.

ISPRA
Institute for Environmental Protection and Research

Italian Greenhouse Gas Inventory 1990-2007

National Inventory Report 2009

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

ISPRA - Institute for Environmental Protection and Research

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

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

ISPRA is the Institute for Environmental Protection and Research established by Italian Law 133/2008, as published in the Official Journal n. 195, August 21 2008. The Institute performs the functions of three former institutions: APAT (Agency for Environmental Protection and Technical Services), ICRAM (Central Institute for Applied Marine Research), INFS (National Institute for Wildlife).
This publication refers to activities carried out prior to the unification of the three institutions and, therefore, individual reference is still made to them.

Authors

Chiara Arcarese (national registry), Antonella Bernetti (energy-road transport), Antonio Caputo (energy- fugitive), Rocío D. Cóndor (agriculture), Mario Contaldi (energy), Riccardo De Lauretis (energy, industrial processes), Eleonora Di Cristofaro (energy-navigation, solvent and other product use), Sandro Federici (national registry for forest carbon sinks), Andrea Gagna (industrial processes), Barbara Gonella (industrial processes, waste), Riccardo Liburdi (national registry), Daniela Romano (general coordination and editing, cross cutting issues), Ernesto Taurino (industrial processes), Marina Vitullo (land use, land use change and forestry)

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

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

Premessa

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

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

L'ISPRA, infatti, realizza ogni anno l'inventario nazionale delle emissioni in atmosfera, che è strumento indispensabile di verifica degli impegni assunti a livello internazionale sulla protezione dell'ambiente atmosferico, come la Convenzione Quadro sui Cambiamenti Climatici (UNFCCC), il Protocollo di Kyoto, la Convenzione di Ginevra sull'inquinamento atmosferico transfrontaliero (UNECE-CLRTAP), le Direttive europee sulla limitazione delle emissioni.
In particolare, ogni Paese che partecipa alla Convenzione sui Cambiamenti Climatici, oltre a fornire annualmente l'inventario nazionale delle emissioni dei gas serra secondo i formati richiesti, deve documentare in uno specifico documento, il *National Inventory Report*, le metodologie di stima unitamente ad una spiegazione degli andamenti osservati.

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

In particolare, il rapporto "Italian Greenhouse Gas Inventory 1990-2007. National Inventory Report 2009" descrive la comunicazione annuale italiana dell'inventario delle emissioni dei gas serra dal 1990 al 2007.

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

Nuove politiche ed interventi a livello nazionale ed internazionale saranno, infatti, indispensabili per garantire nel futuro il rispetto degli obiettivi del Protocollo di Kyoto, dal momento che, come emerge dal rapporto, le emissioni totali dei gas serra (espressi in termini di CO_2 equivalente) sono aumentate, dal 1990 al 2007, del 7.1% a fronte di un impegno nazionale di riduzione pari al 6,5% entro il periodo 2008-2012.

Contents

Executive Summary

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

The United Nations Framework Convention on Climate Change (FCCC) was ratified by Italy in the year 1994 through law no.65 of 15/01/1994.
The Kyoto Protocol, adopted in December 1997, has established emission reduction objectives for Annex B Parties (i.e. industrialised countries and countries with economy in transition): in particular, the European Union as a whole is committed to an 8% reduction within the period 2008-2012, in comparison with base year levels. For Italy, the EU burden sharing agreement, set out in Annex II to Decision 2002/358/EC and in accordance with Article 4 of the Kyoto Protocol, has established a reduction objective of 6.5% in the commitment period, in comparison with 1990 levels.
Subsequently, on 1st June 2002, Italy ratified the Kyoto Protocol through law no.120 of 01/06/2002. The ratification law prescribed also the preparation of a National Action Plan to reduce greenhouse gas emissions, which was adopted by the Interministerial Committee for Economic Planning (CIPE) on 19th December 2002 (deliberation n. 123 of 19/12/2002).
The Kyoto Protocol finally entered into force in February 2005.
As a Party to the Convention and the Kyoto Protocol, Italy is committed to develop, publish and regularly update national emission inventories of greenhouse gases (GHGs) as well as formulate and implement programmes to reduce these emissions.
In order to establish compliance with national and international commitments, the national GHG emission inventory is compiled and communicated annually by the Institute for Environmental Protection and Research (ISPRA) to the competent institutions, after endorsement by the Ministry for the Environment, Land and Sea. The submission is carried out through compilation of the Common Reporting Format (CRF), according to the guidelines provided by the United Nations Framework Convention on Climate Change and the European Union's Greenhouse Gas Monitoring Mechanism. As a whole, an annual GHG inventory submission shall consist of a national inventory report (NIR) and the common reporting format (CRF) tables as specified in the Guidelines on reporting and review of greenhouse gas inventories from Parties included in Annex I to the Convention, implementing decisions 3/CP.5 and 6/CP.5, doc.FCCC/SBSTA/2002/L.5/Add.1.
Detailed information on emission figures and estimation procedures, including all the basic data needed to carry out the final estimates, are to be provided to improve the transparency, consistency, comparability, accuracy and completeness of the inventory provided.
The national inventory is updated annually in order to reflect revisions and improvements in the methodology and use of the best information available. Adjustments are applied retrospectively to earlier years, which accounts for any difference in previously published data.

This report is compiled according to the guidelines on reporting as specified in the document FCCC/SBSTA/2002/L.5. It provides an analysis of the Italian GHG emission inventory communicated to the Secretariat of the Climate Change Convention and to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism in the year 2009, including the update for the year 2007 and the revision of the entire time series 1990-2006.
The assigned amount for Italy, pursuant to Article 3, paragraphs 7 and 8 and calculated in accordance with the annex to decision 13/CMP.1, has been established together with the commitment period reserve (CPR), required in accordance with paragraph 18 of decision 15 CMP.1, during the last in country review in 2007. The calculated figures are reported in the document FCCC/IRR/2007/ITA and amount to 2,416,277,898 tonnes CO_2 eq. for the assigned amount and 2,174,650,108 tonnes of CO_2 eq. for the CPR. The CRP is calculated on the basis of the assigned amount so it has not changed from the previous submission.

Emission estimates comprise the six direct greenhouse gases under the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride) which contribute directly to climate change owing to their positive radiative forcing effect and four indirect greenhouse gases (nitrogen oxides, carbon monoxide, non-methane volatile organic compounds, sulphur dioxide).
This report, the CRF files and other related documents are available on website at the address http://www.sinanet.apat.it/it/sinanet/serie_storiche_emissioni.
The official inventory submissions can also be found at the UNFCCC website http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/4303.php.

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

Total greenhouse gas emissions, in CO_2 equivalent, excluding emissions and removals of CO_2 from land use, land use change and forestry, increased by 7.1% between 1990 and 2007 (from 516 to 553 millions of CO_2 equivalent tons), while the national Kyoto target is a reduction of 6.5% as compared to the base year levels by the period 2008-2012.
The most important greenhouse gas, CO_2, which accounted for 86.0% of total emissions in CO_2 equivalent in 2007, showed an increase by 9.3% between 1990 and 2007. In the energy sector, specifically, emissions in 2007 were 10.2% greater than in 1990.

CH_4 and N_2O emissions were equal to 6.9% and 5.8%, respectively, of the total CO_2 equivalent greenhouse gas emissions in 2007. Both gases showed a decrease from 1990 to 2007, equal to 8.4% and 14.9% for CH_4 and N_2O, respectively.

Other greenhouse gases, HFCs, PFCs and SF_6, ranged from 0.1% to 1.2% 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 1990-2007, expressed in CO_2 equivalent terms, by substance and category.

GHG Emissions	1990 (base year)	1995	2000	2001	2002	2003	2004	2005	2006	2007
	CO_2 equivalent (Gg)									
CO_2 emissions including net CO_2 from LULUCF	367,036.98	359,584.64	383,389.41	375,767.27	374,906.87	359,144.61	397,091.49	394,682.39	395,617.40	404,175.53
CO_2 emissions excluding net CO_2 from LULUCF	434,687.67	445,400.65	462,715.45	468,439.04	470,590.27	486,014.24	488,969.97	490,056.41	485,753.66	475,302.06
CH_4 emissions including CH_4 from LULUCF	41,881.77	44,184.91	44,283.69	42,977.57	41,870.01	41,143.38	39,872.85	39,678.68	38,074.79	38,414.21
CH_4 emissions excluding CH_4 from LULUCF	41,738.88	44,157.53	44,196.69	42,922.38	41,839.08	41,078.41	39,838.23	39,644.52	38,044.18	38,217.46
N_2O emissions including N_2O from LULUCF	37,414.74	38,563.14	39,781.10	39,793.53	39,056.12	38,558.95	39,645.33	37,902.46	32,841.82	31,855.78
N_2O emissions excluding N_2O from LULUCF	37,400.24	38,364.14	39,772.27	39,787.93	39,052.98	38,552.36	39,641.82	37,898.99	32,540.21	31,835.81
HFCs	351.00	671.29	1,985.67	2,549.75	3,099.90	3,795.82	4,514.91	5,267.03	5,956.20	6,700.69
PFCs	1,807.65	490.80	345.85	451.24	423.74	497.63	347.89	352.62	282.30	287.78
SF_6	332.92	601.45	493.43	795.34	739.72	467.56	502.14	465.39	405.87	427.55
Total (including LULUCF)	**448,825.07**	**444,096.25**	**470,279.15**	**462,334.69**	**460,096.36**	**443,607.96**	**481,974.60**	**478,348.57**	**473,178.39**	**481,861.53**
Total (excluding LULUCF)	**516,318.37**	**529,685.87**	**549,509.36**	**554,945.68**	**555,745.69**	**570,406.02**	**573,814.96**	**573,684.95**	**562,982.42**	**552,771.35**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990 (base year)	1995	2000	2001	2002	2003	2004	2005	2006	2007
	CO_2 equivalent (Gg)									
1. Energy	418,945.37	431,961.27	450,722.44	455,289.63	457,263.97	471,622.91	473,756.12	474,505.53	469,585.98	458,672.79
2. Industrial Processes	36,466.66	34,530.35	34,903.34	36,946.22	37,039.91	38,231.91	40,522.46	40,366.88	35,915.85	36,295.95
3. Solvent and Other Product Use	2,394.46	2,179.77	2,284.53	2,210.51	2,219.20	2,166.67	2,143.88	2,139.11	2,146.55	2,132.81
4. Agriculture	40,576.25	40,348.92	39,939.85	38,953.95	38,250.04	38,101.53	37,917.46	37,241.73	36,627.42	37,210.50
5. Land Use, Land-Use Change and Forestry [(5)]	-67,493.30	-85,589.62	-79,230.21	-92,610.99	-95,649.34	-126,798.06	-91,840.36	-95,336.38	-89,804.03	-70,909.82
6. Waste	17,935.63	20,665.57	21,659.21	21,545.38	20,972.57	20,283.00	19,475.03	19,431.70	18,706.62	18,459.31
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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

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

The energy sector is the largest contributor to national total GHG emissions with a share, in 2007, of 83.0%. Emissions from this sector increased by about 9.5% from 1990 to 2007. Substances with the highest increase rates were CO_2, whose levels increased by 10.2% from 1990 to 2007 and accounts for 97.4% of the total in the energy sector, and N_2O which showed an increase of 18.0% but its share out of the sectoral total is only 1.2%; CH_4, on the other hand, showed a decrease of 27.7% from 1990 to 2007 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 was observed in the transport, in the energy industries and in the other sectors, about 25.1%, 17.6% and 4.8%, respectively; in 2007 these sectors, altogether, account for 80.6% of total emissions.

For the industrial processes sector, emissions showed a a decrease of 0.5% from the base year to 2007. Specifically, by substance, CO_2 emissions account for 74.2% and showed a decrease by about 1.0%, due to opposite trends, specifically an increase of the mineral sector production and decrease of chemical and metal production emissions. CH_4 decreased by 40.3%, but it accounts only for 0.2%, while N_2O, whose levels share 5.2% of total industrial emissions, decreased by 71.7% due to the fully operational abatement technology in the adipic acid industry. A considerable increase was observed in F-gas emissions (about 197.6%), whose level on total sectoral emissions is 20.4%.

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 10.9% from 1990 to 2007. The reduction is mainly to be attributed to a decrease by 14.9% in CO_2 emissions, which account for 63.8% of the sector. As regards CO_2, emission levels from paint application sector, which accounts for 51.4% of total CO_2 emissions from this sector, decreased by 17.2%; emissions from other use of solvents in related activities, such as domestic solvent use other than painting, application of glues and adhesives, printing industries, fat edible and non edible oil extraction, vehicle dewaxing, glass wool enduction, which account for 43.6% of the total, show an increase of 2.8%. Finally, CO_2 emissions from metal degreasing and dry cleaning activities, decreased by 61.3% but they account for only 5.0% of the total.
The level of N_2O emissions, on the other hand, did not show a significant variation from 1990 to 2007 (-3.0%).

For agriculture, emissions refer to CH_4 and N_2O levels, which account for 42.0% and 58.0% of the sector, respectively. The decrease observed in the total emissions (-8.3%) was mostly due to the decrease of CH_4 emissions from enteric fermentation (-9.5%), which account for 29.6%, and to a minor decrease from manure management (-7.2%), which accounts for 18.4% of the sectoral emissions.

Finally, emissions from the waste sector increased by 2.9% from 1990 to 2007 due to an increase in the emissions from solid waste disposal (0.3%), which account for 72.3% of waste emissions and from waste-water handling, which increased of about 15.6% and accounts for 24.1% of the total. The most important greenhouse gas in this sector is CH_4 which accounts for 87.0% of the sectoral emissions and shows an increase of 3.9% from 1990 to 2007. N_2O levels increased by 9.5%, whereas CO_2 decreased by 49.7%; these gases account for 11.6% and 1.5%, respectively.

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

Source category	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
1A. Energy: fuel combustion	**408,183**	**421,904**	**441,713**	**446,780**	**448,960**	**462,891**	**465,889**	**466,669**	**462,203**	**451,425**
CO_2: 1. Energy Industries	134,092	137,973	146,913	150,303	157,183	158,253	157,142	159,308	159,179	157,850
CO_2: 2. Manufacturing Industries and Construction	88,937	87,955	88,134	85,412	81,540	86,418	86,244	81,732	82,106	78,867
CO_2: 3. Transport	101,269	111,446	120,109	122,181	124,143	125,106	127,091	125,830	127,151	127,212
CO_2: 4. Other Sectors	76,677	76,090	78,596	81,373	78,782	85,362	87,083	91,844	85,967	79,746
CO_2: 5. Other	1,046	1,440	806	354	314	660	1,091	1,198	982	896
CH_4	1,548	1,701	1,494	1,456	1,345	1,343	1,359	1,297	1,318	1,412
N_2O	4,614	5,298	5,661	5,701	5,655	5,749	5,880	5,462	5,501	5,442
1B2. Energy: fugitives from oil & gas	**10,762**	**10,057**	**9,010**	**8,510**	**8,304**	**8,732**	**7,867**	**7,836**	**7,383**	**7,248**
CO_2	3,341	3,174	2,585	2,440	2,261	2,834	2,152	2,112	2,189	2,176
CH_4	7,420	6,882	6,424	6,069	6,042	5,896	5,713	5,723	5,193	5,071
N_2O	1	1	1	1	1	1	1	1	1	1
2. Industrial processes	**36,467**	**34,530**	**34,903**	**36,946**	**37,040**	**38,232**	**40,522**	**40,367**	**35,916**	**36,296**
CO_2	27,190	25,415	24,097	24,858	24,818	25,856	26,653	26,457	26,559	26,924
CH_4	108	113	63	59	57	58	61	64	66	65
N_2O	6,676	7,239	7,918	8,232	7,902	7,557	8,443	7,760	2,647	1,891
HFCs	351	671	1,986	2,550	3,100	3,796	4,515	5,267	5,956	6,701
PFCs	1,808	491	346	451	424	498	348	353	282	288
SF_6	333	601	493	795	740	468	502	465	406	428
3. Solvent and other product use	**2,394**	**2,180**	**2,285**	**2,211**	**2,219**	**2,167**	**2,144**	**2,139**	**2,147**	**2,133**
CO_2	1,598	1,424	1,274	1,295	1,306	1,310	1,315	1,331	1,354	1,361

Source category	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
N_2O	796	756	1,011	915	913	857	829	808	793	772
4. Agriculture	**40,576**	**40,349**	**39,940**	**38,954**	**38,250**	**38,102**	**37,917**	**37,242**	**36,627**	**37,210**
CH_4: Enteric fermentation	12,179	12,267	12,165	11,340	11,030	11,056	10,836	10,844	10,629	11,027
CH_4: Manure management	3,462	3,286	3,278	3,343	3,263	3,252	3,156	3,151	3,031	3,057
CH_4: Rice Cultivation	1,562	1,657	1,382	1,382	1,420	1,463	1,534	1,472	1,477	1,523
CH_4: Field Burning of Agricultural Residues	13	13	12	11	13	11	14	13	13	13
N_2O: Manure management	3,921	3,782	3,862	4,000	3,847	3,816	3,731	3,725	3,618	3,797
N_2O: Agriculture soils	19,435	19,340	19,237	18,875	18,673	18,500	18,643	18,032	17,856	17,791
N_2O: Field Burning of Agricultural Residues	4	4	4	4	4	4	4	4	4	4
5A. Land-use change and forestry	**-67,493**	**-85,590**	**-79,230**	**-92,611**	**-95,649**	**-126,798**	**-91,840**	**-95,336**	**-89,804**	**-70,910**
CO_2	-67,651	-85,816	-79,326	-92,672	-95,683	-126,870	-91,878	-95,374	-90,136	-71,127
CH_4	143	27	87	55	31	65	35	34	31	197
N_2O	15	199	9	6	3	7	4	3	302	20
6. Waste	**17,936**	**20,666**	**21,659**	**21,545**	**20,973**	**20,283**	**19,475**	**19,432**	**18,707**	**18,459**
CO_2	537	483	202	222	245	216	199	245	267	270
CH_4	15,447	18,239	19,379	19,263	18,670	17,998	17,165	17,080	16,319	16,051
N_2O	1,952	1,944	2,079	2,061	2,058	2,069	2,111	2,107	2,121	2,138
TOTAL EMISSIONS (with LULUCF)	***448,825***	***444,096***	***470,279***	***462,335***	***460,096***	***443,608***	***481,975***	***478,349***	***473,178***	***481,862***
TOTAL EMISSIONS (without LULUCF)	***516,318***	***529,686***	***549,509***	***554,946***	***555,746***	***570,406***	***573,815***	***573,685***	***562,982***	***552,771***

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

ES.4. Other information

In Table ES.3 NO_X, CO, NMVOC and SO_2 emission trends from 1990 to 2007 are summarised. All gases showed a significant reduction in 2007 as compared to 1990 levels. The highest reduction is observed for SO_2 (-81.1%), while CO and NO_X emissions reduced by about 51.9% and 42.8% respectively, NMVOC levels showed a decrease by 38.4%.

Indirect greenhouse gases and SO2	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
	ktons									
NO_X	2,007	1,868	1,434	1,422	1,367	1,360	1,319	1,229	1,188	1,147
CO	6,927	6,876	4,857	4,646	4,218	4,064	3,881	3,506	3,342	3,334
NMVOC	1,939	2,001	1,565	1,500	1,431	1,373	1,319	1,248	1,221	1,194
SO_2	1,795	1,320	749	697	616	518	480	401	379	339

Table ES.3. Total emissions of indirect greenhouse gases and SO_2 (1990-2007) (Gg)

Sommario (*Italian*)

Nel documento "Italian Greenhouse Gas Inventory 1990-2007. National Inventory Report 2009" si descrive la comunicazione annuale italiana dell'inventario delle emissioni dei gas serra in accordo a quanto previsto nell'ambito della Convenzione Quadro sui Cambiamenti Climatici delle Nazioni Unite (UNFCCC), del protocollo di Kyoto. Tale comunicazione è anche trasmessa all'Unione Europea nell'ambito del Meccanismo di Monitoraggio dei Gas Serra.

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

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

I dati di emissione dei gas-serra, così come i risultati dei processi di *review*, sono pubblicati sul sito web del Segretariato della Convenzione sui Cambiamenti Climatici www.unfccc.int.

La serie storica nazionale delle emissioni è anche disponibile sul sito web all'indirizzo http://www.sinanet.apat.it/it/sinanet/serie_storiche_emissioni.

Da una analisi di sintesi della serie storica dei dati di emissione dal 1990 al 2007, si evidenzia che le emissioni nazionali totali dei sei gas serra, espresse in CO_2 equivalente, sono aumentate del 7.1% nel 2007 rispetto all'anno base (corrispondente al 1990), a fronte di un impegno nazionale di riduzione del 6.5% entro il periodo 2008-2012.

In particolare, le emissioni complessive di CO_2 sono pari all'86.0% del totale e risultano nel 2007 superiori del 9.3% rispetto al 1990, mentre le emissioni relative al solo settore energetico sono aumentate del 10.2%. Le emissioni di metano e di protossido di azoto sono pari rispettivamente a circa il 6.9% e 5.8% del totale e presentano andamenti in diminuzione sia per il metano (-8.4%) che per il protossido di azoto (-14.9%). Gli altri gas serra, HFC, PFC e SF_6, hanno un peso complessivo sul totale delle emissioni che varia tra lo 0.1% e l'1.2%; le emissioni degli HFC evidenziano una forte crescita, mentre le emissioni di PFC decrescono e quelle di SF_6 mostrano un minore incremento. Sebbene al momento tali variazioni non risultino determinanti ai fini del conseguimento degli obiettivi di riduzione delle emissioni, la significatività del trend degli HFC potrebbe renderli sempre più importanti nei prossimi anni.

Chapter 1: INTRODUCTION

1.1 Background information on greenhouse gas inventories and climate change

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

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

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

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

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

The Kyoto Protocol finally entered into force on 16th February 2005.

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

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

Specifically, the national GHG emission inventory is communicated through compilation of the Common Reporting Format (CRF), according to the guidelines provided by the United Nations Framework Convention on Climate Change and the European Union's Greenhouse Gas Monitoring Mechanism (IPCC, 1997; IPCC, 2000; IPCC, 2003; IPCC, 2006; EMEP/CORINAIR, 2005).

The inventory is updated annually in order to reflect revisions and improvements in methodology and availability of new information. Recalculations are applied retrospectively to earlier years, which account for any difference in previously published data.
The submission also provides for detailed information on emission figures and estimation methodologies in the annual National Inventory Report.

As follows, this report is compiled according to the guidelines on reporting as specified in the document FCCC/SBSTA/2002/L.5. It provides an analysis of the 2007 Italian GHG emission inventory, and a revision of the entire time series 1990-2006, communicated in the framework of the Climate Change Convention and the Kyoto Protocol. It is also the annual submission to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism.

The assigned amount for Italy, pursuant to Article 3, paragraphs 7 and 8, of the Kyoto Protocol, and calculated in accordance with the annex to decision 13/CMP.1, has been established during the last in country review in 2007. The commitment period reserve (CPR), required in accordance with paragraph 18 of decision 15/CMP.1, has also been calculated and confirmed during the review. The determined figures are reported in the document FCCC/IRR/2007/ITA and amount to 2,416,277,898 tonnes CO_2 eq., for the assigned amount, and 2,174,650,108 tonnes of CO_2 eq., for the CPR. The CRP is calculated on the basis of the assigned amount so it has not change from the previous submissions.

Emission estimates comprise the six direct greenhouse gases under the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride) which contribute directly to climate change owing to their positive radiative forcing effect and four indirect greenhouse gases (nitrogen oxides, carbon monoxide, non-methane volatile organic compounds, sulphur dioxide).
The CRF files, the national inventory reports and other related documents are available at the address http://www.sinanet.apat.it/it/sinanet/serie_storiche_emissioni.
The official inventory submissions can also be found at the UNFCCC website http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/4303.php.

1.2 Description of the institutional arrangement for inventory preparation

1.2.1 National Inventory System

The Legislative Decree 51 of March 7th 2008 institutes the National System for the Italian Greenhouse Gas Inventory.
As required by article 5.1 of the Kyoto Protocol, Annex I Parties shall have in place a National System by the end of 2006 at the latest for estimating anthropogenic greenhouse gas emissions by sources and removals by sinks and for reporting and archiving inventory information according to the guidelines specified in the 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.
The 'National Registry for Carbon sinks', instituted by a Ministerial Decree on 1st April 2008, is part of the Italian National System and includes information on units of lands subject of activities under Article 3.3 and activities elected under Article 3.4 and related carbon stock changes. The National Registry for Carbon sinks is the instrument to estimate, in accordance with the COP/MOP

decisions, the IPCC Good Practice Guidance on LULUCF and every relevant IPCC guidelines, the greenhouse gases emissions by sources and removals by sinks in forest land and related land-use changes and to account for the net removals in order to allow the Italian Registry to issue the relevant amount of removal units (RMUs). Detailed information on the Registry is included in Annex 10, whereas additional information on activities under Article 3.3 and Article 3.4 is reported in paragraph 1.2.2.

The Italian National System, currently in place, is fully described in the document 'National Greenhouse Gas Inventory System in Italy' (APAT, 2008[a]). No changes with respect to the last year submission occurred in the National System. A summary picture is reported herebelow.

As indicated by art. 14 bis of the Legislative Decree, the Institute for Environmental Protection and Research (ISPRA), former Agency for Environmental Protection and Technical Services (APAT), is the single entity in charge of the development and compilation of the national greenhouse gas emission. The Institute for Environmental Protection and Research (ISPRA) was established by Italian Law 133/2008 and performs the functions of three former institutions: APAT, ICRAM (Central Institute for Applied Marine Research) and INFS (National Institute for Wildlife).
The Ministry for the Environment, Land and Sea is responsible for the endorsement of the inventory and for the communication to the Secretariat of the Framework Convention on Climate Change and the Kyoto Protocol. The inventory is also submitted to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism.

The Institute develops annually a national system document which includes all updated information on institutional, legal and procedural arrangements for estimating emissions and removals of greenhouse gases and for reporting and archiving inventory information. The last year report is publicly available at http://www.apat.gov.it/site/_files/NationalSystemItaly08.pdf.

A specific unit of the Institute is responsible for the compilation of the Italian Atmospheric Emission Inventory and the Italian Greenhouse Gas Inventory in the framework of the Convention on Climate Change and the Convention on Long Range Transboundary Air Pollution. The whole inventory is compiled by the Institute; scientific and technical institutions and consultants may help in improving information both on activity data and emission factors of some specific activities. All the measures to guarantee and improve the transparency, consistency, comparability, accuracy and completeness of the inventory are undertaken.
ISPRA (former APAT) bears the responsibility for the general administration of the inventory, co-ordinates participation in reviews, publishes and archives the inventory results.
Specifically, ISPRA is responsible for all aspects of national inventory preparation, reporting and quality management. Activities include the collection and processing of data from different data sources, the selection of appropriate emissions factors and estimation methods consistent with the IPCC 1996 Revised Guidelines, the IPCC Good Practice Guidance and Uncertainty management and the IPCC Good Practice Guidance for land use, land-use change and forestry, the compilation of the inventory following the QA/QC procedures, the assessment of uncertainty, the preparation of the National Inventory Report and the reporting through the Common Reporting Format, the response to the review process, the updating and data storage.

Different institutions are responsible for statistical basic data and data publication, which are primary to ISPRA for carrying out emission estimates. These institutions are part of the National Statistical System (Sistan), which provides national official statistics, and therefore are asked periodically to update statistics; moreover, the National Statistical System ensures the homogeneity of the methods used for official statistics data through a coordination plan, involving the entire public administration at central, regional and local levels.

The National Statistical System is coordinated by the Italian National Institute of Statistics (ISTAT) whereas other bodies, joining the National Statistical System, are the statistical offices of ministries, national agencies, regions and autonomous provinces, provinces, municipalities, research institutes, chambers of commerce, local governmental offices, some private agencies and private subjects who have specific characteristics determined by law.
The Italian statistical system was instituted on 6th September 1989 by the Legislative Decree n. 322/89, which established guiding principles and criteria for reforming public statistics. This decree addresses to all public statistical bodies and agencies which provide official statistics both at local, national and international level in order to assure homogeneity of the methods and comparability of the results. To this end, a national statistical plan which defines surveys, data elaborations and project studies for a three-year period shall be drawn up and updated annually, as established in the Decree n. 322/89. The procedures to be followed with relation to the annual fulfilment as well as the forms to be filled in for census, data elaborations and projects, and how to deal with sensitive information are also defined.
The plan is deliberated by the Committee for addressing and coordinating statistical information (Comstat) and forwarded to the Commission for the assurance of statistical information; the Commission adopts the plan after endorsement of the Guarantor of the privacy of personal data.
Finally, the plan is approved by a Prime Ministerial Decree after consideration of the Interministerial Committee for economic planning (Cipe). The latest Prime Ministerial Decree, which approved the three-year plan for 2008-2010, was issued on 6th August 2008. The statistical information and results deriving from the completion of the plan are of public domain and the system is responsible for wide circulation.
Ministries, public agencies and other bodies are obliged to provide the data and information specified in the annual statistical plan; the same obligations regard the private entities. All the data are protected by the principles of statistical disclosure control and can be distributed and communicated only at aggregate level even though microdata can circulate among the subjects of the Statistical System.
Sistan activity is supervised by the Commission for Guaranteeing Statistical Information (CGIS) which is an external and independent body. In particular, the Commission supervises: the impartiality and completeness of statistical information, the quality of methodologies, the compliance of surveys with EU and international directives. The Commission, established within the Presidency of the Council of Ministers, is composed of high-profile university professors, directors of statistical or research institutes and managers of public administrations and bodies, which do not participate at Sistan.

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

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

The national emission inventory itself is a Sistan product.

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

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

The 'National Registry for Carbon sinks' has been instituted by a Ministerial Decree on 1st April 2008 and is part of the National Greenhouse Gas Inventory System in Italy (APAT, 2008 [a]); at the moment, there isn't a fund for the activities related to art. 3.3 and 3.4 of Kyoto, considering that the fund of 2 million euros per year for each of the years 2008, 2009 and 2010 established in the Budget Law 2008 (subparagraph 335) was zeroed by the actual Government. The National Registry for Carbon sinks should have been in place from January 2008, to supply data for the first Kyoto submission in January 2010. Up to now, National Registry for Carbon Sinks is not operational even though, in the last months, a technical group, formed by experts from different istitutions (ISPRA, Ministry for the Environment, Land and Sea, Ministry of Agriculture, Food and Forest Policies and University of Tuscia), is working to set up the methodological plan of the activities and define the relative funding.

The description of the main elements of the institutional arrangement under Article 3.3 and activities elected under Article 3.4 is detailed in Annex 10.

The forest definition adopted by Italy agrees with the Food and Agriculture Organization of the United Nations definitions, therefore the threshold values for tree crown cover, land area and tree height are applied:

a. a minimum area of land of 0.5 hectares;
b. tree crown cover of 10 per cent;
c. minimum tree height of 5 meters.

Deforestation data will be derived from administrative records, inventory data and mapping information. These sources of information will be also used to distinguish deforestation from harvested areas.

Regarding the selection of activities under Article 3, paragraph 4, for accounting in the first commitment period, Italy has elected forest management activity. Under SBSTA conclusion FCCC/SBSTA/2006/L.6 and related COP/MOP2 decision[1], credits from forest management are capped, in the first commitment period, to 2.78 Mt C per year times fives. Italy intends to account for Article 3.3 and 3.4 elected activities for the entire commitment period.

1.2.3 National Registry System

The Italian Government modified the previous Legislative Decree 216/2006 which enforced the Directive 87/2003/CE, by the new Legislative Decree 51 of March 7th 2008. Due to this new Decree, ISPRA (former APAT) is responsible for developing, operating and maintaining the national registry under Directive 2003/87/CE; the Institute performs these tasks under the supervision of the national Competent Authority for the implementation of directive 2003/87/CE, jointly established by the Ministry for Environment, Land and Sea and the Ministry for Economic Development. ISPRA, as Registry Administrator, becomes responsible for the management and functioning of the Registry, including Kyoto protocol obligations.

[1] FCCC/KP/CMP/2006/10/Add.1 - Decision 8/CMP.2, Forest management under Article 3, paragraph 4, of the Kyoto Protocol: Italy

The Decree 51/2008 also establishes that the economic resources for the technical and administrative support of the Registry will be supplied to ISPRA by operators paying a fee for the use of the Registry. The amount of such a fee will be regulated by a future Decree.

Italy carried out all required steps of the initialization process with the UNFCCC: in particular, Italy successfully performed and passed:

- SSL connectivity testing (Oct. 26th 2007);
- VPN connectivity testing (Oct. 15th 2007);
- Interoperability test according to Annex H of the UN Data Exchange Standards (DES) (Nov. 9th 2007),

and submitted all required information through a complete Readiness questionnaire.

This implies that the Italian registry fulfilled all of its obligations regarding conformity with the UN DES. These obligations include having adequate transaction procedures, adequate security measures to prevent and resolve unauthorized manipulations and adequate measures for data storage and registry recovery. The registry was therefore deemed fully compliant with the registry requirements defined in decisions 13/CMP.1 and 5/CMP.1.

As a result, Italy could participate to the "ETS go-live" event that took place in October 2008.
After successful completion of the go-live process on 16th October 2008, the Italian registry commenced live operations with the ITL and it's been operational ever since.

All data referring to units holdings and transactions during the year 2008 are reported in the SEF submission. All relevant figures are included in Annex 11. In 2008, no discrepant transactions, no invalid units, no CDM notifications or non-replacements, have been detected.
Information on accounts, legal entities, Art. 6 projects, holdings and transactions is publicly available at www.greta-public.sinanet.apat.it.

At present, Italy is also operating its registry under Article 19 of Directive 2003/87/CE establishing the EU Emission Trading Scheme and according to Regulation No. 2216/2004 of the European Commission, which require national registries to be compliant with the UN DES document.
The Italian registry is based on the GRETA registry software developed by the UK Department for Environment, Food and Rural Affairs (DEFRA) and used by many other Member States. Currently, the development of this software adheres to the standards specified in Draft #7 of the UN DES document. Italy had the registry systems tested successfully with the EU Commission on February 6th 2006; the connection between the registry's production environment and the CITL was established on March 13th 2006 and the Registry has since gone live, starting on March 28th 2006.
Detailed information on the national registry is reported in Annex 11.

1.3 Brief description of the process of inventory preparation

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

The main basic data needed for the preparation of the GHG inventory are energy statistics published by the Ministry of Economic Development Activities (MSE) in the National Energy Balance (BEN), statistics on industrial and agricultural production published by the National Institute of Statistics (ISTAT), statistics on transportation provided by the Ministry of Transportation (MINT), and data supplied directly by the relevant professional associations.
Emission factors and methodologies used in the estimation process are consistent with the IPCC Good Practice Guidance and supported by national experiences and circumstances. Final decisions are up to inventory experts, taking into account all the information available.

For the industrial sector, emission data collected through the National Pollutant Emission Register (EPER, E-PRTR), the Large Combustion Plant (LCP) Directive and in the framework of the European Emissions Trading Scheme have yielded considerable developments in the inventory of the relative sectors. In fact, these data, even if not always directly used, are taken into account as a verification of emission estimates and improve national emissions factors as well as activity data figures.
In addition, final estimates are checked and verified also in view of annual environmental reports by industries.
For large industrial point sources, emissions are registered individually, when communicated, based upon detailed information such as fuel consumption.
Other small plants communicate their emissions which are also considered individually.

Emission estimates are drawn up for each sector. Final data are communicated to the UNFCCC Secretariat filling in the CRF files.

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

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

Technical reports and emission figures are publicly accessible by website at the address http://www.sinanet.apat.it/it/sinanet/serie_storiche_emissioni.

1.4 Brief general description of methodologies and data sources used

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

Methodologies are consistent with the Revised 1996 IPCC Guidelines, IPCC Good Practice Guidance and EMEP-CORINAIR Emission Inventory Guidebook (IPCC, 1997; IPCC, 2000; IPCC, 2003; EMEP/CORINAIR, 2007); national emission factors are used as well as default emission factors from international guidebooks, when national data are not available. The development of national methodologies is supported by background documents.

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

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

In Table 1.2 a summary of the methods and emission factors used in the compilation of the Italian inventory is reported. A more detailed table, as communicated to the European Community in the framework of the monitoring mechanism of GHG emission inventory for the purpose of Article 4(1)(b) under the Implementing Provisions (EC, 2005), is included in Annex 9.

SUMMARY 3 SUMMARY REPORT FOR METHODS AND EMISSION FACTORS USED

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

Use the following notation keys to specify the method applied:

D (IPCC default) **T1a, T1b, T1c** (IPCC Tier 1a, Tier 1b and Tier 1c, respectively) **CR** (CORINAIR)

RA (Reference Approach) **T2** (IPCC Tier 2) **CS** (Country Specific)

T1 (IPCC Tier 1) **T3** (IPCC Tier 3) **OTH** (Other)

If using more than one method within one source category, list all the relevant methods. Explanations regarding country-specific methods, other methods or any modifications to the default IPCC methods, as well as information

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

D (IPCC default) **CS** (Country Specific) **OTH** (Other)

CR (CORINAIR) **PS** (Plant Specific)

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

Table 1.2 Methods and emission factors used in the inventory preparation

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

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

The analysis of data from the Italian Emissions Trading Scheme database is used to develop country-specific emission factors and check activity data levels.

For the industrial sector, the annual production data are provided by national and international statistical yearbooks. Emission data collected through the National Pollutant Emission Register (EPER, E-PRTR) are also used in the development of emission estimates or taken into account as a verification of emission estimates for some specific categories. According to the Italian Decree of 23 November 2001, data from the Italian EPER are validated and communicated by ISPRA to the Ministry for the Environment, Land and Sea and to the European Commission within October of the current year for data referring to the previous year. These data are used for the compilation of the inventory whenever they are complete in terms of sectoral information; in fact, industries communicate figures only if they exceed specific thresholds; furthermore, basic data such as fuel consumption are not supplied and production data are not split by product but reported as an overall value. Anyway, 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 sectoral emission estimates.
In addition, final emissions are checked and verified also taking into account figures reported by industries in their annual environmental reports.

Both for energy and industrial processes, emissions of large industrial point sources are registered individually; communication also takes place in the framework of the European Directive on Large Combustion Plants, based upon detailed information such as fuel consumption. Other small plants communicate their emissions which are also considered individually.

For the other sectors, i.e. for solvents, the amount of solvent use is provided by environmental publications of sector industries and specific associations as well as international statistics.
For agriculture, annual production data and number of animals are provided by the National Institute of Statistics and other sectoral associations.
For land use, land use change and forestry, forest and soil surfaces are provided by the National Institute of Statistics while statistics on forest fires are supplied by the State Forestry Corps.
For waste, the main activity data are provided by the Agency for Environmental Protection and Technical Services and the Waste Observatory.

In case basic data are not available proxy variables are considered; unpublished data are used only if supported by personal communication and confidentiality of data is respected.
All the material and documents used for the inventory emission estimates are stored at the Agency for Environmental Protection and Technical Services. The inventory is composed by spreadsheets to calculate emission estimates; activity data and emission factors as well as methodologies are referenced to their data sources. A 'reference' database has also been developed to increase the transparency of the inventory.

1.5 Brief description of key categories

A key category analysis of the Italian inventory is carried out according to the Tier 1 and Tier 2 methods described in the IPCC Good Practice Guidance with and without emissions and removals from the LULUCF sector (IPCC, 2000; IPCC, 2003). According to these guidelines, a key category is defined as an emission category that has a significant influence on a country's GHG inventory in terms of the absolute level and trend in emissions and removals, or both. Key categories are those which, when summed together in descending order of magnitude, add up to over 95% of the total emissions.

National emissions have been disaggregated into the categories proposed in the Good Practice Guidance; other categories have been added to reflect specific national circumstances. Both level and trend analysis have been applied to the last submitted inventory; a key category analysis has also been carried out for the base year emission levels.

For the base year, 19 sources were individuated according to the Tier 1 approach, whereas 22 sources were carried out by the Tier 2. Including the LULUCF categories in the analysis, 25 categories were selected jointly by the Tier 1 and the Tier 2. The description of these sources is shown in Table 1.3 and Table1.4.

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

L1 = level key category by Tier 1
L2 = level key category by Tier 2
L = level key category by Tier 1 and Tier 2

Table 1.3 Key categories (excluding LULUCF) by the IPCC Tier 1 and Tier 2 approaches (L=Level). Base year

Key categories (including the LULUCF sector)	
CO_2 stationary combustion liquid fuels	L
CO_2 stationary combustion solid fuels	L
CO_2 stationary combustion gaseous fuels	L
N_2O stationary combustion	L
CO_2 Mobile combustion: Road Vehicles	L
CH_4 Fugitive emissions from Oil and Gas Operations	L
CO_2 Cement production	L
CH_4 Enteric Fermentation in Domestic Livestock	L
CH_4 Manure Management	L
N_2O Manure Management	L
Direct N_2O Agricultural Soils	L
Indirect N_2O from Nitrogen used in agriculture	L
CH_4 from Solid waste Disposal Sites	L
CO_2 Forest land remaining Forest land	L

L1 = level key category by Tier 1
L2 = level key category by Tier 2
L = level key category by Tier 1 and Tier 2

CO_2 Cropland remaining Cropland	L
CO_2 Land converted to Forest Land	L
CO_2 Fugitive emissions from Oil and Gas Operations	L
CO_2 Mobile combustion: Waterborne Navigation	L1
CO_2 Iron and steel production	L1
N_2O Adipic Acid	L1
CO_2 Limestone and Dolomite Use	L1
N_2O from animal production	L2
CH_4 Emissions from Wastewater Handling	L2
CO_2 Emissions from solvent use	L2
CO_2 Land converted to Settlements	L2

Table 1.4 Key categories (including LULUCF) by the IPCC Tier 1 and Tier 2 approaches (L=Level). Base year

Applying the category analysis to the 2007 inventory, without considering the LULUCF sector, 29 key categories were totally individuated, both at level and trend. Results are reported in Table 1.5.

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

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

Table 1.5 Key categories (excluding LULUCF) by the IPCC Tier 1 and Tier 2 approaches (L=Level, T=Trend). Year 2007

If considering emissions and removals from the LULUCF sector, 28 key categories were individuated as reported in Table 1.6.
There are no additional categories as compared to the previous analysis expect for those referring to the LULUCF sector.

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

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

Table 1.6 Key categories (including LULUCF) by the IPCC Tier 1 and Tier 2 approaches (L=Level, T=Trend). Year 2007.

It should be noted that higher tiers are mostly used for calculating emissions from these categories as requested by the Good Practice Guidance (IPCC, 2000).

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

ISPRA has elaborated an inventory QA/QC plan which describes specific QC procedures to be implemented during the inventory development process, facilitates the overall QA procedures to be conducted, to the extent possible, on the entire inventory and establishes quality objectives.
Particularly, an inventory QA/QC procedures manual (APAT, 2006 [b]) has been drawn up which describes QA/QC procedures and verification activities to be followed during the inventory compilation and helps in the inventory improvement. Furthermore, specific QA/QC procedures and different verification activities implemented thoroughly the current inventory compilation, as part of the estimation process, are figured out in the annual QA/QC plans (APAT, 2005; APAT, 2006 [c]; APAT, 2007 [a]; APAT, 2008 [b]). These documents are publicly available at ISPRA website http://www.apat.gov.it/site/it-IT/APAT/Pubblicazioni/Altre_Pubblicazioni.html.

Quality control checks and quality assurance procedures together with some verification activities are applied both to the national inventory as a whole and at sectoral level. Future planned improvements are prepared for each sector, by the relevant inventory compiler; each expert

identifies areas for sectoral improvement based on his own knowledge and in response to inventory UNFCCC reviews and other kind of processes.
The quality of the inventory has improved over the years and further investigations are planned for all those sectors relevant in terms of contribution to total CO_2 equivalent emissions and with a high uncertainty.

In addition to *routine* general checks, source specific quality control procedures are applied on a case by case basis focusing on key categories and on categories where significant methodological and data revision have taken place or on new sources.
Checklists are compiled annually by the inventory experts and collected by the QA/QC coordinator. These lists are also registred in the 'reference' database.
General QC procedures also include data and documentation gathering. Specifically, the inventory analyst for a source category maintains a complete and separate project archive for that source category; the archive includes all the materials needed to develop the inventory for that year and is kept in a transparent manner.

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

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

Even though official independent and public reviews prior to the Italian inventory submission are not implemented yet, emission figures are subjected to a process of re-examination once the inventory, the inventory related publications and the national inventory reports are posted on website, specifically www.apat.gov.it, and from the communication of data to different institutions and/or at local level.
In some cases, sectoral major recalculations are presented and shared with the relevant stakeholders prior to the official submission.
For istance this year, there has been a revision of the methodology and an update of emission factors to estimate emissions from the aviation and maritime sectors. Emissions have also been calculated at point source level for the major airports and ports and results have been presented to the relevant sectoral authorities which comments have been considered before publishing the final figures. This work has also been develeped in the framework of the extension of the European Emissions Trading Scheme to the aviation sector.
In addition, for the industrial sector, different meetings have been held jointly with the industrial associations, the Ministries of the Environment and Economic Development and ISPRA in the framework of the European Emissions Trading Scheme, specifically for assessing carbon leakage in EU energy intensive industries; also in this context, estimations of the emission inventory for different sectors have been presented.

In 2008, ISPRA has finalised the provincial inventory at local scale for the years 1990, 1995, 2000 and 2005; in fact, every 5 years, in the framework of the Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) under the Convention on Long-range Transboundary Air Pollution (CLTRAP), Parties has to report their national air emissions disaggregated on a 50*50 km grid. Specifically, ISPRA has applied a top-down approach to estimate emissions at provincial areas based on proxy variables. The results were checked out by regional and local environmental agencies and authorities; data are already available at ISPRA web address http://www.sinanet.apat.it/it/inventaria and a report which describes detailed methodologies to carry out estimates is under publication.
The inventory is also presented to a Technical Committee on Emissions (CTE), coordinated by the Ministry for the Environment, Land and Sea, where all the relevant Ministries and local authorities are represented; within this task emission figures and results are shared and discussed.
Expert peer reviews of the national inventory also occur annually within the UNFCCC process, whose results and suggestions can provide valuable feedback on areas where the inventory should be improved. Specifically, in June 2007, Italy was subjected by the UNFCC Secretariat to the in-country review of the national initial report and the GHG inventory submitted in 2006, which results and recommendations can be found on website at the addresses http://unfccc.int/resource/docs/2007/arr/ita.pdf, http://unfccc.int/resource/docs/2007/irr/ita.pdf, (UNFCCC, 2007 [a]; UNFCCC, 2007 [b]). The results of the 2008 centralised review are reported in UNFCCC (2009).

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

The only official review, apart from those by the UNFCCC, was performed by Ecofys, in 2000, in order to verify of the effectiveness of policies and measures undertaken by Italy to reduce greenhouse gas emissions to the levels established by the Kyoto Protocol. In this framework an independent review and checks on emission levels were carried out as well as controls on the transparency and consistency of methodological approaches (Ecofys, 2001).

The preparation of environmental reports where data are needed at different aggregation levels or refer to different contexts, such as environmental and economic accountings, is also a check for emission trends. At national level, for instance, emission time series are reported in the Environmental Data Yearbooks published by the Agency. Emission data are also published by the Ministry for the Environment, Land and Sea in the Reports on the State of the Environment and the National Communications as well as in the Demonstrable Progress Report. Moreover, figures are communicated to the National Institute of Statistics to be published in the relevant Environmental Statistics Yearbooks as well as used in the framework of the EUROSTAT NAMEA Project.
At European level, ISPRA also reports on indicators meeting the requirements of Article 3 (1)(j) of Decision N° 280/2004/EC. In particular, Member States shall submit figures on specified priority indicators and should submit information on additional priority and supplementary indicators for the period from 1990 to the last submitted year and forecasts for some specified years. The national trends of these indicators are explained in the report 'Carbon Dioxide Intensity Indicators' (APAT, 2007 [b]; APAT, 2008 [b]). Also these reports are posted on ISPRA website http://www.apat.gov.it/site/it-IT/APAT/Pubblicazioni/Altre_Pubblicazioni.html.

Comparisons between national activity data and data from international databases are usually carried out in order to find out the main differences and an explanation to them. Emission intensity indicators among countries (e.g. emissions per capita, industrial emissions per unit of value added, road transport emissions per passenger car, emissions from power generation per kWh of electricity produced, emissions from dairy cows per tonne of milk produced) can also be useful to provide a preliminary check and verification of the order of magnitude of the emissions. This is carried out at European and international level by considering the annual reports compiled by the EC and the UNFCCC as well as related documentation available from international databases and outcome of relevant workshops.

Additional comparisons between emission estimates from industrial sectors and those published by the industry itself in their Environmental reports are carried out annually in order to assess the quality and the uncertainty of the estimates.

The quality of the inventory has also improved by the organization and participation in sector specific workshops. Follow-up processes are also set up in the framework of the WGI under the EC Monitoring Mechanism, which addresses to the improvement of different inventory sectors. Specifically in the last years, two workshops were held, one related to the management of uncertainty in national inventories and problems on the application of higher methodologies to calculate uncertainty figures, the other on how to use data from the European emissions trading scheme in the national greenhouse gas inventories. Previous workshops addressed methodologies to estimate emissions from the agriculture and LULUCF sectors, involving the Joint Research Centre, from the waste sector, involving the European Topic Center on Resource and Waste Management, as well as from international bunkers, involving the International Energy Agency and EUROCONTROL. Presentations and documentation of the workshops are available on the website at the address: http://air-climate.eionet.europa.eu/meetings/past_html.

A national conference on the Italian emission inventory was organized by ISPRA in October 2006. Methodologies used to carry out national figures and results of time series from 1990 to 2004 were presented detailing explanations for each sector. More than one hundred participants from national and local authorities, Ministries, Industry, Universities and Research organizations attended the two days meeting.

In 2007, in the context of the national conference on climate change a specific session was dedicated to the national emission inventory. In addition, a specific event was held on the results of the 2005 national GHG inventory.

A specific procedure undertaken for improving the inventory regards the establishment of national expert panels (in particular, in road transport, land use change and forestry and energy sectors) which involve, on a voluntary basis, different institutions, local agencies and industrial associations cooperating for improving activity data and emission factors accuracy. Specifically, for the LULUCF sector, following the election of the 3.3 and 3.4 activities and on account of an in-depth analysis on the information needed to report LULUCF under the Kyoto Protocol, a Scientific Committee, *Comitato di Consultazione Scientifica del Registro dei Serbatoi di Carbonio Forestali,* constituted by the relevant national experts has been established by the Ministry for the Environment, Land and Sea in cooperation with the Ministry of Agriculture, Food and Forest Policies.

In addition to these expert panels, ISPRA participates in technical working groups within the National Statistical System. These groups, named *Circoli di qualità*, coordinated by the National Institute of Statistics, are constituted by both producers and users of statistical information with the aim of improving and monitoring statistical information in specific sectors such as transport, industry, agriculture, forest and fishing. As reported in previous sections, these activities improve the quality and details of basic data, as well as enable a more organized and timely communication.

Other specific activities relating to improvements of the inventory and QA/QC practises in the last year regarded the progress on the building of a unique database where information collected in the framework of different European directives, Large Combustion Plant, EPER and Emissions Trading, are gathered together thus highlighting the main discrepancies in information and detecting potential errors. Even though the database is not completed yet all the figures are considered in an overall approach and used in the compilation of the inventory.

A summary of all the main QA/QC activies over the past years which ensure the continous improvement of the inventory is presented in the document 'Quality Assurance/Quality Control plan for the Italian Emission Inventory. Year 2008' (APAT, 2008 [a]).

A proper archiving and reporting of the documentation related to the inventory compilation process is also part of the national QA/QC programme.
All the material and documents used for the inventory preparation are stored at the Institute for Environmental Protection and Research.
Information relating to the planning, preparation, and management of inventory activities are documented and archived. The archive is organised so that any skilled analyst could obtain relevant data sources and spreadsheets, reproduce the inventory and review all decisions about assumptions and methodologies undertaken. A master documentation catalogue is generated for each inventory year and it is possible to track changes in data and methodologies over time. Specifically, the documentation includes:

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

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

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

The IPCC Good Practice Guidance (IPCC, 2000) defines the Tier 1 and Tier 2 approaches to estimating uncertainties in national greenhouse gas inventories. Quantitative estimates of the uncertainties for the Italian GHG inventory are calculated using a Tier 1 approach, which provides a calculation based on the error propagation equations. In addition, a Tier 2 approach, corresponding to the application of Monte Carlo analysis, has been applied to specific categories of the inventory but the results show that, with the information available at present, applying methods higher than the Tier 1 does not make a significant difference in figures. The Tier 2 approach was applied to CO_2 emissions from road transport and N_2O emissions from agricultural soils; in the first case measurements were available for emission factors so a low uncertainty was expected, in the other no information on EFs was available and a high uncertainty was supposed. A combination of Montecarlo and Bootstrap simulation was applied to CO_2 emissions, in consideration of the specific data availability assuming a normal distribution for activity data and for the emission factor of natural gas. The overall uncertainty of CO_2 emissions for road transport resulted in 2.06, lower than the Tier 1 approach which estimated a figure of 4.2; the reason of the difference is in the lower uncertainty resulting from the application of bootstrap analysis to the emission factor of diesel oil, all the other figures are very similar. For N_2O emissions from agricultural soils, a Montecarlo analysis was applied assuming a normal distribution for activity data and two tests one with a lognormal and the other with a normal for emission factors; the results with the normal distribution

calculated an uncertainty figure equal to 32.44, lower than the uncertainty by the Tier 1 approach which was 102; in the case of the lognormal distribution there were problems caused by the formula specified in the IPCC guidelines which is affected by the unit and needs further study before a throughout application. The importance of these results is that in neither of the cases does the uncertainty estimation of the national sectors result in an underestimation.
The results and details of the study, 'Evaluating uncertainty in the Italian GHG inventory', were presented at a EU workshop on Uncertainties in Greenhouse Gas Inventories, held in Finland in September 2005, and they are also available on website at the address
http://air-climate.eionet.europa.eu/docs/meetings/050905_EU_GHG_Uncert_WS/meeting050905.html.
A further research on uncertainty, specifically on the comparison of different methodologies to evaluate emissions uncertainty, was also carried out (Romano et al., 2004).
For the Italian inventory, the application of the Tier 1 approach is described in Annex 1 considering national total with or without emissions and removals from the LULUCF sector. Emission sources are disaggregated into a detailed level and uncertainties are therefore estimated for these categories.
The Tier 1 approach estimates, for the 2007 total emission figures without LULUCF, an uncertainty of 3.3% in the combined global warming potential (GWP) total emissions, whereas for the trend between 1990 and 2007 the analysis assesses an uncertainty of 2.6%.
Including the LULUCF sector into the national figures, the uncertainty according to the Tier 1 approach is equal to 6.4% for the year 2007, whereas the uncertainty for the trend is estimated to be 5.3%.
The slight differences in the level uncertainty as compared the 2008 submission is due to the different weights of the different sources and the relative uncertainty figures.
The assessment of uncertainty has also been applied to the base year emission levels. The results show an uncertainty of 3.5% in the combined GWP total emissions, excluding emissions and removals from LULUCF, whereas it increases to 7.0% including the LULUCF sector.
QC procedures are also undertaken on the calculations of uncertainties in order to confirm the correctness of the estimates and that there is sufficient documentation to duplicate the analysis. The assumptions on which uncertainty estimations are based are documented for each category. Figures used to draw up uncertainty analysis are checked both with the relevant analyst experts and literature references and are consistent with the IPCC Good Practice Guidance (IPCC, 2000; IPCC, 2003).
More in details, plant data are used to check and verify data in the industrial sector; these data also include information from the European Emissions Trading Scheme, the European E-PRTR registry which is also collected and elaborated by the inventory team. Most of the times there is a correspondence among activity data from different databases so that the level of uncertainty could be assumed lower than the one fixed at 3%; the same occurs for emission factors coming from measurements at plant level, even in this case the uncertainty may be assumed lower than the predetermined level. Since the overall uncertainty of the Italian inventory is low due to the prevalence of the energy sector sources out of the total which estimates derive from accurate parameters, it has been decided to use conservative figures, especially for energy and industrial sectors. For the categories with a high uncertainty further improvements are planned whenever sectoral studies can be carried out. For this year, for example, researches have been implemented in the LULUCF sector examining all available national studies and researches, regarding C content of soils; results improves the accuracy of emission inventory although not allowing the update of the default uncertainty values used for those categories.

1.8 General assessment of the completeness

The inventory covers all major sources and sinks, as well as direct and indirect gases, included in the IPCC guidelines.

Sources and sinks not estimated (NE) [1]			
GHG	Sector [2]	Source/sink category [2]	Explanation
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	up to now there is a lack of data concerning urban tree formations. Therefore it is not possible to give estimates on the C stock changes in living biomass
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	up to now there is a lack of data concerning urban tree formations. Therefore it is not possible to give estimates on the C stock changes in living biomass
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	up to now there is a lack of data concerning urban tree formations. Therefore it is not possible to give estimates on the C stock changes in dead organic matter
Carbon	5 LULUCF	5.E.2.2 Cropland converted to Settlements	up to now there are no sufficient data for estimating C stock changes in dead organic matter.
Carbon	5 LULUCF	5.E.2.3 Grassland converted to Settlements	up to now there are no sufficient data for estimating C stock changes in dead organic matter.
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	up to now there is a lack of data concerning urban tree formations. Therefore it is not possible to give estimates on the C stock changes in soils
CH4	1 Energy	1.AA.2.D 1.AA.2.D Pulp, Paper and Print	emissions have not been estimated because fuel data are not available
CH4	1 Energy	1.C2 Multilateral Operations	information and statistical data are not available
CO2	1 Energy	1.AA.2.D 1.AA.2.D Pulp, Paper and Print	emissions have not been estimated because fuel data are not available
CO2	1 Energy	1.C2 Multilateral Operations	information and statistical data are not available
N2O	1 Energy	1.AA.2.D 1.AA.2.D Pulp, Paper and Print	emissions have not been estimated because fuel data are not available
N2O	1 Energy	1.C2 Multilateral Operations	information and statistical data are not available
N2O	3 Solvent and Other Product Use	3.D.4 Other Use of N2O	no information is available on other use of N2O

Table 1.7 Source and sinks not estimated in the 2007 inventory

Details are reported in Table 1.7 and Table 1.8. Sectoral and background tables of CRF sheets are complete as far as the details of basic information are available. For instance, multilateral operations emissions are not estimated because no activity data are available; pulp, paper and print emissions from the combustion of biomass are not estimated because no data on this use is available. There is no information on other use of N_2O for solvent and other product use except for the emissions reported.

Allocation of emissions is not consistent with the IPCC Guidelines only where there is no data available to split the information. For instance, for fugitive emissions, CO_2 and CH_4 emissions from oil and natural gas exploration and venting are included in those from oil production because no detailed information is available. CH_4 emissions from other leakage emissions are included in distribution emission estimates. N_2O emissions from oil and natural gas exploration and refining and storage activities are reported under category 1.B.2.C oil flaring. Further investigation will be carried out closely with industry about these figures. For industrial processes, emissions from soda ash use are included in glass production emissions because the use of soda is part of that specific production process.

Sources and sinks reported elsewhere (IE)[(3)]				
GHG	Source/sink category	Allocation as per IPCC Guidelines	Allocation used by the Party	Explanation
CH4	1.B.2.A.1 Exploration	1.B.2.A.1	1.B.2.A.2	Emissions are included in 1.B.2.A.2 Production
CH4	1.B.2.B.1 Exploration	1.B.2.B.1	1.B.2.B.2	Emissions are included in 1.B.2.B.2 Production
CH4	1.B.2.B.5.1 at industrial plants and power stations	1.B.2.B.5.1	1.A.1 /1.A.2	Emissions are reported under the respective sectors where they occurr
CH4	1.B.2.B.5.2 in residential and commercial sectors	1.B.2.B.5.2	1.A.4	Emissions are reported under the respective sectors where they occurr
CH4	1.B.2.C.1.1 Oil	1.B.2.C.1.1	1.B.2.A.2	Emissions are included in 1.B.2.A.2 Oil production
CH4	1.B.2.C.1.2 Gas	1.B.2.C.1.2	1.B.2.B.2	Emissions are included in 1.B.2.B.2 Gas production
CH4	1.B.2.C.2.2 Gas	1.B.2.C.2.2	1.B.2.B.2	Emissions are included in 1.B.2.B.2 Gas production
CH4	2.C.1.4 Coke	2.C.1.4	1.B.1.b	CH4 emissions from coke production are fugitive emissions due to the door leakage during the solid transformation and are reported under the 1.B.1.b category, fugitive emissions from solid fuel.
CH4	6.B.1 Industrial Wastewater	6.B.1 Industrial Wastewater/Sludge	6.B.1 Industrial Wastewater/Wastewater	Emissions are reported under 6.B.1 Industrial Wastewater/Wastewater
CH4	1.AA.3.B Road Transportation	1.AA.3B biomass	1.AA.3B liquid fuel	emissions are included in liquid fuel - gasoil/diesel category
CO2	1.B.2.A.1 Exploration	1.B.2.A.1	1.B.2.A.2	Emissions are included in 1.B.2.A.2 Production
CO2	1.B.2.B.1 Exploration	1.B.2.B.1	1.B.2.B.2	Emissions are included in 1.B.2.B.2 Production
CO2	1.B.2.C.1.1 Oil	1.B.2.C.1.1	1.B.2.A.2	Emissions are included in 1.B.2.A.2 Oil Production
CO2	1.B.2.C.1.2 Gas	1.B.2.C.1.2	1.B.2.B.2	Emissions are included in 1.B.2.B.2 Gas production
CO2	1.B.2.C.2.2 Gas	1.B.2.C.2.2	1.B.2.B.2	Emissions are included in 1.B.2.B.2 Gas production
CO2	2.A.4.2 Soda Ash Use	2.A.4.2	2.A.7	Emissions from soda ash use are included in other processes (glass, paper,etc).
CO2	5.A.1 Forest Land remaining Forest Land	5.A.1. - 5(V) - Biomass Burning - Wildfires	5.A.1 Carbon stock change	CO2 emissions due to wildfires in forest land remaining forest land are included in table 5.A.1, Carbon stock change in living biomass, Losses
N2O	1.B.2.A.1 Exploration	1.B.2.A.1	1.B.2.c.2	Emissions are included in 1.B.2.c.2 oil flaring
N2O	1.B.2.A.4 Refining / Storage	1.B.2.A.4	1.B.2.C.2	Emission are included in 1.B.2.C.2 flaring oil
N2O	6.B.1 Industrial Wastewater	6.B.1 Industrial Wastewater/Sludge	6.B.1 Industrial Wastewater/Wastewater	Emissions are reported under 6.B.1 Industrial Wastewater/Wastewater
N2O	6.B.2.1 Domestic and Commercial (w/o human sewage)	6.B.2.1 Domestic and commercial/Wastewater	6.B.2.2 Human sewage	Emissions are reported under 6.B.2.2 Human sewage
N2O	6.B.2.1 Domestic and Commercial (w/o human sewage)	6.B.2.1 Domestic and commercial/Sludge	6.B.2.2 Human sewage	Emissions are reported under 6.B.2.2 Human sewage
N2O	1.AA.3.B Road Transportation	1.AA.3B biomass	1.AA.3B liquid fuel	Emissions are included in liquid fuel - gasoil/diesel category
SF6	2.F.7 Semiconductor Manufacture	2.F.7 Semiconductor Manufacture/SF6/Amount of fluid in operating systems	2.F.7 Semiconductor Manufacture/SF6/Amount of fluid in new mnufactured products	Data are included in new manufactured products
SF6	2.F.7 Semiconductor Manufacture	2.F.7 Semiconductor Manufacture/SF6/Amount of fluid remained in products at decommissioning	2.F.7 Semiconductor Manufacture/SF6/Amount of fluid in new mnufactured products	Data are included in new manufactured products
SF6	2.F.7 Semiconductor Manufacture	2.F.7 Semiconductor Manufacture/SF6/Actual emissions from stocks	2.F.7 Semiconductor Manufacture/SF6/Actual emissions from manufacturing	Emissions are included in emissions from manufacturing
SF6	2.F.7 Semiconductor Manufacture	2.F.7 Semiconductor Manufacture/SF6/Actual emissions from disposal	2.F.7 Semiconductor Manufacture/SF6/Actual emissions from manufacturing	Emissions are included in emissions from manufacturing

Table 1.8 Source and sinks reported elsewhere in the 2007 inventory

Chapter 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 1990-2007 are reported in Tables A8.1- A8.5 of Annex 8.
The emission figures presented are those sent to the UNFCCC Secretariat and to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism.
Total greenhouse gas emissions, in CO_2 equivalent, excluding emissions and removals from LULUCF, have increased by 7.1% between 1990 and 2007, varying from 516 to 553 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 86.0% of total emissions in CO_2 equivalent, shows an increase by 9.3% between 1990 and 2007. In the energy sector, in particular, emissions in 2007 are 10.2% greater than in 1990.
CH_4 and N_2O emissions are equal, respectively, to 6.9% and 5.8% of the total CO_2 equivalent greenhouse gas emissions. CH_4 emissions have decreased by 8.4% from 1990 to 2007, while N_2O has decreased by 14.9%.
Other greenhouse gases, HFCs account for 1.2% of total emissions, PFCs and SF_6 are equal to 0.1% of total emissions; HFC emissions show a strong increase, while PFC emissions show a decrease and SF_6 emissions show a lighter increase. Although at present, variations in these gases are not relevant to reaching the emission reduction objectives, the meaningful increasing trend of HFCs will make them even more important in next years.
Figure 2.1 illustrates the national trend of greenhouse gases for 1990-2007, expressed in CO_2 equivalent terms and by substance; total emissions do not include emissions and removals from land use, land use change and forestry.

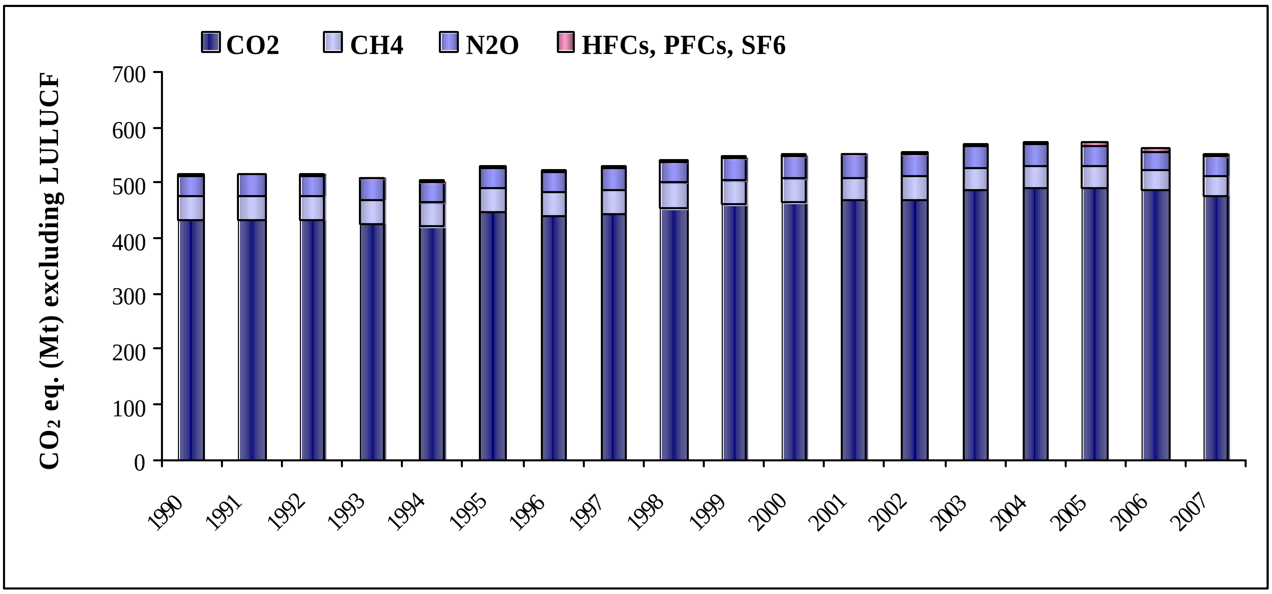


Figure 2.1 National greenhouse gas emissions from 1990 to 2007 (without LULUCF) (Mt CO_2 eq.)

The share of the different sectors in terms of total emissions remains nearly unvaried over the period 1990-2007. Specifically for the year 2007, the greatest part of the total greenhouse gas emissions is to be attributed to the energy sector, with a percentage of 83.0%, followed by agriculture and industrial processes, accounting respectively for 6.7% and 6.6% of total emissions, waste contributing with 3.3% and use of solvents with 0.4%.

Considering total greenhouse gas emissions with emissions and removals from LULUCF, the energy sector accounts, in 2007, for 73.5% of total emissions and removals, as absolute weight, followed by the LULUCF sector which contributes with 11.4%.
Figure 2.2 shows total greenhouse gas emissions and removals subdivided by sector.

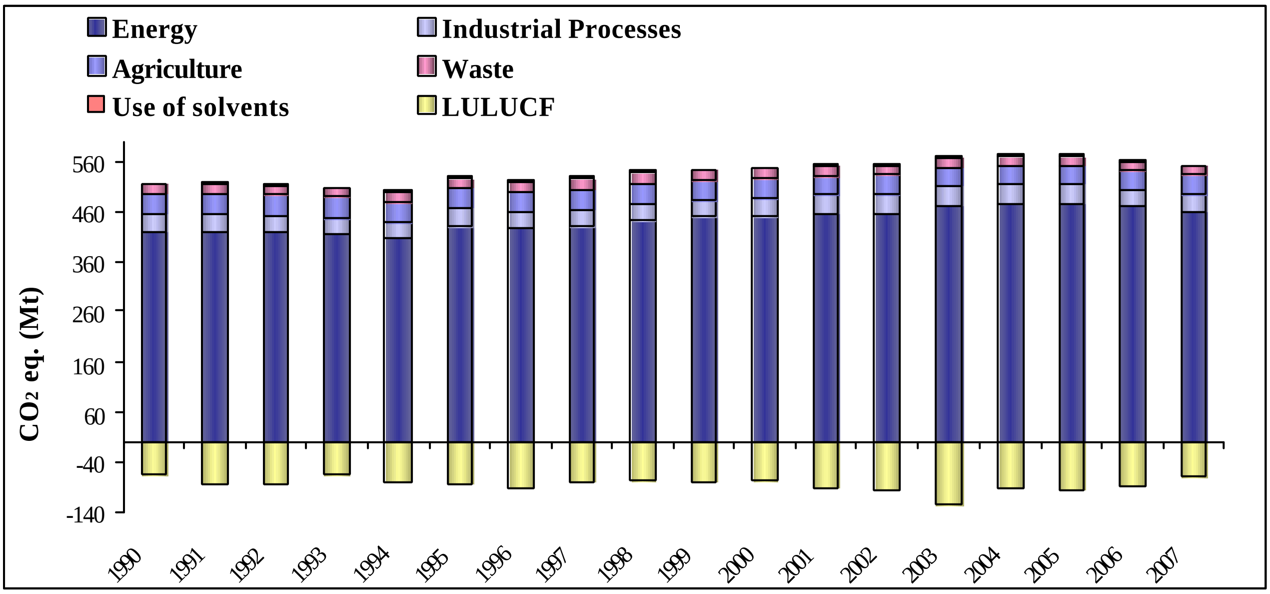


Figure 2.2 Greenhouse gas emissions and removals from 1990 to 2007 by sector (Mt CO_2 eq.)

2.2 Description and interpretation of emission trends by gas

2.2.1 Carbon dioxide emissions

CO_2 emissions, excluding CO_2 emissions and removals from LULUCF, have increased by approximately 9.3% from 1990 to 2007, ranging from 435 to 475 million tons.
The most relevant emissions derive from the energy industries (33.2%) and transportation (26.8%). Non-industrial combustion accounts for 17.0% and manufacturing and construction industries for 16.6%, while the remaining emissions derive from industrial processes (5.7%) and other sectors (0.8%).
The performance of CO_2 emissions by sector is shown in Figure 2.3.

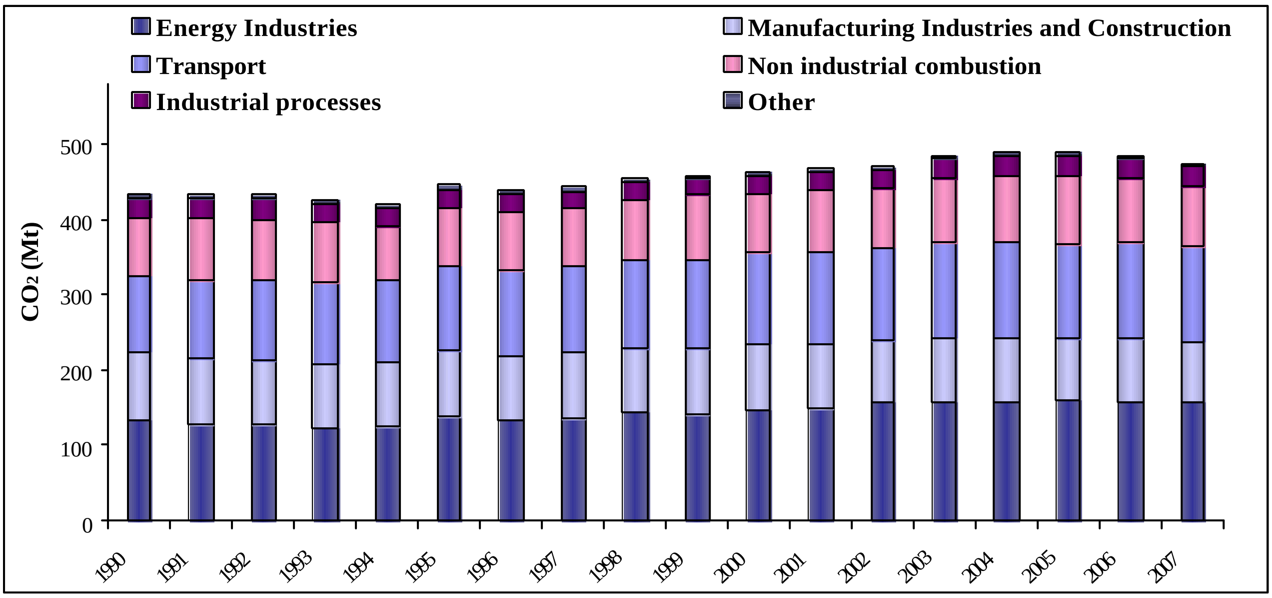


Figure 2.3 National CO_2 emissions by sector from 1990 to 2007 (Mt)

The main sectors responsible for the increase of CO_2 emissions are transport and energy industries; in particular, emissions from transport have increased by 25.6% from 1990 to 2007 while those from energy industries increased by 17.7%. Non industrial combustion emissions have raised by 3.8% and those from industrial processes decreased by 1.0%; emissions from manufacturing industries and construction show a decrease of about 11.3%, emissions in the 'Other' sector, mostly fugitive emissions from oil and natural gas and emissions from solvent and other product use, reduced by 30.5%.

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

- Gross Domestic Product (GDP) at market prices as of 2000 (base year 1990=100);
- Total Energy Consumption;
- CO_2 emissions, excluding emissions and removals from land-use change and forests;
- CO_2 *intensity*, which represents CO_2 emissions per unit of total energy consumption.

The figures of CO_2 emissions per total energy unit show that CO_2 emissions in the 1990s essentially mirrored energy consumption. A decoupling between the curves is observed only in recent years, mainly as a result of the substitution of fuels with high carbon contents by methane gas in the production of electric energy and in industry; nevertheless, this trend slowed in 2002, due to the increase of coal consumption in power plants.

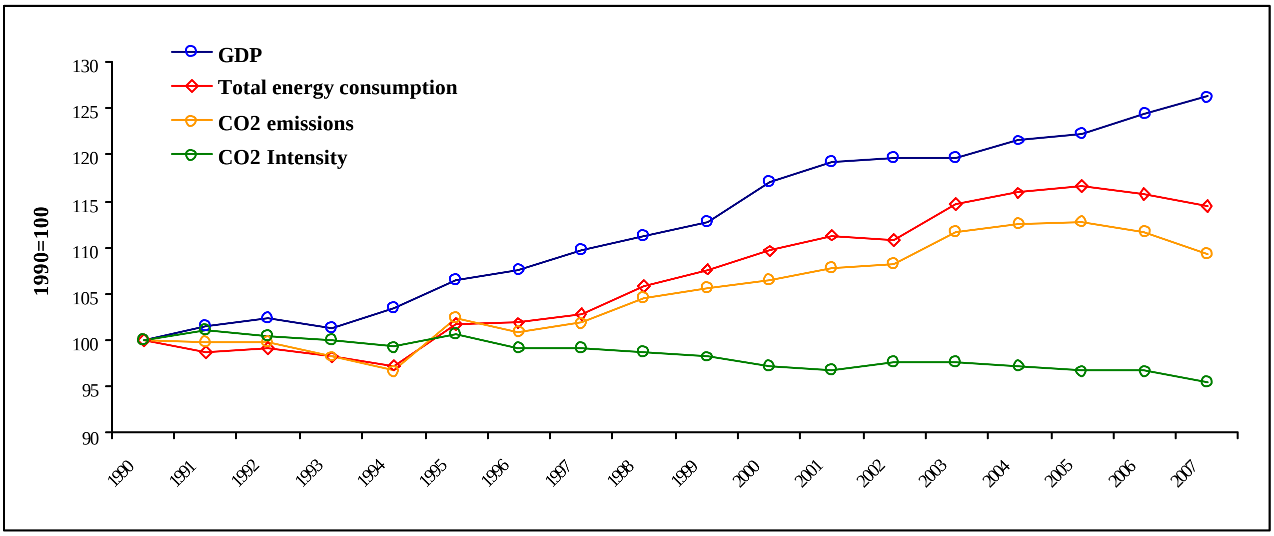


Figure 2.4 Energy-related and economic indicators and CO_2 emissions

2.2.2 Methane emissions

Methane emissions (excluding LULUCF) in 2007 represent 6.9% of total greenhouse gases, equal to 38.2 Mt in CO_2 equivalent, and show a decrease of approximately 3.5 Mt as compared to 1990 levels.

CH_4 emissions, in 2007, are mainly originated from the waste sector which accounts for 42.0% of total methane emissions, as well as from agriculture (40.9%) and energy (17.0%).

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 an increase in emission levels, 3.9% compared to 1990, the highest increases concern waste-water handling (22.5%) and waste incineration (68.5%) subcategories, while the largest emission share origins from solid waste disposal on land subcategory (83.1%).

Emissions in the agricultural sector regard mainly the enteric fermentation and manure management categories. The agriculture sector shows a decrease of emissions equal to 9.3% as compared to 1990.

In terms of CH_4 emissions in the energy sector, the reduction (-27.7%) is the result of two contrasting 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 increased on account of the overall rise in consumption and, in the civil sector, as the result of increased use of methane in heating systems.
Figure 2.5 shows the emission figures by sector.

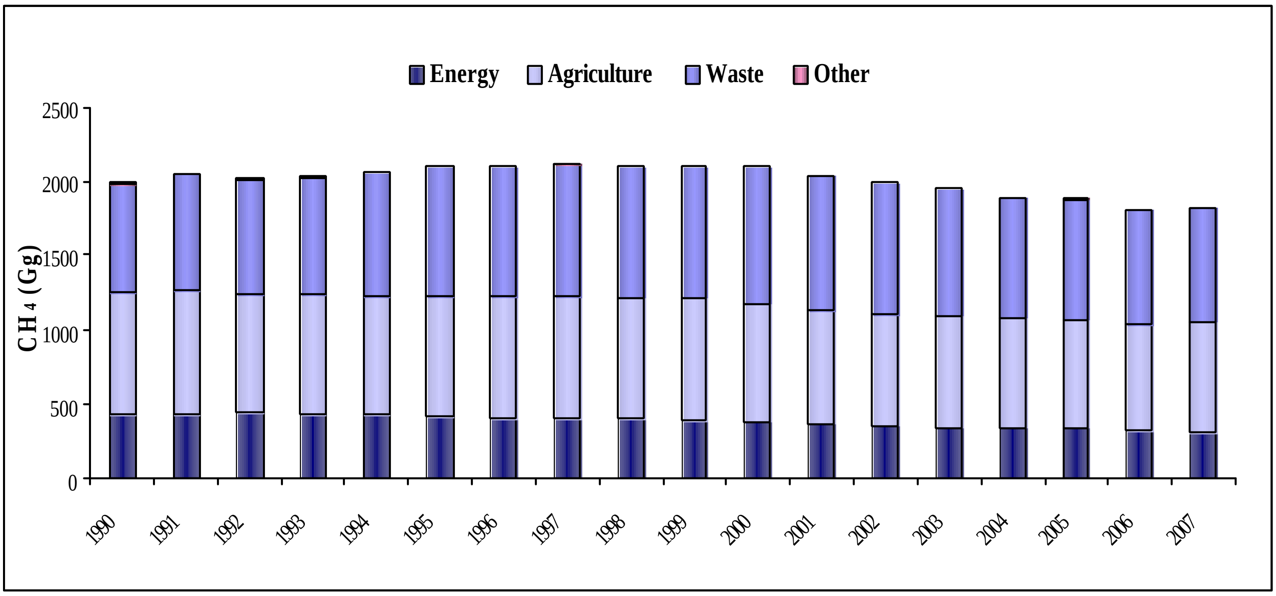


Figure 2.5 National CH_4 emissions by sector from 1990 to 2007 (Gg)

2.2.3 Nitrous oxide emissions

In 2007 nitrous oxide emissions (excluding LULUCF) represent 5.8% of total greenhouse gases, with a a decrease of 14.9% between 1990 and 2007, from 37.4 to 31.8 Mt CO_2 equivalent.
The major source of N_2O emissions is the agricultural sector (67.8%), 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 7.6% during the period 1990-2007.
Emissions in the energy-use sector (17.1% of the total) show an increase by 18.0% from 1990 to 2007; this growth can be traced primarily to the road transport sector and it is related to the introduction of catalytic converters. However, a high degree of uncertainty still exists with regard to the N_2O emission factors of catalysed automobiles.
Emissions from production of nitric acid have decreased from 1990 to 2007 of 46.8%; emissions from production of adipic acid show an increase from 1990 to 2005 of 32.6% and a decrease from 2005 to 2007 of 87.1% because of the introduction of an abatement technology, showing a global reduction of 82.9% (joint emissions in 2005 accounted for 20.5% and in 2007 for 5.9% 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.

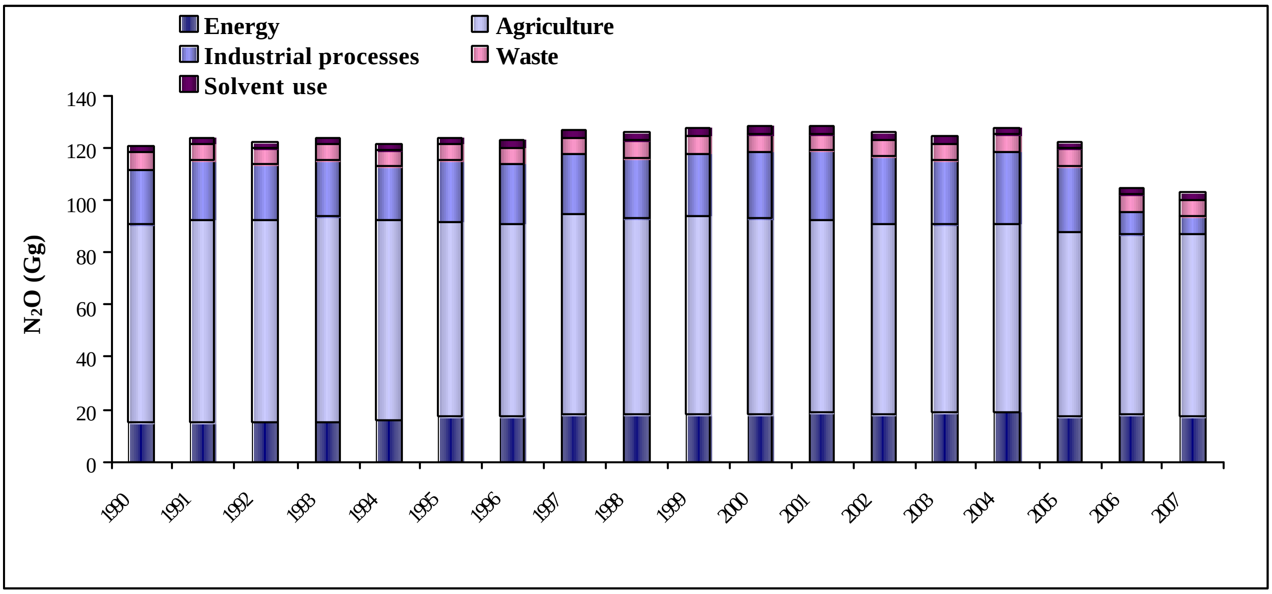


Figure 2.6 National N_2O emissions by sector from 1990 to 2007 (Gg)

2.2.4 Fluorinated gas emissions

Italy has set 1990 as the base year for reduction in the emissions of the fluorinated gases covered by the Kyoto Protocol, HFCs, PFCs and SF_6. Taken altogether, the emissions of fluorinated gases represent 1.3% of total greenhouse gases in CO_2 equivalent in 2007, and they show an increase of 197.6% between 1990 and 2007. This increase is the result of different features for the different gases.

HFCs, for instance, have increased considerably from 1990 to 2007, from 0.4 to 6.7 Mt in CO_2 equivalent. The main sources of emissions are the consumption of HFC-134a, HFC-125, HFC-32 and HFC-143a in refrigeration and air-conditioning devices, together with the use of HFC-134a in pharmaceutical aerosols. Increases during this period are due both to the use of these substances as substitutes for gases that destroy the ozone layer and to the greater use of air conditioners in automobiles.

Emissions of PFCs show a decrease of 84.1% from 1990 to 2007. The level of these emissions in 2007 is 0.3 Mt in CO_2 equivalent, and it it is due to the use of the gases in the production of aluminium (69.5%) and in the production of semiconductors (30.5%).. Although the production of PFCs is equal to zero in Italy from the year 1999 onwards, the upward trend shown by the series is due to their consumption and to their use in metal production.

Emissions of SF_6 are equal to 0.4 Mt in CO_2 equivalent in 2007, with an increase of 28.4% as compared to 1990 levels. 12.6% of SF_6 emissions derive from the use of gas in aluminium and magnesium foundries, 78.9% from the gas contained in electrical equipments, 8.5% from the gas use in the semiconductors manufacture. From 2005 to 2006, emissions of SF_6 have fallen of 12.8%, showing during last year an increase of 5.3%.

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

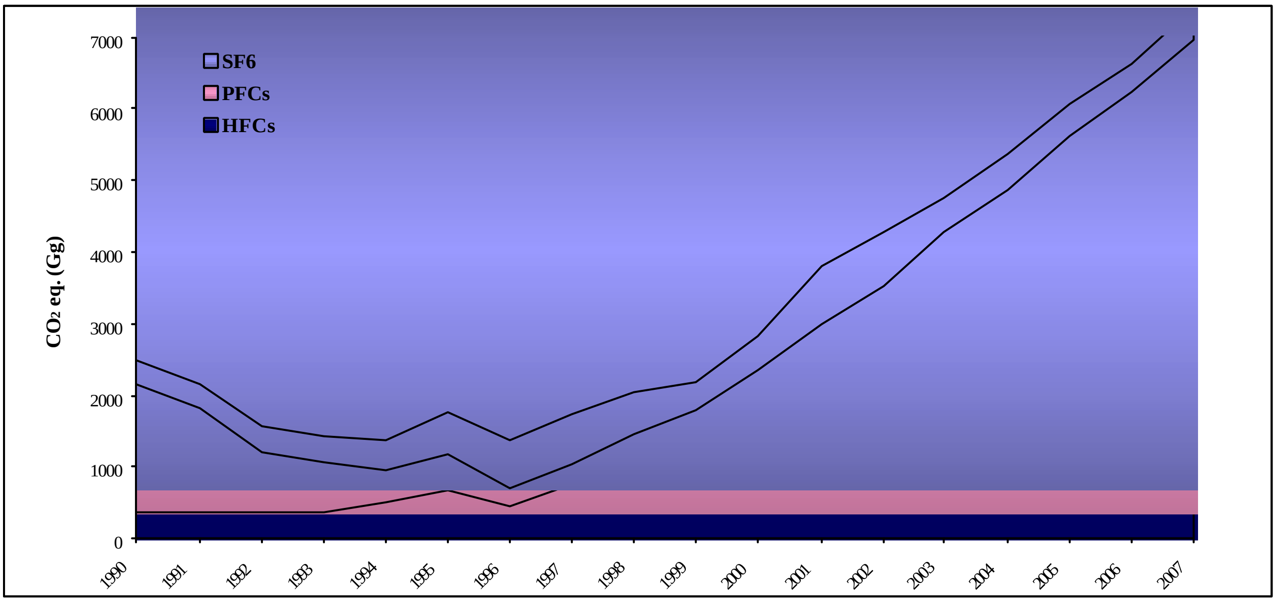


Figure 2.7 National emissions of fluorinated gases by sector from 1990 to 2007 (Gg CO_2 eq.)

2.3 Description and interpretation of emission trends by source

2.3.1 Energy

Emissions from the energy sector account for 83.0% of total national greenhouse gas emissions, excluding LULUCF.
Emissions in CO_2 equivalent from the energy sector are reported in Table 2.1 and Figure 2.8.

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
	Gg CO_2 eq									
Total emissions	**418,945**	**431,961**	**450,722**	**455,290**	**457,264**	**471,623**	**473,756**	**474,506**	**469,586**	**458,673**
Fuel Combustion (Sectoral Approach)	408,183	421,904	441,713	446,780	448,960	462,891	465,889	466,669	462,203	451,425
Energy Industries	134,791	138,664	147,554	150,953	157,854	158,940	157,856	160,025	159,886	158,548
Manufacturing Industries and Construction	90,609	89,503	89,699	87,003	83,138	88,068	87,923	83,419	83,802	80,547
Transport	103,276	114,244	122,949	124,942	126,821	127,663	129,557	127,804	129,178	129,189
Other Sectors	78,387	77,982	80,660	83,517	80,824	87,520	89,374	94,130	88,279	82,173
Other	1,120	1,511	851	365	322	701	1,180	1,291	1,058	969
Fugitive Emissions from Fuels	10,762	10,057	9,010	8,510	8,304	8,732	7,867	7,836	7,383	7,248
Solid Fuels	122	65	73	81	78	95	64	69	54	84
Oil and Natural Gas	10,640	9,993	8,936	8,429	8,225	8,637	7,803	7,768	7,329	7,164

Table 2.1 Total emissions in CO_2 equivalent from the energy sector by source (1990-2007) (Gg CO_2 eq.)

An upward trend is noted from 1990 to 2005, total greenhouse gas emissions, in CO_2 equivalent, show an increase by 13.3%, while between 2005 and 2007 emissions have decreased by 3.3%, showing from 1990 to 2007 an increase of about 9.5%.
Substances with the highest impact are CO_2, whose levels have increased by 10.2% from 1990 to 2007 and account for 97.4% of the total, and N_2O which shows an increase of 18.0% but its share

out of the total is only 1.2%; CH_4, on the other hand, shows a decrease of 27.7% from 1990 to 2007 but this is not relevant on total emissions, accounting only for 1.4%.
It should be noted that from 1990 to 2007 the most significant increase, in terms of total CO_2 equivalent, is observed in the transport, in the energy industries and in the other sectors, about 25.1%, 17.6% and 4.8%, respectively; in 2007 these sectors, altogether, account for 80.6% of total emissions.
Details on these figures are described in the specific chapter.

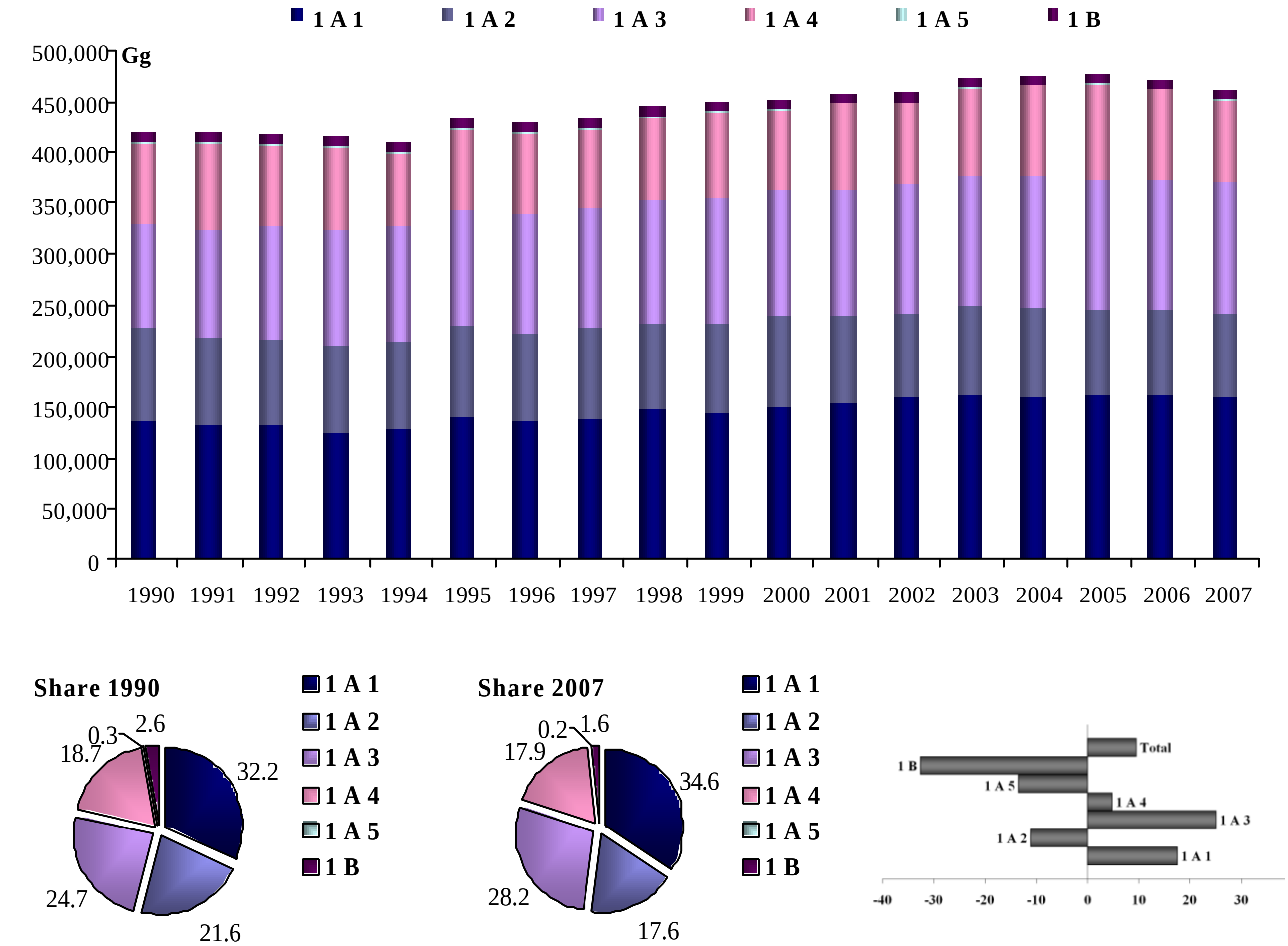


Figure 2.8 Trend of total emissions in CO_2 equivalent from the energy sector (1990-2007) (Mt CO_2 eq.)

2.3.2 Industrial processes

Emissions from industrial processes account for 6.6% of total national greenhouse gas emissions, excluding LULUCF.
Emission trends from industrial processes are reported in Table 2.2 and Figure 2.9.
Total emission levels, in CO_2 equivalent, show a decrease of 0.5%, from the base year to 2007. Taking into account emissions by substance, CO_2 level decreased by 1.0%, while N_2O level decreased by 71.7%; these two substances account altogether for about 79.4% of the total emissions from industrial processes. The increase in emissions is mostly due to an increase in the mineral products category (12.2%), for the increase in production figures especially for cement and lime. The decrease of GHG emissions in the chemical industry (-64.1%) is due to adipic acid production. Emissions from metal production decreased by 49.5% mostly for the different materials used in the pig iron and steel production processes.

A considerable increase is observed in F-gas emissions (197.6%), whose share on total emissions is 20.4%.
Details for industrial processes emissions can be found in the specific chapter.

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
	Gg CO2 eq									
Total	**36,467**	**34,530**	**34,903**	**36,946**	**37,040**	**38,232**	**40,522**	**40,367**	**35,916**	**36,296**
CO2	27,190	25,415	24,097	24,858	24,818	25,856	26,653	26,457	26,559	26,924
CH4	108	113	63	59	57	58	61	64	66	65
N2O	6,676	7,239	7,918	8,232	7,902	7,557	8,443	7,760	2,647	1,891
F-gases	2,492	1,764	2,825	3,796	4,263	4,761	5,365	6,085	6,644	7,416
HFCs	351	671	1,986	2,550	3,100	3,796	4,515	5,267	5,956	6,701
PFCs	1,808	491	346	451	424	498	348	353	282	288
SF_6	333	601	493	795	740	468	502	465	406	428

Table 2.2 Total emissions in CO_2 equivalent from the industrial processes sector by gas (1990-2007)

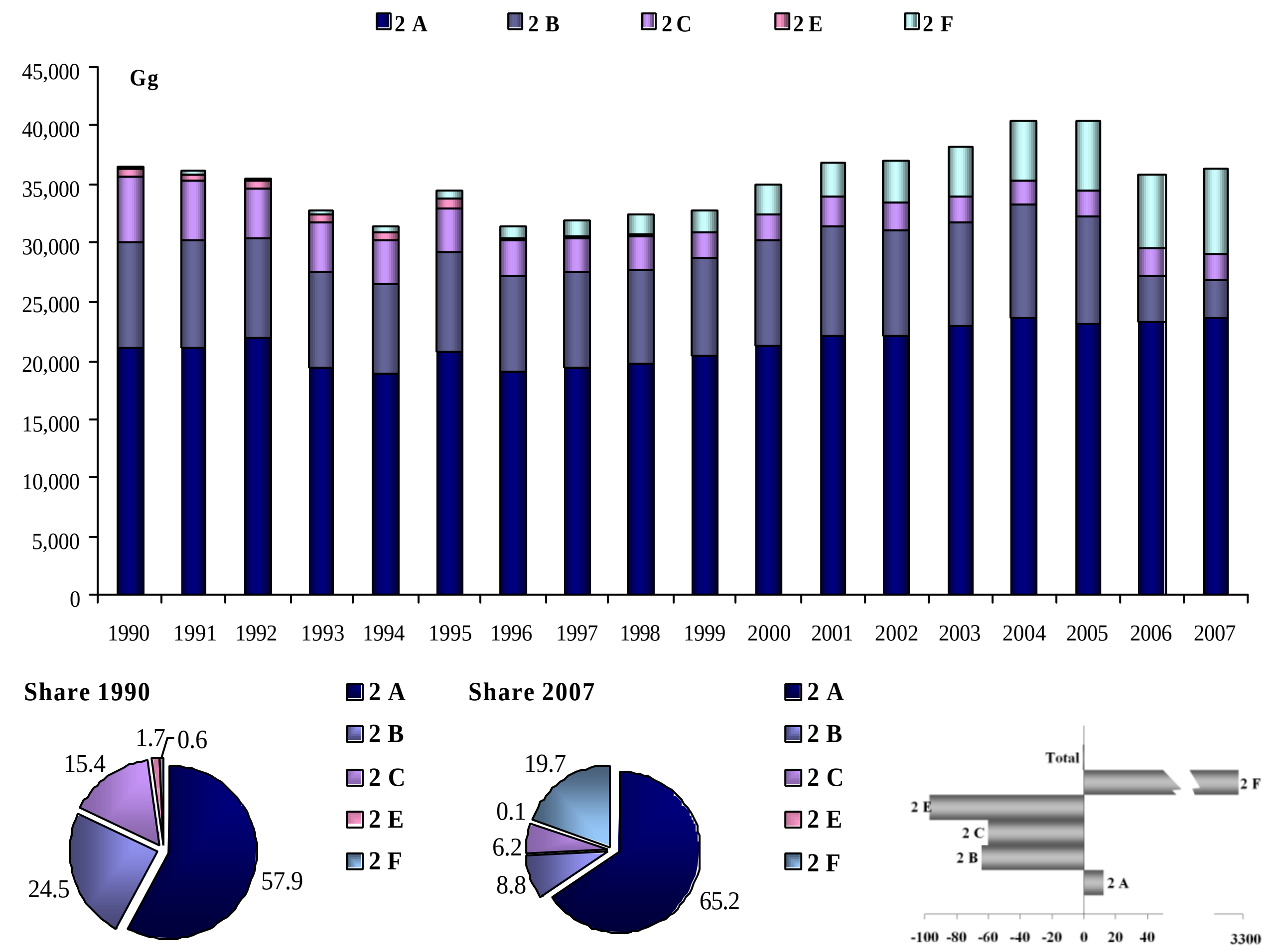


Figure 2.9 Trend of total emissions in CO_2 equivalent from industrial processes (1990-2007) (Mt CO_2 eq.)

2.3.3 Solvent and other product use

Emissions from the solvent and other product use sector refer to CO_2 and N_2O, and to other gases that are not greenhouse.

A considerable amount of emissions from this sector is, in fact, mostly to be attributed to NMVOC. The share of CO_2 emissions, in this sector, is 63.8% out of the total; a decrease by 14.9% is noted from this sector from 1990 to 2007, which is to be attributed to different sources. As regards CO_2, emission levels from paint application sector, which accounts for 51.4% of total CO_2 emissions from this sector, decreased by 17.2%; emissions from other use of solvents in related activities, such as domestic solvent use other than painting, application of glues and adhesives, printing industries, fat edible and non edible oil extraction, vehicle dewaxing, glass wool enduction, which account for 43.6% of the total, show an increase of 2.8%. Finally, CO_2 emissions from metal degreasing and dry cleaning activities, decreased by 61.3% but they account for only 5.0% of the total.
In 2007, solvent use is responsible for 0.4% of the total CO_2 equivalent emissions (excluding LULUCF) and for 42.7% of the total NMVOC emissions, and represents the main source of anthropogenic NMVOC national emissions.
N_2O emissions from this sector, in 2007, represent 2.4% of the total N_2O national emissions.
Emissions from paint application and other use of solvents for NMVOC and CO_2 are about equal to 80.5% and 95.0%, respectively, of the total sector.
From 1990 to 1995, a quite stable level of N_2O emissions is observed, afterwards from 1995 to 1998 emissions increased by 37.5%. 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.

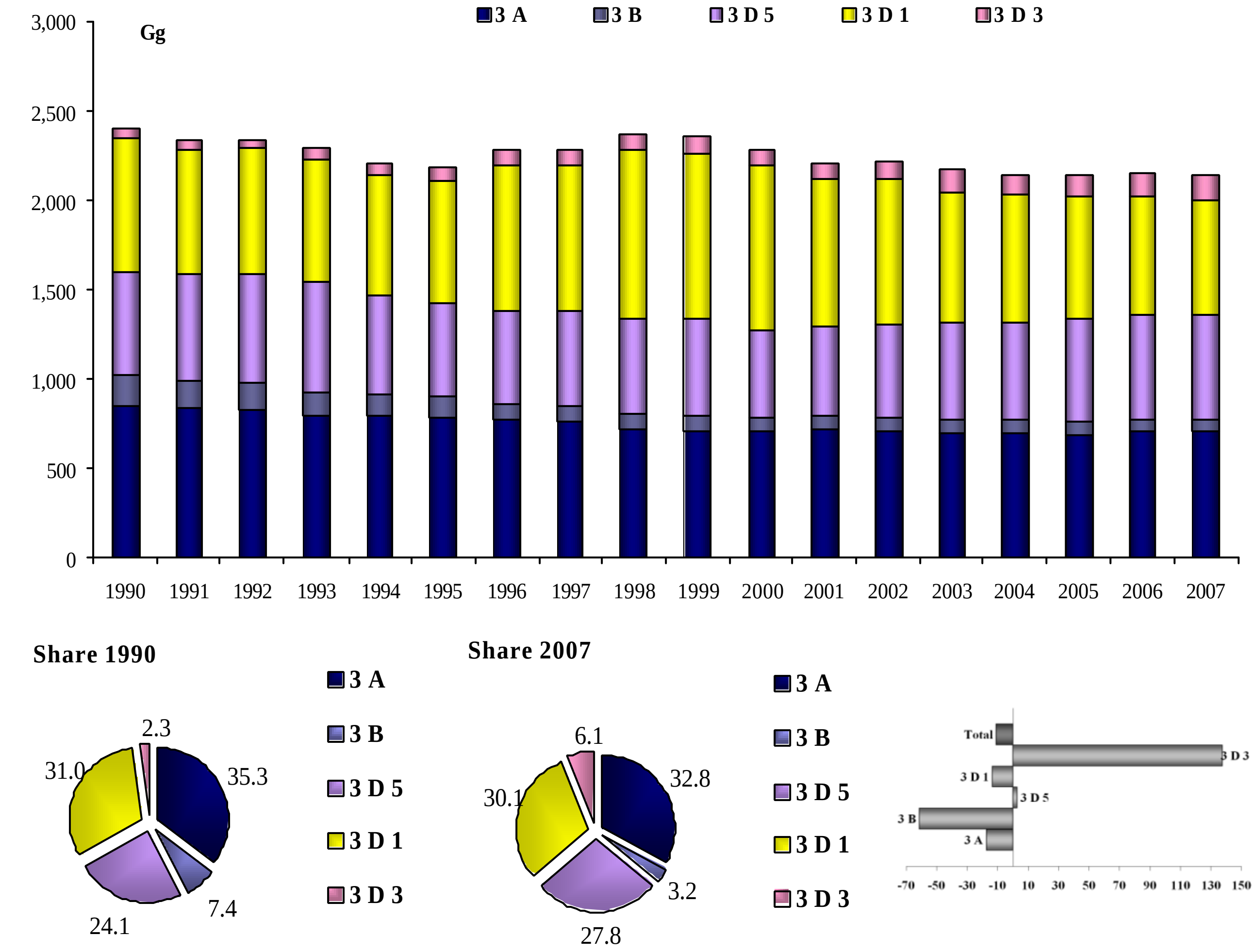


Figure 2.10 Trend of total emissions in CO_2 equivalent from the solvent and other product use sector (1990-2007) (Mt CO_2 eq.)

