive emissions from Oil and Gas Operations	CH4	6,831	4,993	3%	25%	0.252	0.002	-0.005	0.010	-0.001	0.000	0.001
CO2 Cement production	CO2	16,884	11,222	3%	10%	0.104	0.003	-0.001	0.024	0.000	0.001	0.001
CO2 Lime production	CO2	1,711	2,892	3%	10%	0.104	0.001	0.000	0.006	0.000	0.000	0.000
CO2 Limestone and Dolomite Use	CO2	3,481	3,303	3%	10%	0.104	0.001	-0.001	0.006	0.000	0.000	0.000
CO2 Soda Ash Use	CO2	1,349	1,384	3%	10%	0.104	0.000	0.000	0.003	0.000	0.000	0.000
CO2 Other industrial processes	CO2	3,843	2,435	3%	10%	0.104	0.000	-0.003	0.005	0.000	0.000	0.000
N2O Adipic Acid	N2O	4,578	6,417	3%	10%	0.104	0.001	0.003	0.013	0.000	0.001	0.001
N2O Nitric Acid	N2O	2,188	644	3%	10%	0.104	0.000	-0.003	0.001	0.000	0.000	0.000
CH4 Industrial Processes	CH4	108	58	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
PFC Aluminium production	PFC	143	277	5%	10%	0.112	0.000	0.000	0.001	0.000	0.000	0.000
SF6 Magnesium production	SF6	0	136	5%	5%	0.071	0.000	0.000	0.000	0.000	0.000	0.000
SF6 Electrical Equipment	SF6	462	288	5%	10%	0.112	0.000	0.000	0.001	0.000	0.000	0.000
SF6 Other sources of SF6	SF6	0	0			0.000	0.000	0.000	0.000	0.000	0.000	0.000
SF6 Production of SF6	SF6	128	0	5%	10%	0.112	0.000	0.000	0.000	0.000	0.000	0.000
PFC, HFC, SF6 Semiconductor manufacturing	PFC-HFC	50	286	30%	50%	0.583	0.000	0.000	0.001	0.000	0.000	0.000
HFC, PFC substitutes for ODS	HFC	308	4,544	30%	50%	0.583	0.015	0.033	0.009	0.004	0.004	0.005
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	HFC	441	23	5%	10%	0.112	0.000	-0.001	0.000	0.000	0.000	0.000
CH4 Enteric Fermentation in Domestic Livestock	CH4	12,241	10,873	20%	20%	0.283	0.005	-0.005	0.021	-0.001	0.005	0.005
CH4 Manure Management	CH4	4,826	3,823	20%	100%	1.828	0.007	-0.001	0.007	-0.001	0.002	0.002
N2O Manure Management	N2O	3,829	3,972	20%	100%	1.828	0.007	-0.001	0.008	-0.001	0.002	0.002
CH4 Savanna Burning	CH4	0	0			0.000	0.000	0.000	0.000	0.000	0.000	0.000
N2O Savanna Burning	N2O	0	0			0.000	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Agricultural Residues Burning	CH4	13	11	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
N2O Agricultural Residues 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	9,122	9,711	20%	100%	1.828	0.018	0.003	0.011	0.003	0.005	0.005
Indirect N2O from Nitrogen used in agriculture	N2O	1,878	1,999	20%	100%	1.828	0.014	0.002	0.015	0.002	0.004	0.005
CH4 from Rice production	CH4	1,539	1,592	3%	40%	0.401	0.001	0.000	0.003	0.000	0.000	0.000
CH4 from Other agriculture	CH4	0	0			0.000	0.000	0.000	0.000	0.000	0.000	0.000
N2O from animal production	N2O	1,887	1,892	20%	100%	1.828	0.003	-0.001	0.003	-0.001	0.001	0.001
N2O from Other agricultural soils (pasture, wastes)	N2O	0	0			0.000	0.000	0.000	0.000	0.000	0.000	0.000
CH4 from Solid waste Disposal sites	CH4	10,248	9,890	20%	30%	0.361	0.006	-0.004	0.019	-0.001	0.005	0.005
CH4 Emissions from Wastewater Handling	CH4	1,340	1,432	100%	30%	1.044	0.003	0.000	0.003	0.000	0.004	0.004
N2O Emissions from Wastewater Handling	N2O	1,841	1,892	30%	30%	0.424	0.001	0.000	0.002	0.000	0.001	0.001
CO2 Emissions from Waste Incineration	CO2	402	188	5%	25%	0.255	0.000	-0.001	0.000	0.000	0.000	0.000
CH4 Emissions from Waste Incineration	CH4	151	281	5%	20%	0.206	0.000	0.000	0.001	0.000	0.000	0.000
N2O Emissions from Waste Incineration	N2O	98	110	5%	100%	1.801	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Emissions from Other Waste	CH4	0	4	10%	100%	1.805	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Emissions from solvent use	CO2	1,747	1,324	30%	50%	0.583	0.001	-0.001	0.003	-0.001	0.001	0.001
N2O Emissions from solvent use	N2O	798	697	50%	10%	0.510	0.001	0.000	0.002	0.000	0.001	0.001
N2O Emissions from Other Sources (please list)	N2O	15	7	50%	50%	0.707	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Emissions from Other Sources (please list)	CH4	182	85	50%	50%	0.707	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL		518,485	561,629				0.832					0.824

Table A1.3 Results of the uncertainty analysis for the LULUCF sector (Tier1)

Tier 1 Uncertainty calculation and reporting

IPCC	Gas	Base year emissions	Year t emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in the year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into trend in total national emissions
Source category		1990	2003									
		Gg CO_2 eq	Gg CO_2 eq	%	%	%	%	%	%	%	%	%
A. Forest Land	CO_2	-58,286	-80,044	--	--	63%	62%	3%	131%	1%	58%	58%
B. Cropland	CO_2	-20,236	-19,724	75%	75%	106%	26%	-12%	32%	-9%	34%	36%
- *living biomass*	CO_2	*-3,868*	*-5,718*	*75%*	*75%*	*106%*	7%	1%	9%	1%	10%	10%
- *soils*	CO_2	*-32,432*	*-38,281*	*75%*	*75%*	*106%*	50%	-9%	63%	-7%	67%	67%
C. Grassland	CO_2	16,173	16,995	75%	75%	106%	21%	9%	27%	7%	29%	29%
- *living biomass*	CO_2	*-21,650*	*-20,897*	*75%*	*75%*	*106%*	27%	-12%	34%	-9%	36%	38%
- *soils*	CO_2	*814*	*1,173*	*75%*	*75%*	*106%*	2%	0%	2%	0%	2%	2%
E. Settlements	CO_2	1,465	1,473	75%	75%	106%	2%	1%	2%	1%	9%	3%
TOTAL		**-60,884**	**-81,900**				**71%**					**72%**

[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

Emission sources of the Italian inventory are disaggregated into a detailed level, 60 sources, according to the IPCC list in the Good Practice Guidance, which has been slightly revised taking into account national circumstances and importance. Uncertainties are therefore estimated for these categories. To estimate the uncertainty for both activity data and emission factors, information provided in the IPCC Good Practice Guidance as well as expert judgement has been used; standard deviations have also been considered whenever measurements were available.

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 used. 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 (IPCC, 2000) are used when the emission factor is a default value, low values are attributed to measured data whereas the uncertainty values are high in all other cases. Details of the figures can be found in Table A1.2.

The Tier 1 approach suggests an uncertainty of 3.2% in the combined GWP total emissions in 2003. The analysis also estimates an uncertainty of 2.4% in the trend between 1990 and 2003.

For the LUCF sector, the uncertainty value resulting from the Tier 1 approach is 71% in the combined GWP total emissions for the year 2003, whereas the uncertainty in the trend is 72%. Details of the figures are shown in Table A1.3.

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 Tier 2 key source assessment

The Tier 2 method can be used to identify key source categories when an uncertainty analysis has been carried out on the inventory. It is helpful in prioritising activities to improve inventory quality and reduce overall uncertainty.
Under the Tier 2, the source category uncertainties are incorporated by weighting the Tier 1 level and trend assessment results with the source category's relative uncertainty.
Therefore the following equations:

Level Assessment, with Uncertainty = Tier 1 Level Assessment · Relative Source Uncertainty

Trend Assessment, with Uncertainty = Tier 1 Trend Assessment · Relative Source Uncertainty

The results of the key source Tier 2 analysis are provided in Table A1.3
The application of the Tier 2 gives as a result 21 key sources accounting for the 95% of the total levels uncertainty; when applying the trend analysis the key sources increased to 22 with differences with respect to the previous list.

Table A1.3 Results of the key sources analysis (Tier2)

TIER 2							
CATEGORIES	Level assessment with uncertainty	Relative level assessment with uncertainty	Cumulative Percentage	CATEGORIES	Trend assessment with uncertainty	Relative Trend assessment with uncertainty	Cumulative Percentage
Direct N2O Agricultural Soils	0.0157	0.13	0.13	CO2 stationary combustion gaseous fuels	0.01	0.14	0.14
Indirect N2O from Nitrogen used in agriculture	0.0143	0.11	0.24	CO2 stationary combustion liquid fuels	0.01	0.12	0.26
CO2 stationary combustion gaseous fuels	0.0107	0.09	0.32	CO2 Mobile combustion: Road Vehicles	0.01	0.11	0.37
CO2 stationary combustion liquid fuels	0.0093	0.07	0.40	CH4 Enteric Fermentation in Domestic Livestock	0.01	0.07	0.44
CO2 Mobile combustion: Road Vehicles	0.0087	0.07	0.47	Direct N2O Agricultural Soils	0.01	0.06	0.50
N2O Manure Management	0.0071	0.06	0.52	HFC, PFC substitutes for ODS	0.01	0.06	0.56
CH4 Manure Management	0.0068	0.05	0.58	CH4 Unmanaged Solid waste Disposal Sites	0.01	0.06	0.62
N2O stationary combustion	0.0062	0.05	0.63	CO2 stationary combustion solid fuels	0.01	0.06	0.68
CH4 from Solid waste Disposal Sites	0.0061	0.05	0.68	Indirect N2O from Nitrogen used in agriculture	0.00	0.05	0.73
CH4 Enteric Fermentation in Domestic Livestock	0.0054	0.04	0.72	CH4 Emissions from Wastewater Handling	0.00	0.04	0.78
HFC, PFC substitutes for ODS	0.0045	0.04	0.76	CH4 Manure Management	0.00	0.03	0.80
CO2 stationary combustion solid fuels	0.0046	0.04	0.79	N2O Manure Management	0.00	0.03	0.83
N2O Mobile combustion: Road Vehicles	0.0032	0.03	0.82	N2O Mobile combustion: Road Vehicles	0.00	0.02	0.85
CO2 Cement production	0.0032	0.03	0.84	CO2 Cement production	0.00	0.02	0.87
N2O from Animal production	0.0030	0.02	0.87	CO2 Emissions from cement use	0.00	0.01	0.88
CH4 Emissions from Wastewater Handling	0.0026	0.02	0.89	CH4 Fugitive emissions from Oil and Gas Operations	0.00	0.01	0.90
CH4 Fugitive emissions from Oil and Gas Operations	0.0022	0.02	0.91	N2O from Animal production	0.00	0.01	0.91
CO2 Emissions from cement use	0.0014	0.01	0.92	N2O Emissions from product use	0.00	0.01	0.92
N2O Adipic Acid	0.0012	0.01	0.93	N2O Emissions from Wastewater Handling	0.00	0.01	0.93
CO2 Fugitive emissions from Oil and Gas Operations	0.0011	0.01	0.94	N2O stationary combustion	0.00	0.01	0.94
CH4 from Rice production	0.0011	0.01	0.94	N2O Adipic Acid	0.00	0.01	0.95
CH4 stationary combustion	0.0010	0.01	0.95	CO2 Mobile combustion: Waterborne Navigation	0.00	0.01	0.95
N2O Emissions from Wastewater Handling	0.0008	0.01	0.96	CO2 Fugitive emissions from Oil and Gas Operations	0.00	0.01	0.96
N2O Emissions from product use	0.0008	0.01	0.96	CO2 Other industrial processes	0.00	0.00	0.96
CO2 Limestone and Dolomite Use	0.0006	0.00	0.97	N2O Nitric Acid	0.00	0.00	0.97
CH4 Fugitive emissions from Coal Mining and Handling	0.0005	0.00	0.97	PFC, HFC, SF6 Semiconductor manufacturing	0.00	0.00	0.97
CO2 Mobile combustion: Waterborne Navigation	0.0005	0.00	0.98	CO2 Limestone and Dolomite Use	0.00	0.00	0.97
CO2 Other industrial processes	0.0004	0.00	0.98	CH4 stationary combustion	0.00	0.00	0.98
CO2 Lime production	0.0004	0.00	0.98	CH4 Fugitive emissions from Coal Mining and Handling	0.00	0.00	0.98
PFC, HFC, SF6 Semiconductor manufacturing	0.0003	0.00	0.99	CO2 Mobile combustion: Aircraft	0.00	0.00	0.98
CO2 Iron and Steel production	0.0003	0.00	0.99	CO2 Emissions from Waste Incineration	0.00	0.00	0.98
CO2 Mobile combustion: Aircraft	0.0002	0.00	0.99	CH4 Human Non production	0.00	0.00	0.99
N2O Emissions from Waste Incineration	0.0002	0.00	0.99	CO2 Lime production	0.00	0.00	0.99
CO2 Mobile combustion: Other	0.0001	0.00	0.99	N2O Mobile combustion: Other	0.00	0.00	0.99
N2O Mobile combustion: Other	0.0001	0.00	0.99	CO2 Mobile combustion: Other	0.00	0.00	0.99
N2O Nitric Acid	0.0001	0.00	0.99	CH4 Emissions from Other Sources (forest fires)	0.00	0.00	0.99
CH4 Mobile combustion: Road Vehicles	0.0001	0.00	1.00	CO2 Iron and Steel production	0.00	0.00	0.99
CH4 Emissions from Waste Incineration	0.0001	0.00	1.00	HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.00	0.00	1.00
CH4 Emissions from Other Sources (forest fires)	0.0001	0.00	1.00	CH4 Mobile combustion: Road Vehicles	0.00	0.00	1.00
N2O Mobile combustion: Waterborne Navigation	0.0001	0.00	1.00	SF6 Electrical Equipment	0.00	0.00	1.00
CO2 Emissions from Waste Incineration	0.0001	0.00	1.00	CH4 Industrial Processes	0.00	0.00	1.00
SF6 Electrical Equipment	0.0001	0.00	1.00	CH4 Emissions from Waste Incineration	0.00	0.00	1.00
PFC Aluminium production	0.0001	0.00	1.00	PFC Aluminium production	0.00	0.00	1.00
CH4 Industrial Processes	0.0001	0.00	1.00	N2O Emissions from Waste Incineration	0.00	0.00	1.00
N2O Mobile combustion: Aircraft	0.0000	0.00	1.00	SF6 Production of SF6	0.00	0.00	1.00
CH4 Mobile combustion: Waterborne Navigation	0.0000	0.00	1.00	SF6 Magnesium production	0.00	0.00	1.00
SF6 Magnesium production	0.0000	0.00	1.00	CH4 Agricultural Residue Burning	0.00	0.00	1.00
CH4 Agricultural Residue Burning	0.0000	0.00	1.00	N2O Mobile combustion: Aircraft	0.00	0.00	1.00
N2O Emissions from Other Sources (forest fires)	0.0000	0.00	1.00	N2O Emissions from Other Sources (forest fires)	0.00	0.00	1.00
CH4 Emissions from Other Waste	0.0000	0.00	1.00	CH4 Emissions from Other Waste	0.00	0.00	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.0000	0.00	1.00	N2O Agricultural Residue Burning	0.00	0.00	1.00
N2O Agricultural Residue Burning	0.0000	0.00	1.00	N2O Mobile combustion: Waterborne Navigation	0.00	0.00	1.00
CH4 Mobile combustion: Other	0.0000	0.00	1.00	CH4 Mobile combustion: Waterborne Navigation	0.00	0.00	1.00
CH4 Mobile combustion: Aircraft	0.0000	0.00	1.00	CH4 Mobile combustion: Other	0.00	0.00	1.00
SF6 Production of SF6	0.0000	0.00	1.00	CH4 Mobile combustion: Aircraft	0.00	0.00	1.00
SF6 Other sources of SF6	0.0000	0.00	1.00	SF6 Other sources of SF6	0.00	0.00	1.00
CH4 Savanna Burning	0.0000	0.00	1.00	CH4 Savanna Burning	0.00	0.00	1.00
N2O Savanna Burning	0.0000	0.00	1.00	N2O Savanna Burning	0.00	0.00	1.00
CH4 from Other agriculture	0.0000	0.00	1.00	CH4 from Other agriculture	0.00	0.00	1.00
N2O from Other agricultural soils (wetlands, waters)	0.0000	0.00	1.00	N2O from Other agricultural soils (wetlands, waters)	0.00	0.00	1.00