2.3.4 Agriculture

Emissions from the agriculture sector account for 6.7% of total national greenhouse gas emissions, excluding LULUCF.
Emissions from the agriculture sector are reported in Table 2.3 and Figure 2.11.

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
	Gg CO2 eq									
Total emissions	**40,576**	**40,349**	**39,940**	**38,954**	**38,250**	**38,102**	**37,917**	**37,242**	**36,627**	**37,210**
Enteric Fermentation	12,179	12,267	12,165	11,340	11,030	11,056	10,836	10,844	10,629	11,027
Manure Management	7,383	7,068	7,140	7,342	7,110	7,067	6,886	6,877	6,649	6,853
Rice Cultivation	1,562	1,657	1,382	1,382	1,420	1,463	1,534	1,472	1,477	1,523
Agricultural Soils	19,435	19,340	19,237	18,875	18,673	18,500	18,643	18,032	17,856	17,791
Prescribed Burning of Savannas	0	0	0	0	0	0	0	0	0	0
Field Burning of Agricultural Residues	17	17	16	15	17	15	18	17	17	17

Table 2.3 Total emissions in CO_2 equivalent from the agricultural sector by source (1990-2007) (Gg CO_2 eq.)

Emissions refer to CH_4 and N_2O levels, which account for 42.0% and 58.0% of the total emission of the sector, respectively. The decrease observed in the total emissions (-8.3%) is mostly due to the decrease of CH_4 emissions from enteric fermentation (-9.5%) which account for 29.6% of the total emissions. Detailed comments can be found in the specific chapter.

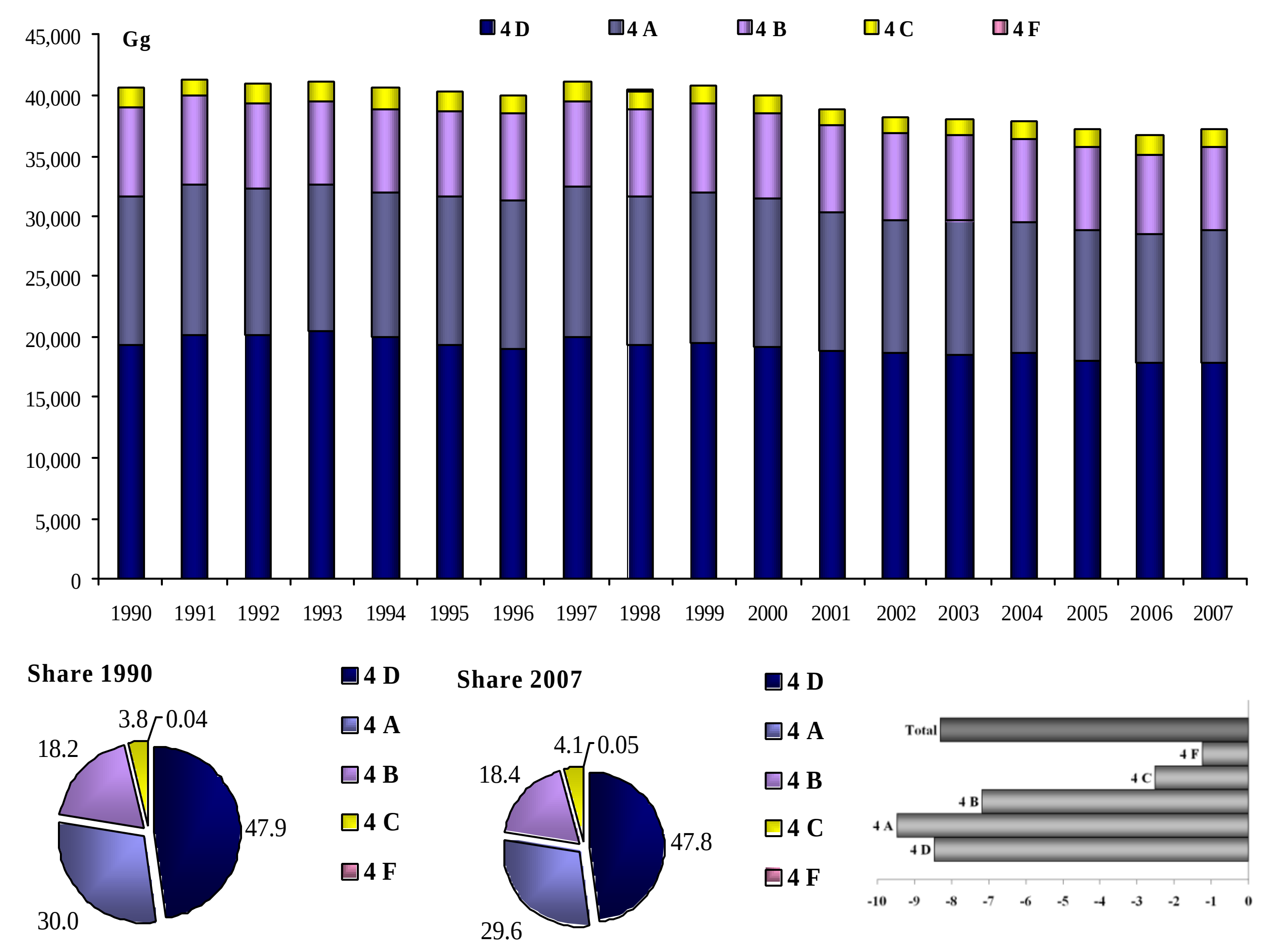


Figure 2.11 Trend of total emissions in CO_2 equivalent from agriculture (1990-2007) (Mt CO_2 eq.)

2.3.5 LULUCF

Emissions from the LULUCF sector are reported in Table 2.4 and Figure 2.12.

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
	Gg CO_2 eq									
Total emissions - removals	**-67,493**	**-85,590**	**-79,230**	**-92,611**	**-95,649**	**-126,798**	**-91,840**	**-95,336**	**-89,804**	**-70,910**
Forest Land	-53,392	-77,525	-70,356	-78,948	-85,389	-74,718	-80,895	-83,486	-84,161	-55,372
Cropland	-16,876	-10,210	-11,697	-10,956	-11,544	-11,085	-8,881	-10,155	-7,788	-10,960
Settlements	3,160	2,145	3,210	3,204	3,202	3,165	3,160	3,153	2,145	3,181
Grassland	-385	0	-387	-5911	-1,918	-44,161	-5,224	-4,849	0	-7,760
Wetlands	0	0	0	0	0	0	0	0	0	0
Other Land	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0

Table 2.4 Total emissions in CO_2 equivalent from the LULUCF sector by source/sink (1990-2007) (Gg CO_2 eq.)

Total removals, in CO_2 equivalent, show an increase of 5.1%, from the base year to 2007.
CO_2 accounts for more than 99% to total emissions and removals of the sector.
Further details for LULUCF emissions and removals can be found in the specific chapter.

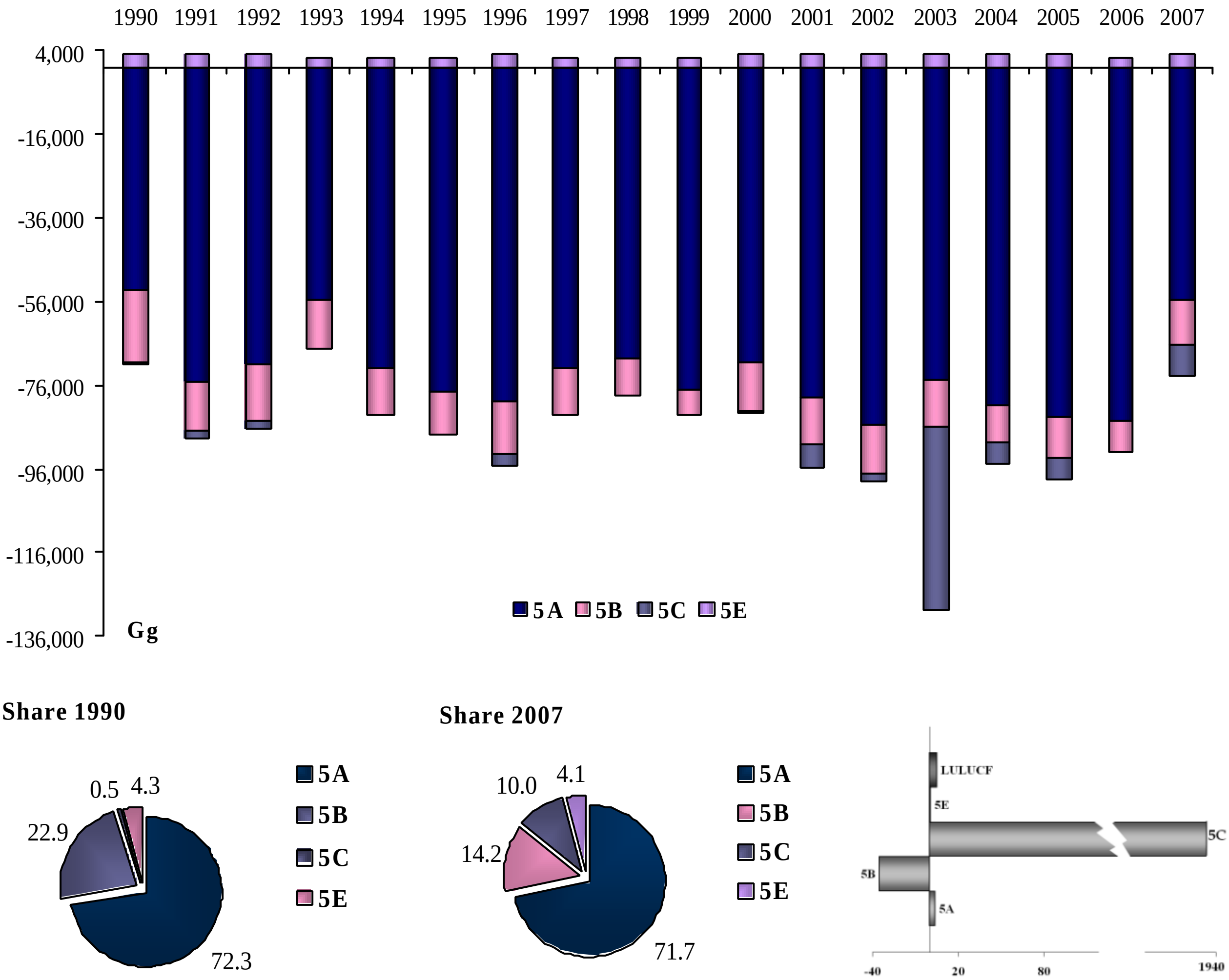


Figure 2.12 Trend of total emissions and removals in CO_2 equivalent fr om LULUCF (1990-2007) (Mt CO_2 eq.)

2.3.6 Waste

Emissions from the waste sector account for 3.3% of total national greenhouse gas emissions, excluding LULUCF.
Emissions from the waste sector are shown in Table 2.5 and Figure 2.13.
Total emissions in CO_2 equivalent increased by 2.9% from 1990 to 2007. The increase is due to the increase in emissions from solid waste disposal (0.3%) due to the increase of waste production, which accounts for 72.3% of the total, as well as from waste-water handling (15.6%), which accounts for 24.1% of the total.
Considering emissions by gas, the most important greenhouse gas is CH_4 which accounts for 87.0% of the total and shows an increase of 3.9% from 1990 to 2007. N_2O levels have increased by 9.5% while CO_2 decreased by 49.7%; these gases account for 11.6% and 1.5%, respectively.
Further details can be found in the specific chapter.

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
	Gg CO2 eq									
Total emissions CO2 equivalent	**17,936**	**20,666**	**21,659**	**21,545**	**20,973**	**20,283**	**19,475**	**19,432**	**18,707**	**18,459**
Solid Waste Disposal on Land	13,298	15,754	16,824	16,662	16,067	15,402	14,490	14,437	13,638	13,341
Waste-water Handling	3,852	4,027	4,269	4,264	4,275	4,273	4,295	4,320	4,390	4,454
Waste Incineration	785	884	564	617	627	604	686	671	675	660
Other	0	0	2	3	3	4	4	4	4	5

Table 2.5 Total emissions in CO_2 equivalent from the waste sector by source (1990-2007) (Gg CO_2 eq.)

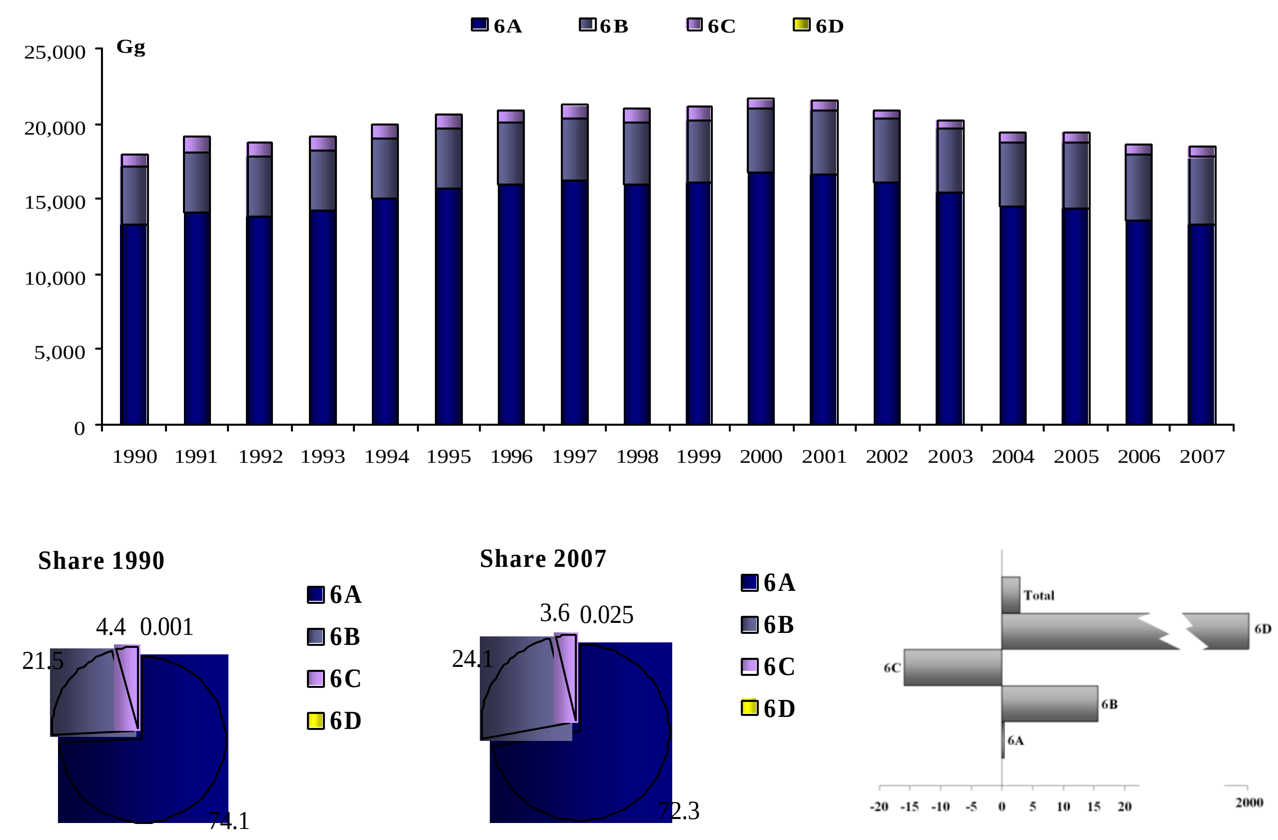


Figure 2.13 Trend of total emissions in CO_2 equivalent from waste (1990-2007) (Mt CO_2 eq.)

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

Emission trends of NO_X, CO, NMVOC and SO_2 from 1990 to 2007 are presented in Table 2.6 and Figure 2.14.

Indirect greenhouse gases and SO_2	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
kt										
NO_X	2,007	1,868	1,434	1,422	1,367	1,360	1,319	1,229	1,188	1,147
CO	6,927	6,876	4,857	4,646	4,218	4,064	3,881	3,506	3,342	3,334
NMVOC	1,939	2,001	1,565	1,500	1,431	1,373	1,319	1,248	1,221	1,194
SO_2	1,795	1,320	749	697	616	518	480	401	379	339

Table 2.6 Total emissions for indirect greenhouse gases and SO_2 (1990-2007) (kt)

All gases show a significant reduction in 2007 as compared to 1990 levels. The highest reduction is observed for SO_2 (-81.1%), CO levels have reduced by 51.9%, while NO_X and NMVOC show a decrease by 42.8% and 38.4%, respectively. A detailed description of the trend by gas and sector as well as the main reduction plans can be found in the Italian National Programme for the progressive reduction of the annual national emissions of SO_2, NO_X, NMVOC and NH_3, as requested by the Directive 2001/81/EC.

The most relevant reductions occurred as a consequence of the Directive 75/716/EC, and of the successive ones related to the transport sector, and of other European Directives which established maximum levels for sulphur content in liquid fuels and introduced emission standards for combustion installations. As a consequence, in the combustion processes, oil with high sulphur content and coal have been substituted with oil with low sulphur content and natural gas.

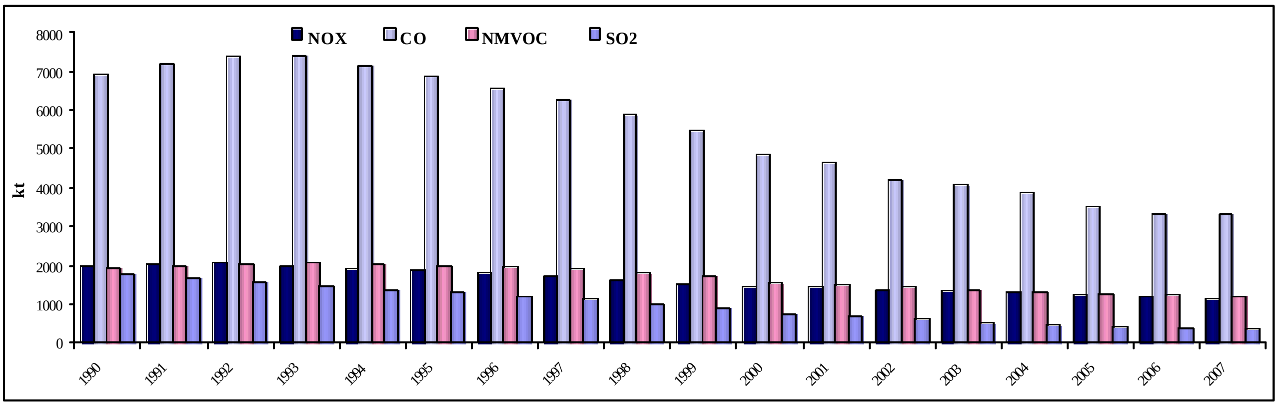


Figure 2.14 Trend of total emissions for indirect greenhouse gases and SO2 (1990-2007) (kt)

Chapter 3: ENERGY [CRF sector 1]

3.1 Introduction

The aim of this section is to describe in detail the methodology used to estimate emissions from fuel combustion for energy. These sources correspond to IPCC Tables 1A.
The national 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.
The continuous monitoring of GHG emissions in Italy is negligible; hence, information is rarely available on actual emissions over a specific period 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:

Total Emission = Emission Factor x Activity Statistic

Emission factors are typically derived from measurements on a number of representative sources and the resulting factor applied to the whole country.
For 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:

Emission = Σ Point Source Emissions

However, it is necessary to carry out an estimate of the fuel consumption associated with these point sources, so that 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 (e.g. power stations, cement kilns, refineries). Direct greenhouse gas emissions and most non-industrial sources are estimated using emission factors.

3.2 Key categories

Key category analysis, for the years 1990 and 2007, identified 12 categories at level or trend assessment with the Tier 1 and 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 underlying data of most key source categories. In the following box, the relevant key categories are listed making reference to the section of the text where they are quoted.
With reference to the box, six of the key categories (n. 1, 2, 3, 5, 10 and 11) are linked to stationary combustion and to the same set of energy data: the energy sector CRF table 1.A.1, the industrial sector, table 1.A.2 and the civil sector tables 1.A.4a and 1.A.4b. Four out of six key categories refer to CO_2 emissions. All these sectors refer to the national energy balance (MSE, several years [a]) for the basic energy data and the distribution among various subsectors, even if more accurate data for the electricity production sector can be found in Terna database (Terna, several years). Evolution of energy consumptions/emissions is linked to the activity data of each sector; see paragraph 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 2007, 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 key categories (n. 4, 6, 8 and 12) are referred to the transport sector, with basic total energy consumption reported in the national energy balance and then subdivided in the different subsectors with activity data taken from various statistical sources; see paragraph 3.6, transport, for an accurate analysis of these key sources. This sector also shows a remarkable increase in emissions, in particular CO_2 from air transport and road transport, as can be seen in the Table 3.18 and 3.19, respectively. The trend of N_2O and CH_4 emissions is linked to technological changes occurred in the period.
Finally, the last group of two key categories (n.7, and 9) refers to oil and gas operations. For this sector basic overall production data are reported in the national balance but emissions are calculated with more accurate data published or delivered to ISPRA by the relevant operators, see paragraph 3.11.
Most of these categories are also key categories for the years 1990 and 2007 taking into account LULUCF emissions and removals.

Key-categories identification in the energy sector with the IPCC Tier1 and Tier2 approaches for 2007

KEY CATEGORIES	TIER	with LULUCF	Relevant paragraphs	Notes
CO_2 stationary combustion liquid fuels	L,T	X	3.4, 3.5 and 3.7	Table 3.9
CO_2 stationary combustion solid fuels	L,T	X	3.4, 3.5 and 3.7	Table 3.9
CO_2 stationary combustion gaseous fuels	L,T	X	3.4, 3.5 and 3.7	Table 3.9
CO_2 mobile combustion: Road Vehicles	L,T	X	3.6 and 3.6.3	Tables 3.18, 3.19
N_2O stationary combustion	L	X	3.4, 3.5 and 3.7	Table 3.9
CO_2 mobile combustion: Waterborne Navigation	L1,T2	X	3.6.4	Table 3.24
CH_4 fugitive emissions from Oil and Gas Operations	L,T	X	3.11	Table 3.28
N_2O mobile combustion: Road Vehicles	L2		3.6 and 3.6.3	Tables 3.18, 3.19
CO_2 fugitive emissions from Oil and Gas Operations	L2,T	X	3.11	Table 3.28
CO_2 stationary combustion other fuels	L1,T1 not key in 1990		3.4, 3.5 and 3.7	Table 3.9
CH_4 stationary combustion	L2 not key in 1990		3.4, 3.5 and 3.7	Table 3.9
CH_4 mobile combustion: Road Vehicles	L2 key only in 1990		3.6 and 3.6.3	Tables 3.18, 3.19

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 by the Ministry of Economic Development in the national energy balance (MSE, several years [a]), by Terna (Terna, several years) for the power sector and some additional data sources to characterise the technologies used at sectoral level, quoted in the relevant sections.

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 (metal works factories, food, textiles, others);
Road Transport;
Coastal Shipping;
Railways;
Aircraft;
Domestic;
Commercial;
Public Service;
Fishing and 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 national 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 shown 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 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 Economic Development (Ministero dello Sviluppo Economico, MSE) publishes annually energy balances (MSE, several years [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, 2007 data are attached, while the full time series is available on website: http://dgerm.sviluppoeconomico.gov.it/dgerm/ben.asp.
Additionally to fossil fuel, the national energy balance (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, several years) for non commercial wood use. Carbon dioxide emissions from biomass combustion are not included in the national total as suggested in the IPCC Guidelines (IPCC, 1997) but emissions of other GHGs and other pollutants are included. CORINAIR methodology (EMEP/CORINAIR, 2007) includes emissions from the combustion of wood in the industrial and domestic sectors as well as the combustion of biomass in agriculture.
The inventory 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", row "Productions", see Annex 5, Table A5.1- National energy balance, year 2007, Primary fuels. From 2004 onwards, it has been necessary to use also those quantities to calculate emissions in the reference approach, so to minimize differences with sectoral approach. From 2004, the energy balances prepared by MSE do include those quantities in the input while estimating final consumption; this procedure summarizes a complex stock change reporting by operators.

For most of the combustion source categories, emissions are estimated from fuel consumption data reported in the BEN and from an emission factor appropriate to the type of combustion. However, the industrial category covers a range of sources and types, so the inventory disaggregates this category into a number of sub-categories, namely:

- Other Industry;
- Other Industry Off-road: See paragraph 3.7;
- Iron & Steel (Combustion, Blast Furnaces, Sinter Plant);
- Petrochemical industries (Combustion);
- Other combustion with contact industries: glass and tiles;
- Other industries (Metal works factories, food, textiles, others);
- Ammonia Feedstock (natural gas only);
- Ammonia (Combustion) (natural gas only);
- Cement (Combustion);
- Lime Production (non-decarbonising).

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

Emissions from waste incineration facilities with energy recovery are reported under category 1.A.4.a (Combustion activity, commercial/institutional sector), whereas emissions from other types of waste incineration facilities are reported under category 6.C (Waste incineration). In fact, energy recovered by these plants is mainly used for district heating of commercial buildings. In particular, for 2007, 95% of the total amount of waste incinerated is treated in plants with energy recovery system. To estimate CO_2 emissions, considering the total amount of waste incinerated in plants with energy recovery, the carbon content is calculated, as described in paragraph 8.4.2, in the waste chapter; the value is considered constant for the whole time series. Different emission factors for municipal, industrial and oils, hospital waste, and sewage sludge are applied, as reported in the waste chapter, Tables 8.20-8.24. Waste amount is then converted in energy content applying an emission factor equal to 9.2 Gj/t of waste. In 2007, the resulting average emission factor is equal to 112.9 kg CO_2/Gj.
Emissions from landfill gas recovered are used for heating and power in commercial facilities and reported under 1.A.4.a.
Biogas recovered from the anaerobic digester of animal waste is used for utilities in the agriculture sector and relative emissions are reported under 1.A.4.c
In consideration of the increasing of the share of waste used to produce electricity, we plan to revise the allocation of these emissions under category 1.A.1.a.

Recalculations

In 2006 submission, there has been an overall revision of CO_2 from the iron and steel industry. CO_2 emissions due to the consumption of coke, coal or other reducing agents as fuel used in the iron and steel industry, including fuel consumption of derived gases, have been accounted for and reported in the energy sector. On the other hand, CO_2 emissions from iron and steel industry referring to the carbonates used in sinter plants and basic oxygen furnaces, as well as iron and steel scraps and graphite electrodes used in electric arc furnaces have been accounted for, and reported in the industrial processes sector under 2C1.

In 2009 submission, main recalculations in this sector regarded the transport sector, 1.A.3 as planned during the previous submission. The whole time series of road transport emissions has been recalculated because of the updated version of the model/software (COPERT4) used to estimate emissions. Aviation emissions have been also recalculated for the whole time series because of a specific sectoral study so as maritime emissions that have been updated from 1998. More detailed information on these recalculations is reported in the respective paragraphs in 3.6.
For all the energy sectors, natural gas CO_2 emission factors have been updated for 2006 because of additional information collected on the chemical composition of natural gas imported; coal CO_2 average emission factors have also been revised from 2005 based on updated amounts of fuel imported from different countries. Fuel oil CO_2 average emission factors have been recalculated from 1999 taking in account the percentage of low-sulphur fuel out of the total fuel oil consumed and its specific characteristics.
Moreover, from 2000, a double counting related to refinery gas fuel consumption in refineries, 1.A.1.b, already accounted for in the chemical sector, 1.A.2.c, has been detected and corrected.

Small changes in activity data from 2004, for oil production and gas distribution, and update of emission factors, from 2005, for minor gas distributor companies, lead to recalculations of fugitive emissions, reported in 1.B.2.

Recalculations affected the whole time series 1990-2006 for all gases. The following table shows the percentage differences between the 2009 and 2008 submissions for the total energy sector and by gas.
Recalculation resulted for the energy sector in a reduction of emissions in the base year and in 2006 of 0.12% and 0.86% respectively, mainly due to the application of the COPERT4 model for road transport estimates, which completely revised N_2O emission factors.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
									%								
Energy	***-0.12***	***-0.19***	***-0.19***	***-0.23***	***-0.28***	***-0.16***	***-0.17***	***-0.20***	***-0.28***	***-0.30***	***-0.60***	***-0.65***	***-0.76***	***-0.79***	***-0.86***	***-0.73***	***-0.86***
CO2	0.00	-0.08	-0.10	-0.14	-0.20	-0.09	-0.08	-0.09	-0.10	-0.07	-0.34	-0.38	-0.41	-0.41	-0.42	-0.22	-0.31
CH4	1.41	1.45	1.41	1.54	0.90	0.46	0.00	-0.27	-0.22	-1.12	-1.17	-0.11	0.04	-0.13	-1.21	0.69	-1.95
N2O	-11.63	-10.99	-10.52	-10.04	-8.14	-6.45	-6.65	-7.80	-12.55	-14.66	-16.38	-18.41	-22.53	-24.34	-26.15	-31.65	-31.71

Source: ISPRA elaborations

Table 3.1 Emission recalculations in the energy sector 1990-2006 (%)

3.4 Energy industries

3.4.1 Electricity production

The source of 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 (Terna), 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 monopolist. The time series is available since 1963.
In these publications, consumptions of all power plants are reported, either public or privately owned. The base data are collected at plant level, on monthly basis. They include electricity production and estimation of physical quantities of fuels and the related energy content; for the biggest installations, the energy content is based on laboratory tests. Up to 1999, the fuel consumption was reported at a very detailed level, 17 different fuels, allowing a quite precise estimation of the carbon content. From 2000 onward, the published data aggregate all fuels in five groups that do not allow for a precise evaluation of the carbon content. In Table 3.2, time series 1990-2007 is reported.
For the purpose of calculating GHG emissions, the detailed list of fuels used was delivered to ISPRA by Terna for the years from 2000 to 2007. The detailed list is confidential and only the output of the simulation model used to calculate emissions for the years 2006 and 2007 at the aggregated level of Table 3.2 is 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 (MSE, several years). 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.

	1990	1995	1999	2000	2001	2002	2003	2004	2005	2006	2007
national coal	58	-	96	Solids	Solids	Solids	Solids	Solids	Solids	Solids	Solids
imported coal	10,724	8,216	8,378	9,633	11,445	13,088	14,252	17,031	16,253	16,587	16,886
lignite	1,501	380	62								
Natural gas, m^3	9,731	11,277	19,766	22,334	21,930	22,362	25,534	28,768	30,544	31,381	33,957
BOF(steel conve	509	633	536	Coal	Coal	Coal	Coal	Coal	Coal	Coal	Coal
Blast furnace ga	6,804	6,428	8,611	gases	gases	gases	gases	gases	gases	gases	gases
Coke gas, m^3	693	540	660	8,690	9,785	10,034	10,479	10,640	12,104	13,131	11,353
Light distillate	5	6	12	oil	oil	oil	oil	oil	oil	oil	oil
Diesel oil	303	184	560	products	products	products	products	products	products	products	products
Heavy fuel oil	21,798	25,355	17,511	19,352	17,186	17,694	14,993	10,522	7,941	7,629	5,292
Refinery gas	211	378	409								
Petroleum coke	186	189	216								
Orimulsion	-	-	1,688								
Gases from chen	444	803	1,155	Others	Others	Others	Others	Others	Others	Others	Others
Tar	2	-	-			m^3=769	m^3=857	m^3=955	m^3=978	m^3=1,321	m^3=1,423
Heat recovered f	146	3	-			kt=10,686	kt=12,588	kt=15,031	kt=15,460	kt=16,253	kt=17,490
Other fuels	344	697	1,819	5,153	9,175						

Source: Terna, several years

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

Both BEN and Terna publications could be used for the inventory preparation, as they are part of the national statistical system and published regularly. The preference, up to date, for Terna data arises from the following reasons:

- BEN data are prepared on the basis of Terna reports to IEA, so both data sets come from the same source;
- Before being published in the BEN, Terna data are revised to be adapted to the reporting methodology: balance is done on the energy content of fuels and the physical quantities of fuels are converted to energy using standard conversion factors; so the total energy content of the fuels is the "right" information extracted from the Terna reports and the physical quantities are changed to avoid discrepancies; the resulting information cannot be cross checked with detailed plant data (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 Terna 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 "Basic Oxygen Furnace (BOF) converter gas" are not reported in BEN up to 1999, from the 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 the national energy balance and ENEL/Terna data are detailed by primary fuel for the last two years: 2006 and 2007. For the other years, see previous NIR reports.

The other two statistical publications quoted before, UP (UP, several years) and ENI (ENI, several years [a]), have direct access to fuel consumption data from the associated companies, but both rely on Terna data for the complete picture. Data from those two sources are used for cross checking and estimation of point source emissions.

To estimate CO_2 emissions, and also N_2O and CH_4 emissions, a rather complex calculation sheet is used, see document, 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.
In response to the review process of the Initial report of the Kyoto Protocol and of the 2006 submission under the Convention, N_2O and CH_4 stationary combustion emission factors have been revised for the whole time series taking into account default IPCC (IPCC, 1997; IPCC, 2000) and CORINAIR emission factors (EMEP/CORINAIR, 2007).
The energy data used for the years 2006 and 2007 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, in the 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 2007. 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, according to the best information available.

	TJ	C, Kt	CO_2, Kt - Gg
For table 1.A.1, a. Public Electricity and Heat Production			
Liquid fuels	197,048	4,150	15,205
Solid fuels	431,819	11,117	40,735
Natural gas	1,132,086	17,190	62,986
Refinery gases	15,051	255	934
Coal gases	12,417	159	583
Biomass	68,940	1,958	7,174
Other fuels (incl.waste)	25,196	658	2,411
Total	**1,882,557**	**33,529**	**122,854**
Industrial producers (Table 1.A.1, a-b-c) and auto-producers, to table "1.A.2 Manufacturing Industries "			
Liquid fuels	5,150	114	417
Solid fuels	3	0	0
Natural gas	52,513	797	2,922
Refinery gases	2,293	39	142
Other refinery products	83,891	1,836	6,727
Coal gases	38,531	2,655	9,727
Biomass			
Other fuels (incl.waste)	6,071	374	1,371
Total	**188,454**	**5,815**	**21,306**
General total	**2,071,011**	**39,344**	**144,160**

Source: ISPRA elaborations

Table 3.3 Power sector, Energy/CO_2 emissions in CRF format, year 2007

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.
The time series clearly shows that although the specific carbon content of the kWh generated in Italy has constantly improved over the years, total emissions are growing due to the even bigger increase of electricity production. Specific thermoelectric emissions are nearly stable from the year 2000 to 2002 because efficiency increases have been balanced by a growing coal share. From 2003

a remarkable improvement is reported in emissions of thermoelectric production, due to the entry into service of more efficient plants, but the improvement was much less in total production due to the reduction of hydroelectric production.

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Total electricity produced (gross)	216.9	241.5	276.6	279.0	284.4	293.9	303.3	303.7	314.1	313.9
Total CO_2 emitted, Mt	128.5	135.7	140.5	138.3	145.4	148.1	146.0	146.4	148.7	144.2
g CO_2 / kwh of gross thermo-electric production	720	693	645	640	641	624	609	596	578	556
g CO_2 / kwh of total gross production	592	562	508	496	511	504	481	482	474	459

Source: ISPRA elaborations

Table 3.4 Time series of CO_2 emissions from electricity production

3.4.2 Refineries

The consumption data used come from BEN (MSE, several years [a]), the same data are also reported by UP (UP, several years).
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 reported losses of crude oil and other fuels (that are mostly due to statistical discrepancies) are considered to calculate emissions. Fuel lost in the distribution network is accounted for here and not in the individual end use sector.
Parts 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 see Table 3.7. In Table 3.5, a sample calculation for the year 2007 is reported, with energy and emission data. In Table 3.6 GHG emissions in the years 1990, 1995, 2000-2007 are reported.

	Consumption, TJ				CO_2 emissions, kt			
REFINERIES	Petroleum coke	Ref. gas	Liquid fuels	Natural gas	Petroleum coke	Ref. gas	Liquid fuels	Natural gas
			105,939	13,283	0	0	8,413	739
	38,130	115,880	75,180		3,803	7,201	5,706	0
TOTAL				348,412	0	0	0	25.9

Source: APAT elaborations

Table 3.5 Refineries, CO_2 emission calculation, year 2007

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
CO_2 emissions, Mt	16.3	18.6	21.8	23.6	23.6	22.7	24.2	26.1	24.9	25.9
CH_4 emissions, kt	0.46	0.53	0.59	0.67	0.68	0.64	0.64	0.67	0.67	0.70
N_2O emissions, kt	0.49	0.56	0.60	0.63	0.63	0.61	0.64	0.68	0.65	0.67
Refinery, total, Mt C	16.5	18.8	22.0	23.8	23.8	22.9	24.4	26.3	25.1	26.1

Source: ISPRA elaborations

Table 3.6 Refineries, GHG emission time series

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 were operating in the early nineties and they have been reported here. Only one small manufactured gas producing plant is still in operation from 2002.

In this section, emissions from power plants which use coal gases are also reported. In particular, we refer to the electricity generated in the steel plant sites (using coal gases and other fuels). The high implied emission factor for solid fuels is due to the large use of derived steel gases and in particular blast furnace gas to produce energy. These gases are assimilated to the renewable sources and incentives are provided for their use.

3.5 Manufacturing industries and construction

Energy consumption for this sector is reported in the BEN, see Annex 5, Tables A5.9 and A5.10. The data comprise specification of consumption for 13 sub-sectors and more than 25 fuels. Those very detailed data, combined with industrial production data, allow for a good estimation of all the fuel used by most industrial processes (see list in paragraph 3.3). Source category descriptions for the most important sectors are supplied in the Industrial Processes chapter (chapter 4). A more sophisticated procedure is used to estimate coal use in steel production and coal gases used for electricity generation, see paragraph 3.5.1 and Annex 3 for details. The balance of fuel (total consumption less industrial processes consumption) is assumed as used in boilers and heaters in small and medium size enterprises; the emissions are estimated with the emission factors listed in Table 3.7. These factors account for the fraction of carbon oxidised equal to 0.98 for solid fuels, 0.99 for liquid fuels and 0.995 for natural gas, as suggested by the 1996 IPCC guidelines (IPCC, 1996). During the revision of the aviation sector, for jet gasoline and jet kerosene, a fraction of carbon oxidised equal to 1 has been applied, as reported in the 2006 IPCC guidelines (IPCC, 2006).

	t CO_2 / TJ	t CO_2 / t	t CO_2 / tep
Liquid fuels			
Crude oil	72.549	3.035	3.035
Jet gasoline	70.000	3.075	2.929
Jet kerosene	71.500	3.111	2.992
Petroleum Coke	99.755	3.464	4.174
Orimulsion	77.733	2.177	3.252
TAR	80.189	3.120	3.355
Gaseous fuels, national data			
Natural gas (dry) 2007 average	55.636	1.947 (sm^3)	2.328
Solid fuels			
Steam coal, 2007 average	95.041	2.465	3.977
"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)
Derived Gases, national data			
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 , 2007 average	76.518	3.129	3.201
Coking coal	95.702	2.963	4.004
Other fuels			
Municipal solid waste	47.877	0.718	2.003
Transport			
Petrol, 1990-99	71.034	3.121	2.972
Petrol, test data, 2000-07	71.145	3.109	2.977
Gas oil, 1990-99	73.274	3.127	3.066
Gas oil, engines, test data, 2000-07	73.153	3.138	3.061

Gas oil, heating, test data, 2000-07	73.693	3.141	3.083
LPG, 1990-99, IPCC	64.350	3.000	2.692
LPG, test data, 2000-07	64.936	2.994	2.717

Source: ISPRA elaborations

Table 3.7 Emission Factors for Power, Industry and Civil sector

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 can bring to 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 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 gases 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 2000-2007 are reported. Industrial emissions do show oscillations, connected to economic cycles.

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
CO_2 emissions, kt	88,937	87,955	88,134	85,412	81,540	86,418	86,244	81,732	82,106	78,867
CH_4 emissions, t	6,819	7,021	5,717	5,778	5,676	5,817	5,742	6,267	6,225	6,508
N_2O emissions, t	4,931	4,519	4,661	4,742	4,772	4,928	5,028	5,018	5,047	4,979
Industry, total, kt C	90,609	89,503	89,699	87,003	83,138	88,068	87,923	83,419	83,802	80,547

Source: ISPRA elaborations

Table 3.8 Manufacturing industry, GHG emission time series

In Table 3.9, the emissions of energy industries (paragraph 3.4), manufacturing industries (paragraph 3.5) and other sectors (paragraph 3.7) are summarized according to key sources categories. From 1990 to 2007, an increase in use of natural gas instead of fuel oil and gas oil in stationary combustion plants is observed; it results in a decrease of CO_2 emissions from combustion of liquid fuels and an increase of emissions from gaseous fuels.

		1990	2007
CO_2 stationary combustion liquid fuels	kt	153,467	86,306
CO_2 stationary combustion solid fuels	kt	59,395	66,727
CO_2 stationary combustion gaseous fuels	kt	85,066	159,220
CH_4 stationary combustion	t	1,779	4,210
N_2O stationary combustion	t	647	963

Source: ISPRA elaborations

Table 3.9 Stationary combustion, GHG emissions in 1990 and 2007

3.6 Transport

This sector shows a pronounced increase in emissions over time, reflecting the huge increase in fuel consumption for road transportation. The mobility demand and particularly the road transportation share have always increased in the period from 1990 to 2007.
The time series of CO_2, CH_4 and N_2O emissions is reported in Table 3.10. Emissions in the table comprise all the emissions reported in table 1.A.3 of the CRF.
Emission estimates are discussed below for each sub sector.
The trend of N_2O emissions is related to the evolution of the technologies in the road transport sector and the distribution between gasoline and diesel fuel consumption.
Methane emission trend is due to the combined effect of technological improvements that limit VOCs from tail pipe and evaporative emissions (for cars) and the expansion of two-wheelers fleet. It has to be underlined that in Italy there is a remarkable fleet of motorbikes and mopeds (about 10 millions vehicles in 2007) that use gasoline and is increasing every year since 1990. Only a small part of this fleet comply with tight VOC emissions controls.

		1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
CO_2	Mt	101.3	111.4	120.1	122.2	124.1	125.1	127.1	125.8	127.2	127.2
CH_4	Mt	0.90	0.99	0.75	0.71	0.65	0.61	0.55	0.49	0.47	0.45
N_2O	Mt	1.11	1.81	2.09	2.05	2.02	1.95	1.92	1.48	1.55	1.53
Total, Mt CO_2 eq.	Mt	103.3	114.2	122.9	124.9	126.8	127.7	129.6	127.8	129.2	129.2

Source: ISPRA elaborations

Table 3.10 GHG emissions for the transport sector (Mt)

3.6.1 Aviation

3.6.1.1 Source category description

The IPCC requires the estimation of emissions for category 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). Emissions from international aviation are reported as a memo item, and are not included in national totals.
Civil aviation gives mainly rise to CO_2 emissions. CH_4 and N_2O emissions also occur and are estimated in this category but their contribution is insignificant.
In 2007 total GHG emissions from this source category were about 1.9 per cent of the national total emissions from transport, and about 0.4 per cent of the GHG national total; in terms of CO_2 only, the share is almost the same.
From 1990 to 2007 GHG emissions from the sector increased by 51% due to the expansion of the aviation transport mode. Emission fluctuations over time are therefore mostly dictated by the growth rates in the number of flights.
Specifically, in 2007 GHG emissions were about 6% higher than 2006.
Civil aviation is not a key category in the Italian inventory.

3.6.1.2 Methodological issues

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

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

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

Specifically, for the years referred to in the surveys, the current method estimates emissions from the number of aircraft movements broken down by aircraft type (and engine type derived when not specified from ICAO database) at each of the principal Italian airports considering the information of whether the flight is international or domestic and the relevant distance travelled.
For those years, a Tier 3 method has been applied. In fact, figures on the number of flights, destination, aircraft fleet and engines has been provided by the local airport authorities, national airlines (Alitalia, AirOne) and European Civil Aviation (EUROCONTROL), covering about 80% of the official national statistics on aircraft movements for the relevant years. Data on 'Times in mode' have also been supplied by the four principal airports and estimates for the other minor airports have been carried out on the basis of previous sectoral studies at local level. Consumption and emission factors are those derived from the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2007). Based on sample information, estimates have been carried out at national level for the relevant years considering the official statistics of the aviation sector.

In general, to carry out national estimates of greenhouse gases and other pollutants in the Italian inventory for LTO cycles, both domestic and international, consumptions and emissions are calculated for the complete time series using the average consumption and emission factors multiplied by the total number of flights. The same method is used to estimate emissions for domestic cruise; on the other hand, for international cruise, consumptions are derived by difference from the total fuel consumption reported in the national energy balance and the estimated values as described above and emissions are therefore calculated.
Data on domestic and international aircraft movements from 1990 to 2007 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.

Emissions from military aircrafts are also estimated and reported under category 1.A.5 Other. The methodology to estimate military aviation emissions is simpler than the one described for civil aviation since LTO data are not available in this case. As for activity data, total consumption for military aviation is published in the petrochemical bulletin (MSE, several years [b]) by fuel. Emission factors are those provided in the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2007). Therefore, emissions are calculated by multiplying military fuel consumption data for the EMEP/CORINAIR default emission factors shown in Table 3.13.

Flights	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Domestic	186,446	199,585	319,963	303,354	298,104	325,179	313,171	311,218	324,779	346,724
International	139,733	184,233	303,747	315,736	310,271	325,755	343,052	363,140	385,159	420,021

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

Table 3.11 Aircraft Movement Data (LTO cycles)

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

a Emission factor as kg carbon/t.

Table 3.12 CO_2 and SO_2 emission factors for Aviation (kg/t) 1990-2007

	Units	CH_4	N_2O	NO_x	CO	NMVOC	Fuel
Domestic LTO	kg/LTO	0.189	0.040	5.313	6.939	1.698	461.7
International LTO	kg/LTO	0.306	0.048	5.702	8.524	2.758	553.3
Domestic Cruise	kg/t fuel	-	0.152	24.003	3.313	0.822	-
International Cruise	kg/t fuel	-	0.535	70.916	7.190	2.569	-
Aircraft Military [a]	kg/t fuel	0.4	0.2	15.8	126	3.6	-

a EMEP/CORINAIR, 2007

Table 3.13 Non-CO_2 Emission Factors for Aviation (2007)

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
						kt				
Domestic LTO	121	129	198	180	178	175	160	150	153	160
International LTO	123	162	250	241	208	212	204	195	212	232
Domestic cruise	387	385	464	502	546	629	642	588	590	587
International cruise	1,215	1,662	2,327	2,334	2,143	2,529	2,567	2,733	2,948	3,120

Source: ISPRA elaborations

Table 3.14 Aviation jet fuel consumptions for domestic and international flights (kt)

3.6.1.3 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions from aviation is estimated to be about 4% in annual emissions; a higher uncertainty is calculated for CH_4 and N_2O emissions on account of the uncertainty levels attributed to the related emission factors.
Time series of domestic emissions from the aviation sector is reported in Table 3.15.
An upward trend in emission levels is observed from 1990 to 2007 which is explained by the increasing number of LTO cycles. Nevertheless, the propagation of more modern aircraft into the fleet slow down the tendency in the last years.

		1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
CO_2	kt	1.613	1.709	2.649	2.424	2.425	2.415	2.231	2.204	2.291	2.428
CH_4	t	32	33	63	69	78	96	102	112	98	72
N_2O	t	45	48	74	68	64	68	62	62	64	68

Source: ISPRA elaborations

Table 3.15 GHG emissions from domestic aviation

3.6.1.4 Source-specific QA/QC and verification

Data used for estimating emissions from the aviation sector, derive from different sources: local airport authorities, national airlines operators, EUROCONTROL and official statistics by different Ministries and national authorities.

Specifically, the results of the estimation method, deriving from the 2009 research commissioned by ISPRA, applied at national and airport level have been shared with national experts in the framework of an ad hoc working group on air emissions instituted by the national Aviation Authority (ENAC). The group is chaired by ISPRA and includes participants from ENAC, Ministry of Environment, Land and Sea, Ministry of Transport, national airlines and local airport authorities. The results reflect differences between airport, aircraft used and time in mode spent for each operation.

3.6.1.5 Source-specific recalculations

There has been an overall recalculation of emissions from the sector due to the update of the methodological study completed in 2009. In fact, in previous submissions, constant parameters were applied for the all time series considering model input of the year 1999. The time series did not take into account most recent trends in civil aviation in terms of technological improvements, fleet composition and changes in the split between national and international fuel consumption; in particular the distribution between European and extra-European flights has changed from 1999 with an increase of the shortest distances. As specified in the last review reports (UNFCCC, 2006; UNFCC, 2009), the ERT recommended to update these results in view of recent available national research to improve the accuracy of the inventory and correct the potential overestimation for recent years.
Aim of the revision was, principally, to revise the consumption values and relative parameters which are very important for local air quality, in terms of pollutants such as NO_X, NMVOC, PM, and consequently greenhouse gases. In fact, the revision of the methodology resulted mainly in a reduction of domestic fuel consumptions for the last years, due to technological improvements and fleet composition for domestic flights.

Specifically, for greenhouse gases, CO_2 emissions were recalculated from 1990 due to a different emission factor applied with respect to previous submissions. The emission factors used are provided in the EMEP/CORINAIR guidebook in line with the IPCC 2006 guidelines and the guidelines specified for the Emissions Trading Scheme of the aviation sector (EMEP/CORINAIR, 2007; IPCC, 2006; EC, 2009) and are equal to 71.5 kg/Gj for the jet fuel and 70.0 kg/Gj for the avio gasoline. For these fuels, an oxidation factor equal to 1 has been considered. This recalculation resulted in an increase of CO_2 emission by 1% with respect to previous submissions.
N_2O and CH_4 emissions were also recalculated but they are less important in terms of absolute values. N_2O emissions were revised applying the emission factor reported in EMEP/CORINAIR guidebook in line with the IPCC 1996 and 2006 guidelines (EMEP/CORINAIR, 2007; IPCC, 1996; IPCC, 2006) and equal to 2 kg/Tj of fuel, about 20% higher than the previous value. The methodology was also applied to revise NMVOC estimations therefore leading to new estimates of CH_4 emissions which have been calculated applying the default emission factor of 10% of total hydrocarbons (EMEP/CORINAIR, 2007; IPCC, 1996; IPCC, 2006). This revision has lead to an emission factor generally lower than the previous one.

The recalculation affected only slightly the time series up to 1999 (about +1.5%) but consistently the estimations from 2000 to 2006, with differences ranging from -2% to -17%, with respect to earlier submissions.
The revision of model assumptions has lead to a recalculation of international bunkers, accordingly.

3.6.1.6 Source-specific planned improvements

No specific improvements are planned for the next submission.

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 category 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 (MSE, several years [a]).
Carbon dioxide, sulphur dioxide and N_2O emissions are calculated on fuel based emission factors using fuel consumption data from BEN. Emissions of CO, NMVOC, NO_x and methane are based on the EMEP/CORINAIR methodology (EMEP/CORINAIR, 2007). The emission factors shown in Table 3.16 are aggregate factors so that all factors are reported on the common basis of fuel consumption.

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

Source: EMEP/CORINAIR, 2007

Table 3.16 Railway Emission Factors (kt/Mt)

3.6.3 Road Transport

3.6.3.1 Source category description

The IPCC requires the estimation of emissions for category 1.A.3.b Road transportation.
In 2007, total GHG emissions from this category were about 93.3 per cent of the national total emissions from transport, 26.3 per cent of the energy sector and about 21.8 per cent of the GHG national total.

From 1990 to 2007, GHG emissions from the sector increased by 25% due to the increase of vehicle fleet, total mileage and consequently fuel consumptions. In the last years, from 2004, fuel consumption and emissions stabilised. In 2007, GHG emissions were about 0.3% higher than those of 2006 were.

CO_2 for road transport is key category for 2007 with Tier 1 and Tier 2 methods at level and trend assessment, with and without LULUCF. N_2O emissions are key category at level assessment only with Tier 2. CH_4 emissions are key category only for 1990 at level assessment with Tier 2 methodology.

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.

3.6.3.2 Methodological issues

According to the IPCC Guidelines and Good Practice Guidance (IPCC, 1997; IPCC, 2000) and the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2007), a national methodology has been developed and applied to estimate emissions. In particular, the model COPERT 4 (EEA, 2007) has been used to estimate emissions for the whole time series.
Methodologies are described in the following, distinguishing emissions calculated from fuel consumption and traffic data.

3.6.3.2.1 Fuel-based emissions

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

Emissions of CO_2, expressed as kg carbon per tonne of fuel, are based on the H/C ratio of the fuel; emissions of SO_2 are based on the sulphur content of the fuel. Values of the fuel-based emission factors for CO_2 from consumption of petrol and diesel fuels are shown in Table 3.17. These factors account for the fraction of carbon oxidised for liquid fuels equal to 0.99, as suggested by the 1996 IPCC guidelines (IPCC, 1996).

Values for SO_2 vary annually as the sulphur-content of fuels change and are calculated every year for gasoline and gas oil and officially communicated to the European Commission in the framework of European Directives on fuel quality; these figures are also published by the refineries industrial association (UP, several years).

National emission factors	t CO_2 / TJ	t CO_2 / t
Mtbe	73.121	-
Gasoline, 1990-'99, interpolated emission factor	71.034	3.121
Gasoline, test data, 2000-07[b]	71.145	3.109
Gas oil, 1990-'99, IPCC OECD[a]	73.274	3.127
Gas oil, engines, test data, 2000-07[b]	73.153	3.138
LPG, 1990-'99, IPCC[a] Europe	64.350	3.000
LPG, test data, 2000-07[b]	64.936	2.994
Natural gas (dry) 1990	55.328	-
Natural gas (dry) 2007	55.636	-

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

Table 3.17 Fuel-Based Emission Factors for Road Transport

Emissions of CO_2 and SO_2 can be broken down by vehicle type based on estimated fuel consumption factors and traffic data in a manner similar to the traffic-based emissions described below for other pollutants. The 2007 inventory used fuel consumption factors expressed as g of fuel per kilometre for each vehicle type and average speed calculated from the emission functions and speed-coefficients provided by the model COPERT 4 (EEA, 2007). The updated version of the model has been used for the whole time series. As reported more in details in the following, the new model updates especially NO_X and N_2O emission factors; the application to Italian data resulted in a strong increase of NO_X emissions and a strong decrease of N_2O emissions for the whole time series.

Fuel consumptions 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 gasoline and diesel consumption by each vehicle type calculated on the basis of the fuel consumption factors added up to the BEN figures for total fuel consumption in Italy (adjusted for off-road consumption).

SNAP CODE	Sub sector	Type of fuel	Tons of fuel consumed	Mileage, km_kVEH
070101	PC Hway	diesel	4,058,171	72,660,282
070101	PC Hway	gasoline	2,317,954	46,377,378
070101	PC Hway	lpg	299,168	4,735,048
070102	PC rur	diesel	6,232,637	124,316,120
070102	PC rur	gasoline	3,505,641	79,896,926
070102	PC rur	lpg	285,265	6,313,398
070103	PC urb	diesel	2,471,652	32,518,256
070103	PC urb	gasoline	4,053,517	50,845,958
070103	PC urb	lpg	356,552	4,735,048
070201	LDV Hway	diesel	1,342,239	13,039,098
070201	LDV Hway	gasoline	59,924	867,572
070202	LDV rur	diesel	2,172,416	35,857,521
070202	LDV rur	gasoline	169,013	2,385,822
070203	LDV urb	diesel	1,772,680	16,298,873
070203	LDV urb	gasoline	175,216	1,084,465
070301	HDV Hway	diesel	3,465,100	19,824,452
070301	HDV Hway	gasoline	939	5,690
070302	HDV rur	diesel	2,346,353	13,699,772
070302	HDV rur	gasoline	2,561	17,071
070303	HDV urb	diesel	1,329,668	4,721,297
070303	HDV urb	gasoline	1,280	5,690
070400	mopeds	gasoline	409,309	18,166,330
070501	Moto Hway	gasoline	71,097	1,648,320
070502	Moto rur	gasoline	325,861	11,538,242
070503	Moto urb	gasoline	574,195	19,779,844
Total				581,338,476

Source: ISPRA elaborations

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

Table 3.18 Average fuel consumption and mileage for main vehicle category and road type, year 2007

3.6.3.2.2 Traffic-based emissions

Emissions of NMVOC, NO_X, CO, CH_4 and N_2O are calculated from emission factors expressed in grams per kilometre and road traffic statistics estimated by ISPRA on data released from Ministry of Transport (MINT, several years). The emission factors are based on experimental measurements of emissions from in-service vehicles of different types driven under test cycles with different average speeds calculated from the emission functions and speed-coefficients provided by COPERT 4 (EEA, 2007). This source provides emission functions and coefficients relating emission factors (in g/km) to average speed for each vehicle type and Euro emission standard derived by fitting experimental measurements to polynomial functions. These functions were then used to calculate emission factor values for each vehicle type and Euro emission standard at each of the average speeds of the road and area types.

The road traffic data used are vehicle kilometre estimates for the different vehicle types and different road classifications in the national road network. These data have to be further broken down by composition of each vehicle fleet in terms of the fraction of diesel- and petrol-fuelled vehicles on the road and in terms of the fraction of vehicles on the road made to the different emission regulations which applied when the vehicle was first registered. These are related to the age profile of the vehicle fleet.
Additional data are required for the estimation of consumption of buses, because the available traffic data seldom distinguish beyond "heavy vehicles". Moreover, traffic data on motorcycles are not exhaustive. In both cases, the energy consumption is estimated on the basis of the oil companies' reports on sold fuels.

It is beyond the scope of this paper to illustrate in details the COPERT 4 methodology: in brief, the emissions from motor vehicles fall into three different types calculated as hot exhaust emissions, cold-start emissions and, for NMVOC and methane, evaporative emissions.
Hot exhaust emissions are emissions from the vehicle exhaust when the engine has warmed up to its normal operating temperature. Emissions depend on the type of vehicle, type of fuel the engine runs on, the driving profile of the vehicle on a journey and the emission regulations applied when the vehicle was first registered as this defines the type of technology the vehicle is equipped with.
For a particular vehicle, the drive cycle over a journey is the key factor which determines the amount of pollutant emitted.

Key parameters affecting emissions are acceleration, deceleration, steady speed and idling characteristics of the journey, as well as other factors affecting load on the engine such as road gradient and vehicle weight. However, studies have shown that for modelling vehicle emissions over a road network at national scale, it is sufficient to calculate emissions from emission factors in g/km related to the average speed of the vehicle in the drive cycle (EEA, 2007). Emission factors for average speeds on the road network are then combined with the national road traffic data.

Emissions are calculated from vehicles of the following types:

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

Basic data derive from different sources. Detailed data on the national fleet composition is found in the yearly report from ACI (ACI, several years). The National Association of Cycle-Motorcycle Accessories (ANCMA, several years) supplies useful information on mopeds fleet composition and mileages. The Ministry of Transport in the national transport yearbook (MINT, several years) reports passenger car mileages time series. The National Institute of Statistics carries out annually a survey on heavy goods vehicles, including annual mileages (ISTAT, several years [b]). The National Association of concessionaries of motorways and tunnels produces monthly statistics on highway mileages by light and heavy vehicles (AISCAT, several years). The National General Confederation of Transport and Logistics (CONFETRA, several years) and the national Central

Commitee of road transporters (Giordano, 2007) supplied useful information and statistics about heavy goods vehicles fleet composition and mileages.

In the following Tables 3.19, 3.20 and 3.21 detailed data on the relevant vehicle mileages in the circulating fleet between 1990 and 2007 are reported, subdivided according to the main emission regulations.

	1990	1995	2000	2007
pre-1972, PRE ECE	0.05	0.03	0.01	0.01
1972 -1977, ECE 15.00/.01	0.10	0.04	0.01	0.00
1978 -1986, ECE 15.02/.03	0.32	0.14	0.03	0.01
1987 -1992, ECE 15.04	0.53	0.55	0.28	0.08
91/441/EC, from 1/1/93, euro I	0.00	0.25	0.28	0.11
94/12/ EC, from 1-1-97 , euro II			0.39	0.33
98/69/EC, from 1/1/2001, euro III				0.22
98/69/EC, from 1/1/2006, euro IV, V				0.25
Total	1.00	1.00	1.00	1.00

Source: ISPRA elaborations on ACI data

Table 3.19 Gasoline cars technological evolution: circulating fleet calculated as stock data multiplied by effective mileage (%)

	1990	1995	2000	2007
pre- 1993	1.00	0.91	0.35	0.02
91/441/EC, from 1/1/93, euro I		0.09	0.10	0.02
94/12/ EC, from 1-1-97 , euro II			0.55	0.18
98/69/EC, from 1/1/2001, euro III				0.41
98/69/EC, from 1/1/2006, euro IV, V				0.36
Total	1.00	1.00	1.00	1.00

Source: ISPRA elaborations on ACI data

Table 3.20 Diesel cars technological evolution: circulating fleet calculated as stock data multiplied by effective mileage (%)

	1990	1995	2000	2007
pre -1996	1.00	0.93	0.61	0.14
from 1/1/96, Dir. 91/542 EEC, euro I		0.07	0.22	0.10
from 1/1/97, Dir. 91/542 EEC, euro II			0.17	0.26
from 1/1/2001, Dir. 99/96, euro III				0.37
from 1/1/2006, Dir. 99/96, euro IV, V				0.13
Total	1.00	1.00	1.00	1.00

Source: ISPRA elaborations on ACI data

Table 3.21 Trucks technological evolution: circulating fleet for light duty (%)

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

ISPRA estimates total annual vehicle kilometres for the road network in Italy by vehicle type, see Table 3.22, based on data from various sources:

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

	1990	1995	2000	2005	2006	2007
All passenger vehicles, total mileage (10^9 veh-km/y)	295	352	389	426	426	426
Car fleet (10^6)	27	30	32	34	35	35
Moto, total mileage (10^9 veh-km/y)	31	39	45	49	50	51
Moto fleet (10^6)	7	7	9	10	10	10
Goods transport, total mileage (10^9 veh-km/y)	69	77	93	98	102	104
Truck fleet (10^6), including LDV	2	3	3	4	4	5

Source: ISPRA elaborations

Table 3.22 Evolution of fleet consistency and mileage

When a vehicle engine is cold, it emits at a higher rate than when it has warmed up to its designed operating temperature. This is particularly true for gasoline engines and the effect is even more severe for cars fitted with three-way catalysts, as the catalyst does not function properly until the catalyst is also warmed up. Emission factors have been derived for cars and LGVs from tests performed with the engine starting cold and warmed up. The difference between the two measurements can be regarded as an additional cold-start penalty paid on each trip a vehicle is started with the engine (and catalyst) cold.
Evaporative emissions of gasoline fuel vapour from the tank and fuel delivery system in vehicles constitute a significant fraction of total NMVOC and methane emissions from road transport. The procedure for estimating evaporative emissions of NMVOCs and methane takes account of changes in ambient temperature and fuel volatility.

3.6.3.3 Uncertainty and time-series consistency

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

The following Table 3.23 summarizes the time series of GHG emissions in CO_2 equivalent from road transport, highlighting the evolution of this growing source.
An upward trend in CO_2 emission levels is observed from 1990 to 2004, which is explained by the increasing of the fleet, total mileages and fuel consumptions.
Nevertheless, the propagation of the number of vehicles with low fuel consumption per kilometre, slows down the tendency in the last years.

		1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
CO_2	kt	93,387	103,553	110,385	113,064	115,209	116,321	118,395	117,035	118,268	118,721
CH_4	kt	867	956	713	674	621	576	515	459	440	415
N_2O	kt	996	1,694	1,966	1,935	1,907	1,832	1,804	1,371	1,437	1,420
Total	**kt**	**95,249**	**106,204**	**113,064**	**115,672**	**117,737**	**118,729**	**120,713**	**118,865**	**120,145**	**120,556**

Source: ISPRA elaborations

Table 3.23 GHG emissions from road transport (kt CO_2 equivalent)

3.6.3.4 Source-specific QA/QC and verification

Data used for estimating emissions from the road transport sector, derive from different sources, including official statistics providers and industrial associations.

A specific procedure undertaken for improving the inventory in the sector regards the establishment of a national expert panel in road transport which involves, on a voluntary basis, different institutions, local agencies and industrial associations cooperating for improving activity data and emission factors accuracy. In this group, emission estimates are presented annually, and new methodologies are shared and discussed.

Besides, time series resulting from the recalculation due to the application of Copert 4 have been discussed with national experts in the framework of an ad hoc working group on air emissions inventories. The group is chaired by ISPRA and includes participants from the local authorities responsible for the preparation of local inventories, sectoral experts, the Ministry of Environment, Land and Sea, and air quality model experts. Recalculations are comparable with those resulting from application of the new model at local level. Top-down and bottom-up approaches have been compared with the aim to identify the major problems and future possible improvements in the methodology to be addressed.

3.6.3.5 Source-specific recalculations

The transition from Copert III to Copert 4 was indeed the occasion for a general review of input data, as activity data, model parameters and emission factors. The new version revised both the estimation methodology and the software.

The most recent update of the software is Copert 4, version 6.1 since February 2009 (EEA, 2007) which is a user-friendly version enhancing import/export capabilities and the management of time series of estimates.

Methodological differences affected mainly emission estimates of heavy good vehicles, especially in terms of fleet classification, emission factors, and emission degradation parameters.

In addition, hot emission factors of regulated pollutants for conventional passenger cars and powered two wheelers and nitrous oxide and ammonia from passenger cars and light duty vehicles have been updated; particulate matter emissions have been distinguished by exhaust and not exhaust emissions. Copert 4 also includes a new methodology for the estimation of evaporative emissions and a revision of heavy metal estimates due to the inclusion of emissions from tyre and brakes wear.

As regards passenger cars, light duty vehicles, mopeds and motorcycles, the fleet classification considered in Copert 4 is the same as the older version. On the contrary, the classification regarding heavy goods trucks and buses is more detailed in Copert 4 than Copert III, so accordingly input data for the whole series were recalculated from 1990 to 2007.

The uploading of the whole time series data in the new software has been the occasion for the review of the fuel consumption time series. Diesel and gasoline fuel consumptions, for road transport, have been revised in order to avoid double counting for some years of consumptions of military diesel oil and gasoline for motor boating, which are included in the road transport row in the National Energy Balance (MSE, several years). In particular, diesel fuel has been updated for the years from 1991 to 2000, while gasoline from 1991 to 2005. LPG activity data have been updated only in 2000 while no changes occurred for natural gas and biomass activity data.

With regard to CO_2 emission factors, IPCC values were considered as reference values for diesel and LPG, for years from 1990 to 1999, and H/C ratios incorporated accordingly in the Copert 4.

Hence, emission factors have been slightly changed, while from 2000 national emission factors have been used as in the previous estimates (see Table 3.17).

Methane emission values are higher in the nineties and lower from 2000 onwards, in comparison with the previous submission. The difference is mainly explained by the update in the model of hydrocarbon emission factors for all vehicles, involving both recalculation of non methane volatile organic compounds and methane emissions.

Finally, Copert 4 revised emission factors of N_2O and NO_X for the whole time series, for all vehicles. The main update regarded heavy goods vehicles and passenger cars diesel fuelled. New estimates of N_2O emissions result lower than the previous time series. On the other hand, nitrogen oxides show higher values in the new estimates for all the years and this, at national level, will be a problem for the compliance with the national emission ceilings European Directive.

Recalculations, in the total road transport GHG emissions, account for -0.7% in 1990 and -2.1% in 2006. Higher discrepancies are observed for methane (ranging from 16.6% in 1990 to -16.6% in 2006) and nitrous oxide (ranging from -38% in 1990 to -63.9% in 2006); carbon dioxide values are relatively homogeneous varying from -0.2% in 1990 to -0.002% in 2006.

3.6.3.6 Source-specific planned improvements

No specific improvements are planned for the next submission.

3.6.4 Navigation

3.6.4.1 Source category description

This source category includes all emissions from fuels delivered to water-borne navigation.
Mainly CO_2 emissions derive from this category, whereas CH_4 and N_2O emissions are less important.
Emissions from navigation constituted 3.9 per cent of the total GHG in the transport sector in 2007 and 0.9 per cent of the national total. If considering CO_2 only, emissions from navigation are 1.1% out of the national CO_2 emissions. GHG emissions decreased by 8.3 per cent from 1990 to 2007, although an increase in the number of movements is observed, on account of the reduction in fuel consumed in harbour and navigation activities.

Navigation is a key category with respect to CO_2 emissions in level and trend with uncertainty.

3.6.4.2 Methodological issues

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

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

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

As for emission and consumption factors, figures are derived by the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2007), both for recreational and harbour activities and national cruise, taking into account national specificities. These specificities derive from the results of a national study which, taking into account detailed information on the Italian marine fleet and the origin-destination movement matrix for the year 1997, calculated national values (ANPA, 2001; Trozzi et al., 2002 [b])) on the basis of the default emission and consumption factors reported in the EMEP/CORINAIR guidebook.
National average emissions and consumption factors were therefore estimated for harbour and cruise activities both for domestic and international shipping from 1990 to 1999. At present, as in the case of aviation, the study has been updated for the years 2004, 2005 and 2006 in order to consider most recent trends in the maritime sector both in terms of modelling between domestic and international consumptions and operational improvements in harbour (TECHNE, 2009). On the basis of the results, national average emissions and consumption factors were updated from 2000.

Specifically, for the years referred to in the surveys, the current method estimates emissions from the number of ships movements broken down by ship type at each of the principal Italian ports considering the information of whether the ship movement is international or domestic, the average tonnage and the relevant distance travelled.

For those years, in fact, figures on the number of arrivals, destination, and fleet composition have been provided by the local port authorities and by the National Institute of Statistics (ISTAT, 2009), covering about 90% of the official national statistics on ship movements for the relevant years. Consumption and emission factors are those derived from the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2007) and refer to the Tier 3 ship movement methodology that takes in account origin-destination ship movements matrices as well as technical information on the ships, as engine size, gross tonnage of ships and operational times in harbours. On the basis of sample information, estimates have been carried out at national level for the relevant years considering the official statistics of the maritime sector.

In general, to carry out national estimates of greenhouse gases and other pollutants in the Italian inventory for harbour and domestic cruise activities, consumptions and emissions are calculated for the complete time series using the average consumption and emission factors multiplied by the total number of movements. On the other hand, for international cruise, consumptions are derived by difference from the total fuel consumption reported in the national energy balance and the estimated values as described above and emissions are therefore calculated.

3.6.4.3 Uncertainty and time-series consistency

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

Estimates of fuel consumption for domestic use, in the national harbours or for travel within two Italian destinations, and bunker fuels used for international travels are reported in Table 3.24. Time series of domestic GHG emissions for waterborne navigation are also shown in the same table.

An upward trend in emission levels is observed from 1990 to 1997 explained by the increasing number of ship movements. Nevertheless, the operational improvements in harbour activities and a reduction in ship domestic movements inverted the tendency in the last years.

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Fuel in domestic travels (kt)	778	706	802	843	866	818	811	787	748	741	732	740	709	673
Fuel in harbours (dom+int ships) (kt)	748	693	794	824	853	814	818	800	767	766	763	759	727	690
Fuel in international Bunkers (kt)	1,398	1,286	911	975	1,019	1,053	1,333	1,534	1,768	2,001	2,167	2,203	2,369	2,468
CO_2 (kt)	5,420	5,117	5,749	5,959	6,126	5,855	5,842	5,723	5,477	5,448	5,392	5,403	5,204	4,970
CH_4 (kt CO_2 eq.)	29	32	33	33	33	32	32	32	31	31	30	30	29	29
N_2O (kt CO_2 eq.)	39	32	33	33	33	32	32	32	31	31	30	30	29	29

Source: ISPRA elaborations

Table 3.24 Marine fuel consumptions in domestic and international travels (kt) and GHG emissions from domestic navigation (kt CO_2 eq.)

3.6.4.4 Source-specific QA/QC and verification

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

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

3.6.4.5 Source-specific recalculations

There has been an overall recalculation of emissions from the sector due to the update of the methodological study completed in 2009 referring to the years 2004-2006.
In fact, in previous submissions, constant parameters were applied for the all time series considering model results of the year 1997. The time series did not take into account most recent trends in maritime activities in terms of technological improvements, fleet composition and relevant fuel consumption, and operational times especially hotelling and manoeuvring in harbour activities.

As specified in the last review reports (UNFCCC, 2006; UNFCC, 2009), the ERT recommended to update these results in view of recent available national research to improve the accuracy of the inventory and correct the potential overestimation for recent years.
Aim of the revision was, principally, to revise the consumption values and relative parameters which are very important for local air quality, in terms of pollutants such as NO_X, NMVOC, CO, PM, and consequently greenhouse gases. In fact, the revision of the methodology resulted mainly in a reduction of domestic fuel consumptions for the last years, due, for cruise activities, to a different ship type distribution in domestic routes with an average gross tonnage lower than the previous years and, for in port activities, a reduction of the average hotelling and manoeuvring times. Average fuel consumption reduced in harbour from 1.54 t, calculated in the previous research study, to 1.32 t by ship and in domestic cruise from 1.73 t to 1.40 t by ship.
From 1998 to 2004, values have been reconstructed by an interpolation method.
Minor recalculations regarded an update of domestic ferryboat movements for 1991, 1992 and 1994 and gasoline emission factor for recreational crafts from 1990 to 1999.

The recalculation affected only slightly the time series up to 1997 (from +0.4% to +1.5%) but consistently the estimations from 1998 to 2006, with differences ranging from -1.4% to -14.7%, with respect to earlier submissions.
The revision of model assumptions has lead to a recalculation of international bunkers, accordingly.

3.6.4.6 Source-specific planned improvements

Further improvements will regard a verification of activity data on ship movements for the last two years. In fact, origin destination data supplied by ISTAT do not match with the statistics supplied by the same Institute at international level to EUROSTAT. Besides EUROSTAT figures seems for 2006 and 2007 to be clearly underestimated.

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 (see Annex 5, Tables A5.9 and A5.10, in physical units, row “DOMESTIC AND COMMERCIAL USES”, subtracting the quantities for military use in diesel oil and off-road uses in petrol) 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, several years).
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 paragraph 3.7.2. Emissions from fishing vessels are estimated from fuel consumption data (MSE, several years [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 paragraphs 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 paragraph 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 combined harvesters; construction equipment such as bulldozers and excavators; domestic lawn mowers; aircraft support equipment; and industrial machines such as portable generators and compressors. In the CORINAIR inventory they are grouped into four main categories (EMEP/CORINAIR, 2007):

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

Those categories are mapped to the appropriate IPCC classes: Aircraft support is mapped to Other Transport and the other categories map to the off-road vehicle subcategories of Residential, Agriculture and Manufacturing Industries and Construction.
Estimates are calculated using a modification of the methodology given in EMEP/CORINAIR (EMEP/CORINAIR, 2007). This involves the estimation of emissions from around seventy classes of off-road source using the following equation for each class:

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

where

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

For gasoline 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

Population data have been revised based on a survey of machinery sales (Frustaci, 1999). Machinery lifetime is estimated on the European averages, see EMEP/CORINAIR (EMEP/CORINAIR, 2007), the annual usage data were taken either from industry or published data (EEA, 2000). The emission factors used came mostly from EMEP/CORINAIR and from Samaras (EEA, 2000). The load factors were taken from Samaras (EEA, 2000).
It was possible to calculate fuel consumptions for each class based on fuel consumption factors given in EMEP/CORINAIR (EMEP/CORINAIR, 2007). Comparison with known fuel consumption

for certain groups of classes (e.g. agriculture and construction) suggested that the population method overestimated fuel consumption by factors of 2-3, especially for industrial vehicles.

Estimates were derived for fuel consumptions for the years 1990-2007 for each of the main categories:

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

Emissions from off-road sources are particularly uncertain. The revisions in the population data produced higher fuel consumption estimates. The gasoline consumption increased markedly but is still only a tiny proportion of total gasoline 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 2007 are given.
Data are based on a detailed yearly report available by Ministry of Economic development (MSE, several years [b]). The report summarizes answers from a detailed questionnaire that all operators in Italy prepare monthly. The data are more detailed than those normally available by international statistics and refer to:

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

In the national energy balances, only the input and output quantities from the petrochemical plants are reported, so the output quantity could be greater than the input quantity, due to internal transformation. Therefore it is possible to have negative values for some products mainly gasoline, refinery gas, fuel oil.
The quantities of fuels stored in products, in percentage on net and gross petrochemical input, are estimated with these data, see Table 3.26 for details by product and Table 3.25 for the overall figure. As can be seen from the value reported for the year 2007 there is a sizeable difference of the estimated quantities of fuel stored in product if reference is made to "net" or "gross" input. Moreover the estimation of quantities stored in product are quite different from those reported in the Revised 1996 IPCC Guidelines for National GHG Inventories, Reference Manual, ch1, tables 1-5 (IPCC, 1997).

An attempt was made to estimate the quantities stored in products using IPCC percentage values as reported in table 1-5 and the fuels reported as “petrochemical input” in Table 3.26. The resulting estimate of about 6,889 kt of products for the year 2007, is more than 50% bigger than the quantities reported, 4,752, 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 3.27, those non-energy products are mainly outputs of refineries. The estimate refers to quantities produced that are reported by manufacturers and summarized by BEN. The data should not be controversial. Minor differences in the overall energy content of those products do occur if the calculation is based on national data or IPCC default values.

BREAKDOWN OF TOTAL PETROCHEMICAL FLOW	Petroch. Input	Returns to refin./market	Internal consumption / losses	Quantity stored in products
ALL ENERGY CARRIERS, kt	10,685	3,162	2,771	4,752
% of total input		29.6%	25.9%	44.5%
% of net input			36.8%	63.2%

Table 3.25 Other non energy uses, year 2007

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		575	568	276	-269			0.8137
Refinery gas		262	103	961	-802			0.8549
Virgin naphtha		5,862	0	0	5,862			0.8703
Gasoline		1,114	1,702	0	-588			0.8467
Kerosene		537	371	0	166			0.8485
Gas oil		591	142	0	449			0.8569
Fuel oil		619	205	455	-41			0.8678
Petroleum coke		0	0	0	0			0.955
Others (feedstock)		124	71	78	-25			0.8368
Losses				0	0			0.8368
Natural gas		1,001	0	1,001	0			0.727
	total	10,685	3,162	2,771	4,752	44%	63%	

Table 3.26 Petrochemical, detailed data from MSE, year 2007 (MSE, detailed petrochemical breakdown)

NON ENERGY FROM REFINERIES	**Quantity stored in products kt**	**Energy content IPCC '96**	**Emission factor t C / t**	**Total energy content, IPCC values TJ**
Bitumen + tar	3,951	40.19	0.8841	158.8
lubricants	1,252	40.19	0.8038	50.3
recovered lubricant oils	179	40.19	0.8038	7.2
paraffin	79	40.19	0.8368	3.2
others (benzene, others)	664	40.19	0.8368	26.7
Totals	6,125			246.1

Table 3.27 Other non energy uses, year 2007, MSE several years [a]

3.10 Country specific issues

3.10.1 National energy balance

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

- it is a balance, every year professional people carry out the exercise balancing final consumption data with import-export information;
- the balance is made on the energy value of energy carriers, taking into account transformations that may occur in the energy industries (refineries, coke plants, electricity production);
- data are collected regularly by the Ministry of Economic Development, on a monthly basis, from industrial subjects;
- oil products, natural gas and electricity used by industry, civil or transport sectors are taxed with excise duties linked to the physical quantities of the energy carriers; 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 Economic Development.

3.10.2 National emission factors

Monitoring of the carbon content of the fuels used nationally is an ongoing activity at ISPRA. The principle is to analyse regularly the chemical composition of the used fuel or relevant activity statistics, to estimate the carbon content and the emission factor. National emission factors are reported in 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 1.6% out of the total emissions in the energy sector. Both CH_4 and CO_2 emissions show a reduction from 1990 to 2007 by 32% and 35%, respectively.

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
CO_2										
Oil and natural gas	3,341	3,174	2,585	2,440	2,261	2,834	2,152	2,112	2,189	2,176
CH_4										
Solid fuels	122	65	73	81	78	95	64	69	54	84
Oil and natural gas	7,298	6,817	6,351	5,988	5,964	5,802	5,650	5,654	5,139	4,987
N_2O										
Oil and natural gas	1.2	1.3	1.1	1.0	1.3	1.3	1.3	1.5	1.4	1.4

Table 3.28 Fugitive emissions from oil and gas 1990-2007 (Gg CO_2 eq.)

The decrease of CO_2 fugitive emissions is driven by the reduction in crude oil losses in refineries. Emissions are balanced with the amount of crude oil losses reported in the national Energy Balance (MSE, several years [a]).
The trend of CH_4 fugitive emissions from solid fuels is related to the extraction of coal and lignite that in Italy is quite low while the decrease of CH_4 fugitive emissions from oil and natural gas is due to the reduction of losses for gas transportation and distribution, and to the gradual replacement of old pipelines.
The results of key category analysis are shown in the following box.

Key-category identification in the fugitive sector with the IPCC Tier1 and Tier2 approaches (without LULUCF)

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, T)

Specifically, methane emissions from oil and gas operations are a key category source according to the level and trend assessment with both Tier 1 and Tier 2 approaches, either including or excluding LULUCF emissions and removals. CO_2 emissions from oil and gas operations are a key category for trend assessment, with both Tier 1 and Tier 2 approaches, and level assessment with Tier 2 without LULUCF; these emissions are a key category only for trend assessment with Tier 1 when including LULUCF. Both categories are also key categories for the year 1990, either including or excluding LULUCF emissions and removals. The uncertainty in CH_4, N_2O and CO_2 emissions from oil and gas operations is estimated to be 25% as a combination of 3% and 25% for activity data and emission factors, respectively.
Fugitive emissions from solid fuels, reported in 1.B.1, are not relevant. In fact, CH_4 emissions from coal mining refer to only two mines with very low production in the last ten years, one of which is underground and produces coal and the other, on the surface, produces lignite. The surface mine stopped the activity in 2001. CH_4 emissions from solid fuel transformation refer to the coke production in the iron and steel industry, which is also decreasing in the last years.
CH_4 emissions from coal mining have been estimated on the basis of activity data published on the National Energy Balance (MSE, several years [a]) and emission factors provided by the IPCC guidelines (IPCC, 1997). CH_4 emissions from coke production have been estimated on the basis of activity data published in the national statistical yearbooks (ISTAT, several years) and emission factors reported in the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2005). CO_2 and N_2O emissions from 1.B.1 are not occurring. The uncertainty in methane emissions from coal mining and handling is estimated to be 200% as combination of 3% and 200% for activity data and emission factors, respectively.

Fugitive CO_2 emissions reported in 1.B.2 refer to fugitive emissions in refineries during petroleum production processes, e.g. fluid catalytic cracking and flaring, and emissions from the production of oil and natural gas. Emissions in refineries have been estimated on the basis of activity data published in the National Energy Balance (MSE, several years [a]) or supplied by industry (UP, several years) and operators especially in the framework of the European emissions trading scheme. Emissions occurring in production of oil and gas have been calculated on the basis of activity data published in the National Energy Balance (MSE, several years [a]), data published by industry (UP, several years) and data supplied by operators and emission factors published on the IPCC Good Practice Guidance (IPCC, 2000).

CH_4 emissions reported in 1.B.2 refer mainly to the production of oil and natural gas and to the transmission in pipelines and distribution of natural gas. CH_4 emissions from the production of oil and natural gas have been calculated on the basis of activity data published in the National Energy Balance (MSE, several years [a]) and by industry (UP, several years), and emission factors published on the IPCC Good practice Guidance (IPCC, 2000). CH_4 emissions from the transmission in pipelines and distribution of natural gas have been estimated on the basis of activity data published by industry and competent national authority and information collected annually by the Italian gas operators. More in details, emission estimates take into account the information regarding the amount of natural gas distributed (ENI, several years [a]), length of pipelines distinct by low, medium and high pressure and by type, iron, grey iron, steel or polyethylene pipelines (AEEG, several years), natural gas losses reported in the national energy balance (MSE, several years [a]) and methane emissions reported by operators in their environmental reports (ENI, several years [b]; EDISON, several years); estimates include emissions emitted in the different phases of distribution and transmission of gas including losses in pumping stations and in reducing pressure stations. Emissions are verified considering emission factors reported in literature and detailed information supplied by the main operators (ENI, several years [b]; Riva, 1997). More details on the methodology used and on the basic information collected from operators are reported in a technical paper (Contaldi, 1999).

In response to the review process of the Initial Report under the Kyoto Protocol and of the 2006 submission under the Convention, N_2O emissions from flaring in oil and gas production have been estimated on the basis of activity production data and emission factors reported in the IPCC GPG (IPCC, 2000). They amount, for the whole time series, for less than 1 kilotons of CO_2 equivalent.

In the submission 2009, CH_4 emissions from the transmission in pipelines and distribution of natural gas have been recalculated from 2004 because of more detailed information was available on the amount of imported gases from Lybia and Algeria and emission factors from minor distributors of gas in urban areas have been updated. This resulted in an increase of CH_4 emission equal to 0.5% and 3.4% in 2004 and 2005, respectively, and a reduction of 0.9% in 2006. Moreover CH_4 emissions from the production of oil from 2005 were updated on the basis of new activity data. This recalculation resulted in an increase of emissions of 0.01% in 2005 and 0.2% in 2006.

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.
CO_2 and CH_4 fugitive emissions from oil exploration are included in those from production because no detailed information is available. N_2O emissions from flaring in oil exploration and in refining activities are reported under oil flaring. Emissions from transport and distribution of oil result as not occurring. CO_2 and CH_4 emissions from gas exploration are also included in those from production while CH_4 emissions from other leakage are included in distribution emission estimates. Further investigation will be carried out with industry about these figures.

CO_2 and CH_4 emissions from 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.
CO_2 and CH_4 emissions from gas flaring are also included in production under 1.B.2.b.
A summary of the completeness of CO_2, CH_4 and N_2O fugitive emissions is shown in the following Table 3.29.

1.B. 2.a. Oil		
i. Exploration	CO_2, CH_4	Included in 1.B.2.a production
i. Exploration	N_2O	Included in 1.B.2.c oil flaring
iv. Refining	N_2O	Included in 1.B.2.c oil flaring
1.B.2.b. Natural Gas		
i. Exploration	CO_2, CH_4	Included in 1.B.2.b production
iii. Other leakage	CH_4	Included in 1.B.2.b distribution
1.B. 2.c. Venting and flaring		
i. Oil	CO_2, CH_4	Included in 1.B.2.a production
ii. Gas	CO_2, CH_4	Included in 1.B.2.b production

Table 3.29 Completeness of CO_2 CH_4 and N_2O fugitive emissions

Chapter 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 2007 industrial processes account for 5.7% of CO_2 emissions, 0.2% of CH_4, 5.9% of N_2O, 100% of PFCs, HFCs and SF_6. In term of CO_2 equivalent, industrial processes share 6.6% 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 2007, while CO_2 emissions from chemical and metal industry reduced sharply.

GAS/SUBSOURCE	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
CO_2 (Gg)										
2A. Mineral Products	21,100	20,768	21,266	22,096	22,089	22,986	23,553	23,131	23,219	23,678
2B. Chemical Industry	2,199	1,230	1,062	1,034	1,082	1,243	1,328	1,317	1,308	1,311
2C. Metal Production	3,892	3,417	1,769	1,729	1,648	1,627	1,772	2,009	2,032	1,935
CH_4 (Gg)										
2B. Chemical Industry	2.45	2.65	0.40	0.33	0.33	0.31	0.33	0.33	0.32	0.34
2C. Metal Production	2.71	2.71	2.61	2.50	2.38	2.46	2.58	2.72	2.81	2.75
N_2O (Gg)										
2B. Chemical Industry	21.54	23.35	25.54	26.55	25.49	24.38	27.24	25.03	8.54	6.10
HFCs (Gg CO_2 eq.)	351	671	1,986	2,550	3,100	3,796	4,515	5,267	5,956	6,700
PFCs (Gg CO_2 eq.)	1,808	491	346	451	424	498	348	353	282	288
SF_6 (Gg CO_2 eq.)	333	601	493	795	740	468	502	465	406	428

Table 4.1 Trend in greenhouse gas emissions from the industrial process sector, 1990-2007 (Gg)

Seven key categories 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-category identification in the industrial processes sector with the IPCC Tier1 and Tier2 approaches

2F	HFC, PFC	Emissions from substitutes for ODS	Key (L, T)
2A	CO_2	Emissions from cement production	Key (L, T2)
2B	N_2O	Emissions from adipic acid	Key (T)
2A	CO_2	Emissions from limestone and dolomite use	Key (L1)
2C	CO_2	Emissions from iron and steel production	Key (T1)
2B	CO_2	Emissions from ammonia production	Key (T1)
2C	PFC	Emissions from aluminium production	Key (T1)

CO_2 emissions from cement and limestone and dolomite use are included in category 2A; N_2O emissions from adipic acid and CO_2 emissions from ammonia refer both to 2B; PFCs from aluminium production are included in 2C as CO_2 emissions from iron and steel production. Methane emissions from the sector are not a key source.
All these categories, except CO_2 emissions from limestone and dolomite use and ammonia, are also key category sources including the LULUCF estimates in the key category assessment.
In addition CO_2 emissions from limestone and dolomite use is a key category in the base year at level assessment with the Tier 1 approach including LULUCF and N_2O emissions from nitric acid is a key category in the base year at level assessment with the Tier 1 approach excluding LULUCF.

4.2 Mineral Products (2A)

4.2.1 Source category description

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

Cement

Cement production (2A1) is the main source of CO_2 emissions in this sector. As already mentioned, it is a key source both at level (with both the Tier 1 and Tier 2 approaches) and trend assessment (with the Tier 2 approach) and accounts for 3.77% of the total national emissions.

During the last 15 years in Italy changes in cement production sector have occurred which have led to a more stable structure. The oldest plants were closed, wet processes were abandoned in favour of dry processes so as to improve the implementation of more modern and efficient technologies. There are 29 companies (90 plants of which: 60 full cycle and 30 grinding plants) currently operating in this sector: multinational companies and small and medium size enterprises (operating at national or only at local level) are present in the country. As for the localization of the operating plants: 47% is in northern Italy, 18% is in the central regions of the country and 35% is in the southern regions and in the islands. There are 80 active sintering rotary kilns which belong to the "dry" or of "semidry" types. The larger size cement plants (i.e. with cement production capacity > 1 Mt/y) have been contributing with about 36% of the national cement production. In Italy different types of cement are produced, as for 2007 AITEC, the national cement association, has characterised the national production as follows: 76% is CEM II (Portland composite cement); 12% is CEM IV (pozzolanic cement); 6.9% is CEM I (ordinary Portland Cement) and 4.3% is CEM III (blastfurnace cement).

Lime

CO_2 emissions occur also from processes where lime is produced and account for 0.51% of the total national emissions. Lime production can also occur, beside lime industry, in different industrial sectors such as iron and steel making, pulp and paper production, soda ash production, sugar production and lime can also be used in a number of processes concerning wastewater treatment, agriculture and the neutralization of acidic emissions in the industrial flue gases. In particular the other relevant lime productions accounted for in Italy are those occurring in the iron and steel making process and in the sugar production process.

Lime is basically produced by calcination of limestone (calcium carbonate) or dolomite (calcium/magnesium carbonate) at 900 °C. The process leads to quicklime and CO_2 emissions according to the following reaction:

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

CO_2 is released because of the process reaction itself and also because of combustion to provide energy to the process. CaO and MgO are called quicklime. Quicklime together with water give another product of the lime industry which is called calcium hydroxide $Ca(OH)_2$.

CO_2 emissions estimation is related to lime production in mineral industry and it includes also the production of lime in iron and steel making facilities and lime production in sugar mills.

The number of lime producing facilities has been relevantly changing through the years: 85 operating plants in 1990, 46 plants in 2003, 35 plants in 2007 (this figure is based on the European emission trading scheme data): 46% is in the southern regions and in the islands, 39% is in the northern regions and 15% in the central regions. The number of operating kilns has also decreased significantly through the years (about 171 in 1990, 75 in 2003). During the '90s lime industry invested in technology implementation to replace the old kilns with regenerative and high efficiency kilns, rotary kilns are no longer used. As for fuel consumptions, 80% of the Italian lime industry uses natural gas, 20% uses coke.

Limestone and dolomite use (brick and tiles; fine ceramics)

CO_2 emissions are also related to the use of limestone and dolomite in different industrial processes, they account for 0.53% of the total national emissions. Limestone or dolomite can be added in different steps of the production process so as to obtain the desired product features (i.e. colour, porosity). Sometimes carbonates in limestone and dolomite may have to be calcined ("dead burned") in order to be added to the manufacturing process. Limestone and dolomite are also used in paper production process. CO_2 emissions from limestone and dolomite use is a key source at level assessment with the Tier 1 approach.

Glass production

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

- raw materials storage and batch formulation;
- melting of the formulated batch at temperature ranging from 1400 °C to 1600 °C, in different furnaces according to the type of glass product;
- forming into glass products at specific temperature ranges;
- annealing of glass products to prevent weak glass due to stress;

The formulated batch is generally melted in continuous furnaces, whose size and features are related to the types of glass production. In Italy 80% of the glass industry production is carried out using natural gas as fuel, other fossil fuels consumption is limited to low sulphur content oil. Emissions to air are released basically by the high temperature melting step and depend on the type of glass product, raw materials and furnaces involved in the production process. Main pollutants are: dust, NO_x, SO_x, CO_2; occasionally and depending on the specific production process heavy metals, fluorides and chlorides gases could be released. CO_2 emissions are mainly related to the decarbonisation of carbonates used in the process (soda ash, limestone, dolomite) during the melting phase.

Soda Ash production and use

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

4.2.2. Methodological issues

IPCC Guidelines and Good Practice Guidance are used to estimate emissions from this sector (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, 2007) or by other international Guidebooks (USEPA, 1997).

Cement

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). Emission factors are estimated on the basis of information provided by the Italian Cement Association (AITEC, several years) and by cement facilities in the framework of the European pollutant emission register (EPER, now E-PRTR) and the European emission trading scheme. In this latter context, all cement production plants reported fuel consumption and emissions, split between combustion process and decarbonising process. For the years from 1990 up to 2003 the resulting emission factor for cement production was equal to 540 kg CO_2/ton clinker, based on the average CaO content in the clinker and taking into account the contribute of carbonates and additives. This value was suggested to the operators by AITEC (AITEC, 2004) on the basis of a tool provided by the World Business Council for Sustainable Development and available on website at the following address http://www.ghgprotocol.org/standard/tools.htm.

From 2004, emission factors were based on the data reported under the frame of the EPER/EPRTR and of the European Emission Trading scheme and resulted in the following values: 532 kg CO_2/ton clinker in 2004, 525 kg CO_2/ton clinker in 2005, 526 kg CO_2/ton clinker in 2006 and 531 kg CO_2/ton clinker in 2007, based on the average CaO content in the clinker and taking into account the contribute of carbonates and additives.

Lime

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

Limestone and dolomite

CO_2 emissions from limestone and dolomite use are related to the use of limestone and dolomite in bricks, tiles and ceramic and paper production. In the CRF the total amount of limestone and dolomite used in these processes is reported as activity data and it has been estimated on the basis of the average content of $CaCO_3$ in the different products. Detailed production activity data and emission factors have been supplied in the framework of the European emissions trading scheme and relevant data are annually provided by the Italian bricks and tiles industrial association and by the Italian ceramic industrial associations (ANDIL, 2000; ANDIL, several years; ASSOPIASTRELLE, several years; ASSOPIASTRELLE, 2004).

Soda ash

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

Glass

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

Asphalt roofing and road paving

NMVOC emissions from asphalt roofing and road paving have been estimated by production activity data (ISTAT, 1990-95; Federchimica and SITEB, since 1996) and default emission factors (EMEP/CORINAIR, 2007).

4.2.3. Uncertainty and time-series consistency

The uncertainty in CO_2 emissions from cement, lime, limestone and dolomite use and glass production is estimated to be equal to 10.4% from each activity, as a combination of 3% and 10% for activity data and emission factor, respectively. Official statistics of activity data for these categories are quite reliable when compared to the activity data reported by facilities under different data collections, thus leading to the considered uncertainty level for the activity data. The uncertainty level for emission factors is equal to the maximum level reported in the IPCC Good Practice Guidance (IPCC, 2000) for the cement production; this is a conservative estimation because the range of values of the emission factors of the Italian cement plants would lead to a lower uncertainty level.
In Tables 4.2 and 4.3, the production of mineral products and CO_2 emission trend is reported.

ACTIVITY DATA	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Cement production (decarbonizing)	29,786	28,778	29,816	30,893	30,770	32,077	33,049	33,122	33,210	33,742
Glass (decarbonizing)	3,779	4,259	4,930	5,014	4,811	5,141	5,178	5,328	5,327	5,385
Lime (decarbonizing)	2,583	2,873	2,760	2,958	2,951	3,174	3,357	3,344	3,496	3,444
Limestone and dolomite use	5,397	4,907	4,843	5,014	5,240	5,359	5,714	5,792	5,747	5,712
Soda ash production and use	610	1,070	1,000	1,000	918	847	870	915	883	874

Table 4.2 Production of mineral products, 1990 – 2007 (kt)

CO_2 EMISSIONS	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Cement production (decarbonizing)	16,084	15,540	16,101	16,682	16,616	17,322	17,575	17,403	17,474	17,914
Glass (decarbonizing)	416	468	549	549	521	524	528	543	543	549
Lime (decarbonizing)	2,042	2,279	2,185	2,358	2,365	2,540	2,679	2,361	2,426	2,434
Limestone and dolomite use	2,375	2,159	2,131	2,206	2,306	2,358	2,514	2,548	2,529	2,513
Soda ash production and use	183	321	300	300	281	242	258	275	247	268

Table 4.3 CO_2 emissions from mineral products, 1990 – 2007 (Gg)

Emission trends are related to the production, which are increasing, in the last years, for cement and glass and decreasing for fine ceramics.

4.2.4. Source-specific QA/QC and verification

CO_2 emissions have been checked with the relevant industrial associations.
Both activity data and average emission factors are also compared every year with data reported in the national EPER/E-PRTR registry and in the European emissions trading scheme.

4.2.5. Source-specific recalculations

Recalculations have been done as CO_2 emission factors for cement and lime industries (2004-2006) have been changed on account of the complete information availability from emissions trading scheme. Consequently, as for CO_2 emissions, recalculations for cement industries result in -1.52%, -2.70% and -2.56% respectively for 2004, 2005 and 2006; recalculations for lime industries result in -0.25%, -11.56% and -13.20% respectively for 2004, 2005 and 2006.

4.2.6. Source-specific planned improvements

No further improvements are planned.

4.3 Chemical industry (2B)

4.3.1 Source category description

CO_2, CH_4 and N_2O emissions from chemical productions are estimated and included in this sector. In this submission, CO_2 emissions from calcium carbide production are also estimated and reported for the years 1990-1995 where production and emissions occurred.

Adipic acid

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

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

Adipic acid is then used to produce nylon or is fed to other production processes. Together with adipic acid, N_2O is produced and CO_2 is one of the by-products (Radici Chimica, 1993).
Emissions data from adipic acid production are provided and referenced by one plant, which is the sole producer in Italy (Radici Chimica, several years). Specifically, for N_2O, adipic acid is a key source at trend assessment, both with the Tier 1 and Tier 2 approach. These emissions accounted for 16.0% of total N_2O emissions in 2005 and 2.45% in 2007 because the technology to reduce N_2O emissions started to be fully operative at the existing producing facility.
N_2O emissions have been relevantly decreasing thanks to the implementation of a catalytic abatement system (pilot scale plant). The use of thermally stable catalysts in the pilot plant has allowed the treatment of highly N_2O concentrated flue gas from the adipic acid production plant, thus reducing the volumes of treated gas and the size of the pilot plant itself. In 2004 this system was tested for one month resulting in complete decomposition of N_2O, in 2005 because of technical changes in the system the catalytic process was started only at the end of 2005; in 2006 the abatement system had been operating continuously for 9 months (three months were needed for maintenance and technical changes) leading to the decomposition of 95% of N_2O emissions; in 2007 the operating time was 11 months (about one month was needed for maintenance operations). The abatement pilot scale plant is generally run together with the adipic acid production process; the abatement rate for N_2O emissions was 90% in 2007.
Also CO_2 emissions are estimated from this source.

Ammonia production

In Italy only two plants are currently producing ammonia as a consequence of the resizing of the production at national level after the crisis of the larger fertilizer producer (Enichem Agricoltura). Ammonia is obtained after processing in ammonia converters a “synthesis gas” which contains hydrogen and nitrogen. CO_2 is also contained in the synthesis gas, but it is removed in the decarbonising step within the ammonia production process, partly it is recovered as a by-product and partly is released to atmosphere.
CO_2 emissions from ammonia production are 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.

Nitric acid

In early ‘90s seven facilities manufactured nitric acid, but since 2003 the production has been carried on only in three plants. Nitric acid is produced from ammonia by catalytic oxidation with air

of NH_3 to NO_2 and subsequent reaction with water. Currently the reactions involved take place in low and medium pressure processes.
N_2O emissions from nitric acid production are not a key source although they also show a relevant decrease in emissions from 1990 due to a reduction in production.

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

Ethylene, Ethylene oxide, Propylene, Styrene
Ethylene, ethylene oxide, propylene and styrene productions belong to the organic chemical processes. In particular, ethylene is produced in petrochemical industry by steam cracking to manufacture ethylene oxide, styrene monomer and polyethylenes. Ethylene oxide is obtained via oxidation of ethylene and it is largely used as precursor of ethylene glycol and in the manufacture of surfactants and detergents. Propylene is obtained by cracking of oil and it is used to manufacture polypropylene but also acetone and phenol. Styrene, also known as vinyl benzene, is produced on industrial scale by catalytic dehydrogenation of ethyl benzene. Styrene is used in the rubber and plastic industry to manufacture through polymerisation processes such products as polystyrene, ABS, SBR rubber, SBR latex. Except for ethylene oxide production, which has stopped since 2002, the other productions of the above mentioned chemicals still occur in Italy.
As far as ethylene, ethylene oxide and propylene, Syndial Spa (ex Enichem) and Polimeri Europa were the main producers in Italy up to 2006. In 2007 Polimeri Europa has become the main producer for those products, while it has been the main producer of styrene since 2002.

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

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

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

$$CaO+3C \rightarrow CaC_2+CO$$

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

4.3.2. Methodological issues

Adipic acid

Italian production figures and emission estimates for adipic acid have been provided by the process operator (Radici Chimica, several years); for the whole time series. 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, from 1990 to 2003. In 2004, the N_2O catalytic decomposition abatement technology has been tested so that the value of emission factor has been reduced taking into account the efficiency and the time, one month, that the technology operated. From the end of 2005 the abatement technology is fully operative; the average emission factor in 2006 is equal to 0.05 kg N_2O/kg adipic acid produced and the abatement system had been operating continuously for 9 months; in 2007 the average emission factor was 0.03 kg N_2O/kg adipic acid produced and the operating time of the abatement system was 11 months.

Ammonia

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/E-PRTR registry. For the years 1990-2001 CO_2 emission factor, equal to 1.175 t CO_2/t ammonia production, has been calculated on the basis of information reported by the production plants for 2002 and 2003 in the framework of the national EPER/E-PRTR registry. This value has been used for the previous years in consideration that, as communicated by the operators, no modifications to the production plants have occurred along the period (YARA, 2007). For the years 2002-2007 the average emission factors result from data reported by the plants in the national EPER/PRTR. Natural gas is used as feedstock in the ammonia production plants and the amount of fuel used is included in the energy balance under the no energy final consumption sector (see Annex 5), therefore double counting does not occur.

Nitric acid

With regard to nitric acid production (2B2), production figures at national level are published in the national statistical yearbooks (ISTAT, several years), while at plant level they have been collected from industry (Norsk Hydro, several years; Yara, 2007; Radici Chimica, several years). In 1990 there were seven production plants in Italy; three of them closed between 1992 and 1995, and another one closed in 2004. The N_2O average emission factors are calculated from 1990 on the basis of the emission factors provided by the existing production plants in the national EPER/E-PRTR registry, applied for the whole time series, and default IPCC emission factors for low and medium pressure plants attributed to the plants, now closed, where it was not possible to collect detailed information. The implied emission factor varies year by year depending on the production levels of the different plants and it is equal to 6.49 and 7.07 kg N_2O/Mg nitric acid production, in 1990 and in 2007 respectively.

Caprolactame

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

Carbon Black

CO_2 and CH_4 emissions from carbon black production process have been estimated on the basis of information supplied by the Italian production plants in the framework of the national EPER/E-PRTR registry and the European emissions trading scheme. In 1996 a change in the production technology in the existing plants caused a reduction of CH_4, NMVOC, NO_x, SO_x and PM_{10}

emissions. In 2005, the CO_2 implied emission factor is equal to 2.55 t CO_2/t carbon black production, in 2007 it is 2.50 t CO_2/t carbon black production.

Calcium carbide

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

4.3.3. Uncertainty and time-series consistency

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

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

Adipic acid emission trends are directly related to the production and for the last years to the abatement technology introduced while nitric acid emissions are related to a reduction in production, and to the closure of the plants where old technology was implemented. Adipic acid production is increasing whereas nitric acid production and emissions show a decrease in the last years.

Total CO_2 emissions from ammonia have decreased as a result of a relevant reduction in production while CO_2 emissions from other chemical production have increased.

ACTIVITY DATA	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Adipic acid	49	64	71	75	74	69	78	75	84	84
Ammonia	1,455	592	414	430	474	578	648	607	559	578
Calcium carbide	12	7	-	-	-	-	-	-	-	-
Caprolactame	120	120	111	91	78	7	-	-	-	-
Carbon black	184	208	221	208	209	210	219	214	226	234
Ethylene	1,466	1,807	1,771	1,662	1,687	1,530	1,698	1,721	1,639	1,797
Ethylene oxide	61	54	13	5	-	-	-	-	-	-
Nitric acid	1,037	588	556	527	542	539	616	572	526	505
Propylene	774	693	690	653	1,035	931	996	1,037	988	971
Styrene	365	484	613	563	487	545	542	520	558	549
Titanium dioxide	58	69	72	60	69	66	70	60	68	72

Table 4.4 Production of chemical industry, 1990 – 2007 (kt)

EMISSIONS	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
CO_2 (Gg)										
Ammonia	1,709.63	695.60	486.19	505.46	557.53	679.57	747.55	705.18	656.52	649.38
Calcium carbide	13.08	7.09	-	-	-	-	-	-	-	-
Carbon black	422.05	477.48	508.83	479.30	460.43	489.89	506.62	548.22	579.21	585.73
Titanium dioxide	52.80	48.11	64.70	47.00	61.60	72.00	72.00	62.01	70.57	74.28
Adipic acid	1.33	1.72	1.93	2.03	2.00	1.86	1.56	1.50	1.68	1.68
CH_4 (Gg)										
Carbon black	1.84	2.08	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Ethylene	0.12	0.15	0.15	0.14	0.14	0.13	0.14	0.15	0.14	0.15
Propylene	0.07	0.06	0.06	0.06	0.09	0.08	0.08	0.09	0.08	0.08
Styrene	0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylene oxide	0.42	0.37	0.09	0.03	NA	NA	NA	NA	NA	NA
N_2O (Gg)										
Nitric acid	6.73	4.22	4.09	3.94	3.27	3.67	5.82	5.44	3.95	3.58
Adipic acid	14.77	19.09	21.42	22.59	22.20	20.70	21.41	19.59	4.58	2.52
Caprolactame	0.04	0.04	0.03	0.03	0.02	0.00	-	-	-	-

Table 4.5 CO_2, CH_4 and N_2O emissions from chemical industry, 1990 – 2007 (Gg)

4.3.4. Source-specific QA/QC and verification

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

4.3.5. Source-specific recalculations

Recalculations in the sector have been done because CO_2 emissions from calcium carbide production process have been estimated and reported for the years from 1990 to 1995. So in terms of Gg CO_2 equivalent emissions the time series for the Chemical industry show an increase of 13.08 (0.60%), 12.54 (0.60%), 13.19 (0.64%), 12.64 (0.87%), 10.36 (0.87%) and 7.09 (0.58%) respectively in 1990, 1991, 1992, 1993, 1994 and 1995 which are equal to the amounts of emission reported for calcium carbide production process in the same years.

4.3.6. Source-specific planned improvements

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

4.4 Metal production (2C)

4.4.1. Source category description

The sub-sector metal production comprises four sources: iron and steel production, ferroalloys production, aluminium production and magnesium foundries; CO_2 emissions from iron and steel production and PFC emissions from aluminium production are key sources at Tier 1 trend assessment.
The share of CO_2 emissions from metal production accounts, in the year 2007, for 0.4% of the national total CO_2 emissions, and 7.2% of the total CO_2 from industrial processes.
The share of CH_4 emissions is, in the year 2007, equal to 0.15% of the national total CH_4 emissions while N_2O emissions do not occur.

The share of F-gas emissions from metal production out of the national total F-gas levels was 67.2% in the base-year and has decreased to 2.7% (0.04% of the national total greenhouse gas emissions) in the year 2007.

Iron and steel

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

The sintering process is a pretreatment step in the production of iron where fine particles of metal ores are agglomerated. Agglomeration of the fine particles is necessary to increase the passageway for the gases during the blast furnace process and to improve physical features of the blast furnace burden. Coke and a mixture of sinter, lump ore and fluxes are introduced into the blast furnace. In the furnace the iron ore is increasingly reduced and liquid iron and slag are collected at the bottom of the furnace, from where they are tapped. The combustion of coke provides both the carbon monoxide (CO) needed for the reduction of iron oxide into iron and the additional heat needed to melt the iron and impurities.

The resulting material, pig iron (and also scrap), is transformed into steel in subsequent furnaces which may be a basic oxygen furnace (BOF) or electric arc furnace (EAF).

Oxygen steelmaking allows the oxidation of undesirable impurities contained in the metallic feedstock by blowing pure oxygen. The main elements thus converted into oxides are carbon, silicon, manganese, phosphorus and sulphur.

In an electric arc furnace steel is produced from polluted scrap. The scrap is mainly produced by cars shredding and does not have a constant quality.

The iron and steel cycle is closed by rolling mills with production of long products, flat products and pipes.

In 1990, there were four integrated iron and steel plants in Italy. In 2007, there are only three of the above mentioned plants, one of which lacks sintering facilities. Oxygen steel production represents about 40% of the total production and the arc furnace steel the remaining 60% (FEDERACCIAI, 2008).

Currently, long products represent about 50% of steel production in Italy, flat products about 40% and pipes the remaining 10%. Almost the whole flat production derives from one only integrated iron and steel plant while, in steel plants equipped with electric ovens, almost all located in the northern regions, long products are produced (e.g carbon steel, stainless steels) and seamless pipes (only one plant) (FEDERACCIAI, 2008).

CO_2 emissions from steel production refer to carbonates used in basic oxygen furnaces and crude iron and electrodes in electric arc furnaces. CO_2 emissions from pig iron production refer to carbonates used in sinter and pig iron production. CO_2 emissions from iron and steel production due to the fuel consumption in combustion processes are estimated and reported in the energy sector (1A2a) to avoid double counting.

CH_4 emissions from steel production refer to blast furnace charging, basic oxygen furnace, electric furnaces and rolling mills. CH_4 emissions from coke production are fugitive emissions during solid fuel transformation and have been reported under 1B1b.

Ferroalloys

Ferroalloy is the term used to describe concentrated alloys of iron and one or more metals such as silicon, manganese, chromium, molybdenum, vanadium and tungsten. Usually alloy formation occurs in Electric Arc Furnaces (EAF) and CO_2 emissions occur during oxidation of carbon still present in coke and because of consumption of the graphite electrodes.

In early ‘90s there were thirteen plants producing various kinds of ferroalloys: FeCr, FeMn, FeSi, SiMn, Si-metal and other particular alloys, but since 2001 the production has been carried on only in one plant (ISPESL, 2005). The last remaining plant in Italy produces mainly ferro-manganese and silicon-manganese alloys.

Aluminium
From primary aluminium production CO_2 and two PFCs (CF_4 and C_2F_6) are emitted.
PFCs are formed during a phenomenon known as the 'anode effect', when alumina levels are low.
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. Primary aluminium production passed from 232 kt in 1990 to 180 kt in 2007.

Magnesium foundries
In the magnesium foundries, SF_6 is used as a cover gas to prevent oxidation of molten magnesium. In Italy there is only one plant, located in the north, which started its activity in September 1995. From the end of 2007, SF_6 has been replaced by HFC 125, due to the enforcement of fluorinated gases regulation (EC, 2006).

4.4.2. Methodological issues

CO_2 and CH_4 emissions from the sector have been estimated on the basis of activity data published in the national statistical yearbooks (ISTAT, several years), data reported in the framework of the national EPER/E-PRTR registry and the European emissions trading scheme, and supplied by industry (FEDERACCIAI, several years). Emission factors reported in the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2007), in sectoral studies (APAT, 2003; CTN/ACE, 2000) or supplied directly by industry (FEDERACCIAI, 2004) have been used.

Iron and steel
CO_2 emissions from iron and steel production refer to the carbonates used in sinter plants, in blast furnaces and in steel making plants to remove impurities; they are also related to the steel and pig iron scraps, and graphite electrodes consumed in electric arc furnaces.
Basic information for this sector derives from different sources in the period 1990-2007.
Activity data are supplied by official statistics published in the national statistics yearbook (ISTAT, several years) and by the sectoral industrial association (FEDERACCIAI, several years).
For the integrated plants, emission and production data have been communicated by the two largest plants for the years 1990-1995 in the framework of the CORINAIR emission inventory, distinguished by sinter, blast furnace and BOF, and by combustion and processes emissions. From 2000 CO_2 emission and production data have been supplied by all the plants in the framework of the ETS scheme, for the years 2000-2004 disaggregated for sinter, blast furnace and BOF plants, from 2005 specifying carbonates and fuels consumption and related CO_2 emissions. For 2002-2006 data have also been supplied by all the four integrated iron and steel plants in the framework of the European EPER registry not distinguished for combustion and processes. Qualitative information and documentation available on the plants allowed us to reconstruct their history including closures or modifications of part of the plants; additional qualitative information regarding the plants collected and checked for other environmental issues or directly asked to the plant allowed us to individuate the main driving of the emission trends for pig iron and steel productions.
Time series of carbonates used in basic oxygen furnaces have been reconstructed on the basis of the above mentioned information resulting in no emissions in the last years. Indeed, as regards the largest Italian producer of pig iron and steel, lime production has increased significantly from 2000 to 2007 by about 250,000 over 370,000 tonnes and the amount introduced in basic oxygen furnaces was, in 2004, about 490,000t (ILVA, 2006).

Concerning the electric arc furnaces, additional information on the consumption of scraps, pig iron, graphite and electrodes and their average carbon content have been supplied together with the steel production by industry for a typical plant in 2004 (FEDERACCIAI, 2004) and checked with other sectoral study (APAT, 2003). On the basis of these figures an average emission factor has been calculated.
On account of the amount of carbonates estimated in sinter plants, average emission factor was equal in 1990 to 0.15 t CO_2/t pig iron production, while in 2007 it reduced to 0.071 t CO_2/t pig iron production. The reduction is driven by the increase in the use of lime instead of carbonates in sinter and blast furnaces in the Italian plants. Emissions are reported under pig iron because they are emitted as CO_2 in the blast furnaces producing pig iron.
CO_2 average emission factor in basic oxygen furnaces results in 1990 equal to 0.079 t CO_2/t steel production, while from 2003 is null.
CO_2 average emission factor in electric arc furnaces, equal to 0.035 t CO_2/t steel production, has been calculated on the basis of equation 3.6B of the IPCC Good Practice Guidance (IPCC, 2000) taking into account the pig iron and graphite electrodes used in the furnace. The same emission factor has been used for the whole time series.
Implied emission factors for steel production reduced from 0.053 to 0.022 t CO_2/t steel production, from 1990 to 2007, due to the reduction in the basic oxygen furnaces.
CO_2 emissions due to the consumption of coke, coal or other reducing agents used in the iron and steel industry have been accounted for as fuel consumption and reported in the energy sector, including fuel consumption of derived gases; in Annex 3, the energy and carbon balance in the iron and steel sector, with detailed explanation, is reported.
CH_4 emissions from steel production have been estimated on the basis of emission factors derived from the IPPC specific BREF Report (IPPC, 2001 available at http://eippcb.jrc.es), sectoral study (APAT, 2003) and the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2007) and refer to blast furnace, basic oxygen furnace, electric furnaces and rolling mills.

Ferroalloys
CO_2 emissions from ferroalloys have been estimated on the basis of activity data published in the national statistical yearbooks (ISTAT, several years) until 2001. Time series of ferroalloys activity data have been updated from 2002 on the basis of information provided by industry concerning the production of Si-Mn steel (FEDERACCIAI, several years) and on the basis of production data communicated to E-PRTR register from the only plant of ferroalloys production in 2007. Emission factors have been updated according to the IPCC Guidelines (IPCC, 2006) taking into consideration the different types of ferroalloys produced while the splitting up of national production in different types of ferroalloys was obtained from U. S. Geological Survey (USGS, several years).
Implied emission factors for ferroalloys reduced from 1.97 to 1.60 t CO_2/t ferroalloys production, from 1990 to 2007, as a consequence of the sharp reduction in ferroalloys production, which is characterized by high emission factors (ferro-silicon and silicon-metal alloys). The simultaneous reduction of total production (from about 200 kt to 100 kt) has resulted in CO_2 emissions decreasing from 408 Gg in 1990 to 174 Gg in 2007.

Aluminium production
PFC emissions from aluminium production, key source at trend assessment calculated with Tier 1, have been estimated using both IPCC Tier 1 and Tier 2 methodologies. These emissions, specifically CF_4 and C_2F_6, have been calculated on the basis of information provided by national statistics (ENIRISORSE, several years; ASSOMET, several years) and the national primary aluminium producer (ALCOA, several years), with reference to the document drawn up by the 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. From the year 2000, the more accurate Tier 2 method has been followed, based on default technology specific slope and overvoltage coefficients.
Regarding 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 (ALCOA, 2004). 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.

	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 4.6 Historical default Tetrafluoromethane (CF_4) emission values by reduction 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 4.7 Multiplier factor for calculation of Hexafluoroethane (C_2F_6) by technology type

	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 4.8 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

* site specific value
** default value

Table 4.9 Coefficients used for estimation with the Tier 2 methodology by plant

CO_2 emissions from aluminium production have been also estimated on the basis of activity data provided by industrial association (ENIRISORSE, several years; ASSOMET, several years) and default emission factor reported by industry (ALCOA, 2004) and by the IPCC Guidelines (IPCC, 1997) which refer to the prebaked anode process; emission factor has been assumed equal to 1.55 t CO_2/t primary aluminium production for the whole time series.

Magnesium foundries
For SF_6 used in magnesium foundries, according to the IPCC Guidelines (IPCC, 1997), emissions are estimated from consumption data made available by the company (Magnesium products of Italy, several years), assuming that all SF_6 used is emitted. In 2007, SF_6 has been used partially, replaced in November by HFC 125, due to the enforcement of fluorinated gases regulation (EC, 2006).

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 emission trends of CO_2, CH_4 and F-gas from metal production are reported. The decreasing of CO_2 emissions from iron and steel sector is driven by the use of lime instead of limestone and dolomite to remove impurities in pig iron and steel while CO_2 emissions from aluminium and ferroalloys are driven by the production levels.
In Table 4.11 the emission trend of F-gases per compound from metal production is given. PFC emissions from aluminium production decreased on the basis of the closure of three old plants in 1991 and 1992 and the update of technology for the two plants still operating. The decreasing of SF_6 consumption in the magnesium foundry from 2003 is due to the abandonment of recycling plant and the optimisation of mixing parameters.

EMISSIONS	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
CO_2 (Gg)										
Iron and steel	3,124	2,898	1,230	1,239	1,187	1,133	1,281	1,533	1,562	1,483
Aluminium production	359	276	294	291	295	297	303	303	301	278
Ferroalloys	408	244	245	199	165	197	188	172	169	174
CH_4 (Gg)										
Pig iron	2.13	2.10	2.02	1.89	1.75	1.82	1.91	2.06	2.07	2.00
Steel	0.58	0.60	0.60	0.61	0.62	0.63	0.67	0.67	0.74	0.75
PFC (Gg CO_2 eq.)										
Aluminium production	1,673	298	199	234	199	268	157	181	154	200
SF_6 (Gg)										
Magnesium foundries	-	-	0.0072	0.0188	0.0167	0.0057	0.0039	0.0035	0.0026	0.0023

Table 4.10 CO_2, CH_4 and F-gas emissions from metal production, 1990 – 2007 (Gg)

COMPOUND	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Gg CO_2 eq.										
CF_4 (PFC-14)	1,289.2	235.8	168.1	198.1	168.1	226.4	133.1	153.0	130.6	170.9
C_2F_6 (PFC-16)	384.1	61.7	30.6	36.0	30.6	41.2	24.2	27.8	23.8	29.3
Total PFC emissions from aluminium production	*1,673.4*	*297.5*	*198.7*	*234.1*	*198.6*	*267.6*	*157.3*	*180.8*	*154.4*	*200.1*
Total SF_6 emissions from magnesium foundries	*0.0*	*0.0*	*172.1*	*449.9*	*400.1*	*135.2*	*94.3*	*84.7*	*61.2*	*53.9*
Total F-gas emissions from metal production	1,673.4	297.5	370.8	684.0	598.7	402.8	251.5	265.5	215.6	254.0

Table 4.11 Actual F-gas emissions per compound from metal production in Gg CO_2 equivalent, 1990 – 2007

The consistency of the time series of PFC emissions from aluminium production has been verified, as two different methodologies have been used on the basis of the information provided by the industry (ALCOA, 2004). In Table 4.12 two time-series are reported, one calculated with only the Tier 1 methodology and the other calculated with both the Tier 1 and Tier 2 methodologies as mentioned above. Notwithstanding it is good practice to maintain consistency of the methodology throughout the time series, the ERTs in the last review processes noted that this approach is transparent, accurate and conservative (UNFCCC, 2007; UNFCCC, 2009). In fact, the trend of PFC emissions calculated with the Tier 1 methodology shows lower values compared to those calculated with the Tier 2 methodology; from 2004 C_2F_6 values calculated with Tier 1 rise up.

COMPOUND	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Tier 1										
CF_4 (t)	198.3	36.3	19.0	18.8	19.0	19.1	19.5	19.3	19.4	18.0
C_2F_6 (t)	41.8	6.7	3.2	3.2	3.2	3.3	3.3	3.3	3.3	3.1
Tier 1 and Tier 2										
CF_4 (t)	198.3	36.3	25.9	30.5	25.9	34.8	20.5	23.5	20.1	26.3
C_2F_6 (t)	41.8	6.7	3.3	3.9	3.3	4.5	2.6	3.0	2.6	3.2

Table 4.12 Comparison between PFC emissions from aluminium production in tonnes, calculated with only the Tier 1 methodology and with both the Tier 1 and Tier 2 methodologies

4.4.4. Source-specific QA/QC and verification

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

4.4.5. Source-specific recalculations

Recalculations in the sector have been done because iron and steel activity data for 2004 and 2006 and ferroalloys activity data and emission factors have been updated.
Ferroalloys activity data have been updated from 2002 to 2007 on the basis of information provided by industry and emission factors have been updated for the whole time series according to the IPCC Guidelines (IPCC, 2006). In terms of CO_2 emissions from ferroalloys production it results in a decrease of 18.21% in 1990 and an increase of 30.60% in 2007.

Additional data supplied by the integrated iron and steel plants allowed to refine CO_2 emission estimates for 2004 and to improve 2006 estimates. This review process has resulted in an increase of CO_2 emissions in iron and steel equal to 7.83% for 2004 and in a decrease equal to 7.00% in 2006. CH_4 emissions from iron and steel production show an increase of 0.03% in 2006.

4.4.6. Source-specific planned improvements

We plan to check the average emission factor of CO_2 from electric arc furnaces with ETS data communicated for the years 2005, 2006 and 2007 in the next submission.

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. CO_2 added to water or beverages) can be of biogenic or non-biogenic origin but only information on CO_2 emissions of non-biogenic origin should be reported in the CRF.
According to the information provided by industrial associations, CO_2 emissions do not occur, but only NMVOC emissions originate from these activities. CO_2 emissions from food and beverage included in previous submissions have been removed since they originated from sources of carbon that are part of a closed cycle.
As regards the pulp and paper production, NO_X and NMVOC emissions as well as SO_2 are estimated.

4.6 Production of halocarbons and SF_6 (2E)

4.6.1. Source category description

The sub-sector production of halocarbons and SF_6 consists of two sources, "By-product emissions" and "Fugitive emissions", identified as non-key sources. Only two production plants are present in Italy, located in Porto Marghera and Spinetta Marengo. Within by-product emissions, HFC-23 emissions are released from HCFC-22 manufacture, whereas C_2F_6, CF_4 and HFC 143a emissions are released from the production of CFC 115, SF_6 and HFC 134a, respectively. Production of HFC 125, HFC 134a, HFC 227ea and SF_6 lead to fugitive emissions of the same gases. CFC115 and SF_6 productions stopped in 1998 and in 2005, respectively.
The share of F-gas emissions from the production of halocarbons and SF_6 in the national total of F-gases was 24.3% in the base-year, 1990, and 0.25% in 2007; the share in the national total greenhouse gas emissions was 0.12% in the base-year and 0.003% in 2007.

4.6.2. Methodological issues

For both source categories "By-product emissions" and "Fugitive emissions", the IPCC Tier 2 method is used, based on plant-level data. The communication is supplied annually by the only national producer, and includes productions, emissions, import and export data for each gas (Solvay, several years).

4.6.3. Uncertainty and time-series consistency

The uncertainty in F-gas emissions from production of halocarbons and SF_6 is estimated to be about 11% in annual emissions.
HFC-23 emissions from HCFC-22 had already been drastically reduced in 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. This information is yearly directly updated by the producer, and it is also reported in the framework of the European EPER registry, confirming that the technology is fully operating,
PFC by-product emissions and SF_6 fugitive emissions, from the same plant, are constant from 1990 to 1995 and from 1996 to 1998, reducing to zero from 1999 due to the stop of the CFC 115 production and the use of the thermal afterburner mentioned above. Besides SF_6 production stopped from the 1st of January 2005.
Regarding fugitive emissions, emissions of HFC-125 and HFC-134a have been cut in 1999 thanks to a rationalisation in the new production facility located in Porto Marghera, whereas HFC-143 released as by-products from the production of HFC-134a has been recovered and commercialised.

In Table 4.13 an overview of the emissions from production of halocarbons and SF_6 is given for the 1990-2007 period, per compound.

COMPOUND	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
				Gg CO_2 eq.						
HFC 23	351.0	351.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HFC 143a	0.0	22.8	3.8	3.8	0.0	3.8	3.8	4.2	4.6	4.6
CF_4	97.5	97.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PFC C2÷C3	36.8	36.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total F-gas by product emissions	*485.3*	*508.1*	*3.8*	*3.8*	*0.0*	*3.8*	*3.8*	*4.2*	*4.6*	*4.6*
HFC 125	0.0	28.0	2.8	5.6	5.6	11.2	2.8	3.4	3.9	5.0
HFC 134a	0.0	39.0	15.6	15.6	15.6	7.8	11.7	12.6	12.4	8.8
HFC 227ea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SF_6	119.5	119.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total F-gas fugitive emissions	*119.5*	*186.5*	*18.4*	*21.2*	*21.2*	*19.0*	*14.5*	*16.0*	*16.3*	*13.9*
Total F-gas emissions from production of halocarbons and SF_6	604.8	694.6	22.2	25.0	21.2	22.8	18.3	20.2	20.8	18.4

Table 4.13 Actual emissions of F-gases per compound from production of halocarbons and SF_6 in Gg CO_2 equivalent, 1990 – 2007

4.6.4. Source-specific QA/QC and verification

Emissions from production of halocarbons and SF_6 have been checked with data reported to the national EPER/E-PRTR registry.

4.6.5. Source-specific recalculations

No recalculations have been done.

4.6.6. Source-specific planned improvements

No further improvements are planned.

4.7 Consumption of halocarbons and SF_6 (2F)

4.7.1. Source category description

The sub-sector consumption of halocarbons and SF_6 consists of three sources, "HFC, PFC emissions from ODS substitutes", key category at level and trend assessment, both Tier 1 and 2 approaches, "PFC, HFC, SF_6 emissions from semiconductor manufacturing", "SF_6 emissions from electrical equipment", that are non-key categories.

Potential emissions are also reported in this section. The share of F-gas emissions from the consumption of halocarbons and SF_6 in the national total of F-gases was 8.6% in the base-year 1990 and 96.3% in 2007; the share in the national total greenhouse gas emissions was 0.04% in the base-year and 1.3% in 2007.

4.7.2. Methodological issues

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

Sub-sources of F-gas emissions and calculation methods

Source category	Sub-source	Calculation method
HFC, PFC emissions from ODS substitutes	Refrigeration and air conditioning equipment (2F1)	IPCC Tier 2a
	Foam blowing (2F2)	IPCC Tier 2a
	Fire extinguishers (2F3)	IPCC Tier 2a
	Aerosols/metered dose inhalers (2F4)	IPCC Tier 2a
PFC, HFC, SF_6 emissions from semiconductor manufacturing (2F6)		IPCC Tier 2a
SF_6 emissions from electrical equipment (2F7)		IPCC Tier 3c

Basic data have been supplied by industry: specifically, for the mobile air conditioning equipment the national motor company and the agent's union of foreign motor-cars vehicles have provided the yearly consumptions (FIAT, several years; IVECO, several years; UNRAE, several years; CNH, several years); for the other air conditioning equipment the producers supply detailed table of consumption data by gas (Solvay, several years); pharmaceutical industry has provided aerosols/metered dose inhaler data (Sanofi Aventis, several years; Boehringer Ingelheim, several years; Chiesi Farmaceutici, several years; GSK, several years; Lusofarmaco, several years; Menarini, several years); the semiconductor manufacturing industry has supplied consumption data for four national plants (ST Microelectronics, several years; MICRON, several years); finally, for the sub-source fire extinguishers, the European Association for Responsible Use of HFCs in Fire Fighting has been contacted (ASSURE, 2005).

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

Refrigeration activities, such as commercial, transport, industrial and other stationary, are all reported under domestic refrigeration because no detailed information is available to split consumptions and emissions in the different sectors. Anyway, appropriate losses rates have been applied for each gas taking into account the equipment where refrigerants are generally used. Therefore implied product life factors, especially for HFC 134a, result from the weighted average of different losses rates, from 0.7% for domestic refrigeration to 10% for large chillers.

SF_6 emissions from electrical equipment have been estimated according to the IPCC Tier 2a approach from 1990 to 1994, and IPCC Tier 3c from 1995. SF_6 leaks from installed equipment have been estimated on the basis of the total amount of sulphur hexafluoride accumulated and average leakage rates; leakage data published in environmental reports have also been used for major electricity producers (ANIE, several years). Additional data on SF_6 used in high voltage gas-insulated transmission lines have been supplied by the main energy distribution companies (ACEA, 2004; AEM, several years; EDIPOWER, 2003; EDIPOWER, 2007; EDISON, several years; ENDESA, 2004; ENDESA, several years [a] and [b]; ENEL, several years; TERNA, 2006).

The IPCC Tier 1a method has been used to calculate potential emissions, using production, import, export and destruction data provided by the national producer (Solvay, several years; ST Microelectronics, several years; MICRON, several years). From 2008, in compliance with article 6 of the fluorinated gases European regulation (EC, 2006), producers, importers and exporters have communicated to the Ministry of the Environment and to the Commission the required data;

unfortunately, only few companies have reported data and we expect that more information will be available next year (General Gas, 2008; Mariel, 2008; Safety Hi Tech, 2008; Solvay, 2008). As regard PFC potential emissions, since no production occurs in Italy, export has been reasonably assumed negligible, whereas import corresponds to consumption of PFCs by semiconductor manufactures, that use these substances.

4.7.3. Uncertainty and time-series consistency

The combined uncertainty in F-gas emissions from HFC, PFC emissions from ozone depletion substances (ODS) substitutes and PFC, HFC, SF_6 emissions from semiconductor manufacturing is estimated to be about 58% in annual emissions, 30% and 50% concerning respectively activity data and emission factors; the uncertainty in SF_6 emissions from electrical equipment is estimated to be about 11 % in annual emissions, 5% and 10% concerning respectively activity data and emission factors.
In Table 4.14 an overview of the emissions from consumption of halocarbons and SF_6 is given for the 1990-2007 period, per compound.
HFC emissions from refrigeration and air conditioning equipment increased from 1994 driven by the increase of their consumptions, especially HFC 134a consumption for mobile air conditioning. HFC emissions from ODS substitutes started in 1996 and they continue to increase, especially HFC 134a from foam blowing and from aerosols. Emissions from semiconductor manufactures are driven by the consumption data provided by the producers, one started in 1995 and the second one in 1998. SF_6 emissions from electrical equipment increased from 1995 to 1997 and decreased in the following years; from 2004 emissions are enough stable: they are driven by emissions from manufacturing due to the amount of fluid filled in the new manufacturing products while emissions from stocks are slightly increasing.

COMPOUND	**1990**	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
			Gg CO_2 eq.							
HFC 23	0.0	1.6	7.1	8.6	10.3	12.2	14.3	17.0	19.2	20.8
HFC 32	0.0	0.0	52.6	80.9	113.7	150.6	191.3	235.3	276.5	316.7
HFC 125	0.0	1.8	371.5	564.8	791.3	1,048.0	1,332.8	1,643.2	1,932.3	2,215.3
HFC 134a	0.0	224.3	1,128.6	1,302.3	1,448.8	1,591.2	1,735.5	1,888.8	2,056.4	2,221.0
HFC 143a	0.0	2.7	206.3	308.6	430.2	570.2	727.6	901.5	1,062.0	1,220.7
Total HFC emissions from refrigeration and air conditioning equipment	*0.0*	*230.5*	*1,766.1*	*2,265.2*	*2,794.2*	*3,372.2*	*4,001.3*	*4,685.7*	*5,346.4*	*5,994.6*
HFC 134a emissions from foam blowing	0.0	0.0	64.2	88.0	118.8	158.6	210.2	234.1	247.4	259.0
HFC 227ea emissions from fire extinguishers	0.0	0.0	19.6	26.5	35.8	47.4	61.3	79.9	97.7	114.6
HFC 134a emissions from aerosols/metered dose inhalers	0.0	0.0	108.4	137.6	123.7	186.2	215.2	240.2	237.3	307.7
Total HFC emissions from ODS substitutes	*0.0*	*0.0*	*192.2*	*252.1*	*278.3*	*392.3*	*486.7*	*554.2*	*582.4*	*681.3*
HFC 23	0.0	0.0	5.1	7.4	6.2	8.6	8.6	7.0	6.5	5.4
HFC 134a	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CF_4	0.0	24.4	64.8	107.8	106.2	117.1	127.3	96.8	87.0	71.5
C_2F_6	0.0	34.6	82.0	99.1	108.0	97.7	52.6	62.8	30.8	11.4
C_3F_8	0.0	0.0	0.0	9.0	10.2	13.2	9.6	3.5	3.5	0.1
C_4F_8	0.0	0.0	0.4	1.2	0.8	2.0	1.2	8.7	6.6	4.6
SF_6	0.0	0.0	20.9	49.4	53.3	60.5	75.2	61.5	46.5	36.3
Total PFC, HFC, SF_6 *emissions from semiconductor*	*0.0*	*59.0*	*173.2*	*273.9*	*284.6*	*299.0*	*274.5*	*240.4*	*181.0*	*129.4*

COMPOUND	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
manufacturing										
SF_6 emissions from electrical equipment	*213.4*	*482.0*	*300.4*	*296.0*	*286.3*	*271.9*	*332.6*	*319.1*	*298.1*	*337.4*
Total F-gas emissions from consumption of halocarbons and SF_6	213.4	771.4	2,432.0	3,087.3	3,643.4	4,335.4	5,095.1	5,799.4	6,408.0	7,142.6

Table 4.14 Actual F-gas emissions per compound from the consumption of halocarbons and SF_6 in Gg CO_2 equivalent, 1990-2007

In Table 4.15 an overview of the potential emissions is given for the 1990-2007 period, per compound. Negative values for HFC compounds in some years are derived from the circumstance that in those years import data are equal to zero and exports are greater than production data because of the availability of stocks; the formula suggested by the UNFCCC guidelines to calculate potential emissions does not consider stock variations.

COMPOUND	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
					Gg CO_2 eq.					
HFC 32	0.0	0.0	10.4	3.3	-5.2	29.3	70.2	31.9	129.4	139.1
HFC 125	0.0	148.4	268.8	1,671.6	803.6	-123.2	2,200.8	1,131.2	1,456.0	4,704.0
HFC 134a	0.0	1,739.4	2,107.3	4,371.9	2,960.1	4,551.3	4,308.2	5,575.7	6,026.8	5,825.3
HFC 143a	0.0	11.4	68.4	258.4	79.8	547.2	972.8	801.8	1.691.0	1.417.4
HFC 227ea	0.0	0.0	72.5	133.4	89.9	0.0	0.0	0.0	0.0	0.0
Total HFC potential emissions	*0.0*	*1,899.2*	*2,527.4*	*6,438.6*	*3,928.2*	*5,004.6*	*7,552.0*	*7,540.6*	*9,303.2*	*12,085.8*
CF_4	0.0	0.0	55.8	158.6	167.4	183.9	186.1	148.9	159.9	141.3
C_2F_6	0.0	0.0	65.5	147.9	164.5	134.0	114.7	111.4	67.8	54.9
C_3F_8	0.0	0.0	0.0	33.9	36.8	47.0	40.3	17.9	17.9	1.5
C_4F_8	0.0	0.0	0.5	4.6	2.6	6.1	5.4	29.0	28.8	53.5
Total PFC potential emissions	*0.0*	*0.0*	*121.8*	*345.0*	*371.4*	*371.0*	*346.5*	*307.2*	*274.4*	*251.2*
SF_6	*3,752.3*	*3,675.8*	*3,919.6*	*5,903.3*	*3,689.2*	*3,211.2*	*2,943.2*	*1,541.8*	*2,182.9*	*1,985.9*
Total F-gas potential emissions	3,752.3	5,575.0	6,568.8	12,686.9	7,988.8	8,586.7	10,841.7	9,389.6	11,760.5	14,322.9

Table 4.15 Potential F-gas emissions per compound from the consumption of halocarbons and SF_6, in Gg CO_2 equivalent, 1990 – 2007

4.7.4. Source-specific QA/QC and verification

This source category is covered by the general QA/QC procedures. Where information is available, emissions from production of halocarbons and SF_6 have been checked with data reported to the national EPER/E-PRTR registry.

4.7.5. Source-specific recalculations

Due to updated information supplied by the main national company, FIAT, HFC 134a emissions from air conditioning equipments have been updated for 2006.
Moreover, semiconductor manufacturing industry has supplied updated data from 2004.
Other minor modifications have regarded emissions from electrical equipments, due to updated data from main energy distribution companies from 2001.

In Table 4.16 recalculations from the previous submission are reported for each gas.

COMPOUND	2001	2002	2003	2004	2005	2006
HFC 23						
HFC 32						
HFC 125						
HFC 134a						1.19%
HFC 143a						
Total HFC emissions from refrigeration and air conditioning equipment						
HFC 134a emissions from foam blowing						
HFC 227ea emissions from fire extinguishers						
HFC 134a emissions from aerosols/metered dose inhalers						
Total HFC emissions from ODS substitutes						
HFC 23				-2.50%	-2.50%	-2.50%
HFC 134a						
CF_4				14.04%	14.04%	14.04%
C_2F_6				-22.69%	-22.69%	-22.69%
C_3F_8				-18.60%	-18.60%	-18.60%
C_4F_8				-13.00%	-13.00%	-13.00%
SF_6				7.66%	7.66%	7.66%
Total PFC, HFC, SF_6 *emissions from semiconductor manufacturing*						
SF_6 emissions from electrical equipment	0.13%	0.73%	1.07%	1.59%	0.26%	4.46%
Total F-gas emissions from consumption of halocarbons and SF_6	0.01%	0.06%	0.07%	0.16%	-0.06%	0.63%

Table 4.16 Comparison between recalculated and previous F-gas emissions from the consumption of halocarbons and SF_6 per gas in percentage, 1990-2006

4.7.6. Source-specific planned improvements

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

Chapter 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 from this sector have also been estimated. These emissions arise from the use of N_2O in medical applications, such as anaesthesia, and in food industry, where N_2O is used as a propelling agent in aerosol cans, specifically those for whipped cream.

In 2007, solvent use is responsible for 0.29% of the total CO_2 emissions (excluding LULUCF) and 42.68% of total NMVOC emissions, and represents the second source of anthropogenic NMVOC national emissions.
N_2O emissions, in 2007, share 2.42% of the total N_2O national emissions.

GAS/SUBSOURCE	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
NMVOC (Gg)										
3A. Paint application	270.79	252.60	226.07	229.60	226.37	221.65	221.30	219.24	223.47	224.16
3B. Degreasing and dry cleaning	56.66	34.12	26.40	25.70	25.02	24.36	23.72	23.10	22.50	21.92
3C. Chemical products	77.21	88.25	103.64	89.72	85.43	79.75	80.06	72.70	78.08	78.53
3D. Other	185.23	170.13	156.21	160.19	167.61	174.23	176.80	184.82	188.43	190.43
CO_2 (Gg)										
3A. Paint application	844.07	787.35	704.65	715.67	705.61	690.88	689.79	683.37	696.57	698.72
3B. Degreasing and dry cleaning	176.62	106.34	82.27	80.09	77.98	75.93	73.94	72.01	70.14	68.33
3D. Other	577.36	530.29	486.90	499.31	522.44	543.07	551.09	576.08	587.32	593.56
N_2O (Gg)										
3D. Other (use of N_2O for anaesthesia and aerosol cans)	2.57	2.44	3.26	2.95	2.95	2.76	2.67	2.61	2.56	2.49

Table 5.1 Trend in NMVOC, CO_2 and N_2O emissions from the solvent use sector, 1990 – 2007 (Gg)

CO_2 emissions from the sector is a key source both for level and trend assessment calculated with the Tier 2 approach, especially because of the high level of uncertainty in the estimates and a reduction of emissions in the years. On the other hand, N_2O emissions from the use of the gas in anaesthesia and aerosol cans are a key source for trend assessment calculated with Tier 2 approach too. Both these sources are not key categories if including the LULUCF sector in the uncertainty analysis. The results are reported in the following box.

Key-source identification in the solvent and other product use sector with the IPCC Tier1 and Tier2 approaches (without LULUCF)

3	CO_2	Solvent and other product use	Key (L2, T2)
3D	N_2O	Use 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 methodology reported in the EMEP/CORINAIR guidebook, applying both national and international emission factors (Vetrella, 1994; EMEP/CORINAIR, 2005). Country specific emission factors provided by several accredited sources have been used extensively, together with data from the national EPER Registry; in particular, for paint application (Offredi, several years; FIAT, several years), solvent use in dry cleaning (ENEA/USLRMA, 1995), solvent use in textile finishing and in the tanning industries (TECHNE, 1998; Regione Toscana, 2001; Regione Campania, 2005; GIADA 2006). Basic information from industry on percentage reduction of solvent content in paints and other products has been applied to EMEP/CORINAIR emission factors in order to evaluate the reduction in emissions during the considered period.
Emissions from domestic solvent use have been calculated using a detailed methodology, based on VOC content per type of consumer product.
As regards household and car care products, information on VOC content and activity data has been supplied by the Sectoral Association of the Italian Federation of the Chemical Industry (Assocasa, several years) and by the Italian Association of Aerosol Producers (AIA, several years [a] and [b]).
As regards cosmetics and toiletries, basic data have been supplied by the Italian Association of Aerosol Producers too (AIA, several years [a] and [b]) and by the national Institute of Statistics and industrial associations (ISTAT, several years [a], [b], [c] and [d]; UNIPRO, several years); emission factors time series have been reconstructed on the basis of the information provided by the European Commission (EC, 2002). The conversion of NMVOC emissions into CO_2 emissions has been carried out considering that carbon content is equal to 85% as indicated by the European Environmental Agency for the CORINAIR project (EEA, 1997), except for CO_2 emissions from the 3C sub-sector which are not calculated to avoid double-counting. These emissions are, in fact, already accounted for in sectors 1A2c and 2B.
Emissions of N_2O have been estimated taking into account information available by industrial associations. Specifically, the manufacturers and distributors association of N_2O products has supplied data on the use of N_2O for anaesthesia from 1994 to 2008 (Assogastecnici, several years). For previous years, data have been estimated by the number of surgical beds published by national statistics (ISTAT, several years [a]).
Moreover, the Italian Association of Aerosol Producers (AIA, several years [a] and [b]) has provided data on the annual production of aerosol cans. It is assumed that all N_2O used will eventually be released to the atmosphere, therefore the emission factor for anaesthesia is 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, 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 2007 is about 13%, mainly due to the reduction of emissions in degreasing and dry cleaning. The European Directives (EC, 1999; EC, 2004) regarding NMVOC emission reduction in this sector entered into force in Italy respectively in January 2004 and in March 2006, establishing a reduction of the solvent content in products. Figure 5.1 shows emission trends from 1991 to 2007 with respect to 1990 by sub-sector.
From 2000, the reduction in N_2O emissions is due to a decrease in the anaesthetic use of N_2O that has been replaced by halogen gas.

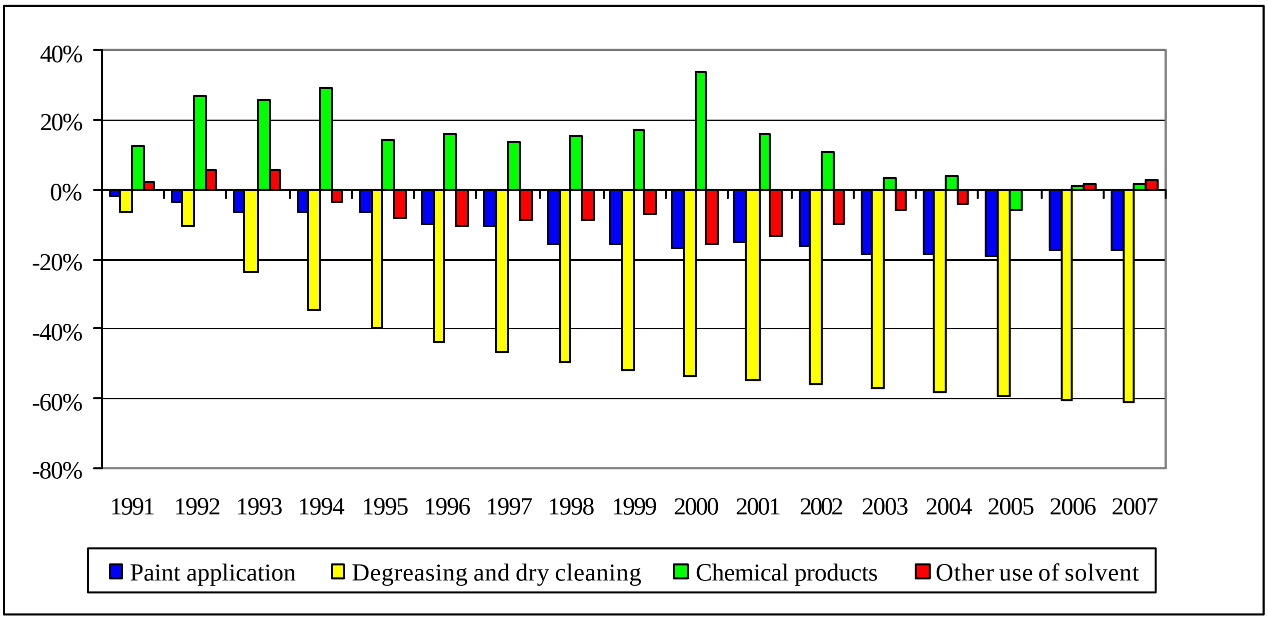


Figure 5.1 Trend of NMVOC emissions from 1991 to 2007 as compared to 1990

5.5 Source-specific QA/QC and verification

Data production and consumption time series for some activities (paint application in constructions and buildings, polyester processing, polyurethane processing, pharmaceutical products, paints manufacturing, glues manufacturing, textile finishing, leather tanning, fat edible and non edible oil extraction, application of glues and adhesives) are checked with data acquired by the National Statistics Institute (ISTAT, several years [a], [b] and [c]), the Sectoral Association of the Italian Federation of the Chemical Industry (AVISA, several years) and the Food and Agriculture Organization of the United Nations (FAO, several years).

In the framework of the MeditAIRaneo project, ISPRA (ex APAT) commissioned to *Techne Consulting S.r.l.* a survey to collect national information on emission factors in the solvent sector. The results, published in the report "*Rassegna dei fattori di emissione nazionali ed internazionali relativamente al settore solventi*" (TECHNE, 2004), have been used to verify and validate the emission estimates. At the end of 2008, ISPRA has commissioned to *Techne Consulting S.r.l.* a survey to compare emission factors with the last update published in the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2008). The results are reported in "*Fattori di emissione per l'utilizzo di solventi*" (TECHNE, 2008) and have been used to update emission factors for polyurethane and polystyrene foam processing activities.

5.6 Source-specific recalculations

In Table 5.2 the comparison for NMVOC between total recalculations and previous estimations is given in percentages from 1990 to 2006. No recalculations have been carried out for N_2O emissions.

For NMVOC, the main modification occurred 3C category where emission factors for the polyurethane and polystyrene foam processing activities have been modified. These recalculations did not affect CO_2 emissions. Other modifications are due to the update of 2006 activity data, in particular, referring to the Pharmaceutical products manufacturing, Paints manufacturing, Glass wool enduction, Domestic solvent use and Vehicles dewaxing, Paint application-coil coating, Leather tanning activity data for 2000 and Domestic solvent use average emission factor for 2004-2006.

Year	SUBSOURCE	
	3C. Chemical products	3D. Other use of solvents and related activities
1990	29.67%	0.00%
1991	43.70%	0.00%
1992	58.18%	0.00%
1993	73.63%	0.00%
1994	71.18%	0.00%
1995	49.57%	0.00%
1996	48.47%	0.00%
1997	50.46%	0.00%
1998	53.21%	0.00%
1999	56.38%	0.00%
2000	70.03%	0.00%
2001	53.71%	0.00%
2002	47.72%	0.00%
2003	46.39%	0.00%
2004	51.05%	-0.06%
2005	40.16%	-0.05%
2006	43.63%	-0.28%

Table 5.2 Differences between NMVOC emissions in the updated time series and the 2008 submission

Chapter 6: AGRICULTURE [CRF sector 4]

6.1 Overview of sector

In this chapter information on the estimation of greenhouse gas (GHG) emissions from the Agriculture sector, as reported under the IPCC Category 4 in the Common Reporting Format[2] (CRF), is given. Emissions from enteric fermentation (4A), manure management (4B), rice cultivation (4C), agriculture soils (4D) and field burning of agriculture residues (4F) are included in this sector. Methane (CH_4) and nitrous oxide (N_2O) emissions are estimated and reported. Savannas areas (4E) are not present in Italy. Emissions from other sources (4G) have not been estimated. CO_2 and F-gas emissions do not occur.

To provide update information on the characteristics of the agriculture sector in Italy, figures from the Farm Structure Survey 2007 (FSS 2007) are reported. In Italy, there are 1.7 millions of agricultural holdings with a Utilized Agricultural Area (UAA) of 12.7 million hectares, +0.3% more than FSS 2005. Between 2000 (Agricultural Census) and 2007, agricultural holdings have decreased by 22% (474,000 units). Moreover, at national level, the average size of the agricultural holdings varied from 7.4 hectare in 2005 to 7.6 hectares in 2007. With respect to 2000 Agricultural Census, holdings have gained 1.5 hectares of UAA. The distribution of agricultural holdings by type confirms a typical family conduction system which characterized the Italian agriculture. Direct conduction of holdings by farmers is around 1.6 million (93.9% of total agricultural holdings with UAA) which hold 10 million hectares of UAA (78.8% of total) (EUROSTAT, 2007[a], [b]; ISTAT, 2008[a]).

6.1.1 Emission trends

Emission trends per gas

In 2007, 6.7% of the Italian GHG emissions, without emissions and removals from LULUCF, (7.9% in 1990) originated from the agriculture sector, which is the second source of emissions, after the energy sector (83%). For the agriculture sector, the trend of GHGs from 1990 to 2007 shows a decrease of 8.3% due to reduction in activity data, such as the number of animals and cultivated surface/crop production (see Figure 6.1). CH_4 and N_2O emissions have decreased by 9.3% and 7.6%, respectively (see Table 6.1). In 2007, the agriculture sector has been the dominant national source for CH_4 and N_2O emissions, sharing 40.9% and 67.8%, respectively.

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
					Gg CO_2 eq.					
CH_4	17,216	17,223	16,837	16,076	15,726	15,782	15,540	15,480	15,149	15,619
N_2O	23,360	23,126	23,103	22,878	22,524	22,319	22,378	21,761	21,478	21,591
Total	**40,576**	**40,349**	**39,940**	**38,954**	**38,250**	**38,102**	**37,917**	**37,242**	**36,627**	**37,210**

Table 6.1 Emissions of GHG and trend from 1990 to 2007 for the Agriculture sector (Gg CO_2 eq.)

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

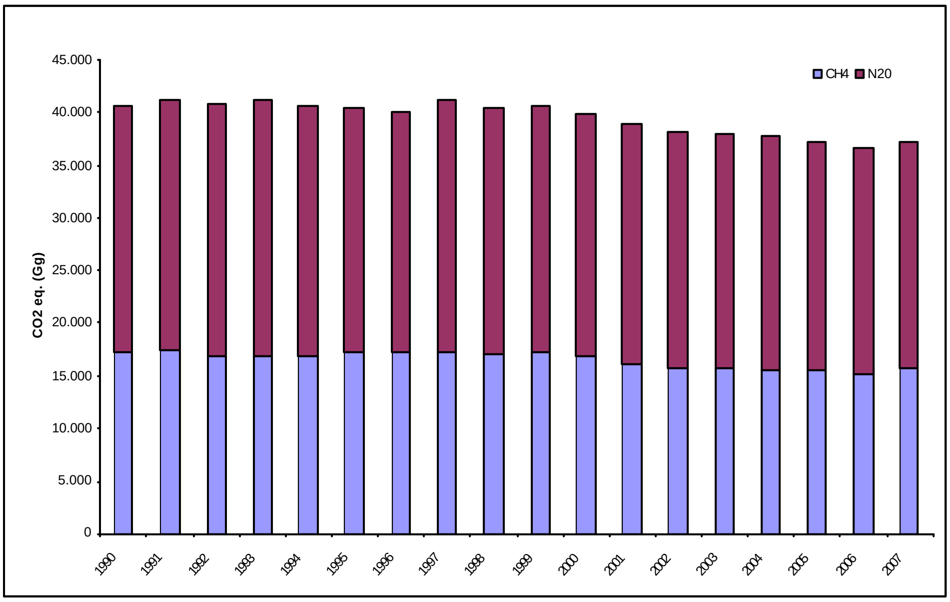


Figure 6.1 Trend of GHG emissions for the Agriculture sector from 1990 to 2007 (Gg CO_2 eq.)

Emission trends per sector

Total GHG emissions and trends by sub category from 1990 to 2007 are presented in Table 6.2 (expressed in Gg. CO_2 eq.). CH_4 emissions from enteric fermentation (4A) and N_2O emissions from direct agriculture soils (4D) are the most relevant source categories. In 2007, their individual share in national GHG emissions without LULUCF was 2.8% and 3.9 %, respectively.

Year	**GHG emissions [Gg CO_2 equivalent] by sub category**					
	4A	4B	4C	4D	4F	**TOTAL**
1990	12,179	7,383	1,562	19,435	17	**40,576**
1991	12,449	7,376	1,493	20,035	19	**41,371**
1992	12,071	7,081	1,551	20,142	18	**40,862**
1993	11,944	7,038	1,627	20,537	17	**41,163**
1994	12,051	6,920	1,664	19,989	18	**40,641**
1995	12,267	7,068	1,657	19,340	17	**40,349**
1996	12,323	7,119	1,623	19,015	18	**40,097**
1997	12,377	7,138	1,615	20,004	16	**41,150**
1998	12,292	7,253	1,533	19,323	18	**40,418**
1999	12,429	7,344	1,497	19,508	17	**40,795**
2000	12,165	7,140	1,382	19,237	16	**39,940**
2001	11,340	7,342	1,382	18,875	15	**38,954**
2002	11,030	7,110	1,420	18,673	17	**38,250**
2003	11,056	7,067	1,463	18,500	15	**38,102**
2004	10,836	6,886	1,534	18,643	18	**37,917**
2005	10,844	6,877	1,472	18,032	17	**37,242**
2006	10,629	6,649	1,477	17,856	17	**36,627**
2007	11,027	6,853	1,523	17,791	17	**37,210**

Table 6.2 Total GHG emissions and trend from 1990 to 2007 for the Agriculture sector

6.1.2 Key categories

In 2007, CH_4 from enteric fermentation, N_2O and CH_4 from manure management, and N_2O from agricultural soils, both direct and indirect emissions were ranked among the top-10 level key sources with the Tier 2 analysis, including the uncertainty (L2). N_2O from agricultural soils, both direct and indirect emissions, and CH_4 enteric fermentation are ranked among the top-10 trend key sources with the Tier 2 analysis, including the uncertainty (T2). In the following box, key and non-key sources from the agriculture sector are shown, with a level and/or trend assessment (*IPCC Tier 1 and Tier 2 approaches*). These sources are also key categories when including the LULUCF sector in the analysis.

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, T2)
4B	N_2O	Emissions from manure management	Key (L, T2)
4D1	N_2O	Direct soil emissions	Key (L, T)
4D2	N_2O	Emissions from animal production	Key (L2, T2)
4D3	N_2O	Indirect soil emissions	Key (L, T2)
4C	CH_4	Rice cultivation	Non-key
4F	CH_4	Emissions from field burning of agriculture residues	Non-key
4F	N_2O	Emissions from field burning of agriculture residues	Non-key

6.1.3 Activities

Emission factors used for the preparation of the national inventory reflect the characteristics of the Italian agriculture sector. Information from national research studies is considered. Activity data are mainly collected from the National Institute of Statistics (ISTAT, *Istituto Nazionale di Statistica*). Every year, national and international references, and personal communications used for the preparation of the agriculture inventory are kept in the *National References Database*.
Improvements for the Agriculture sector are described in the Italian Quality Assurance/Quality Control plan (ISPRA, 2009). Moreover, an internal report describes the procedure for preparing the agriculture UNFCCC/CLRTAP national emission inventory (Cóndor, 2009).
In the last years, results from different research projects have improved the quality of the agriculture national inventory (MeditAIRaneo project and convention signed between ISPRA and the Ministry for the Environment, Land and Sea). Furthermore, suggestions from the inventory review processes have been considered (ISPRA, 2009; UNFCCC, 2009). Methodologies for the preparation of agriculture national inventory under the Convention on Long-Range Transboundary Air Pollution (CLRTAP) and the United Nations Framework Convention on Climate Change (UNFCCC) are kept consistent. Synergies among international conventions and European directives while preparing the agriculture inventory are implemented (Cóndor *et al*., 2008[b]; Cóndor *et al*., 2007[b]; Cóndor and De Lauretis, 2007; Cóndor, 2006).
The national agriculture UNFCCC/CLRTAP emission inventory is used every 5 years to prepare a more disaggregated inventory by region and province as requested by CLRTAP (Cóndor *et al*., 2008[c]). A database with the time series for all sectors and pollutants has been published (ISPRA, 2008[a], [b]). Furthermore, the same methodologies are used for estimating emission scenarios and projections for the years 2010, 2015 and 2020 (MINAMBIENTE, 2007).

6.1.4 Agricultural statistics

The Italian National Statistical System (SISTAN[3]) revises every year the National Statistical Plan that covers three years and includes the system of agricultural statistics among others. In this

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

framework, the Agriculture, Forestry and Fishing Quality Panel has been established under coordination of the Agriculture service of ISTAT, where the producers and users of agricultural statistics (mainly public institutions) meet every year in order to monitor and improve national statistics. Among those producing statistics, ISTAT plays a major role in the agricultural sector collecting comprehensive data through different surveys as reported by Greco and Martino (2001):

- Structural surveys (Farm Structure Survey, survey on economic results of the farm, survey on the production means);
- Conjunctural surveys[4] (survey on the area and production of the cultivation, livestock number, milk production, slaughter, etc.);
- General Agricultural Census[5], carried out every 10 years (1990, 2000, 2010).

Detailed information on the agriculture sector is found every two years in the **Farm Structure Survey – FSS**[6] (ISTAT, 2008[a]; ISTAT, 2007[a]; ISTAT, 2006[a]). Furthermore, the quality reports of the FSS 2005 and FSS 2007 have been obtained from ISTAT (ISTAT, 2008[b]; ISTAT, 2007[e]). The main agricultural statistics sources, used in the agriculture emission inventory, are available online, as reported in the following box:

Main activity data sources used for the Agriculture emission inventory

Agricultural statistics	Time series	Web site
Livestock number	Table 6.3; 6.4; 6.7	http://www.istat.it/agricoltura/datiagri/consistenza/
Milk production	Table 6.3	http://www.istat.it/agricoltura/datiagri/latte/
Fertilizers	Table 6.30	http://www.istat.it/agricoltura/datiagri/mezzipro/
Crops production/surface	Table 6.26; 6.32; 6.33	http://www.istat.it/agricoltura/datiagri/coltivazioni/

6.2. Enteric fermentation (4A)

6.2.1. Source category description

Methane is produced as a by-product of enteric fermentation, which is a digestive process where carbohydrates are degraded by microorganisms into simple molecules.
Methane emissions from enteric fermentation are a major key source, both in terms of level and trend for Tier 1 and Tier 2 approaches. All livestock categories have been estimated except camels and llamas, which are not present in Italy. Methane emissions from poultry do not occur, and emissions from rabbits are estimated and included in "Other" as suggested by IPCC guidelines. In 2007, CH_4 emissions from this category were 525.07 Gg, which represent 70.6% of CH_4 emissions for the agriculture sector (70.7% in 1990) and 28.9% for national CH_4 emissions (29.2% in 1990). Methane emissions from this source mainly consist of cattle emissions: dairy cattle (208.13 Gg) and non-dairy cattle (205.03 Gg); these sub-categories sources represented 39.6% (42.3% in 1990) and 39.0% (40.2% in 1990), respectively, of total enteric fermentation emissions.

6.2.2. Methodological issues

Methane emissions from enteric fermentation are estimated by defining an emission factor for each livestock category, which is multiplied by the population of the same category. Data for each livestock category are collected from ISTAT (several years [a], [b], [c], [f]; ISTAT, 1991; 2009[a]; 2007[a],[b]). Livestock categories provided by ISTAT are classified according to the type of production, slaughter or breeding, and the age of animals. In Table 6.20, activity data for the

[4] http://www.istat.it/agricoltura/datiagri/
[5] http://www.census.istat.it/
[6] Indagine sulla struttura e produzione delle aziende agricole (SPA), survey carried out every two years in agricultural farms.

livestock categories are shown. In the following box, livestock categories and source of information are provided. In order to have a consistent time series, it was necessary to reconstruct the number of animals for some categories. Reconstruction used information available from other official sources such as FAO (2009) and UNA (2009).

Activity data for the different livestock categories

Livestock category	Source
Cattle	ISTAT
Buffalo	ISTAT
Sheep	ISTAT
Goats	ISTAT
Horses	ISTAT/FAO(a)
Mules and asses	ISTAT/FAO(a)
Swine	ISTAT
Poultry	ISTAT/UNA(b)
Rabbits	ISTAT(c)

(a) Reconstruction of a consistent time series
(b) For 1990 data from the census and reconstruction for brood-rabbits and other rabbits based on meat production (UNA, 2009)
(c) For 1990 data from the census and reconstruction based on a production index (ISTAT, 2009[f]; 2007[b])

Dairy cattle

Methane emissions from enteric fermentation for dairy cattle are estimated using a Tier 2 approach, as suggested in the Good Practice Guidance (IPCC, 2000). Feeding characteristics are described in a national publication (CRPA, 2004[a]) and have been discussed in a specific working group, in the framework of the MeditAIRaneo project (CRPA, 2006[a]; CRPA, 2005). Parameters used for the calculation of the emission factor are presented in the following box:

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

Parameters	Value	Reference
Average weight (kg)	602.7	CRPA, 2006
Coefficient NEm (dairy cattle)	0.335	NRC, 2001; IPCC, 2000
Pasture (%)	5	CRPA, 2006[a]; ISTAT, 2003
Weight gain (kg day^{-1})	0.051	CRPA, 2006[a]; CRPA, 2004[b]
Milk fat content (%)	3.59-3.71	ISTAT, several years [a], [b], [d], [e]; ISTAT, 2009[b]
Hours of work per day	0	CRPA, 2006
Portion of cows giving birth	0.90-0.97	AIA, 2009
Milk production (kg $head^{-1}$ day^{-1})	11.5-17.4	CRPA, 2006[a]; ISTAT, 2009[b]; OSSLATTE/ISMEA, 2003; ISTAT, several years [a], [b], [c] [d], [e], [f];OSSLATTE, 2001
Digestibility of feed (%)	65	CRPA, 2006[a]; CRPA, 2005
Methane conversion rate (%)	6	CRPA, 2006
MJ/kg methane	55.65	IPCC, 2000

In a national publication, an analysis of the different milk production statistics has been described (Cóndor *et al*., 2005). Milk used for dairy production and milk used for calf feeding contributes to total milk production. This value has been reconstructed with national and ISTAT publications, as well as personal communication with ISTAT (ISTAT, 2009[e]). For calculating milk production (kg $head^{-1}$ d^{-1}), total production has been divided by the number of animals and by 365 days, as suggested by the IPCC (2000). Therefore, lactating and non-lactating periods are included in the estimation of the CH_4 dairy cattle EF (CRPA, 2006[a]). In Table 6.3, the time series of the dairy cattle population, fat content in milk, portion of cows giving birth and milk production are presented. Further information on parameters used for dairy cattle estimations with the Tier 2 approach are found in Annex 5.1.

In Table 6.6, the time series of the dairy cattle emission factors (EF) is presented. In 2007, the CH_4 dairy cattle EF was 113.19 kg CH_4 head^{-1} year^{-1} with an average milk production of 6,320 kg head^{-1} year^{-1} (17.3 kg head^{-1} day^{-1}). This value is close to the default EF of 109 kg CH_4 head^{-1} year^{-1} with a milk production of 6,000 kg head^{-1} year^{-1} reported by the IPCC (2006).

Year	Dairy cattle (head)	Fat content in milk (%)	Portion of cows giving birth	Milk production yield (kg head^{-1} d^{-1})
1990	2,641,755	3.59	0.973	11.5
1991	2,339,520	3.59	0.971	13.0
1992	2,146,398	3.59	0.961	13.9
1993	2,118,981	3.63	0.955	13.8
1994	2,011,919	3.64	0.963	14.5
1995	2,079,783	3.64	0.948	14.8
1996	2,080,369	3.65	0.948	15.2
1997	2,078,388	3.66	0.946	15.5
1998	2,116,176	3.71	0.931	15.3
1999	2,125,571	3.69	0.919	15.3
2000	2,065,000	3.65	0.926	15.1
2001	2,077,618	3.65	0.915	14.9
2002	1,910,948	3.67	0.913	16.2
2003	1,913,424	3.67	0.913	16.2
2004	1,838,330	3.71	0.899	16.8
2005	1,842,004	3.71	0.910	17.2
2006	1,821,370	3.69	0.901	17.4
2007	1,838,783	3.71	0.897	17.3

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

Non-dairy cattle

For non-dairy cattle, CH_4 emissions from enteric fermentation are estimated with a Tier 2 approach (IPCC, 2000). The estimation of the EF uses country-specific data, disaggregated livestock categories (see Table 6.4), and is based on dry matter intake (kg head^{-1} day^{-1}) calculated as percentage of live weight (CRPA, 2000; INRA, 1988; NRC, 1984; NRC, 1988; Borgioli, 1981; Holter and Young, 1992; Sauvant, 1995). Dry matter intake is converted into gross energy (MJ head^{-1} day^{-1}) using 18.45 MJ/kg dry matter (IPCC, 2000). Emission factors for each category have been calculated with equation 4.14 from IPCC (2000). In Table 6.5, parameters used for the estimation of non-dairy cattle EF are shown. Since 2006 submission, average weights have been updated with information from the Inter-regional project on nitrogen balance project (CRPA, 2006[a]; Regione Emilia Romagna, 2004).

For reporting purposes, some animal categories are aggregated, such as the non-dairy and swine categories. For example, the non-dairy cattle category is composed of the different sub-categories as shown in Table 6.4. For this reason, the gross energy intake, CH_4 conversion factor and EFs for this category are calculated as a weighted average.

Year	<1 year		1-2 years Males		1-2 years Females		>2 years Males	>2 years Females			TOTAL
	for slaughter	others	breeding	for slaughter	breeding	for slaughter	all	breeding	for slaughter	others	
1990	300,000	2,127,959	72,461	708,329	749,111	186,060	128,958	467,216	57,654	312,649	**5,110,397**
1991	300,000	2,060,091	71,191	732,421	1,077,802	197,078	82,957	498,136	59,281	503,041	**5,581,998**
1992	300,000	2,036,527	65,656	654,622	1,019,928	197,507	102,182	464,814	49,749	534,632	**5,425,617**
1993	300,000	2,002,856	63,214	639,922	995,481	175,146	95,929	449,996	47,921	551,683	**5,322,148**
1994	300,000	1,794,806	63,926	651,708	1,040,424	145,475	107,640	451,864	31,569	569,429	**5,156,841**
1995	458,936	1,796,034	27,871	783,300	684,881	154,548	155,116	430,564	40,198	657,856	**5,189,304**
1996	405,986	1,802,849	29,877	721,711	700,560	166,137	119,478	416,038	34,167	696,760	**5,093,563**
1997	354,006	1,910,283	62,983	600,315	699,133	160,238	162,187	413,383	63,765	668,553	**5,094,846**
1998	392,432	1,865,075	25,454	611,973	677,915	166,266	115,269	413,456	60,962	684,530	**5,013,332**
1999	385,251	1,807,169	28,133	655,749	708,152	179,488	101,922	410,062	46,392	713,872	**5,036,190**
2000	408,000	1,783,000	27,521	641,479	736,000	160,000	93,000	500,000	51,000	588,000	**4,988,000**
2001	496,264	1,498,068	25,528	595,029	709,941	181,550	75,365	591,000	46,000	442,525	**4,661,270**
2002	409,970	1,617,127	26,194	610,550	647,656	176,481	65,948	541,233	59,582	444,408	**4,599,149**
2003	412,682	1,594,994	27,598	643,277	673,246	158,094	78,890	520,237	48,873	433,388	**4,591,279**
2004	445,231	1,509,387	28,458	663,316	648,308	149,053	71,762	460,765	38,385	451,606	**4,466,271**
2005	500,049	1,418,545	26,424	615,921	588,660	181,971	102,081	466,566	37,971	471,733	**4,409,921**
2006	540,223	1,407,401	26,091	608,152	584,680	182,719	78,328	395,066	54,022	419,083	**4,295,765**
2007	519,034	1,410,357	26,852	625,902	593,369	189,704	79,936	498,091	59,961	440,845	**4,444,051**

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

	<1 year	1-2 years Males		1-2 years Females		>2 years Males	>2 years Females		
Parameters	Others(*)	breeding	for slaughter	breeding	for slaughter	all	breeding	for slaughter	Others
Average weight (kg)	236	557	557	405	444	700	540	540	557
Percentage weight ingested	2.0	1.9	2.1	2.1	2.1	2.4	2.1	2.1	1.9
Dry matter intake (kg head^{-1}day^{-1})	4.8	10.7	11.6	8.5	9.3	17.1	11.5	11.5	10.6
Gross Energy (MJ head^{-1}day^{-1})	89.4	197.31	214.78	156.92	171.21	315.50	212.18	212.18	195.26
CH_4 conversion (%)	4	4.5	4	6	4	6	6	6	6

(*) It has been considered that calves for slaughter of <1 year, do not emit CH_4 emissions, as they are milk fed. Therefore, the average weight for the category "others" of <1 year take into account fattening male cattle, fattening heifer and heifer for replacement.

Table 6.5 Main parameters used for non-dairy cattle CH_4 emission factor estimations

National characteristics of Italian breeding are reflected in EFs and are also related to the age classification of animals and dry matter intake. In Table 6.6, implied emission factors (IEF) for non-dairy cattle are shown. In 2007, the non dairy-cattle EF was 46.13 kg CH_4 head^{-1} year^{-1} while IPCC default EF is 48 kg CH_4 head^{-1} year^{-1} (IPCC, 1997). The interannual decrease 2005/2006 of the IEF for non-dairy cattle is related to the reduction in the number of animals for some categories (see Table 6.4) and increase of the 'less than 1 year' for the slaughter category (no emissions).

Buffalo

Data collected in the framework of the MeditAIRaneo project have allowed the implementation of the Tier2 approach for the buffalo category (IPCC, 2000). Two different country specific CH_4 EFs, for cow buffalo and other buffaloes have been developed. Detailed description of the methodology, parameters and assumptions are reported in Cóndor *et al*. (Cóndor *et al.*, 2008[a]). In 2007, the cow buffalo CH_4 EF was 73.50 kg CH_4 head^{-1} year^{-1} and for *other buffaloes* the value was 56.0 kg CH_4 head^{-1} year^{-1}. The IEF in the CRF is an average EF for the buffalo category (67.08 kg CH_4 head^{-1} year^{-1}).

In the following boxes, parameters used for the Tier 2 approach are presented:

Parameters for the calculation of CH_4 cow buffalo emission factors from enteric fermentation

Parameters	Value	Reference
Average body weight (kg)	630	Infascelli, 2003; Consorzio per la tutela del formaggio mozzarella di bufala campana, 2002
Coefficient NEm, cattle/buffalo (lactating)	0.335	IPCC, 2000
Pasture (%)	2.90	ISTAT, 2003; Zicarelli, 2001; expert judgement
Weight gain (kg day^{-1})	0.27	Estimations
Milk fat content (%)	7.7-8.1	ISTAT, several years [a], [b], [d], [e]; ISTAT, 2009[b]
Hours of work per day	0	Our estimation
Proportion of calving cows	0.84-0.89	Barile, 2005; De Rosa and Trabalzi, 2004
Milk production (kg head^{-1} day^{-1})	1.9-4.4	ISTAT, 2009[b]; OSSLATTE/ISMEA, 2003; ;OSSLATTE, 2001; ISTAT, several years [a], [b], [c] [d], [e], [f]
Digestibility of feed (%)	65	Infascelli, 2003; Masucci *et al.*, 1997, 1999;
Methane conversion rate (%)	6	CRPA, 2006
MJ/kg methane	55.65	IPCC, 2000

Parameters for the calculation of other buffalo emission factors from enteric fermentation

Parameter	**Calves (3 months-1 year)**	**Sub-adult buffaloes (1-3 years)**
Average body weight (kg)	130	405
Dry matter intake (% of body weight head^{-1} day^{-1})	3.0	2.5
Dry matter intake (kg head^{-1} day^{-1})	3.9	10.1
Gross Energy (MJ head^{-1} day^{-1})	71.68	186.58
CH_4 conversion (%)	6	6
CH_4 emission factor (kg head^{-1} year^{-1})	21.16 (*)	73.42

(*) original CH_4 emission factor was 28.208 kg CH4 head^{-1} year^{-1}; a correction factor of 9/12 has been applied in order to consider the time between 3 months and 1 year, therefore the final emission factor was 21.16 kg CH_4 head^{-1} year^{-1}.

Rabbits

Methane emissions from rabbits have been estimated using a country-specific EF suggested by the Research Centre on Animal Production (CRPA). Daily dry matter intake for brood-rabbits and rabbits are 0.13 kg day^{-1} and 0.11 kg day^{-1}, respectively. Besides, 0.6% as CH_4 conversion rate has been assumed (CRPA, 2004[c]).

Other livestock categories

A Tier 1 approach, with IPCC default EFs, has been used to estimate CH_4 emissions from swine, sheep, goats, horses, mules and asses (IPCC, 1997). In Table 6.6, emission factors for all livestock categories (dairy cattle, non-dairy cattle, buffalo, swine, sheep, goats, horses, mules and asses, and rabbit) are presented. In Table 6.7, time series from livestock number are shown.

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sheep	Goats	Horses	Mules and asses	Sows	Other swine	Rabbits
1990	92.8	45.6	61.7	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1991	97.7	47.5	62.9	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1992	100.9	47.5	62.4	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1993	100.6	47.4	65.5	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1994	103.4	48.7	65.6	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1995	104.3	47.4	63.2	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1996	105.8	47.5	62.4	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1997	106.7	47.8	62.9	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1998	106.4	47.0	62.0	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1999	106.3	47.3	64.9	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2000	105.3	47.0	65.7	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2001	104.6	46.7	68.2	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2002	109.1	46.5	66.4	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2003	109.0	46.6	66.2	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2004	111.5	46.3	68.3	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2005	112.9	46.4	71.0	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2006	113.24	44.7	69.7	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2007	113.19	46.1	67.1	8.0	5.0	18.0	10.0	1.5	1.5	0.08

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

Year	Buffalo	Sheep	Goats	Horses	Mules and asses	Sows	Other swine	Rabbits	Poultry
1990	94,500	8,739,253	1,258,962	287,847	83,853	650,919	7,755,602	14,893,771	173,341,562
1991	83,300	8,397,070	1,260,980	314,125	66,255	711,500	7,837,300	15,877,391	173,060,622
1992	103,200	8,460,557	1,355,485	315,848	56,946	691,400	7,553,000	16,398,563	172,683,589
1993	100,900	8,669,560	1,408,767	323,305	49,383	702,900	7,645,200	16,530,691	173,261,404
1994	108,300	9,964,108	1,658,051	323,986	43,063	677,100	7,346,300	16,905,054	178,659,192
1995	148,404	10,667,971	1,372,937	314,778	37,844	689,846	7,370,830	17,110,587	184,202,416
1996	171,558	10,943,457	1,419,225	312,080	34,120	726,155	7,444,937	17,433,566	183,044,930
1997	161,491	10,893,711	1,351,003	313,000	30,000	693,366	7,599,426	17,609,737	186,815,499
1998	186,276	10,894,264	1,331,077	290,000	33,500	707,644	7,614,981	17,705,163	198,799,819
1999	200,481	11,016,784	1,397,329	288,000	33,000	691,590	7,722,893	18,020,802	196,573,062
2000	192,000	11,089,000	1,375,000	280,000	33,000	708,000	7,599,000	17,873,993	176,722,211
2001	193,774	8,311,383	1,024,769	285,000	33,000	697,491	8,068,771	18,343,782	209,187,654
2002	185,438	8,138,309	987,844	277,819	28,913	751,159	8,415,099	18,505,272	205,524,395
2003	222,268	7,950,981	960,994	282,936	28,507	736,637	8,420,087	18,226,335	196,511,409
2004	210,195	8,106,043	977,984	277,767	28,932	724,891	8,247,181	21,199,217	191,315,963
2005	205,093	7,954,167	945,895	278,471	30,254	721,843	8,478,427	22,153,475	188,595,022
2006	230,633	8,227,185	955,316	287,123	31,013	771,751	8,509,352	21,801,133	177,535,443
2007	293,947	8,236,668	920,085	315,725	34,557	753,721	8,519,214	22,748,051	188,871,886

Table 6.7 Time series of number of animals from 1990 to 2007

6.2.3. Uncertainty and time-series consistency

Uncertainty related to CH_4 emissions from enteric fermentation was 28% for annual emissions, resulting from the combination of 20% of uncertainty for both activity data and emission factors.
In 2007, livestock CH_4 emissions from enteric fermentation have been 9.5% (525.07 Gg) lower than in 1990 (579.93 Gg), while from 1990 to 2007 cattle livestock has decreased by 19% (from 7,752,152 to 6,282,834 heads). Dairy cattle and non-dairy cattle have decreased by 30.4% (from 2,641,755 to 1,838,783) and 13% (from 5,110,397 to 4,444,051), respectively. The decrease in cattle number is driving down CH_4 emissions, particularly as emissions per head from cattle are 10 times greater than emissions per head of sheep or goat. In 2007, cattle contribute with 82.4% to total CH_4 emissions from enteric fermentation. In Table 6.8, emission trends from the enteric fermentation category are shown. Emissions from swine, as reported in the CRF submission 2009 are represented by other swine and sow category (13.91 Gg).

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sheep	Goats	Horses	Mules and asses	Sows	Other swine	Rabbits	TOTAL
1990	245.11	233.00	5.83	69.91	6.29	5.18	0.84	0.98	11.63	1.16	**579.93**
1991	228.61	265.10	5.24	67.18	6.30	5.65	0.66	1.07	11.76	1.23	**592.81**
1992	216.49	257.52	6.44	67.68	6.78	5.69	0.57	1.04	11.33	1.27	**574.81**
1993	213.23	252.38	6.61	69.36	7.04	5.82	0.49	1.05	11.47	1.28	**568.74**
1994	207.94	251.21	7.10	79.71	8.29	5.83	0.43	1.02	11.02	1.31	**573.87**
1995	216.88	246.22	9.38	85.34	6.86	5.67	0.38	1.03	11.06	1.33	**584.15**
1996	220.10	241.79	10.71	87.55	7.10	5.62	0.34	1.09	11.17	1.35	**586.80**
1997	221.80	243.78	10.15	87.15	6.76	5.63	0.30	1.04	11.40	1.37	**589.39**
1998	225.18	235.38	11.54	87.15	6.66	5.22	0.34	1.06	11.42	1.38	**585.33**
1999	225.85	238.33	13.00	88.13	6.99	5.18	0.33	1.04	11.58	1.40	**591.84**
2000	217.40	234.48	12.61	88.71	6.88	5.04	0.33	1.06	11.40	1.39	**579.30**
2001	217.22	217.91	13.22	66.49	5.12	5.13	0.33	1.05	12.10	1.42	**539.99**
2002	208.45	213.95	12.31	65.11	4.94	5.00	0.29	1.13	12.62	1.44	**525.24**
2003	208.65	214.17	14.71	63.61	4.80	5.09	0.29	1.10	12.63	1.42	**526.47**
2004	204.92	206.60	14.36	64.85	4.89	5.00	0.29	1.09	12.37	1.65	**516.01**
2005	207.95	204.65	14.57	63.63	4.73	5.01	0.30	1.08	12.72	1.72	**516.37**
2006	206.26	192.10	16.08	65.82	4.78	5.17	0.31	1.16	12.76	1.69	**506.13**
2007	208.13	205.03	19.72	65.89	4.60	5.68	0.35	1.13	12.78	1.77	**525.07**

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

6.2.4. Source-specific QA/QC and verification

Since 2006 submission, results from the MeditAIRaneo project focusing on the assessment of critical points of the enteric fermentation category have been incorporated (CRPA, 2006[a]; Valli *et al.*, 2004). In Table 6.9, a list of parameters from the QA/QC plan is reported.

6.2.5. Source-specific recalculations

For the whole time series some corrections have been identified: a parameter used for calculating the cow buffalo EF, the average weight of the category of 'less than 1 year' for slaughter, and the Bo parameter for the buffalo category.

In Table 6.10, new and old dairy cattle and buffalo EFs, from 2008 and 2009 submissions, are shown.

Sub category	Parameter	Year of submission 2009	2010	Activities
Dairy cattle	Fat content	v		Data from 2007 fat parameter has been collected (ISTAT web site)
Dairy cattle	Portion cow giving birth	v		Data from 2007 has been collected (AIA, 2008)
Dairy cattle/buffalo	Milk production	v		Data from 2007 on milk production has been collected (ISTAT web site)

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

	Dairy cattle		Buffalo	
Year	**EF 2008 submission**	**EF 2009 submission**	**EF 2008 submission**	**EF 2009 submission**
1990	92.8	92.8	61.7	61.7
1991	97.7	97.7	62.9	62.9
1992	100.9	100.9	62.4	62.4
1993	100.6	100.6	65.5	65.5
1994	103.4	103.4	65.6	65.6
1995	104.3	104.3	63.2	63.2
1996	105.8	105.8	62.4	62.4
1997	106.7	106.7	62.9	62.9
1998	106.4	106.4	62.0	62.0
1999	106.3	106.3	64.9	64.9
2000	105.3	105.3	65.7	65.7
2001	104.6	104.6	68.2	68.2
2002	109.1	109.1	66.4	66.4
2003	109.0	109.0	66.2	66.2
2004	111.5	111.5	68.3	68.3
2005	112.9	112.9	71.0	71.0
2006	113.2	113.2	69.7	69.7
2007		113.2		67.1

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

6.2.6. Source-specific planned improvements

In the framework of collaboration between ISPRA (former APAT) and ISTAT (Agriculture Service) we expect to continuosly update and improve activity data.

6.3. Manure management (4B)

6.3.1 Source category description

In 2007, CH_4 emissions from manure management were 145.57 Gg, which represents 19.6% of CH_4 emissions for the agriculture sector (20.1% in 1990) and 8.0% of national CH_4 emissions (8.3% in

1990). CH_4 emissions from swine were 66.42 Gg and from cattle 56.33 Gg; these sub-categories represented 45.6% and 38.7% of total CH_4 manure management emissions, respectively.
In 2007, N_2O emissions from manure management were 12.25 Gg, which represents 17.6% of total N_2O emissions for the agriculture sector (16.8% in 1990) and 11.9% of national N_2O emissions (10.5% in 1990). In 2007, N_2O emissions from this source mainly consist of the solid storage source (10.79 Gg), which accounts for 88.1% of the N_2O manure management source.
Since the 2006 submission, parameters related to the estimation of CH_4 and N_2O emissions have been updated: average weight, production of slurry and solid manure and the nitrogen excretion rates. The source of the updating has been the Inter-regional project on nitrogen balance and other national research studies. In this section references are provided.
Methane and nitrous oxide emissions from manure management are key sources. Nitrous oxide emissions are key sources at level for Tier 1 and Tier 2, and trend assessment (Tier 2), while CH_4 emissions are key sources at level for Tier 1 and Tier 2, and Tier 2 trend assessment.

6.3.2. Methodological issues

The IPCC Tier 2 approach has been used for estimating CH_4 EFs for manure management of cattle, buffalo and swine. For estimating slurry and solid manure EFs and the specific conversion factor, a detailed methodology (*Method 1*) has been applied at a regional basis (cattle and buffalo categories). Then, a simplified methodology, for estimating EF time series, has been followed (*Method 2*). Livestock population activity data are collected from ISTAT (see Table 6.3; Table 6.4; Table 6.7).

Methane emissions (cattle and buffalo)

Method 1: Regional basis

Methane emissions estimations for manure management are drawn up on a regional basis and depend on specific manure management practices and environmental conditions (Safley *et al*., 1992; Steed and Hashimoto, 1995; Husted, 1994). In particular, the following factors are used: average regional monthly temperatures (UCEA, 2008), amount of slurry and solid manure produced per livestock category (CRPA, 2006[a]; Regione Emilia Romagna, 2004) and management techniques for the application of slurry and solid manure for agricultural purposes in Italy (CRPA, 1993).
For cattle and buffalo, the estimation of the EF begins with the calculation of the *methane emission rate* (g CH_4 m^{-3} day^{-1}), which is obtained from an equation presented for slurry (Husted, 1994) and solid manure (Husted, 1993). Then the *methane emission rate* is transformed to g m^{-3} $month^{-1}$. The equations used are presented below (CRPA, 2006[a]; CRPA, 1997[a]):
For slurry:

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

For solid manure:

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

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

$$T\ \text{solid manure storage} = 6{,}7086e^{\ 0.1014t\ (°C)\ (\text{average regional monthly temperature})}$$

For temperatures below 10°C emissions are considered negligible.

The volume of slurry and solid manure produced per livestock category was obtained (m^3 $head^{-1}$) with the average production of slurry and solid manure per livestock category per day (m^3 $head^{-1}$ day^{-1}) and the days of storage of slurry and solid manure. These days are related to the temporal application dynamics of slurry and solid manure under Italian conditions (CRPA, 1997[a]). On the other hand, the production of solid manure and slurry have been estimated assuming a distribution of housing systems in Italy, which will be updated with information coming from the Farm Structure Survey (FSS) 2005. Emission factors for slurry and solid manure (g CH_4 $head^{-1}$ $month^{-1}$) are calculated for each month, and are obtained with the *methane emission rates* (Eq. 6.1 and 6.2), and the volume of slurry and solid manure produced. The annual EF for each livestock category is the sum of slurry and solid manure EFs (kg CH_4 $head^{-1}$ $year^{-1}$). Then, to correlate CH_4 emission production and volatile solid (VS) production a *specific conversion factor* has been estimated. Later, this factor is used for the simplified methodology (*Method 2*). The *specific conversion factor* values for slurry and solid manure are 15.32 g CH_4/kg VS and 4.80 g CH_4/kg VS, respectively.

Method 2: National basis

A simplified methodology (*Method 2*) for estimating methane EFs from manure management has been used for the whole time series. Slurry and solid manure EFs (kg CH_4 $head^{-1}$ $year^{-1}$) have been calculated with Equations 6.3 and 6.4, respectively. These equations include the *specific conversion factor*, previously estimated on a regional basis. Furthermore, the production of volatile solids (kg $head^{-1}day^{-1}$) has been estimated with the slurry and solid manure production, and the factors proposed by Husted: 47g VS/kg (slurry) and 142 g VS/kg, (solid manure). The daily VS excreted, estimated for slurry and solid manure, are summed and used for estimating the methane producing potential (Bo). In Table 6.11, EF estimations are presented.

EF slurry = 15.32 gCH_4/Kg VS • VS production slurry (kg VS $head^{-1}$ day^{-1}) • 365 days *Eq. 6.3*

EF manure = 4.8 gCH_4/Kg VS • VS production slurry (kg VS $head^{-1}$ day^{-1}) • 365 days *Eq. 6.4*

Livestock category	**Slurry (kg CH_4 $head^{-1}$ yr^{-1})**	**Solid manure (kg CH_4 $head^{-1}$ yr^{-1})**	**CH_4 manure management EF (kg CH_4 $head^{-1}$ yr^{-1})**
Calf (*vitelli*)	6.22	0.00	**6.22**
Cattle (*bovini*)	5.07	3.49	**8.56**
Female cattle (*bovine*)	2.87	4.18	**7.05**
Other dairy cattle (*altre vacche*)	4.01	6.65	**10.66**
Dairy cattle (*vacche da latte*)	5.64	9.41	**15.04**
Cow buffalo (*bufale*)	4.99	10.26	**15.25**
Other buffaloes (*altri bufalini*)	3.13	3.16	**6.29**

Table 6.11 Methane manure management emission factors for cattle and buffalo in 2007 (kg CH_4 $head^{-1}$ yr^{-1})

Since the 2006 submission, the average production of slurry and solid manure per livestock category per day (m^3 $head^{-1}$ day^{-1}) has been updated with results from the Inter-regional project on nitrogen balance project (Regione Emilia Romagna, 2004). Based on the type and distribution of housing systems for the different animal categories, and the average weight of animals, a time series of slurry and solid manure production has been obtained. In Table 6.12 the disaggregated manure management EFs for cattle and buffalo are shown. However, in Table 6.14 the average EFs for the main categories (dairy, non-dairy and buffalo) are shown.

Year	Calf	Cattle	Female cattle	Other dairy cattle	Dairy cattle	Cow buffalo	Other buffaloes
1990	6.22	8.11	6.71	10.66	15.04	15.25	6.34
1991	6.22	8.06	6.91	10.66	15.04	15.25	6.34
1992	6.22	8.01	6.86	10.66	15.04	15.25	6.34
1993	6.22	7.99	6.83	10.66	15.04	15.25	6.33
1994	6.22	8.20	6.93	10.66	15.04	15.25	6.33
1995	6.22	8.56	6.71	10.66	15.04	15.25	6.33
1996	6.22	8.29	6.76	10.66	15.04	15.25	6.32
1997	6.22	8.33	6.62	10.66	15.04	15.25	6.32
1998	6.22	8.16	6.65	10.66	15.04	15.25	6.32
1999	6.22	8.22	6.71	10.66	15.04	15.25	6.31
2000	6.22	8.27	6.80	10.66	15.04	15.25	6.31
2001	6.22	8.48	7.07	10.66	15.04	15.25	6.31
2002	6.22	8.23	6.99	10.66	15.04	15.25	6.30
2003	6.22	8.38	6.94	10.66	15.04	15.25	6.30
2004	6.22	8.34	6.98	10.66	15.04	15.25	6.30
2005	6.22	8.61	6.95	10.66	15.04	15.25	6.30
2006	6.22	8.52	6.87	10.66	15.04	15.25	6.29
2007	6.22	8.56	7.05	10.66	15.04	15.25	6.29

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

Since the 2006 submission, a reduction of CH_4 emissions has been considered for the manure management category on account of biogas production. A national census on biogas production/technology can be found in CRPA (2008) and CRPA/AIEL (2008). Activity data are collected every year from the National Electric Network - TERNA[7] (2009). Further information on biogas activity data can be found in Annex 7.

Reduction of CH_4 emissions are assumed for cattle and swine livestock categories, and distributed according to the contribution of emissions from each category. This reduction is evident in the implied emission factor (IEF) reported in the CRF. In 2007, IEFs, for dairy cattle and non-dairy cattle, were 13.63 kg CH_4 head^{-1} year^{-1} and 7.04 kg CH_4 head^{-1} year^{-1}, respectively. IPCC default emissions factors for cool temperature are 14 kg CH_4 head^{-1}year^{-1} and 6 kg CH_4 head^{-1}year^{-1}, respectively (IPCC, 1997).

The IEF for non-dairy cattle and buffalo represents a weighted average. The non-dairy cattle IEF includes: calf, cattle, female cattle and other dairy cattle. The buffalo category includes: cow buffalo and other buffaloes categories. In the following box, EFs and IEFs are presented. Differences, as mentioned before, are related to the amount of CH_4 reductions from biogas recovery. Moreover, interannual decrease 2005/2006 of the non-dairy IEF reflects the strong increase of biogas recovery.

Livestock category	EF (kg CH_4 head^{-1} yr^{-1})	IEF(*) (kg CH_4 head^{-1} yr^{-1})
Dairy cattle	15.04	13.63
Non-dairy cattle	7.77	7.04
Buffalo	11.97	11.97

(*) IEF as reported in the CRF submission 2009

7 TERNA, Rete Elettrica Nazionale

For reporting purposes, the estimation of the methane producing potential (Bo), has been estimated with Equation 4.17 from IPCC (2000). Moreover, the average methane conversion factors (MCF), for each manure management system (classified by climate) is estimated with data coming from the Agriculture Census from 1990 and 2000 and the FSS 2005 (ISTAT, 2007[a]). Average MCFs have not been used for estimating manure management EF, but they are useful to verify the EF accuracy. In the following box, estimated country-specific VS and Bo parameters, and IPCC default values are shown. Differences are mainly attributed to country-specific characteristics.

Livestock category	VS country-specific (*) (kg dm head^{-1} yr^{-1})	VS IPCC default (kg DM head^{-1} yr^{-1})	Bo country-specific (*) (CH_4 m^3/kg VS)	Bo IPCC default (CH_4 m^3/kg VS)
Dairy cattle	6.37	4.13	0.14	0.24
Non-dairy cattle	2.85	2.68	0.13	0.17
Buffalo	5.14	2.68	0.13	0.10
Swine	0.32	0.50	0.46	0.45

(*) IEF as reported in the CRF submission 2009

Methane emissions (swine)

For the estimation of CH_4 emissions for swine, a country-specific *methane emission rate* has been experimentally determined by the Research Centre on Animal Production (CRPA, 1996). The estimation of the EF considers: the structure of the storage for slurry (tank and lagoons), type of breeding and seasonal production of biogas.

Different parameters have been considered, such as the livestock population, average weight for fattening swine and sows, and *methane emission rate*. Methane emission rates used are 41 normal litre CH_4/100 kg live weight/day for fattening swine and 47 normal litre CH_4/100 kg live weight/day for sows including piglets (CRPA, 1997[a]). Then, a reduction of emissions of 8% for covered storage structures has been applied to the *methane emission rate*. In Table 6.13, characteristics of swine breeding and EFs are shown.

Since the 2006 submission, parameters such as: average weight of sows, production of slurry (t year^{-1} per t live weight) and volatile solid content in the slurry (g SV/kg slurry w.b.) have been updated. Moreover, the slurry production has considered the different swine categories (classified by weight and housing characteristics). Volatile solid content has been determined experimentally from 598 measurements carried out by CRPA (2006[a]).

In 2007, the EF from sow was 22.21 kg CH_4 head^{-1}year^{-1} and for the other swine category was 8.33 kg CH_4 head^{-1} year^{-1} (average EF swine of 7.91 kg CH_4 head^{-1}year^{-1}). In Table 6.14 the time series of EFs for the disaggregated swine category (sow and other swine) are shown. The IEF as reported in the CRF submission 2009 is 7.16 kg CH_4 head^{-1} year^{-1}. The difference between the EF and the IEF for the swine category is due to the reduction in CH_4 because of biogas recovery.

For reporting purposes, the VS daily excretion and Bo have been estimated by a procedure to verify the EF accuracy. The VS daily excretion has been estimated for each sub-category with the following parameters: animal number, production of slurry (t/a/t live weight) and the volatile solids content in the slurry (g VS/kg slurry w.b.). Methane producing potential (Bo) has been estimated with Equation 4.17 from the IPCC (2000).

Livestock category	Average weight (kg)	Breed live weight (t)	Methane emission rate with 8% emission reduction (nl CH_4/100 kg live weight)	Emission factor (kg CH_4 head^{-1} yr^{-1})
Other swine	**84**	**569,829**	**13,768**	**8.33**
20-50 kg	35	65,142	13,768	3.48
50-80 kg	65	98,279	13,768	6.46
80-110 kg	95	135,778	13,768	9.44
110 kg and more	135	264,089	13,768	13.41
Boar	200	6,543	13,768	19.86
Sow	**172**	**146,994**	**15,783**	**22.21**
Piglets	10	17,279	15,783	1.14
Sow	172.1	129,715	15,783	19.60
			TOTAL	**7.91**

Table 6.13 Methane manure management parameters and emission factors for swine in 2007

The fundamental characteristic of Italian swine production is the high live weight of the animals slaughtered as related to age; the optimum weight for slaughtering to obtain meat suitable for producing the typical cured meats is between 155 and 170 kg of live weight. Such a high live weight must be reached in no less than nine months of age. Other two specific characteristics which have to be considered are the feeding situation, 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 (Mordenti *et al.*, 1997). These peculiarities of Italian swine production influence the methane EF for manure management as well as nitrogen excretion factors used for the estimating of N_2O emissions.

Other livestock categories

Methane EFs used for calculating the other livestock categories are those proposed by IPCC. Since the yearly average temperature in Italy is 13 °C, EFs are characteristic of the "cold" climatic region (IPCC, 1997). In Table 6.14, the average methane EFs for cattle, buffalo and swine categories are shown. For the other categories, the EFs are as follows:

- rabbits, 0.080 kg CH_4 head^{-1} year^{-1}
- sheep, 0.22 kg CH_4 head^{-1} year^{-1}
- goats, 0.145 kg CH_4 head^{-1} year^{-1}
- horses, 1.48 kg CH_4 head^{-1} year^{-1}
- mules and asses, 0.84 kg CH_4 head^{-1} year^{-1}
- hen, 0.082 kg CH_4 head^{-1} year^{-1}
- broilers, 0.079 kg CH_4 head^{-1} year^{-1}
- other poultry, 0.079 kg CH_4 head^{-1} year^{-1}

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sows	Other swine
			kg CH_4 head^{-1} year^{-1} (*)		
1990	15.04	7.47	12.17	22.14	8.54
1991	15.04	7.61	11.94	22.03	8.42
1992	15.04	7.59	12.02	22.01	8.41
1993	15.04	7.59	11.93	22.05	8.43
1994	15.04	7.73	11.90	21.96	8.42
1995	15.04	7.82	11.95	21.96	8.52
1996	15.04	7.79	11.92	21.95	8.54
1997	15.04	7.70	11.90	22.05	8.34
1998	15.04	7.66	12.06	22.04	8.36
1999	15.04	7.72	12.12	22.12	8.44
2000	15.04	7.67	11.71	21.97	8.43
2001	15.04	7.72	13.74	22.20	8.55
2002	15.04	7.66	14.07	22.27	8.21
2003	15.04	7.69	12.98	22.19	8.20
2004	15.04	7.73	12.87	22.22	8.27
2005	15.04	7.78	12.29	22.30	8.35
2006	15.04	7.67	11.96	22.16	8.35
2007	15.04	7.77	11.97	22.21	8.33

(*) These are the EFs used for estimating methane emissions from manure management. They do not include CH_4 reduction.

Table 6.14 Average methane EF for manure management (kg CH_4 head^{-1} year^{-1})

Nitrous oxide emissions

Nitrous oxide emissions have been estimated with equation 4.18 from IPCC, as suggested in the IPCC (2000). Different parameters have been used for the estimation: number of livestock species, country-specific nitrogen excretion rates per livestock category, the fraction of total annual excretion per livestock category related to a manure management system and EFs for manure management systems (IPCC, 1997).

Liquid system, solid storage and other management systems (chicken-dung drying process system) have been considered according to their significance and major distribution in Italy. For these management systems, the following EFs have been used: 0.001 kg N_2O-N/kg N excreted, 0.02 kg N_2O-N/kg N excreted and 0.02 kg N_2O-N/kg N excreted, respectively (CRPA, 2000; CRPA, 1997[b]). The chicken-dung drying process system has been considered since 1995 since it has been significantly widespread in poultry breeding (CRPA, 2000; CRPA, 1997[b]).

When estimating emissions from manure management, the amount related to manure excreted while grazing is subtracted and reported in "Agricultural soils" under soil emissions - animal production (see Table 6.15). Since 2006 submission, different parameters such as the nitrogen excretion rates (CRPA, 2006[a]; GU, 2006; Xiccato *et al*., 2005), the slurry and solid manure production, and the average weight (CRPA, 2006[a]; GU, 2006; Regione Emilia Romagna, 2004) have been updated. In Table 6.15, nitrogen excretion rates used for the estimation of N_2O are shown. The nitrogen excretion rate for swine as reported in CRF submission 2009 is 11.67 kg head^{-1} yr^{-1}. This last parameter is a weighted average, where sow (28.2 kg head^{-1} yr^{-1}) and other swine (12.81 kg head^{-1} yr^{-1}) categories have been considered.

Livestock category	Average weight (kg)	N excreted Housing *(Ricoveri)* (kg head^{-1} yr^{-1})	N excreted Grazing *(Pascolo)* (kg head^{-1} yr^{-1})	TOTAL Nitrogen excreted (kg head^{-1} yr^{-1})
Non-dairy cattle	383	48.58	1.27	**49.84**
Dairy cattle	603	110.20	5.80	**116.00**
Buffalo	514	89.92	2.69	**92.61**
Other swine	84	12.81	0.00	**12.81**
Sow	172	28.18	0.00	**28.18 (*)**
Sheep	47	1.62	14.58	**16.20 (*)**
Goat	47	1.62	14.58	**16.20**
Horses	500	20.00	30.00	**50.00**
Mules and asses	300	20.00	30.00	**50.00**
Poultry	1.8	0.53	0.00	**0.53**
Rabbit	1.6	1.02	0.00	**1.02**

(*) average N excretion for swine is 11.67 kg head^{-1} yr^{-1}

Table 6.15 Average weight and nitrogen excretion rates in 2007

Since the 2006 submission, country-specific annual nitrogen excretion rates have been incorporated with information from the Inter-regional nitrogen balance project. The nitrogen balance project involved Emilia Romagna, Lombardia, Piemonte and Veneto regions, where animal breeding is concentrated. The nitrogen balance methodology was followed, as suggested by IPCC. As a result, estimations of nitrogen excretion rates[8] and net nitrogen arriving to the field[9] were obtained. In order to get reliable information on feed consumption and characteristics, and composition of the feed ratio, the project considered territorial and dimensional representation of Italian breeding. Final annual nitrogen excretion rates used for the UNFCCC/CLRTAP agriculture national inventory are reported in CRPA (2006[a]). In Table 6.16, nitrogen excretion rates for the main livestock categories are shown. For the other livestock categories nitrogen excretion is the same for the whole time series, as shown below:

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

The same N excretion rate has been applied for the whole time series, for the dairy cattle category. This figure is the result of a national inter-regional project on nitrogen balance, which is not possible to develop annually. Further explanation on the efforts to improve the modelling of N excretion is given in the following section 6.3.6.

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sows	Other swine
1990	116.0	50.00	93.94	28.10	13.13
1991	116.0	51.43	92.27	27.94	12.94
1992	116.0	50.97	92.89	27.92	12.93

[8] Nitrogen excretion = N consumed – N retained

[9] Net nitrogen to field= (N consumed – N retained) – N volatilized

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sows	Other swine
1993	116.0	50.82	92.24	27.97	12.97
1994	116.0	51.83	92.04	27.85	12.95
1995	116.0	49.86	92.42	27.86	13.10
1996	116.0	49.83	92.17	27.84	13.12
1997	116.0	49.81	92.04	27.98	12.82
1998	116.0	49.19	93.21	27.96	12.86
1999	116.0	49.62	93.68	28.06	12.98
2000	116.0	50.08	90.76	27.87	12.96
2001	116.0	50.69	105.23	28.17	13.14
2002	116.0	50.39	107.58	28.27	12.61
2003	116.0	50.53	99.82	28.16	12.60
2004	116.0	50.04	99.01	28.20	12.72
2005	116.0	49.76	94.91	28.30	12.84
2006	116.0	48.52	92.59	28.12	12.84
2007	116.0	49.84	92.61	28.18	12.81

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

Since the 2006 submission, new average weight data has been used for UNFCCC/CLRTAP agriculture national inventory. For a verification purpose, a time series reported by ISTAT in the yearbooks (animal weight before slaughter) has been collected (CRPA, 2006[a]). For the specific case of sheep and goats, a detailed analysis was applied with information coming from the National Association for Sheep Farming [10] (ASSONAPA, 2006). Then, to estimate the average weight for sheep and goat, breed distribution in Italy and consistency for each breed were considered (CRPA, 2006[a]; PROINCARNE, 2005). As mentioned before, slurry and solid manure production parameters were updated since the 2006 submission. These parameters consider characteristics from Italian breeding, for slurry and solid manure effluents, housing systems and the distribution for the different animal categories (CRPA, 2006[a]; Bonazzi *et al.*, 2005; APAT, 2004[a]; APAT, 2004[b]).

6.3.3. Uncertainty and time-series consistency

Uncertainty of CH_4 and N_2O emissions from manure management has been estimated equal to 102% for annual emissions, as a combination of 20% and 100% for activity data and emission factors, respectively.

In 2007, livestock CH_4 emissions from manure management were 11.7% (145.57 Gg CH_4) lower than in 1990 (164.86 Gg CH_4). From 1990 to 2007, dairy and non-dairy cattle livestock population decreased by 30.4% and 13%, respectively, whereas swine increased by 10.3%. Consequently, manure management emissions have mainly been driven down by the reduction in the number of cattle. We have to consider that cattle CH_4 emissions contribute with 38.7% (in 1990 with 47.3%) to total manure management emissions and swine with 41.4% (in 1990 with 41.4%). In Table 6.17, CH_4 emission trends from manure management are shown. These CH_4 emissions considered the reduction of CH_4 because of biogas recovery.

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

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sows	Other swine	Sheep	Goats	Horses	Mules and asses	Poultry	Rabbits	TOTAL
1990	39.74	38.18	1.15	14.41	53.78	1.90	0.18	0.43	0.07	13.82	1.19	**164.86**
1991	35.12	42.40	0.99	15.64	53.06	1.83	0.18	0.46	0.06	13.80	1.27	**164.82**
1992	32.26	41.15	1.24	15.20	51.18	1.84	0.20	0.47	0.05	13.77	1.31	**158.67**
1993	31.86	40.36	1.20	15.49	51.67	1.89	0.20	0.48	0.04	13.82	1.32	**158.32**
1994	29.93	39.40	1.29	14.70	49.50	2.17	0.24	0.48	0.04	14.24	1.35	**153.34**
1995	30.85	40.01	1.77	14.94	49.85	2.32	0.20	0.47	0.03	14.67	1.36	**156.48**
1996	30.88	39.14	2.04	15.73	50.08	2.38	0.21	0.46	0.03	14.57	1.39	**156.90**
1997	30.89	38.76	1.92	15.11	50.25	2.37	0.20	0.46	0.03	14.87	1.40	**156.26**
1998	31.52	38.00	2.25	15.44	50.46	2.37	0.19	0.43	0.03	15.85	1.41	**157.94**
1999	31.62	38.47	2.43	15.13	51.67	2.40	0.20	0.43	0.03	15.67	1.44	**159.48**
2000	30.80	37.92	2.25	15.42	51.14	2.41	0.20	0.41	0.03	14.09	1.42	**156.10**
2001	30.78	35.43	2.66	15.25	54.51	1.81	0.15	0.42	0.03	16.68	1.46	**159.18**
2002	28.17	34.54	2.61	16.40	53.46	1.77	0.14	0.41	0.02	16.39	1.48	**155.39**
2003	28.11	34.47	2.89	15.96	53.97	1.73	0.14	0.42	0.02	15.68	1.45	**154.84**
2004	26.73	33.38	2.70	15.57	52.58	1.76	0.14	0.41	0.02	15.27	1.69	**150.26**
2005	26.44	32.74	2.52	15.36	53.87	1.73	0.14	0.41	0.03	15.05	1.77	**150.06**
2006	25.21	30.31	2.76	15.73	52.04	1.79	0.14	0.42	0.03	14.18	1.74	**144.34**
2007	25.05	31.28	3.52	15.16	51.26	1.79	0.13	0.47	0.03	15.07	1.81	**145.57**

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

In 2007, N_2O emissions from manure management were 3.2% (12.25 Gg N_2O) lower than in 1990 (12.65 Gg N_2O). The major contribution is given by the solid storage system with 88.1% (in 1990 with 95.1%). In Table 6.18, N_2O emissions for the manure management systems are shown.