ANNEX 2: DETAILED TABLES OF ENERGY CONSUMPTION FOR POWER GENERATION

In the following tables the detailed breakdown of total fuels consumed for electricity generation in the years 1990, 1995, 2000-2003 is reported. For each year data from three different sources are reported:

– output of the model used to estimate consumption and emissions for each plant type;

– detailed report by GRTN;

– data available in BEN.

For each source three kind of data are presented: electricity produced, physical quantities of consumed fuels and amount of energy used.

As one can notice from the following tables, there are not negligible differences in total consumption figures between GRTN and BEN. Both data sets are supposed to be based on the same data. As already said in paragraph 3.4, differences may be partially explained by the process of adapting GRTN data to BEN methodology. BEN considers for each fuel always the same heat value, adjusting the physical quantities accordingly. This calculation process combined with the reduction of fuel types from 17 to 12 add rounding errors and this may be responsible for the small difference between the energy consumption value in most of the years (between 0.0% and 0.9%, refer to last row of each table, last value).

Differences between those two data sets and the model output are also present, they can be improved (i.e. reduced) and depend on the modeller choice: a compromise between GRTN and the BEN data according to cross check done with other sources (UP or point source data).

There are also discrepancies in the estimates of the total electricity produced, refer to last row of each table, first value. They are rather small, between 0.1% and 0.8% and can be due to rounding errors. Not surprisingly the differences between the fuel quantities, when expressed in physical values are much bigger, range from 4 to 7%, with the year 2003 going up to an astonishing 17%.

In conclusion the main question of the accuracy of the underlining energy data of three key sources is connected to the unexplained discrepancy between BEN and GRTN in the estimates of electricity produced and of the energy content of the used fuels. The difference is small but it should occur because both data sets are derived from the same source. On the basis of this consideration, we decided to base the inventory on GRTN data that are expected to be more reliable. In particular because the EF used are based on the energy content of the fuel we have made an effort to reproduce with the model the GRTN energy consumption figure and ignored discrepancies in the electricity production or in the physical quantities of fuel used.

Table A2.1- Energy consumption for electricity production, year 1990

Fuels		Model Output			GRTN / ENEL			BEN		
		Gwe, gross	kt	TJ	Gwe, gross	kt	T.o.e./TJ	Gwe, gross	kt	kcal / TJ
Coal		32057	11213	2.966E+08	31007	10782	6812	32042	10782	68120
Lignite					1035	1501	264		1056	2640
tot		32057	11213	2.966E+08	32042	12283	2.961E+08	32042	11838	.961E+08
Coke oven gas		1183	689	1.226E+07	1177	693	296	1177	693	2960
Blast furnace gas		1930	6272	2.363E+07	1929	6804	524	1929	5822	5240
Oxi converter gas		432	682	2569860	446	509	106			
tot		3545	7643	3.846E+07	3552	8690	3.874E+07	3106	8690	3.431E+07
tot coal				3.350E+08			3.348E+08			3.304E+08
Light distillates				26	5	4		26	5	4
Diesel		1189	332	13813267	1025	303	302	1026	303	3020
Fuel oil	atz	99383	21765	8.881E+08	99682	21798	21210	99681	21798	212100
	btz							0	0	0
Refinery gas		1765	363	14889594	1149	211	250	1149	211	2500
Petroleum coke		875	139	5721952	836	186	139	836	186	1390
Oriemulsion		0	0	0						
tot		103212	22599	9.226E+08	102718	19352	9.165E+08	102717	22503	9.165E+08
Gas from chemical processes					627	444	97			
Heavy residuals/ tar				6	2	2				
Recovered heat from pirite				163	146	36				
Others		415	89	1319174	192	344	39			
tot		415	89	1.319E+06	988	5153	7.280E+06		0	0.000E+00
oil+residues		103627	22689	9.239E+08	103706	24505	9.238E+08	102717	22503	9.165E+08
Natural gas		39080	9728	3.386E+08	39082	9731	3.383E+08	39083	9731	3.383E+08
Bio - gas		11								
totals		178419	51272	1.597E+09	178382	55209	1.597E+09	176948	52762	1.585E+09
BEN/ GRTN differences								0.8%	4.6%	0.7%

Table A2.2 - Energy consumption for electricity production, year 1995

Fuels		Model Output -			GRTN / ENEL -			BEN -		-
		Gwe, gross	kt	TJ	Gwe, gross	kt	T.o.e./TJ	Gwe, gross	kt	kcal / TJ
Coal		24164	8537	224733553	23970	8216	5245	23970	8216	52450
Lignite					152	380	43	152	172	430
tot		24164	8537	2.247E+08	24122	8596	2.212E+08	24122	8388	2.212E+08
			mc			mc				
Coke oven gas		996	523	9297651	985	540	231	985	540	2310
Blast furnace gas		1998	6425	24211400	1921	6428	496	1921	5511	4960
Oxi converter gas		420	649	2447086	537	633	132			
tot		3414	7597	3.596E+07	3443	7601	3.594E+07	2906	8690	3.042E+07
tot coal							2.572E+08			2.517E+08
Light distillates					48	6	6	48	6	60
Diesel		797	211	8.84E+06	697	184	184	697	184	1840
Fuel oil	atz	116855	25261	1.03E+09	117022	25355	24619	117022	25355	246190
	btz									
Refinery gas		2253	298	1.43E+07	2261	378	407	2260	378	4070
Petroleum coke		780	189	5.94E+06	755	189	156	755	189	1560
Oriemulsion		0	0	0.00E+00	0		0			
tot		120686	25958	1.060E+09	120783	26112	1.062E+09	120781	26112	1.062E+09
Gas from chemical proc.					556	803	89			
Heavy residuals/ tar						0				
Recovered heat from pirite					3	3	1			
Others		826	375	6454448	405	697	94			
tot		826	375	6.454E+06	964	1503	7.699E+06			
oil+residues		121511	26333	1.066E+09	121747	27615	1.069E+09	120781	26112	1.062E+09
Natural gas		46433	11304	3.923E+08	46442	11277	3.923E+08	46442	11277	3.923E+08
Biogas		65								
Municipal waste / Biomass		331								
total		195919	53771	1.719E+09	195754	55089	1.719E+09	194252	54467	1.705E+09
BEN/ GRTN differences								0.8%	1.1%	0.78%

Table A2.3 - Energy consumption for electricity production, year 2000

Fuels		Model Output			GRTN / ENEL			BEN		
		Gwe, gross	kt	TJ	Gwe, gross	kt	T.o.e./TJ	Gwe, gross	kt	kcal / TJ
Coal		26271	9538	2.533E+08	26272	9633	6052	26273	9259	60509
									1	9
tot		26271	9538	2.533E+08	26272	9633	2.532E+08	26273	9260	2.532E+08
Coke oven gas				1.200E+07				1422	660	2807
Blast furnace gas				2.534E+07				2601	7064	6358
Oxi converter gas				3.122E+06				229		1.984E+06
tot		4253	8601	4.047E+07	4252	8690	4.050E+07	4252	8690	4.033E+07
tot coal							2.937E+08			2.935E+08
Light distillates				1.880E+06				162	21	223
Diesel				1.674E+07				3745	762	7772
Fuel oil	atz			6.418E+08				31437	7084	69418
	btz							47157	10625	104127
Refinery gas			2.925E+07					5905	870	10444
Petroleum coke			9.520E+06					1067	274	2276
Oriemulsion				7.015E+07						
tot		83081	19689	7.693E+08	85878	19352	7.868E+08	89473	19637	8.128E+08
Gas from chemical processes			3.346E+06					38		3.100E+06
Heavy residuals/ tar			5.418E+07							
Others				3.619E+06						
tot		6549	6962	6.114E+07	3753.8	5153	4.577E+07	38	0	3.100E+06
oil+residues		89630	26651	8.305E+08	89632	24505	8.325E+08	89511	19637	8.159E+08
Natural gas		97605	22541	7.882E+08	97607	22334	7.877E+08	97609	22819	7.877E+08
Biogas		563			566.1					
Municipal waste / Biomass		1344			1340.1			1905	1723	
total		219667	67331	1.912E+09	219669	65162	1.914E+09	219551	60406	1.897E+09
BEN/ GRTN differences								0.05%	7.9%	0.89%

Table A2.4 - Energy consumption for electricity production, year 2001

Fuels		Model Output			GRTN / ENEL			BEN		
		Gwe, gross	kt	TJ	Gwe, gross	kt	T.o.e./TJ	Gwe, gross	kt	kcal / TJ
Coal		31746	11232	2.983E+08	31727.4	11444	7127	31730	11219	71272
Lignite					2.6	2	1.0E+00		1	8
tot		31746	11232	2.983E+08	31730	11446	2.982E+08	31730	11220	2.982E+08
Coke oven gas				1.181E+07				1427	659	2805
Blast furnace gas				2.962E+07				3288	7878	7092
Oxi converter gas				2.974E+06				330		2.851E+06
tot		5043	9853	4.440E+07	5045.6	9786	4.439E+07	5045	8537	4.426E+07
tot coal				3.427E+08			3.426E+08			3.425E+08
Light distillates				1.251E+06				148	19	198
Diesel				1.909E+07				2227	446	4559
Fuel oil	atz			5.744E+08				38037	8159	81683
	btz							37673	8411	82428
Refinery gas			1.731E+07						2419	344
Petroleum coke			9.749E+06						1126	281
Oriemulsion				6.067E+07						
tot		74999	17457	6.825E+08	75009	17185	6.824E+08	81629	17660	7.336E+08
Gas from chemical proc.			5.945E+06					443		
Heavy residuals/ tar			4.775E+07							
Others				3.454E+06						
tot		8284	6888	5.715E+07	8280	6719	5.711E+07	443		6.084E+06
oil+residues		83283	24345	7.396E+08	83289	23904	7.395E+08	82072	17660	7.397E+08
Natural gas		95902	21725	7.578E+08	95906	21929	7.640E+08	95901	21869	7.640E+08
Biogas		681			684.4		6.987E+06			
Municipal waste / Biomass		1908			1902.9		2.07E+07	2587		2.77E+07
total		218563	67156	1.840E+09	218557	67065	1.846E+09	217336	59287	1.846E+09
BEN/ GRTN differences								0.6%	13.1%	0.0%