Year	Liquid system	Solid storage	Other	TOTAL
1990	0.62	12.03	0.00	**12.65**
1991	0.62	12.01	0.00	**12.63**
1992	0.59	11.50	0.00	**12.09**
1993	0.59	11.39	0.00	**11.98**
1994	0.57	11.37	0.00	**11.93**
1995	0.57	11.54	0.09	**12.20**
1996	0.56	11.61	0.17	**12.34**
1997	0.56	11.63	0.25	**12.44**
1998	0.56	11.72	0.42	**12.70**
1999	0.56	11.80	0.53	**12.89**
2000	0.54	11.36	0.56	**12.46**
2001	0.54	11.59	0.78	**12.90**
2002	0.52	11.04	0.84	**12.41**
2003	0.52	10.90	0.89	**12.31**
2004	0.51	10.64	0.89	**12.03**
2005	0.51	10.54	0.97	**12.02**
2006	0.50	10.22	0.95	**11.67**
2007	0.51	10.79	0.94	**12.25**

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

6.3.4. Source-specific QA/QC and verification

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

Category/sub category	**Parameter**	**Year of submission 2009**	**2010**	**Activities**
Livestock categories	Type of housing		v	A query on the type of housing of different livestock categories has been introduced in the Farm and structure survey 2005. Results need to be further analysed and are expected to be incorporated in a coming submission.
Livestock categories	Slurry and solid manure storage facilities		v	We expect to get more detailed data from the Farm and Structure Survey 2007, where a query related to storage facilities for slurry and solid manure have been incorporated.
Livestock categories	Production methods		v	Different queries have been incorporated in a specific section of the 2010 Agricultural Census. Grazing, housing, storage systems and land spreading information will be collected.
Livestock categories	Biogas	v		Data on biogas from 2007 has been collected (web site GSE)

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

6.3.5. Source-specific recalculations

In Table 6.20, parameters used for the 2009 submission are shown. Recalculations affected both CH_4 and N_2O emissions. A reduction of CH_4 occurred because of an update of biogas recovered for cattle and swine categories (see section 6.3.2).
For N_2O emissions, the liquid and solid manure production parameters have been updated for the years 2004 and 2006.

6.3.6. Source-specific planned improvements

A national publication describes how future agricultural surveys will contribute to improving the national agriculture emission inventory (Cóndor *et al*., 2005). We expect to analyse results obtained from the FSS 2005 which are related to the type of housing of cattle, swine and poultry categories. Results coming from the convention between ISPRA and the Ministry for the Environment, Land and Sea on the type of housing for swine and poultry have been already considered.
A new query on liquid and manure storage systems has been incorporated in the FSS 2007. Therefore, information from the FSS 2005 and FSS 2007 on housing and storage systems, respectively, will be analysed and updated in future submissions. Furthermore, we expect that in the Italian Agricultural Census 2010 detailed information on production systems will be obtained with and *ad hoc* survey. Finally, a specific research on land spreading practices has started in 2009.

For the dairy cattle category, the suggestions by the review process (UNFCCC, 2009) have been taken into consideration. For this category, the same N excretion rate is actually applied to the whole time series, but this figure is the result of a specific inter-regional project on nitrogen balance, which is not possible to develop annually. Nevertheless, we have tried to individuate a proper proxy variable, in collaboration with dairy-cattle breeding experts (CRPA, 2009), and information related to N excretion and milk production parameters has been acquired. At present, initial results do not supply reliable information to make a correlation between these parameters but we continue on consulting with experts in order to get more additional figures and individuate a way to model this information.

Livestock category			Average weight (kg) Submission 2009	N exretion (kgN head^{-1} yr^{-1}) Submission 2009
DAIRY CATTLE (*vacche da latte*)			603	116
NON- DAIRY CATTLE				
Less than 1 year (*)			213(**)	25.0 (**)
From 1 year - less than 2 years				
	Male	for reproduction	557	66.8
		for slaughter	557	66.8
	Female	for breeding	405	67.6
		for slaughter	444	53.3
From 2 years and more				
	Male	for reproduction	700	84.0
		for slaughter and work	700	84.0
	Female	Breeding heifer (*manze da allevamento*)	540	90.2
		Slaughter heifer (*manze da macello*)	540	64.8
		Other dairy cattle (*altre vacche)*	557	54.1
BUFFALO		Cow buffalo (*bufale*)	630	116
		Other buffaloes (*altri bufalini*)	313	52.2
OTHER SWINE	Weight less than 20 kg		10	
	From 20 kg weight and under 50 kg		35	5.3
	From 50 kg and more			
		Boar (*verri*)	200	30.5
		For slaughter (*macello*)		
		from 50 to 80 kg	65	9.9
		from 80 to 110 kg	95	14.5
		from 110 kg and more	135	20.6
SOW (*scrofe*)			172.1	28.2 (**)
SHEEP	Sheep (*pecore*)		51	16.2
	Other sheep (*altri ovini*)		21	16.2
GOAT	Goat (*capre*)		54	16.2
	Other goat (*altri caprini*)		15	16.2
EQUINE	Horses (*cavalli*)		550	50.0
	Mules and asses (*altri equine*)		300	50.0
POULTRY	Broilers (*polli da carne*)		1.2	0.36
	Hen (*galline da uova*)		1.8	0.66
	Other poultry (*atri avicoli*)		3.3	0.83
RABBIT	Female rabbits (f*attrici*)		4	2.5
	Other rabbit (*altri conigli*)		1.3	0.8

Table 6.20. Parameters used for the different livestock categories in 2009 submission
(*) Categories included in less than 1 year are: calf (*vitelli carne bianca*), fattening male cattle (*bovini maschi ingrasso*), fattening heifer (*manze ingrasso*) and heifer for replacement (*manze rimonta*);
(**) values are variable for the time series.

6.4. Rice cultivation (4C)

6.4.1. Source category description

For the rice cultivation category, only CH_4 emissions are estimated, other GHGs do not occur; N_2O from fertilisation during cultivation has been estimated and reported in "Agricultural soils" under direct soil emissions - synthetic fertilizers. In 2007, CH_4 emissions from rice cultivation were 72.52 Gg, which represents 9.8 % of CH_4 emissions for the agriculture sector (9.1% in 1990) and 4.0% for national CH_4 emissions (3.7% in 1990).
In Italy, CH_4 emissions from rice cultivation are estimated only for an irrigated regime, other categories suggested by IPCC (rainfed, deep water and "other") are not present. Methane emissions, reported in the CRF, represent two water regimes: the single aeration and multiple aeration categories, where CH_4 emissions were 12.93 Gg and 59.58 Gg, respectively.
In response to UNFCCC review processes from 2004 and 2005 (UNFCCC, 2005; 2004) and in consultation with an expert in CH_4 emissions and rice cultivation (Wassmann, 2005), a detailed methodology has been implemented. New activity data and parameters have been used for the estimation of CH_4 emissions for rice cultivation (Cóndor *et al*., 2007[a]). For this purpose, an expert group on rice cultivation together with the C.R.A. – Experimental Institute of Cereal Research – Rice Research Section of Vercelli was established. Different national experts from the rice cultivation sector were also contacted[11].
The quality of the Italian rice emission inventory has been verified with the DNDC[12] model. Initial results have found a high correspondence between the EFs used for the Italian inventory and those simulated with DNDC model (Leip and Bocchi, 2007).

6.4.2. Methodological issues

For the estimation of CH_4 emissions from rice cultivation a detailed methodology has been implemented following the IPCC guidelines (IPCC, 2006). We have considered country-specific circumstances, therefore, we have used an adjusted integrated emission factor (kg CH_4 $m^{-2}day^{-1}$), cultivation period of rice (days) and annual harvested area (ha) cultivated under specific conditions. Information of the cultivated surface is collected from 100% of rice farmers. Every year, data are collected timeliness by the *Ente Nazionale Risi* – ENR (National Rice Institute) (ENR, 2007). Later these data are published in the ENR web site and also provided to ISTAT. In the following box, information related to the collection of data is shown.

Parameters used for the calculation of CH_4 emissions from rice cultivation

Parameters	Reference
Cultivated surface with "dry -seeded" technique (%)	Centro Ricerche sul Riso, 2007
Cultivated surface – national (ha)	ISTAT, 2009[d]; ISTAT, several years [a],[b]; ENR, 2009
Cultivated surface by rice varieties (ha)	ENR, 2009
Cultivation period of rice varieties (days)	ENR, 2009
Methane emission factor (kg CH_4 m^{-2} d^{-1})	Leip *et al.*, 2002; Schutz *et al.*, 1989[a], [b]
Crop production (t yr^{-1})	ISTAT, several years [a],[b]; ISTAT, 2009[d]
Yield (t ha^{-1})	Estimations based on cultivated surface and crop production data
Straw incorporation (%)	Expert judgement (Tinarelli, 2005; Lupotto *et al.*, 2005)
Agronomic practices (%)	ISTAT, 2006[b]; Tinarelli, 2005; Lupotto *et al.*, 2005; Zavattaro et. al, 2004; Baldoni & Giardini, 1989; Tinarelli, 1973; 1986
Scaling factors (SFw, SFp, SFo)	IPCC, 2006; Yan et. al, 2005

[11] Stefano Bocchi, Crop Science Department (University of Milan); Aldo Ferrero, Department of Agronomy, Forestry and Land Management (University of Turin); Antonino Spanu, Department of agronomic science and agriculture genetics (University of Sassari).
[12] DNDC, Denitrification Decomposition model

Rice cultivation practice

In Italy, rice is sown from mid-April to the end of May and harvested from mid-September to the end of October; the only practised system is the controlled flooding system, with variations in water regimes (Regione Emilia Romagna, 2005; Mannini, 2004; Tossato & Regis, 2002). In Table 6.21, water regimes descriptions are presented. Normally, the aeration periods are very variable in number and time, depending on different circumstances, as for example, the type of herbicide, which is used (Baldoni & Giardini, 1989). Another water regime system, present in southern Italy, is the sprinkler irrigation, which exist only on experimental plots and could contribute to the diffusion of rice cultivation in areas where water availability is a limiting factor (Spanu *et al.*, 2004; Spanu & Pruneddu, 1996).

Type of seeding	**April**	**May**	**June**	**July**	**August**	**September -October**	**Description**
Wet-seeded "classic"	15-30 April Flooding and <u>wet-seeded</u> (*)	10 may	Herbicide treatment.	Fertilizer application (1/3), soil is saturated but not flooded. Panicle formation	Final aeration	Harvest	2 aeration periods during rice cultivation, as minimum, not including the final aeration IPCC classification: Intermittently flooded – <u>multiple aeration</u>
		1ºaeration - AR	2º aeration-AA		3º final aeration		
Wet-seeded "red rice control"	15 April Flooding and <u>wet-seeded</u> (*)	First application of herbicides, the soil is dry. Approximately, on 15 may flooding and after some days seeding	At the end of June, fertilization treatment	Fertilizer application (1/3), soil is saturated but not flooded. Panicle formation	Final aeration	Harvest	2 aeration periods during rice cultivation, as minimum, not including the final aeration. In some cases, between April and May, even 3 aeration periods are practised. IPCC classification: Intermittently flooded – <u>multiple aeration</u>
		1° aeration – AC Approx. after 10 days 2° aeration - AR	3ºaeration - AA		Final aeration		
Dry-seeded with delay flooding	15 April <u>Dry-seeded</u>	Approximately, on 15 may flooding	Herbicide treatment	Fertilizer application (1/3), soil is saturated but not flooded. Panicle formation		Harvest	1 aeration period during rice cultivation, as minimum, not including the final aeration. IPCC classification: Intermittently flooded – <u>single aeration</u>
			1º aeration-AA		2º final aeration		

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

(*) the first fertilization (2/3) during the initial part of the rice cultivation, generally on July there is a second period for the fertilization (1/3), normally there is no aeration during the second fertilization period. Aeration periods mostly last between 5-15 days and are classified as follows: AC= aeration to control red rice (*lotta al crodo*); AR = drained, aeration in order promote rice rooting, (*asciutta di radicamento*); AA= drained, tillering aeration (*asciutta di accestimento*).

In general, rice seeds are mechanically broadcasted in flooded fields. However, in Italy for the last 15 years, seeds are also drilled to dry soil in rows. The rice which has been planted in dry soil is generally managed as a dry crop until it reaches the 3-4 leaf stage. After this period, the rice is flooded and grows in continuous submersion, as in the conventional system (Ferrero & Nguyen, 2004; Russo, 1994).

During the cultivation period, water is commonly kept at a depth of 4-8 cm, and drained away 2-3 times during the season to improve crop rooting, to reduce algae growth and to allow application of herbicides. Rice fields are drained at the end of August to allow harvesting, once in a year (Ferrero & Nguyen, 2004; Baldoni & Giardini, 1989; Tinarelli, 1973; 1986).

Nitrogen is generally the most limiting plant nutrient in rice production and is subject to losses because of the reduction processes (denitrification) and leaching. Sufficient nitrogen should be applied pre-plant or pre-flood to assure that rice plant needs no additional nitrogen until panicle initiation or panicle differentiation stage. When additional nitrogen is required, it should be top-dressed at either of these plant stages or whenever nitrogen deficiency symptoms appear. The above-mentioned applications are usually used in two or three periods; the first period is always before sowing, that is on dry soil, while the others occur during the growing season (Russo, 2001; Russo, 1993; Russo *et al.*, 1990; Baldoni & Giardini, 1989).

In Italy, another type of fertilization practise is the incorporation of straw. The incorporation period can vary according to weather conditions, but probably mainly incorporated approximately one month before flooding (Russo, 1988; Russo 1976). Rice straw are often burned in the field, otherwise incorporated into the soil or buried. For other agronomic practice, a recent national publication has been considered for understanding fertilizer and crop residues management (Zavattaro *et al.*, 2004).

Methane emission factor

An analysis on recent and past literature, for the CH_4 daily emission factor (kg CH_4 m^{-2} d^{-1}), has been done. Different scientific publications related to the CH_4 daily emission factor measurements in Italian rice fields have been revised (Marik *et al.*, 2002; Leip *et al.*, 2002; Dan *et al.*, 2001; Butterbach-Bahl *et al.*, 1997; Schutz, 1989[a], [b]; Holzapfel-Pschorn & Seiler, 1986), other publications are indirectly related with CH_4 production (Kruger *et al.*, 2005; Weber *et al.*, 2001; Dannenberg & Conrad, 1999; Roy *et al.*, 1997). Butterbach-Bahl *et al.* have presented interesting results associated to the difference in EF of two cultivation periods (1990 and 1991). In these consecutive years, fields planted with rice cultivar Lido showed a level of CH_4 emissions 24-31% lower than fields planted with cultivar Roma. Marik *et al.* have published detailed information on agronomic practices (fertilized fields) related to measurements of CH_4 emission factor for years 1998 and 1999; values are similar to those presented in previous publications (Schutz, 1989[a], [b]; Holzapfel-Pschorn & Seiler, 1986). Leip *et al.*, have also published specific CH_4 emission factors for a particular agronomic practice, which has been presented in Table 6.21, the so called dry-seeded with delay flooding (*semina interrata a file*). The dry–seeded technique could bring interesting benefits in emission reduction, since experimentally it has been determined lower emission rates compared with a normal practice.

The estimation of CH_4 emissions for the rice cultivation category considers an irrigated regime, which includes intermittently flooded with single aeration and multiple aeration regimes. The CH_4 emission factor has been adjusted with the following parameters: daily integrated emission factor for continuously flooded fields without organic fertilizers, scaling factor to account for the differences in water regime in the rice growing season (*SFw*), scaling factor to account for the differences in water regime in the preseason status (*SFp*) and scaling factor which varies for both types and amount of amendment applied (*SFo*). Scaling factor parameters have been updated according to a recent publication (Yan *et al*., 2005) and new IPCC 2006 Guidelines (IPCC, 2006). Assumptions of agronomic practices are described in Table 6.21. Parameters used for CH_4 emission estimations are shown in Table 6.22.

Rice cultivation water regimes: Intermittently flooded	**Single aeration**	**Multiple aeration**	**Multiple aeration**
Type of seeding	Dry-seeded	Wet-seeded (classic)	Wet-seeded (*red rice control*)
Surface (ha)	46,773	87,840	93,897
Daily EF (g CH_4 m^{-2} d^{-1})	0.20	0.28	0.28
SFw	0.06	0.52	0.52
SFp	0.68	0.68	0.68
SFo	2.2	2.2	2.2
Adjusted daily EF (g CH_4 m^{-2} d^{-1})	0.18	0.21	0.21
Days of cultivation (days)	138	156	1556
Seasonal EF (g CH_4 m^{-2} yr^{-1})	24.48	33.16	33.16
Methane emissions (Gg)	**12.93**	**27.81**	**31.78**

Table 6.22 Parameters used for estimating CH_4 emissions from rice cultivation in 2007

6.4.3. Uncertainty and time-series consistency

Uncertainty of emissions from rice cultivation has been estimated equal to 20% as a combination of 3% and 20% for activity data and emissions factor, respectively.
In 2007, CH_4 emissions from rice cultivation were 2.5% (72.52 Gg CH_4) lower than in 1990 (74.39 Gg CH_4). In Italy, the driving force of CH_4 emissions from rice cultivation is the harvest area and the percentage of single aerated surface. Methane emissions have decreased by 2.5% and the harvest area has increased by 7.9%, from 215,442 ha $year^{-1}$ in 1990 to 232,549 ha $year^{-1}$ in 2007. The percentage of single aerated surfaces have increased from 1% (1990) to 22.7% (2007); therefore, emissions have verified a slow decrease. Water regime trends have been calculated together with expert judgement expertise (Tinarelli, 2005; Lupotto *et al*., 2005) and national available statistics (Centro Ricerche sul Riso, 2007). In Table 6.24, CH_4 emissions from rice cultivation and harvested area are shown.

6.4.4. Source-specific QA/QC and verification

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

Category/sub category	**Parameter**	**Year of submission 2009**	**2010**	**Activities**
Activity data	Days of cultivation and cultivars	v		Update data 2004, 2005, 2006 and collected 2007. Updated rice production statistics has been provided for the years 2004, 2005, 2006 (ENR, 2008)
Rice	Emission factor	v	v	We have contact DG Joint Research Centre Institute for Environment and Sustainability - Climate Change Unit, which have been in charge of measuring rice paddy fields in Italy. New measurements have been done in 2007 and 2008. Data is still not available.

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

6.4.5. Source-specific recalculations

In Table 6.24, CH_4 emission from 2007 and 2008 submissions are presented. Period of cultivation of rice varieties have been updated for the years 2003-2006. For the years 2004-2006 updated information on rice production has been provided (ENR, 2009).

Year	Harvested area ($10^9 m^2 yr^{-1}$)	Emissions 2008 submission (Gg)	Emissions 2009 submission (Gg)
1990	2.15	74.4	74.4
1991	2.06	71.1	71.1
1992	2.16	73.9	73.9
1993	2.32	77.5	77.5
1994	2.36	79.2	79.2
1995	2.39	78.9	78.9
1996	2.38	77.3	77.3
1997	2.33	76.9	76.9
1998	2.23	73.0	73.0
1999	2.21	71.3	71.3
2000	2.20	65.8	65.8
2001	2.18	65.8	65.8
2002	2.19	67.6	67.6
2003	2.20	69.6	69.7
2004	2.30	73.0	73.0
2005	2.24	70.0	70.1
2006	2.29	69.9	70.3
2007	2.33		72.5

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

6.4.6. Source-specific planned improvements

Lack of experimental data and knowledgement about the occurrence and duration of drainage periods in Italy is the major cause of uncertainty. Moreover, it is not easy to quantify the surface where the traditional or the different number of aerations is practiced, which depends on the degree and the type of infestation, and the positive or negative results of the herbicide treatment application (Spanu, 2006). In Table 6.21, a general classification has been done for the most common agronomic practices in Italy. Since the 2006 submission, a trend in water regime has been calculated together with expert judgement expertise (Tinarelli, 2005; Lupotto *et al.*, 2005) and available statistics (Centro Ricerche sul Riso, 2007). Provincial estimations on the basis of the relation between emissions and temperature would result in further possible improvements, even if enhancement would be limited since the largest Italian rice production is in the Po valley, where monthly temperatures of the rice paddies are similar. In 1990, *Piemonte* and *Lombardia* regions represented 94.8% of the national surface area of rice cultivation, while in 2006 they represented 93.9% (ENR, 2009; Confalonieri and Bocchi, 2005).

6.5. Agriculture soils (4D)

6.5.1. Source category description

In 2007, N_2O emissions from agricultural soils were 57.39 Gg, representing 82.4% of emissions for the agriculture sector (83.2% in 1990) and 55.9% for national N_2O emissions (52.0% in 1990). N_2O emissions from this source mainly consist of direct soil emissions with 28.04 Gg and indirect soil emissions with 24.28 Gg.
Direct N_2O emissions from agricultural soils are key sources at level and trend assessment, both with Tier 1 and Tier 2 approaches. Indirect N_2O emissions are key sources at level for Tier 1 and

Tier 2, and trend assessment (Tier 2). Animal Production is a key source at level and trend assessment with the Tier 2 approach, taking into account the uncertainty.
In Italy, agricultural soil emissions are estimated for direct and indirect soils and animal production. For direct soil emissions the following sources 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 under “Animal Production”.
ISPRA (former APAT) is in charge of collecting, elaborating and reporting the UNFCCC/CLRTAP agriculture national emission inventory (APAT, 2005), where consistent methodologies and parameters are used. Since the 2006 submission, the UNFCCC/CLRTAP inventory has updated country specific nitrogen excretion rates and EFs. Moreover, the nitrogen balance coming from the CLRTAP emission inventory feeds the UNFCCC inventory, specifically for the estimation of $FRAC_{GASM}$ and $FRAC_{GASF}$ parameters, used for calculating F_{AM} and F_{SN}.

6.5.2. Methodological issues

Methodologies used for estimating N_2O emissions from “Agricultural soils” follow the IPCC approach. Emission factors suggested by the IPCC (1997) and by the Research Centre on Animal Production (CRPA, 2000; CRPA, 1997[b]) have been used. Activity data used for estimations are shown in the following box.

Data used for estimating agricultural soil emissions

Data	Reference
Fertilizer distributed (t/yr)	ISTAT, 2009[c]; ISTAT, several years [a], [b]
Nitrogen content (%)	ISTAT, 2009[c]; ISTAT, several years [a], [b]
N excretion rates (kg head^{-1} yr^{-1})	CRPA, 2006[a]; GU, 2006; Xiccato *et al.*, 2005
Cultivated surface (ha yr^{-1})	ISTAT, 2009[d]; ISTAT, several years [a], [b]
Annual crop production (t yr^{-1})	ISTAT, 2009 [d]; ISTAT, several years [a], [b]
N fixed by type of species (kg N ha^{-1})	Erdamn,1959 in Giardini, 1983
Residue/crop product ratio by crop type	CESTAAT, 1988
Crop residue production (t dry matter ha^{-1}yr^{-1})	CRPA/CNR, 1992
Dry matter content by crop type	CRPA/CNR, 1992
Protein content in dry matter by crop type	CESTAAT, 1988
Livestock data	ISTAT, 2009[a]; ISTAT, several years [a], [b]

In Table 6.32 and Table 6.33, time series of cultivated surface and crop production used for the preparation of the inventory are shown. In Table 6.30 the time series of the N content from fertilizers are shown.

For estimating N_2O direct soil emissions, the IPCC approach has been followed, and some modifications have been included because of country-specific peculiarities (IPCC, 2000; IPCC, 1997). N_2O-N emissions have been estimated from the amount of synthetic fertilizers (F_{SN}), animal waste applied to soil (F_{AM}), crop residues (F_{CR}), N-fixing crops (F_{BN}) and cultivation of histosols (F_{OS}). Then default IPCC emission factors (IPCC, 2000) have been applied. Afterwards N_2O-N emissions were converted to N_2O emissions, multiplying by the 44/28 coefficient. Animal Production emissions have been estimated according to the methodology described in section 6.3.2, for manure management. Indirect emissions have been estimated as suggested by IPCC (1997). As requested in the review process (UNFCCC, 2005), a review of the $FRAC_{LEACH}$ parameter was done. Italy has verified that the IPCC default value is similar to the country specific reference value reported for the main regional basin authority - Po Valley (ADBPO, 2001; ADBPO, 1994).

Direct emissions

Synthetic fertilizers (F_{SN})

The total use of synthetic fertilizer (expressed in t N year^{-1}) has been estimated for each type of fertilizer (see Table 6.25). The calculation of synthetic fertilizer use (F_{SN}**)** has been obtained by multiplying the total use of fertilizer by (1- $FRAC_{GASF}$). $FRAC_{GASF}$ parameter has been estimated for the whole time series, following the IPCC definition where the total N-NH_3 and N-NOx emissions from fertilizers are divided by the total nitrogen content of fertilizers. N_2O emissions for synthetic fe rtilizers have been obtained multiplying F_{SN} by the emission factor 0.0125 kg N-N_2O/kg N (IPCC, 1997). In 2007, the total use of synthetic fertilizers was 760,063 t N, while F_{SN} parameter was 869,044 t N (see Table 6.27). In the 2007 submission, a specification for "Other nitrogenous fertilizers" was introduced (ENEA, 2006). This improvement has been introduced since 1998, because of activity data availability. In Table 6.30, the time series of N content from fertilizers is presented.

Type of fertilizers	Fertilizers distributed (t/yr)	Nitrogen content (%)	Total use of synthetic fertilizers (t N yr^{-1})
Ammonium sulphate	168,883	20.7%	35,039
Calcium cianamide	14,387	19.8%	2,847
Ammonium nitrate < 27%	369,152	22.4%	82,760
Ammonium nitrate > 27%	127,106	47.7%	60,646
Calcium nitrate	64,414	15.7%	10,120
Urea	732,213	46.0%	336,686
Other nitric nitrogen (*Altri azotati nitrico*)	146,247	27.0%	4,989
Other ammoniacal nitrogen (*Altri azotati ammoniacale*)	-	-	17,881
Other amidic nitrogenous (*Altri azotati ammidico*)	-	-	17,412
Phosphate nitrogen	382,757	14.5%	55,674
Potassium nitrogen	110,070	16.4%	18,047
NPK nitrogen	883,037	9.5%	83,694
Organic mineral	396,219	8.7%	34,277
TOTAL	**3,394,485**		**760,073**

Table 6.25 Total use of synthetic fertilizer in 2007 (t N yr^{-1})

Animal waste applied to soil (F_{AM})

The manure nitrogen corrected for NH_3 and NO_x emissions, excluding manure produced during grazing (kg N yr^{-1}), has been calculated with the IPCC methodology (IPCC, 1997), using country-specific nitrogen excretion rates (CRPA, 2006[a]; GU, 2006; Xiccato *et al.*, 2005). A country-specific $FRAC_{GASM}$ parameter has been estimated and used for the calculation of the animal waste applied to soil. In the 2009 submission $FRAC_{GASM}$(direct) and $FRAC_{GASM}$(indirect) have been reported (see Table 6.27). The estimation has followed the IPCC definition; therefore, the NH_3 and NO_x emissions from animal manure have been divided by the total nitrogen excreted. The F_{AM} (t yr^{-1}) value has been estimated by summing the F_{AM} for each livestock category; then emissions have been calculated with emission factor 0.0125 kg N-N_2O/kgN (IPCC, 1997). In 2007, F_{AM} parameter was 447,969 t N. In the 2009 submission the time series of F_{AM} has been updated due to a revision of CLRTAP-NH_3 agriculture inventory (see recalculation section 6.5.5).

N-fixing crops (F_{BN})
Nitrogen input from N-fixing crops (F_{BN}, kg N yr^{-1}) has been calculated with a country-specific methodology. Peculiarities that are present in Italy have been considered: N-fixing crops and legumes forage. F_{BN} has been calculated with two parameters: cultivated surface and nitrogen fixed per hectare (Erdamn 1959 in Giardini, 1983). Emissions have been calculated using the emission factor 0.0125 kg N_N2O/kgN (IPCC, 1997). In Table 6.26, cultivated surface from N-fixing species (ha yr^{-1}) and nitrogen fixed by each species (kg N ha^{-1} yr^{-1}) are presented. In 2007, F_{BN} parameter was 160,757 t N (time series Table 6.27).

Crop residues (F_{CR})
For the estimation of nitrogen input from crop residues (FCR), a country-specific methodology has been used. For all crops, the total amount of crop residues has been estimated (t dry matter yr-1), using the following parameters: annual crop production (t yr-1), residue/crop product ratio, and dry matter content by type of crop (%), while, when cultivated surface (ha) has been used as activity data, only the crop residue production (t dry matter ha-1 yr-1) parameter has been used to assess total amount of crop residues.
The nitrogen content from cereals, legumes, tubers and roots and legumes forages crop residues (t N yr-1) has been estimated multiplying the total amount of crop residue as dry matter by the reincorporated fraction (1- FRACBURN, where FRACBURN is the fraction of crop residue that is burned rather than left on field equal to 0.1 kg N/kg crop-N), and the nitrogen content for each crop type. The nitrogen content has been obtained converting protein content in dry matter, dividing by factor 6.25. The FCR parameter has been obtained by adding the nitrogen content of cultivars crop residues. In 2007, FCR parameter was 124,377 t N (see Table 6.27). Emissions are calculated with emission factor 0.0125 kg N-N2O/kg N (IPCC, 1997). The time series of crop residues production is shown in Table 6.32.

	Nitrogen fixed	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**
	(kg N ha^{-1} yr^{-1})	(ha)					
Bean, fresh seed (*fagiolo*)	40	29,096	23,943	23,448	23,146	22,017	22,130
Bean, dry seed (*fagiolo*)	40	23,002	14,462	11,046	8,755	8,179	6,923
Broad bean, fresh seed (*fava*)	40	16,564	14,180	11,998	9,484	9,694	9,792
Broad bean, dry seed (*fava*)	40	104,045	63,257	47,841	48,507	44,617	49,972
Pea, fresh seed (*pisello*)	50	28,192	21,582	11,403	11,636	12,589	11,805
Pea, dry seed (*pisello*)	72	10,127	6,625	4,498	11,134	13,625	12,957
Chickpea (*cece*)	40	4,624	3,023	3,996	5,256	5,188	5,299
Lentil (*lenticchia*)	40	1,048	1,038	1,016	1,786	1,738	1,806
Tare (*veccia*)	80	5,768	6,532	6,500	6,500	6,500	6,500
Lupin (*lupino*)	40	3,303	3,070	3,000	3,000	3,000	3,000
soya bean (*soia*)	58	521,169	195,191	252,647	152,331	176,134	130,335
Alfalfa (*erba medica*)	194	987,000	823,834	810,866	779,430	766,316	705,370
Clover grass (*trifoglio*)	103	224,087	125,009	114,844	103,677	101,499	98,772
TOTAL		**1,958,025**	**1,301,746**	**1,307,102**	**1,164,642**	**1,171,097**	**1,064,660**

Table 6.26. Cultivated surface and nitrogen fixed by each variety

Cultivation of histosols (F_{os})

In Italy, the area of organic soils cultivated annually (histosols) is estimated to be 9,000 hectares (CRPA, 1997[b]). This value has been multiplied by 8 kg $N\text{-}N_2O$ ha^{-1} yr^{-1}, as suggested by 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 in Florence (ISSDS). These values have been verified with related data for Emilia Romagna region, where this type of soil is most prevalent.

Year	F_{SN} (t N)	F_{AM} (t N)	F_{BN} (t N)	F_{CR} (t N)	F_{os} (ha)	$FRAC_{GASF}$	$FRAC_{GASM}$ (direct)	$FRAC_{GASM}$ (indirect) (*)
1990	691,723	473,804	254,654	147,541	9,000	0.087	0.319	0.328
1991	764,911	473,328	240,032	149,041	9,000	0.087	0.319	0.328
1992	808,237	454,552	228,560	152,456	9,000	0.086	0.315	0.324
1993	860,390	451,435	211,235	141,823	9,000	0.090	0.311	0.321
1994	795,479	445,199	201,884	141,799	9,000	0.091	0.301	0.311
1995	726,343	453,400	191,018	142,216	9,000	0.089	0.298	0.308
1996	691,890	454,385	190,601	145,826	9,000	0.085	0.295	0.305
1997	782,973	456,905	194,257	147,351	9,000	0.086	0.293	0.303
1998	703,640	463,906	202,718	150,090	9,000	0.089	0.292	0.302
1999	716,405	469,741	191,722	150,228	9,000	0.091	0.290	0.300
2000	715,366	457,670	189,545	0	9,000	0.089	0.286	0.296
2001	737,063	467,276	182,928	137,779	9,000	0.089	0.299	0.307
2002	745,286	453,088	177,529	142,457	9,000	0.090	0.297	0.305
2003	750,296	452,633	175,154	119,184	9,000	0.090	0.295	0.304
2004	765,064	440,978	172,532	143,172	9,000	0.091	0.294	0.302
2005	710,888	440,822	176,624	145,247	9,000	0.088	0.293	0.302
2006	710,021	431,635	175,243	128,431	9,000	0.092	0.290	0.299
2007	689,044	447,969	160,575	124,377	9,000	0.093	0.292	0.301

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

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

Animal production

As mentioned in section 6.3.2, when estimating N_2O emissions from manure management, the amount related to manure excreted while grazing is subtracted and reported in "Agricultural soils" under animal production. In Table 6.15, nitrogen excretion rates (kg $head^{-1}yr^{-1}$) used for estimations are presented. Nitrous oxide emissions are estimated with the total nitrogen excreted from grazing (include all livestock categories), number of animals, and an EF of 0.02 kg N_2O-N/kg N excreted (IPCC, 1997).

Indirect emissions

For indirect emissions from agricultural soils the following parameters have been estimated:

- Atmospheric deposition
- Nitrogen leaching and run-off

The estimation of N_2O emissions due to atmospheric deposition of NH_3 and NO_x has followed the IPCC approach (IPCC, 1997). Parameters which have been used are: total use of synthetic fertilizer, t N yr^{-1}, $FRAC_{GASF}$ emission factor, total N excreted by livestock (kg $head^{-1}yr^{-1}$), $FRAC_{GASM}$ emission factor (see Table 6.27) and emission factor 0.01 kg N_2O-N per kg NH_3-N + NO_x-N emitted (IPCC, 2000; IPCC, 1997).
The estimation of N_2O emissions due to nitrogen leaching and run-off has followed the IPCC approach (IPCC, 1997). Parameters which have been used are: total use of synthetic fertilizer, t N yr^{-1} (see Table 6.25), total N excreted by livestock (kg $head^{-1}$ yr^{-1}), $FRAC_{LEACH}$ emission factor 0.3 N/kg nitrogen of fertilizer or manure and the emission factor 0.025 Kg N_2O-N per kg nitrogen leaching/run-off (IPCC, 2000; IPCC, 1997). As mentioned above, the $FRAC_{LEACH}$ IPCC default value has been compared with the country specific $FRAC_{LEACH}$ (ADBPO, 2001; ADBPO, 1994).
In the 2009 submission the time series of for Atmospheric deposition has been updated due to a revision of CLRTAP-NH_3 agriculture inventory (see recalculation section 6.5.5).

6.5.3. Uncertainty and time-series consistency

Uncertainty for N_2O emissions from agricultural soils (direct soil emissions, indirect soil emissions and animal production) has been estimated to be 102%, as combination of 20% and 100% for activity data and emission factor, respectively. In the Table 6.28, time series of N_2O emission are reported.

Year	Direct Soil Emissions	Animal Production	Indirect Soil emissions	TOTAL
		Gg		
1990	30.91	5.60	26.19	**62.69**
1991	32.08	5.45	27.10	**64.63**
1992	32.40	5.47	27.10	**64.97**
1993	32.82	5.59	27.85	**66.25**
1994	31.23	6.27	26.97	**64.48**
1995	29.83	6.44	26.12	**62.39**
1996	29.24	6.58	25.52	**61.34**
1997	31.18	6.52	26.83	**64.53**
1998	29.98	6.50	25.85	**62.33**
1999	30.13	6.59	26.21	**62.93**
2000	29.71	6.60	25.74	**62.06**
2001	30.07	5.18	25.64	**60.89**
2002	29.94	5.03	25.27	**60.24**
2003	29.52	4.93	25.22	**59.68**
2004	30.00	4.98	25.15	**60.14**
2005	29.06	4.90	24.21	**58.17**
2006	28.50	5.02	24.08	**57.60**
2007	28.04	5.06	24.28	**57.39**

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

In 2007, N_2O emissions from agricultural soils were 8.5% (57.39 Gg N_2O) lower than in 1990 (62.69 Gg N_2O). In 2007, major contributions come from direct soil emissions (28.04 Gg) and indirect soil emissions (24.28 Gg). Indirect N_2O emissions from nitrogen leaching and run-off sub-category has the highest individual contribution with respect to total 4D N_2O emissions (19.10 Gg N_2O; 33%). N_2O emissions from leaching and run-off are related to the nitrogen content in

fertilizers and animal wastes. Therefore, emissions are mainly linked to the use of fertilizers and the trend of livestock number.
In 2007, the second individual source with respect to total N_2O emissions was the direct emissions of synthetic fertilizers with 13.53 Gg (23.6%), followed by animal wastes applied to soils, with 8.80 Gg (15.3%). In Table 6.29, a time series of N_2O emissions is presented. We should highlight that between 1996 and 1997 there has been a high increase in nitrogen fertilizers in Italy, then emissions from N_2O could be identified as outlier (see Table 6.30).

Year	Direct N_2O emissions					Animal Production	Indirect N_2O emissions	
	Synthetic fertilizer	Animal Wastes Applied to Soils	N-fixing Crops	Crop Residue	Cultivation of Histosols		Atmospheric Deposition	Nitrogen Leaching and Run-off
			(Gg)			(Gg)	(Gg)	
1990	13.59	9.31	5.00	2.90	0.11	5.60	5.97	20.22
1991	15.03	9.30	4.71	2.93	0.11	5.45	6.03	21.07
1992	15.88	8.93	4.49	2.99	0.11	5.47	5.86	21.23
1993	16.90	8.87	4.15	2.79	0.11	5.59	5.94	21.91
1994	15.63	8.74	3.97	2.79	0.11	6.27	5.77	21.20
1995	14.27	8.91	3.75	2.79	0.11	6.44	5.66	20.45
1996	13.59	8.93	3.74	2.86	0.11	6.58	5.52	20.00
1997	15.38	8.97	3.82	2.89	0.11	6.52	5.65	21.18
1998	13.82	9.11	3.98	2.95	0.11	6.50	5.58	20.27
1999	14.07	9.23	3.77	2.95	0.11	6.59	5.64	20.57
2000	14.05	8.99	3.72	2.84	0.11	6.60	5.46	20.28
2001	14.48	9.18	3.59	2.71	0.11	5.18	5.48	20.16
2002	14.64	8.90	3.49	2.80	0.11	5.03	5.34	19.93
2003	14.74	8.89	3.44	2.34	0.11	4.93	5.30	19.92
2004	15.03	8.66	3.39	2.81	0.11	4.98	5.23	19.92
2005	13.96	8.66	3.47	2.85	0.11	4.90	5.08	19.13
2006	13.95	8.48	3.44	2.52	0.11	5.02	5.05	19.03
2007	13.53	8.80	3.15	2.44	0.11	5.06	5.18	19.10

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

6.5.4. Source-specific QA/QC and verification

Synthetic fertilizers and nitrogen content are compared with the international FAO agriculture database statistics (FAO, 2009). In Table 6.30, national and FAO time series of total nitrogen applied are reported. Differences between national data and FAO database are related to the difference in data elaboration (ISTAT, 2004) and could be attributed to different factors. First, national data are more disaggregated by substance than FAO data and the national nitrogen content is considered for each substance, while FAO utilises default values. Besides, differences could also derive from different products classification. In Table 6.31, activity data used for N_2O estimations have been provided. In Table 6.32, the QA/QC plan for this category is presented.

6.5.5. Source-specific recalculations

Updates of N_2O emissions occurred due to the revision of NH_3 estimates for the CLRTAP-NH_3 agriculture inventory. Emission factors for cattle and buffalo for estimating N-NH_3 emissions from the spreading phase have been revised. Consequently, the fraction of livestock nitrogen excretion that volatilizes as NH_3 and NO_x from the CRLTAP-NH_3 inventory has changed. This update is linked to the UNFCCC inventory, then N_2O emissions, for the sub-categories animal waste applied to soil and atmospheric deposition (volatized nitrogen from fertilizers, animal manures and other), have changed.

Year	National data (t N)	FAO database (Nitrous fertilizer consumption, Mt)
1990	757,509	878,960
1991	837,402	906,720
1992	884,121	910,000
1993	945,290	917,900
1994	875,536	879,200
1995	797,500	875,000
1996	756,057	876,000
1997	856,945	855,000
1998	772,227	845,000
1999	788,243	868,000
2000	785,593	828,000
2001	808,964	773,161
2002	819,352	785,314
2003	824,649	Not available
2004	841,363	Not available
2005	779,846	Not available
2006	781,824	Not available
2007	760,073	Not available

Table 6.30 Total annual N content in fertilizer applied from 1990 to 2006

Year	Cultivated surface (ha)	Crop production (t)	Total residue production (dry matter)
1990	2,128,674	82,247,958	20,719,032
1991	1,945,347	83,683,020	21,282,647
1992	1,831,020	86,462,112	21,505,656
1993	1,623,307	80,844,539	20,516,890
1994	1,568,346	81,267,156	20,465,054
1995	1,484,453	81,343,949	20,466,710
1996	1,484,242	83,163,618	21,302,559
1997	1,548,889	83,792,787	20,778,350
1998	1,622,647	84,466,234	21,453,885
1999	1,494,345	87,413,587	21,412,200
2000	1,491,315	82,090,948	20,685,353
2001	1,438,578	77,979,120	19,813,878
2002	1,350,329	82,289,945	20,647,499
2003	1,338,109	66,503,842	17,301,569
2004	1,314,187	81,403,175	21,351,753
2005	1,338,663	84,706,239	20,800,493
2006	1,352,385	71,186,530	19,239,493
2007	1,242,481	67,956,014	18,761,665

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

Year of submission	Activities

		Year of submission 2009	2010	Activities
Direct emissions	Sewage sludge		v	A new study is being carried out for the land spreading category. We expect results for the end of 2009. Italy is aware that sewage sludge is applied to soils but no reliable information is available to estimate emissions in the agriculture sector. Currently, the total amount of nitrogen present in the sewage sludge and its emissions are estimated in the waste sector
Activity data	Fertilizer		v	Verify outcomes from ISPRA/MINAMBIENTE project for the use of slow release fertilizers.

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

6.5.6. Source-specific planned improvements

Italy is aware that sewage sludge is applied to soils but no reliable information is available to estimate emissions in the agriculture sector. Anyway, the total amount of nitrogen present in the sewage sludge and its emissions are estimated in the waste sector (section 8.3, CRF 6B).

6.6. Field burning of agriculture residues (4F)

6.6.1. Source category description

Methane and nitrous oxide emissions from field burning agriculture residues have not been identified as a key source. In 2007, CH_4 emissions from this source were 0.61 Gg, which represents only 0.082% of emissions for the agriculture sector. N_2O emissions were 0.013 Gg, which represents 0.019% of emissions for the agriculture sector.

6.6.2. Methodological issues

A country-specific methodology has been used for estimating emissions from field burning of agriculture residues. Different IPCC parameters have been considered, such as amount of residues produced, amount of dry residues, total biomass burned, and total carbon and nitrogen released. Activity data used for estimating burning of agriculture residues have been summarised in the following box (see Table 6.33).

Data used for estimating field burning of agriculture residues emission

Data	Reference
Annual crop production	ISTAT, 2009[d]; ISTAT, several years [a], [b]
Removable residues/product ratio	CESTAAT, 1988
Fixed residues/removable residues ratio	ENEA, 1994
Fraction of dry matter in residues	IPCC, 1997; CRPA/CNR, 1992; CESTAAT, 1988; Borgioli, 1981
Fraction of the field where “fixed” residues are burned	ANPA-ONR, 2001; CESTAAT, 1988; IPCC, 1997
Fraction of residues oxidized during burning	IPCC, 1997
Fraction of carbon from the dry matter of residues	IPCC, 1997
Raw protein content from residues (dry matter fraction)	CESTAAT, 1988; Borgioli, 1981
IPCC Default Emission rates (CH_4, N_20)	IPCC, 1997

The same methodology has been used to estimate emissions from burning of agriculture residues, fixed and removable, but they are 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 waste sector (waste incineration- 6C category).

Year	Wheat	Barley	Maize	Oats	Rye	Rice	Sorghum
1990	8,108,500	1,702,500	5,863,900	298,400	20,800	1,290,700	114,200
1991	9,415,700	1,792,900	6,237,700	359,400	18,800	1,235,600	149,500
1992	8,938,400	1,742,087	7,394,100	333,100	22,586	1,271,600	178,700
1993	8,169,800	1,634,200	8,028,900	372,200	22,800	1,305,100	226,800
1994	8,251,401	1,467,378	7,483,438	354,660	20,295	1,360,519	236,060
1995	7,946,081	1,387,069	8,454,164	301,322	19,780	1,320,851	214,802
1996	8,424,492	1,350,494	9,547,541	351,622	20,400	1,359,697	209,191
1997	6,758,351	1,179,575	10,004,700	310,706	19,000	1,442,400	173,570
1998	8,338,301	1,359,076	9,054,600	362,627	20,100	1,407,100	159,872
1999	7,742,782	1,313,323	10,017,178	331,150	12,363	1,427,130	202,370
2000	7,427,660	1,261,560	10,139,639	317,926	10,292	1,245,555	215,200
2001	6,413,329	1,125,720	10,556,185	310,087	8,588	1,272,952	213,992
2002	7,547,763	1,190,326	10,554,423	328,759	9,631	1,378,796	215,072
2003	6,229,454	1,020,838	8,702,289	306,425	6,941	1,448,212	158,217
2004	8,638,721	1,156,620	11,368,007	337,694	7,851	1,525,509	215,394
2005	7,717,129	1,214,054	10,427,930	429,153	7,876	1,444,818	184,915
2006	7,181,720	1,297,395	9,626,373	394,866	8,590	1,449,973	221,392
2007	7,170,180	1,225,282	9,809,265	361,147	8,953	1,540,097	193,243

Table 6.33 Time series of activity data used for field burning of agricultural residues (t)

The methodology for estimating emissions refers to fixed residues burnt. The same steps have been followed to calculate emissions from removable residues burnt reported in 6C. Parameters taken into consideration are the following:

a) Amount of "fixed" burnable residues[13] (t), estimated with annual crop production, removable residues/product ratio, and "fixed" residue/removable residues ratio.
b) Amount of dry residues in "fixed" residue[14] (t dry matter), calculated with amount of burnable residues and fraction of dry matter.
c) Amount of "fixed" dry residues oxidized[15] (t dry matter), assessed with amount of dry residues in the "fixed" residues, fraction of the field where "fixed" residues are burned, and fraction of residues oxidized during burning.
d) Amount of carbon from stubble burning release in air[16] (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[17] (t C-CH_4), calculated with the amount of carbon from stubble burning release in air and default emissions rate for C-CH_4, equal to 0.005 (IPCC, 1997).

In 2007, final CH_4 emissions from on field burning of agriculture residues (0.61 Gg CH_4) have been estimated multiplying the C-CH_4 value (0.459 Gg C-CH_4) by the coefficient 16/12. In Table 6.34, parameters used for the estimation of CH_4 emissions from on field burning of agriculture residues are shown.

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

Crop	Annual crop production (t 1000)	Amount of "fixed" burnable residues (t 1000)	Amount of dry residue in the "fixed" residues (t 1000 dry matter)	Amount of "fixed" dry residues oxidized (t 1000 dry matter)	Amount of carbon from stubble burning (t 1000 C)	C-CH_4 from stubble burning (t C-CH_4)
Wheat (*frumento*)	7,170	1,237	1,055	92	45	224
Rye (*segale*)	9	2	1	0	0	0
Barley (*orzo*)	1,225	245	210	19	7	35
Oats (*avena*)	361	63	54	5	2	10
Rice (*riso*)	1,540	258	194	87	36	180
Maize (*granoturco*)	9,809	981	409	0	0	0
Sorghum (*sorgo da granella*)	193	68	56	5	2	9
TOTAL	**20,308**	**2,853**	**1,979**	**208**	**92**	**459**

Table 6.34 Parameters used for the estimation of CH_4 emissions from agriculture residues in 2007

For estimating N_2O emissions, the same amount of "fixed" dry residue oxidized described above has been used; further parameters are:

a) Amount of nitrogen from stubble burning release in air[18] (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[19] (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 2007, final N_2O emissions from on field burning of agriculture residues (0.013 Gg N_2O) are estimated by multiplying the N-N_2O value (0.008 Gg N) with the coefficient 44/28. Table 6.35 shows parameters for the estimation of CH_4 emissions from field burning of agriculture residues.

Crop	Amount of "fixed" dry residue oxidized (t 1000 dry matter)	Raw protein content from residues (dry matter fraction)	Fraction of nitrogen from the dry matter of residues	Amount of nitrogen from stubble burning (t 1000 N)	N-N_2O from stubble burning (t N-N_2O)
Wheat (*frumento*)	92	0.030	0.005	0.443	3.1
Rye (*segale*)	0	0.036	0.006	0.001	0.0
Barley (*orzo*)	19	0.037	0.006	0.112	0.8
Oats (*avena*)	5	0.04	0.006	0.031	0.2
Rice (*riso*)	87	0.041	0.007	0.571	4.0
Maize (*granoturco*)	0		0.007	0.000	0.0
Sorghum (*sorgo da granella*)	5	0.037	0.006	0.030	0.2
TOTAL	**208**			**1.188**	**8.3**

Table 6.35 Parameters used for the estimation of nitrous oxide from agriculture residues in 2007

6.6.3. Uncertainty and time-series consistency

Uncertainties for CH_4 and N_2O emissions from field burning of agriculture residues are estimated to be 54% as a result of 50% and 20% for activity data and emission factor, respectively. In 2007, CH_4

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

emissions from field burning of agriculture residues were 0.61 Gg CH_4 and N_2O emissions were 0.013 Gg N_2O (see Table 6.36). Variation in emissions trend is related to cereal production trends.

Year	CH_4 (Gg)	N_2O (Gg)
1990	0.623	0.013
1991	0.677	0.014
1992	0.662	0.014
1993	0.635	0.013
1994	0.641	0.013
1995	0.616	0.013
1996	0.642	0.013
1997	0.575	0.012
1998	0.643	0.013
1999	0.621	0.013
2000	0.578	0.012
2001	0.534	0.011
2002	0.601	0.013
2003	0.546	0.012
2004	0.669	0.014
2005	0.621	0.013
2006	0.604	0.013
2007	0.612	0.013

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

6.6.4. Source-specific QA/QC and verification

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

6.6.5. Source-specific recalculations

For the years 2004-2006 updated information on rice production has been provided (ENR, 2009).

6.6.6. Source-specific planned improvements

No specific improvements are planned.

Chapter 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 70.9 Mt of CO_2 removals from the atmosphere in 2007.
The 2003 IPCC Good Practice Guidance for LULUCF has been entirely applied for all the categories of this sector as detailed data were available from national statistics and from researches at national and regional level, whereas for category 5A (Forest Land) estimates were supplied by a growth model, applied to national forestry inventory data, with country specific used emission factors.

CO_2 emissions from forest fires have been included in the calculation of the net carbon stocks reported in 5A.
Greenhouse gas removals and emissions in the main categories of the LULUCF sector in 2007 are shown in Figure 7.1:

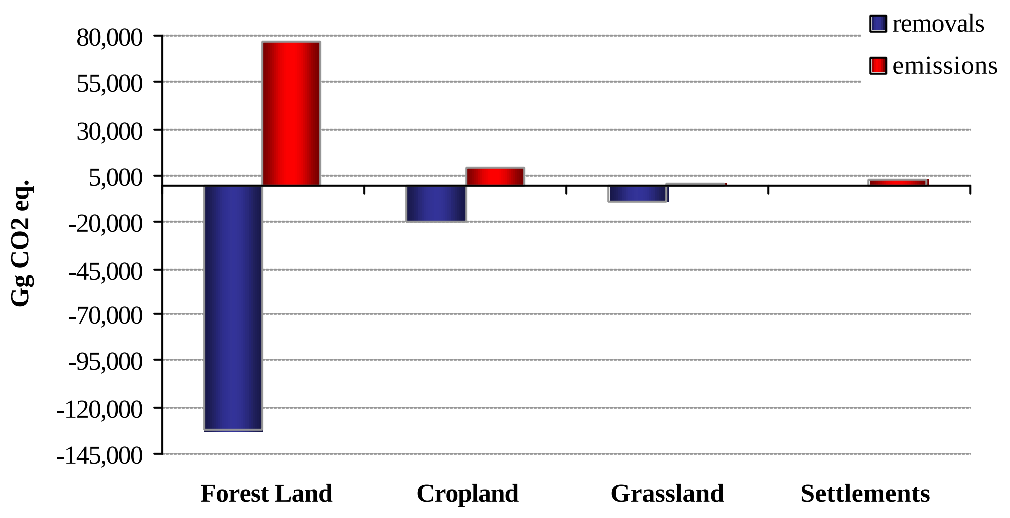


Figure 7.1 Greenhouse gas removals and emissions in LULUCF sector in 2007 [Gg CO_2 eq.]

In Table 7.1 emissions and removals time series is reported.

GHG Gas Source and Sink Categories	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
CO_2	**-67,651**	**-85,816**	**-79,326**	**-92,672**	**-95,683**	**-126,870**	**-91,878**	**-95,374**	**-90,136**	**-71,127**
A. Forest Land	-53,549	-77,555	-70,452	-79,009	-85,423	-74,789	-80,933	-83,523	-84,194	-55,588
B. Cropland	-16,876	-10,406	-11,697	-10,956	-11,544	-11,085	-8,881	-10,155	-8,087	-10,960
C. Grassland	-385	NO	-387	-5,911	-1,918	-44,161	-5,224	-4,849	NO	-7,760
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	3,160	2,145	3,210	3,204	3,202	3,165	3,160	3,153	2,145	3,181
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CH_4	**142.89**	**27.37**	**87.00**	**55.19**	**30.93**	**64.97**	**34.62**	**34.16**	**30.62**	**196.75**
A. Forest Land	142.89	27.37	87.00	55.19	30.93	64.97	34.62	34.16	30.62	196.75
B. Cropland	0	0	0	0	0	0	0	0	0	0
C. Grassland	0	0	0	0	0	0	0	0	0	0
D. Wetlands	0	0	0	0	0	0	0	0	0	0
E. Settlements	0	0	0	0	0	0	0	0	0	0
F. Other Land	0	0	0	0	0	0	0	0	0	0
G. Other	0	0	0	0	0	0	0	0	0	0
N_2O	**14.50**	**199.00**	**8.83**	**5.60**	**3.14**	**6.59**	**3.51**	**3.47**	**301.62**	**19.97**
A. Forest Land	14.50	2.78	8.83	5.60	3.14	6.59	3.51	3.47	3.11	19.97
B. Cropland	0	196.23	0	0	0	0	0	0	298.51	0
C. Grassland	0	0	0	0	0	0	0	0	0	0
D. Wetlands	0	0	0	0	0	0	0	0	0	0
E. Settlements	0	0	0	0	0	0	0	0	0	0
F. Other Land	0	0	0	0	0	0	0	0	0	0
G. Other	0	0	0	0	0	0	0	0	0	0
LULUCF (*Gg CO2 equivalent*)	**-67,493**	**-85,590**	**-79,230**	**-92,611**	**-95,649**	**-126,798**	**-91,840**	**-95,336**	**-89,804**	**-70,910**

Table 7.1 Trend in greenhouse gas emissions from the LULUCF sector in the period 1990-2007

CO_2 emissions and removals in LULUCF sector, in the period 1990-2007, are shown in the figure 7.2:

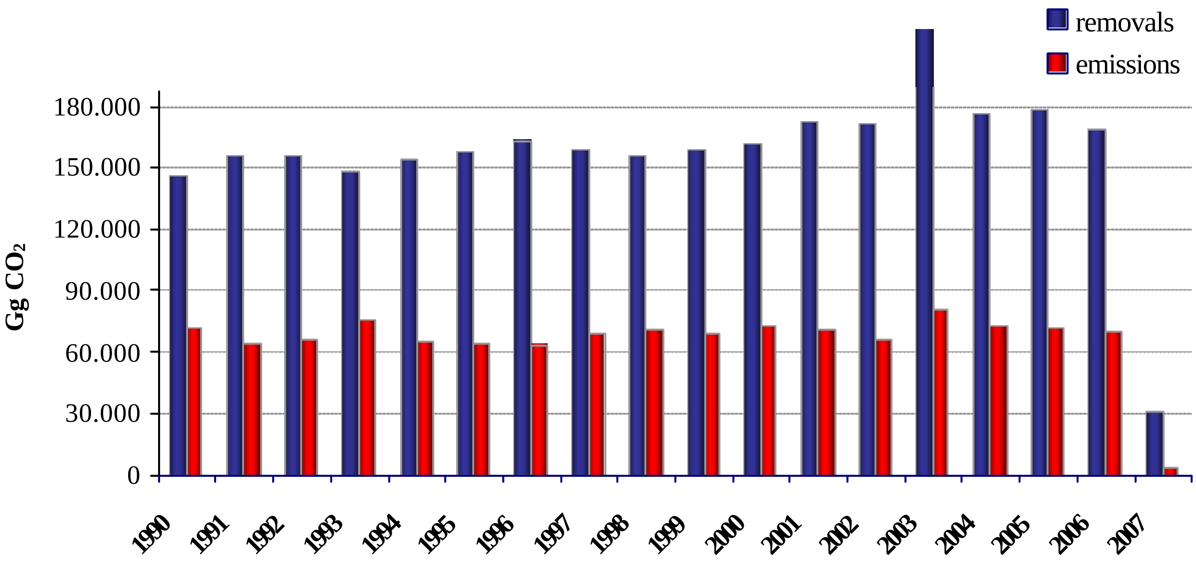


Figure 7.2 CO_2 removals and emissions in LULUCF sector in the period 1990-2007 [Gg CO_2]

The outcome of the key category analysis for 2007, according to a level and/or trend assessment (*IPCC Tier 1 and Tier 2 approaches*), is listed in the Table 7.2. CO_2 emissions and removals from forest land remaining forest land, conversion to forest land, cropland remaining cropland, conversion to cropland, land converted to grassland and land converted to settlements have been identified as key sources or sinks. Concerning CH_4 or N_2O emissions, no categories have resulted as a key source.

	gas	*categories*	2007
5.A.1	CO_2	Forest land remaining forest land	key (L, T)
5.A.2	CO_2	Land converted to forest land	key (L2, T2)
5.B.1	CO_2	Cropland remaining cropland	key (L, T)
5.B.2	CO_2	Land converted to cropland	Non-key
5.C.1	CO_2	Grassland remaining Grassland	Non-key
5.C.2	CO_2	Land converted to Grassland	key (L, T)
5.D	CO_2	Wetlands	Non-key
5.E	CO_2	Settlements remaining Settlements	Non-key
5.E	CO_2	Land converted to Settlements	key (L,T2)
5.A.1	CH_4	Forest land remaining forest land	Non-key
5.A.1	N_2O	Forest land remaining forest land	Non-key
5.B.2	N_2O	Land converted to cropland	Non-key

Table 7.2 Key categories identification in LULUCF sector

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

LUC matrices for each year of the period 1990–2007 have been assembled based on time series of national land use statistics for forest lands, croplands, grasslands, wetlands and settlement areas. Annual figures for areas in transition between different land uses have been derived by a hierarchy of basic assumptions (informed by expert judgement) of known patterns of land-use changes in Italy as well as the need for the total national area to remain constant. Growth in

forest land area as detected by the National Forest Inventory is used as the basis. The rule then assumes that new forest land area can only come from grassland and no deforestation is occurring. Settlements area can only come from grassland or cropland. New cropland area can only come from grassland area, as new grassland area can only come from cropland area.
Changes in carbon stocks associated with the transitions have been reported as a whole in a single year (i.e. the year of conversion). While this may be valid for losses of aboveground biomass due to some land conversions, soil carbon is in a steady state equilibrium in natural ecosystems and change in land use is expected to affect soil carbon sequestration dynamics and consequently soil carbon stocks. Current approaches assume that after a cultivation of a forest or grassland, there is an initial carbon loss over the first years which rapidly reduces to a lower subsequent loss rate in the following years (Davidson and Ackerman 1993). This loss could be attributed to the response of the faster-cycling C pools that contribute most of the decomposition flux, commonly described by first-order decomposition kinetics (Olson, 1963). In a similar way, soils are expected to gain carbon in cropland converted to grassland (Guo & Giffort 2002, Post and Kwon 2000) at fast rates in the first stages of the conversion (Reeder 1998). However because the dynamics of soil carbon storage and release are complex and still not well understood, the magnitude and timing of the response of the soil carbon to change in land use should be considered affected by a large uncertainty.
On this basis and by considering the spatial resolution of data we used, we conclude that a reasonable approach, in calculating the effect of land use change, could be assuming that the changes in carbon stocks carbon occur in the first year after the land conversion, in spite of considering them over the time period (20 years as default) specified by IPCC GPG LULUCF (2003). From a technical point of view, we are confident to account, by this method, for the larger part of the total amount of carbon exchanged to the atmosphere; a severe effort and enhanced quality data would be required to obtain the necessary high degree of spatial disaggregation of areas affected by the land use change every year in a 20 years time period. The contribution from stock changes is thus applied in the first year following the relevant land-use change, and it is applied only once, for the year in which it is determined.
In the following Table 7.3, the land use matrices for each year of the period 1990–2007 are reported.

		1989						
		Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
	1990	9.058	7.747	11.045	57	1.340	887	*30.134*
1990	**Forest**	**9.058**						*9.058*
	Grassland	96	**7.747**	0		0		*7.747*
	Cropland		9	**11.045**		8		*11.045*
	Wetland				**57**			*57*
	Settlements					**1.340**		*1.340*
	Other Land						**887**	*887*
	Final sum	*9.154*	*7.659*	*11.028*	*57*	*1.348*	*887*	30.134

		1990						
		Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
	1991	9.154	7.659	11.028	57	1.348	887	*30.134*
1991	**Forest**	**9.154**						*9.154*
	Grassland	96	**7.659**	0		0		*7.659*
	Cropland		41	**11.028**		8		*11.028*
	Wetland				**57**			*57*
	Settlements					**1.348**		*1.348*
	Other Land						**887**	*887*
	Final sum	*9.250*	*7.605*	*10.979*	*57*	*1.356*	*887*	30.134

		1991						
		Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
	1992	9.250	7.605	10.979	57	1.356	887	*30.134*
1992	**Forest**	**9.250**						*9.250*
	Grassland	96	**7.605**	0		0		*7.605*
	Cropland		42	**10.979**		8		*10.979*
	Wetland				**57**			*57*
	Settlements					**1.356**		*1.356*
	Other Land						**887**	*887*
	Final sum	*9.345*	*7.551*	*10.928*	*57*	*1.365*	*887*	30.134

		1992						
		Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
	1993	9.345	7.551	10.928	57	1.365	887	*30.134*
1993	**Forest**	**9.345**						*9.345*
	Grassland	96	**7.551**	17		8		*7.551*
	Cropland		0	**10.928**		0		*10.928*
	Wetland				**57**			*57*
	Settlements					**1.365**		*1.365*
	Other Land						**887**	*887*
	Final sum	*9.441*	*7.430*	*10.945*	*57*	*1.373*	*887*	30.134

		1993						
		Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
	1994	9.441	7.430	10.945	57	1.373	887	*30.134*
1994	**Forest**	**9.441**						*9.441*
	Grassland	96	**7.430**	43		8		*7.430*
	Cropland		0	**10.945**		0		*10.945*
	Wetland				**57**			*57*
	Settlements					**1.373**		*1.373*
	Other Land						**887**	*887*
	Final sum	*9.537*	*7.284*	*10.988*	*57*	*1.381*	*887*	30.134

		1994						
		Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
	1995	9.537	7.284	10.988	57	1.381	887	*30.134*
1995	**Forest**	**9.537**						*9.537*
	Grassland	96	**7.284**	34		8		*7.284*
	Cropland		0	**10.988**		0		*10.988*
	Wetland				**57**			*57*
	Settlements					**1.381**		*1.381*
	Other Land						**887**	*887*
	Final sum	*9.632*	*7.145*	*11.022*	*57*	*1.389*	*887*	30.134

		1995						
		Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
	1996	9.632	7.145	11.022	57	1.389	887	*30.134*
1996	**Forest**	**9.632**						*9.632*
	Grassland	96	**7.145**	0		0		*7.145*
	Cropland		64	**11.022**		8		*11.022*
	Wetland				**57**			*57*
	Settlements					**1.389**		*1.389*
	Other Land						**887**	*887*
	Final sum	*9.728*	*7.114*	*10.949*	*57*	*1.398*	*887*	30.134

		1996						
		Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
	1997	9.728	7.114	10.949	57	1.398	887	*30.134*
1997	**Forest**	**9.728**						*9.728*
	Grassland	96	**7.114**	9		8		*7.114*
	Cropland		0	**10.949**		0		*10.949*
	Wetland				**57**			*57*
	Settlements					**1.398**		*1.398*
	Other Land						**887**	*887*
	Final sum	*9.824*	*7.001*	*10.958*	*57*	*1.406*	*887*	30.134

		1997						
		Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
	1998	9.824	7.001	10.958	57	1.406	887	*30.134*
1998	**Forest**	**9.824**						*9.824*
	Grassland	96	**7.001**	68		8		*7.001*
	Cropland		0	**10.958**		0		*10.958*
	Wetland				**57**			*57*
	Settlements					**1.406**		*1.406*
	Other Land						**887**	*887*
	Final sum	*9.920*	*6.829*	*11.026*	*57*	*1.414*	*887*	30.134

		1998						
		Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
	1999	9.920	6.829	11.026	57	1.414	887	*30.134*
1999	**Forest**	**9.920**						*9.920*
	Grassland	96	**6.829**	97		8		*6.829*
	Cropland		0	**11.026**		0		*11.026*
	Wetland				**57**			*57*
	Settlements					**1.414**		*1.414*
	Other Land						**887**	*887*
	Final sum	*10.015*	*6.628*	*11.123*	*57*	*1.422*	*887*	30.134

		1999						
		Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
	2000	10.015	6.628	11.123	57	1.422	887	*30.134*
2000	**Forest**	**10.015**						*10.015*
	Grassland	96	**6.628**	0		0		*6.628*
	Cropland		9	**11.123**		8		*11.123*
	Wetland				**57**			*57*
	Settlements					**1.422**		*1.422*
	Other Land						**887**	*887*
	Final sum	*10.111*	*6.541*	*11.106*	*57*	*1.431*	*887*	30.134

		2000						
		Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
	2001	10.111	6.541	11.106	57	1.431	887	*30.134*
2001	**Forest**	**10.111**						*10.111*
	Grassland	96	**6.541**	0		0		*6.541*
	Cropland		132	**11.106**		8		*11.106*
	Wetland				**57**			*57*
	Settlements					**1.431**		*1.431*
	Other Land						**887**	*887*
	Final sum	*10.207*	*6.578*	*10.965*	*57*	*1.439*	*887*	30.134

		2001						
		Forest	Grassland	Cropland	Wetland	Settlements	Other Land	Initial sum
	2002	10.207	6.578	10.965	57	1.439	887	30.134
2002	Forest	**10.207**						10.207
	Grassland	96	**6.578**	0		0		6.578
	Cropland		43	**10.965**		8		10.965
	Wetland				**57**			57
	Settlements					**1.439**		1.439
	Other Land						**887**	887
	Final sum	10.303	6.525	10.914	57	1.447	887	30.134

		2002						
		Forest	Grassland	Cropland	Wetland	Settlements	Other Land	Initial sum
	2003	10.303	6.525	10.914	57	1.447	887	30.134
2003	Forest	**10.303**						10.303
	Grassland	96	**6.525**	0		0		6.525
	Cropland		990	**10.914**		8		10.914
	Wetland				**57**			57
	Settlements					**1.447**		1.447
	Other Land						**887**	887
	Final sum	10.398	7.419	9.916	57	1.455	887	30.134

		2003						
		Forest	Grassland	Cropland	Wetland	Settlements	Other Land	Initial sum
	2004	10.398	7.419	9.916	57	1.455	887	30.134
2004	Forest	**10.398**						10.398
	Grassland	96	**7.419**	0		0		7.419
	Cropland		117	**9.916**		8		9.916
	Wetland				**57**			57
	Settlements					**1.455**		1.455
	Other Land						**887**	887
	Final sum	10.494	7.441	9.791	57	1.464	887	30.134

		2004						
		Forest	Grassland	Cropland	Wetland	Settlements	Other Land	Initial sum
	2005	10.494	7.441	9.791	57	1.464	887	30.134
2005	Forest	**10.494**						10.494
	Grassland	96	**7.441**	0		0		7.441
	Cropland		109	**9.791**		8		9.791
	Wetland				**57**			57
	Settlements					**1.464**		1.464
	Other Land						**887**	887
	Final sum	10.590	7.454	9.674	57	1.472	887	30.134

		2005						
		Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
	2006	10.590	7.454	9.674	57	1.472	887	*30.134*
2006	**Forest**	**10.590**						*10.590*
	Grassland	96	**7.454**	52		8		*7.454*
	Cropland		0	**9.674**		0		*9.674*
	Wetland				**57**			*57*
	Settlements					**1.472**		*1.472*
	Other Land						**887**	*887*
	Final sum	*10.686*	*7.297*	*9.726*	*57*	*1.480*	*887*	30.134

		2006						
		Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
	2007	10.686	7.297	9.726	57	1.480	887	*30.134*
2007	**Forest**	**10.686**						*10.686*
	Grassland	97	**7.297**	0		0		*7.297*
	Cropland		174	**9.726**		8		*9.726*
	Wetland				**57**			*57*
	Settlements					**1.480**		*1.480*
	Other Land						**887**	*887*
	Final sum	*10.782*	*7.375*	*9.544*	*57*	*1.488*	*887*	30.134

Table 7.3 Land use change matrices for the years 1990-2007

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 72% of total CO_2 2007 LULUCF emissions and removals, while the mean forest land removals for the years 1990-2007 is 81% of total mean CO_2 LULUCF emissions and removals; in particular the living biomass removals represent 46%, while the removals from dead organic matter and soils stand for 8% and 46% of total 2007 forest land CO_2 removals, respectively.

Forest Land	**1990**	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
- *living biomass*	*39*	*47*	*46*	*48*	*49*	*47*	*48*	*48*	*49*	*41*
- *dead organic matter*	*8*	*8*	*9*	*8*	*8*	*9*	*8*	*8*	*8*	*9*
- *soils*	*53*	*45*	*45*	*44*	*43*	*45*	*44*	*43*	*43*	*49*

Table 7.4 Percentage contribution of carbon pools to forest land category, in 1990-2007

CO_2 removals from forest land remaining forest land have identified as key category (sinks) in level and in trend assessment (Tier 1); CO_2 emissions and removals from land converting to forest land have identified as key category in level and in trend assessment (Tier 2);
Concerning the CH_4 or N_2O emissions, neither forest land nor land converting to forest land have resulted as a key source.

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., 2008), estimating the evolution in time of the Italian forest carbon pools, according to the GPG classification and definition: living biomass, both aboveground and belowground, dead organic matter, including dead wood and litter, and soils as soil organic matter.

The model has been applied at regional scale (NUTS2) because of availability of any forest-related statistical data: input data for the forest area, per region and inventory typologies[20], were the First Italian National Forest Inventory (IFN) data and the Inventory of Forests and Carbon pools (INFC).

The Italian Ministry of Agriculture and Forests (MAF) and the Experimental Institute for Forest Management (ISAFA) carried out the first National Forest Inventory in 1985. As a result of the first IFN based on a regular sampling grid of 3 km by 3 km, the global Italian extent of forest resources was about 8.7 million hectares (MAF/ISAFA, 1988). A second national forest inventory, using a grid of 1 km by 1 km, had been launched in 2001. A first inventory phase, consisting in interpretation of orthophotos, was followed by a ground survey, in order to assess the forest use, and to detect the main attributes of Italian forests. The final result, regarding forest surfaces, has been used (INFC, 2007).

The estimation for 1990 was calculated through a linear interpolation between the 1985 and 2005 data. By assuming that the defined trend may well represent the near future, it was possible to extrapolate data for 2006-2007.

Additional source of information was the National Statistics Institute (ISTAT), which had provided annual data on forest area extent, till 2005. In 2006, the National Statistics Institute has officially recognized the INFC data, suspending the annual assessment on forest area extent.

To estimate the growing stock of Italian forest, from 1990 to 2007, the following methodology was applied:

1. the initial growing stock volume is the 1985 growing stock data (MAF/ISAFA, 1988);
2. starting from 1985, for each year, the current increment per hectare [m^3 ha^{-1}] is computed with the derivative Richards function[21], for each forest typology by the Italian yield tables collection;
3. starting from 1986, for each year the growing stock per hectare [m^3 ha^{-1}] is computed, from the previous year growing stock volume, with the addition of the calculated increment ("y" value of the derivative Richards) for the current year and subtraction of the losses due to harvest, mortality and fire for the current year.

---

[20]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*

[21] In the followed approach the Richards function is fitted through the data of growing stock [m^3] and increment [m^3 y^{-1}] obtained by the data of the national forestry inventory and yield tables collection. 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.

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

where the general constrain for the parameters are the following:

a,*k*>0 -1=v=8 and *v*?0

The constant y_0 is derived from the data of age and volume reported in the yield tables: more precisely y_0 has the value of the volume for the age 1. After choosing the function, it is fitted to the measurements by non-linear regression. The minimization of the deviation is performed by the least squares method. The model performances were evaluated against the data by validation statistics according to Jabssen and Heuberger (1995).

The relationship can be summarized as follows:

$$v_i = \frac{V_{i-1} + I_i - H_i - F_i - M_i - D_i}{A_i}$$

where:

$$I_i = f(v_{i-1}) \cdot A_{i-1}$$

in which the current increment is estimated year by year applying the derivative Richards function and

v_i is the volume per hectare of growing stock for the current year

V_{i-1} is the total previous year growing stock volume

I_i is the total current increment of growing stock for the current year

H_i is the total amount of harvested growing stock for the current year

F_i is the total amount of burned growing stock for the current year

Mi is the annual rate of mortality

D is the annual rate of drain and grazing for the protective forest

A_i is the total area referred to a specific forest typology for the current year

v_{i-1} is the previous year growing stock volume per hectare

A_{i-1} is the total area referred to a specific forest typology for the previous year

f is the Richards function reported above

The average rate of mortality, the fraction of standing biomass per year, used for the calculation was 0.0116, concerning the evergreen forest, and 0.0117, for deciduous forest, according to the GPG (IPCC, 2003).

The rate of draining and grazing, applied to protective forest, has been set as 3% following an expert judgement (Federici et al., 2008) because of total absence of referable data.

Total commercial harvested wood, for construction and energy purposes, has been obtained from national statistics (ISTAT, several years [a]); even if data on biomass removed in commercial harvest published by ISTAT are probably underestimated, particularly concerning fuelwood consumption ((APAT - ARPA Lombardia, 2007, UNECE – FAO, Timber Committee, 2008). Data of wood use for construction and energy purposes, reported in m^3, are disaggregated at NUTS2 level, in sectoral statistics (ISTAT, several years [a]) or at NUTS1 level for coppices and high forests in national statistics (ISTAT, several years [c]). These figures have been subtracted, as losses, to growing stock volume, as abovementioned.

Carbon amount released by forest fires has been included in the overall assessment of carbon stocks change. Not having data on the fraction of growing stock oxidised as consequence of fires, the most conservative hypothesis has been adopted; all growing stock of burned forest areas has been assumed to be completely oxidised and so released. Moreover, not having data on forest typologies of burned areas, the total value of burned forest area coming from national statistics has been subdivided and assigned to forest typologies based on their respective weight on total national forest area. Finally, the amount of burned growing stock has been calculated multiplying average growing stock per hectare of forest typology for the assigned burned area. Assessed value has been subtracted to total growing stock of respective typology, as aforesaid.

In the figure 7.3, losses of carbon due to harvest and forest fires, referred to forest land category and reported as percentage on total aboveground carbon, are shown.

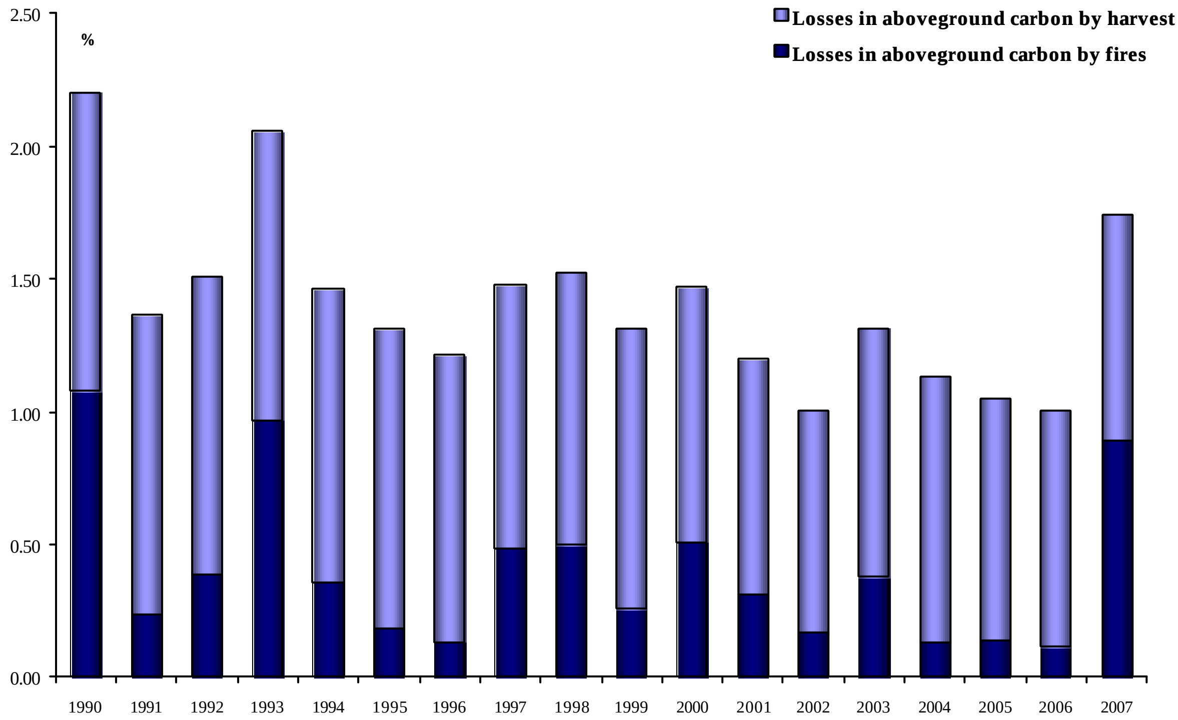


Figure 7.3 Losses by harvest and fires in relation to aboveground carbon

In the following Table 7.5, values of burned growing stocks and respective CO_2 released, for different categories (stands, coppices, plantations, protective forests) are shown.

Year	**burned growing stock** *m^3*					**CO_2 released** *Gg*				
	stands	*coppice*	*plantations*	*protective*	*total*	*stands*	*coppice*	*plantations*	*protective*	*total*
1990	3,605,243	5,008,295	558,556	1,312,728	10,484,822	4,486	7,264	588	1,985	14,106
1991	769,375	1,054,229	199,019	351,979	2,374,602	959	1,526	207	532	3,191
1992	1,190,733	1,879,681	265,177	604,804	3,940,395	1,487	2,717	273	913	5,290
1993	3,278,021	3,655,253	1,374,661	1,540,808	9,848,743	4,094	5,275	1,400	2,325	13,203
1994	1,256,586	913,725	892,145	723,258	3,785,713	1,572	1,317	901	1,091	5,070
1995	592,225	1,125,952	64,213	229,956	2,012,346	742	1,620	65	347	2,694
1996	607,844	574,687	86,259	196,597	1,465,386	763	826	86	296	1,961
1997	1,844,170	2,710,183	241,607	641,728	5,437,688	2,318	3,891	241	967	7,274
1998	2,268,656	1,823,976	659,442	945,449	5,697,523	2,855	2,616	657	1,424	7,620
1999	906,408	1,281,072	410,996	414,620	3,013,095	1,142	1,835	409	624	4,030
2000	2,298,337	2,207,523	618,394	910,445	6,034,700	2,899	3,160	613	1,370	8,068
2001	1,331,146	1,500,629	376,182	566,232	3,774,190	1,681	2,146	373	852	5,045
2002	616,383	1,043,236	69,219	351,051	2,079,889	779	1,490	69	528	2,780
2003	1,497,546	2,026,409	523,450	699,212	4,746,616	1,896	2,893	518	1,051	6,344
2004	532,580	771,111	62,493	331,883	1,698,067	675	1,100	62	499	2,270
2005	535,665	913,009	36,918	320,715	1,806,308	680	1,301	37	482	2,414
2006	453,576	752,789	46,616	274,666	1,527,647	577	1,072	46	413	2,042
2007	4,718,965	4,421,439	1,197,777	1,695,183	12,033,364	5,998	6,290	1,187	2,545	16,081

Table 7.5 Burned growing stocks and CO_2 released for the years 1990-2007

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 2007, can be assessed. In the following, the default value of carbon fraction of dry matter (0.5 t d.m.) has been applied to obtain carbon amount from biomass.

With regard to the aboveground biomass:

1. starting from the 1985 growing stock data, reported in the IFN, the amount of aboveground woody tree biomass (d.m) [t] was calculated, for every forest typology, through the relation:

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

   where:
   GS = volume of growing stock (MATT/ISAFA, 1988) [m^3 ha^{-1}]
   BEF = Biomass Expansion Factors which expands growing stock volume to volume of aboveground woody biomass (ISAFA, 2004)
   WBD = Wood Basic Density for conversions from fresh volume to dry weight (d.m) [t m^{-3}] (Giordano, 1980)
   A = forest area occupied by specific typology [ha] (MATT/ISAFA, 1988)

   The BEF were derived for each forest typology and wood basic density (WBD) values were different for the main tree species:
2. starting from 1985, for each year, current increment per hectare [m^3 ha^{-1} y^{-1}] is computed with the derivative Richards function, for every specific forest typology by the Italian yield tables collection;
3. starting from 1986, for each year growing stock per hectare [m^3 ha^{-1}] is computed, from the previous year growing stock volume, adding the calculated increment ("y" value of the derivative Richards) for the current year and subtracting losses due to harvest, mortality and fire for the current year, as described above.
   Re-applying the relation:

   $$\text{Aboveground tree biomass} = GS \cdot BEF \cdot WBD \cdot A$$

   it is possible to obtain the aboveground woody tree biomass (d.m) [t] for each forest typology, for each year, starting from the 1986.

In Table 7.6 biomass expansion factors for the conversions of volume to aboveground tree biomass and wood basic densities are reported.

	Inventory typology	BEF *aboveground biomass / growing stock*	WBD *Dry weigth t/ fresh volume*
stands	norway spruce	1.29	0.38
	silver fir	1.34	0.38
	larches	1.22	0.56
	mountain pines	1.33	0.47
	mediterranean pines	1.53	0.53
	other conifers	1.37	0.43
	european beech	1.36	0.61
	turkey oak	1.45	0.69
	other oaks	1.42	0.67
	other broadleaves	1.47	0.53
	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**

Table 7.6 Biomass Expansion Factors and Wood Basic Densities

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

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

where:
GS = volume of growing stock [m^3 ha^{-1}]
R = Root/Shoot ratio which converts growing stock biomass in belowground biomass
WBD = Wood Basic Density [t d.m. m^{-3}]
A = forest area occupied by specific typology [ha]
Also in this case, the BEFs and WBDs were derived for each forest typology:

	Inventory typology	R *Root/shoot ratio*	WBD *Dry weigth t/ fresh volume*
stands	norway spruce	0.29	0.38
	silver fir	0.28	0.38
	Larches	0.29	0.56
	mountain pines	0.36	0.47
	mediterranean pines	0.33	0.53
	other conifers	0.29	0.43
	european beech	0.20	0.61
	turkey oak	0.24	0.69
	other oaks	0.20	0.67
	other broadleaves	0.24	0.53
	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*

Table 7.7 Root/Shoot ratio and Wood Basic Densities

The net carbon stock change of living biomass has been calculated according to the GPG for LULUCF (IPCC, 2003), from the aboveground tree biomass and belowground biomass:

$$\Delta C_{\text{Living biomass}} = \Delta C_{\text{Aboveground biomass}} + \Delta C_{\text{Belowground biomass}}$$

where the total amount of carbon has been obtained from the biomass (d.m.), multiplying by the conversion factor carbon content / dry matter.

The deadwood mass was assessed applying a dead mass conversion factor (DCF[10]) of respectively 0.2 for evergreen forests and 0.14 for deciduous forests, as reported in table 3.2.2 of GPG (IPCC 2003).
The dead mass [t] is:

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

where:

GS = volume of growing stock [m^3 ha^{-1}]
BEF = Biomass Expansion Factors for the conversions of volume to aboveground woody tree biomass
WBD = Wood Basic Density [t d.m. m^{-3}]
DCF = Dead mass Conversion Factor which converts aboveground woody biomass in dead mass
A = forest area occupied by specific typology [ha]

The total litter carbon amount is estimated from the aboveground carbon amount with linear relations, deduced from the results of the European project CANIF[22] (*CArbon and NItrogen cycling in Forest ecosystems)* which has reported such relations for a number of European forest stands. The total litter carbon amount has been estimated from aboveground carbon amount with linear relations differentiated per forestry use: stands (resinous, broadleaves, mixed stands) and coppices. The relationship is based on the widely reported findings that litter production increase linearly with NPP (Waring and Runnings, 1998). In our calculation, applying such relationship at stand level, the annual rate of accumulation of litter C is 0.0723 t C $ha^{-1}yr^{-1}$ which is in accordance with the default value reported in GPG LULUCF based on 20 years time period (1.4 t C ha^{-1} yr^{-1}, T 3.2.1). In Table 7.8 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:

	Inventory typology	Relation litter – aboveground C per ha
stands	norway spruce	$y = 0.0659 \cdot x + 1.5045$
	silver fir	$y = 0.0659 \cdot x + 1.5045$
	larches	$y = 0.0659 \cdot x + 1.5045$
	mountain pines	$y = 0.0659 \cdot x + 1.5045$
	mediterranean pines	$y = 0.0659 \cdot x + 1.5045$
	other conifers	$y = 0.0659 \cdot x + 1.5045$
	european beech	$y = -0.0299 \cdot x + 9.3665$
	turkey oak	$y = -0.0299 \cdot x + 9.3665$
	other oaks	$y = -0.0299 \cdot x + 9.3665$
	other broadleaves	$y = -0.0299 \cdot x + 9.3665$
coppices	european beech	$y = -0.0299 \cdot x + 9.3665$
	sweet chestnut	$y = -0.0299 \cdot x + 9.3665$
	hornbeams	$y = -0.0299 \cdot x + 9.3665$
	other oaks	$y = -0.0299 \cdot x + 9.3665$
	turkey oak	$y = -0.0299 \cdot x + 9.3665$
	evergreen oaks	$y = -0.0299 \cdot x + 9.3665$
	other broadleaves	$y = -0.0299 \cdot x + 9.3665$
	conifers	$y = 0.0659 \cdot x + 1.5045$
plantations	eucalyptuses coppices	$y = -0.0299 \cdot x + 9.3665$
	other broadleaves coppices	$y = -0.0299 \cdot x + 9.3665$
	poplars stands	$y = -0.0299 \cdot x + 9.3665$
	other broadleaves stands	$y = -0.0299 \cdot x + 9.3665$
	conifers stands	$y = 0.0659 \cdot x + 1.5045$
	others	$y = -0.0165 \cdot x + 7.3285$
protective	rupicolous forest	$y = -0.0165 \cdot x + 7.3285$
	riparian forest	$y = -0.0299 \cdot x + 9.3665$
	shrublands	$y = -0.0299 \cdot x + 9.3665$

Table 7.8 Relations litter - aboveground carbon per ha

[22] CANIF project: http://www.bgc-jena.mpg.de/bgc-processes/research/Schulze_Euro_CANIF.html

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 7.9 the different relations used to obtain soil carbon amount per ha [t C ha^{-1}] from the aboveground carbon amount per ha [t C ha^{-1}] have been reported:

	Inventory typology	Relation 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	$y = 0.9843 \cdot x + 5.0746$
	turkey oak	$y = 0.9843 \cdot x + 5.0746$
	other oaks	$y = 0.9843 \cdot x + 5.0746$
	other broadleaves	$y = 0.9843 \cdot x + 5.0746$
coppices	european beech	$y = 0.3922 \cdot x + 65.356$
	sweet chestnut	$y = 0.3922 \cdot x + 65.356$
	hornbeams	$y = 0.3922 \cdot x + 65.356$
	other oaks	$y = 0.3922 \cdot x + 65.356$
	turkey oak	$y = 0.3922 \cdot x + 65.356$
	evergreen oaks	$y = 0.3922 \cdot x + 65.356$
	other broadleaves	$y = 0.3922 \cdot x + 65.356$
	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	$y = 0.7647 \cdot x + 33.638$
protective	rupicolous forest	$y = 0.7647 \cdot x + 33.638$
	riparian forest	$y = 0.9843 \cdot x + 5.0746$
	shrublands	$y = 0.3922 \cdot x + 65.356$

Table 7.9 Relations soil - aboveground carbon per ha

Land converted in Forest Land

The area of land converted to forest land is always coming from grassland. There is no occurrence for other conversion. Carbon stocks change due to grassland converting to forest land has been estimated and reported.

The carbon stock change of living biomass has been calculated taking into account the increase and the decrease of carbon stock related to the areas in transition to forest land. Net carbon stock change in dead organic matter and soil has been calculated as well. SOC reference value for grassland has been currently revised and set to 70.8 tC ha^{-1}, after a review of the latest papers reporting data on soil carbon in mountain meadows, pastures, set-aside lands as well as soil not disturbed since the agricultural abandonment, in Italy (Viaroli and Gardi 2004, CRPA 2009, IPLA 2007, ERSAF 2008, Del Gardo *et al* 2003, LaMantia *et al* 2007, Benedetti *et al* 2004, Masciandaro and Ceccanti 1999, Xiloyannis 2007).
The total amount of carbon for dead organic matter has been obtained from the dead organic matter (d.m.), multiplying by the conversion factor carbon content / dry matter.
In Table 7.10 carbon stock changes due to conversion to forest land, for the living biomass, dead organic matter and soil pools, have been reported:

	Carbon stock change in living biomass			Net C stock change in dead organic matter	Net C stock change in mineral soils
	Increase	*Decrease*	*Net change*		
year			*Gg C*		
1990	239.73	-179.92	59.80	12.69	201.10
1991	240.44	-142.13	98.30	17.06	225.27
1992	240.96	-150.97	90.00	16.22	245.73
1993	241.42	-178.07	63.35	14.13	251.38
1994	241.59	-150.36	91.23	16.53	271.01
1995	241.71	-143.01	98.70	16.88	295.55
1996	241.96	-139.36	102.60	17.61	320.72
1997	241.95	-154.12	87.83	15.86	339.02
1998	241.78	-158.14	83.64	15.37	354.03
1999	241.84	-147.17	94.67	16.92	375.27
2000	241.96	-158.34	83.62	15.79	390.01
2001	241.90	-145.57	96.33	17.01	411.50
2002	241.80	-136.16	105.64	17.94	437.55
2003	241.77	-154.21	87.56	16.00	455.31
2004	241.73	-145.60	96.13	16.90	477.60
2005	241.63	-142.22	99.41	17.06	501.43
2006	241.51	-140.74	100.77	17.27	525.44
2007	244.02	-187.73	56.29	12.93	531.85

Table 7.10 Carbon stock changes in land converting to 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.
Values of burned growing stocks and respective CO_2 released, for different categories (stands, coppices, plantations, protective forests), are reported in the previous Table 7.5.

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 1990–2007, 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:

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

where the terms $V_{AG_{1985}}$, $V_{BG_{1985}}$, $V_{D_{1985}}$, $V_{L_{1985}}$ e $V_{S_{1985}}$ stand for the 1985 carbon stocks of the five pools, aboveground, belowground, dead mass, litter and soil, while, with the letter E, the related uncertainties have been indicated. In Table 7.11 the relations for assessing the overall uncertainties associated to the carbon pools have been reported:

Carbon pool	Relation for uncertainty assessing
Aboveground	$E_{AG_{1985}} = \sqrt{E_{NFI}^2 + E_{BEF_1}^2 + E_{BD}^2 + E_{CF}^2}$
Belowground	$E_{BG_{1985}} = \sqrt{E_{NFI}^2 + E_{BEF_2}^2 + E_{BD}^2 + E_{CF}^2}$
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	$E_{S_{1985}} = \sqrt{E_{SS_{1985}}^2 + E_{SR_5}^2}$

Table 7.11 Relations for assessing uncertainties of the C pools

where the term E_{NFI} stands for the uncertainty associated to the growing stock data given by the first National Forest Inventory, E_{BEF_1} points to uncertainty related to biomass expansion factors for the aboveground biomass, E_{BD} is the basic density uncertainty and the term E_{CF} indicates the conversion factor uncertainty, where GPG default values have been used (IPCC, 2003). In the relation for the belowground carbon pool, the term E_{BEF_2} 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 CANIF Project[23] data and the CONECOFOR Programme (Corpo Forestale, 2005) respectively. 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 7.12, the values of carbon stocks in the five pools, for the 1985, and the abovementioned uncertainties are reported:

[23] CANIF project: http://medias.obs-mip.fr/ricamare/interface/projet/canif.html

Carbon stocks *t CO_2 eq. ha^{-1}*	*Aboveground biomass*	V_{AG}	137.8
	Belowground biomass	V_{BG}	31.5
	Dead mass	V_D	20.8
	Litter	V_L	27.4
	Soil	V_S	264.7
Uncertainty	*Growing stock*	E_{NFI}	3.2%
	Current increment (Richards)[24]	E_{NFI}	51.6%
	Harvest[25]	E_H	30%
	Fire[26]	E_F	30%
	Drain and grazing	E_D	30%
	Mortality	E_M	30%
	BEF	E_{BEF1}	30%
	R	E_{BEF2}	30%
	DCF	E_{DEF}	30%
	Litter (stock + regression)	E_L	161%
	Soil (stock + regression)	E_S	152%
	Basic Density	E_{BD}	30%
	C Conversion Factor	E_{CF}	2%

Table 7.12 Carbon stocks and uncertainties for year 1985 and current increment related uncertainty

The uncertainties related to the carbon pools and the overall uncertainty for 1985 has been computed and shown in Table 7.13, using the relations in Table 7.11.

Aboveground biomass	E_{AG}	42.59%
Belowground biomass	E_{BG}	42.59%
Dead mass	E_D	52.10%
Litter	E_L	161.22%
Soil	E_S	152.05%
Overall uncertainty	$\mathbf{E_{1985}}$	**84.91%**

Table 7.13 Uncertainties for the year 1985

The overall uncertainty related to 1985 (the year of the first National Forest Inventory) has been propagated through the years, till 2007, following Tier 1 approach.

The equations for the years following 1985 are similar to the one for the 1985 uncertainty estimate, with the exception of the terms linked to aboveground biomass: the biomass increment was estimated with the methodology described in paragraph 7.2.2; therefore, the related uncertainty, e.g. for 1986, is expressed by the following formula:

---

[24] The current increment is estimated by the Richards function (first derivative); uncertainty has been assessed considering the standard error of the linear regression between the estimated values and the corresponding current increment values reported in the National Forest Inventory

[25] Good Practice Guidance default value (IPCC, 2003)

[26] Good Practice Guidance default value (IPCC, 2003)

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

The uncertainties related to the carbon pools and the overall uncertainty for 1986 are shown in Table 7.14:

Aboveground biomass	E_{AG}	42.67%
Belowground biomass	E_{BG}	42.67%
Dead mass	E_D	52.16%
Litter	E_L	161.22%
Soil	E_S	152.05%
Overall uncertainty	E_{1986}	84.75%

Table 7.14 Uncertainties for the year 1986

Following the Tier 1 approach and the abovementioned methodology, the overall uncertainty in the estimates produced by the described model has been quantified; in Table 7.15 the uncertainties of the 1985-2007 period are reported.

1985	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
					%					
84.9	88.0	87.3	86.55	86.39	86.17	86	85.88	85.7	85.5	81.4

Table 7.15 Overall uncertainties 1985 - 2007

The overall uncertainty in the model estimates between 1990 and 2007 has been assessed with the following relation:

$$E_{1990-2006} = \frac{\sqrt{(E_{1990}\cdot V_{1990})^2 + (E_{2005}\cdot V_{2006})^2}}{\left|V_{1990}+V_{2006}\right|}$$

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 1990–2007 is equal to 61.35%. The table reporting the uncertainties referring to all the categories (Forest Land, Cropland, Grassland, Wetlands, Settlements, Other Land) is shown in Annex 1.
A comparison between carbon in the aboveground biomass pool, estimated with the described methodology, and the new INFC data about 2006 aboveground carbon stock of the whole Italian forest results in 0.26% difference (Table 7.16).

INFC aboveground carbon stock *t C*	**Estimated aboveground carbon stock** *t C*
486,018,500	484,753,744

Table 7.16 Comparison between estimated and INFC preliminary 2006 aboveground carbon stock

7.2.4 Source-specific QA/QC and verification

Systematic quality control activities have been carried out in order to ensure completeness and consistency in time series and correctness in the sum of sub-categories; where possible, activity data comparison among different sources (FAO database[27], ISTAT data[28]) has been made. Data entries have been checked several times during the compilation of the inventory; particular attention has been focussed on the categories showing significant changes between two years in succession. Land use matrices have been accurately checked and cross-checked to ensure that data were properly reported. Regarding both soil and litter, a validation of the applied methodology has been done in Piemonte region, comparing results of a regional soil inventory with data obtained with the abovementioned methodology. Results show a good agreement between the two dataset either in litter and soil. An interregional project, named INEMAR[29], developed to carry out atmospheric emission inventories at local scale, has added a module to estimate forest land emission and removals, following the abovementioned methodology. The module will be applied, at local scale with local data, in seven of the 20 Italian regions and the results will constitute a good validation of the used methodology.
Further identification of critical issues and uncertainties in the estimations derived from the participation at workshops and pilot projects (MATT, 2002). Specifically, the European pilot project to harmonise the estimation and reporting of EU member states, in 2003, led to a comparison among national approaches and problems related to the estimation methodology and basic data needed (JRC, 2004). The estimate methodology has been presented and discussed during several national workshops; findings and comments collected have been used in the refining estimation process.

7.2.5 Source-specific recalculations

Recalculations of emissions and removals have been carried out on the basis of the IPCC Good Practice Guidance for LULUCF (IPCC, 2003). Moderate deviations from the precedent sectoral estimates occurred, essentially because of the release of official INFC forest surfaces, resulting in an average decrease of 6.6% in living biomass, 14.7% in dead organic matter and 15.3% in soils carbon pools estimates, and of 11.3% in total forest land category, as shown in the Figure 7.4. As well as soils carbon pools estimates, the different SOC reference level used for grassland in conversion to forestland results in a significant decrease in reported carbon stock change for land converting to forest land; this resulted in a reassessment of carbon stock change in forestland remaing forestland.

[27] FAO, 2005. FAOSTAT, http://faostat.fao.org
[28] ISTAT, several years [a], [b], [c]
[29] INEMAR: INventario EMissioni Aria: http://www.ambiente.regione.lombardia.it/inemar/e_inemarhome.htm

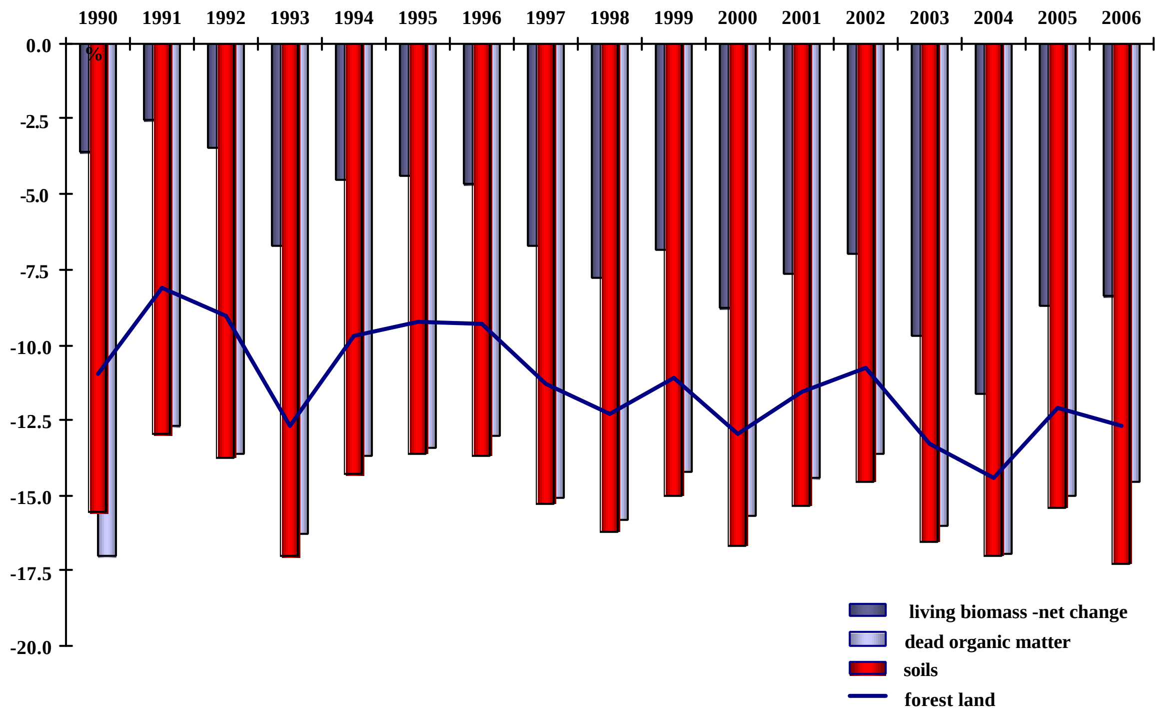


Figure 7.4 Difference between current and 2007 submission carbon pools estimates

7.2.6 Source-specific planned improvements

The final result of the INFC has allowed a more precise evaluation of the estimated time series of the forest areas; the INFC data related to the soils survey will definitely constitute a robust database, allowing refined estimates and lower related uncertainty. The 'National Registry for Carbon sinks', instituted by a Ministerial Decree on 1st April 2008, is part of the Italian National System and includes information on units of lands subject of activities under Article 3.3 and activities elected under Article 3.4 and related carbon stock changes. The National Registry for Carbon sinks is the instrument to estimate, in accordance with the COP/MOP decisions, the IPCC Good Practice Guidance on LULUCF and every relevant IPCC guidelines, the greenhouse gases emissions by sources and removals by sinks in forest land and related land-use changes and to account for the net removals in order to allow the Italian Registry to issue the relevant amount of RMUs. Activities planned in the framework of the National Registry for Forest Carbon Sinks should also provide data to improve estimate of carbon sequestration due to Afforestation/reforestation activities (with a special focus on soil organic content), and should allow to refine the estimate of forest land category. Specifically, for the LULUCF sector, following the election of the 3.3 and 3.4 activities and on account of an in-depth analysis on the information needed to report LULUCF under the Kyoto Protocol, a Scientific Committee, *Comitato di Consultazione Scientifica del Registro dei Serbatoi di Carbonio Forestali*, constituted by the relevant national experts has been established by the Ministry for the Environment, Land and Sea in cooperation with the Ministry of Agriculture, Food and Forest Policies.

An expert panel on forest fires has been set up, in order to obtain geographically referenced data on burned area; the overlapping of land use map and georeferenced data should assure the estimates of burned areas in the different land uses. The fraction of CO_2 emissions due to forest fires, now included in the estimate of the forest land remaining forest land, will be pointed out.

In addition to these expert panels, ISPRA participates in technical working groups, denominated *Circoli di qualità*, within the National Statistical System (Sistan). Concerning LULUCF sector, this group, coordinated by the National Institute of Statistics, is constituted by both producers and users of statistical information with the aim of improving and monitoring statistical information for forest sector. These activities should improve the quality and details of basic data, as well as enable a more organized and timely communication.

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 12.4% of total CO_2 LULUCF emissions and removals, in particular the living biomass removals represent 97%, while the emissions from soils stand for 3% of total cropland CO_2 emissions and removals.
Removals are almost entirely due to cropland remaining cropland, while only land converting to cropland category is responsible for emissions.
CO_2 emissions and removals from cropland remaining cropland have been identified as key category in level and in trend assessment (Tier 1). Concerning N_2O emissions, the category land converting to cropland has not resulted as a key source.

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. Activity data for cropland remaining cropland have been subdivided into annual and 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. Biomass carbon losses have been estimated, taking into account the pruning of woody cropland, using the same country-specific methodology developed for estimating emissions from field burning of agriculture residues (§ 6.6.2).
Net changes in cropland C stocks obtained are equal to 4.693 Tg C for 1990, and 3.079 Tg C for 2007, as well as concerns living biomass pool.
According to the LULUCF GPG (IPCC, 2003), the change in soil C stocks (Equation 3.3.4) is the result of a change in practices or management between the two time periods and concentration of soil carbon is only driven by the change in practice or management. It wasn't possible to point out different sets of relative stock change factors [F_{LU} (land use), F_{MG} (management), F_I (input factor)] for the period 1990-2007 under investigation; therefore, as no management changes can be documented, resulting change in carbon stock has been reported as zero.