Table A2.5 - Energy consumption for electricity production, year 2002

Fuels		Model Output			GRTN / ENEL			BEN		
		Gwe, gross	kt	TJ	Gwe, gross	kt	T.o.e./TJ	Gwe, gross	kt	kcal / TJ
Coal		35480	12852	3.413E+08	35446.9	13088	8163	35449	12855	81629
									0	0
tot		35480	12852	3.413E+08	35447	13088	3.415E+08	35449	12855	3.415E+08
Coke oven gas				1.172E+07				1384	646	2746
Blast furnace gas				3.073E+07				3341	8152	7337
Oxi converter gas				2.431E+06				276		2.456E+06
tot		5009	10115	4.488E+07	5021.1	10034	4.485E+07	5000	8690	4.464E+07
tot carbone							3.864E+08			3.862E+08
Light distillates				9.211E+05				170	21	218
Diesel				1.356E+07				1601	316	3223Fuel oil
atz			5.774E+08					32659	6839	67022
	btz							48169	10489	102792
Refinery gas			1.770E+07						2386	350
Petroleum coke				9.370E+06				1081	270	2241
Oriemulsion				7.565E+07						
tot		77000	17935	6.946E+08	76997	17693	6.955E+08	86066	10737	7.518E+08
Gas from chemical proc.			6.784E+06						699	
Heavy residuals/ tar				5.626E+07						
Others				1.725E+06						
tot		9996	7484	6.477E+07	9998	7548	6.477E+07	699	7548	8.708E+06
oil+residues	86996	25419	7.593E+08	86995	25241	7.603E+08		86765	18285	7.606E+08
Natural gas		99378	22349	7.798E+08	99414	22362	7.793E+08	99413	22577	7.793E+08
Biogas		942			943.1		9.791E+06			
Municipal waste/ biom		2479.5					3.31E+07	3387		4.29E+07
total		230291	70735	1.925E+09	230299	70725	1.926E+0			1.926E+09
BEN/ GRTN differences								0.1%	13.3%	0.0%

Table A2.6 - Energy consumption for electricity production, year 2003

Fuels		Model Output			GRTN / ENEL			BEN		
		Gwe, gross	kt	TJ	Gwe, gross	kt	T.o.e./TJ	Gwe, gross	kt	kcal / TJ
Coal		38802	14010	3.721E+08	38813.3	14252	8874	38816	12855	88740
									0	0
tot		38802	14010	3.721E+08	38813	14252	3.713E+08	38816	12855	3.713E+08
Coke oven gas				1.317E+07				1527	646	3098
Blast furnace gas				3.138E+07				3381	8152	7533
Oxi converter gas				3.434E+06				350		2.792E+06
tot		5303	10506	4.798E+07	5303.5	10478	4.799E+07	5258	8690	4.727E+07
tot carbone							4.193E+08			4.186E+08
Light distillates				9.386E+05				170	21	221
Diesel				1.810E+07				2052	316	4298
Fuel oil	atz			4.980E+08				20614	6839	36953
	btz							49080	10489	108751
Refinery gas			1.584E+07						2135	350
Petroleum coke				8.631E+06				1023	270	2070
Oriemulsion				5.257E+07						
tot		65787	15207	5.941E+08	65771	14992	5.952E+08	75074	10456	6.529E+08
Gas from chemical proc.			1286						505	
Heavy residuals/ tar				5.770E+07						
Others				1.779E+06						
tot		10173	7961	6.523E+07	10159.3	7829	6.527E+07	505	7829	8.376E+06
oil+residues		75960	23168	6.593E+08	75930	22821	6.604E+08	75579	18285	6.613E+08
Natural gas		117320	25624	8.939E+08	117301	25534	8.887E+08	117303	22577	8.887E+08
Biogas		1030			1032.9		1.067E+07			
Municipal waste / Biomass		3467			3460.1		5.04E+07	4492		6.11E+07
total		241881	73307	1.973E+09	241841	73085	1.968E+09	241449	62407	1.969E+09
BEN/ GRTN differences								0.2%	17.1%	0.0%

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 gasses are separately accounted for and reported in the electricity generation section.

An other specific national circumstance is the concentration of steel works in two sites, with integrated steel plants, coke ovens and electricity self-production. Limited quantities of steel are produced also in two additional locations. 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 EF 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 by BEN, with one exception, the methodology starts with a verification of the energy balance reported by BEN, see also Annex 5, table A5.3/.4, that seldom presents problems, and then apply the standard EFs to the energy carriers, trying to balance the carbon inputs with emissions. The exception mentioned refers to the recovered gasses of BOFs (Basic Oxygen Furnace) that are used to produce electricity but are not accounted for by BEN from year 1990 up to year 1999. From year 2000 those gasses are (partially) include in the estimate of blast furnace gas. The data used to estimate the emissions from 1990 to 1999 are reported by GRTN. The consideration of the BOF gasses do not change the following discussion, its contribution to the total emissions is quite limited.

Table A3.1 summarize the quantities of coal and coal by-products used by the energy system, all the data mentioned can be found in “enclosures 1/a, 2/a and 3/a” of BEN, see also Annex 5.

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 of 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 the 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.

If we now look at Table A3.2, in the first two boxes from top we found the same energy data of table

A3.1 valuated for their carbon content, according to the standard EF reported in Table 3.6 of the NIR. Then in the coloured cells we fund the balance of carbon inputs and outputs of two processes coke oven and blast furnaces. In this case there is no balance at all, and while the coke production process keep the balance within reasonable percentages, the blast furnaces shows an unbalance of more than 60%, it seems that it produces carbon. For the other years we found similar unbalances.
The rationale of the industrial process does not justify a similar increase in carbon emissions. There is usually no carbon in the iron ore used or in other additives used in the process, on the contrary a limited quantities of the input of carbon (max 2%) is stocked in the produced steel (not considered here) and small quantities are also contained in the solid slag produced by the process.
All those data are produced with the energy statistical data and standard EF, if we add to this the process EF considered by the CORINAIR methodology, based on the quantities of steel or iron produced, we should add other quantities of carbon emissions to the already unbalanced total just described.
If the physical quantities of the coal by products reported by BEN are correct, as shows the energy balance, then the EFs have to be verified. In the meantime APAT decided to report according to the following principle: total carbon emissions at a certain location cannot be higher than carbon inputs from the imported coals. A sort of "bubble" concept applied to carbon emissions at sectorial level.
Of the three main processes involved, coke ovens, blast furnaces and electricity production, the first and the latter appear to be balanced and/or are well monitored, so, pending further investigation of EF, the changes have to be made in the blast furnaces estimates.

Table A3.1 Energy balance, 2003, 10^9kcal

coke	coke gas	Blast furnace gas	NOTES
8,469			For blast furnace
0	3,098	7,533	For electricity prod.
26,915	223	155	For steel industries
364	0	0	For other industries use
161	0		For domestic use
35,909	3,321	7,688	Total consumption
444	270	155	Consumption for production of secondary fuels
0	18	18	Losses of transformation
36,353	3,608	7,861	Total consumption + losses and prod.
Energy balance coke ovens	Energy balance, blast furnace		
1,233	-608.0		Difference in energy consumption
4.2%	-7.7%		Unbalance in %
29,607			Coke oven output
6,919			Transformation losses, coke ovens
1,310			non energy use
37,836			sub total
			Coke input to coke ovens
37,836			Blast fornace coal input
7,806			import + stock change

So in the end the methodology actually foresees as a first step the calculation of the total carbon inputs (imported fuels plus standard IPCC EFs), see table A3.1 column "total according to BEN". A second step foresee 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, reference to column "total

used for CRF" in table A3.1 . 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 seems to be produced using very low EFs for coal produced CO_2, near to the natural gas EF, for the steel making process and quite high carbon emissions for the coal use 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.

Table A3.2 Carbon balance, 2003, Mt CO_2

coke	coke gas	Blast furnace gas + oxi gas	NOTES	Total according to BEN	Total used for CRF
4.525	1.965	10.950	Emission factor, t CO2 / tep		
3.83			From blast furnace (no direct emissions, transformed in coal gasses)		
0.00	0.54	8.25	From electricity prod.	8.79	10.66
12.18	0.18	0.17	From steel industries	12.53	11.45
0.16	0.00	0.00	From other industries use	0.16	0.16
0.07	0.00		From domestic use	0.07	0.07
16.25	0.72	8.42	Total emissions, final uses	25.39	22.34
0.18	0.19	0.17	Consumption for production of secondary fuels	0.54	0.0
0.00	0.02	0.02	Losses of transformation	0.04	0.0
16.43	0.93	8.61	Total consumption + losses and prod.	25.97	
Carbon balance, coke ovens	Carbon balance, blast furnace				
1.4		4.8	Difference in physical emissions		
12%		55%	Unbalance in %		
Emissions	EFs				
11.86	4.525		Carbon in produced coke		
2.77	4.004		Transformation losses		
0.421	4.004		non energy use	0.42	0.42
15.05			sub total		
15.15	4.004		Coal input to coke ovens		
3.48	4.004		Coal input to blast furnace		
4.13	4.525		Coke import + stock change		
22.76			Total carbon input	26.39	22.76

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 followed is that outlined in 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 Italian energy and emission factor data (ENEA, 2002 [a]), and these are described in the following. The BEN (MAP, 2005 [a]) reports the energy balances for all primary and secondary fuels, with data on imports, exports and production. Refer to Annex 5, Tables A5.1-A5.8, for an example of the year 2003 and to the web site of the Ministry of Production Activities for the whole time series https://dgerm.attivitaproduttive.gov.it/dgerm/

Starting from those data and using the emission factors reported in chapter 3, Table 3.7, it is possible to estimate the total carbon entering in the national energy system. With time 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 3.9 and directly subtracted to the emission balance by the CRF software. 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 next session.

With reference to table 1.A(b) of the CRF 2003, the main energy data source is the BEN. We make reference to the BEN tables reported in Annex 5. In particular the following data are available:
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 (MAP, 2005 [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 because it is

explicitly excluded by the IPCC methodology referring to petrochemical feedstock coming back to the refineries, subtracted from the non energy use estimate; therefore it cannot be considered as additional carbon inserted in the energy system;

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 EF estimate, see paragraph 3.9) are from foreign trade statistics or SNAM, the former national gas monopoly, fiscal budgets; natural gas data show not negligible variations from source to source, with particular reference to the underground stocked quantities;
8) from 1990 to 2003 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, 2005); but the same source quotes BEN biomass consumption estimates as official statistics up to the year 2003, pending further investigations; the inventory follows the same methodology.

The following additional information is needed to complete table 1.A(b) of CRF 2003 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, 2005), the former electricity monopoly, presently the only user of this fuel, in their environmental report. As long as the emission factors are quite different, a note is needed in the BEN, at least as a warning.
2) Motor oils and bitumen.
   a) Data on those materials are mixed up in the no energy use by BEN, detailed data are available in BPT (MAP, 2005 [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 9000 kcal/kg for bitumen and 9800 kcal/kg for motor oils. In the CRF those products are estimated with the OECD energy contend and this may explain part of the unbalance between imported oil and used products.

For further information please refer to 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

In principal the IPCC Reference total can be compared with the IPCC Table 1A total plus the fugitive emissions arising from fuel consumption reported in 1B1 Solid Fuel Transformation and

Table 2 Industrial Processes (Iron and Steel and Ammonia Production). Results show the IPCC Reference totals are between 0-4 % lower than the comparable 'bottom up' totals.
Differences between emissions estimated by the reference and sectoral approach are reported in the following Table A4.1.

Table A4.1 Reference and Sectoral approach CO_2 emission estimates 1990-2003 (Mt) and percentage differences

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Sectoral approach	399.1	399.4	397.9	395.7	389.5	417.0	411.5	415.2	425.1	432.5	438.6	442.6	442.5	456.8
Reference approach	396.3	393.3	398.5	391.3	385.0	406.2	404.4	407.0	416.1	415.9	422.5	430.1	436.9	452.8
Δ %	*-0.7*	*-1.5*	*0.1*	*-1.1*	*-1.2*	*-2.6*	*-1.7*	*-2.0*	*-2.1*	*-3.8*	*-3.7*	*-2.8*	*-1.3*	*-0.9*

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 (MAP, 2005 [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 became 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 2003

The following table reproduces the part expressed in amount of energy consumed of the National Energy Balance (BEN) of the year 2003.
The complete balance, containing the physical quantities as well as the amount of energy and a consistent time series from the year 1994 onwards, is also available on the web site: https://dgerm.attivitaproduttive.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 6 to page 14 the energy vectors are represented in physical quantities (kt) while from page 16 to page 24 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 6 of the national energy balance (non reproduced here) is an "adjusted" quantity of kt. 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 is 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 Lybia have also been added to the supply list. The big customers where actually billed according to the measured heat value of the natural gas delivered. After the end of the state monopoly on this marked 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 12 and 13 of BEN (see Tables A5.9-10), mirror sheet of the tables, page 22 and 23 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 2003, Primary fuels, 10^9 kcal

Year 2003 (numbers expressed in 10E9 kcal)

BALANCE	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 (c)	7.400	6.350	7.400	2.500	2.500	8.250	10.000	10.000	2.200	2.200	2.200	2.500	2.500	
1. PRODUCTIONS (d)		1.586	0	0	4.625	114.551	55.700	21.210	80.685	11.749	5.219	6.916	18.750	316.991
2. IMPORTS	54.616	100.495	570	20	0	512.688	845.370	24.700	0	0	0	0	6.253	1.572.572
3. EXPORTS						478.5	6750	4380					13	11,621
4. Stock changes (e)	-3.604	1.075	-116	0	0	-11.410	8.170	1.050	0	0	0	0	0	-4.839
5. TOTAL RESOURCES	58.280	101.009	488	20	4.625	638.171	884.150	90.480	80.685	11.749	5.219	6.916	24.990	1.884.781
6. Transformations (Enclosure 1/a)	57.856	88.740		0	4.624	312.406	974.630	0	80.685	11.749	5.219	6.916	8.759	1.429.568
7. Consumptions and Losses (Encl 2/a)	444	8	0	0	1	6.459	0	0	0	0	0	0	1	6,919
8. Final Consumptions (Enclosure 3 /a)		12.262	488	20	0	419.306	0	0				0	16.230	448.506
a) Agriculture		0	0	0	0	1,337	0	0	0	0	0	0	1,370	2,707
b) Industry		12.262	481	17	0	169.749		0				0	2.055	184.558
c) Services						3.671		0					2.185	5.856
d) Domestic and civil uses			7	3		235.191		0					10.620	245.821
Total (a+b+c+d)	0	12.262	488	20	0	409.948		0				0	16.230	438.942
e) Non energy uses						9.364	0	0	0	0	0	0	0	9.364
TOTAL ENERGY CONSUMPTIONS (7+8)	444	12.270	488	20	1	425.765	0	0	0	0		0	16.231	455.219
9. Non energy final uses														0
10. BUNKERS														0
12. TOTAL USES	58.260	101.010	488	20	4.625	638.171	974.630	0	80.685	11.749	5.219	6.916	24.990	1.884.781

(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.
(c) - Lower heat value has been adopted for all fuels
(d) - Oil products include: returns from petrolchimical industry, some reclassification of feedstocks and regeneration of lubricant oils.

Table A5.2 – National Energy Balance, year 2003, Secondary fuels, 10^9 kcal

Year 2003 (numbers expressed in 10E9 kcal)

BALANCE	SECONDARY SOURCES																	
	Electric Energy	Char- coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas (f)	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 (d)
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32
Conversion factor (c)	0.860	7.500	7.000	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	9.950
1. PRODUCTIONS (d)	246,186	615	26,789	3,281	7,861	1,310	0	28,710	34,368	37,596	217,561	45,545	9,399	391,568	(g) 80,821	65,996	8,972	35,843
2. IMPORTS	44,278	508	11,085					18,590	0	10,421	4,515	365	1,720	7,585	(h) 23,540	14,215	26,867	3,219
3. EXPORTS	446	0	1,155			259		5,161		9,100	54,569	5,439	2,451	98,032	29,498	5,548	206	13,981
4. Stock changes (e)		0	749					242		250	-504	811	-649	-6,293	-196	-862	1,370	-381
5. TOTAL RESOURCES	290,018	923	35,910	3,281	7,861	1,051	0	41,877	34,368	38,667	168,052	37,679	9,317	307,214	74,059	155,545	33,964	26,062
6. Transformations (Enclosure 1 (a)			8,475	3,096	(g) 7,533	0		0	3,753	221	0	0	0	4,298	36,953	108,751	2,070	0
7. Consumptions and Losses (Encl 2 (a)	39,446	0	-5	115	173	1	0	473	24,795	2,150	60	1	22	2,548	10,645	7,340	5,789	126
8. Final Consumptions (Enclosure 3 (a)	250,571	923	27,442	68	155	1,050	0	41,404	5,820	36,296	167,971	37,679	9,295	293,463	4,959	35,759	26,104	1,035
a) Agriculture	4,439							757	0	0	221	0	0	25,510	0	0	0	0
b) Industry	118,744	223	27,284	68	155		0	4,697	840	0	2,995	156	92	5,447	5,783	32,084	26,104	1,035
c) Services	34,628							19,921			161,712	37,523	0	215,087	0	0	0	0
d) Domestic and civil uses	92,760	698	158				0	22,029	0	0	0		449	38,576	0	3,214	0	0
Total (a+b+c+d)	250,571	923	27,442	68	155	0	0	40,854	840	0	164,926	37,679	535	284,620	5,783	35,298	26,104	1,035
e) No energetic uses				0		1,050		550	4,980	36,296	3,045	0	2,760	8,843	1,196	461	0	24,520
TOTAL ENERGY CONSUMPTIONS (7+8)	290,018	923	27,437	183	328	1,051	0	41,877	30,615	38,446	168,031	37,680	9,317	296,011	15,624	43,099	31,893	1,161
9. Non energy final user	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24,520
10. BUNKERS	0	0	0	0	0	0	0	0	0	0	0	0	0	6,905	21,482	5,695	0	381
12. TOTAL USES	290,018	923	35,910	3,281	7,861	1,051	0	41,877	34,368	38,667	168,051	37,680	9,317	307,214	74,059	155,545	33,963	26,062

(e) - In the "TOTAL RESOURCES", this entry is considered negative.
(f) - Including residual gases from chimical processes
Note - due to automatic rounding, the real totals don't always coincided with the displayed ones.

Table A5.3 – National Energy Balance, year 2003, Primary fuels used by transformation industries, "Enclosure 1/a", 10^9 kcal

Enclosure 1/a (numbers expressed in 10^9 kcal)

TRANSFORMATIONS	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	8.250	10.000	10.000	2.200	2.200	2.200	2.500	2.500	
1) INPUT QUANTITY														
a) Charcoal pit	0	0	0	0		0	0	0	0	0			1,078	1,078
b) Coking	37,836							0	0	0			0	37,836
c) Town gas Workshop	0	0	0	0		0	0	0	0	0			0	0
d) Blast furnaces	0	0	0	0		0	0	0	0	0			0	0
e) Petroleum refineries	0	0	0	0		0	974,630	0	0	0			0	974,630
f) Hydroelectric power plants	0	0	0	0		0	0	0	80,683				0	80,683
g) Geothermal power plants	0		0	0			0	0	0	11,749			0	11,749
h) Thermoelectric power plants	0	68,140			4,624	212,406	0	0	0	0		6,916	7,681	300,967
i) Wind / Photovoltaic power plants	0	0	0	0	0	-	0	0	0	0	3,219	0	0	3,219
TOTAL	37,836	68,140	0	0	4,624	212,406	974,630	0	80,683	11,749	3,219	6,916	8,759	1,429,562
2) OUTPUT QUANTITY (b)														
A) Obtained sources														
a) Charcoal pit	0	0	0	0		0	0	0	0	0			540	540
b) Coking	29,607	0	0	0		0	0	0	0	0			0	29,607
c) Town gas Workshop	0	0	0	0		0	0	0	0	0			0	0
d) Blast furnaces	0	0	0	0		0	0	0	0	0			0	0
e) Petroleum refineries	0	0	0	0		0	930,557	0	0	0			0	930,557
f) Hydroelectric power plants	0	0	0	0		0	0	0	31,540	0			0	31,540

Table A5.3 – National Energy Balance, year 2003, Primary fuels used by transformation industries, "Enclosure 1/a", 10^9 kcal

Enclosure 1/a (numbers expressed in 10^9 kcal)

TRANSFORMATIONS	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
g) Geothermal power plants	0	0	0	0		0	0	0		4,599			0	4,599
h) Thermoelectric power plants	0	33,379	0		1,896	100,879	0	0	0	0		1,558	2,306	140,018
i) Wind / Photovoltaic power plants	0	0	0	0	0	0	0	0	0	0	1,259	0	0	1,259
Sub-Total A	29,607	33,379	0	0	1,896	100,879	990,557	0	31,540	4,599	1,259	1,558	2,846	1,138,115
B) Losses of transformation														
a) Charcoal pit	0	0	0	0		0	0	0	0	0			538	538
b) Coking	6,919	0	0	0		0	0	0	0	0			0	6,919
c) Town gas Workshop	0	0	0	0		0	0	0	0	0			0	0
d) Blast furnaces	0	0	0	0		0	0	0	0	0			0	0
e) Petroleum refineries	0	0	0	0		0	8,230	0	0	0			0	8,230
f) Hydroelectric power plants	0	0	0	0		0	0	0	49,143	0			0	49,143
g) Geothermal power plants	0	0	0	0		0	0	0	0	7,156			0	7,156
h) Thermoelectric power plants	0	55,561		0	1,728	111,527	0	0	0	0		5,558	5,375	180,949
i) Wind / Photovoltaic power plants	0	0	0	0	0	0	0	0	0	0	1,960	0	0	1,960
Sub-Total B	6,919	55,561	0	0	1,728	111,527	8,230	0	49,143	7,156	1,960	5,558	5,913	254,295
C) Non energy products														
a) Coke ovens (d)	1,310	0	0	0		0	0	0	0	0			0	1,310
b) Town Gas Workshop	0	0	0	0		0	0	0	0	0			0	0
c) Petroleum refineries (e)	0	0	0	0		0	35,843	0	0	0			0	35,843
Sub-Total C	1,310	0	0	0		0	35,843	0	0	0	0	0	0	37,153
TOTAL A+B+C	37,836	88,940	0	0	4,624	212,406	974,630	0	80,683	11,749	3,219	6,916	8,759	1,429,562

(a) - See note (a) in the table of the Balance
(b) - Lower heat value has been adopted for all fuels
(c) - Pumping excluded

Table A5.4 – National Energy Balance, year 2003, Secondary fuels used by transformation industries, "Enclosure 1/a", 10^9 kcal

Continued: Enclosure 1/a (numbers expressed in 10^9 kcal)

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 (f)	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 (d)
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32
Conversion factor (b)	0.860	7.500	7.000	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	8.500	5.950
1) INPUT QUANTITY																		
a) Charcoal pit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
b) Coking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
c) Town gas Workshop	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
d) Blast furnaces	0	0	8,475	0	0	0	0	0	0	0	0	0	0	0	0		0	0
e) Petroleum refineries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
f) Hydroelectr power plants (c)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
g) Geothermal power plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
h) Thermoelectr power plants	0	0	0	3,098	7,553				5,753	221	0	0	0	4,298	36,958	108,751	2,070	
i) Wind/Photo-voltaic power pl	0	0	0															
TOTAL	0	0	8,475	3,098	7,553	0	0	0	5,753	221	0	0	0	4,298	36,958	108,751	2,070	0
2) OUTPUT QUANTITY (b)																		
A) Obtained sources																		
a) Charcoal pit																		
b) Coking																		
c) Town gas Workshop								0		0								
d) Blast furnaces			8,475															
e) Petroleum refineries																	0	
f) Hydroelectric power plants																		

Table A5.4 – National Energy Balance, year 2003, Secondary fuels used by transformation industries, “Enclosure 1/a”, 10^9 kcal

Continued: Enclosure 1/a (numbers expressed in 10^9 kcal)

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 (f)	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 (e)
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32
g) Geothermal power plants																		
h) Thermoelectric power plants				1,311	2,908				1,835	144				1,760	17,059	42,882	877	
i) Wind / Photovoltaic power pl.																		
Sub-Total A	0	0	8,473	1,311	2,908	0	0	0	1,835	144		0	0	1,760	17,059	42,882	877	0
B) Losses of transformation																		
a) Charcoal pit	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0
b) Coking	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0
c) Town gas Workshop	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0
d) Blast furnaces	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0
e) Petroleum refineries	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0
f) Hydroelectric power plants	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0
g) Geothermal power plants	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0
h) Thermoelectric power plants	0	0	0	1,787	4,625	0	0	0	1,918	77		0	0	2,538	19,894	65,869	1,193	
i) Wind / Photovoltaic power plants	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0
Sub-Total B	0	0	0	1,787	4,625	0	0	0	1,918	77		0	0	2,538	19,894	65,869	1,193	0
C) Non energy products																		
a) Coking	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0
b) Town Gas Workshop	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0
c) Petroleum refineries	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0
Sub-Total C	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0
TOTAL A+B+C	0	0	8,473	3,098	7,533	0	0	0	3,753	221	0	0	0	4,298	36,953	108,751	2,070	0

(d) - Including tars, benzol and ammonic sulphate.
(e) - Including solvent gasoline, turpentine, lubricants, white oils, insulating oils, vaseline, paraffin, bitumen and other products.

Table A5.5 – National Energy Balance, year 2003, Primary fuels losses, “Enclosure 2/a”, 10^9 kcal

Enclosure 2/a (numbers expressed in 10^9 kcal)

CONSUMPTIONS AND LOSSES	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Sub-products (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		8.250	10.000	10.000	2.200	2.200			2.500	
1) Consumptions for production of primary sources														
a) Biomass														0
b) Coal	0	0	0	0		0	0	0	0	0			0	0
c) Lignite	0	0	0	0		0	0	0	0	0			0	0
d) Nuclear fuels	0	0	0	0		0	0	0	0	0			0	0
e) Natural Gas	0	0	0	0		569	0	0	0	0			0	569
f) Natural gas liquids	0	0	0	0		0	0	0	0	0			0	0
g) Crude oil	0	0	0	0		0	0	0	0	0			0	0
h) Hydraulic Energy	0	0	0	0		0	0	0	0	0			0	0
i) Geothermal Energy									0					0
Sub-total	0	0	0	0	0	569	0	0	0	0	0	0	0	569
2) Consumptions for production of secondary sources (c)														
a) Charcoal pit	0	0	0	0		0	0	0	0	0			0	0
b) Coke ovens	444	0	0	0		0	0	0	0	0			0	444
c) Town Gas Workshop	0	0	0	0		0	0	0	0	0			0	0
d) Blast furnaces	0	0	0	0		0	0	0	0	0			0	0
e) Petroleum refineries	0	0	0	0		0	0	0	0	0			0	0
f) Hydraulic power plants	0	0	0	0		0	0	0	0	0			0	0
g) Geothermal power plants	0	0	0	0		0	0	0	0	0			0	0
h) Thermoelectric power plants	0	0	0	0		0	0	0	0	0			0	0
i) Nuclear power plants														
Sub-total	444	0	0	0		0	0	0	0	0			0	444

Table A5.5 – National Energy Balance, year 2003, Primary fuels losses, "Enclosure 2/a", 10^9 kcal

Enclosure 2/a (numbers expressed in 10^9 kcal)

CONSUMPTIONS AND LOSSES	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal for other uses	Lignite	Sub-products (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
3) Consumptions and Losses of transport and distribution	0	0	0	0		5.691	0	0	0	0			0	5.691
4) Differences:														
- Statistics	0	6	0	0		0	0	0	0	0			3	9
- of conversion	0	2	0	0	1	-1	0	0	0	0	0	0	-2	0
TOTAL (1+2+3+4)	444	8	0	0	1	6.459	0	0	0	0	0	0	2	6.914

(a) Excluding losses of transformation considered in the balance of transformations
(b) Lower heat value has been adopted for all fuels

Table A5.6 – National Energy Balance, year 2002, Secondary fuels losses, "Enclosure 2/a", 10^9 kcal

Continued: **Enclosure 2/a** (numbers expressed in 10^9 kcal)

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 (f)	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 (k)
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32
Conversion factor (h)	0.860	7.200	7.000	4.250	0.900	7.400	4.250	11.000	12.000	10.400	10.500	10.400	10.500	10.200	9.800	9.800	8.300	5.950
1) Consumptions for production of primary sources:																		
a) Biomass																		
b) Coal	27																	
c) Lignite	-																	
d) Nuclear fuels	9																	
e) Natural Gas	198																	
f) Natural gas liquids																		
g) Crude oil																		
h) Hydraulic Energy	2.485	(l)																
i) Geothermal Energy	-																	
Sub-total	2.713	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2) Consumptions for production of secondary sources (c)																		
a) Charcoal pit																		
b) Coke ovens	102		0	47	155	0												
c) Town Gas Workshop	193						0											
d) Blast furnaces	62			68	0													
e) Petroleum refineries	4.739							475	24.792	2.153	65	0	21	2.550	10.643	7.340	5.793	125
f) Hydraulic power plants	539																	
g) Geothermal power plants	262																	
h) Thermoelectric power plants	10.964																	
l) Wind / Photovoltaic power plants	1																	
Sub-total	16.865	0	0	115	155	0	0	475	24.792	2.153	65	0	21	2.550	10.643	7.340	5.793	125