No CO_2 emissions from organic soils or from application of carbonate containing lime 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 have been provided, since there is not sufficient information to estimate carbon stock change in dead organic matter pool. Concerning soil carbon pool, changes in carbon stocks associated with the transitions have been reported as a whole in a single year (i.e. the year of conversion): dynamics of soil carbon storage and release are complex and still not well understood, even if current approaches assume that after a cultivation of a forest or grassland, there is an initial carbon loss over the first years which rapidly reduces to a lower subsequent loss rate in the following years (Davidson and Ackerman 1993). On this basis and by considering the spatial resolution of data we used, we conclude that a reasonable approach, in calculating the effect of transition to cropland, could be assuming that the changes in carbon stocks carbon occur in the first year after the land conversion, in spite of considering them over the time period (20 years as default) specified by IPCC GPG LULUCF (2003).

CO_2 emissions from cultivated organic soils (CRPA, 1997) in cropland remaining cropland have been estimated, using default emission factor for warm temperate, reported in Table 3.3.5 of GPG (IPCC, 2003).

N_2O emissions arising from the conversion of land to cropland have been also estimated, and reported in Table 5(III) - N_2O emissions from disturbance associated with land-use conversion to cropland.

The carbon stocks change, for land converted to cropland, is equal to the carbon stocks change due to the removal of biomass from the initial land use plus the carbon stocks from one year of growth in cropland following the conversion.

The Tier 1 has been followed, assuming that the amount of biomass is cleared and some type of cropland system is planted soon thereafter. At Tier 1, carbon stocks in biomass immediately after the conversion are assumed to be zero.

The average area of land undergoing a transition from non cropland, only grassland in Italian case, to cropland, during each year, from 1990 to 2007, 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 7.3, conversion of lands into cropland has taken place only in a few years during the period 1990- 2007. C emissions [Gg C] due to change in carbon stocks in living biomass in land converted to cropland, are reported in Table 7.17:

	Conversion Area	$\Delta C_{converted\ land}$
year	*kha*	*Gg C*
1990	0	0
1991	0	0
1992	0	0

1993	17	21.9
1994	43	55.5
1995	34	44.5
1996	0	0
1997	9	11.2
1998	68	88.7
1999	97	125.9
2000	0	0
2001	0	0
2002	0	0
2003	0	0
2004	0	0
2005	0	0
2006	52	67.7
2007	0	0

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

Changes in carbon stocks in mineral soils in land converted to cropland have been estimated following land use changes, resulting in a change of the total soil carbon content. Initial land use soil carbon stock [$SOC_{(0-T)}$] and soil carbon stock in the inventory year [SOC_0] for the cropland area have been estimated from the reference carbon stocks.

SOC reference value for cropland has been currently revised and set to 56.7 tC/ha on the basis of new references. It replaces the previous value (44.5 tC/ha) fixed for cropland and grassland according to an expert judgement.

The new value has been drawn up by analysing a collection of the latest papers reporting data on soil carbon under the most common agricultural practices in Italy, including woody cropland cultivations such as vineyards and olive orchards (Triberti *et al* 2008, Ceccanti *et al* 2008, Monaco *et al* 2008, Martiniello 2007, Lugato and Berti 2008, Francaviglia 2006, IPLA 2007, ERSAF 2008, Del Gardo *et al* 2003, Puglisi *et al*, 2008, Lagomarsino *et al* 2009, Perucci *et al* 2008).

Whenever the soil carbon stock was not reported in the papers, it has been calculated at the default depth of 30 cm from the soil carbon content, the bulk density, and the stoniness according to the following formula (Batjes 1996):

$$T_d = \sum_{i=1}^{K} r_i \cdot P_i \cdot D_i \cdot (1 - S_i)$$

where T_d is the overall soil carbon stock (gcm^{-2}) and, for each K layer of the soil profile, r_i is the soil bulk density (gcm^{-3}), P_i is the soil carbon content (gCg^{-1}), D_i is the layer thickness (cm), S_i is the volume of the gravel > 2mm.

If not available in the papers, soil bulk density has been calculated on the basis of the soil organic matter and texture (Adam 1973):

$$r = \frac{100}{\left(\frac{X}{r_0}\right) + \left(\frac{100 - X}{r_m}\right)}$$

where r soil bulk density (gcm^{-3}), X, percent by weight of organic matter, r_0 average bulk density of organic matter (0.224 gcm^{-3}) and r_m bulk density of the mineral matter usually estimated at 1.33 gcm^{-3} or determined on the “mineral bulk density chart” (Rawls and Brakensiek, 1985).

Since soil carbon stocks are derived from experimental measurements under some representative cropland managements, the effect of the practices is intended to be included into the values and consequently no stock change factors (F_{LU}, F_{MG}, F_I) have been applied on the soil

carbon stock. Each soil carbon stock was assigned to the geographical area where the relative soil carbon content has been measured and the overall values have been averaged by means of weights resulting from the proportional relevance of the indagated area (ha) over the entire Italian territory.
The annual change in carbon stocks in mineral soils has been, at last, assessed as described in the equation 3.3.3 of the GPG (IPCC, 2003), only for the years where conversion has taken place. C emissions [Gg C] due to change in carbon stocks in soils in land converted to cropland are reported in Table 7.18.

	Conversion Area	**Carbon stock**
year	*k ha*	*Gg C*
1990	0	0
1991	0	0
1992	0	0
1993	17	-238.4
1994	43	-602.6
1995	34	-483.4
1996	0	0
1997	9	-121.7
1998	68	-963.4
1999	97	-1,367.2
2000	0	0.0
2001	0	0
2002	0	0
2003	0	0
2004	0	0
2005	0	0
2006	52	-735.3
2007	0	0

Table 7.18 Change in carbon stock in soil in land converted to cropland

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 recalculations

In response to the 2005 submission review process and in agreement with the GPG LULUCF, starting from 2006 inventory submission, soil emissions from cropland remaining cropland previously calculated on the only basis of changes in area surfaces and not to changes in management practices have been deleted because not related to a real change in carbon content in soils. Notable deviations from the precedent sectoral estimates occurred, essentially due to estimates of carbon losses by pruning (in cropland remaining cropland) and to the revision of SOC reference value for cropland. This results in mean decrease of 90% in cropland category, in the period 1990-2006.

7.3.4 Source-specific planned improvements

Additional researches will be made to collect more country-specific data on woody crops. Improvements will concern the implementation of the estimate of carbon change in cropland biomass at a higher 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. Activities planned in the framework of the National Registry for Forest Carbon Sinks should also provide data to improve estimate of carbon sequestration due to Afforestation/reforestation activities (with a special focus on soil organic content), and should allow to refine the estimate of soil organic content in cropland category.

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 category is responsible for 7,760 Gg of CO_2 removals in 2007, with 1,243 Gg of CO_2 emissions due to living biomass pool and 9,003 Gg of CO_2 removals due the soils pool. In the period 1990-2007 mean grassland emissions share 3.8% of absolute CO_2 LULUCF emissions and removals, in particular the living biomass emissions represent 12%, while the removals from soils stand for 88% of absolute total grassland CO_2 emissions and removals.

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 have 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; in accordance to the GPG no data regarding the dead organic matter pool have been provided, since not enough information is available.
According to the LULUCF GPG (IPCC, 2003), the estimation method is based on changes in soil C stocks over a finite period following changes in management that impact soil C (Equation 3.4.8). Soil C concentration for grassland systems is driven by the change in practice or management, reflecting in different specific climate, soil and management combination, applied for the respective time points. It wasn't possible to point out different sets of relative stock change factors [F_{LU} (land use), F_{MG} (management), F_I (input factor)] for the period 1990-2007 under investigation; therefore, as no management changes can be documented, resulting change in carbon stock has been reported as zero.
No CO_2 emissions from organic soils or from application of carbonate containing lime have occurred.

Land converted to Grassland
In accordance with the GPG methodology, estimates 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.
In accordance with the GPG methodology, estimates of carbon stock change in living biomass has been provided, since there is not sufficient information to estimate carbon stock change in dead organic matter pool. Concerning soil carbon pool, changes in carbon stocks associated with the transitions have been reported as a whole in a single year (i.e. the year of conversion), assuming, as for the other categories in transition, that the changes in carbon stocks carbon

occur in the first year after the land conversion, in spite of considering them over the time period (20 years as default) specified by IPCC GPG LULUCF (2003). As a result of conversion to grassland, it is assumed that the dominant vegetation is removed entirely, after which some type of grass is planted or otherwise established; alternatively grassland can result from the abandonment of the preceding land use, and the area is taken over by grassland. The Tier 1 has been followed, assuming that carbon stocks in biomass immediately after the conversion are equal to 0 t C ha^{-1}.

The annual area of land undergoing a transition from non grassland, only cropland in Italian case, to grassland during each year, from 1990 to 2007, has been pointed out, for each initial and final land use, through the use of the land use change matrices, one for each year. Changes in biomass carbon stocks have been accounted for in the year of conversion. The GPG equation 3.4.13 (IPCC, 2003) has been used to estimate the change in carbon stocks, resulting from the land use change. Concerning Italian territory, only conversion from cropland to grassland has occurred; therefore the default biomass carbon stocks present on land converted to grassland, as dry matter, as supplied by Table 3.4.9 of the GPG for warm temperate – dry, have been used, equal to 6.1 t d.m. ha^{-1}. Since, according to national expert judgement, it has been assumed that lands in conversion to grassland are mostly annual crops, carbon stocks in biomass immediately before conversion have been obtained by the default values reported in the Table 3.3.8 of the GPG, for annual cropland.

As pointed out above in the land use matrices, see Table 7.3, the conversion of lands into grassland have taken place only in a few years during the period 1990-2007. C emissions [Gg C] due to change in carbon stocks in living biomass in land converted to grassland, are reported in Table 7.19:

	Conversion Area	C before	DC growth	DC
year	*k ha*	*t C ha^{-1}*	*t C ha^{-1}*	*Gg C*
1990	9	5	3.05	-16.8
1991	41	5	3.05	-79.6
1992	42	5	3.05	-82.5
1993	0	5	3.05	0
1994	0	5	3.05	0
1995	0	5	3.05	0
1996	64	5	3.05	-125.4
1997	0	5	3.05	0
1998	0	5	3.05	0
1999	0	5	3.05	0
2000	9	5	3.05	-16.9
2001	132	5	3.05	-258.3
2002	43	5	3.05	-83.8
2003	990	5	3.05	-1930.0
2004	117	5	3.05	-228.3
2005	109	5	3.05	-211.9
2006	0	5	3.05	0
2007	174	5	3.05	-339.1

Table 7.19 Change in carbon stock in living biomass in land converted to grassland

Changes in carbon stocks in mineral soils in land converted to grassland have been estimated following land use changes, resulting in a change of the total soil carbon content. Initial land use soil carbon stock [$SOC_{(0-T)}$] and soil carbon stock in the inventory year [SOC_0] for the grassland have been estimated from the reference carbon stocks.

SOC reference value for grassland has been currently revised and set to 70.8 tC/ha on the basis of new references. It replaces the previous value (44.5 tC/ha coming from an expert judgement reported also for cropland) and makes the current estimate consistent with the SOC stocks reported for grassland in temperate regions, 60-150 tC/ha (Gardi 2007). The new value has been drawn up by analysing a collection of the latest papers reporting data on soil carbon in mountain meadows, pastures, set-aside lands as well as soil not disturbed since the agricultural abandonment, in Italy (Viaroli and Gardi 2004, CRPA 2009, IPLA 2007, ERSAF 2008, Del Gardo *et al* 2003, LaMantia *et al* 2007, Benedetti *et al* 2004, Masciandaro and Ceccanti 1999, Xiloyannis 2007).

Whenever the soil carbon stock was not reported in the papers, it has been calculated at the default depth of 30 cm from the soil carbon content, the bulk density, and the stoniness according to the following formula (Batjes 1996):

$$T_d = \sum_{i=1}^{K} r_i \cdot P_i \cdot D_i \cdot (1 - S_i)$$

where T_d is the overall soil carbon stock (gcm^{-2}) and, for each K layer of the soil profile, r_i is the soil bulk density (gcm^{-3}), P_i is the soil carbon content (gCg^{-1}), D_i is the layer thickness (cm), S_i is the volume of the gravel > 2mm. If not available in the papers, soil bulk density has been calculated on the basis of the soil organic matter and texture (Adam 1973):

$$r = \frac{100}{\left(\frac{X}{r_0}\right) + \left(\frac{100 - X}{r_m}\right)}$$

where r soil bulk density (gcm^{-3}), X, percent by weight of organic matter, r_0 average bulk density of organic matter (0.224 gcm^{-3}) and r_m bulk density of the mineral matter usually estimated at 1.33 gcm^{-3} or determined on the "mineral bulk density chart" (Rawls and Brakensiek, 1985).

Since soil carbon stocks are derived from experimental measurements under some representative cropland managements, the effect of the practices is intended to be included into the values and consequently no stock change factors (F_{LU}, F_{MG}, F_I) have been applied on the soil carbon stock. Each soil carbon stock was assigned to the geographical area where the relative soil carbon content has been measured and the overall values have been averaged by means of weights resulting from the proportional relevance of the indagated area (ha) over the entire Italian territory.

With the stock change factors, the grassland soil carbon stock [t C] for the inventory year [SOC_0] and the cropland land use soil carbon stock [$SOC_{(0-T)}$] have been estimated, starting from the soil carbon stock for unit of area [t C ha^{-1}]. The inventory time period has been established, as abovementioned, in 1 year. The annual change in carbon stocks in mineral soils has been, at last, assessed as described in the equation 3.3.3 of the GPG, only for the years where conversion has taken place. C emissions [Gg C] due to change in carbon stocks in soils in land converted to grassland, are reported in Table 7.20:

	Conversion Area	**Carbon stock**
year	*k ha*	*Gg C*
1990	9	121.9
1991	41	576.2
1992	42	597.6
1993	0	0
1994	0	0
1995	0	0
1996	64	908.3
1997	0	0
1998	0	0
1999	0	0
2000	9	122.4
2001	132	1,870.4
2002	43	607.0
2003	990	13,973.8
2004	117	1,653.0
2005	109	1,534.4
2006	0	0
2007	174	2,455.4

Table 7.20 Change in car bon stock in soil

7.4.3 Source-specific recalculations

In response to the 2005 submission review process, as already reported in previous submissions and in agreement with the GPG LULUCF, emissions from grassland remaining grassland previously calculated on the only basis of changes in area surfaces and not to changes in management practices have been deleted, because not related to a real change in carbon content in soils. Recalculations of emissions and removals have been carried out on the basis of LULUCF Good Practice Guidance (IPCC, 2003). Remarkable deviations from the precedent sectoral estimates occurred, essentially due to the revision of SOC reference value for grassland. This results in mean increase of 26% in grassland category, in the period 1990-2006.

7.4.4 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 of land converting to grassland, to obtain a more accurate estimate of the carbon stocks change.

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

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[30] have been included in this category (MAMB, 1992). No data were available on flooded lands, therefore reservoirs or water bodies regulated by human activities have not been considered. Concerning land converted to wetland, during the period 1990-2007, 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 and soil, from land converted in settlements have been also reported. In the period 1990-2007 mean settlements emissions share 3.1% of absolute 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[31] maps, relatively to the class "*Artificial surfaces*". By assuming that the defined trend may well represent the near future, it was possible to extrapolate data for the years 2001-2007.

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

Land converted to Settlements

The average area of land undergoing a transition from non-settlements to settlements during each year, from 1990 to 2007, 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 7.3, only conversions from grassland and cropland to settlements have occurred in the 1990-2007 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 7.21:

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

Table 7.21 Stock change factors for cropland

As indicated in the land use matrices of Table 7.3, the conversion of lands into settlements has taken place only in a few years during the period 1990-2007. In Table 7.22 C stocks [Gg C] related to change in carbon stocks in living biomass in cropland (annual and perennial) converted to settlements are reported:

	annual crops to settlements		perennial crops to settlements		
Year	*Conversion Area*	*Carbon stock*	*Conversion Area*	*Carbon stock*	*Total Carbon stock*
	k ha	*Gg C*	*k ha*	*Gg C*	*Gg C*
1990	2.19	-10.94	6.07	-382.5	-393.5
1991	2.17	-10.87	6.09	-383.4	-394.3
1992	2.16	-10.80	6.10	-384.3	-395.1
1993	0	0	0	0	0
1994	0	0	0	0	0
1995	0	0	0	0	0
1996	1.97	-9.87	6.29	-396.0	-405.9
1997	0	0	0	0	0.0
1998	0	0	0	0	0
1999	0	0	0	0	0
2000	1.95	-9.77	6.31	-397.3	-407.0
2001	1.98	-9.89	6.28	-395.7	-405.6
2002	1.99	-9.94	6.27	-395.1	-405.0
2003	2.16	-10.82	6.09	-384.0	-394.8
2005	2.19	-10.94	6.07	-382.5	-393.4
2005	2.22	-11.09	6.04	-380.6	-391.7
2006	0	0	0	0	0
2007	2.23	-13.37	6.03	-386.0	-399.4

Table 7.22 Change in carbon stocks in living biomass in cropland converted to settlements

Changes in soil carbon stocks from land converting to settlements have been also estimated. In Table 7.23 soil C stocks [Gg C] of cropland (annual and perennial) and grassland converted to settlements are reported.

	annual crops to settlements		perennial crops to settlements		grassland to settlements	
Year	***Conversion Area***	***Carbon stock***	***Conversion Area***	***Carbon stock***	***Conversion Area***	***Carbon stock***
	k ha	*Gg C*	*k ha*	*Gg C*	*k ha*	*Gg C*
1990	2.19	-124.04	6.07	-344.3	0	0
1991	2.17	-123.25	6.09	-345.0	0	0
1992	2.16	-122.47	6.10	-345.8	0	0
1993	0	0	0	0	8.26	-584.91
1994	0	0	0	0	8.26	-584.91
1995	0	0	0	0	8.26	-584.91
1996	1.97	-111.93	6.29	-356.4	0	0
1997	0	0	0	0	8.26	-584.91
1998	0	0	0	0	8.26	-584.91
1999	0	0	0	0	8.26	-584.91
2000	1.95	-110.77	6.31	-357.5	0	0
2001	1.98	-112.16	6.28	-356.1	0	0
2002	1.99	-112.72	6.27	-355.6	0	0
2003	2.16	-122.73	6.09	-345.6	0	0
2004	2.19	-124.10	6.07	-344.2	0	0
2005	2.22	-125.79	6.04	-342.5	0	0
2006	0	0	0	0	8.26	-584.91
2007	2.23	-126.33	6.03	-342.0	0	0

Table 7.23 Change in carbon stocks in soil in cropland and grassland converted to settlements

7.6.3 Source-specific recalculations

Estimates of soil carbon stock changes resulting from transition of cropland and grassland to settlements have been provided. Significant deviations from the precedent sectoral estimates occurred, essentially due to the revision of SOC reference value for cropland and grassland. This results in mean increase of emissions equal to 28% in settlements category, in the period 1990-2006.

7.6.4 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 for land in transition to settlements.

7.7 Other Land (5F)

Under this category, CO_2 emissions, from living biomass, dead organic matter and soils, from land converted in other land should be accounted for; no data is reported since the conversion to other land is not occurring.

7.8 Direct N_2O emissions from N fertilization (5(I))

N_2O emissions from N fertilization of cropland and grassland are reported in the agriculture sector; therefore only forest land should be included in this table; no data have been reported, since no fertilizers are applied to forest land.

7.9 N_2O emissions from drainage of soils (5(II))

As regards to 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 are reported, according to the GPG (IPCC, 2003). N_2O emissions from cropland remaining cropland are included in the agriculture sector of the good practice guidance. The good practice guidance provides methodologies only for mineral soils.

7.10.2 Methodological issues

N_2O emissions from land use conversions are derived from mineralization of soil organic matter resulting from conversion of land to cropland. The average area of land undergoing a transition from non-cropland to cropland during each year, from 1990 to 2007, has been estimated with

the land use change matrices; as above mentioned, 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 7.24 N_2O emissions resulting from the disturbance associated with land-use conversion to cropland are reported:

Year	**Conversion Area**	**Carbon stock**	**$N_{net-min}$**	**$N_2O_{net-min}$ -N**	**N_2O emissions**
	k ha	*Gg C*	*kt N*	*kt N_2O-N*	*Gg N_20*
1990	0	0	0	0	0
1991	0	0	0	0	0
1992	0	0	0	0	0
1993	17	238	15.9	0.199	0.312
1994	43	603	40.2	0.502	0.789
1995	34	483	32.2	0.403	0.633
1996	0	0	0	0	0
1997	9	122	8.1	0.10141	0.159
1998	68	963	64.2	0.803	1.262
1999	97	1,367	91.1	1.139	1.790
2000	0	0	0	0	0
2001	0	0	0	0	0
2002	0	0	0	0	0
2003	0	0	0	0	0
2004	0	0	0	0	0
2005	0	0	0	0	0
2006	52	735	49	0.613	0.96
2007	0	0	0	0	0

Table 7.24 N_2O emissions from land-use conversion to cropland

7.10.4 Source-specific recalculations

Several differences are recognisable in the comparison between 2008 and 2009 submission, essentially due to the revision of SOC reference value for cropland and grassland and the consequent variation of carbon stocks in soils for land converting from grassland to cropland. This results in mean increase of emissions equal to 24%, in the period 1990-2006.

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

Carbon emissions from agricultural lime application are not 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, have 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 2007, calculated on the basis of regional parameters (Bovio, 1996), by the emission factors suggested in the IPCC guidelines (IPCC, 1997).
In Table 7.25 CH_4 and N_2O emissions resulting from biomass burning are reported:

	CH_4 emissions	**N_2O emissions**
year	*Gg*	*Gg*
1990	6.80	0.047
1991	1.74	0.012
1992	2.88	0.020
1993	7.18	0.049
1994	2.90	0.020
1995	1.30	0.009
1996	1.06	0.007
1997	3.53	0.024
1998	4.11	0.028
1999	2.02	0.014
2000	4.14	0.028
2001	2.63	0.018
2002	1.47	0.010
2003	3.09	0.021
2004	1.65	0.011
2005	1.63	0.011
2006	1.46	0.010
2007	9.37	0.064

Table 7.25 CH_4 and N_2O emissions from biomass burning

7.12.3 Source-specific planned improvements

An expert panel on forest fires has been set up, in order to obtain geographically referenced data on burned area; the overlapping of land use map and georeferenced data should assure the estimates of burned areas in the different land uses, with a particular focus on grassland fires in order to provide estimates of CO_2 emissions. Activities planned in the framework of the National Registry for Forest Carbon Sinks should also provide data to improve estimate of emissions by biomass burning.

7.12.4 Source-specific recalculations

No variations of CH_4 and N_2O emissions from forest fires between the previous and the current submission are noticeable, except for the year 2006, where an increase of 10% has been evidenced, due to a change in the official statistics of burned area for 2006.

Chapter 8: WASTE [CRF sector 6]

8.1 Overview of sector

The waste sector comprises four source categories:

1. solid waste disposal on land (6A);
2. wastewater handling (6B);
3. waste incineration (6C);
4. other waste (6D).

The waste sector share of GHG emissions in the national greenhouse total is presently 3.34% (and was 3.47% in the base year 1990).

The trend in greenhouse gas emissions from the waste sector is summarised in Table 8.1. It clearly shows that methane emissions from solid waste disposal sites (landfills) are by far the largest source category within this sector; 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 category 1A4a (according to the IPCC reporting guidelines).

Under 6D, CH_4 and NMVOC emissions from compost production are reported.

Emissions from methane recovered, used for energy purposes, in landfills and wastewater treatment plants are estimated and reported under category 1A4a.

GAS/SUBSOURCE	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
CO_2 (Gg)										
6C. Waste incineration	536.90	483.02	201.57	222.26	244.97	215.76	199.23	244.69	267.49	270.17
CH_4 (Gg)										
6A. Solid waste disposal on land	633.22	750.21	801.16	793.42	765.11	733.44	690.02	687.46	649.42	635.27
6B. Wastewater handling	94.67	105.37	109.62	110.74	111.19	110.60	110.98	111.55	113.97	115.95
6C. Waste incineration	7.65	12.91	11.94	12.98	12.59	12.85	16.20	14.14	13.47	12.89
6D. Other (compost production)	0.01	0.02	0.10	0.12	0.16	0.18	0.18	0.20	0.21	0.22
N_2O (Gg)										
6B. Wastewater handling	6.01	5.85	6.35	6.25	6.26	6.29	6.34	6.38	6.44	6.51
6C. Waste incineration	0.28	0.42	0.36	0.39	0.38	0.38	0.47	0.42	0.40	0.39

Table 8.1 Trend in greenhouse gas emissions from the waste sector 1990 – 2007 (Gg)

In the following box, key and non-key sources of the waste sector are presented based on level, trend or both. Methane emissions from landfills result as a key source at level assessment calculated with Tier 1 and Tier 2, whereas at trend assessment taking into account uncertainty; methane and nitrous oxide emission from wastewater handling is a key source at level and trend assessment, when taking into account uncertainty.

When including the LULUCF sector in the key source analysis, the same results are observed for methane emissions from landfills and wastewater handling, whereas nitrous oxide is a key source only at trend level considering the uncertainty.

Key-source identification in the waste sector with the IPCC Tier 1 and Tier 2 approaches (without LULUCF)

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

The source category Solid waste disposal on land is a key category for CH_4, both in terms of level and trend. The share of CH_4 emissions in the national methane total is presently 34.91% (and was 31.86% in the base year 1990).

For this source category, also NMVOC emissions are estimated; it has been assumed that non-methane volatile organic compounds are 1.3 weight per cent of methane (Gaudioso et al., 1993): this assumption refers to US EPA data (US EPA, 1990).

Methane is emitted from the degradation of waste occur in municipal landfills, both managed and unmanaged.

The main parameters that influence the estimation of emissions from landfills are, apart from the amount of waste disposed into managed landfill, the waste composition, the fraction of methane in the landfill gas and the amount of landfill gas collected and treated. These parameters are strictly dependent on the waste management policies throughout the waste streams which start from its generation, flow through collection and transportation, separation for resource recovery, treatment for volume reduction, stabilisation, recycling and energy recovery and terminate at landfill sites.

The disposal of municipal solid waste (MSW) in landfill sites is still the main disposal practice: the percentage of municipal solid waste disposed in landfills dropped from 91% in 1990 to 52% in 2007. This trend is strictly dependent from policies that have been taken in the last 20 years in waste management. In fact, at the same time, waste incineration has fairly increased, whereas composting and mechanical and biological treatment have shown a remarkable rise due to the enforcement of legislation (Figure 8.1). Also recyclable waste collection, which at the beginning of nineties was a scarce practice and waste were mainly disposed in bulk in landfills or incineration plants, has increased: in 2007, the percentage of municipal solid waste separate collection is 27.5%, but still far from legislative targets (fixed 40% in 2007).

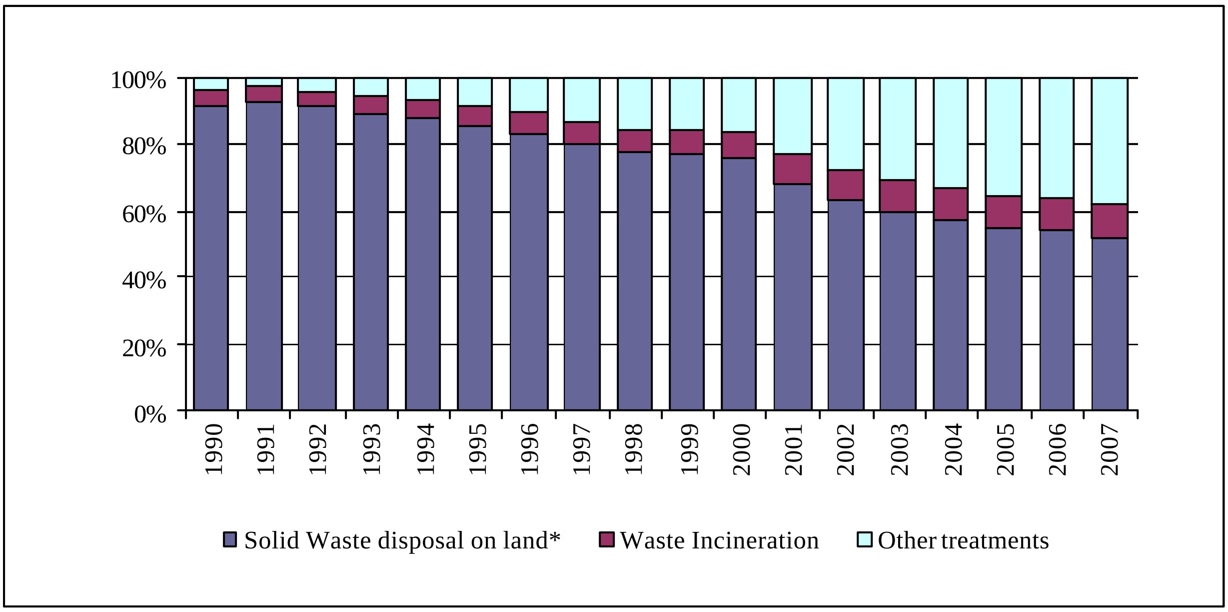


Figure 8.1 Percentage of municipal solid waste treatment and disposal, 1990 – 2007 (%)
*except sludge

In particular, in Italy the first legal provision concerning waste management was issued in 1982 (Decree of President of the Republic 10 September 1982, n.915), as a consequence of the transposition of some European Directives on waste (EC, 1975; EC, 1976; EC, 1978). In this decree, uncontrolled waste dumping as well as unmanaged landfills are forbidden, but the

enforcement of these measures has been concluded only in 2000. Thus, from 2000 municipal solid wastes are disposed only into managed landfills.
For the year 2007, the MSW landfills in Italy are 269, disposing 20,250 kt of wastes.
Since 1999, the number of MSW landfills has diminished from 786 to 269, despite the decrease of the amount of wastes disposed of is less strong. This because both uncontrolled landfills and small controlled landfills have been progressively closed, especially in the south of the country, preferring the use of modern and larger plants, which cover large territorial areas.

Concerning the composition of waste which is disposed in municipal landfills, this has been changed within the years, because of the modification of waste production due to the life-style changing and not for a forceful policy on waste management.

The Landfill European Directive (EC, 1999) has been transposed in national decree only in 2003 by the Legislative Decree 13 January 2003, n. 36 and applied to the Italian landfills since July 2005, but the effectiveness of the policies will be significant in the future. Moreover, a recent law decree (Legislative Decree 30 December 2008, n.208) shift to December 2009 the end of the temporary condition regarding waste acceptance criteria, thus the composition of waste accepted in landfills is hardly changing.

Finally, methane emissions are expected only from non hazardous waste landfills due to biodegradability of wastes disposed; in the past, law's disposition forced only this category to have a collecting gas system. Investigation has been carried out on C&D waste landfills to prove that inert typology do not generate methane emissions. No references demonstrating methane emissions from other than municipal solid waste landfills have been found. Anyway, a preliminary investigation on characterization of C&D waste is carrying out and possible results could be applied in the next year submission.

8.2.2 Methodological issues

Emission estimates from solid waste disposal on land have been carried out using the IPCC Tier 2 methodology, through the application of the First Order Decay Model (FOD).
Parameter values used in the landfill emissions model are:

1) total amount of waste disposed;
2) fraction of Degradable Organic Carbon (DOC);
3) fraction of DOC dissimilated (DOC_F);
4) fraction of methane in landfill gas (F);
5) oxidation factor (O_X);
6) methane correction factor (MCF);
7) methane generation rate constant (k);
8) landfill gas recovered (R).

The assumption that all the landfills, both managed and unmanaged, started operation in the same year, and have the same parameters, has been considered, although characteristics of individual sites can vary substantially.
Moreover, the share of waste disposed of into uncontrolled landfills has gradually decreased, as specified previously, and in the year 2000 it has been assumed equal to 0; nevertheless, emissions still occur due to the waste disposed in the past years. The unmanaged sites have been considered shallow.

Municipal solid waste

Basic data on waste production and landfills system are those provided by the national Waste Cadastre. The Waste Cadastre is formed by a national branch, hosted by ISPRA, and by regional and provincial branches. The basic information for the Cadastre is mainly represented by the data reported through the Uniform Statement Format (MUD), complemented by that provided by regional permits, provincial communications and by registrations in the national register of companies involved in waste management activities.

These figures are elaborated and published by ISPRA yearly since 1999: the yearbooks report waste production data, as well as data concerning landfilling, incineration, composting and generally waste life-cycle data (ANPA-ONR, several years; APAT-ONR, several years).

For inventory purposes, a database of waste production, waste disposal in managed and unmanaged landfills and sludge disposal in landfills was created and it has been assumed that waste landfilling started in 1950.

The complete database from 1975 of waste production, waste disposal in managed and unmanaged landfills and sludge disposal in landfills is reconstructed on the basis of different sources (MATTM, several years; FEDERAMBIENTE, 1992; AUSITRA-Assoambiente, 1995; ANPA-ONR, 1999 [a], [b]; APAT, 2002; APAT-ONR, several years), national legislation (Legislative Decree 5 February 1997, n.22), and regression models based on population (Colombari et al, 1998).

Since waste production data are not available before 1975, they have been reconstructed on the basis of proxy variables. Gross Domestic Product data have been collected from 1950 (ISTAT, several years [a]) and a correlation function between GDP and waste production has been derived from 1975; thus, the exponential equation has been applied from 1975 back to 1950.

Consequently the amount of waste disposed into landfills has been estimated, assuming that from 1975 backwards the percentage of waste landfilled is constant and equal to 80%; this percentage has been derived from the analysis of available data. As reported in the Figure 8.2, in the period 1973 – 1996 data are available for specific years (available data are reported in dark blue, whereas estimated data are reported in light blue). The trend is strictly dependent by national policies adopted for waste management and from news stories happened in those years: above all Seveso incident. From 1973 waste disposal on landfill was decreasing because of the increment of incineration practice: in 1976, Seveso incident affected the use of incineration as final waste treatment, and for some years onwards, waste disposal on land became again the most common practice. Reasonable, before 1973, the percentage of waste disposal on land has been set equal to 80%.

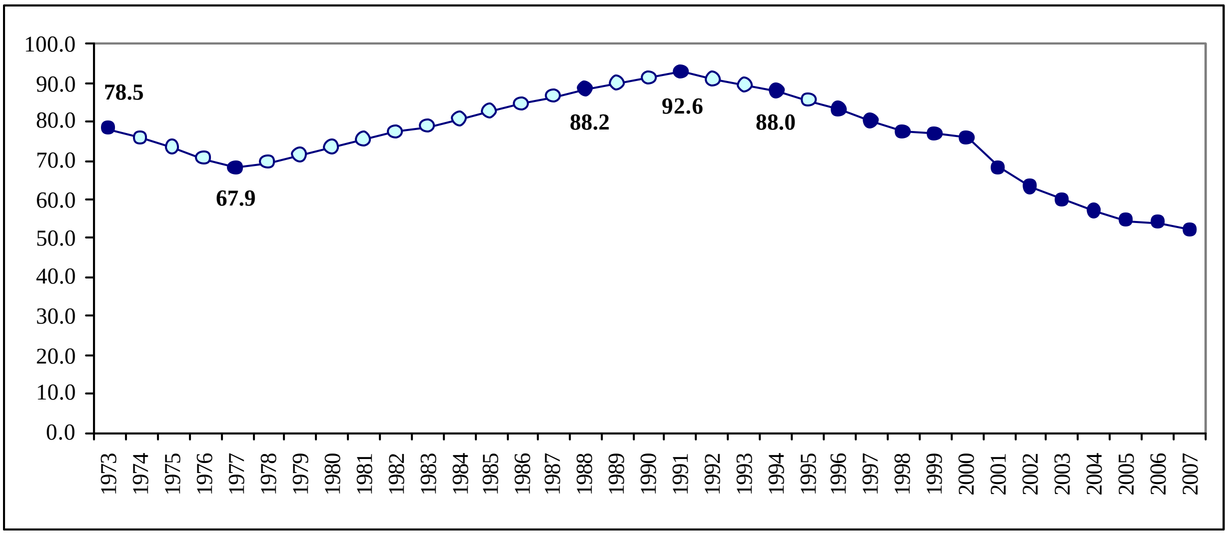


Figure 8.2 Percentage of MSW disposal on land (%)

In Table 8.2, the time series of activity data from 1990 is reported.

ACTIVITY DATA	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
MSW Production (Gg)	22,231	25,780	28,959	29,409	29,864	30,034	31,150	31,664	32,523	32,548
MSW Disposed of (%)	91.1	85.5	75.7	68.0	63.1	59.9	57.0	54.4	53.9	52.0
- in managed landfills	62.1	70.6	75.7	68.0	63.1	59.9	57.0	54.4	53.9	52.0
MSW Disposed in managed landfills (Gg)	13,797	18,196	21,917	20,003	18,848	17,996	17,742	17,226	17,526	16,912
MSW Disposed in unmanaged landfills (Gg)	6,462	3,849	0	0	0	0	0	0	0	0
Total MSW to landfills (Gg)	20,260	22,044	21,917	20,003	18,848	17,996	17,742	17,226	17,526	16,912

Table 8.2 Trend of MSW production and MSW disposed in landfills, 1990 – 2007

Sludge from urban wastewater plants

In addition to municipal solid waste, sludge from urban wastewater handling plants have also been considered, because they can be disposed in the same landfills, once they meet specific requirements.

The fraction of sludge disposed in landfill sites has been estimated to be 75% in 1990, decreasing to 55% in 2007.

On the basis of their characteristics, sludge from urban wastewater handling plants are also used in agriculture, spreading on land, and in compost production, or treated in incineration plants.
The percentage of each treatment (landfilling, soil spreading, composting, incinerating and stocking), has been reconstructed within the years starting from 1993: for that year, data on tonnes of sludge treated in a given way are available from a survey conducted by the National Institute of Statistics on urban wastewater plants (ISTAT, 1998 [a] and [b]; De Stefanis P. et al., 1998). Before 1993 the percentage has been considered constant, whereas from 1993 onwards each percentage has been varied on the basis of data known for specific years (especially for sludge use in agriculture and for compost production (MATTM, 2005; APAT-ONR, several years).

The total production of sludge from urban wastewater plants, to which apply the percentages mentioned above, has been estimated from the equivalent inhabitants treated in wastewater treatment plants, distinguished in primary and secondary plants (MATTM, 1989; ISTAT, 1991; ISTAT, 1993; ISTAT, 1998 [a] and [b]), applying the specific per capita sludge production (Masotti, 1996; ANPA, 2001; ApS, 1997).

As for the waste production, also sludge production has been reconstructed from 1950. Starting from the number of wastewater treatment plants in Italy in 1950, 1960, 1970 and 1980 (ISTAT, 1987), the equivalent inhabitants have been derived.

To summarize, from 1990 both data on equivalent inhabitants and sludge production are available (published or estimated), thus it is possible to calculate a per capita sludge production: the parameter result equal on average to 80 kg $inhab.^{-1}$ yr^{-1}. Consequently, this value has been multiplied to equivalent inhabitants from 1990 back to 1950.

In Table 8.3, time series of equivalent inhabitants treated in urban wastewater plants, as well as sludge production is reported.

ACTIVITY DATA	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Total equivalent inhabitants (*1000)	46,509	60,114	65,016	65,996	66,977	67,957	68,938	70,761	73,905	77,048
Equivalent inhabitants treated with primary system (*1000)	2,105	3,235	4,610	4,680	4,749	4,819	4,888	5,018	5,241	5,464
Equivalent inhabitants treated with secondary system (*1000)	44,404	56,879	60,406	61,317	62,228	63,139	64,050	65,744	68,664	71,585
Per capita primary sludge production (g SS /inhab. year)*	*37*	*37*	*37*	*37*	*37*	*37*	*37*	*37*	*37*	*37*
Per capita secondary sludge production (g SS /inhab. year)*	*55*	*55*	*55*	*55*	*55*	*55*	*55*	*55*	*55*	*55*
Primary sludge production (kt)	28	44	62	63	64	65	66	68	71	74
Secondary sludge production (kt)	891	1,142	1,213	1,231	1,249	1,268	1,286	1,320	1,378	1,437
Total sludge production (kt)	920	1,186	1,275	1,294	1,313	1,333	1,352	1,388	1,449	1,511
Total sludge production - 25% dry solid (kt)	3,679	4,742	5,100	5,177	5,253	5,330	5,407	5,550	5,797	6,043
Sewage sludge landfilled (kt)	2,764	3,479	3,170	3,194	3,022	3,117	3,258	3,241	3,239	3,339

Table 8.3 Trend of equivalent inhabitants treated in urban wastewater plants and sludge production, 1990 – 2007

Waste composition

One of the most important parameter that influences the estimation of emissions from landfills is the waste composition.
An in-depth survey has been carried out, in order to diversify waste composition over the years.
On the basis of data available on waste composition (Tecneco, 1972; CNR, 1980; Ferrari, 1996), three slots (1950 – 1970; 1971 – 1990; 1991 – 2007) have been individuated to which different waste composition has been assigned.
The moisture content and the organic carbon content are from national studies (Andreottola and Cossu, 1988; Muntoni and Polettini, 2002).
In Tables 8.4, 8.5 and 8.6 waste composition of each national survey mentioned above is reported. Waste types containing most of the DOC and thus involved in methane emissions are highlighted in bold type.

WASTE COMPONENT	Composition by weight (wet waste)
Food	**34.1%**
Garden and park	**3.8%**
Paper, paperboard	**31.0%**
Plastic	3.0%
Inert	28.1%

Table 8.4 Waste composition 1950-1970 (TECNECO, 1972)

WASTE COMPONENT	Composition by weight (wet waste)
Food	**37.9%**
Garden and park	**4.2%**
Paper, paperboard, textile and wood	**22.3%**
Plastic	7.2%
Metal	3.0%
Inert	7.1%
Screened waste (< 2 cm)	18.3%

Table 8.5 Waste composition 1971-1990 (CNR, 1980)

WASTE COMPONENT	Composition by weight (wet waste)
Food	**26.3%**
Garden and park	**4.5%**
Paper, paperboard	**30.1%**
Textile, leather	**5.1%**
Plastic	15.0%
Metal	3.1%
Inert	6.3%
Bulky waste	0.6%
Various	1.6%
Screened waste (< 2 cm)	7.4%

Table 8.6 Waste composition 1991-2007 (FERRARI, 1996)

Since sludge is not included in waste composition, because it usually refers to waste production and not to waste landfilled, they have been added to each waste composition, recalculating the percentage of waste type.
On the basis of the waste composition, waste stream have been categorized in three main types: rapidly biodegradable waste, moderately biodegradable waste and slowly biodegradable waste, as reported in Table 8.7. Methane emissions have been estimated separately for each mentioned biodegradability class and the results have been consequently added up.

Waste biodegradability	Rapidly biodegradable	Moderately biodegradable	Slowly biodegradable
Food	X		
Sewage sludge	X		
Garden and park		X	
Paper, paperboard			X
Textiles, leather			X
Wood			X

Table 8.7 Waste biodegradability

Degradable organic carbon (DOC) and Methane generation potential (L_0)

Degradable organic carbon (DOC) is the organic carbon in waste that is accessible to biochemical decomposition, and should be expressed as Gg C per Gg waste. The DOC in bulk waste is estimated based on the composition of waste and can be calculated from a weighted average of the degradable carbon content of various components of the waste stream. The following equation estimates DOC using default carbon content values.

$$DOC = \Sigma_i (DOC_i * W_i)$$

Where:
DOC = fraction of degradable organic carbon in bulk waste, kg C/kg of wet waste
DOC_i = fraction of degradable organic carbon in waste type *i*,
W_i = fraction of waste type *i* by waste category

Degradable organic carbon in waste type *i* can be caluculated as following:

$$DOC_i = C_i * (1-u_i) * W_i$$

Where:
C_i = organic carbon content in dry waste type *i*, kg C/ kg of waste type *i*
u_i= moisture content in waste type *i*
W_i = fraction of waste type *i* by waste category

In Tables 8.8, 8.9 and 8.10, only for waste type generating landfill gas emissions, new composition (including sludge), moisture content, organic carbon content and consequently degradable organic carbon both in waste type *i* and in bulk waste are reported.

WASTE COMPONENT	Composition by weight (wet waste)	Moisture content	Organic carbon content (dry matter)	DOC_i (kg C/t MSW)
Food	32.7%	60%	48%	62.72
Garden and park	3.6%	50%	48%	8.71
Paper, paperboard	29.7%	9%	50%	135.09
Sludge	*4.2%*	*75%*	*48%*	*5.07*
DOC				**211.59**

Table 8.8 Degradable Organic Carbon calculation, 1950-1970

WASTE COMPONENT	Composition by weight (wet waste)	Moisture content	Organic carbon content (dry matter)	DOC_i (kg C/t MSW)
Food	33.3%	60%	48%	63.95
Garden and park	3.7%	50%	48%	8.88
Paper, paperboard, textile and wood	19.6%	9%	50%	89.19
Sludge	*12.1%*	*75%*	*48%*	14.52
DOC				**176.54**

Table 8.9 Degradable Organic Carbon calculation, 1971-1990

WASTE COMPONENT	Composition by weight (wet waste)	Moisture content	Organic carbon content (dry matter)	DOC_i (kg C/t MSW)
Food	22.9%	60%	48%	43.98
Garden and park	3.9%	50%	48%	9.36
Paper, paperboard	26.2%	8%	44%	106.19
Textile, leather	4.5%	10%	55%	22.11
Sludge	*12.9%*	*75%*	*48%*	15.53
DOC				**197.18**

Table 8.10 Degradable Organic Carbon calculation, 1991-2007

Once known the degradable organic carbon, the methane generation potential value (L_0) is calculated as following:

$$L_0 = MCF * DOC * DOC_F * F * 16/12$$

Where:
MCF = methane correction factor
DOC_F = fraction of DOC dissimilated
F = fraction of methane in landfill gas

Fraction of degradable organic carbon (DOC_F) is an estimate of the fraction of carbon that is ultimately degraded and released from landfill, and reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the landfill.
DOC_F value is dependent on many factors like temperature, moisture, pH, composition of waste: the default value 0.5 has been used.
The methane correction factor (MCF) accounts for that unmanaged SWDS produce less CH_4 from a given amount of waste than managed SWDS, because a larger fraction of waste decomposes aerobically in the top layers of managed SWDS. The MCF, in relation to solid waste management, is specific to that area and should be interpreted as the 'waste management correction factor', which reflects the management aspect that it encompasses.

The MCF value used for unmanaged landfill is the default IPCC values reported for uncategorised landfills: in fact, in Italy, before 2000 existing unmanaged landfills were mostly shallow, because they resulted in uncontrolled waste dumping instead of real deep unmanaged landfills. To be conservative, the default IPCC values reported for uncategorised landfills has been used.
Finally, it is assumed that landfill gas composition is 50% carbon dioxide and 50% methane.
The following Table 8.11 summarize the methane generation potential values (L_0) generated, distinguished for managed and unmanaged landfills.

L_0 ($m^3CH_4\ tMSW^{-1}$)	1950 - 1970	1971 - 1990	1991 - 2007
Rapidly biodegradable			
- Managed landfill	90.5	85.1	81.8
- Unmanaged landfill	54.3	51.1	49.1
Moderately biodegradable			
- Managed landfill	118.2	118.2	118.2
- Unmanaged landfill	70.9	70.9	70.9
Slowly biodegradable			
- Managed landfill	224.1	224.1	205.9
- Unmanaged landfill	134.5	134.5	123.5

Table 8.11 Methane generation potential values by waste composition and landfill typology

Methane generation rate constant (k)

The methane generation rate constant *k* in the FOD method is related to the time taken for DOC in waste to decay to half its initial mass (the 'half life' or t½).
The maximum value of *k* applicable to any single solid waste disposal site (SWDS) is determined by a large number of factors associated with the composition of the waste and the conditions at the site. The most rapid rates are associated with high moisture conditions and rapidly degradable material such as food waste. The slowest decay rates are associated with dry site conditions and slowly degradable waste such as wood or paper. Thus, for each rapidly, moderately and slowly biodegradable fraction, a different maximum methane generation rate constant has been assigned, as reported in Table 8.12.
Values are suggested by national experts Andreottola and Cossu (Andreottola and Cossu, 1988), and refer to a study in which *k* values have been determined through experimental tests (Ham, 1979); despite these figures are not from national experimental tests, they well adjust to the Italian landfills.

WASTE TYPE	Half life	Methane generation rate constant
Rapidly biodegradable	1 year	0.69
Moderately biodegradable	5 years	0.14
Slowly biodegradable	15 years	0.05

Table 8.12 Half-life values and related methane generation rate constant

Landfill gas recovered (R)

Landfill gas recovered data have been reconstructed on the basis of information on extraction plants (De Poli and Pasqualini, 1991; Acaia et al., 2004; Asja, 2003) and electricity production (TERNA, several years).
Only managed landfills have a gas collection system, and the methane extracted can be used for energy or can be flared.
In Figure 8.3 methane recovery distinguished in flared amount and energy purposes is reported.

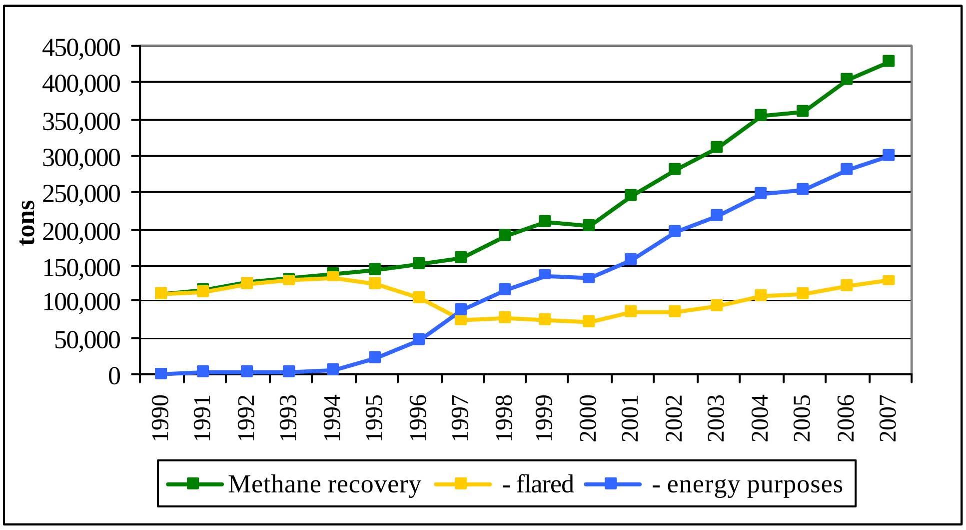


Figure 8.3 Methane recovery distinguished in flared amount and energy purposes (tons)

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% for activity data and emission factors, respectively, as suggested by the IPCC Good Practice Guidance (IPCC, 2000).
The time series of CH_4 emissions is reported in Table 8.13; emissions from the amount used for energy purposes are estimated and reported under category 1A4a.

EMISSIONS	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Managed Landfills										
Methane produced (Gg)	575.1	770.1	965.7	1013.1	1027.5	1029.7	1030.9	1038.2	1042.9	1055.7
Methane recovered (Gg)	108.9	144.1	203.4	245.2	281.6	311.9	355.8	360.5	403.2	427.3
Methane recovered (%)	18.9	18.7	21.1	24.2	27.4	30.3	34.5	34.7	38.7	40.5
CH_4 net emissions (Gg)	414.2	556.1	677.2	682.1	662.6	637.6	599.7	602.0	568.3	558.2
NMVOC net emissions (Gg)	5.5	7.3	8.9	9.0	8.7	8.4	7.9	7.9	7.5	7.4
Unmanaged Landfills										
Methane produced (Gg)	222.0	196.7	125.6	112.8	103.9	97.1	91.5	86.6	82.2	78.1
Methane recovered (Gg)	0	0	0	0	0	0	0	0	0	0
CH_4 net emissions (Gg)	219.1	194.2	124.0	111.3	102.6	95.9	90.3	85.5	81.1	77.1
NMVOC net emissions (Gg)	2.9	2.6	1.6	1.5	1.4	1.3	1.2	1.1	1.1	1.0

Table 8.13 Methane produced, recovered and CH_4 and NMVOC net emissions, 1990 – 2007 (Gg)

Whereas waste production continuously increases, from 2001 solid waste disposal on land has decreased as a consequence of waste management policies (see Tables 8.2). At the same time, the increase in the methane-recovered percentage has led to a reduction in net emissions.
Further reduction is expected in the future because of the increasing in waste recycling.

8.2.4. Source-specific QA/QC and verification

The Waste Cadastre system, as reported above, requires continuous and systematic knowledge exchange and QA/QC checks in order to ensure homogeneity of information concerning waste production and management throughout the entire Italian territory.
Moreover, the methodology, as well as the parameters used in the calculation of the emissions from landfills, have been presented and discussed at the 10th International Trade Fair on Material and Energy Recovery and Sustainable Development, Ecomondo 2006 (Ecomondo, 2006).

8.2.5. Source-specific recalculations

No recalculations occurred.

8.2.6. Source-specific planned improvements

Improvements are expected due to the entering into force of the landfill directive (EC, 1999). The application of the Directive would 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 (EEA, 2005). In particular, an update of waste composition is available, referring to a 35% separate collection waste, and will be used in next inventory submissions.
Moreover, a preliminary investigation on characterization of C&D waste is on going and possible results could be applied in the next year submission.

8.3 Wastewater handling (6B)

8.3.1. Source category description

Under source category 6B, CH_4 and N_2O are estimated both from domestic-commercial and industrial wastewaters.
In Table 8.14 an emissions reporting scheme is shown.

6.B.1 Industrial wastewater	
Wastewater	
Sludge	Emissions from sludge are reported in 6.B.1 Industrial wastewater/wastewater
6.B.2 Domestic and commercial wastewater	
6.B.2.1 Domestic and commercial wastewater	
Wastewater	N_2O emissions are reported in 6.B.2.2 Human sewage
Sludge	N_2O emissions are reported in 6.B.2.2 Human sewage
6.B.2.2 Human sewage	

Table 8.14 Emissions reporting scheme

The principal by-product of the anaerobic decomposition of the organic matter in wastewater is methane gas. Normally, CH_4 emissions are not encountered in untreated wastewater because even small amounts of oxygen tend to be toxic to the organisms responsible for the production of methane. Occasionally, however, as a result of anaerobic decay in accumulated bottom deposits, methane can be produced. On the contrary, in treatment plants, methane is produced from the anaerobic treatment process used to stabilised wastewater sludge.
Actually, in Italy 84% of population is served by sewer systems, whereas 74.8% of population is served by wastewater treatment plants (COVIRI, 2005). In unsewered areas, onsite systems, such as Imhoff tanks, are usually used. The minor percentage of population served by wastewater treatment plants implies a fraction of wastewater directly discharged in the soil or in surface water without any treatment.
On the basis of the characteristics of the influent, the plant typology is usually distinguished in ‘primary’ (only physical-chemical unit operations such as sedimentation), ‘secondary’ (biological unit process) or ‘advanced’ treatments, defined as those additional treatments needed to remove suspended and dissolved substances remaining after conventional secondary treatment.
In Italy wastewater handling is managed mainly using a secondary treatment, with aerobic biological units: a standard design facility consists of bar racks, grit chamber, primary sedimentation, aeration tanks (with return sludge), settling tank, chlorine contact chamber. The

stabilization of sludge occurs in aerobic or anaerobic reactors; where anaerobic digestion is used, the reactors are covered and provided of gas recovery.

As a consequence of these considerations, it is assumed that domestic and commercial wastewaters are treated 95% aerobically and 5% anaerobically: 5% of anaerobically systems refer to those cases where, notwithstanding aerobic treatments, CH_4 emissions can occur due to a bad management.

For high strength organic waste, such as some industrial wastewater, anaerobic process is recommended also for wastewater besides sludge treatment.
It is assumed that industrial wastewaters are treated 85% aerobically and 15% anaerobically (IRSA-CNR, 1998).
Emissions from methane recovered, used for energy purposes, in wastewater treatment plants are estimated and reported under category 1A4a.
A percentage of 2.4% of domestic and commercial wastewater is currently treated in Imhoff tanks, where the digestion of sludge occurs anaerobically without gas recovery. Therefore, very few emissions from sludge disposal do occur.

8.3.2. Methodological issues

Regarding N_2O emissions, the default approach suggested by the IPCC Guidelines (IPCC, 1997), and updated in the Good Practice Guidance (IPCC, 2000), based on population and per capita intake protein has been followed. Fraction of nitrogen protein (Frac $_{NPR}$) 0.16 kg N kg^{-1} protein and emission factor (EF_6) 0.01 kg N-N_2O kg^{-1} N produced have been used, whereas the time series of the protein intake is from the yearly FAO Food Balance (FAO, several years).

The methane estimation concerning industrial wastewaters makes use of the IPCC method based on wastewater output and the respective degradable organic carbon for each major industrial wastewater source. No country specific emission factors of methane per Chemical Oxygen Demand (COD) are available so the default value of 0.25 kg CH_4 kg^{-1} COD, suggested in the IPCC Good Practice Guidance (IPCC, 2000), has been used for the whole time series.

As recommended by the IPCC Good Practice Guidance (IPCC, 2000) for key source categories, data have been collected for several industrial sectors (iron and steel, refineries, organic chemicals, food and beverage, paper and pulp, textiles and leather industry). The total amount of organic material, for each industry selected, has been calculated multiplying the annual production (t $year^{-1}$) by the amount of wastewater consumption per unit of product (m^3 t^{-1}) and by the degradable organic component (kg COD $(m^3)^{-1}$). Moreover, the fraction of industrial degradable organic component removed as sludge has been assumed equal to zero. The yearly industrial productions are reported in the national statistics (ISTAT, several years [a], [b] and [c]), whereas the wastewater consumption factors and the degradable organic component are either from Good Practice Guidance (IPCC, 2000) or from national references. National data have been used in the calculation of the total amount of both COD produced and wastewater output specified as follows: refineries (UP, several years), organic chemicals (FEDERCHIMICA, several years), beer (Assobirra, several years), wine, milk and sugar sectors (ANPA-ONR, 2001), pulp and paper sector (ANPA-FLORYS, 2001; Assocarta, several years), and leather sector (ANPA-FLORYS, 2000; UNIC, several years).

In Table 8.15 detailed references for 2007 are reported: for these national data, slightly differences within the years can occur.

	Wastewater generation (m^3/t)	References	COD (g/l)	References
Coke	1.5	IPCC, 2000	0.1	IPCC, 2000
Petroleum Refineries	UNIONE PETROLIFERA supplies Total COD generated per year			
Organic Chemicals	22.33	FEDERCHIMICA, several years	3	IPCC, 2000
Paints	5.5	IPCC, 2000	5.5	IPCC, 2000
Plastics and Resins	0.6	IPCC, 2000	3.7	IPCC, 2000
Soap and Detergents	3	IPCC, 2000	0.9	IPCC, 2000
Vegetables, Fruits and Juices	20	IPCC, 2000	5.2	IPCC, 2000
Sugar Refining	4	ANPA-ONR, 2001	2.5	ANPA-ONR, 2001
Vegetable Oils	3.1	IPCC, 2000	1.2	IPCC, 2000
Dairy Products	3.9	ANPA-ONR, 2001	2.7	ANPA-ONR, 2001
Wine and Vinegar	3.8	ANPA-ONR, 2001	0.2	ANPA-ONR, 2001
Beer and Malt	7	Assobirra, several years	2.9	IPCC, 2000
Alcohol Refining	24	IPCC, 2000	11.0	IPCC, 2000
Meat and Poultry	13	IPCC, 2000	4.1	IPCC, 2000
Fish Processing	13	same value of Meat and Poultry	2.5	IPCC, 2000
Paper	34	ANPA-FLORYS, 2001; Assocarta, several years	0.1	ANPA-FLORYS, 2001; Assocarta, several years
Pulp	34	ANPA-FLORYS, 2001; Assocarta, several years	0.1	ANPA-FLORYS, 2001; Assocarta, several years
Textiles (dyeing)	60	IPCC, 1995	1.0	IPCC, 2000
Textiles (bleaching)	350	IPCC, 1995	1.0	IPCC, 2000
Leather	0.1	UNIC, 2004	4.03	UNIC, 2004

Table 8.15 Wastewater generation and COD values, 2007.

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 by the National Institute of Statistics (ISTAT, 2004) has provided information on urban wastewater treatment plants in Italy for the year 1999: an investigation on previous references has been done and data on primary treatment plants using Imhoff tanks are also available for 1987 (ISTAT, 1991; ISTAT, 1993) and 1993 (ISTAT, 1998 [a] and [b]).

CH_4 emissions have been calculated on the basis of the equivalent inhabitants treated in Imhoff tanks, the organic loading in biochemical oxygen demand per person equal to 60 g BOD_5 $capita^{-1}$ d^{-1}, as defined by national legislation and expert estimations (Legislative Decree 11 May 1999, no.152; Masotti, 1996; Metcalf and Eddy, 1991), the fraction of BOD_5 that readily settles equal to 0.3 (ANPA, 2001; Masotti, 1996), and the IPCC emission factor default value of 0.6 g CH_4 g^{-1} BOD_5.

8.3.3. Uncertainty and time-series consistency

The combined uncertainty in CH_4 emissions from wastewater handling is estimated to be about 104% in annual emissions 100% and 30% for activity data and emission factor respectively, as derived by the IPCC Good Practice Guidance (IPCC, 2000). The uncertainty in N_2O emissions is 30% both for activity data and emission factor as suggested in the GPG (IPCC, 2000).

The amount of total industrial wastewater production is reported, for each sector, in Table 8.16; as previously noted only the 15% of industrial flows are treated anaerobically (IRSA-CNR, 1998).

CH_4 emission trend for industrial wastewater handling for different sectors is shown in Table 8.17, whereas the emission trend for N_2O emissions both from industrial wastewater handling and human sewage is shown in Table 8.18.

Concerning CH_4 emissions from industrial wastewater, neither wastewater flow nor average COD value change much over time, therefore emissions are stable and mainly related to the production data.

The CH_4 emission trend from wastewater and sludge generated by domestic and commercial wastewater treatment is reported in Table 8.19.

8.3.4. Source-specific QA/QC and verification

Where information is available, wastewater flows and COD concentrations are checked with those reported yearly by the industrial sectoral reports or technical documentation developed in the framework of the Integrated Pollution and Prevention Control (IPPC) Directive of the European Union (http://eippcb.jrc.es).

Moreover, the methodology, as well the parameters used in the calculation of the emissions from wastewater handling, has been presented and discussed at the 10th International Trade Fair on Material and Energy Recovery and Sustainable Development, Ecomondo 2006 (Ecomondo, 2006).

Wastewater production (1000 m^3)	**1990**	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Iron and steel	9,534	7,778	6,756	7,244	6,098	5,741	6,093	6,861	7,032	7,091
Oil refinery	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Organic chemicals	210,936	212,317	215,049	214,670	214,525	214,573	214,869	214,735	214,972	215,265
Food and beverage	179,120	177,383	182,736	184,631	182,777	178,950	185,702	185,657	182,693	180,401
Pulp and paper	377,167	402,952	387,285	325,024	339,015	344,689	351,975	366,025	365,649	368,979
Textile industry	108,460	103,047	101,572	100,120	93,714	86,021	79,079	75,492	78,272	79,796
Leather industry	23,623	25,002	27,216	25,580	24,875	22,310	19,706	19,218	20,680	20,534
Total	908,840	928,479	920,614	857,269	861,004	852,283	857,424	867,989	869,297	872,066

Table 8.16 Total industrial wastewater production by sector, 1990 – 2007 (1000 m^3)

CH_4 Emissions (Gg)	**1990**	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Iron and steel	0.036	0.029	0.025	0.027	0.023	0.022	0.023	0.026	0.026	0.027
Oil refinery	5.850	5.625	4.250	4.750	4.750	4.750	4.750	4.750	4.750	4.750
Organic chemicals	23.794	23.911	24.173	24.205	24.210	24.172	24.204	24.177	24.227	24.274
Food and beverage	22.946	22.112	22.871	23.334	23.536	22.739	23.251	23.197	23.220	23.085
Pulp and paper	0.923	0.986	1.055	0.885	0.923	0.939	0.958	0.997	0.996	1.005
Textile industry	4.067	3.864	3.809	3.755	3.514	3.226	2.965	2.831	2.935	2.992
Leather industry	3.192	3.378	3.677	3.456	3.361	3.368	2.975	2.901	3.122	3.100
Total	60.81	59.91	59.86	60.41	60.32	59.22	59.13	58.88	59.28	59.23

Table 8.17 CH_4 emissions from anaerobic industrial wastewater treatment, 1990 – 2007 (Gg)

N_2O Emissions (Gg)	**1990**	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Industrial Wastewater	0.227	0.232	0.230	0.214	0.215	0.213	0.214	0.217	0.217	0.218
Human Sewage	5.787	5.619	6.115	6.040	6.042	6.079	6.123	6.162	6.222	6.294
Total	6.01	5.85	6.35	6.25	6.26	6.29	6.34	6.38	6.44	6.51

Table 8.18 N_2O emissions from industrial wastewater handling and human sewage, 1990 – 2007 (Gg)

Domestic and Commercial Wastewater	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Wastewater (5% treated anaerobically)										
Organic loading in wastewater (t $year^{-1}$)	49.83	63.83	68.84	69.94	71.05	72.17	73.30	75.42	78.88	82.34
CH_4 emissions (Gg)	29.90	38.30	41.31	41.97	42.63	43.30	43.98	45.25	47.33	49.40
Sludge (generated by Imhoff tanks)										
Eq. inhabitants treated in Imhoff tanks (10^3 millions)	1.005	1.818	2.144	2.123	2.091	2.050	1.999	1.880	1.870	1.855
Organic loading in sludge (t $year^{-1}$)	6.606	11.942	14.087	13.946	13.739	13.468	13.132	12.352	12.287	12.187
CH_4 emissions (Gg)	3.96	7.17	8.45	8.37	8.24	8.08	7.88	7.41	7.37	7.31

Table 8.19 CH_4 emissions from sludge generated by domestic and commercial wastewater treatment, 1990 – 2007 (Gg)

8.3.5. Source-specific recalculations

Minor recalculations due to some new updated data published occur. However, the recalculation is not relevant.

8.3.6. Source-specific planned improvements

No specific activities are planned.

8.4 Waste incineration (6C)

8.4.1. Source category description

Existing incinerators in Italy are used for the disposal of municipal waste, together with some industrial waste, sanitary waste and sewage sludge for which the incineration plant has been authorized from the competent authority. Other incineration plants are used exclusively for industrial and sanitary waste, both hazardous and not, and for the combustion of waste oils, whereas there are few plants that treat residual waste from waste treatments, as well as sewage sludge.

As mentioned above, emissions from waste incineration facilities with energy recovery are reported under category 1A4a (Combustion activity, commercial/institutional sector), whereas emissions from other types of waste incineration facilities are reported under category 6C (Waste incineration). For 2007, nearly 95% of the total amount of waste incinerated is treated in plants with energy recovery system.

A complete database of the incineration plants is now available, updated with the information reported in the yearly report on waste production and management published by ISPRA (APAT-ONR, several years).

Emissions from removable residues from agricultural production are included in the IPCC category 6C: the total residues amount and carbon content have been estimated by both IPCC and national factors. The detailed methodology is reported in Chapter 6 (6.6.2).

CH_4 emissions from biogenic, plastic and other non-biogenic wastes have been calculated.

8.4.2. Methodological issues

Regarding GHG emissions from incinerators, the methodology reported in the IPCC Good Practice Guidance (IPCC, 2000) has been applied, combined with that reported in the

CORINAIR Guidebook (EMEP/CORINAIR, 2005). A single emission factor for each pollutant has been used combined with plant specific waste activity data.
Emissions have been calculated for each type of waste: municipal, industrial, hospital, sewage sludge and waste oils.
A complete database of these plants has been built, on the basis of various sources available for the period of the entire time series, extrapolating data for the years for which there was no information (MATTM, several years; ANPA-ONR, 1999 [a] and [b]; APAT, 2002; APAT-ONR, several years; AUSITRA-Assoambiente, 1995; Morselli, 1998; FEDERAMBIENTE, 1998; FEDERAMBIENTE, 2001; AMA-Comune di Roma, 1996; ENI S.p.A., 2001; COOU, several years).
For each plant a lot of information is reported, among which the year of the construction and possible upgrade, the typology of combustion chamber and gas treatment section, if it is provided of energy recovery (thermal or electric), and the type and amount of waste incinerated (municipal, industrial, etc.).
Different procedures were used to estimate emission factors, according to the data available for each type of waste, expect CH_4 emission factor that is derived from EMEP Corinair (EMEP/CORINAIR, 2005).

Specifically:

1 for municipal waste, emission data from a large sample of Italian incinerators were used (FEDERAMBIENTE, 1998);
2 for industrial waste and waste oil, emission factors have been estimated on the basis of the allowed levels authorized by the Ministerial Decree 19 November 1997, n. 503 of the Ministry of Environment;
3 for hospital waste, which is usually disposed of alongside municipal waste, the emission factors used for industrial waste were also applied;
4 for sewage sludge, in absence of specific data, reference was made to the emission limits prescribed by the Guidelines for the authorisation of existing plants issued on the Ministerial Decree 12 July 1990.

In Table 8.20, emission factors are reported in kg per tons of waste treated, for municipal, industrial, hospital waste, waste oils and sewage sludge.

	NMVOC (kg/t)	CO (kg/t)	CO_2 fossil (kg/t)	N_2O (kg/t)	NO_x (kg/t)	SO_2 (kg/t)	CH_4 (kg/t)
Municipal waste	0.46	0.07	289.26	0.1	1.15	0.39	0.06
Hospital waste	7.4	0.075	1200	0.1	0.604	0.026	0.06
Sewage sludge	0.25	0.6	0	0.227	3	1.8	0.06
Waste oils	7.4	0.075	3000.59	0.1	2	1.28	0.06
Industrial waste	7.4	0.56	1200	0.1	2	1.28	0.06

Table 8.20 Waste incineration emission factors

Here below (Tables 8.21, 8.22, 8.23, 8.24), detail data and calculation for specific emission factors are reported. Emission factors have been estimated on the basis of a study conducted by ENEA (De Stefanis, 1999), based on emission data from a large sample of Italian incinerators (FEDERAMBIENTE, 1998; AMA-Comune di Roma, 1996), legal thresholds (Ministerial Decree 19 November 1997, n. 503 of the Ministry of Environment; Ministerial Decree 12 July 1990) and expert judgements.
In detail, as regard CO_2 emission factor for municipal waste, it has been calculated considering a carbon content equal to 23%; moreover, on the basis of the IPCC Guidelines (IPCC, 1997) and referring to the average content analysis on a national scale (FEDERAMBIENTE, 1992), a distinction was made between CO_2 from fossil fuels (generally plastics) and CO_2 from renewable organic sources (paper, wood, other organic materials). Only emissions from fossil fuels, which are equivalent to 35% of the total, were included in the inventory.

CO_2 emission factor for industrial, oils and hospital waste has been derived as the average of values of investigated industrial plants. On the other hand, CO_2 emissions from the incineration of sewage sludge were not included at all, while all emissions relating to the incineration of hospital and industrial waste were considered.

Municipal waste	**Average concentration values (mg/Nm^3)**	**Standard specific flue gas volume (Nm^3/KgMSW)**	**E.F. (g/t)**
SO_2	78.00	5	390
NO_x	230.00		1,150
CO	14.00		70
N_2O			100
CH_4			59.80
NMVOC			460.46
C content, % weight	23		
CO_2			826.5 (kg/t)

Table 8.21 Municipal waste emission factors

Industrial and oil waste	**Average concentration values (mg/Nm^3)**	**Standard specific flue gas volume (Nm^3/KgMSW)**	**E.F. (g/t)**
SO_2	160.00	8	1,280
NO_x	250.00		2,000
CO	70.00		560
N_2O			100
CH_4			59.80
NMVOC			7,400
CO_2			1,200 (kg/t)

Table 8.22 Industrial waste and oils emission factors

Hospital waste	**Average concentration values (mg/Nm^3)**	**Standard specific flue gas volume (Nm^3/KgMSW)**	**E.F. (g/t)**
SO_2	3.24	8	26
NO_x	75.45		604
CO	9.43		75
N_2O			100
CH_4			59.80
NMVOC			7,400
CO_2			1,200 (kg/t)

Table 8.23 Hospital waste emission factors

Sewage sludge	**Average concentration values (mg/Nm^3)**	**Standard specific flue gas volume (Nm^3/KgMSW)**	**E.F. (g/t)**
SO_2	300	6	1,800
NO_x	500		3,000
CO	100		600
N_2O			100
CH_4			59.80
NMVOC			7,400
CO_2			1,200 (kg/t)

Table 8.24 Sewage sludge emission factors

CH_4 and N_2O emissions from agriculture residues removed, collected and burnt 'off-site', as a way to reduce the amount of waste residues, are reported in the waste incineration sub-sector.

Removable residues from agriculture production are estimated for each crop type (cereal, green crop, permanent cultivation) taking into account the amount of crop produced, the ratio of removable residue in the crop, the dry matter content of removable residue, the ratio of removable residue burned, the fraction of residues oxidised in burning, the carbon and nitrogen content of the residues. Most of these wastes refer especially to the prunes of olives and wine, because of the typical national cultivation. We report in the agriculture sector, under 4.F, emissions due to stubble burning, which are emissions only from the agriculture residues burned on field. Under the waste sector the burning of removable agriculture residues that are collected and could be managed in different ways (disposed in landfills, used to produce compost or used to produce energy) is reported. At the moment no information is available to detail the final management of these wastes so we consider the total amount all burnt.

The methodology is the same used to calculate emissions from residues burned on fields, in the category 4F, described in details in Chapter 6.

On the basis of carbon and nitrogen content of the residues, CH_4 and N_2O emissions have been calculated, both accounting nearly for 100% of the whole emissions from waste incineration. CO_2 emissions have been calculated but not included in the inventory as biomass. All these parameters refer both to the IPCC Guidelines (IPCC, 1997) and country-specific values (CESTAAT, 1988; Borgioli, 1981).

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% for activity data and emission factors respectively. As regards N_2O and CH_4 emissions, the combined uncertainty is estimated to be about 100% and 20.6% in annual emissions.

The time series of activity data, distinguished in Municipal Solid Waste and other, is shown in Table 8.25; CO_2 emission trends for each type of waste category are reported in Table 8.26, both for plants without energy recovery, reported under 6C, and plants with energy recovery, reported under 1A4a. In Table 8.27 N_2O and CH_4 emissions are summarized, including those from open burning.

In the period 1990-2007, total CO_2 emissions have increased by 172.9%, but whereas emissions from plants with energy recovery have increased by nearly 383%, emissions from plants without energy recovery decreased by 49.7%. While CO_2 emission trend reported in 6C is influenced by the amount of waste incinerated in plant without energy recovery, CH_4 and N_2O emission trend are related to the open burning, as already reported above.

SUBSOURCE	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
MSW Production (Gg)	22,231	25,780	28,959	29,409	29,864	30,034	31,150	31,664	32,523	32,548
MSW Incinerated (%)	4.6%	5.6%	8.0%	8.8%	9.0%	9.5%	9.9%	10.2%	10.1%	10.1%
- in energy recovery plants	2.8%	4.6%	7.5%	8.3%	8.7%	9.3%	9.7%	10.0%	10.0%	10.0%
MSW to incineration (Gg)	1,026	1,437	2,325	2,599	2,698	2,853	3,088	3,220	3,269	3,300
Industrial, Sanitary, Sewage Sludge and Waste Oil to incineration (Gg)	691	773	737	930	883	1,134	1,637	1,746	1,797	1,744
Total Waste to incineration (6C and 1A4a) (Gg)	**1,716**	**2,209**	**3,062**	**3,528**	**3,581**	**3,987**	**4,725**	**4,966**	**5,066**	**5,043**

Table 8.25 Waste incineration activity data, 1990 – 2007 (Gg)

SUBSOURCE	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Incineration of domestic or municipal wastes (Gg)	115.47	72.64	47.30	43.63	31.04	18.21	15.61	15.02	6.62	8.35
Incineration of industrial wastes (except flaring) (Gg)	283.31	272.85	113.09	140.84	183.64	151.11	138.35	185.58	200.31	201.08
Incineration of hospital wastes (Gg)	135.46	136.12	40.36	37.11	29.86	45.78	44.76	43.72	60.33	60.33
Incineration of waste oil (Gg)	2.66	1.41	0.82	0.67	0.43	0.65	0.51	0.36	0.24	0.41
Waste incineration (6C) (Gg)	537	483	202	222	245	216	199	245	267	270
Waste incineration reported under 1A4a (Gg)	569	835	1.331	1.598	1.546	1.923	2.634	2.765	2.804	2.747
Total waste incineration (Gg)	1,105	1,318	1,532	1,820	1,791	2,139	2,833	3,009	3,072	3,017

Table 8.26 CO_2 emissions from waste incineration (without and with energy recovery), 1990 – 2007 (Gg)

GAS/SUBSOURCE	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
N_2O (Gg)										
Waste incineration (6C)	0.28	0.42	0.36	0.39	0.38	0.38	0.47	0.42	0.40	0.39
MSW incineration reported under 1A4a	0.05	0.08	0.13	0.16	0.16	0.19	0.25	0.26	0.27	0.26
CH_4 (Gg)										
Waste incineration (6C)	7.65	12.91	11.94	12.98	12.59	12.85	16.20	14.14	13.47	12.89
MSW incineration reported under 1A4a	0.03	0.05	0.08	0.10	0.09	0.11	0.15	0.16	0.16	0.16

Table 8.27 N_2O and CH_4 emissions from waste incineration, 1990 – 2007 (Gg)

8.4.4. Source-specific QA/QC and verification

For the incineration plants reported in the EPER register, verification on emissions has been carried out.
Moreover, the methodology, as well as the parameters used in the calculation of the emissions from incineration, have been presented and discussed at the 10th International Trade Fair on Material and Energy Recovery and Sustainable Development, Ecomondo 2006 (Ecomondo, 2006).

8.4.5. Source-specific recalculations

For the year 2006, activity data from the incineration plants, which treat industrial waste, have been updated on the basis of new information published by ISPRA (APAT-ONR, several years). The main differences are related to CO_2 emissions and account for 14.3%.
In 2005, data has been update for one incineration plant that treats industrial waste.

8.4.6. Source-specific planned improvements

As reported for solid waste disposal on land, the waste composition is very important to improve CO_2 emission factor on the basis of carbon content.

8.5 Other waste (6D)

8.5.1. Source category description

Under this source category CH_4 emissions from compost production have been reported. The amount of waste treated in composting plants has shown a great increase from 1990 to 2007 (from 363,319 tons to 7,488,147 tons).

Information on input waste to composting plants are published yearly by ISPRA since 1996, including data for 1993 and 1994 (ANPA, 1998; APAT-ONR, several years), while for 1987 and 1995 only data on compost production are available (MATTM, several years; AUSITRA-Assoambiente, 1995); on the basis of this information the whole time series has been reconstructed.

8.5.2. Methodological issues

The composting plants are classified in two different kinds: the plants that treat a selected waste (food, market, garden waste, sewage sludge and other organic waste, mainly from the agro-food industry); and the mechanical-biological treatment plants, that treat the unselected waste to produce compost, refuse derived fuel (RDF), and a waste with selected characteristics for landfilling or incinerating system.
It is assumed that 100% of the input waste to the composting plants from selected waste is treated as compost, while in mechanical-biological treatment plants 30% of the input waste is treated as compost on the basis of national studies and references (Favoino and Cortellini, 2001; Favoino and Girò, 2001).
Since no methodology is provided by the IPCC for these emissions, literature data (Hogg, 2001) have been used for the emission factor, 0.029 g CH4 kg^{-1} treated waste, equivalent to compost production.
NMVOC emissions have also been estimated: emission factor (51 g NMVOC kg^{-1} treated waste) is from international scientific literature too (Finn and Spencer, 1997).
In Table 8.28 CH_4 and NMVOC emissions are reported.

GAS	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
CH_4 (Gg)	0.011	0.023	0.097	0.125	0.157	0.179	0.176	0.200	0.213	0.220
Compost production (6D)										
NMVOC (Gg)	0.018	0.040	0.168	0.216	0.272	0.309	0.305	0.346	0.369	0.380
Compost production (6D)	0.011	0.023	0.097	0.125	0.157	0.179	0.176	0.200	0.213	0.220

Table 8.28 CH_4 and NMVOC emissions from compost production, 1990 – 2007 (Gg)

8.5.3. Uncertainty and time-series consistency

The uncertainty in CH_4 emissions from compost production is estimated to be about 100% in annual emissions, 10% and 100% concerning activity data and emission factors respectively.

8.5.4. Source-specific QA/QC and verification

The methodology, as well as the parameters used in the calculation of the emissions from compost production, have been presented and discussed at the 10th International Trade Fair on Material and Energy Recovery and Sustainable Development, Ecomondo 2006 (Ecomondo, 2006).

8.5.5. Source-specific recalculations

No recalculation has been done.

8.5.6. Source-specific planned improvements

No specific activities are planned.

Chapter 9: RECALCULATIONS AND IMPROVEMENTS

9.1 Explanations and justifications for recalculations

To meet the requirements of transparency, consistency, comparability, completeness and accuracy of the inventory, the entire time series from 1990 onwards is checked and revised every year during the annual compilation of the inventory. Measures to guarantee and improve these qualifications are undertaken and recalculations should be considered as a contribution to the overall improvement of the inventory.
Recalculations are elaborated on account of changes in the methodologies used to carry out emission estimates, changes due to different allocation of emissions as compared to previous submissions, changes due to error corrections and in consideration of new available information.
The complete revised CRFs from 1990 to 2006 have been submitted as well as the CRF for the year 2007 and recalculation tables of the CRF have been filled in. Explanatory information on the major recalculations between the 2008 and 2009 submissions for year 2006 are reported in Table 9.1.
The revisions that lead to relevant changes in GHG emissions are pointed out in the specific sectoral chapters and summarized in the following section 9.4.1.

9.2 Implications for emission levels

The time series reported in the 2008 submission and the series reported this year (2009 submission) are shown in Table 9.2 by gas and sector. Specifically, by gas, the comparison and differences in emission levels are reported in Table 9.3.
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 LULUCF, the emission levels of the base year show a minor decrease in comparison with the last year submission (-0.11%) whereas emissions for the year 2006 showed a decrease equal to 0.87%. Considering the national total with the LULUCF sector, the base year has increased by 2.53, and the 2006 emission levels increased by 3.83%.
Detailed explanations of these recalculations are provided in the sectoral chapters.
Changes in the base year levels are related, primarily, to the energy sector due to an overall revision of the emissions from transport; specifically, emissions from road transport have been revised on account of the application of the new version of COPERT 4 and emissions from civil aviation have been updated from the results of a recent study on the aviation sector. In the industrial sector, revisions are due to an update of the emission factor for ferroalloys following the 2006 IPCC guidelines. The LULUCF sector was also affected by a revision due to an update of activity data for forest land and of grassland and cropland of carbon organic contents in soils; in addition, losses in cropland remaining cropland have been added.
For 2006, changes affected the energy sector, due to the same methodological revision for road transport and civil aviation, as for 1990, and a reconsideration of the emissions from navigation due to a new national study. In the industrial sector, revisions are due to the update of the emission factor for ferroalloys following the 2006 IPCC guidelines and new information for cement and lime coming from the European Emissions Trading Scheme; there was also an update of F-gas emissions due to new communication of semiconductor manufacturing industry. The LULUCF sector was also affected by a revision, as for 1990, in terms of update of activity data for forest land and of grassland and cropland of carbon soil organic contents and the addition of losses in cropland remaining cropland. To a minor extent, modifications were due to the update of activity data in the agriculture and waste sectors.

Specify the sector and source/sink category[1] where changes in estimates have occurred:		GHG	RECALCULATION DUE TO				
			CHANGES IN:			Addition/removal/ reallocation of source/sink categories	Other changes in data (e.g. statistical or editorial changes, correction of errors)
			Methods [2]	Emission factors [2]	Activity data [2]		
	Sectors/Totals	CO2	The whole time series has been revised due to the application of the updated version of COPERT model (COPERT 4) for road transport estimates. The whole time series has been revised on the basis of a new methodological study for civil aviation. Figures of the navigation sector have been revised from 1998 on the basis of a new methodological study	revision of LPG emission factor and ferroalloys emission factor			
	Sectors/Totals	CO2	Losses in Cropland remaining Cropland (Living Biomass) have been estimated	Update of Grassland and Cropland Soil Organic Content	Update of AD - official forest inventory data release		
	Sectors/Totals	CH4	The whole time series has been revised due to the application of the updated version of COPERT model (COPERT 4) for road transport estimates. The whole time series has been revised on the basis of a new methodological study for civil aviation. Figures of the navigation sector have been revised from 1998 on the basis of a new methodological study	update of emission factor for reheating furnaces in the iron and steel sector			
	Sectors/Totals	N2O	The whole time series has been revised due to the application of the updated version of COPERT model (COPERT 4) for road transport estimates. The whole time series has been revised on the basis of a new methodological study for civil aviation. Figures of the navigation sector have been revised from 1998 on the basis of a new methodological study	Update of Grassland and Cropland Soil Organic Contents			
	Sectors/Totals	HFCs		Update of emissions communicated by semiconductor manufacturing industry			
	Sectors/Totals	HFC-23		Update of emissions communicated by semiconductor manufacturing industry			
	Sectors/Totals	HFC-134a			Update of HFC134a consumption communicated by FIAT industry		
	Sectors/Totals	PFCs		Update of emissions communicated by semiconductor manufacturing industry			
	Sectors/Totals	CF4		Update of emissions communicated by semiconductor manufacturing industry			
	Sectors/Totals	C2F6		Update of emissions communicated by semiconductor manufacturing industry			
	Sectors/Totals	C3F8		Update of emissions communicated by semiconductor manufacturing industry			
	Sectors/Totals	c-C4F8		Update of emissions communicated by semiconductor manufacturing industry			
	Sectors/Totals	SF6			Update of activity data for electrical equipment		
1	Energy	CO2	The whole time series has been revised due to the application of the updated version of COPERT model (COPERT 4) for road transport estimates. The whole time series has been revised on the basis of a new methodological study for civil aviation. Figures of the navigation sector have been revised from 1998 on the basis of a new methodological study	update of residual oil, natural gas and steam coal emission factor	revision of refinery gas fuel consumption in petroleum refining already accounted for in the chemical sector		
1	Energy	CH4	The whole time series has been revised due to the application of the updated version of COPERT model (COPERT 4) for road transport estimates. The whole time series has been revised on the basis of a new methodological study for civil aviation. Figures of the navigation sector have been revised from 1998 on the basis of a new methodological study	update of emission factor for reheating furnaces in the iron and steel sector	revision of refinery gas fuel consumption in petroleum refining already accounted for in the chemical sector		
1	Energy	N2O	The whole time series has been revised due to the application of the updated version of COPERT model (COPERT 4) for road transport estimates. The whole time series has been revised on the basis of a new methodological study for civil aviation. Figures of the navigation sector have been revised from 1998 on the basis of a new methodological study		revision of refinery gas fuel consumption in petroleum refining already accounted for in the chemical sector		
1.AA	Fuel Combustion - Sectoral Approach	CO2	The whole time series has been revised due to the application of the updated version of COPERT model (COPERT 4) for road transport estimates. The whole time series has been revised on the basis of a new methodological study for civil aviation. Figures of the navigation sector have been revised from 1998 on the basis of a new methodological study	update of residual oil, natural gas and steam coal emission factor	revision of refinery gas fuel consumption in petroleum refining already accounted for in the chemical sector		
1.AA	Fuel Combustion - Sectoral Approach	CH4	The whole time series has been revised due to the application of the updated version of COPERT model (COPERT 4) for road transport estimates. The whole time series has been revised on the basis of a new methodological study for civil aviation. Figures of the navigation sector have been revised from 1998 on the basis of a new methodological study	update of emission factor for reheating furnaces in the iron and steel sector	revision of refinery gas fuel consumption in petroleum refining already accounted for in the chemical sector		
1.AA	Fuel Combustion - Sectoral Approach	N2O	The whole time series has been revised due to the application of the updated version of COPERT model (COPERT 4) for road transport estimates. The whole time series has been revised on the basis of a new methodological study for civil aviation. Figures of the navigation sector have been revised from 1998 on the basis of a new methodological study		revision of refinery gas fuel consumption in petroleum refining already accounted for in the chemical sector		
1.AA.1	Energy Industries	CO2		update of residual oil, natural gas and steam coal emission factor	revision of refinery gas fuel consumption in petroleum refining already accounted for in the chemical sector		
1.AA.1	Energy Industries	CH4			revision of refinery gas fuel consumption in petroleum refining already accounted for in the chemical sector		
1.AA.1	Energy Industries	N2O			revision of refinery gas fuel consumption in petroleum refining already accounted for in the chemical sector		
1.AA.2	Manufacturing Industries and Construction	CO2		update of fuel oil, natural gas and steam coal emission factors			update of cement production
1.AA.2	Manufacturing Industries and Construction	CH4		update of emission factor for reheating furnaces in the iron and steel sector			update of cement production
1.AA.2	Manufacturing Industries and Construction	N2O					update of cement production
1.AA.3	Transport	CO2	The whole time series has been revised due to the application of the updated version of COPERT model (COPERT 4) for road transport estimates. The whole time series has been revised on the basis of a new methodological study for civil aviation. Figures of the navigation sector have been revised from 1998 on the basis of a new methodological study				
1.AA.3	Transport	CH4	The whole time series has been revised due to the application of the updated version of COPERT model (COPERT 4) for road transport estimates. The whole time series has been revised on the basis of a new methodological study for civil aviation. Figures of the navigation sector have been revised from 1998 on the basis of a new methodological study				
1.AA.3	Transport	N2O	The whole time series has been revised due to the application of the updated version of COPERT model (COPERT 4) for road transport estimates. The whole time series has been revised on the basis of a new methodological study for civil aviation. Figures of the navigation sector have been revised from 1998 on the basis of a new methodological study				
1.AA.4	Other Sectors	CO2		revision of residual oil, natural gas and coal emission factors	update of industrial and urban solid waste		
1.AA.4	Other Sectors	CH4			update of industrial and urban solid waste		
1.AA.4	Other Sectors	N2O			update of industrial and urban solid waste		
1.B	Fugitive Emissions from Fuels	CH4		update of emission factor for minor gas distributors	update of activity data (distribution among different sources of oil production and gas consumption)		
1.B.2	Oil and Natural Gas	CH4		update of emission factor for minor gas distributors	update of activity data (distribution among different sources of oil production and gas consumption)		
1.C1	International Bunkers	CO2	revision of the whole time series for aviation and maritime due to a new methodological study				
1.C1	International Bunkers	CH4	revision of the whole time series for aviation and maritime due to a new methodological study				
1.C1	International Bunkers	N2O	revision of the whole time series for aviation and maritime due to a new methodological study				
1.C3	CO2 Emissions from Biomass	CO2			update of urban solid waste in residential combustion		

2	Industrial Processes	CO2		revision of the emission factor according to 2006 IPCC guidelines for ferroalloys production	update of activity data for pig iron, steel and ferroalloys production		
2	Industrial Processes	CH4			update of steel and pig iron production		
2	Industrial Processes	HFCs		Update of emissions communicated by semiconductor manufacturing industry			
2	Industrial Processes	HFC-23		Update of emissions communicated by semiconductor manufacturing industry			
2	Industrial Processes	HFC-134a			Update of HFC134a consumption communicated by FIAT industry		
2	Industrial Processes	PFCs		Update of emissions communicated by semiconductor manufacturing industry			
2	Industrial Processes	CF4		Update of emissions communicated by semiconductor manufacturing industry			
2	Industrial Processes	C2F6		Update of emissions communicated by semiconductor manufacturing industry			
2	Industrial Processes	C3F8		Update of emissions communicated by semiconductor manufacturing industry			
2	Industrial Processes	c-C4F8		Update of emissions communicated by semiconductor manufacturing industry			
2	Industrial Processes	SF6			Update of activity data for electrical equipment		
2.A	Mineral Products	CO2		changes in EF due to use of data collected from the European emissions trading scheme for cement and lime production			
2.C	Metal Production	CO2		revision of the emission factor according to 2006 IPCC guidelines for ferroalloys production. change in EF for pig iron production	update of steel, pig iron and ferroalloys production		
2.C	Metal Production	Recovery/CO2				HFC emissions have been added from 2007	
2.C	Metal Production	CH4			update of steel and pig iron production		
2.C	Metal Production	Recovery/CH4				HFC emissions have been added from 2007	
2.C	Metal Production	N2O				HFC emissions have been added from 2007	
2.C	Metal Production	Recovery/N2O				HFC emissions have been added from 2007	
2.C	Metal Production	HFCs				HFC emissions have been added from 2007	
2.C	Metal Production	HFCs				HFC emissions have been added from 2007	
2.C	Metal Production	PFCs				HFC emissions have been added from 2007	
2.C	Metal Production	SF6				HFC emissions have been added from 2007	
2.F	Consumption of Halocarbons and SF6	HFCs		Update of emissions communicated by semiconductor manufacturing industry			
2.F	Consumption of Halocarbons and SF6	HFCs		Update of emissions communicated by semiconductor manufacturing industry			
2.F	Consumption of Halocarbons and SF6	HFC-23		Update of emissions communicated by semiconductor manufacturing industry			
2.F	Consumption of Halocarbons and SF6	HFC-134a			Update of HFC134a consumption communicated by FIAT industry		
2.F	Consumption of Halocarbons and SF6	HFC-134a			Update of HFC134a consumption communicated by FIAT industry		
2.F	Consumption of Halocarbons and SF6	PFCs		Update of emissions communicated by semiconductor manufacturing industry			
2.F	Consumption of Halocarbons and SF6	PFCs		Update of emissions communicated by semiconductor manufacturing industry			
2.F	Consumption of Halocarbons and SF6	CF4		Update of emissions communicated by semiconductor manufacturing industry			
2.F	Consumption of Halocarbons and SF6	CF4		Update of emissions communicated by semiconductor manufacturing industry			
2.F	Consumption of Halocarbons and SF6	C2F6		Update of emissions communicated by semiconductor manufacturing industry			
2.F	Consumption of Halocarbons and SF6	C2F6		Update of emissions communicated by semiconductor manufacturing industry			
2.F	Consumption of Halocarbons and SF6	C3F8		Update of emissions communicated by semiconductor manufacturing industry			
2.F	Consumption of Halocarbons and SF6	C3F8		Update of emissions communicated by semiconductor manufacturing industry			
2.F	Consumption of Halocarbons and SF6	c-C4F8		Update of emissions communicated by semiconductor manufacturing industry			
2.F	Consumption of Halocarbons and SF6	c-C4F8		Update of emissions communicated by semiconductor manufacturing industry			
2.F	Consumption of Halocarbons and SF6	SF6		Update of emissions communicated by semiconductor manufacturing industry	Update of activity data for electrical equipment		
2.F	Consumption of Halocarbons and SF6	SF6		Update of emissions communicated by semiconductor manufacturing industry	Update of activity data for electrical equipment		
3	Solvent and Other Product Use	CO2		Update of emission factor of domestic solvent use	Update of different activity data		
4	Agriculture	CH4		Update days of cultivation by variety of rice/Update information on solid/liquid production	Update rice production		
4	Agriculture	N2O		update spreading EF in the NH3 national emissioni inventory			
4.B	Manure Management	CH4		Update information on solid/liquid production			
4.B	Manure Management	N2O		Update information on solid/liquid production			
4.C	Rice Cultivation	CH4		update days of cultivation by variety of rice	Update rice production		
4.D	Agricultural Soils	N2O		update spreading EF in the NH3 national emissioni inventory			
4.F	Field Burning of Agricultural Residues	CH4			Update rice production		
4.F	Field Burning of Agricultural Residues	N2O			Update rice production		
5	LULUCF	CO2	Losses in Cropland remaining Cropland (Living Biomass) have been estimated	Update of Grassland and Cropland Soil Organic Content	Update of AD - official forest inventory data release		
5	LULUCF	CH4			Update of activity data (burned area)		
5	LULUCF	N2O			Update of activity data (burned area)		
5.A	Forest Land	CO2	Losses in Cropland remaining Cropland (Living Biomass) have been estimated	Update of Grassland and Cropland Soil Organic Content	Update of AD - official forest inventory data release		
5.A	Forest Land	CH4			Update of activity data (burned area)		
5.A	Forest Land	N2O			Update of activity data (burned area)		
5.B	Cropland	CO2			Update of activity data		
5.B	Cropland	N2O		Update of Grassland and Cropland Soil Organic Contents			
5.E	Settlements	CO2		Update of Grassland and Cropland Soil Organic Contents			
6	Waste	CO2			Update activity data from incineration plants		
6	Waste	CH4			Update activity data from incineration plants and update of activity data from leather industry, food and beverages, organic chemicals and domestic (wastewater) and update of rice production		
6	Waste	N2O			Update activity data from incineration plants and update of activity data from leather industry, food and beverages and organic chemicals (wastewater) and update of rice production		
6.B	Wastewater Handling	CH4			Update of activity data from leather industry, food and beverages, organic chemicals and domestic wastewater		
6.B	Wastewater Handling	N2O			Update of activity data from leather industry, food and beverages, organic chemicals		
6.C	Waste Incineration	CO2			Update of activity data from incineration plants		
6.C	Waste Incineration	CH4			Update of activity data from incineration plants and rice production		
6.C	Waste Incineration	N2O			Update of activity data from incineration plants and rice production		

Table 9.1 Explanations of the main recalculations in the 2009 submission (year 2006)

TABLE 10 EMISSION TRENDS (SUMMARY)
(Sheet 5 of 5)

Italy
2007

GREENHOUSE GAS EMISSIONS	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	CO2 equivalent (Gg)																	
CO2 emissions including net CO2 from LULUCF	367,037	348,232	350,168	361,573	338,908	359,585	346,789	362,122	377,855	378,212	383,389	375,767	374,907	359,145	397,091	394,682	395,617	404,176
CO2 emissions excluding net CO2 from LULUCF	434,688	433,831	433,418	427,116	420,095	445,401	438,910	443,112	454,389	459,592	462,715	468,439	470,590	486,014	488,970	490,056	485,754	475,302
CH4 emissions including CH4 from LULUCF	41,882	43,091	42,498	42,889	43,406	44,185	44,199	44,567	44,290	44,257	44,284	42,978	41,870	41,143	39,873	39,679	38,075	38,414
CH4 emissions excluding CH4 from LULUCF	41,739	43,055	42,437	42,738	43,345	44,158	44,177	44,493	44,204	44,214	44,197	42,922	41,839	41,078	39,838	39,645	38,044	38,217
N2O emissions including N2O from LULUCF	37,415	38,430	37,888	38,535	37,875	38,563	38,161	39,386	39,405	40,101	39,781	39,794	39,056	38,559	39,645	37,902	32,842	31,856
N2O emissions excluding N2O from LULUCF	37,400	38,427	37,882	38,423	37,624	38,364	38,158	39,330	39,006	39,542	39,772	39,788	39,053	38,552	39,642	37,899	32,540	31,836
HFCs	351	355	359	355	482	671	450	756	1,182	1,524	1,986	2,550	3,100	3,796	4,515	5,267	5,956	6,701
PFCs	1,808	1,452	850	707	477	491	243	252	270	258	346	451	424	498	348	353	282	288
SF6	333	356	358	370	416	601	683	729	605	405	493	795	740	468	502	465	406	428
Total (including LULUCF)	**448,825**	**431,917**	**432,120**	**444,430**	**421,563**	**444,096**	**430,525**	**447,812**	**463,608**	**464,756**	**470,279**	**462,335**	**460,096**	**443,608**	**481,975**	**478,349**	**473,178**	**481,862**
Total (excluding LULUCF)	**516,318**	**517,476**	**515,303**	**509,710**	**502,439**	**529,686**	**522,622**	**528,671**	**539,655**	**545,535**	**549,509**	**554,946**	**555,746**	**570,406**	**573,815**	**573,685**	**562,982**	**552,771**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	CO2 equivalent (Gg)																	
1. Energy	418,945	418,508	417,774	414,371	408,283	431,961	427,889	432,025	443,395	448,402	450,722	455,290	457,264	471,623	473,756	474,506	469,586	458,673
2. Industrial Processes	36,467	36,131	35,532	32,697	31,363	34,530	31,480	31,969	32,422	32,862	34,903	36,946	37,040	38,232	40,522	40,367	35,916	36,296
3. Solvent and Other Product Use	2,394	2,334	2,334	2,293	2,210	2,180	2,279	2,280	2,367	2,348	2,285	2,211	2,219	2,167	2,144	2,139	2,147	2,133
4. Agriculture	40,576	41,371	40,862	41,163	40,641	40,349	40,097	41,150	40,418	40,795	39,940	38,954	38,250	38,102	37,917	37,242	36,627	37,210
5. Land Use, Land-Use Change and Forestry(5)	-67,493	-85,559	-83,183	-65,280	-80,876	-85,590	-92,097	-80,859	-76,048	-80,779	-79,230	-92,611	-95,649	-126,798	-91,840	-95,336	-89,804	-70,910
6. Waste	17,936	19,132	18,800	19,187	19,942	20,666	20,876	21,247	21,054	21,126	21,659	21,545	20,973	20,283	19,475	19,432	18,707	18,459
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)(5)	**448,825**	**431,917**	**432,120**	**444,430**	**421,563**	**444,096**	**430,525**	**447,812**	**463,608**	**464,756**	**470,279**	**462,335**	**460,096**	**443,608**	**481,975**	**478,349**	**473,178**	**481,862**

Italy
2006

GREENHOUSE GAS EMISSIONS	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
	CO2 equivalent (Gg)																
CO2 emissions including net CO2 from LULUCF	355,494	332,668	336,172	344,954	322,441	342,202	332,898	344,400	358,867	356,363	367,151	361,413	359,381	361,446	378,435	378,332	375,678
CO2 emissions excluding net CO2 from LULUCF	434,783	434,201	433,842	427,712	420,928	445,845	439,328	443,568	454,875	459,911	464,276	470,178	472,395	487,837	491,055	491,834	488,039
CH4 emissions including CH4 from LULUCF	41,757	42,963	42,370	42,752	43,327	44,145	44,199	44,590	44,309	44,349	44,378	42,986	41,867	41,151	39,963	39,628	38,186
CH4 emissions excluding CH4 from LULUCF	41,614	42,926	42,310	42,601	43,266	44,118	44,177	44,516	44,222	44,307	44,291	42,931	41,836	41,086	39,928	39,594	38,158
N2O emissions including N2O from LULUCF	38,024	39,002	38,443	39,010	38,168	38,814	38,547	39,824	39,970	40,741	40,891	41,080	40,702	40,409	41,703	40,432	35,245
N2O emissions excluding N2O from LULUCF	38,009	38,998	38,437	38,955	38,062	38,731	38,545	39,797	39,801	40,509	40,882	41,075	40,699	40,403	41,700	40,429	35,120
HFCs	351	355	359	355	482	671	450	756	1,182	1,524	1,986	2,550	3,100	3,796	4,515	5,267	5,932
PFCs	1,808	1,452	850	707	477	491	243	252	270	258	346	451	424	498	350	361	282
SF6	333	356	358	370	416	601	683	729	605	405	493	795	738	465	492	460	390
Total (including LULUCF)	**437,766**	**416,796**	**418,552**	**428,149**	**405,311**	**426,925**	**417,021**	**430,551**	**445,203**	**443,639**	**455,244**	**449,276**	**446,211**	**447,764**	**465,458**	**464,480**	**455,713**
Total (excluding LULUCF)	**516,898**	**518,289**	**516,155**	**510,701**	**503,630**	**530,457**	**523,426**	**529,617**	**540,956**	**546,914**	**552,274**	**557,980**	**559,191**	**574,084**	**578,039**	**577,945**	**567,922**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
	CO2 equivalent (Gg)																
1. Energy	419,446	419,285	418,585	415,321	409,437	432,672	428,617	432,907	444,627	449,754	453,425	458,276	460,747	475,373	477,884	478,017	473,681
2. Industrial Processes	36,544	36,165	35,572	32,736	31,399	34,590	31,556	32,032	32,489	32,889	34,965	36,993	37,002	38,162	40,641	41,119	36,783
3. Solvent and Other Product Use	2,394	2,334	2,334	2,293	2,210	2,180	2,279	2,280	2,367	2,348	2,285	2,211	2,219	2,167	2,144	2,139	2,148
4. Agriculture	40,578	41,373	40,864	41,164	40,642	40,350	40,098	41,151	40,419	40,796	39,940	38,954	38,250	38,100	37,895	37,239	36,642
5. Land Use, Land-Use Change and Forestry(5)	-79,132	-101,493	-97,603	-82,552	-98,319	-103,532	-106,405	-99,066	-95,753	-103,275	-97,030	-108,704	-112,979	-126,320	-112,582	-113,465	-112,209
6. Waste	17,936	19,132	18,800	19,187	19,942	20,666	20,876	21,247	21,054	21,126	21,659	21,545	20,973	20,283	19,475	19,431	18,668
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)(5)	**437,766**	**416,796**	**418,552**	**428,149**	**405,311**	**426,925**	**417,021**	**430,551**	**445,203**	**443,639**	**455,244**	**449,276**	**446,211**	**447,764**	**465,458**	**464,480**	**455,713**

Table 9.2 Comparison between the 2008 and 2009 submitted time series by gas and sector

		Base year 1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Net CO_2 emissions/removals (Gg CO_2-eq.)	2007 subm	355,494	342,202	332,898	344,400	358,867	356,363	367,151	361,413	359,381	361,446	378,435	378,332	375,678
	2008 subm	367,037	359,585	346,789	362,122	377,855	378,212	383,389	375,767	374,907	359,145	397,091	394,682	395,617
Difference		*3.25%*	*5.08%*	*4.17%*	*5.15%*	*5.29%*	*6.13%*	*4.42%*	*3.97%*	*4.32%*	*-0.64%*	*4.93%*	*4.32%*	*5.31%*
CO_2 emissions (without LULUCF) (Gg CO2-eq.)	2007 subm	434,783	445,845	439,328	443,568	454,875	459,911	464,276	470,178	472,395	487,837	491,055	491,834	488,039
	2008 subm	434,688	445,401	438,910	443,112	454,389	459,592	462,715	468,439	470,590	486,014	488,970	490,056	485,754
Difference		*-0.02%*	*-0.10%*	*-0.10%*	*-0.10%*	*-0.11%*	*-0.07%*	*-0.34%*	*-0.37%*	*-0.38%*	*-0.37%*	*-0.42%*	*-0.36%*	*-0.47%*
CH_4 emissions (Gg CO_2-eq.)	2007 subm	41,757	44,145	44,199	44,590	44,309	44,349	44,378	42,986	41,867	41,151	39,963	39,628	38,186
	2008 subm	41,882	44,185	44,199	44,567	44,290	44,257	44,284	42,978	41,870	41,143	39,873	39,679	38,075
Difference		*0.30%*	*0.09%*	*0.00%*	*-0.05%*	*-0.04%*	*-0.21%*	*-0.21%*	*-0.02%*	*0.01%*	*-0.02%*	*-0.23%*	*0.13%*	*-0.29%*
CH_4 emissions (without LULUCF) (Gg CO_2-eq.)	2007 subm	41,614	44,118	44,177	44,516	44,222	44,307	44,291	42,931	41,836	41,086	39,928	39,594	38,158
	2008 subm	41,739	44,158	44,177	44,493	44,204	44,214	44,197	42,922	41,839	41,078	39,838	39,645	38,044
Difference		*0.30%*	*0.09%*	*0.00%*	*-0.05%*	*-0.04%*	*-0.21%*	*-0.21%*	*-0.02%*	*0.01%*	*-0.02%*	*-0.23%*	*0.13%*	*-0.30%*
N_2O emissions (Gg CO_2-eq.)	2007 subm	38,024	38,814	38,547	39,824	39,970	40,741	40,891	41,080	40,702	40,409	41,703	40,432	35,245
	2008 subm	37,415	38,563	38,161	39,386	39,405	40,101	39,781	39,794	39,056	38,559	39,645	37,902	32,842
Difference		*-1.60%*	*-0.65%*	*-1.00%*	*-1.10%*	*-1.41%*	*-1.57%*	*-2.71%*	*-3.13%*	*-4.04%*	*-4.58%*	*-4.93%*	*-6.26%*	*-6.82%*
N_2O emissions (without LULUCF) (Gg CO_2-eq.)	2007 subm	38,009	38,731	38,545	39,797	39,801	40,509	40,882	41,075	40,699	40,403	41,700	40,429	35,120
	2008 subm	37,400	38,364	38,158	39,330	39,006	39,542	39,772	39,788	39,053	38,552	39,642	37,899	32,540
Difference		*-1.60%*	*-0.95%*	*-1.00%*	*-1.17%*	*-2.00%*	*-2.39%*	*-2.71%*	*-3.13%*	*-4.04%*	*-4.58%*	*-4.93%*	*-6.26%*	*-7.35%*
HFCs (Gg CO_2-eq.)	2007 subm	351	671	450	756	1,182	1,524	1,986	2,550	3,100	3,796	4,515	5,267	5,932
	2008 subm	351	671	450	756	1,182	1,524	1,986	2,550	3,100	3,796	4,515	5,267	5,956
Difference		*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.40%*
PFCs (Gg CO_2-eq.)	2007 subm	1,808	491	243	252	270	258	346	451	424	498	350	361	282
	2008 subm	1,808	491	243	252	270	258	346	451	424	498	348	353	282
Difference		*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*-0.60%*	*-2.38%*	*-0.04%*
SF_6 (Gg CO_2-eq.)	2007 subm	333	601	683	729	605	405	493	795	738	465	492	460	390
	2008 subm	333	601	683	729	605	405	493	795	740	468	502	465	406
Difference		*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.05%*	*0.28%*	*0.62%*	*2.15%*	*1.13%*	*4.11%*
Total (with LULUCF) (Gg CO2-eq.)	2007 subm	437,766	426,925	417,021	430,551	445,203	443,639	455,244	449,276	446,211	447,764	465,458	464,480	455,713
	2008 subm	448,825	444,096	430,525	447,812	463,608	464,756	470,279	462,335	460,096	443,608	481,975	478,349	473,178
Difference		*2.53%*	*4.02%*	*3.24%*	*4.01%*	*4.13%*	*4.76%*	*3.30%*	*2.91%*	*3.11%*	*-0.93%*	*3.55%*	*2.99%*	*3.83%*
Total (without LULUCF) (Gg CO2-eq.)	2007 subm	516,898	530,457	523,426	529,617	540,956	546,914	552,274	557,980	559,191	574,084	578,039	577,945	567,922
	2008 subm	516,318	529,686	522,622	528,671	539,655	545,535	549,509	554,946	555,746	570,406	573,815	573,685	562,982
Difference		*-0.11%*	*-0.15%*	*-0.15%*	*-0.18%*	*-0.24%*	*-0.25%*	*-0.50%*	*-0.54%*	*-0.62%*	*-0.64%*	*-0.73%*	*-0.74%*	*-0.87%*

Table 9.3 Differences in time series between the 2009 and 2008 submissions due to recalculations

9.3 Implications for emission trends, including time series consistency

Recalculations account for an improvement in the overall emission trend and consistency in time series.