Table A5.6 – National Energy Balance, year 2002, Secondary fuels losses, “Enclosure 2/a”, 10^9 kcal

Continued: **Enclosure 2/a** (numbers expressed in 10E9 kcal)

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 (f)	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 (f)
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32
3) Consumptions and Losses of transport and distribution	19,668	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0
4) Differences :																		
- Statistics	-	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0
- of conversion	- 0	0	-5	0	0	1	0	0	5	-3	-3	1	1	-2	3	0	-4	1
TOTAL (1+2+3+4)	39,446	0	-5	115	175	1	0	475	24,795	2,150	60	1	22	2,548	10,644	7,340	5,789	126

(c) Consumptions for internal uses of energy industries

Table A5.7 – National Energy Balance, year 2003, Primary fuels used by end use sectors, "Enclosure 3/a", 10^9 kcal

Enclosure 3/a (numbers expressed in 10^9 kcal)

FINAL CONSUMPTIONS	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 (a)	7.400	6.950	7.400	2.500	2.500	8.250	10.000	10.000	2.200	2.200	2.200	2.500	2.500	
1) AGRICULTURE AND FISHING														
I- Agriculture	0	0	0	0	0	1,337	0	0	0	0	0	0	1,370	2,707
II- Fishing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	0	0	0	0	1,337	0	0	0	0	0	0	1,370	2,707
2) INDUSTRY														
I- Iron and steel industry	0	7,525	281	0	0	19,297	0	0	0	0	0	0	0	27,103
II- Other industry	0	4,737	200	17	0	150,447	0	0	0	0	0	0	2,055	157,455
a) Mining industry	0	0	0	0	0	2.72	0	0	0	0	0	0	0	2.72
b) Non-Ferrous Metals	0	0	7	0	0	3,902	0	0	0	0	0	0	0	3,910
c) Metal works factories	0	0	0	0	0	22,479	0	0	0	0	0	0	0	22,479
d) Food Processing, Beverages	0	0	0	0	0	18,744	0	0	0	0	0	0	0	18,744
e) Textile and clothing	0	0	0	0	0	13,555	0	0	0	0	0	0	0	13,555
f) Construction industries (cement, bricks)	0	4,737	178	17	0	10,739	0	0	0	0	0	0	2,055	17,719
g) Glass and pottery	0	0	0	0	0	25,839	0	0	0	0	0	0	0	25,839
h) Chemical	0	0	15	0	0	29,675	0	0	0	0	0	0	0	29,690
i) Petrochemical	0	0	0	0	0	0	0	0	0	0	0	0	0	0
l) Pulp, paper and print	0	0	0	0	0	16,706	0	0	0	0	0	0	0	16,706
m) Other industries	0	0	0	0	0	8,547	0	0	0	0	0	0	0	8,547
n) Building and civil works	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	12,262	481	17	0	169,744	0	0	0	0	0	0	2,055	184,558

Table A5.7 – National Energy Balance, year 2003, Primary fuels used by end use sectors, "Enclosure 3/a", 10^9 kcal

Enclosure 3/a (numbers expressed in 10^9 kcal)

FINAL CONSUMPTIONS	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
3) SERVICES														
I - Railways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
II - Navigation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
III - Road transportation	0	0	0	0	0	5,671	0	0	0	0	0	0	1,185	5,856
IV - Civil aviation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V - Other transportation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VI - Public Service	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	0	0	0	0	5,671	0	0	0	0	0	0	1,185	5,856
4) DOMESTIC AND COMMERCIAL USES	0	0	7	3	0	235,191	0.0	0	0	0	0		10,620	245,821
TOTAL (1+2+3+4)	0	12,262	488	19	0	409,943	0	0	0	0	0	0	16,230	438,941
5) NON ENERGY USE (a)														
I - Chemical industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
II - Petrochemical	0	0	0	0	0	9,364	0	0	0	0	0	0	0	9,364
III - Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IV - Other sectors	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	0	0	0	0	9,364	0	0	0	0	0	0	0	9,364
TOTAL (1+2+3+4+5)	0	12,262	488	19	0	419,306	0	0	0	0	0	0	16,230	448,305

(a) - Lower heat value has been adopted for all fuels

Table A5.8 – National Energy Balance, year 2003, Secondary fuels used by end use sectors, "Enclosure 3/a", 10^9 kcal

Continued: **Enclosure 3/a** (numbers expressed in 10^9 kcal)

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
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32
Conversion factor	0.860	7,500	7,000	4,250	0,900	7,400	4,250	11,000	12,000	10,400	10,500	10,400	10,500	10,200	9,800	9,800	8,300	5,950
1) AGRICULTURE AND FISHING																		
I - Agriculture	4.439	0	0	0	0	0	0	715	0	0	210	0	0	23.215	0	0	0	0
II - Fishing	0	0	0	0	0	0	0	22	0	0	11	0	0	2.295	0	0	0	0
Sub-Total	4.439	0	0	0	0	0	0	737	0	0	221	0	0	25.510	0	0	0	0
2) INDUSTRY																		
I - Iron and steel industry	17.059	0	26.915	68	155	0	0	231	0	0	0	0	0	102	0	815	25	0
II - Other industry	101.705	225	969	0	0	0	0	4466	840	0	2.995	156	99	5.345	5.783	31.272	26.079	1.095
a) Mining industry	932	0	0	0	0	0	0	33	0	0	0	0	0	224	49	186	0	0
b) Non-Ferrous Metals	4.678	0	60	0	0	0	0	231	0	0	0	0	10	61	0	608	0	0
c) Metal works factories	22.994	0	3	0	0	0	0	847	0	0	326	156	52	1.346	1.174	5.998	0	0
d) Food Processing, Beverages	10.780	173	3	0	0	0	0	517	0	0	0	0	10	592	294	6.889	0	0
e) Textile and clothing	9.972	0	0	0	0	0	0	407	0	0	0	0	0	714	176	5.440	0	0
f) Construction industries (cement, bricks)	7.469	0	119	0	0	0	0	935	0	0	0	0	0	388	804	186	25.979	839
g) Glass and pottery	5.038	0	0	0	0	0	0	770	0	0	0	0	0	163	0	2.969	0	0
h) Chemical	21.809	53	49	0	0	0	0	77	0	0	0	0	10	598	0	1.519	100	0
i) Petrochemical	1.503	0	0	0	0	0	0	341	840	0	2.667	0	0	0	0	5.831	0	196
l) Pulp, paper and print	9.217	0	0	0	0	0	0	77	0	0	0	0	0	255	0	1.686	0	0
m) Other industries	5.957	0	135	0	0	0	0	231	0	0	0	0	10	602	1.186	9.959	0	0
n) Building and civil works	1.296	0	0	0	0	0	0	0	0	0	0	0	0	622	0	0	0	0
Sub-Total	118.744	225	27.284	68	155	0	0	4.697	840	0	2.995	156	99	5.447	5.783	32.085	26.104	1.095

Table A5.8 – National Energy Balance, year 2003, Secondary fuels used by end use sectors, "Enclosure 3/a", 10^9 kcal

Continued: **Enclosure 3/a** (numbers expressed in 10^9 kcal)

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
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32
3) SERVICES																		
I - Railways	4.627	0	0	0	0	0	0	0	0	0	0	0	0	1.224	0	0	0	0
II - Navigation	20	0	0	0	0	0	0	0	0	0	0	0	0	2.295	0	0	0	0
III - Road transportation	3.366	0	0	0	0	0	0	13.299	0	0	161.312	0	0	208.151	0	0	0	0
IV - Civil aviation	135	0	0	0	0	0	0	0	0	0	156	36.265	0	0	0	0	0	0
V - Other transportation	16.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VI - Public Service	8.490	0	0	0	0	0	0	22	0	0	242	1.258	0	(b) 5417	0	0	0	0
Sub-Total	34.628	0	0	0	0	0	0	13.321	0	0	161.711	37.523	0	215.087	0	0	0	0
4) DOMESTIC AND COMMERCIAL USES	92.760	698	138	0	0	0	0	22.099	0	0	0	0	443	38.576	0	9.214	0	0
TOTAL (1+2+3+4)	250.051	923	27.442	68	155	0	0	40.854	840	0	164.934	37.679	596	264.621	8.785	95.900	26.104	1.035
5) NON ENERGY USE (a)																		
I - Chemical industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
II - Petrochemical	0	0	0	0	0	0	0	590	4.960	96.196	5.045	0	2.760	8.643	1.196	461	0	292
III - Agriculture	0	0	0	0	0	155	0	0	0	0	0	0	0	0	0	0	0	0
IV - Other sectors	0	0	0	0	0	895	0	0	0	0	0	0	0	0	0	0	0	24.228
Sub-Total	0	0	0	0	0	1.051	0	590	4.960	96.196	5.045	0	2.760	8.643	1.196	461	0	24.520
TOTAL (1+2+3+4+5)	250.051	923	27.442	68	155	1.051	0	41.404	5.820	96.196	169.969	37.679	3.296	293.464	4.978	95.760	26.104	25.555

(b) 800.7 10E9 kcal of diesel used for heating for Public Service

Table A5.9 – National Energy Balance, year 2003, Primary fuels used by end use sectors, "Enclosure 3/a", quantity

Enclousure 3/a (numbers expressed in quantity)

FINAL CONSUMPTIONS	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Sub-products (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
Unit of measurement	kt	kt	kt	kt		Mtoe	kt	kt	GWh	GWh	GWh	kt	kt	
1) AGRICULTURE AND FISHING														
I - Agriculture						162							548	
II - Fishing														
Sub-Total	0	0	0	0		162	0	0	0	0			548	
2) INDUSTRY														
I - Iron and steel industry		1.185	38			2.339								
II - Other industry	0	746	27	T		18236	0		0	0		0	622	
a) Mining industry						93								
b) Non-Ferrous Metals			1			475								
c) Metal works factories						2.724								
d) Food Processing, Beverages						2.272								
e) Textile and clothing						1.649								
f) Construction industries (cement, bricks)		746	24	T		1301							822	
g) Glass and pottery						8.132								
h) Chemical			2			5.297								
i) Petrochemical						0								
l) Pulp, paper and print						2.025								
m) Other industries						1.036								
n) Building and civil works						0								
Sub-Total	0	1.931	65	T		20.575	0	0	0	0		0	822	

Table A5.9 – National Energy Balance, year 2003, Primary fuels used by end use sectors, "Enclosure 3/a", quantity

Enclousure 3/a (numbers expressed in quantity)

FINAL CONSUMPTIONS	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Sub-products (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
Unit of measurement	kt	kt	kt	kt		Mmc	kt	kt	GWh	GWh	GWh	kt	kt	
3) SERVICES														
I - Railways														
II - Navigation														
III - Road transportation						445							(b) 257	
IV - Civil aviation														
V - Other transportation														
VI - Public Service														
Sub-Total	0	0	0	0		445	0	0	0	0			257	
4) DOMESTIC AND COMMERCIAL USES			1	1		28.508							(b) 4.132	
TOTAL (1+2+3+4)	0	1.951	66	8		49.690	0	0	0	0			5.179	
5) NON ENERGY USE (a)														
I - Chemical industry														
II - Petrochemical						1.135								
III - Agriculture														
IV - Other sectors														
Sub-Total	0	0	0	0		1.135	0	0	0	0			-	
TOTAL (1+2+3+4+5)	0	1.951	66	8		50.825	0	0	0	0			5.179	

(a) - Non energy uses of energetic sources
(b) - Biodiesel for road transport: 257 kt; biodiesel for domestic and commercial uses: 40 kt

Table A5.10 – National Energy Balance, year 2003, Secondary fuels used by end use sectors, "Enclosure 3/a", quantity

Continued: Enclousure 3/a (numbers expressed in 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 (fl)	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
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32
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	5.162							65			20			2.276				
II - Fishing								2			1			225				
Sub-Total	5.162	0	0	0	0		0	67	0	0	21	0	0	2.501	0	0	0	0
2) INDUSTRY																		
I - Iron and steel industry	19.812		5.845	16	172			21					0	10		65	3	
II - Other industry	118.262	30	52	0	0	0	0	406	70	0	285	15	9	524	386	3.191	3.142	174
a) Mining industry	1.084							3						22	5	19		
b) Non-Ferrous Metals	5.440		9					21					1	6		62		
c) Metal works factories	26.757							77			51	15	5	132	130	408		
d) Food Processing, Beverages	12.585	23						47					1	58	30	708		
e) Textile and clothing	11.596							57						70	16	951		
f) Construction industries (cement, bricks)	8.685		17					85						38	82	19	3.130	141
g) Glass and pottery	5.658							70						16		508		
h) Chemical	25.359	7	7					7					1	39		155	12	
i) Petrochemical	1.746							51	70		254					595		55
l) Pulp, paper and print	10.788							7						29		172		
m) Other industries	6.503		19					21					1	59	121	404		
n) Building and civil works	1.509							0						61				
Sub-Total	198.074	30	5.897	16	172	0	0	427	70	0	285	15	9	534	386	3.274	3.145	174

Table A5.10 – National Energy Balance, year 2003, Secondary fuels used by end use sectors, "Enclosure 3/a", quantity

Continued: Enclousure 3/a (numbers expressed in 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 (8)	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
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32
Unit of measurement	GWh	kt	kt	Mmc	Mmc	kt	Mmc	kt	kt	kt		kt	kt	kt	kt	kt	kt	kt
3) SERVICES																		
I - Railways	5.560													130				
II - Navigation	24													285				
III - Road transportation	5.914							1.209			15.968			20.407				
IV - Civil aviation	145										15	3.487						
V - Other transportation	20.951																	
VI - Public Service	9.872							(a) 2			23	121		(a) 395				
Sub-Total	40.266	0	0	0	0	0	0	1.211	0	0	15.401	3.608	0	21.087	0	0	0	0
4) DOMESTIC AND COMMERCIAL USES	107.860	93	25					2.009					45	3.182		526		
TOTAL 1+2+3+4)	291.562	123	3.920	16	172	0	0	5.714	70	0	15.707	3.623	52	27.904	386	5.602	3.145	174
5) NON ENERGY USE																		
I - Chemical industry																		
II - Petrochemical								50	415	3.490	290	0	268	867	122	47	0	49
III - Agriculture						21												
IV - Other sectors						121												4.072
Sub-Total	-	0	0	0	0	142	0	50	415	3.490	290	0	268	867	122	47	0	4.121
TOTAL (1+2+3+4+5)	291.562	123	3.920	16	172	142	0	5.764	485	3.490	15.997	3.623	320	28.771	508	5.649	3.145	4.295

(a) 78.5 kt of diesel 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 APAT. 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. For each primary fuel (natural gas, oil, coal) a specific procedure has been established.

Natural gas

IPCC methodology reports an emission factor for this energy carrier. Initially to estimate the methane content of the fuel, so that the correct emission factor for fugitive emissions could be evaluated a proper investigation has been performed among main users. Routine checks are performed by final uses to estimate chemical composition of natural gas and its energy value.

It has been found that the national marked is characterized by the commercialisation of natural gas of highly variable composition. Since 1990 natural gas has been produced nationally or imported by pipelines from Russia, Algeria and Netherlands. Moreover an NGL facility is importing gas from Algeria and Libya. In the recent years other countries have been added to the list.

Each of those natural gasses has peculiar properties and it is regularly analysed at the import gates, for budgetary reasons. Energy content for cubic meters and percentage of methane can vary considerably: 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. Carbon content varies significantly also.

Natural gas properties are quite stable with reference to the country of origin and chemical composition and speciation of gas from each country is regularly published by SNAM, the main national operators. Other information is also available from the final distribution companies.

So, for each year, the average methane and carbon content of the natural gas used in Italy are estimated using the 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.

Table A6.1 Natural gas carbon emission factors

	t CO_2 / TJ	t CO_2 / std cubic mt	t CO_2 / tep
Natural gas (dry) IPCC	55.780	1.925	2.334
Natural gas (dry) ‘1990	55.327	1.941	2.315
Natural gas (dry) ‘1995	55.422	1.961	2.319
Natural gas (dry) ‘2000	55.315	1.966	2.314
Natural gas (dry) ‘2003	55.287	1.950	2.313

Diesel oil, petrol and LPG, national production

APAT has made an investigation of the carbon content of the main transportation fuels sold in Italy: petrol, diesel and LPG.

The job has been aimed to test the average fuels sold in the year 2000 and to collect the available information on previous years fuels. The aim of this work is the verification of CO_2 emission factors of the Italian energy system and specifically of the transportation sector. The results of analysis of fuel samples performed by “Stazione Sperimentale Combustibili” (APAT, 2003) are checked against the emission factors used in the Reference Approach of the Intergovernmental Panel for Climate

Change (IPCC, 1997) and the emission factors considered in the COPERT III programme of the European Environment Agency (EEA, 2000).
Those two methodologies are widely used to prepare data at the international level but, when applied to the Italian data set produces results with significant differences, around 2-4%. The reason has been traced back to the emission factors, that is referred to the energy content of the fuel for IPCC and to the physical quantities for the COPERT methodology.
The results of the study performed by APAT 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-OECD emission factors for diesel fuels and 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 (about 50%) 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 petrol instead the IPCC-OECD emission factors is quite low and it has to be upgraded, the reason may be linked to the extensive use of additives in recent years to reach a high octane number after the lead has been phased out. For 2000 and the following years the experimental factor will be used, for the period 1990-1999 it has been decided to use an interpolate factor between IPCC emission factors and the measured value, using the LHV as the link between the national products and the international database. No other information was available.
The list of emission factors for the different years is reported in Table A6.2.

Table A6.2 Fuels, national production, carbon emission factors

	t CO_2 / TJ	t CO_2 / t	t CO_2 / tep
Petrol, 1990-'99, IPCC /OECD	68.531	3.015	2.872
Petrol, test data, 2000	71.145	3.109	2.977
Gasoil, 1990-'99, IPCC / OECD	73.274	3.127	3.066
Gasoil, engines, test data, 2000	73.153	3.137	3.061
Gasoil, heating, test data.	73.693	3.141	3.083
LPG, 1990-'99, IPCC	62.392	2.872	2.610
LPG, test data, 2000	64.936	2.994	2.717

Fuel oil, imported and produced
With reference to fuel oil the main information available was a sizable difference in carbon content between high sulphur and light sulphur brands. IPCC emission factors generally refer to the light sulphur product.
The data where elaborated from literature and from an extensive series of samples (more than 400) analysed by ENEL and made available to APAT.
Carbon content varies to a certain extent also between the medium sulphur content and the very low sulphur products, but the main discrepancies refer to the high sulphur type.
According to the available statistical data, it was possible to trace back to the year 1990 the produced and imported quantities of fuel oil, divided between high and low sulphur products and to estimate the average carbon emission factor for the years of interest, see Table A6.3 for details.

Table A6.3 Fuel oil, average of national and imported products, carbon emission factors

	t CO_2 / TJ	t CO_2 / tep
Fuel oil, 1990 average	76.539	3.202
Fuel oil, 1990 average	76.565	3.203
Fuel oil, 1995 average	76.650	3.207
Fuel oil, 2000 average	76.699	3.209
Fuel oil, 2003 average	76.695	3.209

Coal imports

With reference to coal the information available nationally we found a sizable difference in carbon content of various imported coals. This finding was expected and it can be linked to the hydrogen content and to the LHV of the coal.

We found also that supply of coal is not stable over time: the quantities shipped by the main exporters change considerably from year to year, moreover new suppliers have been added to the list in the last few years. This fact derives from the specific national circumstances of Italy that has a negligible national production and buys the product on the word market.

So an attempt was made to find out a methodology that allow 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 actually still unresolved problem is how to properly link statistical data, referred to the coal "as is" without specifying the moisture and ash content of the product, to the literature data that refer to sample coals.

We envisage to improve the quality of the collected statistical data including moisture content of coals but presently 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 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, 2001);
– for each inventory year it is 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 it is possible to estimate the carbon content of the average "as is" coal reported in the statistics.

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 the average carbon EF for each year, see table A6.4 for same details. The results do not show impressive changes from year to year, any way a noticeable difference of about 1.5% in the emission factor is highlighted in the table.

This methodology can be questioned and certainly can be improved; we continue to use it because, in our view, its use improves the quality of our reporting.

Table A6.4 – Coal, average carbon emission factors

	t CO_2 / TJ	t CO_2 / tep
Solid fuels		
Sub bitumious coal, IPCC	96.234	4.026
Steam coal '90	94.582	3.960
Steam coal '95	94.007	3.936
Steam coal '00	91.446	3.826
Steam coal '03	93.478	3.911

ANNEX 7: CRF TREND TABLES FOR GREENHOUSE GASES

This appendix shows a copy of Tables 10s1-10s5 from the Common Reporting Format 2003, submitted in 2005, 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 A7.1 CO_2 emissions trends, CRF year 2003

TABLE 10 EMISSION TRENDS (CO_2)															Italy
(Sheet 1 of 3)															2001
															2003
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year(1)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
1. Energy	402,129.73	402,129.73	402,382.67	400,854.84	398,768.79	392,435.65	418,822.57	414,191.23	418,090.23	427,914.13	434,569.81	440,941.82	444,709.37	444,491.65	459,254.37
A. Fuel Combustion (Sectoral Approach)	399,081.84	399,081.84	399,392.42	397,928.81	395,684.93	389,522.70	416,979.20	411,498.84	415,155.68	425,146.28	432,508.62	438,644.31	442,616.88	442,523.86	456,755.10
1. Energy Industries	134,951.47	134,951.47	129,449.76	129,291.84	124,264.31	125,962.11	139,974.17	135,166.92	136,392.38	146,567.46	143,250.55	150,409.29	153,465.16	159,501.99	160,882.83
2. Manufacturing Industries and Construction	84,968.82	84,968.82	82,367.53	80,320.16	81,483.03	83,018.62	87,903.83	84,536.23	87,918.78	81,134.22	86,463.01	89,043.89	85,425.71	79,890.02	85,034.51
3. Transport	101,858.24	101,858.24	104,349.59	108,670.74	110,395.57	110,222.64	113,022.54	113,192.39	114,918.96	118,732.06	119,926.94	120,452.33	122,793.25	124,907.10	126,015.47
4. Other Sectors	76,262.36	76,262.36	81,833.73	78,359.90	78,098.84	68,863.57	75,643.05	77,385.60	74,703.67	77,636.50	81,701.14	77,932.09	80,578.83	77,911.19	84,162.14
5. Other	1,040.95	1,040.95	1,191.81	1,276.17	1,443.18	1,455.36	1,435.61	1,177.69	1,221.89	1,036.05	1,106.97	806.10	353.94	313.56	660.15
B. Fugitive Emissions from Fuels	3,047.89	3,047.89	2,990.25	2,926.03	3,083.86	2,913.45	2,843.37	2,692.39	2,874.55	2,767.85	2,091.19	2,297.51	2,182.49	1,927.79	2,499.27
1. Solid Fuels															
2. Oil and Natural Gas	3,047.89	3,047.89	2,990.25	2,926.03	3,083.86	2,913.45	2,843.37	2,692.39	2,874.55	2,767.85	2,091.19	2,297.51	2,182.49	1,927.79	2,499.27
2. Industrial Processes	26,356.61	26,356.61	25,885.72	26,401.98	23,497.02	22,302.51	24,788.61	22,701.04	25,122.58	23,301.25	23,932.49	24,996.85	25,609.70	25,428.23	26,536.23
A. Mineral Products	21,874.96	21,874.96	21,737.15	22,499.88	20,094.41	19,601.53	21,478.71	19,696.58	20,032.02	20,248.86	21,045.11	21,922.71	22,664.42	22,534.66	23,483.28
B. Chemical Industry	2,185.80	2,185.80	2,089.16	2,051.07	1,461.33	1,196.91	1,222.91	962.27	1,034.92	1,040.80	958.46	1,061.65	1,033.79	1,081.56	1,243.32
C. Metal Production	2,204.84	2,204.84	2,060.40	1,881.03	1,941.28	1,934.07	2,086.99	2,042.19	2,055.64	2,031.59	1,838.92	2,012.50	1,911.48	1,772.01	1,809.62
D. Other Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Production of Halocarbons and SF_6															
F. Consumption of Halocarbons and SF_6															
G. Other															
3. Solvent and Other Product Use	1,747.11	1,747.11	1,735.19	1,650.12	1,505.48	1,530.05	1,496.16	1,485.91	1,461.51	1,412.42	1,417.15	1,390.80	1,390.87	1,337.11	1,323.60
4. Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A. Enteric Fermentation															
B. Manure Management															
C. Rice Cultivation															
D. Agricultural Soils (4)															
E. Prescribed Burning of Savannas															
F. Field Burning of Agricultural Residues															
G. Other															

Table A7.1 CO_2 emissions trends, CRF year 2003

5. Land-Use Change and Forestry [1]	-60,883.70	-60,883.70	-83,151.65	-79,135.11	-64,765.02	-81,950.71	-85,800.79	-89,527.68	-80,461.18	-80,785.70	-89,231.27	-81,801.77	-85,901.72	-95,779.70	-81,899.96
A. Changes in Forest and Other Woody Biomass Stocks	-58,286.36	-58,286.36	-80,271.84	-76,793.48	-61,773.41	-78,452.36	-83,376.00	-86,777.41	-78,716.78	-76,464.31	-84,161.14	-78,079.37	-87,030.50	-93,456.32	-80,044.43
B. Forest and Grassland Conversion															
C. Abandonment of Managed Lands															
D. CO_2 Emissions and Removals from Soil															
E. Other	-2,597.34	-2,597.34	-2,879.81	-2,342.63	-2,991.61	-3,498.35	-2,424.79	-2,750.27	-1,744.40	-4,321.39	-5,070.13	-3,722.40	1,528.78	-2,323.38	-1,855.53
6. Waste	493.33	493.33	489.99	527.79	550.59	550.53	552.57	508.48	507.76	335.73	392.09	218.75	235.062	184.889	167.701
A. Solid Waste Disposal on Land															
B. Waste-water Handling															
C. Waste Incineration	493.33	493.33	489.99	527.79	550.59	550.53	552.57	508.48	507.76	335.73	392.09	218.75	235.062	184.889	167.701
D. Other															
7. Other (please specify)	431,195.45	431,195.45	431,272.35	429,751.60	424,018.41	416,576.69	446,582.22	439,644.12	444,179.95	486,795.92	460,075.37	492,075.58	0.00	0.00	0.00
Total Emissions/Removals with LUCF [4]	800,908.53	800,908.53	778,610.35	780,090.22	783,668.26	782,276.71	807,444.36	788,974.11	806,840.85	827,994.74	831,116.64	847,822.04	836,503.29	776,622.18	806,381.94
Total Emissions without LUCF [4]	861,792.23	861,792.23	861,761.99	859,226.33	848,433.28	833,827.42	893,245.15	878,501.79	887,302.04	908,780.44	920,345.91	929,624.81	972,005.00	872,401.88	887,281.90
Memo Items:															
International Bunkers	8,920.18	8,920.18	8,542.72	8,395.00	8,722.03	8,976.25	9,063.77	8,885.06	9,206.94	9,759.99	10,405.92	11,690.53	11,425.60	11,980.31	13,095.42
Aviation	4,116.27	4,116.27	4,939.82	4,887.96	5,028.48	5,296.72	5,612.84	6,016.25	6,134.14	6,665.86	7,313.89	7,835.84	7,054.73	6,957.04	8,053.75
Marine	4,403.91	4,403.91	3,602.89	3,477.04	3,693.55	3,680.03	4,050.93	2,869.82	3,071.79	3,094.13	3,091.03	3,854.69	4,370.87	4,993.27	5,041.67
Multilateral Operations															
CO_2 Emissions from Biomass	5,907.21	5,907.21	6,136.09	6,955.14	6,959.33	7,551.25	8,232.59	7,941.89	8,406.13	7,782.21	9,146.57	9,670.34	10,687.80	11,703.34	14,000.06