In comparison with the time series submitted in 2008, emission levels of the base year, total emissions in CO_2 equivalent without LULUCF, slightly changed (-0.11%) due to a revision in the energy and industrial sectors as previously described.
If considering emission levels with LULUCF, an increase by 2.53% is observed between the 2008 and 2009 total figures in CO_2 equivalent, mainly due to the update of land use areas.
For the year 2006, changes affected negatively CO_2, CH_4 and N_2O emissions (-0.47%, -0.30%, -7.35%, respectively).
The trend 'base year- year 2006' does not show a significant change from the previous to this year submission.
Improvements in methodologies used to compile the inventory 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 2008 submission.
In addition to a new year, the inventory is updated annually by a revision of the existing activity data and emission factors in order to include new information available; the update could also reflect the revision of methodologies. Revisions always apply to the whole time series.
The inventory may also be expanded by including categories not previously estimated if sufficient information on activity data and suitable emission factors have been identified and collected.

9.4.1 Recalculations

The key differences 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 2006, Table 8(a) of the CRF (year 2006), is reported 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. Major recalculations occurred in this sector, especially in transport concerning road as well as aviation and maritime sectors. The whole time series of road transport emissions have been recalculated using the updated version of the model to estimate emissions, COPERT 4. Aviation emissions have also been recalculated for the whole time series as a consequence of a specific sectoral study so as maritime emissions that have been updated from 1998. In addition, CO_2 emission factors for natural gas, coal and fuel oil were revised from 2006, 2005 and 1999, respectively, on account of additional information collected on amount of imported fuels and their specific chemical composition.
Industrial sector. Recalculations are due to the update of the emission factor for ferroalloys. In addition, new information from the European Emissions Trading Scheme and sectoral industry was used to update emission factors for cement and lime and F-gas emissions of semiconductor manufacturing industry.
Solvent and other product use sector. A minor update of activity data and a revision of emission factor for domestic use occurred in this sector.
Agriculture. Besides the update of different basic data, revision concerned some parameters used to calculate emissions for manure management, rice production and agricultural soils.
LULUCF. The main changes concerned the update of activity data, related to land use areas, and the estimation of losses in cropland remaining cropland.
Waste. Minor revisions concerned the update of activity data in wastewater handling and incineration sectors.

9.4.2 Response to the UNFCCC review process

In 2008, the Italian GHG inventory was subject to the centralised review of the 2007 and 2008 Inventory submissions.
Following the recommendations of the review processes different improvements have been carried out.
The main improvements regarded the update of the method for estimating emissions from transportation. Specifically, the new version of the programme to estimate emissions from road transport was applied to revise all the time series, an update of the method for estimating the fuel split for national and international aviation was carried out and a new study was finalised for the maritime sector.

The assumptions and rationale underlying the uncertainty analysis in the Italian inventory have been extensively detailed. Exhaustive results of uncertainty and key category analysis for the base year have been reported.

Verification and QA/QC procedures were explained more in detail for the energy sector, especially for those sectors mostly affected by recalculations and a further improvement is planned for the next submission.
An independent review of the complete inventory is still under consideration but sectoral emissions have been actually presented different institutions, local agencies and industrial sectors and methodologies shared, leading in some cases to a revision of the estimates before submission.

The description of country specific methods and the rationale behind the choice of emission factors, activity data and other related parameters should have improved the transparency of the present NIR.

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

The main institutional and legal arrangements required under the Kyoto Protocol have been finalized except for the institution of a basic independent review of the inventory before its submission which is still under consideration. In addition, progress will regard collection and assessment of supplementary information related to activities under article 3, paragraph 3 and 4, of the Kyoto Protocol required for future reporting.
General priority will concern the improvement of the transparency in the NIR, especially a further revision of the energy chapter.
Other sector specific improvements are identified in the relevant chapters and specified in the 2009 QA/QC plan; they can be summarized in the following.
For the energy and industrial sectors, a major progress will regard the finalisation of a unique database where information collected in the framework of different directives, Large Combustion Plant, EPER-PRTR and Emissions Trading, are gathered together thus highlighting the main discrepancies in information and detecting potential errors.
For the agriculture and waste sectors, improvements will be related to the availability of new information on emission factors, activity data as well as parameters necessary to carry out the estimates; specifically, a study on the best available technologies used in agriculture practises and availability of information on waste composition and other parameters following the entering into force of the European landfill directive.
For the LULUCF; activities planned in the framework of the National Registry for Forest Carbon Sinks should provide data to improve estimate of emissions by biomass burning and the final results

of the INFC data related to the soils survey will definitely constitute a robust database for forest fires, allowing refined estimates and lower related uncertainty.
Finally, efforts will be further addressed to the comparison between local inventories and national inventory.
Further analyses will concern the collection of statistical data and information to estimate uncertainty in specific sectors by implementing the Tier 2 approach of the IPCC Good Practice Guidance.

TABLE 8(a) RECALCULATION - RECALCULATED DATA

Recalculated year: Inventory 2006
Submission 2009 v1.3
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		CO_2						CH_4						N_2O					
		Previous submission	Latest submission	Difference	Difference	excluding LULUCF	including LULUCF	Previous submission	Latest submission	Difference	Difference	excluding LULUCF	including LULUCF	Previous submission	Latest submission	Difference	Difference	excluding LULUCF	including LULUCF
		CO_2 equivalent (Gg)			(%)			CO_2 equivalent (Gg)			(%)			CO_2 equivalent (Gg)			(%)		
Total National Emissions and Removals		**375,677.88**	**395,617.40**	**19,939.52**	5.31	3.54	4.21	38,185.63	38,074.79	**-110.84**	-0.29	-0.02	-0.02	35,245.20	32,841.82	**-2,403.38**	-6.82	-0.43	-0.51
1. Energy		**458,983.83**	**457,573.05**	**-1,410.78**	-0.31	-0.25	-0.30	6,639.76	6,510.52	**-129.24**	-1.95	-0.02	-0.03	8,057.44	5,502.41	**-2,555.04**	-31.71	-0.45	-0.54
1.A.	Fuel Combustion Activities	456,795.15	455,384.37	-1,410.78	-0.31	-0.25	-0.30	1,406.65	1,317.56	-89.09	-6.33	-0.02	-0.02	8,056.07	5,501.03	-2,555.04	-31.72	-0.45	-0.54
1.A.1.	Energy Industries	159,108.26	159,178.95	70.69	0.04	0.01	0.01	135.11	135.00	-0.11	-0.08	0.00	0.00	575.17	571.85	-3.32	-0.58	0.00	0.00
1.A.2.	Manufacturing Industries and Constructio	82,083.35	82,106.25	22.90	0.03	0.00	0.00	130.81	130.72	-0.09	-0.07	0.00	0.00	1,564.16	1,564.64	0.47	0.03	0.00	0.00
1.A.3.	Transport	128,531.09	127,151.03	-1,380.07	-1.07	-0.25	-0.29	561.56	472.75	-88.81	-15.81	-0.02	-0.02	4,104.94	1,554.70	-2,550.24	-62.13	-0.45	-0.54
1.A.4.	Other Sectors	86,090.83	85,966.53	-124.30	-0.14	-0.02	-0.03	576.49	576.41	-0.08	-0.01	0.00	0.00	1,737.61	1,735.66	-1.95	-0.11	0.00	0.00
1.A.5.	Other	981.61	981.61					2.67	2.67					74.19	74.19				
1.B.	Fugitive Emissions from Fuels	2,188.68	2,188.68					5,233.11	5,192.96	-40.15	-0.77	-0.01	-0.01	1.38	1.38				
1.B.1.	Solid fuel	NA	NA					53.79	53.79					NA	NA				
1.B.2.	Oil and Natural Gas	2,188.68	2,188.68					5,179.32	5,139.17	-40.15	-0.78	-0.01	-0.01	1.38	1.38				
2. Industrial Processes		**27,465.77**	**26,559.08**	**-906.69**	**-3.30**	**-0.16**	**-0.19**	**65.85**	**65.86**	**0.02**	**0.02**	**0.00**	**0.00**	**2,646.53**	**2,646.53**				
2.A.	Mineral Products	24,048.00	23,219.30	-828.70	-3.45	-0.15	-0.18	NA	NA					NA	NA				
2.B.	Chemical Industry	1,307.98	1,307.98					6.79	6.79					2,646.53	2,646.53				
2.C.	Metal Production	2,109.79	2,031.80	-77.99	-3.70	-0.01	-0.02	59.06	59.07	0.02	0.03	0.00	0.00	NA	NA,NO				
2.D.	Other Production	NA	NA																
2.G.	Other	NA	NA					NA	NA					NA	NA				
3. Solvent and Other Product Use		**1,355.66**	**1,354.03**	**-1.62**	**-0.12**	**0.00**	**0.00**							**792.52**	**792.52**				
4. Agriculture								**15,137.27**	**15,149.19**	**11.92**	**0.08**	**0.00**	**0.00**	**21,504.86**	**21,478.23**	**-26.63**	**-0.12**	**0.00**	**-0.01**
4.A.	Enteric Fermentation							10,628.73	10,628.73										
4.B.	Manure Management							3,029.06	3,031.15	2.09	0.07	0.00	0.00	3,620.87	3,618.16	-2.71	-0.07	0.00	0.00
4.C.	Rice Cultivation							1,466.86	1,476.63	9.77	0.67	0.00	0.00						
4.D.	Agricultural Soils (4)							NA	NA					17,880.03	17,856.09	-23.94	-0.13	0.00	-0.01
4.E.	Prescribed Burning of Savannas							NO	NO					NO	NO				
4.F.	Field Burning of Agricultural Residues							12.62	12.68	0.06	0.49	0.00	0.00	3.96	3.99	0.02	0.61	0.00	0.00
4.G.	Other							NA	NA					NA	NA				
5. Land Use, Land-Use Change and Forestry (net) (		**-112,361.49**	**-90,136.26**	22,225.23	-19.78		4.70	27.47	30.62	3.1470401	11.457108		0.000665	125.02	301.62	176.59	141.25		0.04
5.A.	Forest Land	-94,883.76	-84,194.42	10,689.34	-11.27		2.26	27.47	30.62	3.1470401	11.457108		0.000665	2.79	3.11	0.32	11.46		0.00
5.B.	Cropland	-18,758.01	-8,086.51	10,671.51	-56.89		2.26	NO	NO					122.24	298.509882	176.27	144.21		0.04
5.C.	Grassland	NO	NO					NO	NO					NO	NO				
5.D.	Wetlands	NO	NO					NO	NO					NO	NO				
5.E.	Settlements	1,280.29	2,144.67	864.38	67.51		0.18	NO	NO					NO	NO				
5.F.	Other Land	NO	NO					NO	NO					NO	NO				
5.G.	Other	NA	NA					NA	NA					NA	NA				
6. Waste		**234.11**	**267.49**	33.38	14.26	0.01	0.01	16,315.29	16,318.61	3.32	0.02	0.00	0.00	2,118.82	2,120.52	1.69	0.08	0.00	0.00
6.A.	Solid Waste Disposal on Land	NA,NO	NA,NO					13,637.88	13,637.88										
6.B.	Waste-water Handling							2,390.45	2,393.47	3.02	0.13	0.00	0.00	1,996.26	1,996.26	0.00	0.00	0.00	0.00
6.C.	Waste Incineration	234.11	267.49	33.38	14.26	0.01	0.01	282.49	282.78	0.30	0.11	0.00	0.00	122.56	124.26	1.70	1.38	0.00	0.00
6.D.	Other	NA	NA					4.47	4.47					NA	NA				
7. Other ***(as specified in Summary 1.A)***		NA	NA					NA	NA					NA	NA				
Memo Items:																			
International Bunkers		**15,764.40**	**17,274.95**	**1,510.55**	**9.58**	**0.27**	**0.32**	**20.19**	**18.52**	**-1.67**	**-8.29**	**0.00**	**0.00**	**99.40**	**128.32**	**28.92**	**29.10**	**0.01**	**0.01**
Multilateral Operations		**NE**	**NE**					**NE**	**NE**					**NE**	**NE**				
CO_2 Emissions from Biomass		**14,994.38**	**14,993.25**	**-1.13**	**-0.01**	**0.00**	**0.00**												

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		HFCs						PFCs						SF_6					
		Previous submission	Latest submission	Difference	Difference	excluding LULUCF	including LULUCF	Previous submission	Latest submission	Difference	Difference	excluding LULUCF	including LULUCF	Previous submission	Latest submission	Difference	Difference	excluding LULUCF	including LULUCF
		CO_2 equivalent (Gg)			(%)			CO_2 equivalent (Gg)			(%)			CO_2 equivalent (Gg)			(%)		
Total Actual Emissions		**5,932.24**	**5,956.20**	**23.97**	**0.40**	**0.00**	**0.01**	**282.41**	**282.30**	**-0.11**	**-0.04**	**0.00**	**0.00**	**389.84**	**405.87**	**16.04**	**4.11**	**0.00**	**0.00**
2.C.3.	Aluminium Production							154.36	154.36										
2.E.	Production of Halocarbons and SF_6	20.83	20.83					NA,NO	NA,NO					NA,NO	NA,NO				
2.F.	Consumption of Halocarbons and SF_6	5,911.41	5,935.37	23.97	0.41	0.00	0.01	128.05	127.94	-0.11	-0.09	0.00	0.00	328.61	344.64	16.04	4.88	0.00	0.00
2.G.	Other	NA	NA					NA	NA					NA	NA				
Potential Emissions from Consumption of		**9,303.15**	**9,303.15**					**274.44**	**274.44**					**2,182.88**	**2,182.88**				

	Previous submission	Latest submission	Difference	Difference
	CO_2 equivalent (Gg)			(%)
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Fo	455,713.20	473,178.39	17,465.19	3.83
Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and	567,922.20	562,982.42	-4,939.78	-0.87

Table 9.4 Recalculated data of the year 2006

Chapter 10: REFERENCES

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

10.1 INTRODUCTION

APAT, 2005. Quality Assurance/Quality Control plan for the Italian Inventory. September 2005. Internal document.

APAT, 2006 [a]. Quality Assurance/Quality Control plan for the Italian Emission Inventory. Procedures Manual. June 2006

APAT, 2006 [b]. Quality Assurance/Quality Control plan for the Italian Emission Inventory. Year 2006. June 2006

APAT, 2007 [a]. Quality Assurance/Quality Control plan for the Italian Emission Inventory. Year 2007. May 2007.

APAT, 2007 [b]. Carbon Dioxide Intensity Indicators. May 2007.

APAT, 2008 [a]. National Greenhouse Gas Inventory System in Italy. April 2008. Internal document.

APAT, 2008 [b]. Quality Assurance/Quality Control plan for the Italian Emission Inventory. Year 2008. April 2008. Internal document.

APAT, 2008 [c]. Carbon Dioxide Intensity Indicators. April 2008. Internal document.

EC, 2005. Commission decision of 10 February 2005 laying down rules implementing Decision No 280/2004/EC concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol. 2005/166/EC.

Ecofys, 2001. Evaluation of national climate change policies in EU member states. Country report on Italy, The Netherlands 2001.

EMEP/CORINAIR, 2007. Atmospheric Emission Inventory Guidebook. Technical report No 16/2007.

ENEA/MAP/APAT, 2004. Energy data harmonization for CO_2 emission calculations: the Italian case. Rome 23/02/04. EUROSTAT file n. 200245501004.

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Centre, Meteorological Office, Bracknell, UK.

IPCC, 2000. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. IPCC National Greenhouse Gas Inventories Programme, Technical Support Unit, Hayama, Kanagawa, Japan.

IPCC, 2003. Good Practice Guidance for Land Use, Land-Use Change and Forestry. IPCC Technical Support Unit, Kanagawa, Japan.

Liburdi R., De Lauretis R., Corrado C., Di Cristofaro E., Gonella B., Romano D., Napolitani G., Fossati G., Angelino E., Peroni E., 2004. La disaggregazione a livello provinciale dell'inventario nazionale delle emissioni". Rapporto APAT CTN-ACE 2004.

Romano D., Bernetti A., De Lauretis R., 2004. Different methodologies to quantify uncertainties of air emissions. Environment International vol 30 pp 1099-1107.

UNFCCC, 2007 [a]. Report of the individual review of the greenhouse gas inventory of Italy submitted in 2006. FCCC/ARR/2006/ITA. UNFCCC, 11 December 2007.

UNFCCC, 2007 [b]. Report of the review of the initial report of Italy. FCCC/IRR/2007/ITA. UNFCCC, 10 December 2007.

UNFCCC, 2009. Report of the individual review of the greenhouse gas inventories of Italy submitted in 2007 and 2008. FCCC/ARR/2008/ITA. UNFCCC, 16 January 2009.

10.2 ENERGY [CRF sector 1]

ACI, several years. Annuario statistico. Automobile Club d'Italia, Roma. http://www.aci.it/index.php?id=54.

AEEG, several years. Qualità del servizio gas. Autorità per l'energia elettrica e il gas. http://www.autorita.energia.it/cgi-bin/sintesi_cont_gas/sintesi_datigas.

AISCAT, several years. Aiscat in cifre. Data and reports available on website at: http://www.aiscat.it/pubb_cifre.htm?ck=1&sub=3&idl=4&nome=pubblicazioni&nome_sub=aiscat%20in%20cifre.

ANCMA, several years. Data available on website at: http://www.ancma.it/it/publishing.asp.

ANPA, 2001. Redazione di inventari nazionali delle emissioni in atmosfera nei settori del trasporto aereo e marittimo e delle emissioni biogeniche. Rapporto finale. Gennaio 2001.

APAT, 2003 [a]. Indicatori e modelli settoriali finalizzati alla preparazione di inventari delle emissioni del sistema energetico nazionale nel breve e medio periodo. Tricarico A., Rapporto Tecnico N° 01/2003.

APAT, 2003 [b]. Analisi dei fattori di emissione di CO_2 dal settore dei trasporti. Ilacqua M., Contaldi M., Rapporti n° 28/2003.

CONFETRA, several years. Il trasporto merci su strada in Italia. Data and reports available on website at: http://www.confetra.it/it/centrostudi/statistiche.htm.

Contaldi M., 1999. Inventario delle emissioni di metano da uso gas naturale. ANPA, internal document.

EC, 2009. Proposal for a Commission Decision amending Decision 2007/589/EC as regards th einclusion of monitoring and reporting guidelines for emissions and tonne-kilometre data from aviario activities. Commission of the European Communities, 2009 (draft).

EDISON, several years. Rendiconto ambientale e della sicurezza.

EEA, 2000. COPERT III, Computer Programme to Calculate Emissions from Road Transport - Methodology and Emission Factors, European Environment Agency, Technical report No 49, November 2000.

EEA, 2007. COPERT 4, Computer programme to calculate emissions from road transport. European Environment Agency, December 2007. http://lat.eng.auth.gr/copert/docs.htm .

EMEP/CORINAIR, 2007. Atmospheric Emission Inventory Guidebook. Technical report No 16/2007.

ENAC/MINT, several years. Annuario Statistico. Ente Nazionale per l'Aviazione Civile, Ministero delle Infrastrutture e dei Trasporti.

ENEA, several years. Rapporto Energia Ambiente. Ente per le Nuove tecnologie, l'Energia e l'Ambiente, Roma.

ENEL, several years. Dati statistici sull'energia elettrica in Italia. ENEL.

ENI, several years [a]. La congiuntura economica ed energetica. ENI.

ENI, several years [b]. Health Safety Environment report. ENI.

Frustaci F., 1999. Metodi di stima ed analisi delle emissioni inquinanti degli off-road. Thesis in Statistics.

Giordano R., 2007. Trasporto merci: criticità atttuali e potenziali sviluppi nel contesto europeo. National road transporters central commitee.

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Centre, Meteorological Office, Bracknell, UK.

IPCC, 2000. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. IPCC National Greenhouse Gas Inventories Programme, Technical Support Unit, Hayama, Kanagawa, Japan.

IPCC 2006, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds).Published: IGES, Japan

ISTAT, several years [a]. Annuario Statistico Italiano. Istituto Nazionale di Statistica.

ISTAT, 2009. Personal comunication.

ISTAT, several years [b]. Trasporto merci su strada. Istituto Nazionale di Statistica. http://www.istat.it/dati/dataset/20070109_00/.

MSE, several years [a]. Bilancio Energetico Nazionale (BEN). Ministero delle Attività Produttive, Direzione Generale delle Fonti di Energia ed industrie di base. http://dgerm.sviluppoeconomico.gov.it/dgerm/ben.asp.

MSE, several years [b]. Bollettino Petrolifero Trimestrale (BPT). Ministero delle Attività Produttive.

MINT, several years. Conto Nazionale delle Infrastrutture e dei Trasporti (CNT). Ministero delle Infrastrutture e dei Trasporti. http://www.trasporti.gov.it/page/NuovoSito/site.php?o=vd&id=3011.

Patel M.K., Tosato G.C., 1997. Understanding Non-energy Use and Carbon Storage in Italy in the Context of the Greenhouse Gas Issue.

Romano D., Gaudioso D., De Lauretis R., 1999. Aircraft Emissions: a comparison of methodologies based on different data availability. Environmental Monitoring and Assessment. Vol. 56 pp. 51-74.

Riva A., 1997. Methodology for methane emission inventory from SNAM transmission system. Snam Spa Italy.

Techne, 2009. Stima delle emissioni in atmosfera nel settore del trasporto aereo e marittimo. Final report. TECHNE Consulting, March 2009.

Terna, several years. Dati statistici sugli impianti e la produzione di energia elettrica in Italia. Gestore Rete Trasmissione Nazionale. www.terna.it .

Trozzi C., Vaccaro R., De Lauretis R., Romano D., 2002 [a]. Air pollutant emissions estimate from global air traffic in airport and in cruise: methodology and case study. Presented at Transport and Air Pollution 2002.

Trozzi C., Vaccaro R., De Lauretis R., 2002 [b]. Air pollutant emissions estimate from global ship traffic in port and in cruise: methodology and case study. Presented at Transport and Air Pollution 2002.

UP, several years. Previsioni di domanda energetica e petrolifera in Italia. Unione Petrolifera.

10.3 INDUSTRIAL PROCESSES [CRF sector 2]

ACEA, 2004. Personal Communication. ACEA.

AEM, several years. Rapporto Ambientale. AEM.

AITEC, 2004. Posizione dell'industria cementiera in merito al Piano Nazionale di Allocazione delle emissioni di gas ad effetto serra. Roma 19/03/2004.

AITEC, several years. L'industria Italiana del Cemento. Associazione italiana tecnico economica del cemento.

ALCOA, 2004. Primary Aluminium in Italy. ALCOA.

ALCOA, several years. Personal Communication. ALCOA.

ANDIL, 2000. Primo rapporto ambientaledell'industria italiana dei laterizi. Assolaterizi, Associazione nazionale degli industriali dei laterizi.

ANDIL, several years. Indagine conoscitiva sui laterizi. Assolaterizi, Associazione nazionale degli industriali dei laterizi.

ANIE, several years. Personal Communication. ANIE Federazione.

APAT, 2003. Il ciclo industriale dell'acciaio da forno elettrico. Agenzia per la Protezione dell'Ambiente e per i servizi tecnici, Rapporti 38/2003.

ASSOMET, several years. I metalli non ferrosi in Italia. Associazione nazionale industrie metalli non ferrosi.

ASSOPIASTRELLE, 2004. L'industria italiana delle piastrelle di ceramica e la Direttiva 2003/87.

ASSOPIASTRELLE, several years. Indagine statistica nazionale. Industria italiana delle piastrelle di ceramica. Assopiastrelle, Associazione nazionale dei produttori di piastrelle di ceramica e di materiali refrattari.

ASSURE, 2005. Personal Communication. European Association for Responsible Use of HFCs in Fire Fighting.

Boehringer Ingelheim, several years. Personal Communication. Boehringer Ingelheim Istituto De Angeli.

CAGEMA, 2005. Politiche e misure per la riduzione delle emissioni di gas serra: il settore della calce. Associazione dell'industria italiana della calce, del gesso e delle malte.

CARBITALIA SPA, 2009, Personal Communication

Chiesi Farmaceutici, several years. Personal Communication. Chiesi Farmaceutici S.p.A.

CNH, several years. Personal Communication. Case New Holland.

CTN/ACE, 2000. Rassegna delle informazioni disponibili sulle emissioni di diossine e furani dal settore siderurgico e della metallurgia ferrosa. A cura di Pasquale Spezzano.

EC, 2006. Regulation n. 842/2006 of the European Parliament and of the Council of 17 May 2006 on certain fluorinated greenhouse gases.

EDIPOWER, 2003. Rapporto Ambientale 2003. EDIPOWER.

EDIPOWER, 2007. Rapporto di Sostenibilità 2007. EDIPOWER.

EDISON, several years. Bilancio Ambientale. EDISON.

EMEP/CORINAIR, 2007. Atmospheric Emission Inventory Guidebook. Technical report No 16/2007.

ENDESA, 2004. Personal Communication. ENDESA.

ENDESA, several years [a]. Rapporto ambiente e sicurezza. ENDESA.

ENDESA, several years [b]. Rapporto di sostenibilità. ENDESA.

ENEL, several years. Rapporto ambientale. ENEL.

ENIRISORSE, several years. Statistiche metalli non ferrosi. ENIRISORSE

FEDERACCIAI, 2004. Personal Communication.

FEDERACCIAI, 2008. Rapporto ambientale Federacciai 2007

FEDERACCIAI, several years. La siderurgia in cifre. Federazione Imprese Siderurgiche Italiane.

FIAT, several years. Personal Communication.

General Gas, 2008. Personal Communication. General Gas S.r.l.

GSK, several years. Personal Communication. GlaxoSmithKline S.p.A.

IAI, 2003. The Aluminium Sector Greenhouse Gas Protocol (Addendum to the WBCSD/WRI Greenhouse Gas Protocol). Greenhouse Gas Emission Monitoring and Reporting by the Aluminium Industry. International Aluminium Institute, May 2003.

ILVA, 2006. Analisi ambientale iniziale. Rev. 2, March 2006. IPPC permitting process.

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Centre, Meteorological Office, Bracknell, UK.

IPCC, 2000. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. IPCC National Greenhouse Gas Inventories Programme, Technical Support Unit, Hayama, Kanagawa, Japan.

IPCC 2006, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds).Published: IGES, Japan.

IPPC, 2001. Best Available Techniques Reference Document on the Production of Iron and Steel. Integrated Pollution Prevention and Control. European Commission. December 2001.

ISPESL, 2005. Profilo di rischio e soluzioni. Metallurgia. Produzione ferroleghe. Edited by A. Borroni

ISTAT, several years. Annuario Statistico Italiano. Istituto Nazionale di Statistica.

IVECO, several years. Personal Communication.

Lusofarmaco, several years. Personal Communication. Istituto Luso Farmaco d'Italia S.p.A.

Magnesium products of Italy, several years. Personal Communication. Meridian Technologies Inc. - Magnesium Products of Italy.

Mariel, 2008. Personal Communication. Mariel S.r.l.

Menarini, several years. Personal Communication. Industrie farmaceutiche riunite.

MICRON, several years. Personal Communication. Micron Technology Italia S.r.l.

Norsk Hydro, several years. Personal Communication.

Radici Chimica, 1993. Progetto CORINAIR. Produzione acido adipico: descrizione del processo utilizzato da Radici Chimica. Radici Group, Novara.

Radici Chimica, several years. Personal Communication.

Safety Hi Tech, 2008. Personal Communication. Safety Hi Tech S.r.l.

Sanofi Aventis, several years. Personal Communication. Sanofi Aventis Italia.

Siteb, several years. Rassegna del bitume.

Solvay, 2003. Bilancio di Sostenibilità Solvay 2002. Solvay Solexis S.p.A.

Solvay, several years. Personal Communication. Solvay Solexis S.p.A.

Solvay, 2008. Personal Communication. Solvay Fluor Italia.

Sotacarbo, 2004. Progetto integrato miniera centrale. Studio di fattibilità sito di Portovesme.

ST Microelectronics, several years. Personal Communication. ST Microelectronics.

TERNA, 2006. Rapporto di Sostenibilità 2006. TERNA.

UN, several years. Industrial Commodity Statistics Yearbook. United Nation.

UNFCCC, 2007. Report of the review of the initial report of Italy. FCCC/IRR/2007/ITA 10 December 2007.

UNFCCC, 2009. Report of the individual review of the greenhouse gas inventories of Italy submitted in 2007 and 2008. FCCC/ARR/2008/ITA 16 January 2009.

UNRAE, several years. Personal Communication. Unione Nazionale Rappresentanti Autoveicoli Esteri.

USEPA, 1997. “Compilation of Air Pollutant Emission Factors”. AP-42, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. October 1997.

USGS, several years. Mineral yearbook. Ferroalloys.

YARA, 2007 (technical documentations from IPPC permit issuing process)

10.4 SOLVENT AND OTHER PRODUCT USE [CRF sector 3]

AIA, several years [a]. Personal Communication. Associazione Italiana Aerosol.

AIA, several years [b]. Relazioni annuali sulla produzione italiana aerosol. Associazione Italiana Aerosol.

Assocasa, several years. Personal Communication.

Assogastecnici, several years. Personal Communication.

AVISA, several years. Personal Communication.
Co.Da.P., 2005. Personal Communication.

EEA, 1997. CORINAIR 94 Summary Report, Report to the European Environment Agency from the European Topic Centre on Air Emission.

EC, 1999. Council Directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations. Official Journal of the European Communities 29 March 1999.

EC, 2002. Screening study to identify reduction in VOC emissions due to the restrictions in the VOC content of products. Final Report of the European Commission, February 2002.

EC, 2004. Directive 2004/42/EC of the European Parliament and of the Council of 21 April 2004 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in decorative paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC. Official Journal of the European Communities 30 April 2004.

EMEP/CORINAIR, 2007. Atmospheric Emission Inventory Guidebook. Technical report No 16/2007.

EMEP/CORINAIR, 2008. Atmospheric Emission Inventory Guidebook. Draft.

ENEA/USLRMA, 1995. Lavanderie a secco.

FAO, several years. Food balance. http://faostat.fao.org.

FIAT, several years. Rendiconto Ambientale. Gruppo Fiat.

GIADA, 2006. Progetto Giada and Personal Communication. ARPA Veneto – Provincia di Vicenza.

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Centre, Meteorological Office, Bracknell, UK.

ISTAT, several years [a]. Annuario Statistico Italiano.

ISTAT, several years [b]. Bollettino mensile di statistica.

ISTAT, several years [c]. http://www.istat.it.

ISTAT, several years [d]. Personal communication.

Offredi P., several years. Professione Verniciatore del Legno. Personal communication.

Regione Campania, 2005. Inventario regionale delle emissioni di inquinanti dell'aria della Regione Campania, marzo 2005.

Regione Toscana, 2001. Inventario regionale delle sorgenti di emissione in aria ambiente, febbraio 2001.

TECHNE, 1998. Personal communication.

TECHNE, 2004. Progetto MeditAiraneo. Rassegna dei fattori di emissione nazionali ed internazionali relativamente al settore solventi. Rapporto Finale, novembre 2004.

TECHNE, 2008. Fattori di emissione per l'utilizzo di solventi. Rapporto Finale, marzo 2008.

UNIPRO, several years. Rapporto Annuale - Consumi cosmetici in Italia.

Vetrella G., 1994. Strategie ottimali per la riduzione delle emissioni di composti organici volatili. Thesis in Statistics.

10.5 AGRICULTURE [CRF sector 4]

ADBPO, 1994. Piano delle direttive e degli interventi urgenti per la lotta all'eutrofizzazione delle acque interne e del mare Adriatico. Autorità di bacino del fiume Po. Parma - Italia.

ADBPO, 2001. Progetto di Piano stralcio per il controllo dell'Eutrofizzazione (PsE).Autorità di bacino del fiume Po. Relazione generale. Parma - Italia.

AIA, 2009. Controlli della produttività del latte in Italia - Statistiche Ufficiali - Anno 2007. Associazione Italiana Allevatori. Italia. http://www.aia.it/bollettino/bollettino.htm

ANPA-ONR, 2001. I rifiuti del comparto agro-alimentare, Studio di settore. Agenzia Nazionale per la Protezione dell'Ambiente. Rapporto n. 11/2001. Roma –Italia.

APAT, 2004[a]. Linee guida per l'utilizzazione agronomica degli effluenti di allevamento, Fase 2 Effluenti zootecnici, Risultati di una indagine campionaria sulle caratteristiche degli effluenti di allevamento, a cura di CRPA. Reggio Emilia – Italia.

APAT, 2004[b]. Linee guida per l'utilizzazione agronomica degli effluenti di allevamento, Fase 2 Effluenti zootecnici, Risultati di una indagine campionaria sulle tipologie di stabulazione e di stoccaggio, a cura di CRPA. Reggio Emilia – Italia.

APAT, 2005. Methodologies used in Italy for the estimation of air emission in the agriculture sector. Technical report 64/2005. Rome - Italy.

ASSONAPA, 2006. Database of goat and sheep animal consistency and breeds. Associazione Nazionale della Pastorizia Ufficio Centrale dei Libri Genealogici e dei Registri Anagrafici, Italy. http://www.assonapa.com/.

Baldoni R., Giardini L., 1989. Coltivazione erbacee. Editor Patron, p 1072. Bologna - Italia.

Barile, V.L., 2005. Improving reproductive efficiency in female buffaloes. Livest. Prod. Sci. 92, 83–194.

Bonazzi G., Crovetto M., Della Casa G., Schiavon S., Sirri F., 2005, Evaluation of Nitrogen and Phosphorus in Livestock manure: Southern Europe (Italy). In Workshop: Nutrients in livestock manure, Bruxelles, 14 February 2005.

Borgioli E., 1981. Nutrizione e alimentazione degli animali domestici. Edagricole, p. 464.

Butterbach-Bahl K., Papen H., Rennenberg H., 1997. Impact of rice transport through cultivars on methane emission from rice paddy fields. Plant, Cell and Environment. 20:1175-1183.

Centro Ricerche sul Riso, 2007. Personal communication with the Rice Research Centre from the Ente Nazionale Risi – information requested on dry seeding surface cultivation, Maurizio Tabacchi, Italia.

CESTAAT, 1988. Impieghi dei sottoprodotti agricoli ed agroindustriali, Vol. 1. Centro Studi sull'Agricoltura, l'Ambiente e il Territorio, p. 311.

Cóndor G. R., Vitullo, M., De Lauretis, R., 2005. Contribution of ISTAT statistics to the National Air Emission Inventory of the Agriculture sector. In: Convegno "AGRISTAT - Statistiche Agricole" 30 - 31 Maggio 2005. Florence - Italy.

Cóndor R.D. 2006. Agricoltura. Oral presentation "Cambiamenti Climatici e inquinamento atmosferico. L'inventario nazionale delle emissioni come strumento di conoscenza e verifica dello stato dell'ambiente", 23-24 October 2006 Rome - Italy.
http://www.apat.gov.it/site/_files/Doc_emissioni/RocioCondor.pdf.

Cóndor, R. D., De Lauretis, R. 2007. Agriculture air emission inventory in Italy: synergies among conventions and directives. In: Ammonia Conference abstract book. Ed. G.J. Monteny, E. Hartung,

M. van den Top, D. Starmans. Wageningen Academic Publishers. 19-21 March 2007, Ede - The Netherlands.

Cóndor, R. D., De Lauretis, R., Lupotto, E., Greppi, D., Cavigiolo S. 2007[a]. Methane emission inventory for the rice cultivation sector in Italy. In: Proceeding of the Fourth Temperate Rice Conference". Ed. S. Bocchi, A. Ferrero, A. Porro. 25-28 June Novara –Italy.

Cóndor, R. D., Vitullo, M. De Lauretis, 2007[b]. Emissioni ed assorbimenti di gas serra dai settore Agricoltura e Uso del Suolo e Foreste in Italia. Dipartimento Stato dell'Ambiente e Metrologia Ambientale, APAT. Poster presented *"Conferenza Nazionale sui Cambiamenti Climatici 2007"*. 12-13 September, Rome - Italy. http://www.apat.gov.it/site/_files/CNCC2007Sintesilavori.pdf

Cóndor, R.D., Valli L., De Rosa G., Di Francia A., De Lauretis R. 2008[a]. Estimation of the methane emission factor for the Italian Mediterranean buffalo. International Journal of Animal Biosciences 2:1247-1253.

Cóndor R., De Lauretis R., Romano D., Vitullo M. 2008[b]. Inventario nazionale delle emissioni di particolato e principali fonti di emissione. In: Atti 3° Convegno Nazionale sul Particolato Atmosferico. Il particolato atmosferico: la conoscenza per l'informazione e le e le strategie di intervento Bari 6-8 Ottobre, Italia. http://pm2008.vglobale.it/index.php/fd=cyan/ff=contributi-scientifici.htm

Cóndor, R.D., Cristofaro, E. De Lauretis, R. 2008[c]. Agricoltura: inventario nazionale delle emissioni e disaggregazione provinciale. Istituto superiore per la protezione e la ricerca ambientale, ISPRA Rapporto tecnico 85/2008. Roma, Italia.
http://www.apat.gov.it/site/it-IT/APAT/Pubblicazioni/Rapporti/Documento/rapporto_85_2008.html

Cóndor, R.D., 2009. Procedura per la preparazione, caricamento e *reporting* dell'inventario nazionale delle emissioni settore: agricoltura. Internal report ISPRA. Rome, Italy.

Confalonieri R., Bocchi S. 2005. Evaluation of CropSyst for simulating the yield of flooded rice in northern Italy. European Journal of Agronomy. 2005, 23, 315 – 326.

Consorzio per la tutela del formaggio Mozzarella di Bufala Campana, 2002. Modello di Regolamento per la gestione igienica ed alimentare dell'allevamento bufalino in relazione alla produzione della mozzarella di bufala campana DOP. Edit. Consorzio per la tutela del formaggio mozzarella di bufala campana (Campana Mozzarella Consortium).
CRPA/CNR, 1992. Indagine sugli scarti organici in Emilia Romagna.

CRPA, 1993. Manuale per la gestione e utilizzazione agronomica dei reflui zootecnici. Regione Emilia Romagna, Assessorato agricoltura.

CRPA, 1996. Biogas e cogenerazione nell'allevamento suino. Manuale pratico. ENEL, Direzione studi e ricerche, Centro ricerche ambiente e materiali. Milano – Italia.

CRPA, 1997 [a]. Piani Regionali di Risanamento e tutela della qualità dell'aria. Quadro delle azioni degli enti locali per il settore zootecnico delle aree padane. Allegato 2. Relazione di dettaglio sulla metodologia adottata per la quantificazione delle emissioni di metano. Febbraio 1997.

CRPA, 1997 [b]. Piani Regionali di Risanamento e tutela della qualità dell'aria. Quadro delle azioni degli enti locali per il settore zootecnico delle aree padane. Relazione di dettaglio sulla metodologia adottata per la quantificazione delle emissioni di protossido di azoto. Settembre 1997.

CRPA, 2000. Aggiornamento dell'inventario delle emissioni in atmosfera di ammoniaca, metano e protossido di azoto dal comparto agricolo. Centro Ricerche Produzioni Animali. Gennaio 2000.

CRPA, 2004[a]. L'alimentazione della vacca da latte. Edizioni L'Informatore Agrario. Terza edizione, Centro Ricerche Produzioni Animali.

CRPA, 2004[b]. Personal communication, expert in dairy cattle feeding from the Research Centre on Animal Production (CRPA), Maria Teresa Pacchioli.

CRPA, 2004[c]. Personal communication, expert in greenhouse gases emissions from the agriculture sector from the Research Centre on Animal Production (CRPA), Laura Valli.

CRPA, 2005. Personal communication, working group with experts in animal feeding from the Research Centre on Animal Production (CRPA), Maria Teresa Pacchioli and Paola Vecchia.

CRPA, 2006[a]. Progetto MeditAIRaneo: settore Agricoltura. Relazione finale. Technical report on the framework of the MeditAIRaneo project for the Agriculture sector, Reggio Emilia - Italia.

CRPA, 2006[b], Predisposizione di scenari di emissione finalizzati alla progettazione di interventi per la riduzione delle emissioni nazionali di ammoniaca ed alla valutazione di misure e di progetti per la tutela della qualità dell'aria a livello regionale. Final report. Reggio Emilia – Italy.

CRPA, 2008. Le scelte politiche energetico-ambientali lanciano il biogas. L'Informatore Agrario 3/2008, p.28-32

CRPA, 2009. Personal Communication. Expert in the agricultural emission inventory from the Research Centre on Animal Production (CRPA), Laura Valli.

CRPA/AIEL, 2008. Energia dal biogas prodotto da effluenti zootecnici, biomasse dedicate e di scarto. Ed. Associazione Italiana Energie Ambientali (AIEL).

Dan J., Krüger M., Frenzel P., Conrad R., 2001. Effect of a late season urea fertilization on methane emission from a rice field in Italy. Agri. Ecos. Env. 83: 191–199.

Dannenberg S., Conrad R, 1999. Effect of rice plants on methane production and rhizospheric metabolism in paddy soil. Biogeochemistry 45: 53–71.

De Rosa, M., Trabalzi, F., 2004. Technological innovation among buffalo breeders of southern lazio, Italy. Agricoltura Mediterranea. Vol. 134, 58-67.

ENEA, 1994. Personal communication, expert in agriculture sector. Ente nazionale per l'energia, l'ambiente e le nuove tecnologie (ENEA), Andrea Sonnino.

ENEA, 2006. Valutazione della possibilità di sostituzione dell'urea con altri fertilizzanti azotati. Final report. Rome, Italy.

ENR , 2007. Personal communication, surface statistic from the Ente Nazionale Risi (ENR), Enrico Losi (mail 05/06/2007).

ENR, 2009. Information available on rice surface, rice surface by variety and time of cultivation. Ente Nazionale Risi, Italy. http://www.enterisi.it/ser_database.jsp.

EUROSTAT, 2007[a]. Farm structure in Italy – 2005. Statistics in Focus Agriculture and Fisheries 22/2007 Product KS-SF-07-022 European Comunities.

EUROSTAT, 2007[b]. Agriculture. Main statistics 2005-2006. Product Ks-ED-07-002-En-C. European Comunities.

FAO, 2009. FAOSTAT, the FAO Statistical Database, http://faostat.fao.org/.

Ferrero A., Nguyen N.V., 2004. Constraints and opportunities for the sustainable development of rice-based production systems in Europe. In proceedings: FAO Rice Conference, 12-13 February 2004, FAO, Rome, Italy.

Gazzetta Ufficiale della Repubblica Italiana, 2006. Criteri e norme tecniche generali per la disciplina regionale dell'utilizzazione agronomica degli effluenti di allevamento e di acque reflue di cui all'articolo 38 del decreto legislativo 11 maggio 1999 N. 152. G.U. n. 109 del 12/05/06 - Suppl. Ordinario n.120. Ministero delle Politiche Agricole e Forestali. Italy. http://www.guritel.it/icons/freepdf/SGFREE/2006/05/12/SG109.pdf.

Giardini L., 1983. Agronomia Generale, Patron, Bologna.

Greco, M., Martino, L. 2001. The agricultural statistical system in Italy. In: Conference on Agricultural and Environmental Application, Rome 4-8 June. Italy 46-461pp

Holter J.B., Young A.J., 1992. Methane prediction in dry and lactating holstein cows, Journal of Dairy Science, 8(75), pp. 2165-2175.

Holzapfel-Pschorn A., Seiler W., 1986. Methane emission during a cultivation period from an Italian Rice Paddy. Journal of Geophysical Research Vol. 91 Nº D11 11,803-11,814.

Husted S., 1993. An open chamber technique for determination of methane emission from stored livestock manure. Atmospheric Environment 11 (27).

Husted S., 1994. Seasonal variation in methane emissions from stored slurry and solid manures, J. Env. Qual. 23, pp. 585-592.

Infascelli, F., 2003. Nuove acquisizioni sulla nutrizione e sull'alimentazione della bufala. In: II Congresso Nazionale sull'Allevamento del Bufalo Monterotondo - Roma, pp. 1-18.

INRA, 1988. Alimentation des bovines, ovins et caprins, Paris, p.471.

IPCC, 2000. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. IPCC National Greenhouse Gas Inventories Programme, Technical Support Unit, Hayama, Kanagawa, Japan.

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook.

IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Centre, Meteorological Office, Bracknell, UK.

IPCC, 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA). 2008[a]. Serie storiche dal 1980 al 2006 delle emissioni nazionali di inquinanti atmosferici, Rete del Sistema Informativo Nazionale Ambientale - SINANET. http://www.sinanet.apat.it/it/sinanet/serie_storiche_emissioni/NFR%201980-2006/view

Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA). 2008[b]. Database della disaggregazione a livello provinciale dell'Inventario nazionale delle emissioni:1990-1995-2000-2005. Istituto Superiore per la Protezione e la Ricerca Ambientale, ISPRA. http://www.sinanet.apat.it/it/inventaria/disaggregazione_prov2005/

Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA). 2009. Quality Assurance/Quality Control plan for the Italian Inventory. Year 2009.

ISTAT, 1991. Caratteristiche strutturali delle aziende agricole, fascicoli provinciali, 4° Censimento generale dell'Agricoltura (20 ottobre 1990-22 febbraio 1991), Roma – Italia.

ISTAT, several years [a]. Statistiche dell’agricoltura, zootecnia e mezzi di produzione – Annuari (1990-1993), Istituto Nazionale di Statistica, Roma – Italia.

ISTAT, several years [b]. Statistiche dell’agricoltura – Annuari (1994-2000), Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, several years [c]. Struttura e produzioni delle aziende agricole – Informazione (1995-1999), Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, several years [d]. Statistiche sulla pesca e zootecnia – Informazione (1998-2001), Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, several years [e]. Statistiche sulla pesca, caccia e zootecnia – Informazione (1996-1997), Istituto Nazionale di Statistica, Roma –Italia.
ISTAT, several years [f]. Annuario Statistico Italiano - Annuario (1990; 1993-1994; 1997-2003), Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, 2003. 5º Censimento Generale dell’Agricoltura. Caratteristiche strutturali delle aziende agricole. Fascicolo Nazionale: dati regionali, provinciali e comunali. Istituto Nazionale di Statistica, Roma - Italia.

ISTAT, 2004. Personal communication, expert in agriculture statistics- fertilizers from the National Institute of Statistics (ISTAT), Mario Adua.

ISTAT, 2006 [a]. Struttura e produzioni delle aziende agricole Anno 2005. Statistiche in breve (27 dicembre 2006). Statistiche Servizio Agricoltura – Allevamenti e pesca. Istituto Nazionale di Statistica, Roma – Italia. http://www.istat.it/salastampa/comunicati/non_calendario/20061227_00/testointegrale.pdf.

ISTAT, 2006[b]. Personal communication, expert in agriculture statistics from the National Institute of Statistics (ISTAT), Giampaola Bellini.

ISTAT, 2007[a]. Farm and structure survey from 2005. Information on the number of animals at a provincial level. Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, 2007[b]. Annuario Statistico Italiano 2007- Capitolo 13 Agricoltura. Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, 2007[c]. Personal communication with N. Mattaliano. E-mail request for elaboration SPA 2003 data on burning residues -cereals. Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, 2007[d]. Personal communication with F. Piersimoni. Update of data on livestock collected on 1 December for the year 2001. Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, 2007[e]. "Indagine sulla struttura e produzione delle aziende agricole. Anno 2005" . Prodotto DCSSD1.1.1. Rapporto di qualità su SPA 2005. Istituto Nazionale di Statistica, Roma – Italia.

ISTAT, 2008[a]. Struttura e produzioni delle aziende agricole. Anno 2007 (03 Dicembre 2008). Istituto Nazionale di Statistica, Roma – Italia. http://www.istat.it/salastampa/comunicati/non_calendario/20081203_00/testointegrale20081203.pdf

ISTAT, 2008[b]. Indagine sulla struttura e produzione delle aziende agricole. Anno 2007. Rapporto sulla Qualità. Istituto Nazionale di Statistica, Roma - Italia.

ISTAT, 2009[a]. Dati annuali sulla consistenza del bestiame, periodo di riferimento 2002-2007. Statistiche Servizio Agricoltura – Allevamenti e pesca. Istituto Nazionale di Statistica, Roma – Italia. http://www.istat.it/agricoltura/datiagri/consistenza/

ISTAT, 2009[b]. Dati annuali e mensili sul settore lattiero caseario, periodo di riferimento 2002-2008. Statistiche Servizio Agricoltura – Allevamenti e pesca. Istituto Nazionale di Statistica, Roma – Italia. http://www.istat.it/agricoltura/datiagri/latte/

ISTAT, 2009[c]. Dati congiunturali sui mezzi di produzione 2000-2007. Istituto Nazionale di Statistica, Roma –Italia. http://www.istat.it/agricoltura/datiagri/mezzipro/elecon.html

ISTAT, 2009[d]. Dati congiunturali sulle coltivazioni 1999-2008. Istituto Nazionale di Statistica, Roma –Italia. http://www.istat.it/agricoltura/datiagri/coltivazioni/

ISTAT, 2009[e]. Personal communication with G. D'Acuti: E-mail request of national milk production from 2007. Istituto Nazionale di Statistica, Roma –Italia.

ISTAT, 2009[f]. Personal communication with C. Manzi: E-mail request of rabbit production data for 2007. Istituto Nazionale di Statistica, Roma –Italia.

Kruger M., Frenzel P., Kemnitz D., Conrad R., 2005. Activity, structure and dynamics of the methanogenic archaeal community in a flooded Italian rice field. FEMS Microbiology Ecology 51: 323–331.

Leip, A., S. Russo, K.A. Smith, F. Conen, and G. Bidoglio, 2002. Rice cultivation by direct drilling and delayed flooding reduces methane emissions. In: van Ham et al. (eds): Non-CO2 Greenhouse Gases (NCGG-3): Scientific understanding, control options and policy aspects. p. 457-458.

Leip, A. Bocchi, S. 2007. Contribution of rice production to greenhouse gas emissions in Europe. In: Proceeding of the Fourth Temperate Rice Conference". Ed. S.Bocchi, A. Ferrero, A. Porro. 25-28 June Novara –Italy.

Lupotto E., Greppi D., Cavigiolo S., 2005. Personal communication, group of experts in rice paddy cultivation and agronomic practices from the C.R.A. – Experimental Institute of Cereal Research – Rice Research Section of Vercelli (Consiglio per la Ricerca e sperimentazione in Agricoltura, Istituto sperimentale per la Cerealicoltura, Sezione specializzata per la Risicoltura) Italia.

Mannini P., 2004. Risparmio idrico/metodi e sistemi irrigui. La sommersione. In: Supplementi di Agricoltura 18. Le buone pratiche agricole per risparmiare acqua. Assessorato Agricoltura, Ambiente e Sviluppo Sostenibile, Regione Emilia Romagna. pp.154-157. http://www.ermesagricoltura.it/rivista/2004/supp_18/supp18154.pdf.

Marik T., Fischer H., Conen F., Smith K., 2002. Seasonal variations in stable carbon and hydrogen isotope ratios in methane from rice fields. Global Biogeochemical Cycles, vol. 16, N°4

Masucci, F., Di Francia, A., Proto, V., 1997. In vivo digestibility, rate of particulate passage and dry matter rumen degradability in buffaloes and sheep. In: V World Buffalo Congress, Caserta (Italy) 13-16 October, 296-301.

Masucci, F., Di Francia, A., Gioffrè, F., Zullo, A., Proto, V., 1999. Prediction of digestibility in buffalo. In: XIII ASPA Congress, Piacenza (Italy) 21-24 June 345-347.

MINAMBIENTE, 2007. Fourth National Communication under the UN Framework Convention on Climate Change Italy, November 2007. http://unfccc.int/resource/docs/natc/itanc4.pdf

Mordenti A., Pacchioli M.T., Della Casa, G. 1997. Production and nutrition techniques in the control of meat quality in heavy pigs. XXXII International Symposium on Animal Production: Advances in Technology, Accuracy and Management Milano, 29th September –1st October 1997. pag 81.

NRC, 1984. Nutrient Requirements of beef cattle- Sixth revised Edition. Not. Ac. Press, Washington.

NRC, 1988. Nutrient Requirements of swine - Ninth revised Edition. Not. Ac. Press, Washington.

NRC, 2001. Nutrient Requirements of dairy cattle Ninth edition, Nat. Acad. Press, Washington, D.C. USA.

OSSLATTE, 2001. Annuario del latte, Edizione 2001. Capitolo 3: La produzione di latte secondo l'ISTAT e l'AIA, Osservatorio sul mercato dei prodotti lattiero-caseari del latte.

OSSLATTE/ISMEA, 2003. Il mercato del latte, rapporto 2003. Capitolo 3: La struttura degli allevamenti e la produzione di latte secondo l'ISTAT. Osservatorio sul mercato dei prodotti lattiero-caseari del latte e l'Istituto di Servizi per il Mercato Agricolo ed Alimentare.

PROINCARNE, 2005. Personal communication, expert in goat and sheep breeding. Associazione Produttori Carni Bovine dell'Emilia Romagna, Stefano Ronchi.

Regione Emilia Romagna, 2004 L. R. 28/98 – P.S.A. 2001 - N. PROG. 3 TAB. B3 - Bilancio dell'azoto nelle specie di interesse zootecnico, Relazione finale, a cura di C.R.P.A., September 2004, Reggio Emilia, Italy.

Regione Emilia Romagna, 2005. Disciplinari di produzione integrata 2005 Norme tecniche di coltura - Tecnica agronomica - Colture erbacee – RISO. Direzione Agricoltura, Regione Emilia Romagna.
http://www.ermesagricoltura.it/wcm/ermesagricoltura/consigli_tecnici/disciplinari/sezione_disciplinari/s_norme_coltura/s_erbacee/s_riso/TCD08_riso.pdf

Roy R., Detlef Kluber H., Conrad R., 1997. Early initiation of methane production in anoxic rice soil despite the presence of oxidants. FEMS Microbiology Ecology 24:311-320.

Russo S., 1976. Influenza dell'interramento della paglia su crescita e produzione del riso. Rivista Il Riso Anno XXV Nº 1 p19-36.

Russo S., 1988. L'interramento delle paglie come fattore di fertilità e di risparmio energetico. In proceedings: 10º Convegno Internazionale sulla Risicoltura. Vercelli 16-18 Novembre 1998, Vercelli, Italy.

Russo S., Ferrari G., Raso G., 1990. Ricerche sull'efficienza dell'azoto con la somministrazione frazionata. L'informatore Agrario p 27-29.

Russo S., 1993. Prove di concimazione con azoto frazionato in risaia. L'informatore Agrario 8/93 p 87-94.

Russo S., 1994. Semina interrata con sommersione ritardata: un'alternativa all'impianto della risaia tradizionale. L'informatore Agrario 12/94 p 39-46.

Russo S., 2001. Concimazione più sostenibile in risaia e concimi organo-minerali. L'informatore Agrario 10/2001 p 23-26.

Safley L.M., Casada M.E., Woodbury J., Roos K.F., 1992. Global methane emissions from livestock and poultry manure. USEPA, Washington D.C., EPA/400/191/048.

Sauvant D., 1995. Les émission de méthane par les ruminants: processus, modélisation, quantification et spatialisation. Le dossier de l'environnement de l'INRA, 10 pp. 7-15.

Spanu A., Pruneddu G., 1996. The influence of irrigation volumes on sprinkler-irrigated rice (Oryza sativa) production. Agricoltura Mediterranea, Vol 126, 377-382.

Spanu A., Murtas A., Ledda L., Ballone F., 2004. Confronto tra varietà di riso sottoposte a irrigazione turnata. L'informatore Agrario 18/2004 p 61-62.

Spanu A., 2006. Personal communication, expert in rice cultivation from Università degli Studi di Sassari, Sardegna - Italy.

Schütz H., Holzapfel-Pschorn A., Conrad R., Rennenberg H., Seiler W., 1989 [a]. A 3-year continuous record on the influence of daytime, season and fertilizer treatment on methane emission rates from an Italian rice padd., Journal of. Geophysical Research 94, D13, pp. 16405-16415.

Schütz H., Seiler W.,Conrad R., 1989 [b]. Processes involved in formation and emission of methane in rice paddies. Biogeochemistry, 7, pp. 33-53.

Steed Jr. J., Hashimoto A.G., 1995. Methane emissions from typical manure management systems, Bioresource Technology 50 pp. 123-130.

TERNA, 2009. National production data from biogas. http://www.terna.it/default/Home/SISTEMA_ELETTRICO/statistiche/dati_statistici/tabid/418/Default.aspx

Tinarelli, A., 1973. La coltivazione del riso Editorial Edagricole, First edition p. 425.

Tinarelli, A., 1986. Il riso. Editorail Edagricole, Second edition p. 426.

Tinarelli, 2005. Personal communication, Italian expert in rice cultivation – Antonio Tinarelli, participated in the working group with the Experimental Institute of Cereal Research – Rice Research Section of Vercelli, Italia.

Tossato S., Regis F. 2002. Collana monografica di manuali naturalistico-agronomici, con riferimento alle principali colture geneticamente modificate. Volume 6. Il Riso. Agenzia Regionale per la Protezione Ambientale Piemonte (ARPA Piemonte), Piemonte, Italy.

UCEA, 2007. Temperature data, Ufficio Centrale di Ecologia Agraria. http://www.politicheagricole.it/ucea/forniture/index3.htm

Unione Nazionale Avicoltura (UNA) 2009. Poultry production information. www.unionenazionaleavicoltura.it

UNFCCC, 2004. Report of the Individual review of the GHG Inventory submitted in the year 2004 (4 March 2005). http://unfccc.int/files/national_reports/annex_i_ghg_inventories/inventory_review_reports/application/pdf/2004_irr_centralized_review_italy.pdf

UNFCCC, 2005. Report of the individual review of the greenhouse gas inventory of Italy submitted in 2005 (24 November 2005). http://unfccc.int/resource/docs/2005/arr/ita.pdf

UNFCCC, 2007. Report of the review of the initial report of Italy (FCCC/IRR/2007/ITA; 10 December 2007. http://unfccc.int/resource/docs/2007/irr/ita.pdf

UNFCCC, 2009. Report of the individual review of the greenhouse gas inventories of Italy submitted in 2007 and 2008 (FCCC/ARR/2008/ITA; 16 January 2009). http://unfccc.int/resource/docs/2009/arr/ita.pdf

Valli L., Cóndor R., De Lauretis R. 2004. MeditAIRanean Project: Agriculture sector. In: The quality of greenhouse gas emission inventories for agricultural soils. Report on the Expert Meeting on improving the quality of GHG emissions inventories for Category 4D. Joint Research Centre, 21-22 October, 2004. http://carbodat1.jrc.it/ccu/pweb/leip/home/ExpertMeetingCat4D/index.htm.

Wassmann, R. 2005. Personal communication, expert in methane from rice paddies (Forschungszentrum Karlsruhe IMK-IFU, Garmisch-Partenkirchen, Germany). E-mail communication received on 16/08/2005.

Weber S., Lueders T., Friedrich M.W., Conrad R., 2001. Methanogenic populations involved in the degradation of rice straw in anoxic paddy soil. FEMS Microbiology Ecology 38:11-20.

Xiccato G., Schiavon S., Gallo L., Bailoni L., Bittante G., 2005. Nitrogen excretion in dairy cow, beef and veal cattle, pig, and rabbit farms in Northern Italy. Ital. J.Anim.Sci. Vol. 4 (Suppl.), 103-111.

Yan X., Yagi K., Akiyama H., Akimoto H., 2005. Statistical analysis of the major variables controlling methane emission from rice fields. Global Change Biology (2005) 11, 1131–1141.

Zavattaro L., Romani M., Sacco D., Bassanino M., C.Grignani, 2004. Fertilization management of paddy fields in Piedmont (NW Italy) and its effects on the soil and water quality. In proceedings: Challenges and opportunities for sustainable rice-based production systems. Torino, Italy 13-15 September 2004.

Zicarelli, L., 2001. Evoluzione dell'allevamento bufalino in Italia. In Proc. I Congresso Nazionale sull'Allevamento del Bufalo Eboli, Salerno, Italy, pp. 1-19.

10.6 LAND USE, LAND USE CHANGE AND FORESTRY [CRF sector 5]

APAT, 2004. Corine (Coordination of Information on the Environment) Land Cover Programme. URL: http://www.clc2000.sinanet.apat.it/

APAT, 2008 [a]. National Greenhouse Gas Inventory System in Italy. April 2008. Internal document.

APAT, 2008 [b]. Quality Assurance/Quality Control plan for the Italian Emission Inventory. Year 2008. April 2008. Internal document.

APAT - ARPA Lombardia, 2007. Stima dei consumi di legna da ardere per riscaldamento ed uso domestico in Italia, Rapporto Finale

Adams, W.A. 1973. The effect of organic matter on the bulk and true densities of some uncultivated podzolic soils. J. Soil Sci. 24:10–17

Batjes, 1996. Total carbon and nitrogen in the soils of the world. Eur. J. Soil Sci. 47 : 151-163

Benedetti A., Pompili L., Nisini L., 2004. Ruolo attivo dell'agricoltura nei processi di mitigazione del cambiamento climatico globale. Rapporto del progetto Climagri-Cambiamenti climatici e agricoltura, – CRA- Istituto Sperimentale per la Nutrizione delle Piante

Bovio G., 1996. Stima della biomassa bruciata e della CO_2 prodotta da incendi boschivi in Italia. Schweizerische Zeitschrift für Forstwesen-Journal Forestier Suisse, 147, 4

Ceccanti B., Doni S., Macci C., Cercignani G., Masciandaro G., 2008. Characterization of stable humic–enzyme complexes of different soil ecosystems through analytical isoelectric focussing technique (IEF), Soil Biology & Biochemistry 40 (2008) 2174–2177

CESTAAT, 1988. Impieghi dei sottoprodotti agricoli ed agroindustriali, Vol. 1. Centro Studi sull'Agricoltura, l'Ambiente e il Territorio, p. 311

Corpo Forestale, 2005. CONECOFOR Programme. http://www2.corpoforestale.it/web/guest/serviziattivita/controlloecosistemiforestali

CRPA, 1997. Piani Regionali di Risanamento e tutela della qualità dell'aria. Quadro delle azioni degli enti locali per il settore zootecnico delle aree padane. Relazione di dettaglio sulla metodologia adottata per la quantificazione delle emissioni di protossido di azoto. Settembre 1997

CRPA, 2009. Progetto Salvaguardia e valorizzazione del prato stabile irriguo in area Parmigiano-Reggiano attraverso l'ottimizzazione della risorsa idrica e azotata, Personal communication

Cutini A., 2002. Litterfall and Leaf Area Index in the CONECOFOR Permanent monitoring Plots Mosello, R., B. Petriccione and A. Marchetto (Guest Editors) - Long-term ecological research in Italian forest ecosystems, J. Limnol., 61 (Suppl. 1) pp. 62-68

Davidson E.A., Ackerman I.L., 1993. Changes in soil carbon inventory following cultivation of previously untilled soil. Biogeochemistry 20, pp. 161–194

Del Gardo I., Six J., Peressotti A., Cotrufo M.F., 2003. Assessing the impact of land-use change on soil C sequestration in agricultural soils by means of organic matter fractionation and stable C isotopes. Global Change Biology (2003) 9, 1204–1213

ERSAF, 2008. Stock di carbonio nei suoli regionali. Progetto Kyoto-Ricerca sui cambiamenti climatici e il controllo dei gas serra in Lombardia - GS3

FAO, 2004 [a]. Global Forest Resources Assessment Update 2005, Specification of National Reporting Tables for FRA 2005, Forest Resources Assessment Programme. Food and Agriculture Organization of the United Nations.

FAO, 2004 [b]. Global Forest Resources Assessment 2005. Global Forest Resources Assessment 2005 – Italy – Country Report , UN/ECE- FAO, submitted. Food and Agriculture Organization of the United Nations.

FAO, 2005. FAOSTAT database. URL: http://faostat.fao.org/. Food and Agriculture Organization of the United Nations

Francaviglia R., Aromolo R., Benedetti A., Beni C., Biondi F.A., Dell'Abate M.T., Figliolia A., Mecella G., Pompili L., 2006. Qualità funzionali alla conservazione della fertilità integrale dei suoli. Rapporto del Progetto Conservazione e valorizzazione della risorsa suolo: definizione delle qualità del suolo ai fini della gestione agricola e forestale ecocompatibile – CRA- Istituto Sperimentale per la Nutrizione delle Piante

Federici S, Vitullo M, Tulipano S, De Lauretis R, Seufert G, 2008. An approach to estimate carbon stocks change in forest carbon pools under the UNFCCC: the Italian case. iForest 1: 86-95 URL: http://www.sisef.it/iforest/.

Gardi C, Stefano Brenna, Silvia Solaro et al, 2007 “The Carbon Sequestration Potential of Soils: Some Data from Northern Italian Regions” Ital. J. Agron. 2:163-170.

Giordano G., 1980. Tecnologia del legno. Hoepli. Milano.

Guo L.B., Giffort R.M., 2002. Soil carbon stocks and land-use change: a meta analysis. Global Change Biology 8, pp. 345-360.

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Office, Bracknell, UK.

IPCC, 2003. Good Practice Guidance for Land Use, Land-Use Change and Forestry. IPCC Technical Support Unit, Kanagawa, Japan.

IPLA 2007, Realizzazione della parte piemontese della Carta dei Suoli nazionale a scala 1:250.000, Personal communication

ISAFA, 2004. RiselvItalia Project, Personal communication

ISTAT, several years [a]. Statistiche forestali. Istituto Nazionale di statistica, Roma.

ISTAT, several years [b]. Statistiche dell’agricoltura. Istituto Nazionale di statistica, Roma.

ISTAT, several years [c]. Annuario Statistico Italiano. Istituto Nazionale di statistica, Roma.

Janssen P. H. M., Heuberger P.S.C., 1995. Calibration of process oriented models. Ecological Modelling 83 pp. 55-66.

JRC, 2004. Pilot Project to test and learn harmonisation of reporting of EU member states under the UNFCCC on Land Use change and Forestry (LUCF). Joint Research Centre IES

Lagomarsino A., Moscatelli M.C., Di Tizio A., Mancinelli R., Grego S., Marinari S., 2009. Soil biochemical indicators as a tool to assess the short-term impact of agricultural management on changes in organic C in a Mediterranean environment. Ecological indicators 9 (2009) 518–527

La Mantia T, Oddo G, Rühl J, Furnari G, Scalenghe R, 2007. Variazione degli stock di carbonio in seguito ai processi di abbandono dei coltivi: il caso studio dell’isola di Pantelleria (TP). Forest@ 4 (1): 102-109. URL: http://www.sisef.it/.

Lugato E., Berti A., 2008. Potential carbon sequestration in a cultivated soil under different climate change scenarios: A modelling approach for evaluating promising management practices in north-east Italy. Agriculture, Ecosystems and Environment 128 (2008) 97–103

MAF/ISAFA, 1988. Inventario Forestale Nazionale. Sintesi metodologica e risultati. Ministero dell’Agricoltura e delle foreste. Istituto Sperimentale per l’assestamento forestale e per l’Alpicoltura, Trento.

MAF/ISAFA, 2004. Inventario nazionale delle foreste e del carbonio, preliminary results. Personal communication. Ministero dell'Agricoltura e delle foreste. Istituto Sperimentale per l'assestamento forestale e per l'Alpicoltura, Trento

MAMB, 1992. Inventario delle zone umide del territorio italiano (a cura di G. De Maria, Servizio Conservazione Natura, Ministero dell'ambiente e del territorio)

Martiniello P., 2007. Biochemical parameters in a Mediterranean soil as effected by wheat–forage rotation and irrigation. Europ. J. Agronomy 26 (2007) 198–208

Masciandaro G., Ceccanti B., 1999. Assessing soil quality in different agro-ecosystems through biochemical and chemico-structural properties of humic substances. Soil & Tillage Research 51 (1999) 129±137

MATT, 2002. Third National Communication under the UN Framework Convention on Climate Change. Ministry for the Environment and Territory. October 2002.

Monaco Stefano, Hatch D. J., Sacco D., Bertora C., Grignania C., 2008. Changes in chemical and biochemical soil properties induced by 11-yr repeated additions of different organic materials in maize-based forage systems. Soil Biology & Biochemistry 40 (2008) 608–615

Olson J.S., 1963. Energy storage and the balance of producers and decomposers in ecological systems. Ecology 44 (2), pp. 322-331

Perucci p., Monaci E., Onofri A., Dischetti C., Casacci C., 2008. Changes in physico-chemical and biochemical parameters of soil following addition of wood ash: A field experiment. Europ. J. Agronomy 28 (2008) 155–161

Petrella F., Piazzi M. 2006 – Carbonio nei suoli degli ecosistemi semi-naturali piemontesi. Sherwood N.123, June 2006

Post W.M., Kwon K.C., 2000. Soil carbon sequestration and land-use change: processes and potential. Global Change Biology 6, pp. 317-327

Puglisi E., Fragoulis G., Del Re A.A.M., Spaccini R., Piccolo A., Gigliotti G., Said-Pullicino D., Trevisan M., 2008. Carbon deposition in soil rhizosphere following amendments with compost and its soluble fractions, as evaluated by combined soil–plant rhizobox and reporter gene systems. Chemosphere 73 (2008) 1292–1299

Ramsar, 2005. The Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat http://www.ramsar.org/ United Nations Educational, Scientific and Cultural Organization (UNESCO).

Rawls W.J., Brakensiek, D.L. 1985. Prediction of soil water properties for hydrologic modeling, in Proceedings of Symposium on Watershed Management, ASCE, pp. 293-299

Reeder J.D., Schuman G.E., Bowman R.A., 1998. Soil C and N changes on conservation reserve program lands in the Central Great Plains. Soil & Tillage Research 47, pp. 339-349.

Schulze E-D (ed.), 2000. Carbon and nitrogen cycling in European forest ecosystems, Ecological Studies 142, 500 pp + CD, Springer: Berlin, Heidelberg, New York

Tabacchi G, De Natale F, Di Cosmo L, Floris A, Gagliano C, Gasparini P, Genchi L, Scrinzi G, Tosi V. 2007. Le stime di superficie 2005 – Parte 1. Inventario Nazionale delle Foreste e dei Serbatoi Forestali di Carbonio. MiPAF - Corpo Forestale dello Stato - Ispettorato Generale, CRA - ISAFA, TN. :1-413, versione 2

Triberti L., Nastri A., Giordani G., Comellini F., Baldoni G, Toderi G., 2008. Can mineral and organic fertilization help sequestrate carbon dioxide in cropland? Europ. J. Agronomy 29 (2008) 13–20

UNECE – FAO, Timber Committee, 2008 - Italian statement on potential wood supply, communication by national correspondent, March 2008

UNFCCC, 2005. Report of the individual review of the greenhouse gas inventory of Italy submitted in 2005 (24 November 2005). URL: http://unfccc.int/resource/docs/2005/arr/ita.pdf.

UNFCCC, 2007. Report of the review of the initial report of Italy. FCCC/IRR/2007/ITA. UNFCCC, 10 December 2007. URL: http://unfccc.int/resource/docs/2007/arr/ita.pdf.

Viaroli P., Gardi C., 2004. Censimento e caratterizzazione pedologica e vegetazionale dei "Prati Stabili" presenti nel Parco Regionale Fluviale del Taro. Relazione tecnica - Università degli Studi di Parma - Dipartimento di Scienze Ambientali

Xiloyannis C., 2007. La valutazione del contenuto e composizione del carbonio organico del suolo di sistemi agricoli. Relazione tecnica - Università degli Studi della Basilicata - Dipartimento di Scienze dei sistemi colturali, forestali e dell'ambiente

Waring RH, Running SW (1998). Forest ecosystems, analysis at multiple scales. Academic Press, New York, USA.

10.7 WASTE [CRF sector 6]

Acaia et al., 2004. Emissioni atmosferiche da discariche di rifiuti in Lombardia: stato attuale e scenari tecnologici di riduzione. RS – Rifiuti Solidi vol. XVIII n. 2, pp. 93-112.

AMA-Comune di Roma, 1996. Nuovo impianto per l'incenerimento dei rifiuti ospedalieri. Rapporto AMA.

Andreottola G., Cossu R., 1988. Modello matematico di produzione del biogas in uno scarico controllato. RS – Rifiuti Solidi vol. II n. 6, pp. 473-483.

ANPA, 1998. Il sistema ANPA di contabilità dei rifiuti, prime elaborazioni dei dati. Agenzia Nazionale per la Protezione dell'Ambiente.

ANPA-FLORYS, 2000. Industria conciaria, Studio di settore. Agenzia Nazionale per la Protezione dell'Ambiente.

ANPA-FLORYS, 2001. Industria della carta e cartone, Studio di settore. Agenzia Nazionale per la Protezione dell'Ambiente.

ANPA-ONR, 1999 [a]. Primo Rapporto sui rifiuti speciali. Agenzia Nazionale per la Protezione dell'Ambiente.

ANPA-ONR, 1999 [b]. Secondo Rapporto sui Rifiuti Urbani e sugli Imballaggi e rifiuti di imballaggio. Agenzia Nazionale per la Protezione dell'Ambiente.

ANPA, 2001. Guida alla progettazione dei sistemi di collettamento e depurazione delle acque reflue urbane. Agenzia Nazionale per la Protezione dell'Ambiente. Rapporto n. 1/2001.

ANPA-ONR, 2001. I rifiuti del comparto agro-alimentare, Studio di settore. Agenzia Nazionale per la Protezione dell'Ambiente. Rapporto n. 11/2001.

APAT, 2002. Annuario dei dati ambientali. Agenzia per la Protezione dell'Ambiente e per i servizi Tecnici. Rapporto n. 7/2002.

APAT-ONR, several years. Rapporto Rifiuti. Agenzia per la Protezione dell'Ambiente e per i servizi Tecnici.

ApS, 1997. Technical Paper. Azienda Po Sangone.

Asja, 2003. Dichiarazione Ambientale 2003. Asja Ambiente Italia S.p.A., 2003.

Assobirra, several years. Rapporti Annuali e Dati Statistici. Also available on the website http://www.assobirra.it.

Assocarta, several years. Rapporto Ambientali. Also available on the website http://www.assocarta.it.

AUSITRA-Assoambiente, 1995. Impianti di trattamento dei rifiuti solidi urbani e assimilabili. Indagine a cura di Merzagora W., Ferrari S.P.
Borgioli E., 1981. Nutrizione e alimentazione degli animali domestici. Ed Agricole, p. 464.

CESTAAT, 1988. Impieghi dei sottoprodotti agricoli ed agroindustriali, Vol. 1. Centro Studi sull'Agricoltura, l'Ambiente e il Territorio, edizione fuori commercio, p. 311.

CNR, 1980. Indagine sui Rifiuti Solidi Urbani in Italia. Consiglio Nazionale delle Ricerche, Progetto Finalizzato Energetica.

Colombari et al., 1998. Le emissioni di metano dalle discariche di rifiuti in Italia: stima e scenari futuri. ENEA RT/AMB/98/30.

COOU, several years, Consorzio Olii Usati, also available on the web-site http://www.coou.it.

COOU, 2006, Personal Communication. Consorzio Olii Usati.

COVIRI, 2005. Relazione annuale al parlamento sullo stato dei servizi idrici, Anno 2005. Autorità di vigilanza sulle risorse idriche e sui rifuti.

De Poli F., Pasqualini S., 1991. Landfill gas: the Italian situation. ENEA, atti del convegno Sardinia 91, Third International Landfill Symposium.

De Stefanis P., 1999. Personal communication.

De Stefanis P. et al., 1998. Gestione dei rifiuti ad effetto serra. ENEA-CNR, atti della Conferenza Nazionale Energia e Ambiente, Rome 25-18 November 1998.

Decree of President of the Republic 10 September 1982, n.915. Attuazione delle direttive 75/442/CEE relativa ai rifiuti e 76/403/CEE relativa ai rifiuti tossici e nocivi. G.U. 15 dicembre 1982, n. 343, S.O.

EC, 1975. Council Directive 1975/442/EC. Council Directive 75/442/EC of 15 July 1975 on waste framework. Official Journal of the European Communities 25 July 1975.

EC, 1976. Council Directive 1976/403/EC. Council Directive 76/403/EC of 6 April 1976 on treatment and disposal of PCBs and PCTs. Official Journal of the European Communities 26 April 1976.

EC, 1978. Council Directive 1978/319/EC. Council Directive 78/319/EC of 20 March 1978 on toxic and dangerous waste. Official Journal of the European Communities 31 March 1978.

EC, 1999. Council Directive 1999/31/EC. Council Directive 99/31/EC of 26 April 1999 on the landfill of waste. Official Journal of the European Communities 16 July 1999.

Ecomondo, 2006. Conference Proceedings, 10th International Trade Fair on Material and Energy Recovery and Sustainable Development, Rimini 8 – 10 november 2006.

EEA, 2005. Waste management in Europe and the Landfill Directive. Background paper from the ETC/RWM to the ETC/ACC workshop 'Inventories and Projections of Greenhouse Gas Emissions from Waste', European Environment Agency, April 2005.

EMEP/CORINAIR, 2007. Atmospheric Emission Inventory Guidebook. Technical report No 16/2007.

ENI S.p.A. 2001. Rapporto Salute Sicurezza Ambiente.
FAO, several years. Food balance, available on the website http://faostat.fao.org.

Favoino E., Cortellini L., 2001. Composting and biological treatment in southern European countries: an overview. Conference Proceedings Soil and Biowaste in Southern Europe. Rome 18-19 January, 2001.

Favoino E., Girò F., 2001. An assessment of effective, optimised schemes for source separation of organic waste in Mediterranean districts. Conference Proceedings Soil and Biowaste in Southern Europe. Rome 18-19 January, 2001.

FEDERAMBIENTE, 1992. Analisi dei principali sistemi di smaltimento dei rifiuti solidi urbani.

FEDERAMBIENTE, 1998. Impianti di smaltimento: analisi sui termocombustori RSU – prima edizione. Indagine a cura di Motawi A.

FEDERAMBIENTE, 2001. Impianti di smaltimento: analisi sui termoutilizzatori RU. Indagine a cura di Morabito L., GEA n. 5/2001.

FEDERCHIMICA, several years. Rapporto Responsible Care. Federazione Nazionale dell'Industria Chimica.

Ferrari G., 1996. I rifiuti città per città. GEA, July 1996.

Finn L., Spencer R., 1997. Managing biofilters for consistent odor and VOC treatment. Biocycle, January 1997 Vol. 38 Iss.1.

Gaudioso et al., 1993. Emissioni in atmosfera dalle discariche di rifiuti in Italia. RS, Rifiuti Solidi vol. VII n. 5, Sept.-Oct. 1993.

Ham, R.K., 1979. Predicting gas generation from landfills. Waste Age, 11, 50.

Hogg D., 2001. Biological treatment of waste: a solution for tomorrow. ISWA Beacon Conference.

IPCC, 1995. IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Manual, Reporting Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Centre, Meteorological Office, Bracknell, UK.

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Centre, Meteorological Office, Bracknell, UK.

IPCC, 2000. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. IPCC National Greenhouse Gas Inventories Programme, Technical Support Unit, Hayama, Kanagawa, Japan.

IRSA-CNR, 1998. Personal Communication.

ISTAT, several years [a]. Annuario Statistico. Istituto Nazionale di Statistica.

ISTAT, several years [b]. Bollettino mensile di statistica. Istituto Nazionale di Statistica.

ISTAT, several years [c]. Information available on the website http://www.istat.it.

ISTAT, 1987. Approvvigionamento idrico, fognature e impianti di depurazione in Italia – anno 1987. Collana d'informazione n. 20, ed. 1991.

ISTAT, 1991. Statistiche ambientali 1991. Istituto nazionale di statistica.

ISTAT, 1993. Statistiche ambientali 1993. Istituto nazionale di statistica.

ISTAT, 1998 [a]. Il processo di depurazione e la qualità delle acque reflue urbane. Indagine sugli impianti di depurazione delle acque reflue urbane, anno 1993. Istituto nazionale di statistica.

ISTAT, 1998 [b]. Caratteristiche strutturali degli impianti di depurazione delle acque reflue urbane. Indagine sugli impianti di depurazione delle acque reflue urbane, anno 1993. Istituto nazionale di statistica.

ISTAT, 2004. Sistema di Indagini sulle Acque, SIA – anno 1999. Istituto nazionale di statistica, also available at website http://acqua.istat.it.

Legislative Decree 5 February 1997, n. 22. Attuazione delle direttive 91/156/CEE sui rifiuti 91/698/CEE sui rifiuti pericolosi e 94/62/CEE sugli imballaggi e sui rifiuti di imballaggio. G.U. 15 febbraio 1997, n. 38, S.O.

Legislative Decree 11 May 1999, n. 152. Disposizioni sulla tutela delle acque dall'inquinamento e recepimento della direttiva 91/271/CEE concernente il trattamento delle acque reflue urbane e della direttiva 91/676/CEE relativa alla protezione delle acque dall'inquinamento provocato dai nitrati provenienti da fonti agricole. G.U. 29 maggio 1999, n. 124, S.O.

Legislative Decree 13 January 2003, n. 36. Attuazione della direttiva 1999/31/EC relativa alle discariche di rifiuti. G.U. 12 marzo 2003, n. 59 – S.O. 40/L.

Legislative Decree 30 December 2008, n.208. Misure straordinarie in materia di risporse idriche e protezione dell'ambiente. G.U. 31 dicembre 2008, n. 304, S.O.

Masotti L., 1996. Depurazione delle acque. Edizioni Calderoni.

MATTM, several years. RSA- Rapporto sullo stato dell'ambiente 1989, 1992, 1997, 2001. Ministero dell'Ambiente e della Tutela del Territorio e del Mare.

MATTM, 2005. Personal Communication.

Metcalf and Eddy, 1991. Wastewater engineering: treatment, disposal and reuse. Mc Graw Hill, third edition.

Ministerial Decree 12 July 1990. Linee Guida per il contenimento delle emissioni inquinanti degli impianti industriali e la fissazione dei valori minimi di emissione. G.U. 30 luglio 1990, n. 176.

Ministerial Decree 19 November 1997, n. 503. Regolamento recante norme per l'attuazione delle Direttive 89/369/CEE e 89/429/CEE concernenti la prevenzione dell'inquinamento atmosferico provocato dagli impianti di incenerimento dei rifiuti urbani e la disciplina delle emissioni e delle condizioni di combustione degli impianti di incenerimento di rifiuti urbani, di rifiuti speciali non pericolosi, nonché di taluni rifiuti sanitari. G.U. 29 gennaio 1998, n. 23.

Morselli L., 1998. L'incenerimento dei rifiuti, ricognizione sulla realtà regionale. Università degli Studi di Bologna, Dipartimento di chimica industriale e dei materiali e Regione Emilia Romagna, Assessorato Territorio, Programmazione e Ambiente.

Muntoni A., Polettini A., 2002. Modelli di produzione del biogas - limiti di applicazione e sensitività. Conference proceedings, Università degli Studi di Roma La Sapienza "Gestione del biogas da discarica: controllo, recupero e monitoraggio. Rome, December 2002.

Tecneco, 1972. Indagine Nazionale sullo smaltimento dei Rifiuti Solidi Urbani. Dispense 1995 Prof. Liuzzo, Università degli Studi di Roma "La Sapienza".

TERNA, several years. Dati statistici sull'energia elettrica in Italia. Rete Elettrica Nazionale.

UNIC, several years. Rapporto Ambientale. Unione Nazionale Industria Conciaria.

UP, several years. Statistiche economiche, energetiche e petrolifere. Unione Petrolifera.

US EPA, 1990. Air emissions Species Manual, vol. I: Volatile Organic Compound Species Profiles, Second Edition. EPA-450/2-90-001a (United States Environmental Protection Agency – Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711), January 1990.

10.8 ANNEX 1

IPCC, 2000. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. IPCC National Greenhouse Gas Inventories Programme, Technical Support Unit, Hayama, Kanagawa, Japan.

IPCC, 2003. Good Practice Guidance for Land Use, Land-Use Change and Forestry. IPCC Technical Support Unit, Kanagawa, Japan.

10.9 ANNEX 4

ENEA, 2002 [a]. Calcolo delle emissioni di CO_2 dal settore energetico, metodo di riferimento IPCC. Contaldi M., La Motta S.

ENEA, 2002 [b]. Calcolo delle emissioni di CO_2, reference approach - manuale d'uso per la compilazione del foglio elettronico 1a(b) e 1a(d) del common reference framework (CRF). La Motta S. and Ancona P., Ente per le Nuove tecnologie, l'Energia e l'Ambiente.

ENEA, several years. Rapporto Energia Ambiente. Ente per le Nuove tecnologie, l'Energia e l'Ambiente, Roma.

ENEL, several years. Environmental Report. ENEL. www.enel.it .

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Centre, Meteorological Office, Bracknell, UK.

MSE, several years [a]. Bilancio Energetico Nazionale (BEN). Ministero dello Sviluppo Economico, Direzione Generale delle Fonti di Energia ed industrie di base, also available on website http://dgerm.sviluppoeconomico.gov.it/dgerm/ben.asp

MSE, several years [b]. Bollettino Petrolifero Trimestrale (BPT). Ministero dello Sviluppo Economico.

10.10 ANNEX 6

APAT, 2003. Analisi dei fattori di emissione di CO_2 dal settore dei trasporti. Ilacqua M., Contaldi M., Rapporti n° 28/2003.

EEA, 2000. COPERT III, Computer Programme to Calculate Emissions from Road Transport - Methodology and Emission Factors, European Environment Agency, Technical report No 49, November 2000.

EMEP/CORINAIR, 2007. Atmospheric Emission Inventory Guidebook. Technical report No 16/2007.

IPCC, 1997. Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories. Three volumes: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Centre, Meteorological Office, Bracknell, UK.

ANNEX 1: KEY CATEGORIES AND UNCERTAINTY

A1.1 Introduction

The IPCC Good Practice Guidance (IPCC, 2000) recommends as good practice the identification of *key 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. The concept of key sources was originally derived for emissions excluding the LULUCF sector and expanded in the IPCC Good Practice Guidance for LULUCF (IPCC, 2003) to cover also LULUCF emissions by sources and removals by sinks. In this document whenever the term *key category* is used, it includes both sources and sinks.
The *key (source) categories* have been identified for the inventory excluding LULUCF, following the guidance in *GPG2000*. The *key category* analysis has then been repeated for the full inventory including the LULUCF categories.
Key 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 categories is important because key categories should receive special consideration in terms of methodological aspects and quality assurance and quality control verification.
Two different approaches are reported in the IPCC Good Practice Guidance 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 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 categories should cover up to 90% of inventory uncertainty.
If an uncertainty analysis is carried out at category level for the inventory, the Tier 2 can be used to identify key 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/sink category. Key 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 or a sink a key category have a high contribution to the total, a high contribution to the trend and a high uncertainty.
If both the 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 category analysis has been carried out according to both the Tier 1 and Tier 2 methods, excluding and including the LULUCF sector. 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. For the base year, the level assessment of key categories has been carried out.
Summary of the results of the key category analysis, for the base year and 2007, is reported in Tables 1.3– 1.6 of chapter 1. The tables indicate whether a key category derives from the level assessment or the trend assessment, according to Tier 1, Tier 2 or both the methods.
For the base year, 19 sources were individuated according to the Tier 1 approach, whereas 22 sources were carried out by the Tier 2. Including the LULUCF categories in the analysis, 25 categories were selected jointly by the Tier 1 and the Tier 2.
For the year 2007, 17 sources were individuated by the Tier 1 approach accounting for 95% of the total emissions, without LULUCF; for the trend 13 key sources were selected. Jointly for both the Tier 1 level and trend, 29 key sources were totally individuated.
Repeating the *key category* analysis for the full inventory including the LULUCF categories, 20 categories were individuated accounting for 95% of the total emissions and removals in 2007, and,

in trend assessment, 17 key categories are observed. Jointly for both the Tier 1 level and trend, 22 key categories were totally individuated.
The application of the Tier 2 to the 2007 emission levels gives as a result 21 key categories accounting for the 95% of the total levels uncertainty; when applying the trend analysis the key categories decreased to 20 with differences with respect to the previous list.
The application of the Tier 2 including the LULUCF categories results in 21 key categories, for the year 2007, accounting for the 95% of the total levels uncertainty; for the trend analysis including LULUCF categories, the key categories decreased to 20. Jointly for both the level and trend, 22 key categories were totally individuated.

A1.2 Tier 1 key category assessment

As described in the IPCC Good Practice Guidance (IPCC, 2000), the Tier 1 method for identifying key categories assesses the impacts of various 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 or sink category to the total national inventory level is calculated as follows:

$$\text{Key Category Level Assessment} = \frac{\left|\text{Source or Sink Category Estimate}\right|}{\text{Total Contribution}}$$

Therefore, key 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 and sink category's trend can be assessed by the following equation:

$$\text{Source or Sink Category Trend Assessment} = \\ \left(\text{Source or Sink Category Level Assessment}\right)\cdot\left|\text{Source or Sink Category Trend} - \text{Total Trend}\right|$$

where the source or sink category trend is the change in the category emissions over time, computed by subtracting the base year estimate for a generic category from the 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 categories will be those where the category trend diverges significantly from the total trend, weighted by the emission level of the category.
Both level and trend assessments have been carried out for the Italian GHG inventory. For the base year, a level assessment is computed.
In this section, detailed results are reported for the 2007 inventory.
The results of the Tier 1 method are shown in Table A1.1, reporting level and trend assessment without LULUCF categories, and in Table A1.2 where results of the key categories analysis with the LULUCF categories are reported.
Regarding the trend assessment, as already mentioned, the equation reported above does not enable quantification in case the emission or removal 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 N_2O from other production in the chemical industry and SF_6 from the production of SF_6.

TIER 1						
CATEGORIES	2007 Gg CO_2eq	Level assessment	Cumulative Percentage	CATEGORIES	% Contribution to trend	Cumulative Percentage
CO2 stationary combustion gaseous fuels	159,220	0.288	0.29	CO2 stationary combustion liquid fuels	0.38	0.38
CO2 Mobile combustion: Road Vehicles	118,721	0.215	0.50	CO2 stationary combustion gaseous fuels	0.33	0.72
CO2 stationary combustion liquid fuels	86,306	0.156	0.66	CO2 Mobile combustion: Road Vehicles	0.09	0.81
CO2 stationary combustion solid fuels	66,727	0.121	0.78	HFC, PFC substitutes for ODS	0.03	0.84
CO2 Cement production	17,914	0.032	0.81	N2O Adipic Acid	0.02	0.86
CH4 from Solid waste Disposal Sites	13,341	0.024	0.84	CO2 stationary combustion solid fuels	0.02	0.88
CH4 Enteric Fermentation in Domestic Livestock	11,027	0.020	0.86	CH4 Fugitive emissions from Oil and Gas Operations	0.01	0.89
Direct N2O Agricultural Soils	8,694	0.016	0.87	CO2 stationary combustion other fuels	0.01	0.90
Indirect N2O from Nitrogen used in agriculture	7,527	0.014	0.89	CH4 Enteric Fermentation in Domestic Livestock	0.01	0.91
HFC, PFC substitutes for ODS	6,677	0.012	0.90	CO2 Iron and Steel production	0.01	0.92
CH4 Fugitive emissions from Oil and Gas Operations	4,987	0.009	0.91	PFC Aluminium production	0.01	0.93
CO2 Mobile combustion: Waterborne Navigation	4,970	0.009	0.92	Direct N2O Agricultural Soils	0.01	0.93
CO2 stationary combustion other fuels	4,210	0.008	0.92	CO2 Fugitive emissions from Oil and Gas Operations	0.01	0.94
N2O stationary combustion	3,841	0.007	0.93	CO2 Ammonia production	0.01	0.95
N2O Manure Management	3,797	0.007	0.94	Indirect N2O from Nitrogen used in agriculture	0.01	0.95
CH4 Manure Management	3,057	0.006	0.94	N2O Nitric Acid	0.01	0.96
CO2 Limestone and Dolomite Use	2,513	0.005	0.95	CH4 from Solid waste Disposal Sites	0.00	0.96
CH4 Emissions from Wastewater Handling	2,435	0.004	0.95	CO2 Mobile combustion: Waterborne Navigation	0.00	0.97
CO2 Lime production	2,434	0.004	0.96	CO2 Mobile combustion: Aircraft	0.00	0.97
CO2 Mobile combustion: Aircraft	2,428	0.004	0.96	CO2 Cement production	0.00	0.97
CO2 Fugitive emissions from Oil and Gas Operations	2,176	0.004	0.96	CH4 Manure Management	0.00	0.98
N2O Emissions from Wastewater Handling	2,019	0.004	0.97	CH4 Mobile combustion: Road Vehicles	0.00	0.98
CO2 Mobile combustion: Other	1,990	0.004	0.97	N2O Manure Management	0.00	0.98
CO2 Other industrial processes	1,931	0.003	0.97	HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.00	0.98
N2O from animal production	1,570	0.003	0.98	N2O Mobile combustion: Road Vehicles	0.00	0.99
CH4 from Rice production	1,523	0.003	0.98	CO2 Emissions from solvent use	0.00	0.99
CO2 Iron and Steel production	1,483	0.003	0.98	CH4 Emissions from Wastewater Handling	0.00	0.99
N2O Mobile combustion: Road Vehicles	1,420	0.003	0.99	CO2 Emissions from Waste Incineration	0.00	0.99
CO2 Emissions from solvent use	1,361	0.002	0.99	N2O from animal production	0.00	0.99
N2O Nitric Acid	1,109	0.002	0.99	CH4 stationary combustion	0.00	0.99
CH4 stationary combustion	963	0.002	0.99	CO2 Lime production	0.00	0.99
N2O Adipic Acid	782	0.001	0.99	N2O stationary combustion	0.00	0.99
N2O Emissions from solvent use	772	0.001	0.99	CH4 from Rice production	0.00	1.00
CO2 Ammonia production	649	0.001	1.00	PFC, HFC, SF6 Semiconductor manufacturing	0.00	1.00
CH4 Mobile combustion: Road Vehicles	415	0.001	1.00	SF6 Production of SF6	0.00	1.00
SF6 Electrical Equipment	337	0.001	1.00	SF6 Electrical Equipment	0.00	1.00
CH4 Emissions from Waste Incineration	271	0.000	1.00	CH4 Emissions from Waste Incineration	0.00	1.00
CO2 Emissions from Waste Incineration	270	0.000	1.00	N2O Emissions from solvent use	0.00	1.00
PFC Aluminium production	200	0.000	1.00	CO2 Other industrial processes	0.00	1.00
PFC, HFC, SF6 Semiconductor manufacturing	129	0.000	1.00	SF6 Magnesium production	0.00	1.00
N2O Mobile combustion: Other	123	0.000	1.00	CH4 Industrial Processes	0.00	1.00
N2O Emissions from Waste Incineration	120	0.000	1.00	CH4 Fugitive emissions from Coal Mining and Handling	0.00	1.00
CH4 Fugitive emissions from Coal Mining and Handling	84	0.000	1.00	CO2 Mobile combustion: Other	0.00	1.00
CH4 Industrial Processes	65	0.000	1.00	CO2 Limestone and Dolomite Use	0.00	1.00
SF6 Magnesium production	54	0.000	1.00	N2O Emissions from Waste Incineration	0.00	1.00
N2O Mobile combustion: Waterborne Navigation	36	0.000	1.00	N2O Emissions from Wastewater Handling	0.00	1.00
CH4 Mobile combustion: Waterborne Navigation	29	0.000	1.00	N2O Mobile combustion: Other	0.00	1.00
N2O Mobile combustion: Aircraft	21	0.000	1.00	N2O Other industrial processes	0.00	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	18	0.000	1.00	N2O Mobile combustion: Waterborne Navigation	0.00	1.00
CH4 Agricultural Residue Burning	12.8	0.000	1.00	N2O Mobile combustion: Aircraft	0.00	1.00
CH4 Emissions from Other Waste	4.6	0.000	1.00	CH4 Emissions from Other Waste	0.00	1.00
N2O Agricultural Residue Burning	4.1	0.000	1.00	CH4 Mobile combustion: Waterborne Navigation	0.00	1.00
CH4 Mobile combustion: Other	3.5	0.000	1.00	CH4 Mobile combustion: Other	0.00	1.00
CH4 Mobile combustion: Aircraft	1.5	0.000	1.00	CH4 Agricultural Residue Burning	0.00	1.00
N2O Fugitive emissions from Oil and Gas Operations	1.4	0.000	1.00	CH4 Mobile combustion: Aircraft	0.00	1.00
N2O Other industrial processes	0.0	0.000	1.00	N2O Agricultural Residue Burning	0.00	1.00
SF6 Production of SF6	0.0	0.000	1.00	N2O Fugitive emissions from Oil and Gas Operations	0.00	1.00

Table A1.1 Results of the key categories analysis (Tier1) without LULUCF categories. Year 2007

TIER 1						
CATEGORIES	2007 Gg CO æq	Level assessment	Cumulative Percentage	CATEGORIES	% Contribution to trend	Cumulative Percentage
CO2 stationary combustion gaseous fuels	159,220	0.253	0.25	CO2 stationary combustion liquid fuels	0.35	0.35
CO2 Mobile combustion: Road Vehicles	118,721	0.188	0.44	CO2 stationary combustion gaseous fuels	0.30	0.66
CO2 stationary combustion liquid fuels	86,306	0.137	0.58	CO2 Mobile combustion: Road Vehicles	0.08	0.74
CO2 stationary combustion solid fuels	66,727	0.106	0.68	CO2 Land converted to Grassland	0.03	0.77
CO2 Forest land remaining Forest Land	53,384	0.085	0.77	CO2 Cropland remaining Cropland	0.03	0.80
CO2 Cement production	17,914	0.028	0.80	HFC, PFC substitutes for ODS	0.03	0.83
CH4 from Solid waste Disposal Sites	13,341	0.021	0.82	N2O Adipic Acid	0.02	0.85
CH4 Enteric Fermentation in Domestic Livestock	11,027	0.017	0.84	CO2 Forest land remaining Forest Land	0.01	0.87
CO2 Cropland remaining Cropland	10,960	0.017	0.85	CO2 stationary combustion solid fuels	0.01	0.88
Direct N2O Agricultural Soils	8,694	0.014	0.87	CH4 Fugitive emissions from Oil and Gas Operations	0.01	0.89
CO2 Land converted to Grassland	7,760	0.012	0.88	CO2 stationary combustion other fuels	0.01	0.90
Indirect N2O from Nitrogen used in agriculture	7,527	0.012	0.89	CH4 Enteric Fermentation in Domestic Livestock	0.01	0.91
HFC, PFC substitutes for ODS	6,677	0.011	0.90	CO2 Iron and Steel production	0.01	0.92
CH4 Fugitive emissions from Oil and Gas Operations	4,987	0.008	0.91	PFC Aluminium production	0.01	0.93
CO2 Mobile combustion: Waterborne Navigation	4,970	0.008	0.92	Direct N2O Agricultural Soils	0.01	0.93
CO2 stationary combustion other fuels	4,210	0.007	0.92	CO2 Fugitive emissions from Oil and Gas Operations	0.01	0.94
N2O stationary combustion	3,841	0.006	0.93	Indirect N2O from Nitrogen used in agriculture	0.01	0.95
N2O Manure Management	3,797	0.006	0.94	CO2 Ammonia production	0.01	0.95
CO2 Land converted to Settlements	3,181	0.005	0.94	N2O Nitric Acid	0.01	0.96
CH4 Manure Management	3,057	0.005	0.95	CO2 Land converted to Forest Land	0.01	0.96
CO2 Limestone and Dolomite Use	2,513	0.004	0.95	CH4 from Solid waste Disposal Sites	0.00	0.97
CH4 Emissions from Wastewater Handling	2,435	0.004	0.95	CO2 Mobile combustion: Waterborne Navigation	0.00	0.97
CO2 Lime production	2,434	0.004	0.96	CO2 Mobile combustion: Aircraft	0.00	0.97
CO2 Mobile combustion: Aircraft	2,428	0.004	0.96	CH4 Manure Management	0.00	0.98
CO2 Land converted to Forest Land	2,204	0.003	0.96	CO2 Cement production	0.00	0.98
CO2 Fugitive emissions from Oil and Gas Operations	2,176	0.003	0.97	CH4 Mobile combustion: Road Vehicles	0.00	0.98
N2O Emissions from Wastewater Handling	2,019	0.003	0.97	N2O Manure Management	0.00	0.98
CO2 Mobile combustion: Other	1,990	0.003	0.97	HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.00	0.98
CO2 Other industrial processes	1,931	0.003	0.98	CO2 Emissions from solvent use	0.00	0.99
N2O from animal production	1,570	0.002	0.98	N2O Mobile combustion: Road Vehicles	0.00	0.99
CH4 from Rice production	1,523	0.002	0.98	CO2 Emissions from Waste Incineration	0.00	0.99
CO2 Iron and Steel production	1,483	0.002	0.98	CH4 Emissions from Wastewater Handling	0.00	0.99
N2O Mobile combustion: Road Vehicles	1,420	0.002	0.99	N2O from animal production	0.00	0.99
CO2 Emissions from solvent use	1,361	0.002	0.99	CH4 stationary combustion	0.00	0.99
N2O Nitric Acid	1,109	0.002	0.99	CO2 Lime production	0.00	0.99
CH4 stationary combustion	963	0.002	0.99	CO2 Land converted to Settlements	0.00	0.99
N2O Adipic Acid	782	0.001	0.99	N2O stationary combustion	0.00	0.99
N2O Emissions from solvent use	772	0.001	1.00	CH4 from Rice production	0.00	1.00
CO2 Ammonia production	649	0.001	1.00	PFC, HFC, SF6 Semiconductor manufacturing	0.00	1.00
CH4 Mobile combustion: Road Vehicles	415	0.001	1.00	SF6 Production of SF6	0.00	1.00
SF6 Electrical Equipment	337	0.001	1.00	SF6 Electrical Equipment	0.00	1.00
CH4 Emissions from Waste Incineration	271	0.000	1.00	CH4 Emissions from Waste Incineration	0.00	1.00
CO2 Emissions from Waste Incineration	270	0.000	1.00	N2O Emissions from solvent use	0.00	1.00
PFC Aluminium production	200	0.000	1.00	CO2 Other industrial processes	0.00	1.00
CH4 Forest land remaining Forest Land	197	0.000	1.00	SF6 Magnesium production	0.00	1.00
PFC, HFC, SF6 Semiconductor manufacturing	129	0.000	1.00	CH4 Industrial Processes	0.00	1.00
N2O Mobile combustion: Other	123	0.000	1.00	CH4 Fugitive emissions from Coal Mining and Handlin	0.00	1.00
N2O Emissions from Waste Incineration	120	0.000	1.00	CO2 Mobile combustion: Other	0.00	1.00
CH4 Fugitive emissions from Coal Mining and Handling	84	0.000	1.00	CH4 Forest land remaining Forest Land	0.00	1.00
CH4 Industrial Processes	65	0.000	1.00	CO2 Limestone and Dolomite Use	0.00	1.00
SF6 Magnesium production	54	0.000	1.00	N2O Emissions from Waste Incineration	0.00	1.00
N2O Mobile combustion: Waterborne Navigation	36	0.000	1.00	N2O Emissions from Wastewater Handling	0.00	1.00
CH4 Mobile combustion: Waterborne Navigation	29	0.000	1.00	N2O Mobile combustion: Other	0.00	1.00
N2O Mobile combustion: Aircraft	21	0.000	1.00	N2O Other industrial processes	0.00	1.00
N2O Forest land remaining Forest Land	20	0.000	1.00	N2O Mobile combustion: Waterborne Navigation	0.00	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	18	0.000	1.00	N2O Mobile combustion: Aircraft	0.00	1.00
CH4 Agricultural Residue Burning	12.8	0.000	1.00	N2O Forest land remaining Forest Land	0.00	1.00
CH4 Emissions from Other Waste	4.6	0.000	1.00	CH4 Emissions from Other Waste	0.00	1.00
N2O Agricultural Residue Burning	4.1	0.000	1.00	CH4 Mobile combustion: Waterborne Navigation	0.00	1.00
CH4 Mobile combustion: Other	3.5	0.000	1.00	CH4 Mobile combustion: Other	0.00	1.00
CH4 Mobile combustion: Aircraft	1.5	0.000	1.00	CH4 Agricultural Residue Burning	0.00	1.00
N2O Fugitive emissions from Oil and Gas Operations	1.4	0.000	1.00	CH4 Mobile combustion: Aircraft	0.00	1.00
N2O Other industrial processes	0.0	0.000	1.00	N2O Agricultural Residue Burning	0.00	1.00
SF6 Production of SF6	0.0	0.000	1.00	N2O Fugitive emissions from Oil and Gas Operations	0.00	1.00
CO2 Land converted to Cropland	0.0	0.000	1.00	CO2 Land converted to Cropland	0.00	1.00
N2O Land converted to Cropland	0.0	0.000	1.00	N2O Land converted to Cropland	0.00	1.00

Table A1.2 Results of the key categories analysis (Tier1) with LULUCF categories. Year 2007

The application of the Tier 1, excluding LULUCF categories, gives as a result 17 key sources accounting for the 95% of the total levels; when applying the trend analysis, excluding LULUCF categories, the key sources decreased to 14 with some differences with respect to the previous list (Table A1.1).

The Tier 1 *key category* level assessment, repeated for the full inventory including the LULUCF categories, results in 20 key categories (sources and sinks) and 17 key categories outcome from the trend analysis, with LULUCF categories, presenting some differences with respect to the list resulting from level assessment (Table A1.2).

A1.3 Uncertainty assessment (IPCC Tier 1)

The Tier 2 method for the identification of key categories 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 for the base year and the last submitted year. In this section, detailed results are reported for the 2007 inventory.
The results of the approach are reported in Table A1.3, for the year 2007, excluding the LULUCF sector.
The uncertainty analysis has also been repeated including the LULUCF sector in the national totals. Details on the Tier 1 method used for LULUCF are described in the relevant chapter, chapter 7; in the following Table A1.4, the results by category, concerning only CO_2 emissions and removals, are reported whereas in Table A1.5, the results include CO_2, CH_4, N_2O emissions and removals. Finally, in Table A1.6 figures of inventory total uncertainty, including the LULUCF sector, are shown.

Tier 1 Uncertainty calculation and reporting

IPCC Sorce category	Gas	Base year emissions 1990 Gg	Year t emissions 2007 Gg	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	153,467	86,306	3%	3%	0.042	0.007	-0.151	0.167	-0.005	0.007	0.008
CO2 stationary combustion solid fuels	CO2	59,395	66,727	3%	3%	0.042	0.005	0.006	0.129	0.000	0.005	0.005
CO2 stationary combustion gaseous fuels	CO2	85,066	159,220	3%	3%	0.042	0.012	0.132	0.308	0.004	0.013	0.014
CO2 stationary combustion other fuels	CO2	1,779	4,210	3%	3%	0.042	0.000	0.004	0.008	0.000	0.000	0.000
CH4 stationary combustion	CH4	647	963	3%	50%	0.501	0.001	0.001	0.002	0.000	0.000	0.000
N2O stationary combustion	N2O	3,434	3,841	3%	50%	0.501	0.003	0.000	0.007	0.000	0.000	0.000
CO2 Mobile combustion: Road Vehicles	CO2	93,387	118,721	3%	3%	0.042	0.009	0.036	0.230	0.001	0.010	0.010
CH4 Mobile combustion: Road Vehicles	CH4	867	415	3%	40%	0.401	0.000	-0.001	0.001	0.000	0.000	0.000
N2O Mobile combustion: Road Vehicles	N2O	996	1,420	3%	50%	0.501	0.001	0.001	0.003	0.000	0.000	0.000
CO2 Mobile combustion: Waterborne Navigation	CO2	5,420	4,970	3%	3%	0.042	0.000	-0.002	0.010	0.000	0.000	0.000
CH4 Mobile combustion: Waterborne Navigation	CH4	29	29	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Waterborne Navigation	N2O	39	36	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion: Aircraft	CO2	1,613	2,428	3%	3%	0.042	0.000	0.001	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	14	21	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion: Other	CO2	1,894	1,990	3%	5%	0.058	0.000	0.000	0.004	0.000	0.000	0.000
CH4 Mobile combustion: Other	CH4	5	4	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Other	N2O	131	123	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Fugitive emissions from Coal Mining and Handling	CH4	122	84	3%	200%	2.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Fugitive emissions from Oil and Gas Operations	CO2	3,341	2,176	3%	25%	0.252	0.001	-0.003	0.004	-0.001	0.000	0.001
CH4 Fugitive emissions from Oil and Gas Operations	CH4	7,298	4,987	3%	25%	0.252	0.002	-0.005	0.010	-0.001	0.000	0.001
N2O Fugitive emissions from Oil and Gas Operations	N2O	1	1	3%	25%	0.252	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Cement production	CO2	16,084	17,914	3%	10%	0.104	0.003	0.001	0.035	0.000	0.001	0.001
CO2 Lime production	CO2	2,042	2,434	3%	10%	0.104	0.000	0.000	0.005	0.000	0.000	0.000
CO2 Limestone and Dolomite Use	CO2	2,375	2,513	3%	10%	0.104	0.000	0.000	0.005	0.000	0.000	0.000
CO2 Iron and Steel production	CO2	3,124	1,483	3%	10%	0.104	0.000	-0.004	0.003	0.000	0.000	0.000
CO2 Ammonia production	CO2	1,710	649	3%	10%	0.104	0.000	-0.002	0.001	0.000	0.000	0.000
CO2 Other industrial processes	CO2	1,856	1,931	3%	10%	0.104	0.000	0.000	0.004	0.000	0.000	0.000
N2O Adipic Acid	N2O	4,579	782	3%	10%	0.104	0.000	-0.008	0.002	-0.001	0.000	0.001
N2O Nitric Acid	N2O	2,086	1,109	3%	10%	0.104	0.000	-0.002	0.002	0.000	0.000	0.000
N2O Other industrial processes	N2O	11	0	3%	10%	0.104	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Industrial Processes	CH4	108	65	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
PFC Aluminium production	PFC	1,673	200	5%	10%	0.112	0.000	-0.003	0.000	0.000	0.000	0.000
SF6 Magnesium production	SF6	0	54	5%	5%	0.071	0.000	0.000	0.000	0.000	0.000	0.000
SF6 Electrical Equipment	SF6	213	337	5%	10%	0.112	0.000	0.000	0.001	0.000	0.000	0.000
SF6 Production of SF6	SF6	120	0	5%	10%	0.112	0.000	0.000	0.000	0.000	0.000	0.000
PFC, HFC, SF6 Semiconductor manufacturing	PFC-HFC	0	129	30%	50%	0.583	0.000	0.000	0.000	0.000	0.000	0.000
HFC, PFC substitutes for ODS	HFC	134	6,677	30%	50%	0.583	0.007	0.013	0.013	0.006	0.005	0.008
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	HFC	351	18	5%	10%	0.112	0.000	-0.001	0.000	0.000	0.000	0.000
CH4 Enteric Fermentation in Domestic Livestock	CH4	12,179	11,027	20%	20%	0.283	0.006	-0.004	0.021	-0.001	0.006	0.006
CH4 Manure Management	CH4	3,462	3,057	20%	100%	1.020	0.006	-0.001	0.006	-0.001	0.002	0.002
N2O Manure Management	N2O	3,921	3,797	20%	100%	1.020	0.007	-0.001	0.007	-0.001	0.002	0.002
CH4 Agricultural Residue Burning	CH4	13	13	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
N2O Agricultural Residue Burning	N2O	4	4	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
Direct N2O Agricultural Soils	N2O	9,581	8,694	20%	100%	1.020	0.016	-0.003	0.017	-0.003	0.005	0.006
Indirect N2O from Nitrogen used in agriculture	N2O	8,118	7,527	20%	100%	1.020	0.014	-0.002	0.015	-0.002	0.004	0.005
CH4 from Rice production	CH4	1,562	1,523	3%	20%	0.202	0.001	0.000	0.003	0.000	0.000	0.000
N2O from animal production	N2O	1,736	1,570	20%	100%	1.020	0.003	-0.001	0.003	-0.001	0.001	0.001
CH4 from Solid waste Disposal Sites	CH4	13,298	13,341	20%	30%	0.361	0.009	-0.002	0.026	-0.001	0.007	0.007
CH4 Emissions from Wastewater Handling	CH4	1,988	2,435	100%	30%	1.044	0.005	0.001	0.005	0.000	0.007	0.007
N2O Emissions from Wastewater Handling	N2O	1,864	2,019	30%	30%	0.424	0.002	0.000	0.004	0.000	0.002	0.002
CO2 Emissions from Waste Incineration	CO2	537	270	5%	25%	0.255	0.000	-0.001	0.001	0.000	0.000	0.000
CH4 Emissions from Waste Incineration	CH4	161	271	5%	20%	0.206	0.000	0.000	0.001	0.000	0.000	0.000
N2O Emissions from Waste Incineration	N2O	88	120	5%	100%	1.001	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Emissions from Other Waste	CH4	0	5	10%	100%	1.005	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Emissions from solvent use	CO2	1,598	1,361	30%	50%	0.583	0.001	-0.001	0.003	0.000	0.001	0.001
N2O Emissions from solvent use	N2O	796	772	50%	10%	0.510	0.001	0.000	0.001	0.000	0.001	0.001
TOTAL		**516,318**	**552,771**				***0.033***					***0.026***

Table A1.3 Results of the uncertainty analysis excluding LULUCF (Tier1). Year 2007

Tier 1 Uncertainty calculation and reporting: CO_2

IPCC Sorce category	Gas	Base year emissions 1990	Year t emissions 2007	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total LULUCF emissions in the year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in LULUCF emissions introduced by emission factor uncertainty	Uncertainty in trend in LULUCF emissions introduced by activity data uncertainty	Uncertainty introduced into trend in total LULUCF emissions
		Gg CO_2 eq	*Gg CO_2 eq*	%	%	%	%	%	%	%	%	%
A. Forest Land	CO_2	-53,549	-55,588	*30%*	*54%*	61%	48%	-1%	82%	-1%	35%	35%
B. Cropland	CO_2	-16,876	-10,960	*75%*	*75%*	106%	16%	-10%	16%	-8%	17%	19%
- *living biomass*	CO_2	*-17,206*	*-11,290*	*75%*	*75%*	*106%*	17%	-10%	17%	-8%	18%	19%
- *soils*	CO_2	*330*	*330*	*75%*	*75%*	*106%*	0%	0%	0%	0%	1%	1%
C. Grassland	CO_2	-385	-7.760	*75%*	*75%*	106%	12%	11%	11%	8%	12%	15%
- *living biomass*	CO_2	*62*	*0*	*75%*	*75%*	106%	0%	0%	0%	0%	0%	0%
- *soils*	CO_2	*-447*	*0*	*75%*	*75%*	106%	0%	-1%	0%	-1%	0%	1%
D. Wetlands	CO_2	0	0			0%	0%	0%	0%	0%	0%	0%
E. Settlements	CO_2	3,160	3,181	*75%*	*75%*	106%	5%	0%	5%	0%	5%	5%
F. Other Land	CO_2	0	0			0%	0%	0%	0%	0%	0%	0%
G. Other	CO_2	0	0			0%	0%	0%	0%	0%	0%	0%
TOTAL		**-67,651**	**-71,127**				**52%**					**43%**

[a] the combined uncertainty has been calculated as explained in Chapter 7, 7.2.3 Uncertainty and time series consistency; in order to provide estimate of uncertainties in trend in national emissions introduced by emission factor and activity data, values for the uncertainty related to activity data and emission factor have been assigned by expert judgment, taking into account the final combined uncertainty

Table A1.4 Results of the uncertainty analysis for the LULUCF sector – CO_2 (Tier1)

Tier 1 Uncertainty calculation and reporting: CO_2+CH_4+N_2O

IPCC Sorce category	Gas	Base year emissions 1990	Year t emissions 2007	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total LULUCF emissions in the year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in LULUCF emissions introduced by emission factor uncertainty	Uncertainty in trend in LULUCF emissions introduced by activity data uncertainty	Uncertainty introduced into trend in total LULUCF emissions
		Gg CO_2 eq	*Gg CO_2 eq*	%	%	%	%	%	%	%	%	%
A. Forest Land	CO_2	-53,392	-53,392	*30%*	*54%*	61%	49%	0%	79%	0%	34%	34%
B. Cropland	CO_2	-16,876	-16,876	*75%*	*75%*	106%	27%	0%	25%	0%	27%	27%
- *living biomass*	CO_2	*-17,206*	*-17,206*	*75%*	*75%*	*106%*	27%	0%	25%	0%	27%	27%
- *soils*	CO_2	*330*	*330*	*75%*	*75%*	*106%*	1%	0%	0%	0%	1%	1%
C. Grassland	CO_2	-385	-385	*75%*	*75%*	106%	1%	0%	1%	0%	1%	1%
- *living biomass*	CO_2	*62*	*62*	*75%*	*75%*	106%	0%	0%	0%	0%	0%	0%
- *soils*	CO_2	*-447*	*-447*	*75%*	*75%*	106%	1%	0%	1%	0%	1%	1%
D. Wetlands	CO_2	0	0			0%	0%	0%	0%	0%	0%	0%
E. Settlements	CO_2	3,160	3,160	*75%*	*75%*	106%	5%	0%	5%	0%	5%	5%
F. Other Land	CO_2	0	0			0%	0%	0%	0%	0%	0%	0%
G. Other	CO_2	0	0			0%	0%	0%	0%	0%	0%	0%
TOTAL		**-67,493**	**-67,493**				**56%**					**43%**

Table A1.5 Results of the uncertainty analysis for the LULUCF sector – CO_2, CH_4, N_2O (Tier1)

Tier 1 Uncertainty calculation and reporting

IPCC Sorce category	Gas	Base year emissions 1990 Gg	Year t emissions 2007 Gg	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	153,467	86,306	3%	3%	0.042	0.006	-0.131	0.146	-0.004	0.006	0.007
CO2 stationary combustion solid fuels	CO2	59,395	66,727	3%	3%	0.042	0.004	0.006	0.113	0.000	0.005	0.005
CO2 stationary combustion gaseous fuels	CO2	85,066	159,220	3%	3%	0.042	0.011	0.116	0.270	0.003	0.011	0.012
CO2 stationary combustion other fuels	CO2	1,779	4,210	3%	3%	0.042	0.000	0.004	0.007	0.000	0.000	0.000
CH4 stationary combustion	CH4	647	963	3%	50%	0.501	0.001	0.000	0.002	0.000	0.000	0.000
N2O stationary combustion	N2O	3,434	3,841	3%	50%	0.501	0.003	0.000	0.007	0.000	0.000	0.000
CO2 Mobile combustion: Road Vehicles	CO2	93,387	118,721	3%	3%	0.042	0.008	0.032	0.201	0.001	0.009	0.009
CH4 Mobile combustion: Road Vehicles	CH4	867	415	3%	40%	0.401	0.000	-0.001	0.001	0.000	0.000	0.000
N2O Mobile combustion: Road Vehicles	N2O	996	1,420	3%	50%	0.501	0.001	0.001	0.002	0.000	0.000	0.000
CO2 Mobile combustion: Waterborne Navigation	CO2	5,420	4,970	3%	3%	0.042	0.000	-0.001	0.008	0.000	0.000	0.000
CH4 Mobile combustion: Waterborne Navigation	CH4	29	29	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Waterborne Navigation	N2O	39	36	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion: Aircraft	CO2	1,613	2,428	3%	3%	0.042	0.000	0.001	0.004	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	14	21	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion: Other	CO2	1,894	1,990	3%	5%	0.058	0.000	0.000	0.003	0.000	0.000	0.000
CH4 Mobile combustion: Other	CH4	5	4	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Other	N2O	131	123	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Fugitive emissions from Coal Mining and Handling	CH4	122	84	3%	200%	2.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Fugitive emissions from Oil and Gas Operations	CO2	3,341	2,176	3%	25%	0.252	0.001	-0.002	0.004	-0.001	0.000	0.001
CH4 Fugitive emissions from Oil and Gas Operations	CH4	7,298	4,987	3%	25%	0.252	0.002	-0.005	0.008	-0.001	0.000	0.001
N2O Fugitive emissions from Oil and Gas Operations	N2O	1	1	3%	25%	0.252	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Cement production	CO2	16,084	17,914	3%	10%	0.104	0.003	0.001	0.030	0.000	0.001	0.001
CO2 Lime production	CO2	2,042	2,434	3%	10%	0.104	0.000	0.000	0.004	0.000	0.000	0.000
CO2 Limestone and Dolomite Use	CO2	2,375	2,513	3%	10%	0.104	0.000	0.000	0.004	0.000	0.000	0.000
CO2 Iron and Steel production	CO2	3,124	1,483	3%	10%	0.104	0.000	-0.003	0.003	0.000	0.000	0.000
CO2 Ammonia production	CO2	1,710	649	3%	10%	0.104	0.000	-0.002	0.001	0.000	0.000	0.000
CO2 Other industrial processes	CO2	1,856	1,931	3%	10%	0.104	0.000	0.000	0.003	0.000	0.000	0.000
N2O Adipic Acid	N2O	4,579	782	3%	10%	0.104	0.000	-0.007	0.001	-0.001	0.000	0.001
N2O Nitric Acid	N2O	2,086	1,109	3%	10%	0.104	0.000	-0.002	0.002	0.000	0.000	0.000
N2O Other industrial processes	N2O	11	0	3%	10%	0.104	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Industrial Processes	CH4	108	65	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
PFC Aluminium production	PFC	1,673	200	5%	10%	0.112	0.000	-0.003	0.000	0.000	0.000	0.000
SF6 Magnesium production	SF6	0	54	5%	5%	0.071	0.000	0.000	0.000	0.000	0.000	0.000
SF6 Electrical Equipment	SF6	213	337	5%	10%	0.112	0.000	0.000	0.001	0.000	0.000	0.000
SF6 Production of SF6	SF6	120	0	5%	10%	0.112	0.000	0.000	0.000	0.000	0.000	0.000
PFC, HFC, SF6 Semiconductor manufacturing	PFC-H	0	129	30%	50%	0.583	0.000	0.000	0.000	0.000	0.000	0.000
HFC, PFC substitutes for ODS	HFC	134	6,677	30%	50%	0.583	0.006	0.011	0.011	0.006	0.005	0.007
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	HFC	351	18	5%	10%	0.112	0.000	-0.001	0.000	0.000	0.000	0.000
CH4 Enteric Fermentation in Domestic Livestock	CH4	12,179	11,027	20%	20%	0.283	0.005	-0.003	0.019	-0.001	0.005	0.005
CH4 Manure Management	CH4	3,462	3,057	20%	100%	1.020	0.005	-0.001	0.005	-0.001	0.001	0.002
N2O Manure Management	N2O	3,921	3,797	20%	100%	1.020	0.006	-0.001	0.006	-0.001	0.002	0.002
CH4 Agricultural Residue Burning	CH4	13	13	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
N2O Agricultural Residue Burning	N2O	4	4	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
Direct N2O Agricultural Soils	N2O	9,581	8,694	20%	100%	1.020	0.014	-0.003	0.015	-0.003	0.004	0.005
Indirect N2O from Nitrogen used in agriculture	N2O	8,118	7,527	20%	100%	1.020	0.012	-0.002	0.013	-0.002	0.004	0.004
CH4 from Rice production	CH4	1,562	1,523	3%	20%	0.202	0.000	0.000	0.003	0.000	0.000	0.000
N2O from animal production	N2O	1,736	1,570	20%	100%	1.020	0.003	0.000	0.003	0.000	0.001	0.001
CH4 from Solid waste Disposal Sites	CH4	13,298	13,341	20%	30%	0.361	0.008	-0.001	0.023	0.000	0.006	0.006
CH4 Emissions from Wastewater Handling	CH4	1,988	2,435	100%	30%	1.044	0.004	0.001	0.004	0.000	0.006	0.006
N2O Emissions from Wastewater Handling	N2O	1,864	2,019	30%	30%	0.424	0.001	0.000	0.003	0.000	0.001	0.001
CO2 Emissions from Waste Incineration	CO2	537	270	5%	25%	0.255	0.000	-0.001	0.000	0.000	0.000	0.000
CH4 Emissions from Waste Incineration	CH4	161	271	5%	20%	0.206	0.000	0.000	0.000	0.000	0.000	0.000
N2O Emissions from Waste Incineration	N2O	88	120	5%	100%	1.001	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Emissions from Other Waste	CH4	0	5	10%	100%	1.005	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Emissions from solvent use	CO2	1,598	1,361	30%	50%	0.583	0.001	-0.001	0.002	0.000	0.001	0.001
N2O Emissions from solvent use	N2O	796	772	50%	10%	0.510	0.001	0.000	0.001	0.000	0.001	0.001
CO2 Forest land remaining Forest Land	CO2	52,546	53,384	30%	54%	0.616	0.052	-0.005	0.090	-0.002	0.038	0.038
CH4 Forest land remaining Forest Land	CH4	143	197	30%	54%	0.616	0.000	0.000	0.000	0.000	0.000	0.000
N2O Forest land remaining Forest Land	N2O	15	20	30%	54%	0.616	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Cropland remaining Cropland	CO2	16,876	10,960	75%	75%	1.061	0.018	-0.012	0.019	-0.009	0.020	0.022
CO2 Land converted to Forest Land	CO2	1,003	2,204	75%	75%	1.061	0.004	0.002	0.004	0.001	0.004	0.004
CO2 Land converted to Cropland	CO2	0	0	75%	75%	1.061	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Land converted to Grassland	CO2	385	7,760	75%	75%	1.061	0.013	0.012	0.013	0.009	0.014	0.017
N2O Land converted to Cropland	N2O	0	0	75%	75%	1.061	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Land converted to Settlements	CO2	3,160	3,181	75%	75%	1.061	0.005	0.000	0.005	0.000	0.006	0.006
TOTAL		**590,446**	**630,478**				***0.064***					***0.053***

Table A1.6 Results of the uncertainty analysis including LULUCF (Tier1). Year 2007

Emission sources of the Italian inventory are disaggregated into a detailed level, 57 sources, according to the IPCC list in the Good Practice Guidance and taking into account national circumstances and importance. Considering the LULUCF, sources and sinks of the Italian inventory are disaggregated into 66 categories. Uncertainties are therefore estimated for these categories. To estimate uncertainty for both activity data and emission factors, information provided in the IPCC Good Practice Guidance as well as expert judgement have been used; standard deviations have also been considered whenever measurements were available.

The assumptions on which uncertainty estimations are based on are documented for each category. Figures to draw up uncertainty are checked with the relevant analyst experts and literature references and they are consistent with the IPCC Good Practice Guidance (IPCC, 2000).

The general approach followed for quantifying a level of uncertainty to activity data and emission factors is to set values within a range low, medium and high according to the confidence the expert relies on the value. For instance, a low value (e.g. 3-5%) has been attributed to activity data derived from the energy balance and statistical yearbooks, medium-high values within a range of 20-50% for all the data which are not directly or only partially derived from census or sample surveys or data which are simple estimations. For emission factors, the uncertainties set are usually higher than those for activity data; figures suggested by the IPCC good practice guidance (IPCC, 2000) are used

when the emission factor is a default value or when appropriate, low values are attributed to measured data whereas the uncertainty values are high in all other cases.
For the base year, the uncertainty estimated by the Tier 1 approach is equal to 3.5%; if considering the LULUCF sector the overall uncertainty increases to 7.0%.
In 2007, the Tier 1 approach suggests an uncertainty of 3.3% in the combined GWP total emissions. The analysis also estimates an uncertainty of 2.6 % in the trend between 1990 and 2007.
Specifically, for the LULUCF sector, the uncertainty value resulting from Tier 1 approach is 55% in the combined GWP total emissions for the year 2007, whereas the uncertainty in the trend is 43%. Similar values result from Tier 1 approach in uncertainty related to CO_2 total emissions for the year 2007, and uncertainty in the trend. Details of the figures are shown in Tables A1.4 and A1.5.
Including the LULUCF sector in the total uncertainty assessment, the Tier 1 approach shows an uncertainty of 6.4% in the combined GWP total emissions for the year 2007, whereas the uncertainty in the trend between 1990 and 2007 is equal to 5.3%. Results are shown in Table A1.6.

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 categories when an uncertainty analysis has been carried out on the inventory. It is helpful in prioritising activities to improve inventory quality and to reduce overall uncertainty.
Under the Tier 2, the source or sink 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 Category Uncertainty

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

The Tier 2 analysis has been applied both to the base and the current year submission; in this section detailed results are reported for the 2007 inventory.
The results of the Tier 2 key category analysis, without LULUCF categories, are provided in Table A1.7, for 2006, while in Table A1.8 the results of the analysis, including LULUCF categories, are shown.
The application of the Tier 2 to the base year gives as a result 22 key categories accounting for the 95% of the total levels uncertainty. The application of the Tier 2 to the inventory including the LULUCF categories results in 21 key categories accounting for the 95% of the total levels uncertainty.
For the year 2007, the application of the Tier 2 gives as a result 21 key categories accounting for the 95% of the total levels uncertainty; when applying the trend analysis the key categories increased to 22 with differences with respect to the previous list.
The application of the Tier 2 to the inventory including the LULUCF categories results in 21 key categories accounting for the 95% of the total levels uncertainty; for the trend analysis including LULUCF categories, the key categories decreased to 20 with differences with respect to the previous list.

Results are also shown for the base year key categories, see tables A1.9 A1.10.

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	0.0160	0.127	0.13	CO2 stationary combustion gaseous fuels	0.0137	0.144	0.14
Indirect N2O from Nitrogen used in agriculture	0.0139	0.110	0.24	CO2 Mobile combustion: Road Vehicles	0.0098	0.103	0.25
CO2 stationary combustion gaseous fuels	0.0122	0.097	0.33	CO2 stationary combustion liquid fuels	0.0084	0.088	0.34
CO2 Mobile combustion: Road Vehicles	0.0091	0.072	0.41	HFC, PFC substitutes for ODS	0.0084	0.088	0.42
CH4 from Solid waste Disposal Sites	0.0087	0.069	0.48	CH4 from Solid waste Disposal Sites	0.0073	0.077	0.50
HFC, PFC substitutes for ODS	0.0070	0.056	0.53	CH4 Emissions from Wastewater Handling	0.0067	0.070	0.57
N2O Manure Management	0.0070	0.056	0.59	CH4 Enteric Fermentation in Domestic Livestock	0.0061	0.064	0.63
CO2 stationary combustion liquid fuels	0.0066	0.053	0.64	Direct N2O Agricultural Soils	0.0056	0.059	0.69
CH4 Enteric Fermentation in Domestic Livestock	0.0056	0.045	0.68	CO2 stationary combustion solid fuels	0.0055	0.058	0.75
CH4 Manure Management	0.0056	0.045	0.73	Indirect N2O from Nitrogen used in agriculture	0.0047	0.049	0.80
CO2 stationary combustion solid fuels	0.0051	0.041	0.77	N2O Manure Management	0.0022	0.023	0.82
CH4 Emissions from Wastewater Handling	0.0046	0.037	0.81	CH4 Manure Management	0.0021	0.022	0.85
N2O stationary combustion	0.0035	0.028	0.83	N2O Emissions from Wastewater Handling	0.0017	0.017	0.86
CO2 Cement production	0.0034	0.027	0.86	CO2 Cement production	0.0015	0.016	0.88
N2O from animal production	0.0029	0.023	0.88	CH4 Fugitive emissions from Oil and Gas Operations	0.0014	0.015	0.89
CH4 Fugitive emissions from Oil and Gas Operations	0.0023	0.018	0.90	CO2 Emissions from solvent use	0.0012	0.012	0.91
N2O Emissions from Wastewater Handling	0.0015	0.012	0.91	N2O Emissions from solvent use	0.0011	0.011	0.92
CO2 Emissions from solvent use	0.0014	0.011	0.93	N2O from animal production	0.0010	0.011	0.93
N2O Mobile combustion: Road Vehicles	0.0013	0.010	0.94	N2O Adipic Acid	0.0008	0.008	0.94
CO2 Fugitive emissions from Oil and Gas Operations	0.0010	0.008	0.94	CO2 Fugitive emissions from Oil and Gas Operations	0.0007	0.007	0.94
CH4 stationary combustion	0.0009	0.007	0.95	CO2 Mobile combustion: Waterborne Navigation	0.0004	0.004	0.95
N2O Emissions from solvent use	0.0007	0.006	0.96	CH4 Mobile combustion: Road Vehicles	0.0004	0.004	0.95
CH4 from Rice production	0.0006	0.004	0.96	CO2 Iron and Steel production	0.0004	0.004	0.96
CO2 Limestone and Dolomite Use	0.0005	0.004	0.96	CO2 stationary combustion other fuels	0.0004	0.004	0.96
CO2 Lime production	0.0005	0.004	0.97	N2O Mobile combustion: Road Vehicles	0.0004	0.004	0.96
CO2 Mobile combustion: Waterborne Navigation	0.0004	0.003	0.97	N2O stationary combustion	0.0004	0.004	0.97
CO2 Other industrial processes	0.0004	0.003	0.97	PFC Aluminium production	0.0003	0.003	0.97
CO2 stationary combustion other fuels	0.0003	0.003	0.98	CH4 stationary combustion	0.0003	0.003	0.97
CH4 Fugitive emissions from Coal Mining and Handl	0.0003	0.002	0.98	N2O Nitric Acid	0.0002	0.002	0.98
CH4 Mobile combustion: Road Vehicles	0.0003	0.002	0.98	CO2 Ammonia production	0.0002	0.002	0.98
CO2 Iron and Steel production	0.0003	0.002	0.98	CO2 Limestone and Dolomite Use	0.0002	0.002	0.98
N2O Mobile combustion: Other	0.0002	0.002	0.99	CO2 Lime production	0.0002	0.002	0.98
N2O Emissions from Waste Incineration	0.0002	0.002	0.99	CO2 Mobile combustion: Aircraft	0.0002	0.002	0.99
CO2 Mobile combustion: Other	0.0002	0.002	0.99	CH4 Fugitive emissions from Coal Mining and Hand	0.0002	0.002	0.99
N2O Nitric Acid	0.0002	0.002	0.99	PFC, HFC, SF6 Semiconductor manufacturing	0.0002	0.002	0.99
CO2 Mobile combustion: Aircraft	0.0002	0.001	0.99	CO2 Mobile combustion: Other	0.0002	0.002	0.99
N2O Adipic Acid	0.0001	0.001	0.99	CO2 Other industrial processes	0.0002	0.002	0.99
PFC, HFC, SF6 Semiconductor manufacturing	0.0001	0.001	0.99	CO2 Emissions from Waste Incineration	0.0002	0.002	0.99
CO2 Emissions from Waste Incineration	0.0001	0.001	1.00	CH4 from Rice production	0.0001	0.001	1.00
CO2 Ammonia production	0.0001	0.001	1.00	HFC-23 from HCFC-22 Manufacture and HFCs fugit	0.0001	0.001	1.00
CH4 Emissions from Waste Incineration	0.0001	0.001	1.00	CH4 Emissions from Waste Incineration	0.0001	0.001	1.00
SF6 Electrical Equipment	0.0001	0.001	1.00	N2O Emissions from Waste Incineration	0.0001	0.001	1.00
N2O Mobile combustion: Waterborne Navigation	0.0001	0.001	1.00	SF6 Electrical Equipment	0.0001	0.001	1.00
CH4 Industrial Processes	0.0001	0.000	1.00	CH4 Industrial Processes	0.0000	0.001	1.00
PFC Aluminium production	0.0000	0.000	1.00	N2O Mobile combustion: Other	0.0000	0.000	1.00
N2O Mobile combustion: Aircraft	0.0000	0.000	1.00	SF6 Production of SF6	0.0000	0.000	1.00
CH4 Mobile combustion: Waterborne Navigation	0.0000	0.000	1.00	CH4 Agricultural Residue Burning	0.0000	0.000	1.00
CH4 Agricultural Residue Burning	0.0000	0.000	1.00	N2O Mobile combustion: Waterborne Navigation	0.0000	0.000	1.00
CH4 Emissions from Other Waste	0.0000	0.000	1.00	N2O Mobile combustion: Aircraft	0.0000	0.000	1.00
SF6 Magnesium production	0.0000	0.000	1.00	SF6 Magnesium production	0.0000	0.000	1.00
N2O Agricultural Residue Burning	0.0000	0.000	1.00	CH4 Emissions from Other Waste	0.0000	0.000	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugiti	0.0000	0.000	1.00	N2O Agricultural Residue Burning	0.0000	0.000	1.00
CH4 Mobile combustion: Other	0.0000	0.000	1.00	CH4 Mobile combustion: Waterborne Navigation	0.0000	0.000	1.00
CH4 Mobile combustion: Aircraft	0.0000	0.000	1.00	N2O Other industrial processes	0.0000	0.000	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.0000	0.000	1.00	CH4 Mobile combustion: Other	0.0000	0.000	1.00
SF6 Production of SF6	0.0000	0.000	1.00	CH4 Mobile combustion: Aircraft	0.0000	0.000	1.00
N2O Other industrial processes	0.0000	0.000	1.00	N2O Fugitive emissions from Oil and Gas Operations	0.0000	0.000	1.00

Table A1.7 Results of the key categories analysis (Tier2) without LULUCF categories. Year 2007

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**
CO2 Forest land remaining Forest Land	0.0521	0.256	0.26	CO2 Forest land remaining Forest Land	0.038	0.226	0.23
CO2 Cropland remaining Cropland	0.0184	0.091	0.35	CO2 Cropland remaining Cropland	0.022	0.127	0.35
Direct N2O Agricultural Soils	0.0141	0.069	0.42	CO2 Land converted to Grassland	0.017	0.099	0.45
CO2 Land converted to Grassland	0.0131	0.064	0.48	CO2 stationary combustion gaseous fuels	0.012	0.070	0.52
Indirect N2O from Nitrogen used in agriculture	0.0122	0.060	0.54	CO2 Mobile combustion: Road Vehicles	0.009	0.050	0.57
CO2 stationary combustion gaseous fuels	0.0107	0.053	0.59	CO2 stationary combustion liquid fuels	0.007	0.043	0.62
CO2 Mobile combustion: Road Vehicles	0.0080	0.039	0.63	HFC, PFC substitutes for ODS	0.007	0.043	0.66
CH4 from Solid waste Disposal Sites	0.0076	0.038	0.67	CH4 from Solid waste Disposal Sites	0.006	0.038	0.70
HFC, PFC substitutes for ODS	0.0062	0.030	0.70	CH4 Emissions from Wastewater Handling	0.006	0.034	0.73
N2O Manure Management	0.0061	0.030	0.73	CO2 Land converted to Settlements	0.006	0.034	0.76
CO2 stationary combustion liquid fuels	0.0058	0.029	0.76	CH4 Enteric Fermentation in Domestic Livestock	0.005	0.031	0.80
CO2 Land converted to Settlements	0.0054	0.026	0.79	Direct N2O Agricultural Soils	0.005	0.029	0.82
CH4 Enteric Fermentation in Domestic Livestock	0.0049	0.024	0.81	CO2 stationary combustion solid fuels	0.005	0.028	0.85
CH4 Manure Management	0.0049	0.024	0.83	CO2 Land converted to Forest Land	0.004	0.025	0.88
CO2 stationary combustion solid fuels	0.0045	0.022	0.86	Indirect N2O from Nitrogen used in agriculture	0.004	0.024	0.90
CH4 Emissions from Wastewater Handling	0.0040	0.020	0.88	N2O Manure Management	0.002	0.011	0.91
CO2 Land converted to Forest Land	0.0037	0.018	0.89	CH4 Manure Management	0.002	0.011	0.92
N2O stationary combustion	0.0031	0.015	0.91	N2O Emissions from Wastewater Handling	0.001	0.009	0.93
CO2 Cement production	0.0030	0.015	0.92	CO2 Cement production	0.001	0.008	0.94
N2O from animal production	0.0025	0.012	0.94	CH4 Fugitive emissions from Oil and Gas Operations	0.001	0.007	0.95
CH4 Fugitive emissions from Oil and Gas Operations	0.0020	0.010	0.95	CO2 Emissions from solvent use	0.001	0.006	0.95
N2O Emissions from Wastewater Handling	0.0014	0.007	0.95	N2O Emissions from solvent use	0.001	0.005	0.96
CO2 Emissions from solvent use	0.0013	0.006	0.96	N2O from animal production	0.001	0.005	0.96
N2O Mobile combustion: Road Vehicles	0.0011	0.006	0.96	N2O Adipic Acid	0.001	0.004	0.97
CO2 Fugitive emissions from Oil and Gas Operations	0.0009	0.004	0.97	CO2 Fugitive emissions from Oil and Gas Operations	0.001	0.004	0.97
CH4 stationary combustion	0.0008	0.004	0.97	CO2 Mobile combustion: Waterborne Navigation	0.000	0.002	0.97
N2O Emissions from solvent use	0.0006	0.003	0.98	CH4 Mobile combustion: Road Vehicles	0.000	0.002	0.98
CH4 from Rice production	0.0005	0.002	0.98	CO2 Iron and Steel production	0.000	0.002	0.98
CO2 Limestone and Dolomite Use	0.0004	0.002	0.98	CO2 stationary combustion other fuels	0.000	0.002	0.98
CO2 Lime production	0.0004	0.002	0.98	N2O Mobile combustion: Road Vehicles	0.000	0.002	0.98
CO2 Mobile combustion: Waterborne Navigation	0.0003	0.002	0.98	N2O stationary combustion	0.000	0.002	0.98
CO2 Other industrial processes	0.0003	0.002	0.99	PFC Aluminium production	0.000	0.002	0.99
CO2 stationary combustion other fuels	0.0003	0.001	0.99	CH4 stationary combustion	0.000	0.001	0.99
CH4 Fugitive emissions from Coal Mining and Handling	0.0003	0.001	0.99	N2O Nitric Acid	0.000	0.001	0.99
CH4 Mobile combustion: Road Vehicles	0.0003	0.001	0.99	CO2 Ammonia production	0.000	0.001	0.99
CO2 Iron and Steel production	0.0002	0.001	0.99	CO2 Limestone and Dolomite Use	0.000	0.001	0.99
N2O Mobile combustion: Other	0.0002	0.001	0.99	CO2 Lime production	0.000	0.001	0.99
CH4 Forest land remaining Forest Land	0.0002	0.001	0.99	CO2 Mobile combustion: Aircraft	0.000	0.001	0.99
N2O Emissions from Waste Incineration	0.0002	0.001	0.99	CH4 Fugitive emissions from Coal Mining and Handling	0.000	0.001	0.99
CO2 Mobile combustion: Other	0.0002	0.001	0.99	CH4 Forest land remaining Forest Land	0.000	0.001	0.99
N2O Nitric Acid	0.0002	0.001	0.99	PFC, HFC, SF6 Semiconductor manufacturing	0.000	0.001	0.99
CO2 Mobile combustion: Aircraft	0.0002	0.001	1.00	CO2 Mobile combustion: Other	0.000	0.001	1.00
N2O Adipic Acid	0.0001	0.001	1.00	CO2 Other industrial processes	0.000	0.001	1.00
PFC, HFC, SF6 Semiconductor manufacturing	0.0001	0.001	1.00	CO2 Emissions from Waste Incineration	0.000	0.001	1.00
CO2 Emissions from Waste Incineration	0.0001	0.001	1.00	CH4 from Rice production	0.000	0.001	1.00
CO2 Ammonia production	0.0001	0.001	1.00	HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.000	0.000	1.00
CH4 Emissions from Waste Incineration	0.0001	0.000	1.00	CH4 Emissions from Waste Incineration	0.000	0.000	1.00
SF6 Electrical Equipment	0.0001	0.000	1.00	N2O Emissions from Waste Incineration	0.000	0.000	1.00
N2O Mobile combustion: Waterborne Navigation	0.0001	0.000	1.00	SF6 Electrical Equipment	0.000	0.000	1.00
CH4 Industrial Processes	0.0001	0.000	1.00	CH4 Industrial Processes	0.000	0.000	1.00
PFC Aluminium production	0.0000	0.000	1.00	N2O Mobile combustion: Other	0.000	0.000	1.00
N2O Mobile combustion: Aircraft	0.0000	0.000	1.00	SF6 Production of SF6	0.000	0.000	1.00
CH4 Mobile combustion: Waterborne Navigation	0.0000	0.000	1.00	CH4 Agricultural Residue Burning	0.000	0.000	1.00
N2O Forest land remaining Forest Land	0.0000	0.000	1.00	N2O Forest land remaining Forest Land	0.000	0.000	1.00
CH4 Agricultural Residue Burning	0.0000	0.000	1.00	N2O Mobile combustion: Waterborne Navigation	0.000	0.000	1.00
CH4 Emissions from Other Waste	0.0000	0.000	1.00	N2O Mobile combustion: Aircraft	0.000	0.000	1.00
SF6 Magnesium production	0.0000	0.000	1.00	SF6 Magnesium production	0.000	0.000	1.00
N2O Agricultural Residue Burning	0.0000	0.000	1.00	CH4 Emissions from Other Waste	0.000	0.000	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.0000	0.000	1.00	N2O Agricultural Residue Burning	0.000	0.000	1.00
CH4 Mobile combustion: Other	0.0000	0.000	1.00	CH4 Mobile combustion: Waterborne Navigation	0.000	0.000	1.00
CH4 Mobile combustion: Aircraft	0.0000	0.000	1.00	N2O Other industrial processes	0.000	0.000	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.0000	0.000	1.00	CH4 Mobile combustion: Other	0.000	0.000	1.00
SF6 Production of SF6	0.0000	0.000	1.00	CH4 Mobile combustion: Aircraft	0.000	0.000	1.00
N2O Other industrial processes	0.0000	0.000	1.00	N2O Fugitive emissions from Oil and Gas Operations	0.000	0.000	1.00
CO2 Land converted to Cropland	0.0000	0.000	1.00	CO2 Land converted to Cropland	0.000	0.000	1.00
N2O Land converted to Cropland	0.0000	0.00	1.00	N2O Land converted to Cropland	0.00	0.00	1.00

Table A1.8 Results of the key categories analysis (Tier2) with LULUCF categories. Year 2007

TIER 2			
CATEGORIES	Level assessment with uncertainty	Relative level assessment with uncertainty	Cumulative Percentage
Direct N2O Agricultural Soils	0.0189	0.145	0.14
Indirect N2O from Nitrogen used in agriculture	0.0160	0.123	0.27
CO2 stationary combustion liquid fuels	0.0126	0.097	0.36
CH4 from Solid waste Disposal Sites	0.0093	0.071	0.44
N2O Manure Management	0.0077	0.059	0.49
CO2 Mobile combustion: Road Vehicles	0.0077	0.059	0.55
CO2 stationary combustion gaseous fuels	0.0070	0.054	0.61
CH4 Manure Management	0.0068	0.052	0.66
CH4 Enteric Fermentation in Domestic Livestock	0.0067	0.051	0.71
CO2 stationary combustion solid fuels	0.0049	0.037	0.75
CH4 Emissions from Wastewater Handling	0.0040	0.031	0.78
CH4 Fugitive emissions from Oil and Gas Operations	0.0036	0.027	0.81
N2O from animal production	0.0034	0.026	0.83
N2O stationary combustion	0.0033	0.026	0.86
CO2 Cement production	0.0033	0.025	0.88
CO2 Emissions from solvent use	0.0018	0.014	0.90
CO2 Fugitive emissions from Oil and Gas Operations	0.0016	0.012	0.91
N2O Emissions from Wastewater Handling	0.0015	0.012	0.92
N2O Mobile combustion: Road Vehicles	0.0010	0.007	0.93
N2O Adipic Acid	0.0009	0.007	0.94
N2O Emissions from solvent use	0.0008	0.006	0.94
CH4 Mobile combustion: Road Vehicles	0.0007	0.005	0.95
CO2 Iron and Steel production	0.0006	0.005	0.95
CH4 stationary combustion	0.0006	0.005	0.96
CH4 from Rice production	0.0006	0.005	0.96
CO2 Limestone and Dolomite Use	0.0005	0.004	0.96
CH4 Fugitive emissions from Coal Mining and Handli	0.0005	0.004	0.97
CO2 Mobile combustion: Waterborne Navigation	0.0004	0.003	0.97
N2O Nitric Acid	0.0004	0.003	0.97
CO2 Lime production	0.0004	0.003	0.98
CO2 Other industrial processes	0.0004	0.003	0.98
PFC Aluminium production	0.0004	0.003	0.98
CO2 Ammonia production	0.0003	0.003	0.99
CO2 Emissions from Waste Incineration	0.0003	0.002	0.99
N2O Mobile combustion: Other	0.0003	0.002	0.99
CO2 Mobile combustion: Other	0.0002	0.002	0.99
N2O Emissions from Waste Incineration	0.0002	0.001	0.99
HFC, PFC substitutes for ODS	0.0002	0.001	0.99
CO2 stationary combustion other fuels	0.0001	0.001	1.00
CO2 Mobile combustion: Aircraft	0.0001	0.001	1.00
CH4 Industrial Processes	0.0001	0.001	1.00
N2O Mobile combustion: Waterborne Navigation	0.0001	0.001	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugiti	0.0001	0.001	1.00
CH4 Emissions from Waste Incineration	0.0001	0.000	1.00
SF6 Electrical Equipment	0.0000	0.000	1.00
CH4 Mobile combustion: Waterborne Navigation	0.0000	0.000	1.00
N2O Mobile combustion: Aircraft	0.0000	0.000	1.00
SF6 Production of SF6	0.0000	0.000	1.00
CH4 Agricultural Residue Burning	0.0000	0.000	1.00
CH4 Mobile combustion: Other	0.0000	0.000	1.00
N2O Agricultural Residue Burning	0.0000	0.000	1.00
N2O Other industrial processes	0.0000	0.000	1.00
CH4 Mobile combustion: Aircraft	0.0000	0.000	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.0000	0.000	1.00
CH4 Emissions from Other Waste	0.0000	0.000	1.00
SF6 Magnesium production	0.0000	0.000	1.00
PFC, HFC, SF6 Semiconductor manufacturing	0.0000	0.000	1.00

Table A1.9 Results of the key categories analysis (Tier2) without LULUCF categories. Year 1990

TIER 2			
CATEGORIES	Level assessment with uncertainty	Relative level assessment with uncertainty	Cumulative Percentage
CO2 Forest land remaining Forest Land	0.0548	0.264	0.26
CO2 Cropland remaining Cropland	0.0303	0.146	0.41
Direct N2O Agricultural Soils	0.0165	0.080	0.49
Indirect N2O from Nitrogen used in agriculture	0.0140	0.068	0.56
CO2 stationary combustion liquid fuels	0.0110	0.053	0.61
CH4 from Solid waste Disposal Sites	0.0081	0.039	0.65
N2O Manure Management	0.0068	0.033	0.68
CO2 Mobile combustion: Road Vehicles	0.0067	0.032	0.71
CO2 stationary combustion gaseous fuels	0.0061	0.029	0.74
CH4 Manure Management	0.0060	0.029	0.77
CH4 Enteric Fermentation in Domestic Livestock	0.0058	0.028	0.80
CO2 Land converted to Settlements	0.0057	0.027	0.83
CO2 stationary combustion solid fuels	0.0043	0.021	0.85
CH4 Emissions from Wastewater Handling	0.0035	0.017	0.87
CH4 Fugitive emissions from Oil and Gas Operations	0.0031	0.015	0.88
N2O from animal production	0.0030	0.014	0.89
N2O stationary combustion	0.0029	0.014	0.91
CO2 Cement production	0.0028	0.014	0.92
CO2 Land converted to Forest Land	0.0018	0.009	0.93
CO2 Emissions from solvent use	0.0016	0.008	0.94
CO2 Fugitive emissions from Oil and Gas Operations	0.0014	0.007	0.95
N2O Emissions from Wastewater Handling	0.0013	0.006	0.95
N2O Mobile combustion: Road Vehicles	0.0008	0.004	0.96
N2O Adipic Acid	0.0008	0.004	0.96
CO2 Land converted to Grassland	0.0007	0.003	0.96
N2O Emissions from solvent use	0.0007	0.003	0.97
CH4 Mobile combustion: Road Vehicles	0.0006	0.003	0.97
CO2 Iron and Steel production	0.0006	0.003	0.97
CH4 stationary combustion	0.0005	0.003	0.98
CH4 from Rice production	0.0005	0.003	0.98
CO2 Limestone and Dolomite Use	0.0004	0.002	0.98
CH4 Fugitive emissions from Coal Mining and Handling	0.0004	0.002	0.98
CO2 Mobile combustion: Waterborne Navigation	0.0004	0.002	0.98
N2O Nitric Acid	0.0004	0.002	0.99
CO2 Lime production	0.0004	0.002	0.99
CO2 Other industrial processes	0.0003	0.002	0.99
PFC Aluminium production	0.0003	0.002	0.99
CO2 Ammonia production	0.0003	0.001	0.99
CO2 Emissions from Waste Incineration	0.0002	0.001	0.99
N2O Mobile combustion: Other	0.0002	0.001	0.99
CO2 Mobile combustion: Other	0.0002	0.001	0.99
N2O Emissions from Waste Incineration	0.0001	0.001	1.00
CH4 Forest land remaining Forest Land	0.0001	0.001	1.00
HFC, PFC substitutes for ODS	0.0001	0.001	1.00
CO2 stationary combustion other fuels	0.0001	0.001	1.00
CO2 Mobile combustion: Aircraft	0.0001	0.001	1.00
CH4 Industrial Processes	0.0001	0.000	1.00
N2O Mobile combustion: Waterborne Navigation	0.0001	0.000	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.0001	0.000	1.00
CH4 Emissions from Waste Incineration	0.0001	0.000	1.00
SF6 Electrical Equipment	0.0000	0.000	1.00
CH4 Mobile combustion: Waterborne Navigation	0.0000	0.000	1.00
N2O Mobile combustion: Aircraft	0.0000	0.000	1.00
SF6 Production of SF6	0.0000	0.000	1.00
N2O Forest land remaining Forest Land	0.0000	0.000	1.00
CH4 Agricultural Residue Burning	0.0000	0.000	1.00
CH4 Mobile combustion: Other	0.0000	0.000	1.00
N2O Agricultural Residue Burning	0.0000	0.000	1.00
N2O Other industrial processes	0.0000	0.000	1.00
CH4 Mobile combustion: Aircraft	0.0000	0.000	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.0000	0.000	1.00
CH4 Emissions from Other Waste	0.0000	0.000	1.00
SF6 Magnesium production	0.0000	0.000	1.00
PFC, HFC, SF6 Semiconductor manufacturing	0.0000	0.000	1.00
CO2 Land converted to Cropland	0.0000	0.000	1.00
N2O Land converted to Cropland	0.0000	0.00	1.00

Table A1.10 Results of the key categories analysis (Tier2) with LULUCF categories. Year 1990

ANNEX 2: DETAILED TABLES OF ENERGY CONSUMPTION FOR POWER GENERATION

The detailed breakdown of total fuels consumed for electricity generation in the years 2006 and 2007 is reported in the attached tables A2.1 and A2.2. The consumption of municipal solid waste (MSW) is separated from the biomass consumption, since the use of this fuel for electricity generation is expanding. A specific EF is used to estimate CO_2 emissions from this source, see table 3.7. Energy data of previous years have not been changed (see previous reports).
In each table, annual data from three different sources are reported:

- output of the model used to estimate consumption and emissions for each plant type;
- detailed report by Terna;
- data available in the national energy balance.

For each source, three types of data are presented: electricity produced, physical quantities of consumed fuels and amount of energy used.
As can be noticed from the following tables, there are not negligible differences in total consumption figures between Terna and BEN. Both data sets are supposed to be based on the same data. As already said in paragraph 3.4, differences can be explained by the process of adapting Terna 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 adds rounding errors and this may be responsible for the small difference between the energy consumption value, -1.8% in 2006 and 0.1% in 2007 (refer to last row of each table).
Differences between those two data sets and the model output are also present, they can be improved (i.e. reduced) depending on the modeller choice: a compromise between Terna and the BEN data according to cross check done with other sources (UP or point source data). In the case of power generation the consumption expressed in energy units is the reference value that is optimised, since emission factors refer to the energy content of each fuel.
There are also discrepancies in the estimates of the total electricity produced, see the last row of each table; they are rather small and can be due to different evaluation of the kind of fuel used. The total electricity produced (not shown in the table, see also Annex 5) is the same for both estimates.
In conclusion the main question of the accuracy of the underlying energy data of three key sources is connected to the discrepancies between BEN and Terna in the estimates of electricity produced and of the energy content of the used fuels. The difference is small but it should not occur because both data sets are derived from the same source. On the basis of this consideration, we decided to base the inventory on Terna data that are expected to be more reliable. In particular because the emission factors used are based on the energy content of the fuel we have made an effort to reproduce with the model the Terna energy consumption figure and ignored discrepancies in the electricity production or in the physical quantities of fuel used.

Table A2.1 - Energy consumption for electricity production, year 2006

Fuels	Model output			TERNA			BEN		
	Gwe, gross	kt	TJ	Gwe, gross	kt	T.o.e./TJ	Gwe, gross	kt / Mmc	kcal / TJ
Coal	44,195.78	16,589.56	423,529,146.44	44,207.40	16,587.00	423,462,640.00	44,206.98	15,939.00	101,213.00
Coke oven gas	1,503.50	698.88	13,392,406.91	1,534.40	721.00	13,388,800.00	1,512.79	742.00	13,187,968.00
Blast furnace gas	4,372.00	11,454.81	40,258,605.67	4,319.90	11,859.00	40,250,080.00	4,319.77	10,268.00	38,664,344.00
Oxi converter gas	382.00	487.00	3,749,173.43	397.10	551.00	3,765,600.00	419.77		3,734,039.39
sum	6,257.50	12,640.68	57,400,186.01	6,251.40	13,131.00	57,404,480.00	6,252.33	11,010.00	55,586,351.39
Coal, sum			480,929,332.45			480,867,120.00			479,061,543.39
Light distillates	59.00	6.35	292,050.00	59.20	7.00	292,880.00	26.74	7.00	72.00
Light fuel oil	736.76	190.60	8,033,903.77	738.30	188.00	8,075,120.00	836.05	189.00	1,928.00
Fuel oil - high sulfur content	30,041.50	7,046.11	287,263,361.34	30,039.00	6,942.70	287,189,760.00	9,453.49	1,983.00	19,433.00
Fuel oil - low sulfur content							31,943.02	7,008.00	68,678.00
Refinery gas	2,146.00	307.71	14,290,570.48	2,146.00	300.00	14,267,440.00	2,204.65	276.00	3,310.00
Petroleum coke	847.90	191.67	6,656,015.00	847.90	192.00	6,652,560.00	847.67	192.00	1,591.00
Oriemulsion	0.00	0.00	0.01	-	-	-			
sum	33,831.15	7,742.44	316,535,900.60	33,830.30	7,629.00	316,477,760.00	45,311.63	7,668.00	397,530,208.00
Gas from chemical proc.	547.00	1,241.38	5,359,656.14	546.60	1,083.00	5,355,520.00	1,755.81	1,987.00	17,047,888.61
Heavy residuals/ tar	11,299.38	9,010.00	81,050,389.84	11,296.80	8,345.00	81,044,080.00			
Others	181.28	178.22	1,300,458.98	181.40	138.00	1,304,152.80			
sum	12,027.66	10,429.60	87,710,504.96	12,024.80		87,703,752.80	1,755.81	1,987.00	17,047,888.61
Oil+residuals, sum	45,858.81	18,172.04	404,246,405.56	45,855.10		404,181,512.80	47,067.44	9,655.00	414,578,096.61
Natural gas	158,078.69	31,115.95	1,089,130,974.15	158,078.80	31,381.00	1,088,802,320.00	158,079.00	31,543.00	1,121,835,000.00
Biogas	1,335.07		14,476,640.00	1,336.30	1,292.00	14,489,977.33			
Biomass	2,491.91		32,508,518.16	2,491.70	2,884.00	32,505,843.28	3,827.91	4,392.00	45,940,320.00
Municipal waste	2,915.08		45,994,958.58	2,916.60	3,832.00	46,018,973.14	2,916.28	4,182.00	43,747,904.00
Grand total	261,132.84		2,067,286,828.90	261,137.30		2,066,865,746.55	262,349.93		2,105,162,864.00
GRTN/BEN differences							-0.5%		-1.8%

Table A2.2 - Energy consumption for electricity production, year 2007

Fuels	Model output			TERNA			BEN		
	Gwe, gross	kt	TJ	Gwe, gross	kt	T.o.e./TJ	Gwe, gross	kt / Mmc	kcal / TJ
Coal	44,140.22	16,885.61	431,821,728.00	44,112.30	16,886.00	431,830,640.00	44,206.98	15,939.00	106,213.00
Coke oven gas	1,616.50	746.72	14,309,114.66	1,618.10	766.00	14,309,280.00	1,512.79	742.00	13,187,968.00
Blast furnace gas	3,855.00	9,972.95	35,050,533.89	3,856.00	11,316.00	35,103,760.00	4,319.77	10,268.00	38,664,344.00
Oxi converter gas	170.00	206.38	1,588,855.29	170.00	271.00	1,548,080.00	419.77		3,734,039.39
sum	5,641.50	10,926.05	50,948,503.84	5,645.30	11,353.00	50,961,120.00	6,252.33	11,010.00	55,586,351.39
Coal, sum			482,770,231.84			482,791,760.00			499,981,543.39
Light distillates	59.00	6.35	292,050.00	53.00	7.00	292,880.00	26.74	7.00	72.00
Light fuel oil	681.04	177.01	7,461,022.71	673.60	176.00	7,489,360.00	836.05	189.00	1,928.00
Fuel oil - high sulfur content	19,028.44	4,586.12	186,895,628.14	19,024.80	4,523.00	186,355,360.00	9,453.49	1,983.00	19,433.00
Fuel oil - low sulfur content							31,943.02	7,008.00	48,000.00
Refinery gas	2,053.00	354.41	17,052,100.50	2,052.50	352.00	17,070,720.00	2,204.65	276.00	3,310.00
Petroleum coke	999.00	225.82	7,842,150.00	998.90	226.00	7,824,080.00	847.67	192.00	1,591.00
Oriemulsion	0.00	0.00	0.00	-	-	-			
sum	22,820.48	5,349.71	219,542,951.36	22,865.30	5,292.00	219,450,800.00	45,311.63	7,668.00	311,013,456.00
Gas from chemical proc.	535.00	1,141.58	4,807,038.56	535.10	1,125.00	4,727,920.00	1,755.81	1,987.00	17,047,888.61
Heavy residuals/ tar	11,770.88	9,325.75	83,890,743.63	11,772.00	8,591.00	83,763,680.00			
Others	236.79	190.38	2,427,804.53	213.50	176.00	2,468,560.00			
sum	12,542.67	10,657.71	91,125,586.72	12,432.50		92,760,723.49	1,755.81	1,987.00	17,047,888.61
Oil+residuals, sum	35,363.14	16,007.42	310,668,538.08	35,297.80		312,211,523.49	47,067.44	9,655.00	328,061,344.61
Natural gas	172,651.02	33,886.18	1,184,599,634.93	172,645.90	33,957.00	1,183,737,280.00	158,079.00	31,543.00	1,146,939,000.00
Biogas	1,447.39		15,522,640.00	1,447.00	1,392.00	15,518,457.42			
Biomass	2,480.60		32,767,168.16	2,481.50	2,757.00	32,779,069.23	3,930.23	4,446.00	46,505,160.00
Municipal waste	3,025.57		48,065,052.38	3,024.90	4,872.00	48,054,367.28	3,023.26	5,005.00	52,352,300.00
Grand total	264,749.45		2,074,393,265.39	264,654.70		2,075,092,457.42	262,559.23		2,073,839,348.00
GRTN/BEN differences							0.8%		0.1%

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.

Another specific national circumstance is the concentration of steel works, since the year 2001, in two sites, with integrated steel plants, coke ovens and electricity self-production. Limited quantities of pig iron are produced also in one additional location. This has allowed for careful check of the processes involved and the emissions estimates at site level and, with reference to other countries, may or may not have exacerbated the unbalances in carbon emissions due to the use of standard 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 in the BEN (with one exception) and the methodology starts with a verification of the energy balance reported in the BEN, see also Annex 5, table A5.3/.4, that seldom presents problems, and then apply the standard EFs to the energy carriers, trying to balance the carbon inputs with emissions. The exception mentioned refers to the recovered gases of BOFs (Basic Oxygen Furnace) that are used to produce electricity but were not accounted for by BEN from the year 1990 up to 1999. From the year 2000 those gases are (partially, only in one plant) included in the estimate of blast furnace gas. The data used to estimate the emissions from 1990 to 1999 are reported by GRTN - ENEL. The consideration of the BOF gases does not change the following discussion, because its contribution to the total emissions is quite limited.

Table A3.1 summarises the quantities of coal and coal by-products used by the energy system in the year 2007, 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 or wasted.

Then in the final part of the table, the two coloured groups of cells report the verification of the input-output of two processes, coke ovens and 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 the top we find the same energy data of table A3.1 valuated for their carbon content, according to the standard EF reported in Table 3.7 of the NIR. Then in the coloured cells we find the balance of carbon inputs and outputs of two processes coke oven and blast furnaces.

coke	coke gas	Blast furnace gas	NOTES
9,314			For blast furnace
0	3,368	8,391	For electricity production
26,204	0	59	For steel industries
295	0	0	For other industries use
0	0		For domestic use
35,813	3,368	8,450	Total consumption
437	213	17	Consumption for production of secondary fuels
0	-2	0	Losses of transformation
36,249	3,579	8,468	Total consumption + losses and prod.
Energy balance coke ovens	Energy balance, blast furnace		
1,314	-846.9		Difference in energy consumption
3.6%	-10.0%		Unbalance in %
36,674			Coke oven output
7,074			Transformation losses, coke ovens
1,672			non energy use
45,421			sub total
45,421			Coking coal input to coke ovens
11,117			Blast furnace coal input
1,840			import + stock change

Table A3.1 Energy balance, 2007, Tcal

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 A3.2 column "total according to BEN". A second step foresees the use for the electric sector of the value directly calculated from the coal gasses used and the calculation of a "balance" quantity for blast furnaces, see column "total used for CRF" in Table A3.2. The balance is the resulting quantity of emissions after subtraction of carbon emissions estimated for coke ovens, electricity production, other coal uses and non energy uses.
The resulting carbon quantities are correct but, when reported in the CRF format, they seem to be produced using very low 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 used to produce electricity.

Further investigations are planned, with a verification of the carbon content of the imported coals and of the coal gasses produced at various stages of the process, coke gas, blast furnace gas and BOF gas.

coke	coke gas	Blast furnace gas + oxi gas	NOTES	Total according to BEN	Total used for CRF
4.13			From blast furnace (no direct emissions, transformed in coal gasses)		
0.00	0.66	8.50	From electricity prod.	9.90	10.31
11.61	0.00	0.07	From steel industries	11.68	12.27
0.13	0.00	0.00	From other industries use	0.13	0.13
0.00	0.00		From domestic use	0.00	0.00
15.87	0.66	8.56	Total emissions, final uses	25.84	22.71
0.17	0.06	0.02	Consumption for production of secondary fuels	0.23	-

0.00	0.00	0.00	Losses of transformation	0.00	-
16.04	0.70	8.58	Total consumption + losses and prod.	26.07	

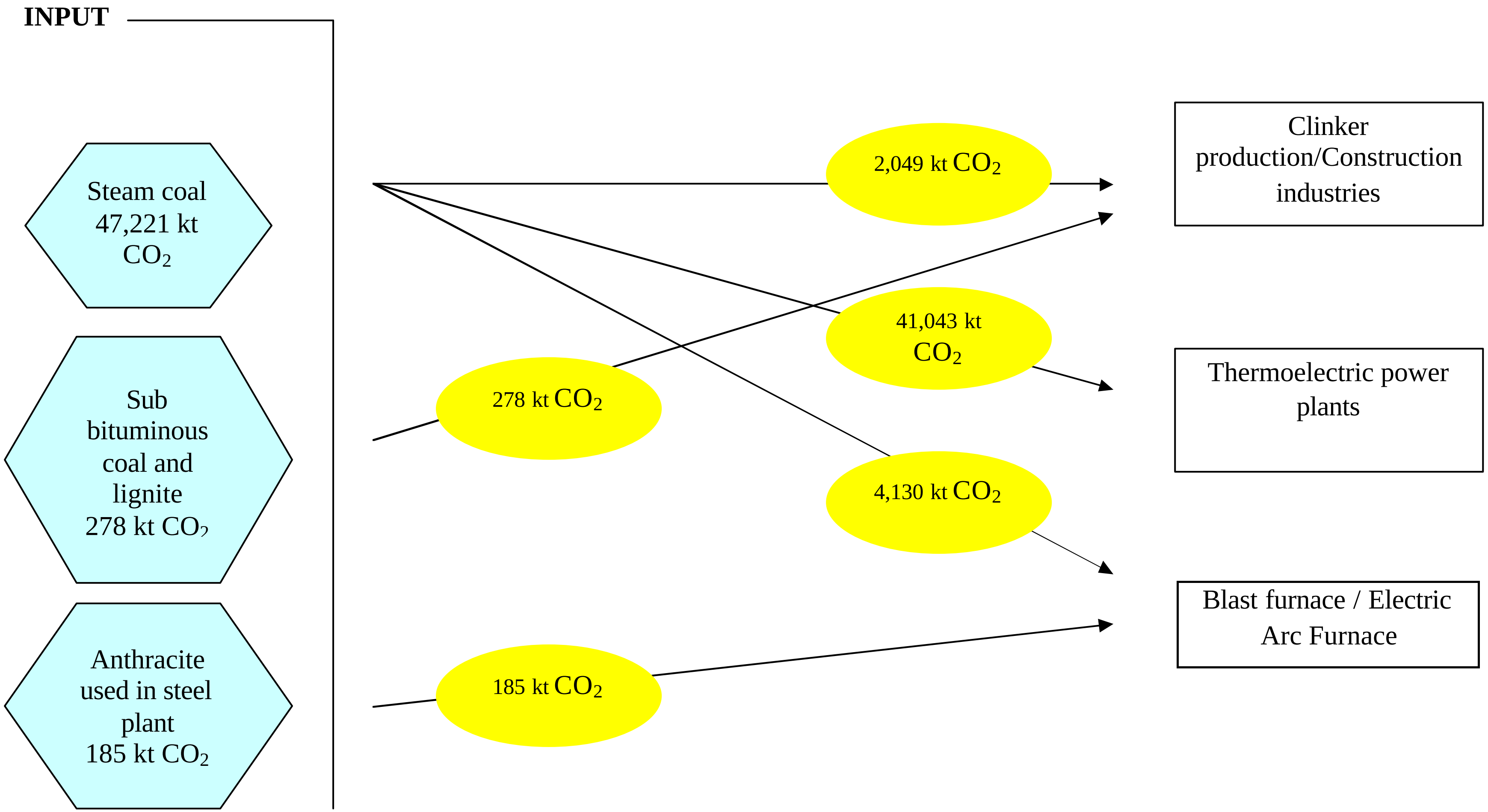
Carbon balance, coke ovens	Carbon balance, blast furnace	
1.2	-1.2	Difference in physical emissions
8%	-14%	Unbalance in %

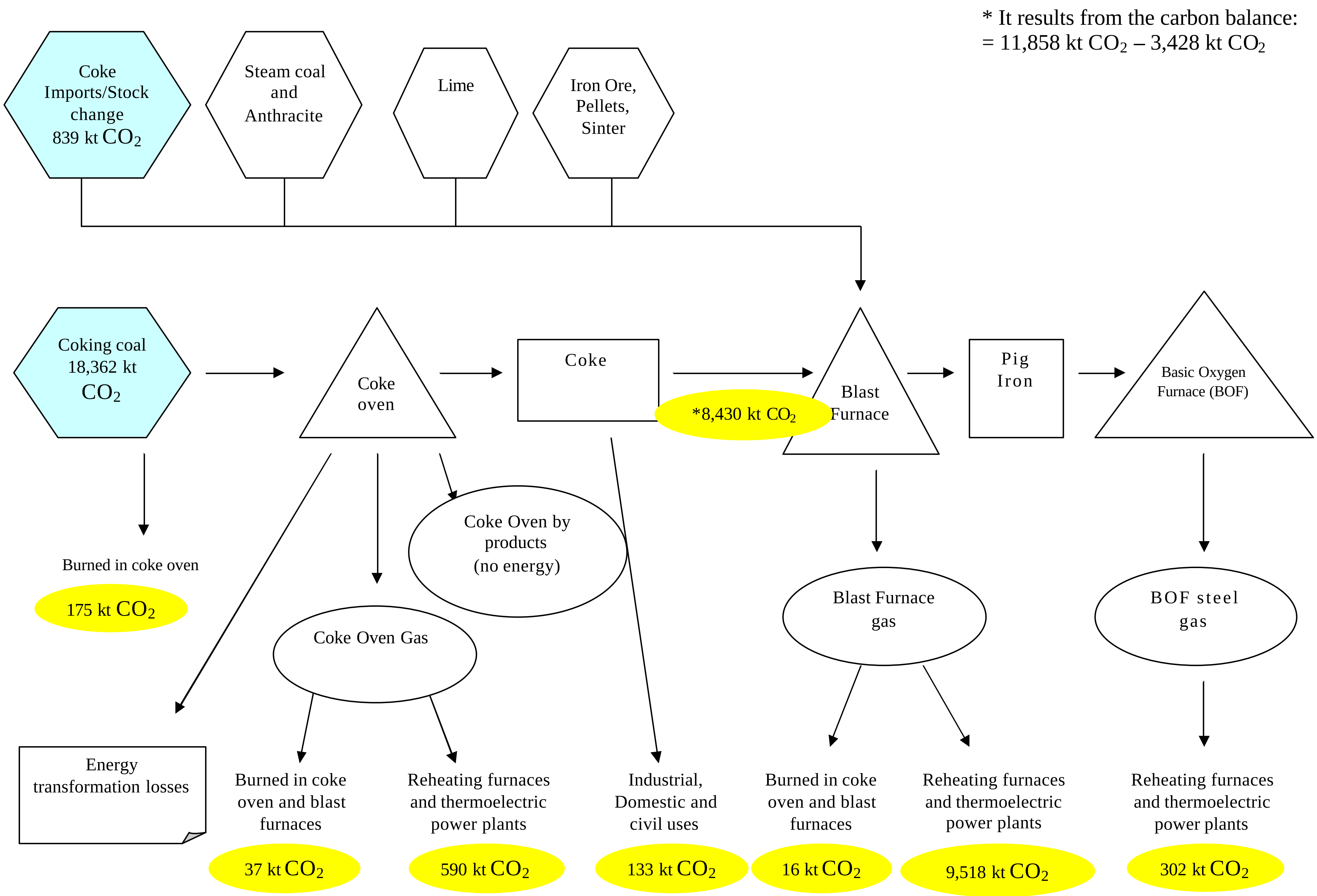
Emissions	Efs (t CO_2/Tcal)			
14.68	400.4	Carbon in produced coke		
2.83	400.4	Transformation losses		
0.67	400.4	non energy use	0.67	0.67
18.19		sub total		
17.61	400.4	Coal input to coke ovens		
4.96	452.5	Coal input to blast furnace		
0.82	452.5	Coke import + stock change		
23.38		Total carbon input	23.38	23.38

Table A3.2 Carbon balance, 2007, Mt CO_2

The flowchart of carbon cycle for the year 2007 is reported below. CO_2 emissions from primary input fuels and from final fuel consumptions are compared. Emissions related to fuel input data are enhanced in light-blue whereas emissions estimated from final fuel consumptions are highlighted in yellow. Emissions from the use of coke in blast furnaces result from differences between emissions from final consumption of coke and the value of the carbon balance for 2007.

CO_2 emission calculation
Year 2007




* It results from the carbon balance:
= 11,858 kt CO_2 – 3,428 kt CO_2
Coke Imports/Stock change 839 kt CO_2
Steam coal and Anthracite
Lime
Iron Ore, Pellets, Sinter
Coking coal 18,362 kt CO_2
Coke oven
Coke
*8,430 kt CO_2
Blast Furnace
Pig Iron
Basic Oxygen Furnace (BOF)
Burned in coke oven
175 kt CO_2
Coke Oven by products (no energy)
Coke Oven Gas
Blast Furnace gas
BOF steel gas
Energy transformation losses
Burned in coke oven and blast furnaces
37 kt CO_2
Reheating furnaces and thermoelectric power plants
590 kt CO_2
Industrial, Domestic and civil uses
133 kt CO_2
Burned in coke oven and blast furnaces
16 kt CO_2
Reheating furnaces and thermoelectric power plants
9,518 kt CO_2
Reheating furnaces and thermoelectric power plants
302 kt CO_2

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 the Italian energy and emission factor data (ENEA, 2002 [a]), and these are described in the following. The BEN (MSE, several years [a]) reports the energy balances for all primary and secondary fuels, with data on imports, exports and production. See Annex 5, Tables A5.1-A5.10, for an example of the year 2007 and to the web site of the Ministry of Economic Development for the whole time series http://dgerm.sviluppoeconomico.gov.it/dgerm/.

Starting from those data and using the emission factors reported in chapter 3, Table 3.7, it is possible to estimate the total carbon entering in the national energy system. It has been developed a direct connection between relevant cells of the CRF tables and the BEN tables and a procedure to insert some additional activity data needed.
The 'missing' data refer to import – export of lubricants, petrol additives, asphalt, other chemical products with energy content, energy use of exhausted lubricants and the evaluation of marine and aviation bunkers fuels used for national traffic.
Those 'missing' data are in fact reported in the BEN but all mixed up together with other substances as sulphur and petrochemicals. The aggregate data do not allow the use of the proper emission factor so inventory is based on more detailed statistics from foreign trade surveys.
The carbon stored in products is estimated according to the procedure illustrated in the paragraph 3.9 and directly subtracted to the emission balance by the CRF software in the current version used by Italy. It may be the case to underline that no direct subtraction of the energy content of the feedstock is performed by CRF. In the cases, as Italy, where those products are not considered in the energy balances this bring to an unbalanced control sheet, as discussed in the following.

With reference to table 1.A(b) of the CRF 2007, we make reference to the BEN tables reported in Annex 5. In particular the following data are reported and used for the *Reference Approach*:

1) crude oil imports and production;
2) natural gas data import;
3) import-export data of petrol, aviation fuel, other kerosene, diesel, fuel oil, LPG and virgin naphtha;
4) import-export data of bitumen and motor oil derive from foreign trade statistics, estimated by an ENEA consultant for the period 1990-1998. BPT data (MSE, several years [b]) are used from 1999 onwards;
5) import-export data of petroleum coke and refinery feedstock are also found in BEN; it has to be underlined that the data reported as "feedstock production" have been ignored up to year 2003 because it is explicitly excluded by the IPCC methodology.

From 2004 onward a careful check with the team in charge to prepare the energy balances induced the inventory team to revise its position on this matter ([1]);

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 "Rete Gas", the national gas grid monopoly, fiscal budgets; the estimated quantities of natural gas used by various sectors show not negligible variations from source to source, with particular reference to the underground stocked quantities; when available we use the estimates of AEEG (Authority for electricity and gas) for consumption of the distribution / storage system and BEN for final consumption;
8) from 1990 to 2007 biomass consumption data are those reported in the BEN; it is well known that other estimates show much bigger, up to 50% more, quantities of used biomass, for example ENEA (ENEA, several years); but the same source quotes BEN biomass consumption estimates as official statistics up to the year 2007 pending further investigations; the inventory follows the same methodology.

The following additional information is needed to complete table 1.A(b) of CRF 2007 and it is found in other sources:

1) Orimulsion, this fuel is mixed up with imported fuel oil (on the base of the energy content), the quantities used for electricity generation are reported by ENEL (ENEL, several years), the former electricity monopoly, presently the only user of this fuel, in their environmental report. This fuel is not used any more since 2004.
2) Motor oils and bitumen.
    a) Data on those materials are mixed up in the no energy use by BEN, detailed data are available in BPT (MSE, several years [b]). The quantities of those materials are quite relevant for the no energy use of oil.
    b) In the BEN those materials are estimated in bulk with other products to have an energy content of about 5100 kcal/kg. Average OECD data 9000 kcal/kg for bitumen and 9800 kcal/kg for motor oils. In the CRF those products are estimated with the OECD energy content and this may explain part of the unbalance between imported oil and used products.

For further information see the paper by ENEA (ENEA, 2002 [b]) in Italian.

A4.2 Comparison of the sectoral approach with the reference approach

The detailed inventory contains a number of sources not accounted for in the IPCC Reference Approach and so gives a higher estimate of CO_2 emissions. The unaccounted sources are:

- Land use change and forestry
- Offshore flaring and well testing
- Waste incineration
- Non-Fuel industrial processes

[1] The feedstock production data refers to petrochemical feedstock and other fuel streams coming back to the refineries from the internal market. Those quantities do not contain additional carbon inputs but because those quantities are not properly subtracted to the final fuel consumption section of the energy balances they should be accounted for also as inputs. A more precise solution would be to reduce the quantities of fuels consumed by the industrial sector, but this is not possible because the team in industry Ministry has only a few details about the origin of those fuel streams returned to refineries. Since 2004 those fuel streams are needed to close the energy balances, which now are much more precise than before. Not considering them in the CRF as input will increase the difference between reference and sectoral approach in the oil section, while with those fuels as inputs the difference is nearly zero. The inventory team considers those fuels as "stock changes" of petrochemical input.

First of all, the IPCC Reference total can be compared with the IPCC Table 1A total plus the fugitive emissions arising from fuel consumption reported in 1B1 Solid Fuel Transformation and in Table 2 Industrial Processes (Iron and Steel and Ammonia Production). Results show the IPCC Reference totals are between 0-4 percent lower than the comparable 'bottom up' totals. The highest difference between the two approaches is observed in 1999 and is equal to 3.1; input data have been checked in details, the difference could be attributed to higher thermo electric fuel input registered by ENEL/TERNA than the figure reported in the energy balance and higher quantities of petcoke calculated from cement production data than those reported in the energy balance.

Differences between emissions estimated by the reference and sectoral approach are reported in the following Table A4.1.

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Sectoral approach	402.02	414.90	434.56	439.62	441.96	455.80	458.65	459.91	455.38	444.57
Reference approach	396.06	406.64	426.15	429.98	432.63	447.16	452.23	453.80	450.33	438.06
Δ %	-1.48%	-1.99%	-1.93%	-2.19%	-2.11%	-1.90%	-1.40%	-1.33%	-1.11%	-1.46%

Table A4.1 Reference and sectoral approach CO_2 emission estimates 1990-2007 (Mt) and percentage differences

There are a number of reasons why the totals differ and these arise from differences in the methodologies and the statistics used.
Explanations for the discrepancies:

1. The IPCC Reference Approach is based on statistics of production, imports, exports and stock changes of fuels whilst the 'bottom-up' approach uses fuel consumption data. The two sets of statistics can be related using mass balances (MSE, several years [a]), but these show that some fuel is unaccounted for. This fuel is reported under 'statistical differences' which consist of measurement errors and losses. A significant proportion of the discrepancy between the IPCC Reference approach and the 'bottom up' approach arises from these statistical differences particularly with liquid fuels.
2. In the power sector in the detailed approach statistics from producers are used, instead for the reference approach the BEN data are used. The two data sets are not connected; in the BEN sections used only the row data of imports-exports are contained. But if one considers the process of "balancing" the import – production data with the consumption ones and the differences between the two data sets, a sizable part of the discrepancy may be connected to this reason only. An investigation is planned as soon as resources become available.
3. The 'bottom up' approach only includes emissions from the no energy use of fuel where they can be specifically identified and estimated such as with fertilizer production and iron and steel production. The IPCC Reference approach implicitly treats the non-energy use of fuel as if it were combustion. A correction is then applied by deducting an estimate of carbon stored from non-energy fuel use. The carbon stored is estimated from an approximate procedure which does not identify specific processes. The result is that the IPCC Reference approach is based on a higher estimate of non-energy use emissions than the 'bottom-up' approach.

The IPCC Reference Approach uses data on primary fuels such as crude oil and natural gas liquids which are then corrected for imports, exports and stock changes of secondary fuels. Thus the estimates obtained will be highly dependent on the default carbon contents used for the primary fuels.
The 'bottom-up' approach is based wholly on the consumption of secondary fuels where the carbon contents are known with greater certainty. In particular the carbon contents of the primary liquid fuels are likely to vary more than those of secondary fuels. Carbon content of solid fuels and of natural gas is quite precisely accounted for, a specific methodology for estimate carbon content of liquid fuel imports is at the moment only planned.

ANNEX 5: NATIONAL ENERGY BALANCE, YEAR 2007

The following table reproduces the part expressed in amount of energy consumed of the National Energy Balance (BEN) of the year 2007.

The complete balance, containing the physical quantities as well as the amount of energy and a consistent time series from the year 1998 onwards, is also available on the website: http://dgerm.sviluppoeconomico.gov.it/dgerm/.

Sectors and fuel definition have been translated here in English, but, of course, the tables on Internet are in Italian language. Definitions are very similar to their English equivalents so this should not be an obstacle to independent verifications of energy data sources for previous years.

The national energy balance is comprised of two "sets" of tables: from page 2 to page 10 the energy vectors are represented in physical quantities (kt) while from page 12 to page 20 they are expressed in energy equivalents (10^9 kcal).

Recalling what already said in Annex 2 related to the BEN reporting methodology (that prefers to use always the same lower heat value for each primary fuel in various years, to better follow the variable energy content of each shipment), we make reference here to the second set of tables. This means, for example, that the primary fuel quantities of two shipments of imported coal are "adjusted" using their energy content as the main reference (see Table A5.1) and the value reported in page 2 of the national energy balance (non reproduced here) is an "adjusted" quantity of 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 it runs the other way: the physical quantities of energy vectors are the only values actually measured on the market and the energy content is actually estimated using fixed average estimates of lower heat value. Experience on the measure of the actual energy content of fuels shows minor variations from one to another year, especially for liquid fuels.

In the case of natural gas the use of a fixed heat value to summarize all transactions was particularly complicated due to the fact that we use fuel from four main different sources: Russia, Netherlands, Algeria and national production. From 2003-2004 onwards Norway and Libya have also been added to the supply list. The big customers were actually billed according to the measured heat value of the natural gas delivered. After the end of the state monopoly on this market the system has recently been changed. From 2004 onwards, the price makes reference to the energy content of natural gas and the metered physical quantities of gas delivered to all final customers are billed according to an energy content variable from site to site and from year to year. The BEN still tries to summarize all production and consumption using only one conventional heat value.

So for the estimations of liquid fuels used in the civil and transportation sector the most reliable data is the physical quantity and this is used to calculate emissions, using updated data for the emission factors, estimated from samples of marketed fuels.

For this reason we attach also the copies of tables, page 8 and 9 of BEN (see Tables A5.9-10), mirror sheet of the tables, page 18 and 19 of BEN (see Tables A5.7-8), that are the base for our emission calculation in the civil and transport sectors.

Table A5.1 – National Energy Balance, year 2007, Primary fuels, 10^9 kcal

BALANCE	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts (a)	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy (e)	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass (f)	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. PRODUCTIONS (c)		1,003			4,395	80,075	58,600	16,050	72,193	12,252	8,961	12,513	29,768	295,810
2. IMPORTS	46,539	117,240	1,487	10		610,088	881,580	78,660					6,925	1,742,529
3. EXPORTS						561	12,130	8,040					25	20,756
4. Stock changes (d)	681	-883	296			-10,799	350	-670						-11,024
5. TOTAL RESOURCES	45,858	119,126	1,191	10	4,395	700,400	927,700	87,340	72,193	12,252	8,961	12,513	36,668	2,028,607
6. Transformations (Enclosure 1/a)	45,421	103,212			4,395	282,920	1,015,040		72,193	12,252	8,961	12,513	13,090	1,569,997
7. Consumptions and Losses (Encl.2/a)	437	1				12,708								13,146
8. Final Consumptions (Enclosure 3/a)		15,913	1,191	10		404,772							23,578	445,464
a) Agriculture						1,576							2,198	3,774
b) Industry		15,913	1,124	10		158,097							3,300	178,444
c) Services						4,876							1,585	6,461
d) Domestic and civil uses			67			232,477							16,495	249,039
Total (a+b+c+d)		15,913	1,191	10		397,026							23,578	437,718
e) Non energy uses						7,746								7,746
TOTAL ENERGY CONSUMPTIONS (7+8)	437	15,914	1,191	10		417,480							23,578	458,610
9. Non energy final uses														

BALANCE	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts (a)	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy (e)	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass (f)	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	
10. BUNKERS														
12. TOTAL USES	45,858	119,126	1,191	10	4,395	700,400	1,015,040		72,193	12,252	8,961	12,513	36,668	2,028,607

(a) - Including secondary products, heat recovered, oxygen furnace gas and compressed gas expansion evaluated at the thermic equivalent of 2200 kcal/kWh, used by electric energy production

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

(c) - Oil products include: returns from petrolchimical industry, some reclassification of feedstocks and regeneration of lubricant oils

(d) - In the "TOTAL RESOURCES", this entry is considered negative

(e) - Pumping excluded

(f) - Biomass production include: total wood removals (from and outside forest); biomass used by electric energy production; biodiesel (202 kt)

Table A5.2 -National Energy Balance, year 2007, Secondary fuels, 10^9kcal

BALANCE	SECONDARY SOURCES																		
	Electric Energy	Char-coal	Coke	Coke oven gas	Blast furnace Gas (g)	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas (h)	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS (i)	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor (b)	0.860	7.500	7.187	4.250	0.900	7.400	4.250	11.000	12.000	10.400	10.500	10.400	10.300	10.200	9.800	9.800	8.300	6.004	
1. PRODUCTIONS (c)	265,071	975	33,973	3,579	8,467	1,635		25,839	45,396	26,468	225,404	41,954	1,957	421,066	93,698	76,401	12,367	38,456	1,322,706
2. IMPORTS	42,081	488	3,062					16,324		23,390	2,709	4,982	2,616	13,352	6,135	16,621	26,452	5,344	163,556
3. EXPORTS	2,277	30	1,545			303		6,358		6,115	99,162	3,817	577	103,826	41,738	6,066	1,411	18,354	291,579
4. Stock changes (d)			-323					792		1,196	-1,155	-884	1,164	836	-1,323	2,352	398	1,525	4,578
5. TOTAL RESOURCES	304,874	1,433	35,813	3,579	8,467	1,332		35,013	45,396	42,547	130,106	44,003	2,832	329,756	59,418	84,604	37,010	23,921	1,190,105
6. Transformations (Encl.1/a)			9,314	3,368	8,391				4,076	68				1,794	24,316	40,347	1,874		93,548
7. Consumptions and Losses (Encl.2/a)	38,861			211	17			330	27,700	286	209	1		14	7,497	9,646	9,115	24	93,909
8. Final Consumptions (Encl.3/a)	266,014	1,433	26,499		59	1,332		34,683	13,620	42,193	129,897	44,002	2,832	322,645	5,055	27,212	26,021	3,050	967,064
a) Agriculture	4,867							704			137			23,725					29,433
b) Industry	119,989	375	26,499		59			4,048	2,100		2,415	177	10	4,590	4,340	24,694	26,021	3,050	218,367
c) Services	38,026							10,384			124,657	43,825		260,568					477,460

BALANCE	SECONDARY SOURCES																		
	Electric Energy	Char-coal	Coke	Coke oven gas	Blast furnace Gas (g)	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas (h)	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS (i)	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor (b)	0.860	7.500	7.187	4.250	0.900	7.400	4.250	11.000	12.000	10.400	10.500	10.400	10.300	10.200	9.800	9.800	8.300	6.004	
d) Domestic and civil uses	103,132	1,058						19,404					113	24,755		1,254			149,716
Total (a+b+c+d)	266,014	1,433	26,499		59			34,540	2,100		127,209	44,002	123	313,638	4,340	25,948	26,021	3,050	874,976
e) No energetic uses						1,332		143	11,520	42,193	2,688		2,709	9,007	715	1,264		20,517	92,088
TOTAL ENERGY CONSUMPTIONS (7+8)	304,875	1,433	26,499	211	76	1,332		35,013	41,320	42,479	130,106	44,003	2,832	322,659	12,552	36,858	35,136	3,074	1,040,458
9. Non energy final uses																		20,516	20,516
10. BUNKERS														5,304	22,550	7,399		330	35,583
12. TOTAL USES	304,875	1,433	35,813	3,579	8,467	1,332		35,013	45,396	42,547	130,106	44,003	2,832	329,756	59,418	84,604	37,010	23,921	1,190,105

(g) - Real quantity of blast furnace gas in trasformations is 10.316 Mmc with l.h.v. of 813 kcal/mc

(h) - Including residuals gas of chemical processes

(i) - Including heavy residuals used for electricity production through gasification

Table A5.3 -National Energy Balance, year 2007, Primary fuels used by transformation industries, "Enclosure 1/a", 10^9kcal

TRANSFORMATIONS	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts (a)	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy (e)	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass	TOTAL PRIMARY SOURCES
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Conversion factor (b)	7.400	6.350	7.400	2.500	2.500	8.250	10.000	10.000	2.200	2.200	2.200	2.500	2.500	
1) INPUT QUANTITY														
a) Charcoal pit													1,975	1,975
b) Coking	45,421													45,421
c) Town gas Workshop														
d) Blast furnaces														
e) Petroleum refineries							1,015,040							1,015,040
f) Hydroelectric power plants									72,193					72,193
g) Geothermal power plants										12,252				12,252
h) Thermoelectric power plants		103,212			4,395	282,920						12,513	11,115	414,155
i) Wind / Photovoltaic power plants											8,961			8,961
TOTAL	45,421	103,212			4,395	282,920	1,015,040		72,193	12,252	8,961	12,513	13,090	1,569,997
2) OUTPUT QUANTITY														
A) Obtained sources														
a) Charcoal pit													988	988
b) Coking	36,674													36,674
c) Town gas Workshop														
d) Blast furnaces														
e) Petroleum refineries							970,554							970,554
f) Hydroelectric power plants									28,221					28,221
g) Geothermal power plants										4,789				4,789

TRANSFORMATIONS	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts (a)	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy (e)	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass	TOTAL PRIMARY SOURCES
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Conversion factor (b)	7.400	6.350	7.400	2.500	2.500	8.250	10.000	10.000	2.200	2.200	2.200	2.500	2.500	
h) Thermoelectric power plants		37,936			1,688	148,475						2,601	3,379	194,079
i) Wind / Photovoltaic power plants											3,503			3,503
Sub-Total A	36,674	37,936			1,688	148,475	970,554		28,221	4,789	3,503	2,601	4,367	1,238,808
B) Losses of transformation														
a) Charcoal pit													987	987
b) Coking	7,074													7,074
c) Town gas Workshop														
d) Blast furnaces														
e) Petroleum refineries							6,030							6,030
f) Hydroelectric power plants									43,972					43,972
g) Geothermal power plants										7,463				7,463
h) Thermoelectric power plants		65,276			2,707	134,445						9,912	7,736	220,076
i) Wind / Photovoltaic power plants											5,458			5,458
Sub-Total B	7,074	65,276			2,707	134,445	6,030		43,972	7,463	5,458	9,912	8,723	291,060
C) Non energy products														
a) Coke ovens (c)	1,673													1,673
b) Town Gas Workshop														
c) Petroleum refineries (d)							38,456							38,456
Sub-Total C	1,673						38,456							40,129
TOTAL A+B+C	45,421	103,212			4,395	282,920	1,015,040		72,193	12,252	8,961	12,513	13,090	1,569,997

TRANSFORMATIONS	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproduct s (a)	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy (e)	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass	TOTAL PRIMARY SOURCES
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Conversion factor (b)	7.400	6.350	7.400	2.500	2.500	8.250	10.000	10.000	2.200	2.200	2.200	2.500	2.500	
(a) - See note (a) in the table of the Balance														
(b) - Lower heat value has been adopted for all fuels														
(c) - Including tars, benzol and ammonic sulphate														
(d) - Including solvent gasoline, turpentine, lubricants, white oils, insulating oils, vaseline, paraffin, bitumen and other products														
(e) - Pumping excluded														

Table A5.4 -National Energy Balance, year 2007, Secondary fuels used by transformation industries, "Enclosure 1/a", 10^9kcal

TRANSFORMATIONS	SECONDARY SOURCES																		
	Electric Energy	Char-coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillate s (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor (b)	0.860	7.500	7.187	4.250	0.900	7.400	4.250	11.000	12.000	10.400	10.500	10.400	10.300	10.200	9.800	9.800	8.300	6.004	
1) INPUT QUANTITY																			
a) Charcoal pit																			
b) Coking																			
c) Town gas Workshop																			
d) Blast furnaces			9,314																9,314
e) Petroleum refineries																			

TRANSFORMATIONS	SECONDARY SOURCES																		
	Electric Energy	Char-coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor (b)	0.860	7.500	7.187	4.250	0.900	7.400	4.250	11.000	12.000	10.400	10.500	10.400	10.300	10.200	9.800	9.800	8.300	6.004	
f) Hydroelectr.power plants																			
g) Geothermal power plants																			
h) Thermoelectr.power plants				3,368	8,391				4,076	68				1,794	24,316	40,347	1,874		84,234
i) Wind / Photovoltaic power plants																			
TOTAL			9,314	3,368	8,391				4,076	68				1,794	24,316	40,347	1,874		93,548
2) OUTPUT QUANTITY																			
A) Obtained sources																			
a) Charcoal pit																			
b) Coking																			
c) Town gas Workshop																			
d) Blast furnaces			9,314																9,314
e) Petroleum refineries																			
f) Hydroelectric power plants																			
g) Geothermal power plants																			

TRANSFORMATIONS	SECONDARY SOURCES																		
	Electric Energy	Char-coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor (b)	0.860	7.500	7.187	4.250	0.900	7.400	4.250	11.000	12.000	10.400	10.500	10.400	10.300	10.200	9.800	9.800	8.300	6.004	
h) Thermoelectric power plants				1,372	3,317				1,765	46				579	10,400	16,139	859		34,477
i) Wind / Photovoltaic power plants																			
Sub-Total A			9,314	1,372	3,317				1,765	46				579	10,400	16,139	859		43,791
B) Losses of transformation																			
a) Charcoal pit																			
b) Coking																			
c) Town gas Workshop																			
d) Blast furnaces																			
e) Petroleum refineries																			
f) Hydroelectric power plants																			
g) Geothermal power plants																			
h) Thermoelectric power plants				1,996	5,074				2,311	22				1,215	13,916	24,208	1,015		49,757
i) Wind / Photovoltaic power plants																			
Sub-Total B				1,996	5,074				2,311	22				1,215	13,916	24,208	1,015		49,757
C) Non energy products																			
a) Coking																			

TRANSFORMATIONS	SECONDARY SOURCES																		
	Electric Energy	Char-coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor (b)	0.860	7.500	7.187	4.250	0.900	7.400	4.250	11.000	12.000	10.400	10.500	10.400	10.300	10.200	9.800	9.800	8.300	6.004	
b) Town Gas Workshop																			
c) Petroleum refineries																			
Sub-Total C																			
TOTAL A+B+C			9,314	3,368	8,391				4,076	68				1,794	24,316	40,347	1,874		93,548

Table A5.5 -National Energy Balance, year 2007, Primary fuels losses, "Enclosure 2/a", 10^9kcal

CONSUMPTIONS AND LOSSES (d)	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts (a)	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass	TOTAL PRIMARY SOURCES
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Conversion factor (b)	7.400	6.350	7.400	2.500	2.500	8.250	10.000	10.000	2.200	2.200	2.200	2.500	2.500	
1) Consumptions for production														
of primary sources														
a) Biomass														
b) Coal														
c) Lignite														
d) Nuclear fuels														
e) Natural Gas						792								792
f) Natural gas liquids														
g) Crude oil														
h) Hydraulic Energy														
i) Geothermal Energy														
Sub-total						792								792
2) Consumptions for production														
of secondary sources (c)														
a) Charcoal pit														
b) Coke ovens	437													437
c) Town Gas Workshop														
d) Blast furnaces														
e) Petroleum refineries						2,492								2,492
f) Hydraulic power plants														

CONSUMPTIONS AND LOSSES (d)	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts (a)	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass	TOTAL PRIMARY SOURCES
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Conversion factor (b)	7.400	6.350	7.400	2.500	2.500	8.250	10.000	10.000	2.200	2.200	2.200	2.500	2.500	
g) Geothermal power plants														
h) Thermoelectric power plants														
i) Nuclear power plants														
Sub-total	437					2,492								2,929
3) Consumptions and Losses of														
transport and distribution						9,430								9,430
4) Differences :														
- Statistics														
- of conversion		1				-6								-5
TOTAL (1+2+3+4)	437	1				12,708								13,146

(a) - See note (a) in the table of the Balance

(b) Lower heat value has been adopted for all fuels

(c) Consumptions for internal uses of energy industries

(d) Excluding losses of transformation considered in the balance of transformations

Table A5.6 -National Energy Balance, year 2007, Secondary fuels losses, "Enclosure 2/a", 10^9kcal

CONSUMPTIONS AND LOSSES	SECONDARY SOURCES																		
	Electric Energy	Char-coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor (b)	0.860	7.500	7.187	4.250	0.900	7.400	4.250	11.000	12.000	10.400	10.500	10.400	10.300	10.200	9.800	9.800	8.300	6.004	
1) Consumptions for production																			
of primary sources																			
a) Biomass																			
b) Coal	34																		34
c) Lignite	2																		2
d) Nuclear fuels	5																		5
e) Natural Gas	293																		293
f) Natural gas liquids																			
g) Crude oil																			
h) Hydraulic Energy	1,709																		1,709
i) Geothermal Energy																			
Sub-total	2,043																		2,043
2) Consumptions for production																			
of secondary sources (c)																			
a) Charcoal pit																			
b) Coke ovens	146			211	17														374
c) Town Gas Workshop	194																		194
d) Blast furnaces																			

CONSUMPTIONS AND LOSSES	SECONDARY SOURCES																		
	Electric Energy	Char-coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor (b)	0.860	7.500	7.187	4.250	0.900	7.400	4.250	11.000	12.000	10.400	10.500	10.400	10.300	10.200	9.800	9.800	8.300	6.004	
e) Petroleum refineries	5,005							330	27,696	281	210			11	7,497	9,642	9,113	24	59,809
f) Hydraulic power plants	446																		446
g) Geothermal power plants	281																		281
h) Thermoelectric power plants	10,098																		10,098
i) Wind / Photovoltaic power plants	2																		
Sub-total	16,172			211	17			330	27,696	281	210			11	7,497	9,642	9,113	24	71,202
3) Consumptions and Losses of																			
transport and distribution	20,647																		20,647
4) Differences :																			
- Statistics	1																	-1	
- of conversion	-2								4	5	-1	1		3		4	2	1	17
TOTAL (1+2+3+4)	38,861			211	17			330	27,700	286	209	1		14	7,497	9,646	9,115	24	93,909

Table A5.7 -National Energy Balance, year 2007, Primary fuels used by end use sectors, "Enclosure 3/a", 10^9kcal

FINAL CONSUMPTIONS	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass	TOTAL PRIMARY SOURCES
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Conversion factor (a)	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) AGRICULTURE AND FISHING														
I- Agriculture						1,576							2,198	3,774
II- Fishing														
Sub-Total						1,576							2,198	3,774
2) INDUSTRY														
I- Iron and steel industry		10,636	481			18,554								29,671
II- Other industry		5,277	643	10		139,543							3,300	148,773
a) Mining industry						289								289
b) Non-Ferrous Metals			22			3,968								3,990
c) Metal works factories						22,853								22,853
d) Food Processing, Beverages						14,842								14,842
e) Textile and clothing						9,125								9,125
f) Construction industries (cement, bricks)		5,277	599	10		7,912							3,300	17,098
g) Glass and pottery						24,857								24,857
h) Chemical			22			27,704								27,726
i) Petrochemical														
l) Pulp, paper and print						19,643								19,643
m) Other industries						8,350								8,350
n) Building and civil works														

FINAL CONSUMPTIONS	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass	TOTAL PRIMARY SOURCES
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Conversion factor (a)	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	
Sub-Total		15,913	1,124	10		158,097							3,300	178,444
3) SERVICES														
I - Railways														
II - Navigation														
III - Road transportation						4,876							1,585	6,461
IV - Civil aviation														
V - Other transportation														
VI - Public Service														
Sub-Total						4,876							1,585	6,461
4) DOMESTIC AND COMMERCIAL USES			67			232,477							16,495	249,039
TOTAL (1+2+3+4)		15,913	1,191	10		397,026							23,578	437,718
5) NON ENERGY USE (b)														
I - Chemical industry														
II - Petrochemical						7,747								7,747
III - Agriculture														
IV - Other sectors														
Sub-Total						7,747								7,747
TOTAL (1+2+3+4+5)		15,913	1,191	10		404,773							23,578	445,465

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

(b) - Non energy uses of energetic sources

Table A5.8-National Energy Balance, year 2007, Secondary fuels used by end use sectors, "Enclosure 3/a", 10^9kcal

FINAL CONSUMPTIONS	SECONDARY SOURCES																		
	Electric Energy	Char-coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor	0.860	7.500	7.187	4.250	0.900	7.400	4.250	11.000	12.000	10.400	10.500	10.400	10.300	10.200	9.800	9.800	8.300	6.004	
1) AGRICULTURE AND FISHING																			
I- Agriculture	4,867							682			126			21,410					27,085
II- Fishing								22			11			2,315					2,348
Sub-Total	4,867							704			137			23,725					29,433
2) INDUSTRY																			
I- Iron and steel industry	18,642		26,204		59			275						82		686	17		45,965
II- Other industry	101,347	375	295					3,773	2,100		2,415	177	10	4,508	4,340	24,008	26,004	3,050	172,402
a) Mining industry	939							44						204	39	137			1,363
b) Non-Ferrous Metals	4,751		43					198						61		441			5,494
c) Metal works factories	24,322							825			336	177	10	1,367	1,078	3,136			31,251
d) Food Processing, Beverages	11,055	300						418						510	137	5,762			18,182
e) Textile and clothing	7,779							209						459	49	1,891			10,387
f) Construction industries (cement, bricks)	7,725		101					891						479	960	274	25,896	3,050	39,376
g) Glass and pottery	4,995							693						163		2,489			8,340
h) Chemical	21,319	75	43					77						224		1,284	108		23,130

FINAL CONSUMPTIONS	SECONDARY SOURCES																		
	Electric Energy	Char-coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor	0.860	7.500	7.187	4.250	0.900	7.400	4.250	11.000	12.000	10.400	10.500	10.400	10.300	10.200	9.800	9.800	8.300	6.004	
i) Petrochemical	1,383							198	2,100		2,079				1,009	4,488			11,257
l) Pulp, paper and print	9,158							88						204		1,891			11,341
m) Other industries	6,375		108					132						337	1,068	2,215			10,235
n) Building and civil works	1,546													500					2,046
Sub-Total	119,989	375	26,499		59			4,048	2,100		2,415	177	10	4,590	4,340	24,694	26,021	3,050	218,367
3) SERVICES																			
I - Railways	4,543													1,071					5,614
II - Navigation	30													2,315					2,345
III - Road transportation	4,279							10,351			124,226			253,082					391,938
IV - Civil aviation	95										158	42,650							42,904
V - Other transportation	20,002																		20,002
VI - Public Service	9,076							33	(c)		273	1,175		4,100	(c)				14,657
Sub-Total	38,026							10,384			124,657	43,825		260,568					477,460
4) DOMESTIC AND COMMERCIAL USES	103,132	1,058						19,404					113	24,755		1,254			149,716
TOTAL (1+2+3+4)	266,014	1,433	26,499		59			34,540	2,100		127,209	44,002	123	313,638	4,340	25,948	26,021	3,050	874,976
5) NON ENERGY USE (b)																			

FINAL CONSUMPTIONS	SECONDARY SOURCES																		
	Electric Energy	Char-coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor	0.860	7.500	7.187	4.250	0.900	7.400	4.250	11.000	12.000	10.400	10.500	10.400	10.300	10.200	9.800	9.800	8.300	6.004	
I - Chemical industry																			
II - Petrochemical								143	11,520	42,193	2,688		2,709	9,007	715	1,264		240	70,479
III - Agriculture						163													163
IV - Other sectors						1,169												20,277	21,446
Sub-Total						1,332		143	11,520	42,193	2,688		2,709	9,007	715	1,264		20,517	92,088
TOTAL (1+2+3+4+5)	266,014	1,433	26,499		59	1,332		34,683	13,620	42,193	129,897	44,002	2,832	322,645	5,055	27,212	26,021	23,567	967,064

(c) 490 10^9 kcal of diesel and 22 10^9 kcal of LPG used for heating for Public Service

Table A5.9 -National Energy Balance, year 2007, Primary fuels used by end use sectors, "Enclosure 3/a", quantity

FINAL CONSUMPTIONS	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass	TOTAL PRIMARY SOURCES
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Unit of measurement	kt	kt	kt	kt		Mmc	kt	kt	GWh	GWh	GWh	kt	kt	
1) AGRICULTURE AND FISHING														
I- Agriculture						191							879	
II- Fishing														
Sub-Total						191							879	
2) INDUSTRY														
I- Iron and steel industry		1,675	65			2,249								
II- Other industry		831	87	4		16,914							1,320	
a) Mining industry						35								
b) Non-Ferrous Metals			3			481								
c) Metal works factories						2,770								
d) Food Processing, Beverages						1,799								
e) Textile and clothing						1,106								
f) Construction industries (cement, bricks)		831	81	4		959							1,320	
g) Glass and pottery						3,013								
h) Chemical			3			3,358								
i) Petrochemical														
l) Pulp, paper and print						2,381								
m) Other industries						1,012								
n) Building and civil works														
Sub-Total		2,506	152	4		19,163							1,320	
3) SERVICES														
I - Railways														

FINAL CONSUMPTIONS	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass	TOTAL PRIMARY SOURCES
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Unit of measurement	kt	kt	kt	kt		Mmc	kt	kt	GWh	GWh	GWh	kt	kt	
II - Navigation														
III - Road transportation						591							202	(b)
IV - Civil aviation														
V - Other transportation														
VI - Public Service														
Sub-Total						591							202	
4) DOMESTIC AND COMMERCIAL USES			9			28,179							6,598	(b)
TOTAL (1+2+3+4)		2,506	161	4		48,124							8,999	
5) NON ENERGY USE (a)														
I - Chemical industry														
II - Petrochemical						939								
III - Agriculture														
IV - Other sectors														
Sub-Total						939								
TOTAL (1+2+3+4+5)		2,506	161	4		49,063							8,999	

(a) - Non energy uses of energetic sources

(b) - Biodiesel for road transport: 202 kt; biodiesel for domestic and commercial uses: 0 kt

Table A5.10 -National Energy Balance, year 2007, Secondary fuels used by end use sectors, "Enclosure 3/a", quantity

FINAL CONSUMPTIONS	SECONDARY SOURCES																		
	Electric Energy	Char-coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Unit of measurement	GWh	kt	kt	Mmc	Mmc	kt	Mmc	kt	kt	kt		kt	kt	kt	kt	kt	kt	kt	
1) AGRICULTURE AND FISHING																			
I- Agriculture	5,659							62			12			2,099					
II- Fishing								2			1			227					
Sub-Total	5,659							64			13			2,326					
2) INDUSTRY																			
I- Iron and steel industry	21,676		3,646		66			25						8		70	2		
II- Other industry	117,844	50	41					343	175		230	17	1	442	443	2,450	3,133	508	
a) Mining industry	1,092							4						20	4	14			
b) Non-Ferrous Metals	5,525		6					18						6		45			
c) Metal works factories	28,281							75			32	17	1	134	110	320			
d) Food Processing, Beverages	12,855	40						38						50	14	588			
e) Textile and clothing	9,045							19						45	5	193			
f) Construction industries (cement, bricks)	8,982		14					81						47	98	28	3,120	508	

FINAL CONSUMPTIONS	SECONDARY SOURCES																		
	Electric Energy	Char-coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Unit of measurement	GWh	kt	kt	Mmc	Mmc	kt	Mmc	kt	kt	kt		kt	kt	kt	kt	kt	kt	kt	
g) Glass and pottery	5,808							63						16		254			
h) Chemical	24,789	10	6					7						22		131	13		
i) Petrochemical	1,609							18	175		198				103	458			
l) Pulp, paper and print	10,649							8						20		193			
m) Other industries	7,412		15					12						33	109	226			
n) Building and civil works	1,797													49					
Sub-Total	139,520	50	3,687		66			368	175		230	17	1	450	443	2,520	3,135	508	
3) SERVICES																			
I - Railways	5,283													105					
II - Navigation	34													227					
III - Road transportation	4,976							941			11,831			24,812					
IV - Civil aviation	111										15	4,101							
V - Other transportation	23,258																		
VI - Public Service	10,554							3	(c)		26	113		402	(c)				
Sub-Total	44,216							944			11,872	4,214		25,546					
4) DOMESTIC AND COMMERCIAL USES	119,921	141						1,764					11	2,427		128			

FINAL CONSUMPTIONS	SECONDARY SOURCES																		
	Electric Energy	Char-coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Unit of measurement	GWh	kt	kt	Mmc	Mmc	kt	Mmc	kt	kt	kt		kt	kt	kt	kt	kt	kt	kt	
TOTAL (1+2+3+4)	309,316	191	3,687		66			3,140	175		12,115	4,231	12	30,749	443	2,648	3,135	508	
5) NON ENERGY USE																			
I - Chemical industry																			
II - Petrochemical								13	960	4,057	256		263	883	73	129		40	
III - Agriculture						22													
IV - Other sectors						158												3,377	
Sub-Total						180		13	960	4,057	256		263	883	73	129		3,417	
TOTAL (1+2+3+4+5)	309,316	191	3,687		66	180		3,153	1,135	4,057	12,371	4,231	275	31,632	516	2,777	3,135	3,925	
(c) 48 kt of gas oil and 2 kt of LPG used for heating for Public Service																			

ANNEX 6: NATIONAL EMISSION FACTORS

Monitoring of the carbon content of the fuels used nationally is an ongoing activity at 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 market 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. From 2003-2004 onwards Norway and Libya have also been added to the supply list, thank to updated pipeline connection. Sizeable additional NGL facilities are under construction.