Table A7.2 CH4 emission trends, CRF year 2003

TABLE 10 EMISSION TRENDS (CH_4) (Sheet 2 of 3)															Italy 2001 2003
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
Total Emissions	1,824.75	1,824.75	1,795.78	1,801.13	1,810.95	1,811.32	1,823.90	1,819.61	1,821.97	1,825.15	1,801.72	1,811.94	1,768.81	1,707.27	1,649.30
1. Energy	395.27	395.27	389.63	390.48	379.37	369.34	369.88	368.69	364.35	361.98	348.29	344.16	328.19	317.01	303.84
A. Fuel Combustion (Sectoral Approach)	73.71	73.71	77.11	80.16	80.19	82.48	86.68	86.74	88.61	82.17	85.56	82.17	78.43	77.01	81.59
1. Energy Industries	15.09	15.09	14.74	14.32	14.06	13.67	16.01	16.05	16.81	11.80	12.96	12.25	13.65	18.03	22.34
2. Manufacturing Industries and Construction	6.82	6.82	6.74	6.56	6.80	6.80	7.22	6.69	7.12	6.89	6.68	6.97	6.88	6.81	7.01
3. Transport	36.89	36.89	39.11	42.11	43.12	44.24	45.19	45.98	44.95	43.60	43.72	40.02	34.00	30.87	29.29
4. Other Sectors	14.74	14.74	16.34	16.96	16.01	17.55	18.03	17.82	19.56	19.72	22.02	22.81	23.82	21.22	22.86
5. Other	0.17	0.17	0.19	0.20	0.22	0.21	0.22	0.19	0.17	0.16	0.18	0.13	0.09	0.07	0.10
B. Fugitive Emissions from Fuels	321.56	321.56	312.52	310.32	299.18	286.86	273.20	265.95	265.75	269.80	262.73	258.99	249.76	240.00	242.25
1. Solid Fuels	5.79	5.79	5.33	5.31	3.90	3.39	3.07	2.88	2.85	2.63	2.52	3.48	3.85	3.72	4.50
2. Oil and Natural Gas	315.77	315.77	307.19	305.01	295.28	283.47	270.13	263.07	262.90	267.17	260.21	255.50	245.90	236.28	237.75
2. Industrial Processes	5.16	5.16	4.95	4.85	4.87	5.07	5.36	2.99	3.23	3.11	3.06	3.01	2.84	2.70	2.77
A. Mineral Products															
B. Chemical Industry	2.45	2.45	2.43	2.40	2.28	2.49	2.65	0.60	0.62	0.59	0.59	0.40	0.33	0.33	0.31
C. Metal Production	2.71	2.71	2.51	2.43	2.59	2.58	2.71	2.39	2.61	2.52	2.46	2.61	2.51	2.37	2.46
D. Other Production															
E. Production of Halocarbons and SF_6															
F. Consumption of Halocarbons and SF_6															
G. Other															
3. Solvent and Other Product Use															
4. Agriculture	853.27	853.27	870.77	880.24	849.05	847.47	860.95	861.62	862.85	858.36	850.98	848.78	822.15	816.22	777.47
A. Enteric Fermentation	587.62	587.62	606.39	609.54	583.59	585.50	594.09	594.21	597.37	594.35	595.84	583.31	559.53	554.51	520.63
B. Manure Management	191.70	191.70	193.53	186.46	186.02	181.09	184.88	185.99	185.72	187.53	189.44	183.97	188.08	186.75	181.94
C. Rice Cultivation	73.26	73.26	70.17	73.58	78.81	80.24	81.36	80.78	79.18	75.73	75.03	74.93	74.01	74.36	74.36
D. Agricultural Soils															
E. Prescribed Burning of Savannas															
F. Field Burning of Agricultural Residues	0.62	0.62	0.68	0.66	0.64	0.64	0.62	0.64	0.57	0.64	0.62	0.58	0.53	0.60	0.54
G. Other															
5. Land-Use Change	6.80	6.80	1.74	2.88	7.18	2.90	1.30	1.06	3.53	4.11	2.02	4.14	2.63	1.47	3.09

Table A7.2 CH4 emission trends, CRF year 2003

and Forestry															
A Changes in Forest and Other Woody Biomass Stocks															
B Forest and Grassland Conversion															
C Abandonment of Managed Lands															
D CO_2 Emissions and Removals from Soil															
E Other	6.80	6.80	1.74	2.82	7.18	2.90	1.30	1.06	3.53	4.11	2.02	4.14	2.63	1.47	3.09
6. Waste	954.34	964.24	988.70	982.70	970.48	986.96	996.01	991.25	968.00	967.69	967.37	960.84	965.00	950.85	942.85
A Solid Waste Disposal on Land	492.76	492.76	508.73	495.29	491.68	507.92	516.92	523.72	527.18	528.46	535.86	540.86	533.29	488.87	461.44
B Wastewater Handling	63.83	63.83	65.18	65.78	66.77	66.80	66.15	66.61	67.52	67.43	67.05	68.01	68.66	68.30	68.18
C Waste Incineration	7.65	7.65	14.78	11.61	12.61	11.81	12.91	10.90	13.24	11.75	14.38	11.87	12.93	12.53	12.43
D Other	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.05	0.06	0.07	0.10	0.12	0.16	0.18
7. Other *(please specify)*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Memo Items:															
International Bunkers	0.54	0.54	0.47	0.47	0.50	0.50	0.55	0.45	0.49	0.51	0.53	0.63	0.69	0.75	0.82
Aviation	0.12	0.12	0.12	0.14	0.14	0.15	0.16	0.18	0.20	0.21	0.24	0.27	0.28	0.27	0.28
Marine	0.42	0.42	0.34	0.33	0.35	0.35	0.39	0.27	0.29	0.29	0.29	0.37	0.42	0.48	0.54
Multilateral Operations															
CO_2 Emissions from Biomass															

Table A7.3 N_2O emission trends, CRF year 2003

TABLE 10 EMISSIONS TRENDS (N_2O)															Italy
(Sheet 3 of 5)															2001
															2003
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
Total Emissions	135.79	135.79	133.79	131.01	131.89	135.65	133.34	131.53	136.51	134.96	136.31	136.69	136.71	136.73	134.61
1. Energy	17.53	17.53	17.43	16.91	16.45	15.80	17.61	15.12	16.39	19.06	21.01	21.26	21.36	23.59	24.95
A. Fuel Combustion (Sectoral Approach)	17.51	17.51	17.41	16.91	16.43	15.80	17.61	15.12	16.39	19.06	21.01	21.15	21.16	23.39	24.85
1. Energy Industries	5.41	5.41	5.15	4.80	4.56	4.71	5.11	5.11	5.09	5.19	5.12	5.16	5.66	6.25	6.56
2. Manufacturing Industries and Construction	5.11	5.11	5.10	5.11	4.89	4.87	4.86	4.80	4.87	4.84	4.86	5.18	5.21	5.24	5.40
3. Transport	5.56	5.56	5.61	5.78	6.01	6.44	7.01	7.56	8.11	9.16	9.85	10.10	10.16	11.81	12.16
4. Other Sectors	11.09	11.09	11.34	10.76	10.70	9.61	10.19	10.11	10.01	9.61	10.81	10.16	10.66	10.16	10.71
5. Other	0.21	0.21	0.24	0.24	0.26	0.25	0.21	0.26	0.21	0.17	0.24	0.24	0.01	0.01	0.17
B. Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Solid Fuels															
2. Oil and Natural Gas															
2. Industrial Processes	11.77	11.77	11.99	11.35	11.39	10.09	13.06	11.16	11.41	11.77	13.43	15.15	15.16	14.09	13.75
A. Mineral Products															
B. Chemical Industry	11.77	11.77	11.99	11.35	11.19	10.09	11.06	11.16	11.41	11.77	11.43	15.15	15.16	14.09	13.75
C. Metal Production															
D. Other Production															
E. Production of Halocarbons and SF_6															
F. Consumption of Halocarbons and SF_6															
G. Other															
3. Solvent and Other Product Use	1.57	1.57	1.41	1.41	1.45	1.41	1.44	1.91	1.91	3.35	3.15	3.16	1.95	1.95	1.76
4. Agriculture	73.11	73.11	76.10	76.63	77.70	76.40	75.11	74.51	77.93	76.01	76.76	75.11	74.41	74.31	72.31
A. Enteric Fermentation															
B. Manure Management	12.75	12.75	12.69	12.40	12.16	12.12	12.85	11.01	11.19	11.41	11.57	11.07	11.56	11.46	12.61
C. Rice Cultivation															
D. Agricultural Soils	60.86	60.86	61.40	64.11	65.46	64.06	62.74	61.47	64.71	62.60	61.17	62.01	60.80	60.81	58.50
E. Prescribed Burning of Savannas															
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	0.01	0.01	0.01	0.01	0.01
G. Other															
5. Land-Use Change and Forestry	0.05	0.05	0.01	0.01	0.05	0.00	-0.01	-0.01	0.01	-0.03	-0.04	0.03	0.01	0.01	0.01
A. Changes in Forest and Other Woody Biomass Stocks															
B. Forest and Grassland Conversion															
C. Abandonment of Managed Lands															
D. CO_2 Emissions and Removals from Soil															
E. Other	0.05	0.05	0.01	0.01	0.01	0.00	-0.01	-0.01	0.01	-0.01	-0.04	0.01	0.01	0.01	0.01
6. Waste	3.65	3.65	3.63	3.75	3.76	3.76	3.61	3.76	3.84	3.77	3.86	3.77	3.80	3.79	3.79
A. Solid Waste Disposal on Land															
B. Waste-water Handling	1.17	1.17	1.15	1.16	1.17	1.16	1.19	1.20	1.21	1.20	1.21	1.21	1.21	1.21	1.21
C. Waste Incineration	0.16	0.16	0.16	0.19	0.21	0.19	0.21	0.16	0.21	0.17	0.25	0.16	0.19	0.17	0.17
D. Other															
7. Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Memo Items:															
International Bunkers	0.17	0.17	0.15	0.15	0.16	0.16	0.15	0.16	0.17	0.15	0.19	0.13	0.14	0.15	0.17
Aviation	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.06	0.06	0.10	0.11	0.12	0.13	0.12	0.13
Marine	0.11	0.11	0.09	0.09	0.09	0.09	0.10	0.07	0.06	0.05	0.08	0.10	0.11	0.13	0.14
Multilateral Operations															
CO_2 Emissions from Biomass															

Table A7.4 HFC, PFC and SF_6 emission trends, CRF year 2003

TABLE 10 EMISSION TRENDS (HFCs, PFCs and SF_6)															Italy			
(Sheet 4 of 5)															2001			
															2003			
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003		Chemical	GWP
	(Gg)																	
Emissions of HFCs[1] - CO_2 equivalent (Gg)	671.29	381.00	395.45	388.78	385.42	481.90	671.29	460.17	795.33	1,180.96	1,481.82	2,005.90	2,758.80	3,950.92	4575.46		HFCs	
HFC-23	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		HFC-23	11700
HFC-32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.08	0.14	0.23	0.35		HFC-32	650
HFC-41																	HFC-41	150
HFC-43-10mee																	HFC-43-10mee	1300
HFC-125	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.04	0.05	0.07	0.14	0.24	0.37	0.55		HFC-125	2800
HFC-134	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		HFC-134	1000
HFC-134a	0.20	0.00	0.00	0.00	0.00	0.10	0.20	0.29	0.43	0.68	0.83	1.00	1.20	1.37	1.53		HFC-134a	1300
HFC-152a																	HFC-152a	140
HFC-143																	HFC-143	300
HFC-143a	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.03	0.05	0.10	0.15	0.20		HFC-143a	3800
HFC-227ea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01		HFC-227ea	2900
HFC-236fa																	HFC-236fa	6300
HFC-245ca																	HFC-245ca	560
Emissions of PFCs[1] - CO_2 equivalent (Gg)	336.71	1,807.65	1,422.87	798.94	630.85	354.77	336.71	343.20	282.08	270.45	258.00	345.85	462.57	413.58	403.96		PFCs	
CF_4	0.04	0.21	0.17	0.10	0.08	0.04	0.04	0.03	0.03	0.03	0.03	0.04	0.05	0.04	0.05		CF_4	6500
C_2F_6	0.01	0.05	0.04	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02		C_2F_6	9200
C_3F_8																	C_3F_8	7000
C_4F_{10}																	C_4F_{10}	7000
c-C_4F_8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		c-C_4F_8	8700
C_5F_{12}																	C_5F_{12}	7500
C_6F_{14}																	C_6F_{14}	7400
Emissions of SF_6[1] - CO_2 equivalent (Gg)	601.45	332.92	395.20	382.85	370.40	456.66	601.45	682.95	728.64	604.81	404.51	493.45	795.34	708.35	486.94		SF_6	23900
SF_6	0.03	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.02	0.02	0.03	0.03	0.02			
[1] Base year information on the actual emissions. When emissions are only available for the personal emission, specify this in a comment in the corresponding cell. Only in this row the emissions are expressed as CO_2 equivalent emissions in order to facilitate the data flow processing spreadsheets.																		

Table A7.5 Total emission trends, CRF year 2003

TABLE 10 EMISSION TRENDS (SUMMARY)															Italy
(Sheet 5 of 5)															2003
															2005
GREENHOUSE GAS EMISSIONS	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)														
Net CO_2 emissions/removals	369,752.09	369,752.09	347,343.91	350,338.62	359,646.86	335,700.02	360,859.13	349,379.99	362,660.89	372,197.82	371,040.27	385,746.46	386,503.39	375,622.18	405,281.94
CO_2 emissions (without LUCF) [4]	430,635.79	430,635.79	430,495.57	429,434.73	424,411.82	417,250.73	446,659.92	432,857.66	443,122.08	452,983.52	460,271.54	467,548.23	472,005.00	471,401.82	487,281.90
CH_4	38,319.71	38,319.71	38,971.34	37,823.64	38,030.09	38,037.79	38,293.56	38,211.82	38,471.27	38,328.10	38,466.02	38,050.72	37,145.04	35,852.68	34,637.28
N_2O	39,934.14	39,934.14	41,164.37	40,613.86	40,871.23	39,828.34	41,025.27	40,734.95	42,010.19	41,837.52	42,877.30	42,994.77	43,000.28	43,005.39	42,253.46
HFCs	671.29	351.00	355.43	358.78	355.42	481.90	671.29	450.17	755.33	1,180.96	1,451.82	2,005.50	2,758.80	3,560.52	4,575.46
PFCs	336.71	1,807.65	1,422.87	798.94	630.85	354.77	336.71	248.39	252.08	270.43	258.00	345.85	452.37	413.58	493.56
SF_6	601.45	332.92	356.39	358.26	370.40	415.66	601.45	682.56	728.64	604.81	404.51	493.43	795.34	738.35	485.94
Total (with net CO_2 emissions/removals)	448,656.40	450,497.51	429,814.51	430,292.10	439,904.84	414,818.48	441,787.42	429,692.87	444,878.39	454,419.64	454,497.92	469,636.73	470,655.12	459,192.69	487,927.65
Total (without CO_2 from LUCF) [3,4]	510,480.10	511,571.22	512,795.97	509,438.21	504,059.85	496,369.18	527,988.21	510,210.95	525,339.58	535,205.34	543,720.19	561,436.49	556,156.84	554,972.40	569,827.59
GREENHOUSE GAS SOURCE AND SINK	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
CATEGORIES	CO_2 equivalent (Gg)														
1 Energy	418,964.45	418,964.45	419,069.03	417,401.18	414,934.95	408,191.11	436,004.87	430,316.30	434,274.06	444,319.86	451,530.22	457,825.06	461,681.51	461,520.65	476,888.49
2 Industrial Processes	34,731.85	35,613.97	35,252.97	34,644.34	31,387.78	30,319.23	33,660.28	31,040.59	31,876.13	32,500.36	33,305.02	35,709.20	37,476.54	37,664.68	39,210.33
3 Solvent and Other Product Use	2,543.53	2,543.53	2,486.09	2,407.87	2,353.48	2,279.29	2,251.94	2,357.61	2,362.40	2,451.27	2,434.65	2,401.50	2,276.30	2,250.79	2,180.40
4 Agriculture	40,618.04	40,618.04	41,277.49	41,610.32	41,928.80	41,420.06	41,395.48	41,191.39	42,279.48	41,590.71	41,874.74	40,981.46	40,334.33	40,176.07	38,347.07
5 Land-Use Change and Forestry [4]	-60,726.31	-60,726.31	-83,111.42	-79,069.52	-64,603.72	-81,490.08	-85,777.03	-89,512.49	-80,379.59	-80,710.02	-89,300.01	-81,705.93	-85,440.93	-95,745.64	-81,828.39
6 Waste	13,473.84	13,473.84	14,040.16	13,297.50	13,703.54	14,038.82	14,251.89	14,299.48	14,465.91	14,267.46	14,553.25	14,475.44	14,327.37	13,336.64	12,729.74
7 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
[4] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report CO_2 emissions and removals from Land-Use Change and Forestry.															
[1] Net emissions.															
[4] The reference number in these rows is required to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table Summary2 if Parties report non-CO_2 emissions from LUCF.															

ANNEX 8: 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 A8.1 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 [2]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [2]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [2]	Emission factor [4]
1. Energy												
A. Fuel Combustion												
1. Energy Industries												
a. Public Electricity and Heat Production		T3	NS, PS	CS		T3	NS, PS	D		T3	NS, PS	D
b. Petroleum Refining		T3	NS, PS	CS		T3	NS, PS	D		T3	NS, PS	D
c. Manufacture of Solid Fuels and Other Energy Industries		T3	NS, PS	CS		T3	NS, PS	D		T3	NS, PS	D
2. Manufacturing Industries and Construction												
a. Iron and Steel		T2	NS	CS		T2	NS	D		T2	NS	D
b. Non-Ferrous Metals		T2	NS	CS		T2	NS	D		T2	NS	D
c. Chemicals		T2	NS	CS		T2	NS	D		T2	NS	D
d. Pulp, Paper and Print		T2	NS	CS		T2	NS	D		T2	NS	D
e. Food Processing, Beverages and Tobacco		T2	NS	CS		T2	NS	D		T2	NS	D
f. Other (*as specified in table 1.A(a)s2*)		T2	NS	CS		T2	NS	D		T2	NS	D
3. Transport												
a. Civil Aviation		T1, T2a	NS	CS		T1, T2a	NS	C		T1, T2a	NS	C
b. Road Transportation		COPERT 3	NS, AS	CS		COPERT 3	NS, AS	CS		COPERT 3	NS, AS	CS
c. Railways		D	NS	CS		D	NS	C		D	NS	C

Table A8.1 Methods, activity data and emission factors used for the Italian Inventory

d. Navigation		T1, T2	NS	CS		T1, T2	NS	C		T1, T2	NS	C
e. Other Transportation (as specified in table 1.A(a)3)		D	NS	CS		D	NS	C		D	NS	C
4. Other Sectors												
a. Commercial/Institutional		T2	NS	CS		T2	NS	C		T2	NS	C
b. Residential		T2	NS	CS		T2	NS	C		T2	NS	C
c. Agriculture/Forestry /Fisheries		T2	NS	CS		T2	NS	C		T2	NS	C
5. Other												
a. Stationary												
b. Mobile		T2	NS	CS		T2	NS	C		T2	NS	C
B. Fugitive Emissions from Fuels												
1. Solid Fuels												
a. Coal Mining						T1	NS	D,CS				
b. Solid Fuel Transformation						T1	NS	C				
c. Other (as specified in table 1.B.1)												
2. Oil and Natural Gas												
a. Oil						T2	NS	CS				
b. Natural Gas						T2	NS	CS				
c. Venting and Flaring		T2	NS	CS		T3	NS	CS				
d. Other (as specified in table 1.B.2)												

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 [1]	Activity data [1]	Emission factor/ [1]	Key source [1]	Method applied [1]	Activity data [1]	Emission factor/ [1]	Key source [1]	Method applied [1]	Activity data [1]	Emission factor/ [1]	Key source [1]	Method applied [1]	Activity data [1]	Emission factor/ [1]	Key source [1]	Method applied [1]	Activity data [1]	Emission factor/ [1]	Key source [1]	Method applied [1]	Activity data [1]	Emission factor/ [1]
2. Industrial Processes																								
A. Mineral Product																								
1. Cement Production		T2	NS	CS, PS																				
2. Lime Production		D	NS	CS, PS																				
3. Limestone and Dolomite Use		D	AS	CS, PS																				
4. Soda Ash Production and Use		D	IS, PS	PS																				
5. Asphalt Roofing																								
6. Road Paving with Asphalt																								
7. Other *(as specified in table 2(I).A-G)*		D	NS	CS, PS																				
B. Chemical Industry																								
1. Ammonia Production		D	NS, PS	C, PS																				
2. Nitric Acid Production		D	NS, PS	C, PS						D	NS, PS	D, PS												
3. Adipic Acid Production		D	PS	PS						D	PS	PS												
4. Carbide Production																								
5. Other *(as specified in table 2(I).A-G)*		D	PS	PS		D	NS, AS	C, PS																
C. Metal Production																								
1. Iron and Steel Production		D	NS	C, CS		D	NS	C, CS																
2. Ferroalloys Production		D	NS	C																				
3. Aluminium Production		D	AS	C														T1, T2	PS	PS				
4. SF_6 Used in Aluminium and Magnesium Foundries																						D	PS	PS
5. Other *(as specified in table 2(I).A-G)*																								
D. Other Production																								
1. Pulp and Paper																								

Table I -2: Community summary report for methods, activity data and emission factors used (industrial processes)

2. Food and Drink																								
E. Production of Halocarbons and SF_6																								
1. By-product Emissions													CS	PS	PS		CS	PS	PS		CS	PS	PS
2. Fugitive Emissions													CS	PS	PS		CS	PS	PS		CS	PS	PS
3. Other *(as specified in table 2(I))*																								
F. Consumption of Halocarbons and SF_6																								
1. Refrigeration and Air Conditioning Equipment													I2a	AS	CS									
2. Foam Blowing													I2a	AS	D									
3. Fire Extinguishers													I2a	AS	CS									
4. Aerosols/ Metered Dose Inhalers													I2a	AS	CS									
5. Solvents																								
6. Other applications using ODS substitutes																								
7. Semiconductor Manufacture													CS	PS	PS		CS	PS	PS		CS	PS	PS
8. Electrical Equipment																					I3a	AS	CS	
9. Other *(as specified in table 2(I))*																								
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 [4]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [4]	Emission factor [4]
3. Solvent and Other Product Use												
A. Paint Application		C	NS, AS	C, CS								
B. Degreasing and Dry Cleaning		C	NS, AS	C, CS								
C. Chemical Products, Manufacture and Processing												
D. Other		C	IS, NS, AS	C, CS						CS	AS	CS
4. Agriculture												
A. Enteric Fermentation												
1. Cattle						T2	NS	D, CS				
2. Buffalo						T2	NS	D, CS				
3. Sheep						T1	NS	D, CS				
4. Other						T1	NS	D, CS				
B. Manure Management												
1. Cattle						T2	NS	D, CS		D	NS	D, CS
2. Buffalo						T2	NS	D, CS		D	NS	D, CS
3. Sheep						T1	NS	D, CS		D	NS	D, CS
4. Other						T1	NS	D, CS		D	NS	D, CS
8. Swine						T2	NS	D, CS		D	NS	D, CS
12. Solid Storage and Dry Lot						T2	NS	D, CS		D	NS	D, CS
13. Other												
C. Rice Cultivation						T2	NS	CS				
D. Agricultural Soils												
1. Direct Soil Emissions										D	NS	D, CS
2. Pasture, range and paddock manure										D	NS	D, CS
3. Indirect Emissions										D	NS	D, CS
4. Other *(as specified in table 4.D)*												
E. Prescribed Burning of Savannas												
F. Field Burning of Agricultural Residues						D	NS	D		D	NS	D
G. Other												

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 [2]	Emission factor[2]	Key source[1]	Method applied [2]	Activity data [2]	Emission factor [2]	Key source [1]	Method applied [2]	Activity data [2]	Emission factor[2]
5. Land-Use, Land-Use Change and Forestry												
A. Forest Land												
1. Forest Land remaining Forest Lands		T1, T2	NS	D, CS		T1, T2	NS	D, CS		T1, T2	NS	D, CS
2. Land converted to Forest Lands		T1, T2	NS	D, CS		T1, T2	NS	D, CS		T1, T2	NS	D, CS
B. Cropland												
1. Cropland remaining Cropland		T1, T2	NS	D, CS						T1, T2	NS	D, CS
2. Land converted to Cropland		T1, T2	NS	D, CS						T1, T2	NS	D, CS
C. Grassland												
1. Grassland remaining Grassland		T1, T2	NS	D, CS								
2. Land converted to Grassland		T1, T2	NS	D, CS								
D. Wetlands												
1. Wetlands remaining Wetlands												
2. Land converted to Wetlands												
E. Settlements												
1. Settlements remaining Settlements		T1, T2	NS	D, CS								
2. Land converted to Settlements		T1, T2	NS	D, CS								
F. Other Land												
1. Other Land remaining Other Land												
2. Land converted to Other Land												
G. Other (please specify)												
Harvested Wood Products												
6. Waste												
A. Solid Waste Disposal on Land												
1. Managed Waste Disposal on Land						T2	NS	D, CS				
2. Unmanaged Waste Disposal Sites						T2	NS	D, CS				
3. Other *(as specified in table 6.A)*												
B. Wastewater Handling												
1. Industrial Wastewater						D	NS	D		D	NS	C
2. Domestic and Commercial Wastewater						D	NS	D		D	NS	D

Table I -4: Community summary report for methods, activity data and emission factors used (land-use change and forestry, waste, other)

3. Other *(as specified in table 6.A)*												
C . Waste Incineration		D	NS	CS		D	NS	C		D	NS	CS
D. Other						CS	NS	CS				
7. Other (as specified in Summary 1.A)												
Memo Items: [1]												
International Bunkers												
Aviation		T1, T2a	NS	CS		T1, T2a	NS	C		T1, T2a	NS	C
Marine		T1, T2	NS	CS		T1, T2	NS	C		T1, T2	NS	C
CO_2 Emissions from Biomass		T2	NS	CS		T2	NS	C		T2	NS	C

Legend for tables I-1 to I-4

[illegible]

[illegible]

D (IPCC default), T1b, T2b, T3 (IPCC Tier 1b, 2b, 3 used for [illegible], respectively), C (CORINAIR), CORINAIR X (Expert Model X - Version)

EA (Enhanced Approach), T2 (IPCC Tier 2), CS (Country Specific),

T1 (IPCC Tier 1), T2 (IPCC Tier 1), M (Model)

[illegible]

[illegible]

[illegible]

AD (national statistics), D (international statistics), AS (associations, business organisations)

ES (regional statistics), PS (Plant Specific data), Q (questionnaires, surveys)

[illegible]

[illegible]

[illegible]

D (IPCC default), CS (Country Specific),

C (CORINAIR), PS (Plant Specific).

[illegible]

Documentation box:

The full information on methodological issues, such as methods, activity data and emission factors used, can be found in the relevant sections or sections of chapter 5 of the NIR. If any additional information is needed to understand the contents of the table, use the documentation box to provide references to the relevant sections of the NIR where further details can be found.

Where a mix of methods/ emission factors has been used within one source category, use the documentation box to specify those methods/ emission factors for the various sub-sources where they have been applied (see also Reference Box 1 on page 1 of the table).