Each of those natural gases 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.

In the 2009 submission the average emission factor for 2006 has been updated.

	t CO_2 / TJ	t CO_2 / 10^3 std cubic mt	t CO_2 / tep
Natural gas (dry) IPCC	55.780	1.925	2.334
Natural gas (dry) 1990	55.328	1.942	2.315
Natural gas (dry) 1995	55.423	1.961	2.319
Natural gas (dry) 1998	55.423	1.970	2.319
Natural gas (dry) 1999	55.437	1.971	2.319
Natural gas (dry) 2000	55.472	1.971	2.321
Natural gas (dry) 2001	55.421	1.960	2.319
Natural gas (dry) 2002	55.974	1.965	2.342
Natural gas (dry) 2003	55.594	1.961	2.326
Natural gas (dry) 2004	55.595	1.945	2.326
Natural gas (dry) 2005	55.590	1.944	2.326
Natural gas (dry) 2006	55.666	1.949	2.329
Natural gas (dry) 2007	55.636	1.947	2.328

Table A6.1 Natural gas carbon emission factors

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 produce results with significant differences, around 2-4%. The reason has been traced back to the emission factors that are referred to the energy content of the fuel for IPCC and to the physical quantities for the COPERT methodology.

The results of the study 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 IPCC-Europe for LPG are almost identical to the experimental results (less than 1% difference), and it has been decided to use IPCC emission factors for the period 1990-1999 and the measured EF from the year 2000 onwards.

Relevant quantities (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.

	t CO2 / TJ	t CO2 / t	t CO2 / tep
Petrol, IPCC / OECD	68.559	3.071	2.868
Petrol, IPCC Europe	72.270	3.148	3.024
Petrol (Italian National Energy Balance), interpolated emission factor 1990-1999	71.034	3.121	2.972
Petrol, experimental averages 2000-2007	71.145	3.109	2.977
Gas oil, IPCC / OECD	73.274	3.175	3.066
Gas oil, IPCC Europe	73.260	3.108	3.065
Gas oil, 1990 - 1999	73.274	3.127	3.066
Gas oil, engines, experimental averages 2000-2007	73.153	3.138	3.061
Gas oil, heating, experimental averages 2000-2007	73.693	3.141	3.083
LPG, IPCC / OECD	62.392	2.952	2.610
LPG, IPCC / Europe	64.350	3.000	2.692
LPG, 1990 - 1999	64.350	3.000	2.692
LPG, experimental averages	64.936	2.994	2.717

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

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. In 2009 submission on the basis of more detailed data available on the amount of low and high sulphur fuel oil sold emission factor have been slightly updated from 1999.

	T CO_2 / TJ	T CO_2 / T	T CO_2 / TEP
Fuel oil, average 1990	76.565	3.111	3.203
Fuel oil, average 1995	76.650	3.127	3.207
Fuel oil, average 1998	76.741	3.139	3.211
Fuel oil, average 1999	76.547	3.124	3.203
Fuel oil, average 2000	75.898	3.124	3.176
Fuel oil, average 2001	75.889	3.122	3.175
Fuel oil, average 2002	75.942	3.125	3.177
Fuel oil, average 2003	76.151	3.131	3.186
Fuel oil, average 2004	76.170	3.132	3.187
Fuel oil, average 2005	76.306	3.133	3.193
Fuel oil, average 2006	76.280	3.134	3.196
Fuel oil, average 2007	76.518	3.129	3.201

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

Coal imports
Italy has only negligible national production of coal, most is imported from various countries and there are not negligible differences in carbon content. The variations in carbon content can be linked to the hydrogen content and to the LHV of the coal.
An additional national circumstance refers to the absence of long term import contracts. The quantities shipped by the main exporters change considerably from year to year; moreover new suppliers have been added to the list in the last few years.
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 improving 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, 2007);
- 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 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.
In the 2009 submission, emission factors for 2005 and 2006 have been updated on the basis of new information available regarding the amount of different coals imported.

	t CO2 / TJ	t CO2 / t	t CO2 / tep
Sub bituminous coal, IPCC	96.234	2.557	4.026
Steam coal 1990	94.582	2.502	3.960
Steam coal 1995	94.007	2.519	3.936
Steam coal 1998	94.582	2.437	3.957
Steam coal 1999	93.844	2.400	3.926
Steam coal 2000	91.446	2.404	3.826
Steam coal 2001	93.398	2.434	3.908
Steam coal 2002	92.832	2.423	3.884
Steam coal 2003	93.478	2.435	3.911
Steam coal 2004	93.474	2.430	3.911
Steam coal 2005	94.623	2.475	3.959
Steam coal 2006	95.076	2.450	4.016
Steam coal 2007	95.041	2.465	3.977

Table A6.4 – Coal, average carbon emission factors

ANNEX 7: AGRICULTURE SECTOR

Additional information used for estimating categories 4A and 4B from the agriculture sector are reported in this section.

Annex 7.1 Enteric fermentation (4A)

Following suggestions from the last centralized review[2], the time series of the parameters used for estimating the Dairy Cattle emission factor using the Tier 2 approach is reported in Table A.7.1. Information on the equations used for estimating the different net energy (NE_m, NE_g, etc.) is detailed in IPCC (2000).

	NE_m (MJ/day)	NE_a (MJ/day)	NE_g (MJ/day)	NE_l (MJ/day)	NE_w (MJ/day)	NE_p (MJ/day)	NE_{ma}/DE	NE_{ga}/DE	GE (MJ/day)
1990	40.75	0.35	0.10	33.52	0.00	3.97	0.51	0.31	235.77
1991	40.75	0.35	0.10	37.71	0.00	3.96	0.51	0.31	248.30
1992	40.75	0.35	0.10	40.42	0.00	3.91	0.51	0.31	256.30
1993	40.75	0.35	0.10	40.25	0.00	3.89	0.51	0.31	255.70
1994	40.75	0.35	0.10	42.53	0.00	3.92	0.51	0.31	262.63
1995	40.75	0.35	0.10	43.38	0.00	3.86	0.51	0.31	264.99
1996	40.75	0.35	0.10	44.66	0.00	3.86	0.51	0.31	268.84
1997	40.75	0.35	0.10	45.46	0.00	3.85	0.51	0.31	271.18
1998	40.75	0.35	0.10	45.25	0.00	3.79	0.51	0.31	270.40
1999	40.75	0.35	0.10	45.17	0.00	3.75	0.51	0.31	270.00
2000	40.75	0.35	0.10	44.31	0.00	3.78	0.51	0.31	267.52
2001	40.75	0.35	0.10	43.74	0.00	3.73	0.51	0.31	265.67
2002	40.75	0.35	0.10	47.60	0.00	3.72	0.51	0.31	277.19
2003	40.75	0.35	0.10	47.57	0.00	3.72	0.51	0.31	277.10
2004	40.75	0.35	0.10	49.68	0.00	3.66	0.51	0.31	283.26
2005	40.75	0.35	0.10	50.84	0.00	3.71	0.51	0.31	286.88
2006	40.75	0.35	0.10	51.17	0.00	3.67	0.51	0.31	287.76
2007	40.75	0.35	0.10	51.15	0.00	3.65	0.51	0.31	287.62

Source: ISPRA, 2009

Table A.7.1 Parameters used for the Tier 2 approach - dairy cattle

[2] http://unfccc.int/resource/docs/2009/arr/ita.pdf

Annex 7.2 Manure management (4B)

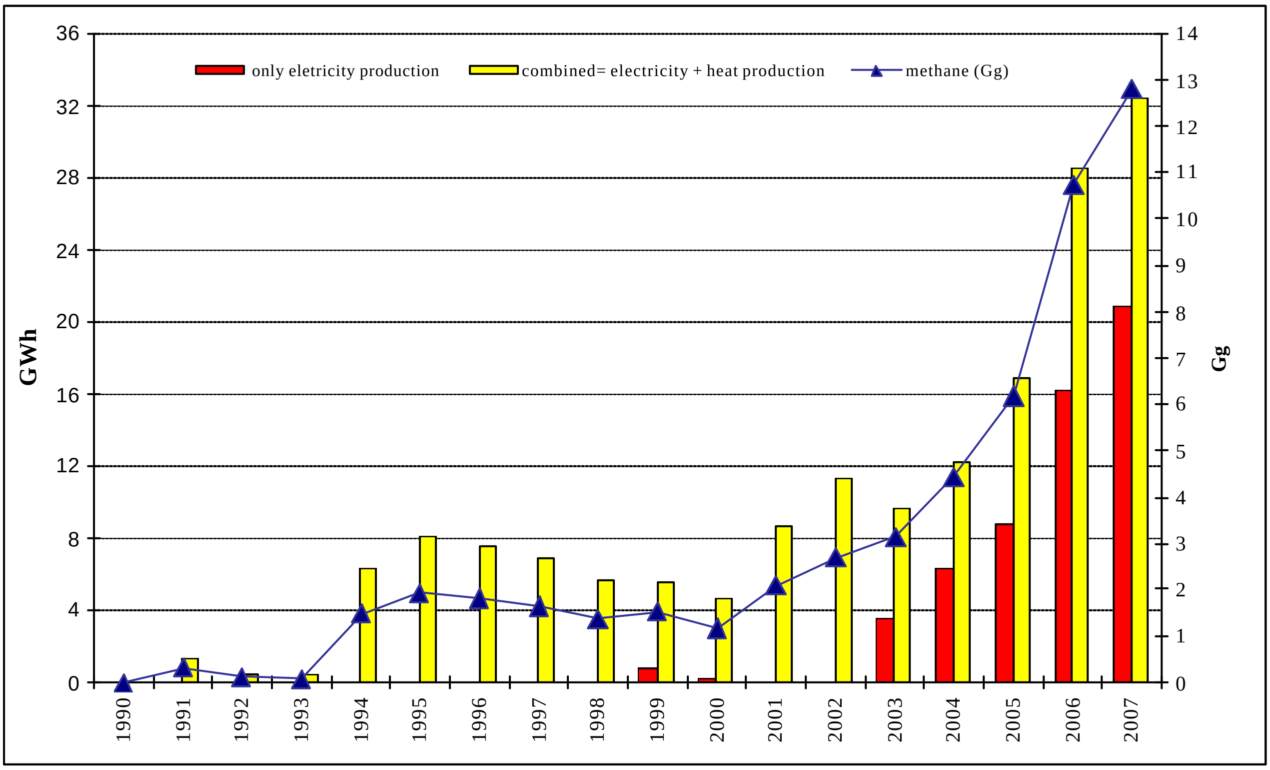
In this section the time series used to apply the methane emission reduction to the 4B Manure management category from the agriculture sector are reported. The source of information is the National Electrical Service Operator - GSE (Gestore Servizi Elettrici)[3]. The total gross production of biogas produced from animal manure is used for the production of electricity and combined (electricity and heat) production. The conversion of this information (GWh) into metane (Gg) has assumed a 30% yield and a net caloric value of 50.038 Gg/TG. A representation of the time series is presented in the following Table A.7.2 and Figure A.7.1.

	BIOGAS			
Year	**Only for electricity production (GWh)**	**Combined: For electricity +heat production (GWh)**	**TOTAL Gross production (GWh)**	**Methane (Gg)**
1990	0	0	0	0.00
1991	0	1.3	1.3	0.31
1992	0	0.5	0.5	0.12
1993	0	0.4	0.4	0.10
1994	0	6.3	6.3	1.51
1995	0	8.1	8.1	1.94
1996	0	7.6	7.6	1.82
1997	0	6.9	6.9	1.65
1998	0	5.7	5.7	1.37
1999	0.8	5.6	6.4	1.53
2000	0.2	4.7	4.9	1.18
2001	0	8.7	8.7	2.09
2002	0	11.3	11.3	2.71
2003	3.5	9.7	13.2	3.17
2004	6.3	12.2	18.5	4.44
2005	8.8	16.9	25.7	6.16
2006	16.2	28.5	44.7	10.72
2007	20.9	32.4	53.3	12.78

Source: TERNA, 2009

Table A.7.2 Time series of gross production of biogas from animal manure

[3] http://www.gse.it



Source: Cóndor *et al.* 2008[c]

Figure A7.1 Time series of gross production of biogas from animal manure

ANNEX 8: CRF TREND TABLES FOR GREENHOUSE GASES

This appendix shows a copy of Tables 10s1-10s5 from the Common Reporting Format 2007, submitted in 2009, in which time series of emission estimates for the following gases are reported:

- CO_2
- CH_4
- N_2O
- HFCs, PFCs, SF_6
- All gases and sources categories

Table A8.1 CO_2 emissions trends, CRF year 2007 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS | Inventory 2007
CO_2 | Submission 2009 v1.3
(Part 1 of 2) | ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**405,362.41**	**404,891.70**	**403,948.05**	**400,610.70**	**394,537.77**	**418,078.67**	**414,043.11**	**418,123.50**	**429,405.09**	**434,558.59**
A. Fuel Combustion (Sectoral Approach)	402,021.44	401,626.94	400,736.43	397,230.81	391,311.70	414,904.60	411,007.89	414,880.10	426,286.57	432,154.14
1. Energy Industries	134,092.13	128,409.96	128,308.81	122,891.90	125,531.51	137,973.44	133,477.62	135,233.81	145,716.93	141,641.43
2. Manufacturing Industries and Construction	88,937.35	85,985.66	84,303.50	84,766.43	85,764.73	87,954.97	85,740.04	88,806.50	83,048.96	86,753.59
3. Transport	101,268.76	103,786.58	108,033.89	109,632.51	109,241.76	111,445.87	112,671.21	114,360.34	118,143.79	119,688.84
4. Other Sectors	76,676.86	82,248.15	78,809.30	78,491.90	69,314.51	76,090.33	77,936.90	75,254.68	78,337.61	82,959.85
5. Other	1,046.34	1,196.59	1,280.93	1,448.07	1,459.19	1,439.99	1,182.11	1,224.77	1,039.27	1,110.43
B. Fugitive Emissions from Fuels	3,340.96	3,264.77	3,211.62	3,379.89	3,226.07	3,174.07	3,035.22	3,243.41	3,118.52	2,404.46
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2. Oil and Natural Gas	3,340.96	3,264.77	3,211.62	3,379.89	3,226.07	3,174.07	3,035.22	3,243.41	3,118.52	2,404.46
2. Industrial Processes	**27,190.32**	**26,792.42**	**27,320.39**	**24,448.95**	**23,570.49**	**25,414.97**	**23,016.25**	**23,102.11**	**23,151.29**	**23,309.33**
A. Mineral Products	21,099.66	21,051.69	21,863.21	19,407.30	18,913.76	20,768.08	19,075.78	19,320.39	19,575.62	20,383.81
B. Chemical Industry	2,198.88	2,101.70	2,064.25	1,473.98	1,207.27	1,229.99	962.27	1,034.92	1,040.80	958.46
C. Metal Production	3,891.78	3,639.03	3,392.93	3,567.68	3,449.47	3,416.89	2,978.20	2,746.80	2,534.86	1,967.06
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	1,598.05	1,584.54	1,586.70	1,535.12	1,463.04	1,423.99	1,378.75	1,378.90	1,328.15	1,330.94
4. Agriculture										

TABLE 10 EMISSION TRENDS

CO_2

(Part 1 of 2)

Inventory 2007
Submission 2009 v1.3
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										
5. Land Use, Land-Use Change and Forestry(2)	**-67,650.69**	**-85,599.15**	**-83,249.16**	**-65,542.83**	**-81,187.16**	**-85,816.00**	**-92,121.65**	**-80,990.35**	**-76,533.85**	**-81,380.38**
A. Forest Land	-53,548.90	-75,038.50	-71,040.61	-55,830.62	-72,326.81	-77,554.80	-80,119.83	-71,947.20	-69,434.80	-77,121.98
B. Cropland	-16,876.40	-11,902.38	-13,485.61	-11,856.88	-11,005.03	-10,405.88	-12,336.71	-11,187.82	-9,243.72	-6,403.07
C. Grassland	-385.17	-1,821.00	-1,888.60	NO	NO	NO	-2,870.31	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	3,159.78	3,162.74	3,165.66	2,144.67	2,144.67	2,144.67	3,205.21	2,144.67	2,144.67	2,144.67
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**536.90**	**562.22**	**562.44**	**521.18**	**524.10**	**483.02**	**472.13**	**507.76**	**504.42**	**393.47**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
B. Waste-water Handling										
C. Waste Incineration	536.90	562.22	562.44	521.18	524.10	483.02	472.13	507.76	504.42	393.47
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

TABLE 10 EMISSION TRENDS

CO_2

(Part 1 of 2)

Inventory 2007
Submission 2009 v1.3
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Total CO_2 emissions including net CO_2 from LULUCF	**367,036.98**	**348,231.74**	**350,168.42**	**361,573.12**	**338,908.25**	**359,584.64**	**346,788.60**	**362,121.93**	**377,855.10**	**378,211.96**
Total CO_2 emissions excluding net CO_2 from LULUCF	**434,687.67**	**433,830.89**	**433,417.57**	**427,115.95**	**420,095.41**	**445,400.65**	**438,910.24**	**443,112.28**	**454,388.95**	**459,592.34**
Memo Items:										
International Bunkers	**8,549.97**	**8,576.11**	**8,392.37**	**8,762.20**	**8,992.41**	**9,708.35**	**8,936.90**	**9,260.17**	**9,930.35**	**10,691.95**
Aviation	4,160.77	4,993.23	4,940.81	5,082.84	5,353.48	5,673.52	6,081.29	6,200.46	6,737.93	7,392.96
Marine	4,389.20	3,582.88	3,451.56	3,679.36	3,638.93	4,034.83	2,855.61	3,059.71	3,192.42	3,298.98
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass	5,243.86	5,962.78	6,286.98	6,209.51	7,215.92	7,076.58	7,063.49	7,702.89	7,572.41	8,897.95

Table A8.1 CO_2 emissions trends, CRF year 2007 (years 2000 – 2007)

TABLE 10 EMISSION TRENDS

CO_2

(Part 2 of 2)

Inventory 2007 Submission 2009 v1.3

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**437,143.25**	**442,063.26**	**444,221.30**	**458,632.83**	**460,802.52**	**462,022.92**	**457,573.05**	**446,746.87**	**10.21**
A. Fuel Combustion (Sectoral Approach)	434,558.53	439,623.18	441,960.77	455,798.73	458,650.37	459,910.88	455,384.37	444,571.12	10.58
1. Energy Industries	146,912.84	150,303.41	157,182.69	158,253.29	157,141.91	159,307.50	159,178.95	157,849.66	17.72
2. Manufacturing Industries and Construction	88,134.43	85,411.61	81,539.62	86,418.00	86,243.55	81,731.73	82,106.25	78,866.83	-11.32
3. Transport	120,109.01	122,181.08	124,142.62	125,105.60	127,090.52	125,830.22	127,151.03	127,212.06	25.62
4. Other Sectors	78,596.14	81,373.15	78,782.28	85,361.70	87,083.41	91,843.74	85,966.53	79,746.38	4.00
5. Other	806.10	353.94	313.56	660.15	1,090.98	1,197.69	981.61	896.19	-14.35
B. Fugitive Emissions from Fuels	2,584.72	2,440.08	2,260.52	2,834.10	2,152.15	2,112.03	2,188.68	2,175.75	-34.88
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	0.00
2. Oil and Natural Gas	2,584.72	2,440.08	2,260.52	2,834.10	2,152.15	2,112.03	2,188.68	2,175.75	-34.88
2. Industrial Processes	**24,096.81**	**24,858.46**	**24,817.98**	**25,855.77**	**26,653.41**	**26,457.34**	**26,559.08**	**26,924.41**	**-0.98**
A. Mineral Products	21,265.81	22,095.84	22,088.70	22,985.79	23,553.49	23,131.30	23,219.30	23,678.01	12.22
B. Chemical Industry	1,061.65	1,033.79	1,081.56	1,243.32	1,327.72	1,316.92	1,307.98	1,311.07	-40.38
C. Metal Production	1,769.35	1,728.83	1,647.72	1,626.67	1,772.19	2,009.12	2,031.80	1,935.33	-50.27
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	0.00
E. Production of Halocarbons and SF_6									
F. Consumption of Halocarbons and SF_6									
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
3. Solvent and Other Product Use	1,273.82	1,295.07	1,306.03	1,309.87	1,314.82	1,331.47	1,354.03	1,360.61	-14.86
4. Agriculture									
A. Enteric Fermentation									
B. Manure Management									

TABLE 10 EMISSION TRENDS

CO_2

(Part 2 of 2)

Inventory 2007
Submission
2009 v1.3

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
C. Rice Cultivation									
D. Agricultural Soils									
E. Prescribed Burning of Savannas									
F. Field Burning of Agricultural Residues									
G. Other									
5. Land Use, Land-Use Change and Forestry(2)	**-79,326.04**	**-92,671.78**	**-95,683.41**	**-126,869.62**	**-91,878.49**	**-95,374.01**	**-90,136.26**	**-71,126.53**	**5.14**
A. Forest Land	-70,452.09	-79,009.29	-85,423.00	-74,789.16	-80,933.35	-83,523.40	-84,194.42	-55,588.35	3.81
B. Cropland	-11,696.68	-10,955.83	-11,544.39	-11,084.57	-8,880.74	-10,154.68	-8,086.51	-10,959.93	-35.06
C. Grassland	-386.82	-5,910.99	-1,918.25	-44,160.58	-5,223.97	-4,849.13	NO	-7,759.75	1,914.64
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Settlements	3,209.54	3,204.33	3,202.23	3,164.68	3,159.56	3,153.20	2,144.67	3,181.49	0.69
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
6. Waste	**201.57**	**222.26**	**244.97**	**215.76**	**199.23**	**244.69**	**267.49**	**270.17**	**-49.68**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
B. Waste-water Handling									
C. Waste Incineration	201.57	222.26	244.97	215.76	199.23	244.69	267.49	270.17	-49.68
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**
Total CO_2 emissions including net CO_2 from LULUCF	**383,389.41**	**375,767.27**	**374,906.87**	**359,144.61**	**397,091.49**	**394,682.39**	**395,617.40**	**404,175.53**	**10.12**
Total CO_2 emissions excluding net CO_2 from LULUCF	**462,715.45**	**468,439.04**	**470,590.27**	**486,014.24**	**488,969.97**	**490,056.41**	**485,753.66**	**475,302.06**	**9.34**

TABLE 10 EMISSION TRENDS

CO_2

(Part 2 of 2)

Inventory 2007
Submission
2009 v1.3

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Memo Items:									
International Bunkers	**12,196.09**	**12,824.92**	**12,862.42**	**14,809.34**	**15,426.56**	**16,029.88**	**17,274.95**	**18,185.82**	**112.70**
Aviation	8,015.50	8,011.06	7,312.69	8,526.80	8,620.09	9,110.86	9,833.14	10,430.30	150.68
Marine	4,180.59	4,813.86	5,549.73	6,282.54	6,806.47	6,919.02	7,441.81	7,755.53	76.70
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	0.00
CO_2 Emissions from Biomass	9,362.29	10,318.00	9,940.73	11,990.42	14,397.94	14,048.31	14,993.25	17,156.24	227.17

Table A8.2 CH_4 emission trends, CRF year 2007 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

CH_4

(Part 1 of 2)

Inventory 2007
Submission 2009 v1.3
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	427.06	428.68	434.14	428.93	420.03	408.72	401.36	399.65	402.51	391.33
A. Fuel Combustion (Sectoral Approach)	73.73	77.29	80.34	80.65	80.78	81.01	78.93	78.94	77.62	75.86
1. Energy Industries	9.27	8.93	8.59	8.14	8.39	8.63	8.41	8.60	8.52	8.26
2. Manufacturing Industries and Construction	6.82	6.67	6.49	6.62	6.59	7.02	6.48	6.69	6.44	6.06
3. Transport	42.74	45.17	48.12	49.69	48.05	47.13	46.03	43.92	42.78	39.33
4. Other Sectors	14.73	16.33	16.95	15.98	17.54	18.01	17.82	19.56	19.72	22.04
5. Other	0.17	0.19	0.20	0.22	0.21	0.22	0.19	0.17	0.16	0.18
B. Fugitive Emissions from Fuels	353.33	351.38	353.80	348.28	339.25	327.71	322.44	320.72	324.89	315.47
1. Solid Fuels	5.79	5.33	5.31	3.90	3.39	3.07	2.88	2.85	2.63	2.52
2. Oil and Natural Gas	347.54	346.06	348.48	344.38	335.86	324.64	319.56	317.87	322.26	312.95
2. Industrial Processes	**5.16**	**4.95**	**4.83**	**4.87**	**5.07**	**5.36**	**2.99**	**3.23**	**3.10**	**3.05**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry	2.45	2.43	2.40	2.28	2.49	2.65	0.60	0.62	0.59	0.59
C. Metal Production	2.71	2.51	2.43	2.59	2.58	2.71	2.39	2.61	2.51	2.46
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use										
4. Agriculture	**819.80**	**829.39**	**807.99**	**805.18**	**807.07**	**820.15**	**821.62**	**823.14**	**816.91**	**823.22**
A. Enteric Fermentation	579.93	592.81	574.81	568.74	573.87	584.15	586.80	589.39	585.33	591.84

TABLE 10 EMISSION TRENDS

CH_4

(Part 1 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
B. Manure Management	164.86	164.82	158.67	158.32	153.34	156.48	156.90	156.26	157.94	159.48
C. Rice Cultivation	74.39	71.09	73.86	77.48	79.22	78.90	77.27	76.91	72.99	71.27
D. Agricultural Soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	0.62	0.68	0.66	0.64	0.64	0.62	0.64	0.57	0.64	0.62
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**6.80**	**1.74**	**2.88**	**7.18**	**2.90**	**1.30**	**1.06**	**3.53**	**4.11**	**2.02**
A. Forest Land	6.80	1.74	2.88	7.18	2.90	1.30	1.06	3.53	4.11	2.02
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**735.55**	**787.21**	**773.85**	**796.16**	**831.87**	**868.51**	**877.68**	**892.69**	**882.43**	**887.85**
A. Solid Waste Disposal on Land	633.22	673.99	660.75	678.80	714.56	750.21	760.43	771.56	762.22	764.72
B. Waste-water Handling	94.67	98.43	101.48	104.73	105.46	105.37	106.34	107.85	108.40	108.66
C. Waste Incineration	7.65	14.78	11.61	12.61	11.81	12.91	10.89	13.24	11.76	14.38
D. Other	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.05	0.06	0.08
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CH_4 emissions including CH_4 from LULUCF	**1,994.37**	**2,051.97**	**2,023.69**	**2,042.32**	**2,066.93**	**2,104.04**	**2,104.72**	**2,122.24**	**2,109.06**	**2,107.46**
Total CH_4 emissions excluding CH_4 from LULUCF	**1,987.57**	**2,050.23**	**2,020.82**	**2,035.14**	**2,064.03**	**2,102.74**	**2,103.66**	**2,118.71**	**2,104.95**	**2,105.44**

TABLE 10 EMISSION TRENDS

CH_4

(Part 1 of 2)

Inventory 2007
Submission 2009 v1.3
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Memo Items:										
International Bunkers	0.47	0.39	0.38	0.41	0.41	0.45	0.34	0.37	0.39	0.41
Aviation	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.08	0.09
Marine	0.42	0.34	0.33	0.35	0.35	0.39	0.27	0.29	0.31	0.32
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass										

Table A8.2 CH_4 emission trends, CRF year 2007 (years 2000 – 2007)

TABLE 10 EMISSION TRENDS

CH_4

(Part 2 of 2)

Inventory 2007
Submission
2009 v1.3

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	377.01	358.32	351.73	344.74	336.78	334.27	310.02	308.70	-27.71
A. Fuel Combustion (Sectoral Approach)	71.12	69.34	64.03	63.97	64.71	61.75	62.74	67.24	-8.80
1. Energy Industries	6.85	5.95	5.92	6.14	6.21	6.34	6.43	6.32	-31.80
2. Manufacturing Industries and Construction	5.72	5.78	5.68	5.82	5.74	6.27	6.22	6.51	-4.55
3. Transport	35.62	33.71	31.15	29.05	26.08	23.45	22.51	21.27	-50.24
4. Other Sectors	22.81	23.82	21.21	22.86	26.53	25.53	27.45	33.03	124.24
5. Other	0.13	0.09	0.07	0.10	0.14	0.16	0.13	0.11	-34.34
B. Fugitive Emissions from Fuels	305.89	288.98	287.70	280.77	272.07	272.52	247.28	241.46	-31.66
1. Solid Fuels	3.48	3.85	3.72	4.50	3.05	3.27	2.56	4.00	-30.93
2. Oil and Natural Gas	302.41	285.13	283.98	276.27	269.03	269.25	244.72	237.46	-31.67
2. Industrial Processes	**3.01**	**2.83**	**2.71**	**2.77**	**2.91**	**3.06**	**3.14**	**3.08**	**-40.25**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	0.00
B. Chemical Industry	0.40	0.33	0.33	0.31	0.33	0.33	0.32	0.34	-86.32
C. Metal Production	2.61	2.50	2.38	2.46	2.58	2.72	2.81	2.75	1.43
D. Other Production									
E. Production of Halocarbons and SF_6									
F. Consumption of Halocarbons and SF_6									
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
3. Solvent and Other Product Use									
4. Agriculture	**801.77**	**765.51**	**748.86**	**751.55**	**739.99**	**737.16**	**721.39**	**743.77**	**-9.27**
A. Enteric Fermentation	579.30	539.99	525.24	526.47	516.01	516.37	506.13	525.07	-9.46

TABLE 10 EMISSION TRENDS

CH_4

(Part 2 of 2)

Inventory 2007
Submission
2009 v1.3

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
B. Manure Management	156.10	159.18	155.39	154.84	150.26	150.06	144.34	145.57	-11.70
C. Rice Cultivation	65.80	65.80	67.63	69.69	73.05	70.11	70.32	72.52	-2.51
D. Agricultural Soils	NA	NA	NA	NA	NA	NA	NA	NA	0.00
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field Burning of Agricultural Residues	0.58	0.53	0.60	0.55	0.67	0.62	0.60	0.61	-1.82
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
5. Land Use, Land-Use Change and Forestry	**4.14**	**2.63**	**1.47**	**3.09**	**1.65**	**1.63**	**1.46**	**9.37**	**37.69**
A. Forest Land	4.14	2.63	1.47	3.09	1.65	1.63	1.46	9.37	37.69
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
6. Waste	**922.81**	**917.27**	**889.05**	**857.06**	**817.38**	**813.34**	**777.08**	**764.32**	**3.91**
A. Solid Waste Disposal on Land	801.16	793.42	765.11	733.44	690.02	687.46	649.42	635.27	0.32
B. Waste-water Handling	109.62	110.74	111.19	110.60	110.98	111.55	113.97	115.95	22.48
C. Waste Incineration	11.94	12.98	12.59	12.85	16.20	14.14	13.47	12.89	68.54
D. Other	0.10	0.12	0.16	0.18	0.18	0.20	0.21	0.22	1,961.04
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**
Total CH_4 emissions including CH_4 from LULUCF	**2,108.75**	**2,046.55**	**1,993.81**	**1,959.21**	**1,898.71**	**1,889.46**	**1,813.09**	**1,829.25**	**-8.28**
Total CH_4 emissions excluding CH_4 from LULUCF	**2,104.60**	**2,043.92**	**1,992.34**	**1,956.11**	**1,897.06**	**1,887.83**	**1,811.63**	**1,819.88**	**-8.44**

TABLE 10 EMISSION TRENDS

CH_4

(Part 2 of 2)

Inventory 2007
Submission
2009 v1.3

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Memo Items:									
International Bunkers	0.51	0.58	0.65	0.74	0.80	0.83	0.88	0.87	86.52
Aviation	0.11	0.12	0.12	0.14	0.15	0.17	0.17	0.13	176.28
Marine	0.40	0.46	0.53	0.60	0.65	0.66	0.71	0.74	76.55
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	0.00
CO_2 Emissions from Biomass									

Table A8.3 N_2O emission trends, CRF year 2007 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

N_2O

(Part 1 of 2)

Inventory 2007
Submission 2009 v1.3
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**14.89**	**14.88**	**15.19**	**15.33**	**15.89**	**17.09**	**17.47**	**17.77**	**17.86**	**18.15**
A. Fuel Combustion (Sectoral Approach)	14.88	14.88	15.19	15.33	15.88	17.09	17.47	17.76	17.86	18.14
1. Energy Industries	1.63	1.55	1.51	1.44	1.46	1.64	1.59	1.59	1.61	1.52
2. Manufacturing Industries and Construction	4.93	4.89	4.90	4.51	4.47	4.52	4.42	4.47	4.49	4.51
3. Transport	3.58	3.77	4.00	4.32	5.03	5.83	6.35	6.61	6.60	6.84
4. Other Sectors	4.52	4.44	4.53	4.78	4.66	4.88	4.94	4.89	4.99	5.13
5. Other	0.23	0.24	0.24	0.28	0.25	0.21	0.18	0.21	0.17	0.14
B. Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2. Oil and Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Industrial Processes	**21.54**	**22.81**	**21.11**	**21.65**	**20.36**	**23.35**	**22.66**	**22.78**	**23.06**	**23.56**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry	21.54	22.81	21.11	21.65	20.36	23.35	22.66	22.78	23.06	23.56
C. Metal Production	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										

TABLE 10 EMISSION TRENDS

N_2O

(Part 1 of 2)

Inventory 2007
Submission 2009 v1.3
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	2.57	2.42	2.41	2.45	2.41	2.44	2.91	2.91	3.35	3.28
4. Agriculture	**75.36**	**77.27**	**77.08**	**78.24**	**76.43**	**74.60**	**73.69**	**76.98**	**75.04**	**75.83**
A. Enteric Fermentation										
B. Manure Management	12.65	12.63	12.09	11.98	11.93	12.20	12.34	12.44	12.70	12.89
C. Rice Cultivation										
D. Agricultural Soils	62.69	64.63	64.97	66.25	64.48	62.39	61.34	64.53	62.33	62.93
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**0.05**	**0.01**	**0.02**	**0.36**	**0.81**	**0.64**	**0.01**	**0.18**	**1.29**	**1.80**
A. Forest Land	0.05	0.01	0.02	0.05	0.02	0.01	0.01	0.02	0.03	0.01
B. Cropland	NO	NO	NO	0.31	0.79	0.63	NO	0.16	1.26	1.79
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**6.30**	**6.57**	**6.41**	**6.28**	**6.29**	**6.27**	**6.36**	**6.43**	**6.51**	**6.74**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	6.01	6.08	6.01	5.86	5.89	5.85	6.01	6.00	6.12	6.28
C. Waste Incineration	0.28	0.49	0.40	0.42	0.40	0.42	0.36	0.43	0.39	0.45
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 10 EMISSION TRENDS

N_2O

(Part 1 of 2)

Inventory 2007
Submission 2009 v1.3
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total N_2O emissions including N_2O from LULUCF	**120.69**	**123.97**	**122.22**	**124.31**	**122.18**	**124.40**	**123.10**	**127.05**	**127.11**	**129.36**
Total N_2O emissions excluding N_2O from LULUCF	**120.65**	**123.96**	**122.20**	**123.95**	**121.37**	**123.76**	**123.09**	**126.87**	**125.82**	**127.55**
Memo Items:										
International Bunkers	**0.23**	**0.21**	**0.22**	**0.24**	**0.24**	**0.26**	**0.25**	**0.27**	**0.29**	**0.31**
Aviation	0.12	0.12	0.13	0.14	0.15	0.16	0.18	0.19	0.21	0.23
Marine	0.11	0.09	0.09	0.09	0.09	0.10	0.07	0.08	0.08	0.08
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass										

Table A8.3 N_2O emission trends, CRF year 2007 (years 2000 – 2007)

TABLE 10 EMISSION TRENDS

N_2O

(Part 2 of 2)

Inventory 2007
Submission 2009 v1.3
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**18.26**	**18.39**	**18.25**	**18.55**	**18.97**	**17.62**	**17.75**	**17.56**	**17.95**
A. Fuel Combustion (Sectoral Approach)	18.26	18.39	18.24	18.55	18.97	17.62	17.75	17.55	17.95
1. Energy Industries	1.60	1.69	1.77	1.80	1.88	1.89	1.84	1.82	12.09
2. Manufacturing Industries and Construction	4.66	4.74	4.77	4.93	5.03	5.02	5.05	4.98	0.97
3. Transport	6.75	6.62	6.53	6.28	6.19	4.78	5.02	4.94	37.84
4. Other Sectors	5.11	5.30	5.15	5.41	5.59	5.64	5.60	5.59	23.69
5. Other	0.14	0.03	0.02	0.13	0.28	0.29	0.24	0.23	0.71
B. Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.01
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	0.00
2. Oil and Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.01
2. Industrial Processes	**25.54**	**26.55**	**25.49**	**24.38**	**27.24**	**25.03**	**8.54**	**6.10**	**-71.68**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	0.00
B. Chemical Industry	25.54	26.55	25.49	24.38	27.24	25.03	8.54	6.10	-71.68
C. Metal Production	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA	0.00
D. Other Production									
E. Production of Halocarbons and SF_6									
F. Consumption of Halocarbons and SF_6									
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00

TABLE 10 EMISSION TRENDS

N_2O

(Part 2 of 2)

Inventory 2007
Submission 2009 v1.3
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
3. Solvent and Other Product Use	3.26	2.95	2.95	2.76	2.67	2.61	2.56	2.49	-3.04
4. Agriculture	**74.52**	**73.80**	**72.66**	**72.00**	**72.19**	**70.20**	**69.28**	**69.65**	**-7.57**
A. Enteric Fermentation									
B. Manure Management	12.46	12.90	12.41	12.31	12.03	12.02	11.67	12.25	-3.18
C. Rice Cultivation									
D. Agricultural Soils	62.06	60.89	60.24	59.68	60.14	58.17	57.60	57.39	-8.46
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field Burning of Agricultural Residues	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.65
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
5. Land Use, Land-Use Change and Forestry	**0.03**	**0.02**	**0.01**	**0.02**	**0.01**	**0.01**	**0.97**	**0.06**	**37.69**
A. Forest Land	0.03	0.02	0.01	0.02	0.01	0.01	0.01	0.06	37.69
B. Cropland	NO	NO	NO	NO	NO	NO	0.96	NO	0.00
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
6. Waste	**6.71**	**6.65**	**6.64**	**6.67**	**6.81**	**6.80**	**6.84**	**6.90**	**9.54**
A. Solid Waste Disposal on Land									
B. Waste-water Handling	6.35	6.25	6.26	6.29	6.34	6.38	6.44	6.51	8.29
C. Waste Incineration	0.36	0.39	0.38	0.38	0.47	0.42	0.40	0.39	35.96
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**

TABLE 10 EMISSION TRENDS

Inventory 2007
Submission 2009 v1.3

N_2O

(Part 2 of 2)

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Total N_2O emissions including N_2O from LULUCF	**128.33**	**128.37**	**125.99**	**124.38**	**127.89**	**122.27**	**105.94**	**102.76**	**-14.86**
Total N_2O emissions excluding N_2O from LULUCF	**128.30**	**128.35**	**125.98**	**124.36**	**127.88**	**122.25**	**104.97**	**102.70**	**-14.88**
Memo Items:									
International Bunkers	**0.35**	**0.36**	**0.36**	**0.37**	**0.38**	**0.39**	**0.41**	**0.44**	**90.94**
Aviation	0.25	0.24	0.22	0.21	0.21	0.21	0.22	0.24	104.38
Marine	0.11	0.12	0.14	0.16	0.17	0.18	0.19	0.20	76.55
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	0.00
CO_2 Emissions from Biomass									

Table A8.4 HFC, PFC and SF_6 emission trends, CRF year 2007 (1990 – 1999)

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 1 of 2)

Inventory 2007
Submission
2009 v1.3
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs[(3)] - (Gg CO_2 equivalent)	**351.00**	**355.43**	**358.78**	**355.42**	**481.90**	**671.29**	**450.33**	**755.74**	**1,181.72**	**1,523.65**
HFC-23	0.03	0.03	0.03	0.03	0.03	0.03	0.00	0.00	0.00	0.00
HFC-32	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00	0.02	0.05
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-125	NA,NO	0.00	0.00	0.00	0.00	0.01	0.01	0.04	0.05	0.08
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-134a	NA,NO	0.00	0.00	0.00	0.10	0.20	0.29	0.43	0.68	0.85
HFC-152a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.01	0.01	0.02	0.03	0.03
HFC-227ea	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00	0.00	0.01
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed HFCs[(4)] - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of PFCs[(3)] - (Gg CO_2 equivalent)	**1,807.65**	**1,451.54**	**849.56**	**707.47**	**476.84**	**490.80**	**243.39**	**252.08**	**270.43**	**258.00**
CF_4	0.21	0.17	0.10	0.08	0.06	0.06	0.03	0.03	0.03	0.03
C_2F_6	0.05	0.04	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
C_3F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
c-C_4F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO

TABLE 10 EMISSION TRENDS

Inventory 2007
Submission
2009 v1.3

HFCs, PFCs and SF_6

(Part 1 of 2)

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**Base year (1990)**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
	(Gg)	**(Gg)**	**(Gg)**	**(Gg)**	**(Gg)**	**(Gg)**	**(Gg)**	**(Gg)**	**(Gg)**	**(Gg)**
Unspecified mix of listed PFCs (4) - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of SF6 (3) - (Gg CO_2 equivalent)	**332.92**	**356.39**	**358.26**	**370.40**	**415.66**	**601.45**	**682.56**	**728.64**	**604.81**	**404.51**
SF_6	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.02

Table A8.4 HFC, PFC and SF_6 emission trends, CRF year 2007 (2000 – 2007)

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 2 of 2)

Inventory 2007
Submission
2009 v1.3

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Emissions of HFCs[(3)] - (Gg CO_2 equivalent)	**1,985.67**	**2,549.75**	**3,099.90**	**3,795.82**	**4,514.91**	**5,267.03**	**5,956.20**	**6,700.69**	**1,809.03**
HFC-23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-92.53
HFC-32	0.08	0.12	0.17	0.23	0.29	0.36	0.43	0.49	100.00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-125	0.13	0.20	0.28	0.38	0.48	0.59	0.69	0.79	100.00
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-134a	1.01	1.19	1.31	1.50	1.67	1.83	1.96	2.15	100.00
HFC-152a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-143a	0.06	0.08	0.11	0.15	0.19	0.24	0.28	0.32	100.00
HFC-227ea	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	100.00
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Unspecified mix of listed HFCs[(4)] - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Emissions of PFCs[(3)] - (Gg CO_2 equivalent)	**345.85**	**451.24**	**423.74**	**497.63**	**347.89**	**352.62**	**282.30**	**287.78**	**-84.08**
CF_4	0.04	0.05	0.04	0.05	0.04	0.04	0.03	0.04	-82.52
C_2F_6	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.00	-90.34
C_3F_8	NA,NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
c-C_4F_8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Unspecified mix of listed PFCs[(4)] - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 2 of 2)

Inventory 2007
Submission
2009 v1.3

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Emissions of SF6[3] - (Gg CO_2 equivalent)	**493.43**	**795.34**	**739.72**	**467.56**	**502.14**	**465.39**	**405.87**	**427.55**	**28.42**
SF_6	0.02	0.03	0.03	0.02	0.02	0.02	0.02	0.02	28.42

Table A8.5 Total emission trends, CRF year 2007 (years 1990 – 1999)
TABLE 10 EMISSION TRENDS

SUMMARY

(Part 1 of 2)

Inventory 2007 Submission 2009 v1.3 ITALY

GREENHOUSE GAS EMISSIONS	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
CO_2 emissions including net CO_2 from LULUCF	367,036.98	348,231.74	350,168.42	361,573.12	338,908.25	359,584.64	346,788.60	362,121.93	377,855.10	378,211.96
CO_2 emissions excluding net CO_2 from LULUCF	434,687.67	433,830.89	433,417.57	427,115.95	420,095.41	445,400.65	438,910.24	443,112.28	454,388.95	459,592.34
CH_4 emissions including CH_4 from LULUCF	41,881.77	43,091.33	42,497.57	42,888.68	43,405.52	44,184.91	44,199.08	44,567.03	44,290.23	44,256.72
CH_4 emissions excluding CH_4 from LULUCF	41,738.88	43,054.80	42,437.17	42,737.86	43,344.67	44,157.53	44,176.91	44,492.96	44,204.00	44,214.27
N_2O emissions including N_2O from LULUCF	37,414.74	38,430.48	37,887.77	38,535.38	37,875.03	38,563.14	38,160.65	39,386.46	39,405.46	40,101.12
N_2O emissions excluding N_2O from LULUCF	37,400.24	38,426.77	37,881.64	38,423.30	37,624.23	38,364.14	38,158.40	39,329.54	39,005.59	39,541.79
HFCs	351.00	355.43	358.78	355.42	481.90	671.29	450.33	755.74	1,181.72	1,523.65
PFCs	1,807.65	1,451.54	849.56	707.47	476.84	490.80	243.39	252.08	270.43	258.00
SF_6	332.92	356.39	358.26	370.40	415.66	601.45	682.56	728.64	604.81	404.51
Total (including LULUCF)	**448,825.07**	**431,916.91**	**432,120.36**	**444,430.47**	**421,563.19**	**444,096.25**	**430,524.60**	**447,811.87**	**463,607.74**	**464,755.97**
Total (excluding LULUCF)	**516,318.37**	**517,475.83**	**515,302.99**	**509,710.39**	**502,438.71**	**529,685.87**	**522,621.82**	**528,671.23**	**539,655.49**	**545,534.56**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
1. Energy	418,945.37	418,507.58	417,773.58	414,370.53	408,283.14	431,961.27	427,888.89	432,024.86	443,394.73	448,402.46
2. Industrial Processes	36,466.66	36,130.61	35,532.23	32,696.69	31,362.64	34,530.35	31,480.33	31,969.10	32,421.90	32,862.34
3. Solvent and Other Product Use	2,394.46	2,334.44	2,334.44	2,293.12	2,210.30	2,179.77	2,279.45	2,279.79	2,367.00	2,348.44
4. Agriculture	40,576.25	41,371.34	40,862.45	41,162.90	40,640.82	40,348.92	40,096.87	41,150.14	40,418.37	40,795.03
5. Land Use, Land-Use Change and	-67,493.30	-85,558.91	-83,182.63	-65,279.92	-80,875.52	-85,589.62	-92,097.22	-80,859.36	-76,047.75	-80,778.59

Forestry[5]										
6. Waste	17,935.63	19,131.86	18,800.28	19,187.14	19,941.81	20,665.57	20,876.28	21,247.33	21,053.50	21,126.28
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)[5]	**448,825.07**	**431,916.91**	**432,120.36**	**444,430.47**	**421,563.19**	**444,096.25**	**430,524.60**	**447,811.87**	**463,607.74**	**464,755.97**

Table A8.5 Total emission trends, CRF year 2007 (years 2000 – 2007)

TABLE 10 EMISSION TRENDS

SUMMARY

(Part 2 of 2)

Inventory 2007
Submission
2009 v1.3
ITALY

GREENHOUSE GAS EMISSIONS	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**Change from base to latest reported year**
	CO_2 equivalent (Gg)	**CO_2 equivalent (Gg)**	**CO_2 equivalent (Gg)**	**CO_2 equivalent (Gg)**	**CO_2 equivalent (Gg)**	**CO_2 equivalent (Gg)**	**CO_2 equivalent (Gg)**	**CO_2 equivalent (Gg)**	**(%)**
CO_2 emissions including net CO_2 from LULUCF	383,389.41	375,767.27	374,906.87	359,144.61	397,091.49	394,682.39	395,617.40	404,175.53	10.12
CO_2 emissions excluding net CO_2 from LULUCF	462,715.45	468,439.04	470,590.27	486,014.24	488,969.97	490,056.41	485,753.66	475,302.06	9.34
CH_4 emissions including CH_4 from LULUCF	44,283.69	42,977.57	41,870.01	41,143.38	39,872.85	39,678.68	38,074.79	38,414.21	-8.28
CH_4 emissions excluding CH_4 from LULUCF	44,196.69	42,922.38	41,839.08	41,078.41	39,838.23	39,644.52	38,044.18	38,217.46	-8.44
N_2O emissions including N_2O from LULUCF	39,781.10	39,793.53	39,056.12	38,558.95	39,645.33	37,902.46	32,841.82	31,855.78	-14.86
N_2O emissions excluding N_2O from LULUCF	39,772.27	39,787.93	39,052.98	38,552.36	39,641.82	37,898.99	32,540.21	31,835.81	-14.88
HFCs	1,985.67	2,549.75	3,099.90	3,795.82	4,514.91	5,267.03	5,956.20	6,700.69	1,809.03
PFCs	345.85	451.24	423.74	497.63	347.89	352.62	282.30	287.78	-84.08
SF_6	493.43	795.34	739.72	467.56	502.14	465.39	405.87	427.55	28.42
Total (including LULUCF)	**470,279.15**	**462,334.69**	**460,096.36**	**443,607.96**	**481,974.60**	**478,348.57**	**473,178.39**	**481,861.53**	**7.36**
Total (excluding LULUCF)	**549,509.36**	**554,945.68**	**555,745.69**	**570,406.02**	**573,814.96**	**573,684.95**	**562,982.42**	**552,771.35**	**7.06**
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**Change from base to latest reported year**
	CO_2 equivalent (Gg)	**CO_2 equivalent (Gg)**	**CO_2 equivalent (Gg)**	**CO_2 equivalent (Gg)**	**CO_2 equivalent (Gg)**	**CO_2 equivalent (Gg)**	**CO_2 equivalent (Gg)**	**CO_2 equivalent (Gg)**	**(%)**
1. Energy	450,722.44	455,289.63	457,263.97	471,622.91	473,756.12	474,505.53	469,585.98	458,672.79	9.48
2. Industrial Processes	34,903.34	36,946.22	37,039.91	38,231.91	40,522.46	40,366.88	35,915.85	36,295.95	-0.47

3. Solvent and Other Product Use	2,284.53	2,210.51	2,219.20	2,166.67	2,143.88	2,139.11	2,146.55	2,132.81	-10.93
4. Agriculture	39,939.85	38,953.95	38,250.04	38,101.53	37,917.46	37,241.73	36,627.42	37,210.50	-8.29
5. Land Use, Land-Use Change and Forestry(5)	-79,230.21	-92,610.99	-95,649.34	-126,798.06	-91,840.36	-95,336.38	-89,804.03	-70,909.82	5.06
6. Waste	21,659.21	21,545.38	20,972.57	20,283.00	19,475.03	19,431.70	18,706.62	18,459.31	2.92
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total (including LULUCF)(5)	**470,279.15**	**462,334.69**	**460,096.36**	**443,607.96**	**481,974.60**	**478,348.57**	**473,178.39**	**481,861.53**	**7.36**

ANNEX 9: METHODOLOGIES, DATA SOURCES AND EMISSION FACTORS

This appendix shows a copy of Tables I-1 - I-4 on methodologies, data sources and emission factors used for the Italian inventory communicated to the European Commission under the implementing provisions for the compilation of The European Community Inventory.

Table A9.1 Methods, activity data and emission factors used for the Italian Inventory

ANNEX I

Table for methodologies, data sources and emission factors used by Member States for EC key sources for the purpose of Article 4(1)(b). Information on methods used could be the tier method, the model or a country-specific approach. Activity data could be from national statistics or plant-specific. Emission factors could be the IPCC default emission factors as outlined in the revised 1996 IPCC guidelines for national greenhouse gas inventories and in the IPCC good practice guidance, country-specific emission factors, plant-specific emission factors or CORINAIR emission factors developed under the 1979 Convention on Long-Range Transboundary Air Pollution.

Table I -1: Community summary report for methods, activity data and emission factors used (Energy)

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)
1. Energy												
A. Fuel Combustion												
1. Energy Industries												
a. Public Electricity and Heat Production												
Liquid fuels	Yes	T3	NS, PS	CS	No				No			
Solid fuels	Yes	T3	NS, PS	CS	No				Yes	T3	NS, PS	C, D
Gaseous fuels	Yes	T3	NS, PS	CS	No				No			
Other fuels	Yes	T3	NS, PS	CS	No				No			
b. Petroleum Refining												
Liquid fuels	Yes	T3	NS, PS	CS	No				No			
Solid fuels	Yes	NA	NA	NA	No				No			
Gaseous fuels	Yes	T3	NS, PS	CS	No				No			
c. Manufacture of Solid Fuels and Other Energy Industries												
Solid fuels	Yes	T3	NS	CS	No				No			
Gaseous fuels	Yes	T3	NS	CS	No				No			
2. Manufacturing Industries and												

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2				CH_4				N_2O			
	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]
Construction												
a. Iron and Steel												
Liquid fuels	Yes	T2	NS	CS	No				No			
Solid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
b. Non-Ferrous Metals												
Solid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	No	T2	NS	CS	No				No			
c. Chemicals												
Liquid fuels	Yes	T2	NS	CS	No				No			
Solid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
Other fuels	Yes	T2	NS	CS	No				No			
d. Pulp, Paper and Print												
Liquid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
e. Food Processing, Beverages and Tobacco												
Liquid fuels	Yes	T2	NS	CS	No				No			
Solid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
f. Other *(as specified in table 1.A(a)s2)*												
Liquid fuels	Yes	T2	NS	CS	No				No			
Solid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
Other fuels	Yes	T2	NS	CS	No				No			
3. Transport												
a. Civil Aviation												

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)
Jet kerosene	Yes	T1, T2	NS	CS	No				No			
b. Road Transportation												
Gasoline	Yes	COPERT IV	NS, AS	CS	Yes	COPERT IV	NS, AS	CS	Yes	COPERT IV	NS, AS	CS
Diesel oil	Yes	COPERT IV	NS, AS	CS	No				Yes	COPERT IV	NS, AS	CS
LPG	Yes	COPERT IV	NS, AS	CS	No				No			
Other fuels	No				No				No			
c. Railways												
Liquid fuels	Yes	D	NS	CS	No				No			
d. Navigation												
Gas/Diesel oil	Yes	T1, T2	NS	CS	No				No			
Residual Oil	Yes	T1, T2	NS	CS	No				No			
e. Other Transportation *(as specified in table 1.A(a)s3)*												
Gaseous Fuels	Yes	T2	NS	CS	No				No			
4. Other Sectors												
a. Commercial/Institutional												
Liquid fuels	Yes	T2	NS	CS	No				No			
Solid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
b. Residential												
Liquid fuels	Yes	T2	NS	CS	No				No			
Solid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
c. Agriculture/Forestry /Fisheries												

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]
Liquid fuels	Yes	T2	NS	CS	No				No			
Solid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
5. Other												
a. Stationary												
Solid fuels	Yes	NA	NA	NA	No				No			
b. Mobile												
Liquid fuels	Yes	T2	NS	CS	No				No			
B. Fugitive Emissions from Fuels												
1. Solid Fuels												
a. Coal Mining	No				Yes	T1	NS	D, CS	No			
b. Solid Fuel Transformation	No				No				No			
c. Other *(as specified in table 1.B.1)*	No				No				No			
2. Oil and Natural Gas												
a. Oil	Yes	T1, T2	NS	D, CS	No				No			
b. Natural Gas	No				Yes	T1, T2	NS	D, CS	No			
c. Venting and Flaring	Yes	T2	NS	CS	No				No			
d. Other *(as specified in table 1.B.2)*	No				No				No			

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

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2				CH_4				N_2O				HFCs				PFCs				SF_6			
	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]
2. Industrial Processes																								
A. Mineral Products																								
1. Cement Production	Yes	T2	NS	CS, PS	No				No															
2. Lime Production	Yes	D	NS	CS,PS	No				No															
3. Limestone and Dolomite Use	Yes	D	NS	D, CS,PS	No				No															
4. Soda Ash Production and Use	No				No				No															
5. Asphalt Roofing	No				No				No															
6. Road Paving with Asphalt	No				No				No															
7. Other *(as specified in table 2(I)A-G)*	No				No				No															
B. Chemical Industry																								
1. Ammonia Production	Yes	D	NS,PS	C, PS	No				No				No				No				No			
2. Nitric Acid Production	No				No				Yes	D	PS	D, PS	No				No				No			
3. Adipic Acid Production	No				No				Yes	D	PS	PS	No				No				No			
4. Carbide Production	No				No				No				No				No				No			
5. Other *(as specified in table 2(I)A-G)*	Yes	D	PS	PS	No				Yes	D	NS, AS	C, CS, PS	No				No				No			
C. Metal Production																								
1. Iron and Steel Production	Yes	D	NS	C, CS, PS	No				No								No				No			
2. Ferroalloys Production	No				No				No								No				No			
3. Aluminium Production	No				No				No								Yes	T1, T2	PS	PS	No			
4. SF_6 Used in Aluminium and Magnesium Foundries	No				No				No								No				No			

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2				CH_4				N_2O				HFCs				PFCs				SF_6			
	Key source [(1)]	Method applied [(2)]	Activity data [(3)]	Emission factor [(4)]	Key source [(1)]	Method applied [(2)]	Activity data [(3)]	Emission factor [(4)]	Key source [(1)]	Method applied [(2)]	Activity data [(3)]	Emission factor [(4)]	Key source [(1)]	Method applied [(2)]	Activity data [(3)]	Emission factor [(4)]	Key source [(1)]	Method applied [(2)]	Activity data [(3)]	Emission factor [(4)]	Key source [(1)]	Method applied [(2)]	Activity data [(3)]	Emission factor [(4)]
5. Other *(as specified in table 2(I)A-G)*	No				No				No								No				No			
D. Other Production																								
1. Pulp and Paper	No																							
2. Food and Drink	No																							
E. Production of Halocarbons and SF_6																								
1. By-product Emissions													Yes	CS	PS	PS	No				Yes	CS	PS	PS
2. Fugitive Emissions													No				No				No			
3. Other *(as specified in table 2(II)*													Yes	NA	NA	NA	No				No			
F. Consumption of Halocarbons and SF_6																								
1. Refrigeration and Air Conditioning Equipment													Yes	T2	AS	CS	No				No			
2. Foam Blowing													Yes	T2	AS	D	No				No			
3. Fire Extinguishers													No				No				No			
4. Aerosols/ Metered Dose Inhalers													Yes	T2	AS	CS	No				No			
5. Solvents													No				No				No			
6. Other applications using ODS substitutes													No				No				No			
7. Semiconductor Manufacture													No				No				No			
8. Electrical Equipment													No				No				No			
9. Other *(as specified in table 2(II)*													No				No				Yes	NA	NA	NA
G. Other																								

Table I -3: Community summary report for methods, activity data and emission factors used (Solvent and Other Product Use, Agriculture)

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)
3. Solvent and Other Product Use												
A. Paint Application	No								No			
B. Degreasing and Dry Cleaning	No								No			
C. Chemical Products, Manufacture and Processing	No								No			
D. Other	No								No			
4. Agriculture												
A. Enteric Fermentation												
1. Cattle					Yes	T2	NS	CS				
2. Buffalo					No							
3. Sheep					Yes	T1	NS	D				
4. Other					No							
B. Manure Management												
1. Cattle					Yes	T2	NS	CS	No			
2. Buffalo					No				No			
3. Sheep					No				No			
4. Other					No				No			
8. Swine					Yes	T2	NS	CS	No			
13. Solid Storage and Dry Lot					No				Yes	T2	NS	D, CS
C. Rice Cultivation												
D. Agricultural Soils												
1. Direct Soil Emissions	No				No				Yes	D	NS	D, CS
2. Pasture, range and paddock manure	No				No				Yes	D	NS	D, CS
3. Indirect Emissions	No				No				Yes	D	NS	D, CS
4. Other *(as specified in table 4.D)*	No				No				No			
E. Prescribed Burning of Savannas					No				No			
F. Field Burning of Agricultural Residues					No				No			
G. Other					No				No			

Table I -4: Community summary report for methods, activity data and emission factors used (Land-Use Change and Forestry, Waste, Other)

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)
5. Land-Use, Land-Use Change and Forestry												
A. Forest Land												
1. Forest Land remaining Forest Lands	Yes	T1, T2	NS	D, CS	No				No			
2. Land converted to Forest Lands	Yes	T1, T2	NS	D, CS	No				No			
B. Cropland												
1. Cropland remaining Cropland	Yes	T1	NS	D, CS	No				No			
2. Land converted to Cropland	Yes	T1	NS	D, CS	No				No			
C. Grassland												
1. Grassland remaining Grassland	Yes	T1	NS	D, CS	No				No			
2. Land converted to Grassland	Yes	T1	NS	D, CS	No				No			
D. Wetlands												
1. Wetlands remaining Wetlands	No				No				No			
2. Land converted to Wetlands	No				No				No			
E. Settlements												
1. Settlements remaining Settlements	No				No				No			
2. Land converted to Settlements	Yes	T1	NS	D, CS	No				No			
F. Other Land												
1. Other Land remaining Other Land					No				No			
2. Land converted to Other Land	No				No				No			
G. Other (please specify)												
Harvested Wood Products	No				No				No			
6. Waste												
A. Solid Waste Disposal on Land												
1. Managed Waste Disposal on Land	No				Yes	T2	NS	CS				
2. Unmanaged Waste Disposal Sites	No				Yes	T2	NS	CS				
3. Other *(as specified in table 6.A)*	No				No							
B. Wastewater Handling												

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]
1. Industrial Wastewater					No				No			
2. Domestic and Commercial Wastewater					Yes	D	NS	D	Yes	D	NS	D
3. Other *(as specified in table 6.B)*					No				No			
C. Waste Incineration												
D. Other	No				No				No			
7. Other (as specified in Summary 1.A)												
Memo Items: [8]												
International Bunkers												
Aviation	No				No				No			
Marine	No				No				No			
CO_2 Emissions from Biomass	No				No				No			

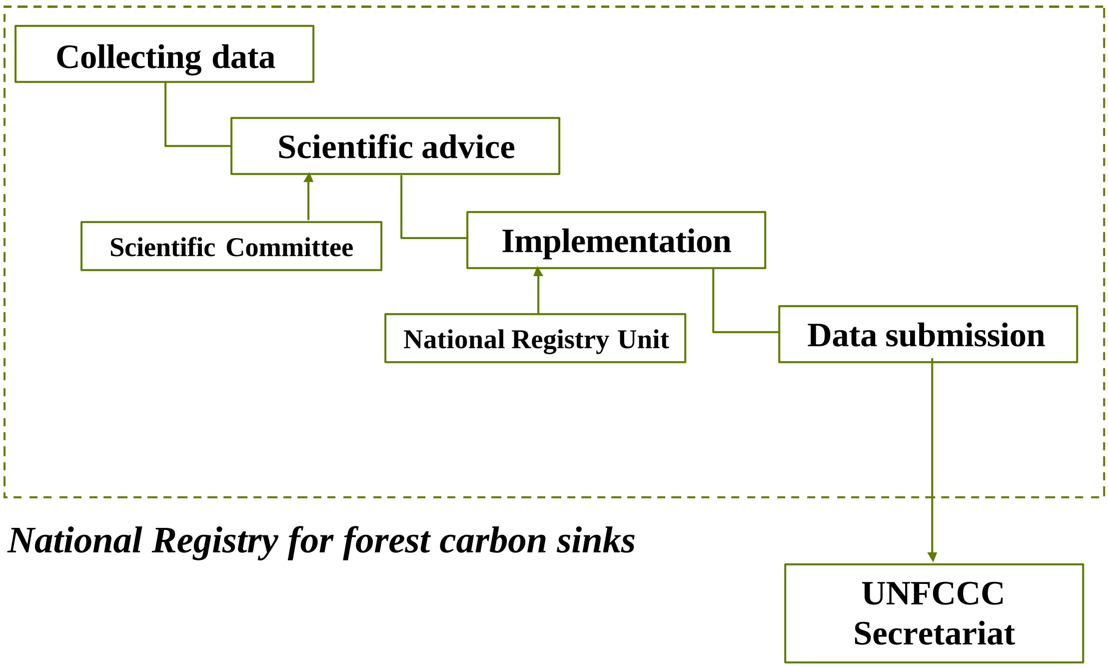
Legend for tables I -1 to I -4

[1] Key sources of the Community. To be completed by Commission/EEA with results from key category analysis from previous inventory submission.			
[2] Use the following notation keys to specify the method applied:			
D (IPCC default),	**T1a, T1b, T1c** (IPCC Tier 1a, Tier 1b and Tier 1c, respectively),	**C** (CORINAIR),	**COPERT X**(Copert Model X = Version)
RA (Reference Approach),	**T2** (IPCC Tier 2),	**CS** (Country Specific).	
T1 (IPCC Tier 1),	**T3** (IPCC Tier 3),	**M** (Model)	
If using more than one method within one source category, enumerate the relevant methods. Explanations regarding country-specific methods or any modifications to the default IPCC methods, as well as information regarding the use of			
Different methods per source category where more than one method is indicated, should be provided in the documentation box.			
[3] Use the following notation keys to specify the sources of activity data used :			
NS (national statistics),	**IS** (International statistics),	**AS** (associations, business organizations)	
RS (regional statistics),	**PS** (Plant Specific data).	**Q** (specific questionnaires, surveys)	
If keys above are not appropriate for national circumstances, use additional keys and explain those in the documentation box.			
Where a mix of AD sources has been used, use different notations in one and the same cells with further explanations in the documentation box.			
[4] Use the following notation keys to specify the emission factor used:			

D (IPCC default),				**CS** (Country Specific),						
C (CORINAIR),				**PS** (Plant Specific).						
Where a mix of emission factors has been used, use different notations in one and the same cells with further explanations in the documentation box.										
Documentation box:										
* The full information on methodological issues, such as methods, activity data and emission factors used, can be found in the relevant sector sections of chapter 5 of the NIR. If any additional information is needed										
To understand the content of this table, use this documentation box to provide references to the relevant section of the NIR where further details can be found.										
* Where a mix of methods/ emission factors has been used within one source category, use this documentation box to specify those methods/emission factors for the various sub-sources where they have been applied										
(see also footnotes 2 to 4 to this table).										

ANNEX 10: THE NATIONAL REGISTRY FOR FOREST CARBON SINKS

The so-called "National Registry for forest carbon sinks" is part of the Italian National System; it is the instrument to estimate, in accordance with the COP/MOP decisions, the IPCC Good Practice Guidance on LULUCF and every relevant IPCC guidelines, the greenhouse gases emissions by sources and removals by sinks in *forest land* and related land-use changes and to account for the net removals in order to allow the Italian Registry to issue the relevant amount of RMUs.



Italy has approved the National Plan for greenhouse gases reduction (PNR_{GHG}) with the CIPE (*Interministerial Economic Planning Committee*) decision n. 123, of 19 December 2002. The PNR_{GHG} sets policies and measures to act in order to achieve the national target of the Kyoto Protocol; Italy has committed to 6.5% reduction below 1990 greenhouse gases emission levels. The article 7.4 of CIPE decision (123/2002) states that Ministry for the Environment, Land and Sea (MATTM), in agreement with Ministry of Agriculture, Food and Forest Policies (MIPAAF) has to constitute, the National Registry for the forest carbon sinks to account for the net removals in the period 2008 – 2012, from *Afforestation*, *Reforestation* and *Deforestation* activities (art. 3.3 KP) and from elected activities under article 3.4 of Kyoto Protocol (*Forest management*).

Italy, in the "*Report on the determination of Italy's assigned amount under Article 7, paragraph 4, of the Kyoto Protocol*" (Decision 13/CMP.1), has reported:

- the election of *Forest Management* as an activity under Article 3.4 of Kyoto Protocol and has adopted the forest definition in agreement with Food and Agriculture Organization of the United Nations definitions, with the following threshold values for tree crown cover, land area and tree height:
  a. a minimum area of land of 0.5 hectares;
  b. tree crown cover of 10 per cent;
  c. minimum tree height of 5 meters.

Italy's forest area eligible under *Forest management* activity is the total forest area, since the entire Italian forest area has to be considered managed.

Under SBSTA conclusion FCCC/SBSTA/2006/L.6 and related draft COP/MOP2 decision (FCCC/SBSTA/2006/L.6/Add.1), credits from *forest management* are capped, in the first commitment period, to 2,78 Mt C per year, times fives.
Italy intends to account for Article 3.3 and 3.4 activities at the end of the commitment period.
Considering that the entire Italian forest area is subject to the *Forest management* activity, Kyoto Protocol reporting has to account for carbon stocks changes (and the related non-CO_2 emissions) on the national forest area, and on deforested areas, occurring in the first Commitments Period.
The key elements of the accounting system in the National Registry for forest carbon sinks are:

National Land-Use Inventory (IUTI)
aimed at identifying and quantifying:
- *forest land* areas;
- land in conversion from *forest land* category since 31 December 1989;
- land in conversion to *forest land* category since 31 December 1989.

National Inventory of Carbon Stocks (ISCI)
aimed at quantifying:
- carbon stocks and carbon stock changes in any land-use category in the first Commitments Period.

National Census of Forest Fires (CIFI)
aimed at identifying and quantifying:
- *forest land* areas affected by fires.

National Inventory of non-CO_2 emissions from forest fires (IEIF)
aimed at quantifying:
- non-CO_2 emissions from *forest land* areas affected by fires.

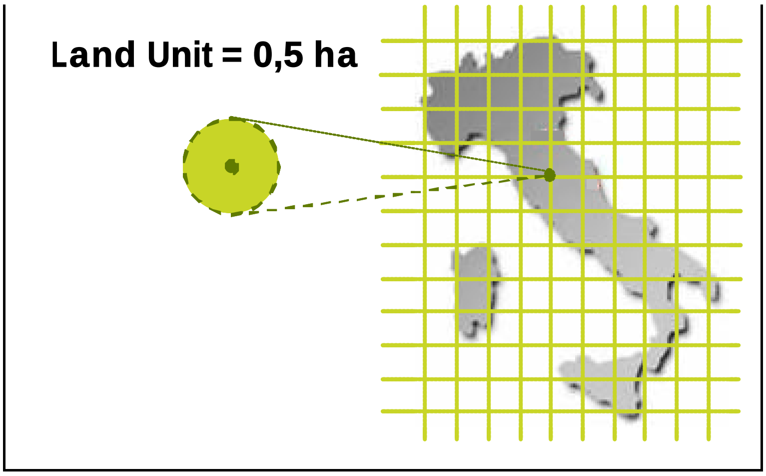
National Land-Use Inventory (IUTI)

The National Land-Use Inventory (IUTI) is aimed at identifying the land uses and land-use changes over the national territory. IUTI will supply data concerning areas of *forest land* category (art. 3.4 of KP) and of land in conversion to and from *forest land* categories (art. 3.3 of KP). IUTI will also supply estimates of the coverage percentage of the most important land-cover elements (that are considered as land-use indicators).

Time:
IUTI will annually provide, from 01/01/2008 in experimental phase and from 01/01/2010 in operational phase, time-series of the areas devoted to any land-use category and any land-use change subcategory to and from *forest land* use, in the KP reporting. For the Kyoto Protocol first Commitment Period (I CP) accounting, the needed time series is related to the period 31/12/1989 - 1/1/2013; in particular the 31/12/1989 data are needed for identifying existing forest lands (*Forest Management*, art. 3.4) and setting land reference scenario for *Afforestation, Reforestation* and *Deforestation* (art. 3.3);

Space:
The sampling grid and the relative sample plots will homogenously cover the national territory and will supply data, at NUT2 level, of the investigated variables (i.e. *forest land* category and each subcategory in conversion to and from *forest land*). The sampling grid will be dimensioned on the basis of the first

phase results of the National Forest Inventory (NFI). The analysis of sample plots will be carried out using remote sensed data and ground truth for present and future dates while for setting the 1990 only remote sensed data (satellite and aerial photographs) will be used since no ground truth is available for that date.



Land-use indicators:
Land-use indicators are the different elements covering the investigated area (e.g. trees, buildings, roads, rivers, grasses, etc.) and that indicated the potential land use. The land-use indicators are used to drive the land-use classification of the area under examination and contribute to quantify the carbon stock related to the same area. For instance, the presence of trees potentially higher than 5 meters can point out the potential forest land use, while the tree-coverage percentage is an important driver for estimating carbon stocks.

Categories and subcategories:
Land use categories are defined according to IPCC Good Practice Guidance for LULUCF:

Settlements:
prevalent urban use. Land-use indicators: building, infrastructures insisting on an area of 0.5 ha, with a density at least equal to X%.

Cropland:
prevalent agricultural use. Land-use indicators: herbaceous cultures, woody crops insisting on an area of 0.5 ha, with a density at least equal to X%.

Forest land
prevalent forest use. Land-use indicators: trees potentially higher more than 5 meter, crops insisting on an area of 0.5 ha, with a density at least equal to 10%.

Wetlands
prevalent wetland use. Land-use indicators: land covered or saturated by water for all or part of the year (e.g. peatland), insisting on an area of 0.5 ha, with a density at least equal to 10%.

Grassland:
prevalent grazing use. Land-use indicators: herbaceous cultures, shrubs crops insisting on an area of 0.5 ha, with a density at least equal to 10%.

Other Lands:
no prevalent use. It corresponds to unproductive category.

	Relation between activities under articles 3.3 and 3.4 of the Kyoto Protocol and the land-use categories						
		Initial					
		Settlements	*Cropland*	*Forest Land*	*Wetlands*	*Grassland*	*Other lands*
Final	*Settlements*	------		**D**			
	Cropland		------	**D**			
	Forest Land	**AR**	**AR**	------	**AR**	**AR**	**AR**
	Wetlands			**D**	------		
	Grassland			**D**		------	
	Other Lands			**D**			------

Quality assurance:
Data supplied by IUTI will be collected in the so-called "*National Registry for the forest carbon sinks*" of Kyoto Protocol, and have to fulfil quality requirements as stated by the IPCC and UNFCCC guidelines.

Classification methodology
The adopted classification methodology ensures that any unit of land could be classified univocally (exclusion of multiple classification of the same unit of land) under a category (exclusion of the null case), by means of*:*
- a systematic sampling design to select classification points;
- a list of land-use definitions as reported in the IPCC GPG land-use classification;
- a list of land-use indicators able to indicate the presence of a certain use on the land;
- a hierarchical order of prevalence of the land uses to assess the predominant land-use. The hierarchical order takes into account the socio-economic value of use, following the FAO-FRA2000 forest definition.

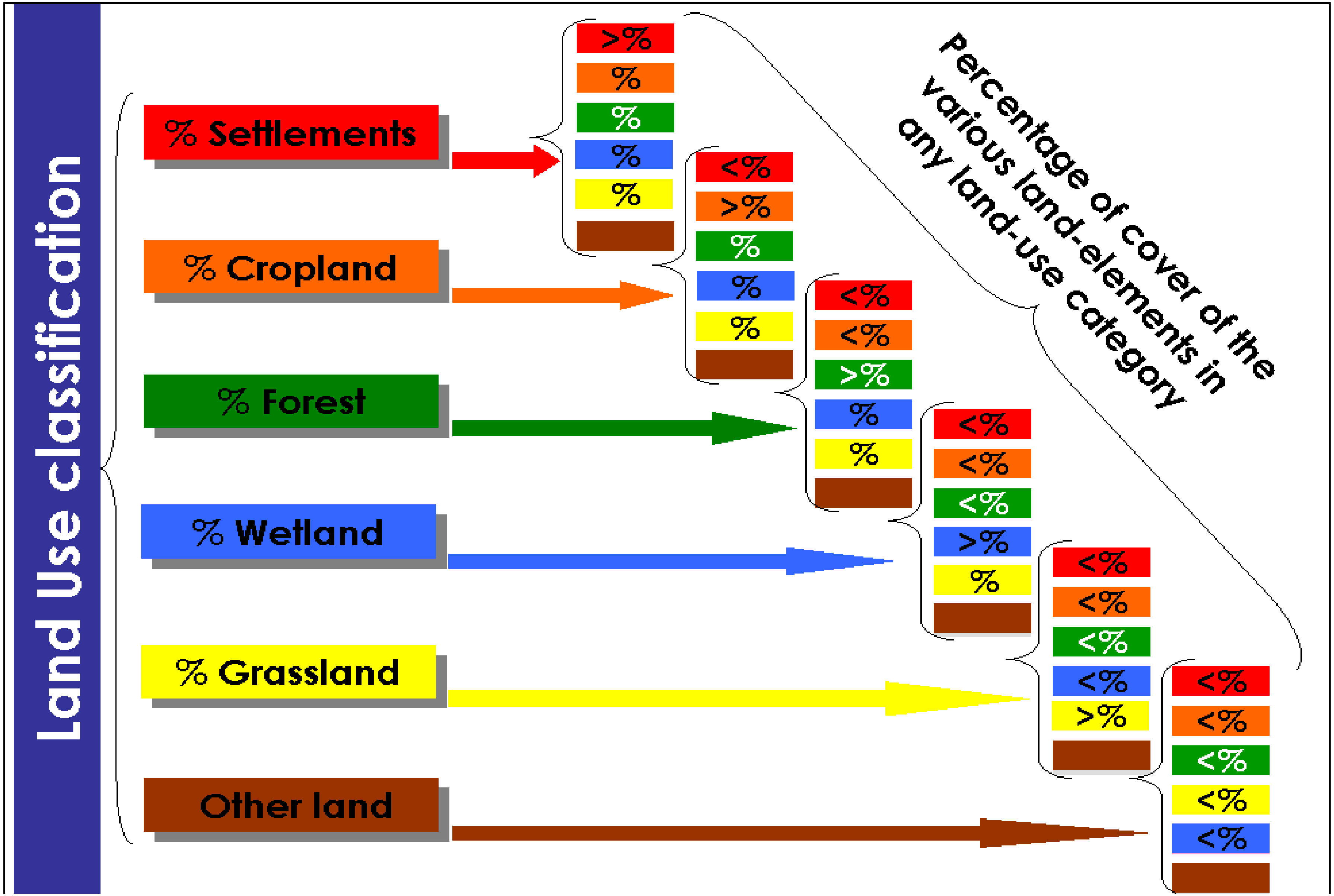
Hierarchical order	Land-use category	**Land-cover indicators**
1	Settlements	building, infrastructures
2	Cropland	herbaceous and woody cultures
3	Forest	trees
4	Wetland	land covered or saturated by water
5	Grassland	grasses, shrubs
6	Other land	none

To achieve land use classification, a 0.5 ha circular neighbourhood of the sample plot is investigated. In the first phase, this area is processed, by the way of a contour mapping software: any sub-area covered by any land-use indicator is contoured. In a second phase, a video-operator codes each contoured sub-area, identifying the different land-use indicators. Then, the processed area is archived and automatically classified under a land use and, at the same time, the surface of each sub-area is measured. The assignment of any unit of land to a land-use category is done with a routine that test the prevalence of a land-use category, following the hierarchical order and checking the exceeding of the cover thresholds set for the land indicators.

For instance, an area, where different land-use indicators, e.g. *farm, herbaceous cultures, coppices,* are present, will be classified, testing:

- if the land-use indicator "*farm*" reaches or exceeds *settlements* threshold, then the sample point is classified as *settlements* land use and the coverage percentage of the land-use indicators is recorded;
- then if the land-use indicator "*herbaceous culture* " reaches or exceeds *cropland* threshold, then the sample point is classified as *cropland* land use and the coverage percentage of the land-use indicators is recorded;
- lastly, if the land-use indicator "*coppices*" reaches or exceeds *forest land* threshold, then the sample point is classified as *forest land* land use and the coverage percentage of the land-cover indicators is recorded.

Once set the land-use classification of the national land, the comparison of subsequent land-use classifications produces land-use change matrices which permits to figure out the activities under which every unit of land shall be accounted for, if any.



Land Use classification
% Settlements
% Cropland
% Forest
% Wetland
% Grassland
Other land
>%
%
%
%
%
<%
>%
%
%
%
<%
<%
>%
%
%
<%
<%
<%
>%
%
<%
<%
<%
<%
>%
<%
<%
<%
<%
<%
Percentage of cover of the various land-elements in any land-use category

National Inventory of Carbon Stocks (ISCI)

The National Inventory of the Carbon Stocks is a sampling of carbon stocks related to the different land-use categories.
The National Inventory of the Carbon Stocks includes:

- carbon stock changes in the land-use category forest land, the dataset is derived by the IFN data;
- carbon stock changes in the subcategories of the conversion to or from forest land to other predominant uses, the land in conversion to and from *forest land* to other uses require data integration with studies and additional surveys in order to estimate, at regional level, the C stock levels related to non-forest land uses(i.e. *settlements*, *cropland*, *grassland*, *wetlands*).

Time:
ISCI will annually provide, from 01/01/2008 in experimental phase and from 01/01/2010 in operational phase, time series of carbon stock levels and carbon stock changes for the category *forest land* and for the sub-categories land in conversion to and from *forest land* to other uses. For the Kyoto Protocol first Commitment Period accounting, the needed time series is related to the period 31/12/2007 - 1/1/2013.

Space:
Concerning the category *forest land* and any other category in conversion to and from *forest land*, the NFIs will assure the spatial coverage, providing carbon stocks data, at NUT2 level.

Quality assurance:
Data supplied by ISCI will be collected in the so-called "*National Registry for the forest carbon sinks*" of Kyoto Protocol, and have to fulfil quality requirements as stated by the IPCC and UNFCCC guidelines.

National Census of Forest Fires (CIFI)

The National Census of Forest Fires is a system aimed at detecting, locating and classifying the *forest land* areas affected by fires; it will provide data on

- forest areas affected by fires;
- forest typology and stand features;
- proxy parameters in order to estimate the initial C stock and losses by fire (e.g. vegetation height, altitude, slope, exposure).

Time:
CIFI will annually provide, from 01/01/2008, time series of forest areas affected by fires. For the Kyoto Protocol first Commitment Period accounting, the needed time series is related to the period 01/01/2008 - 31/12/2012 (because of the strong variability of the forest fires occurrence no interpolation of data is allowed).

Space:
CIFI will cover all the national territory and will provide geographically referenced data on burned *forest land remaining forest land* areas (art. 3.4) and on *land converted to forest land* burned areas (art. 3.3).

Key elements:
The key elements are:

- ground surveys that have to detect fires and record boundaries of burned areas. Additional data will concern collection of attributes as damage evaluation (percentage of oxidised biomass), forest typology (following NFI classification);
- remote sensed data will integrate data from ground surveys, in order to cross-check detected burned areas, at 0.5 ha spatial definition;
- digital terrain model;
- forest-non forest Boolean mask.

Quality assurance:
Data supplied by CIFI will be collected in the so-called "*National Registry for the forest carbon sinks*" of Kyoto Protocol, and have to fulfil quality requirements as stated by the IPCC and UNFCCC guidelines.

National Inventory of non-CO_2 emissions from forest fires (IEIF)

The Forest fires GHG emissions National Inventory is aimed at estimating non-CO_2 emissions from forest fires (CO_2 emissions aren't taken into account, being already computed by National Inventory Carbon Stocks as decreases in carbon stocks). It will provide:

- emission figures of the land-use category *forest land*;
- emission figures of the land-use categories in conversion to or from *forest land* to other predominant uses.

Time:
The Forest fires GHG emissions National Inventory will annually provide, from 01/01/2008 in experimental phase and from 01/01/2010 in operational phase, time series of non-CO_2 emissions from forest fires. For the Kyoto Protocol first Commitment Period (CP) accounting, the needed time series is related to the period 01/01/2008 - 31/12/2012.

Space: IEIF will supply estimates of emissions released by fires detected by National Census of Forest Fires.

Key elements:
For any fire, once identified the prevalent forest typology and the damage of the stand (i.e. percentage of burned biomass) affected by fire, through the National Forest Service surveys, related carbon stocks are estimated by National Inventory Carbon Stocks. Emissions are calculated applying the damage coefficients and the emissions factors referenced or elaborated by research projects to the estimated carbon stocks.

Quality assurance:
Data supplied by IEIF will be collected in the so-called "*National Registry for the forest carbon sinks*" of Kyoto Protocol, and have to fulfil quality requirements as stated by the IPCC and UNFCCC guidelines.

ANNEX 11: THE NATIONAL REGISTRY

A11.1 Introduction

In this annex it is reported a description of the Italian national Registry, in accordance with the guidelines set down in UNFCCC's Decision 22/CP.8 (Additional sections to be incorporated in the guidelines for the preparation of the information required under Article 7, and in the guidelines for the review of information under Article 8, of the Kyoto Protocol).

All data referring to units holdings and transactions during the year 2008 are reported in the SEF submission; figures are included in tables A10.1, A10.2 and A10.3.

Italy carried out all required steps of the initialization process with the UNFCCC: in particular, Italy successfully performed and passed:

- SSL connectivity testing (Oct. 26th 2007);
- VPN connectivity testing (Oct. 15th 2007);
- Interoperability test according to Annex H of the UN Data Exchange Standards (DES) (Nov. 9th 2007),

and submitted all required information through a complete Readiness questionnaire.

This implies that the Italian registry fulfilled all of its obligations regarding conformity with the UN DES. These obligations include having adequate transaction procedures, adequate security measures to prevent and resolve unauthorized manipulations and adequate measures for data storage and registry recovery. The registry was therefore deemed fully compliant with the registry requirements defined in decisions 13/CMP.1 and 5/CMP.1.

As a result, Italy could participate to the "ETS go-live" event that took place in October 2008.
After successful completion of the go-live process on 16th October 2008, the Italian registry commenced live operations with the ITL and it's been operational ever since.

At present, Italy is also operating its registry under Article 19 of Directive 2003/87/CE establishing the EU Emission Trading Scheme and according to Regulation No. 2216/2004 of the European Commission, which require national registries to be compliant with the UN DES document.

The Italian registry is based on the GRETA registry software developed by the UK Department for Environment, Food and Rural Affairs (DEFRA) and used by many other Member States. Currently, the development of this software adheres to the standards specified in Draft #7 of the UN DES document. Italy had the registry systems tested successfully with the EU Commission on February the 6th 2006; the connection between the registry's production environment and the CITL was established on March the 13th 2006 and the Registry has since gone live, starting on 28 March 2006.

A11.2 Registry administrator

The Italian Government modified the previous Legislative Decree 216/2006 which enforced the Directive 87/2003/ CE, by the new Legislative Decree 51 of March 7th 2008. Due to this new Decree, Italy's Agency for the Protection of the Environment and for Technical Services (APAT) is responsible for developing, operating and maintaining the national registry under Directive 2003/87/CE. In August 2008 APAT was merged into ISPRA (Institute for Environmental Protection and Research) and therefore ISPRA, as Registry Administrator, becomes responsible for

the management and functioning of the Registry, including Kyoto protocol obligations. The reference person is Mr Mario Contaldi.
The Decree 51/2008 also establishes that the economic resources for the technical and administrative support of the Registry will be supplied to ISPRA by operators paying a fee for the use of the Registry. The amount of such a fee will be regulated by a future Decree.

Besides the one person designated as Registry administrator, ISPRA set up an operational unit ("Settore del Registro nazionale dei crediti di emissione") where five persons are working in order to manage, develop and maintain the Italian National Registry and, additionally, relays on the structure of the Agency for information, secretary and administrative services:

- one IT expert who is taking care of hardware and software on site, with the support of an external IT supplier giving remote consultancy;
- two persons are responsible for the registry application management, the resolution of problems with operators, the manual intervention in the database and they interface with the "Competent Authority";
- one person is dedicated to the helpdesk for operators;
- one person is dedicated to archiving the documentation.

A11.3 Cooperation with other Parties

Italy's National Registry is currently linked to the other EU member states' National Registries and to the European Commission CITL (Community Independent Transaction Log) by way of the UNFCCC ITL (International Transaction Log), in a consolidated system forming the European Emissions trading scheme (EU ETS).

A11.4 Database structure and capacity of the national registry

The GRETA registry system is implemented using a Microsoft SQL Server 2000 Enterprise Edition relational database management system with a dedicated data model for supporting registry operations. The SQL license adopted has no access limitations of simultaneous transactions.

The actual **production environment** consists in: 1 Firewall server + 1 webserver + 2 DB server in cluster configuration with two controllers fibre channel towards storage unit; the data directory is on the data storage device + 1 Tape Autoloader.

The actual **test environment** is protected by 1 Firewall server. The test environment webserver has the same hardware and software configuration of the production web server. In this case the DB server is on the same unit. It will be reinstalled on another server.

The **disaster recovery environment** is physically separated from the production environment (in a different building in a different part of the city of Rome) and has been implemented in the following way:

- a firewall Cisco ASA is installed and configured and then connected through VPN with the firewall Cisco ASA of the production environment;
- 2 servers S.O. Windows 2003 are installed and configured;
- Microsoft SQL Server 2000 Enterprise Edition is installed, synchronized with the production SQL through VPN;
- Microsoft Internet Information Server 6 and the GRETA software are installed.

This synchronization system between the production environment and the disaster recovery environment is carried out every 15 minutes. In case the primary system falls, the synchronization

platform will be served by a different connection to the internet with the immediate recovery of all functionalities; the time estimated is just the time needed to update the public DNS caches that will have to “memorize” the new path towards a different IP address. The ITL is requested to send the last 15 minutes transaction logs files in order to upgrade the disaster recovery DB and start it again. In the meantime, the dedicated personnel will try to resolve as soon as possible the problem on the production platform.
Once a week, the correct functioning of the disaster recovery platform is checked.

A11.5 Conformity with data exchange standards (DES)

The GRETA registry system has been developed for the EU Emissions Trading Scheme. This scheme requires its Member States' registries to be compliant with the UN Data Exchange Standards specified for the Kyoto Protocol. Currently, the development adheres to the standards specified in Draft #7 of the UN DES document.
In addition, 24 Hour Clean-up, Transaction Status enquiry, Time Synchronisation, Data Logging requirements (including Transaction Log, Reconciliation Log, Internal Audit Log and Message Archive) and the different identifier formats as specified in the UN DES document have been implemented. From February the 7th 2008, however, on both production and test sites a new NTP software has been installed. This software is provided by “http://www.meinberg.de/english/sw/ntp.htm” and was obtained by compiling version 4.2.4p4 sources of the software supplied by ntp.org.

Formats for account numbers, serial numbers for ERUs, CERs, AAUs, and RMUs, including project identifiers and transaction numbers are as specified in the UN DES #7 Annex F – Definition of Identifiers.
The display format is controlled via the registries web configuration file.
Electronical information when transferring ERUs, CERs, AAUs, and/or RMUs to other registries will be transmitted to other registries in the format of the messages specified in the UN DES #7 via the ITL.
Acknowledgement information when acquiring ERUs, CERs, AAUs, and/or RMUs from other national registries or the CDM registry will be transmitted to other registries in the format of the messages specified in the UN DES #7 via the ITL.
Electronical Information when issuing, transferring, acquiring, canceling and retiring ERUs, CERs, AAUs, and/or RMUs.will be transmitted from the national registry to the ITL in the format of the messages specified in the UN DES #7.

A11.6 Procedures for minimizing and handling of discrepancies

Communications between the National Registry and the ITL is via web-services using XML messages – as specified in the UN DES document. These web-services, XML message format and the processing sequence are as per that specified in the UN DES document.
In the EU ETS, to prevent discrepancies between the Registry and the Transaction Log, internal checks (as specified in the UN DES document) are implemented as far as possible. The same approach has been adopted for the development of the GRETA software for the remaining Kyoto functionalities.
Whenever a possible discrepancy is detected by the internal checks no transaction will be started. Moreover, unit blocks involved in a pending transaction are locked for use in any other transaction and there will be an automatic termination of the transaction that has caused the discrepancy.
In the event of a failure to terminate the transaction, an inconsistency with the ITL or STL will be detected during the subsequent reconciliation process. The ITL or STL will then block any transaction involving the related blocks. The status of the blocks will afterwards be corrected

manually by the registry administrator with the help of a manual intervention function. This intervention will be logged automatically in the registry. If no inconsistencies are detected during the next reconciliation process with the ITL or STL, the related unit blocks will be unblocked so that further transactions with these blocks will be possible.

A11.7 Prevention of unauthorized manipulations and operator error

The Agency emphasizes physical security of server premises in addition to normal logical access control methods. All servers and backup media are located in secure premises with electronic access control, allowed only to the system administrators.
Personnel have duty of identification when entering the building and a security channel allows monitoring inside the building. When moving servers or backup media between controlled premises, they are never left unattended.
Computers are accessible through username and password and they are automatically locked after 15 minutes of idle time. Employees are required to lock the computers manually whenever leaving the desk.
Servers are protected by firewalls (Cisco ASA appliances).

To log-in, every user of the registry software is obliged to use username and password. Passwords are of 8 to 15 digits including minimum 1 numbers and minimum 1 alphabet and to change their password every 60 days. The registry administrator disables unused user ids and passwords on a regular basis.
Session security is ensured by using encryption both in management traffic and production network traffic (SSL).
All servers are protected with Anti-Virus product (eTrust Inoculate) updated daily. Regular virus scans are run on all nodes, workstations and servers within their network.
Significant attention is placed on verifying the identity of the operator's or organization's legal representative who is signing the nomination of the account primary and secondary authorized representatives.

For the operators' accounts, such verification requires a "visura camerale", a document produced by the Italian Chamber of Commerce identifying the legal representatives of a specific commercial company. Non Italian Companies are requested to provide an equivalent document, identifying the Company's representatives and their roles and responsibilities.
The same document, "visura camerale" or an equivalent (e.g. statute), is requested for organizations applying for an account.
For individual accounts, only a signed copy of an identity document is required (identity card or passport for non Italian persons).
All persons involved those who delegate and the authorized representatives, need to send a signed copy of an identity document (identity card or passport for non Italians).

A11.8 User interface of the national registry

The GRETA software makes available on the registry site publicly accessible information. These reports are described below in the following.

1. Open Internet Explorer (or similar) and browse to the following URL:

http://www.greta.sinanet.apat.it

2. Click on the link to the national registry

3. Select the public reports link at the bottom of the page. The user can choose from:

a. User details – unchanged, updated, created
b. Account details – unchanged, updated, created
c. Operator holding account – unchanged, updated, created

A11.9 Integrity of data storage and recovery

In addition to disaster recovery in real time (see paragraph A10.4), a backup policy is implemented for the production environment, according to the following schedule:

- full backup of the database is taken everyday in the storage unit;
- differential backups of new logs are taken every hour in the storage unit;
- every week all daily backups are recorded on a tape that is retained for 2 weeks in a separate location.

We are using the internal backup scheduling system of SQL Server 2000 Enterprise Edition. Full database backup are taken everyday. Differential backups of new logs are taken every hour.
Both storage (HP StorageWorks MSA20) and tapes (HP StorageWorks 1/8 Tape Autoloader Ultrium 230) are kept in secure location with controlled access.
Currently APAT uses three backup tapes. After being in use for one week, the tape is stored for two weeks. After two weeks it is erased and used again.
This means that daily backups are available in 14 generations (two weeks).
Backup software's log is checked every weekday. Abnormalities are checked and necessary corrections made.
Reliability of the whole system is guaranteed by the following stability features:

- power supply from the public power supply network through two separate feeding points;
- uninterruptible power supply on battery basis;
- guarantee of the supply through diesel emergency power aggregate in the event of prolonged failure of the public power supply network;
- all essential hardware components of the server are implemented with redundancy (power supply, multiprocessor, hard-disks RAID);
- the database servers are operated as a cluster (switchover).

A11.10 Test results

The performance and security measures of the national registry have been successfully tested through the implementation of secure connection (digital certificates and VPN tunnel).
As reported in paragraph A10.1, Italy carried out all required steps of the initialization process with the UNFCCC. In particular, Italy successfully performed and passed SSL connectivity testing, VPN connectivity testing, interoperability test according to Annex H of the UN DES and submitted all required information through a complete Readiness questionnaire.
Currently, the GRETA registry system for the EU Emissions Trading Scheme uses the security mechanism as specified within the EU Regulation Annex XV; that is, it uses basic authentication and SSL.

Table A11.1 Annual external transactions of Kyoto Protocol units

Submission year	2009
Reported year	2008
Commitment period	1

Table 2 (b). Annual external transactions

	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Transfers and acquisitions												
AT	NO	NO	NO	NO	NO	NO	212000	NO	NO	NO	NO	NO
BE	195000	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CDM	NO	NO	NO	13379879	NO	NO	NO	NO	NO	NO	NO	NO
CH	NO	NO	NO	1230888	NO	NO	NO	NO	NO	50598	NO	NO
DE	61101	NO	NO	90133	NO	NO	200001	NO	NO	NO	NO	NO
DK	168000	NO	NO	100001	NO	NO	100000	NO	NO	900000	NO	NO
ES	19500	NO	NO	NO	NO	NO	4500	NO	NO	3000	NO	NO
EU	579204	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
FI	3400	NO	NO	NO	NO	NO	34000	NO	NO	NO	NO	NO
FR	5466500	NO	NO	388159	NO	NO	1331939	NO	NO	2272401	NO	NO
GB	12239997	NO	NO	3957262	NO	NO	1185263	NO	NO	6689921	NO	NO
NL	1558255	NO	NO	130000	NO	NO	735000	NO	NO	58000	NO	NO
PT	2000	NO	NO	NO	NO	NO	2000	NO	NO	NO	NO	NO
Sub-total	20292957	NO	NO	19276322	NO	NO	3804703	NO	NO	9973920	NO	NO

Additional information

Independently verified ERUs								NO				

Table 2 (c). Total annual transactions

Total (Sum of tables 2a and 2b)	20292957	NO	NO	19276322	NO	NO	3804703	NO	NO	9973920	NO	NO

Table A11.2 Total quantities of Kyoto Protocol units

Party	Italy
Submission year	2009
Reported year	2008
Commitment period	1

Table 4. Total quantities of Kyoto Protocol units by account type at end of reported year

Account type	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Party holding accounts	2232035444	NO	NO	NO	NO	NO
Entity holding accounts	200730708	NO	NO	9302402	NO	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	NO	NO		
Non-compliance cancellation accounts	NO	NO	NO	NO		
Other cancellation accounts	NO	NO	NO	NO	NO	NO
Retirement account	NO	NO	NO	NO	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	2432766152	NO	NO	9302402	NO	NO

Table A11.3 Summary information on Kyoto Protocol units

Party	Italy
Submission year	2009
Reported year	2008
Commitment period	1

Table 5 (a). Summary information on additions and subtractions

	Additions						Subtractions					
	Unit type						Unit type					
Starting values	**AAUs**	**ERUs**	**RMUs**	**CERs**	**tCERs**	**lCERs**	**AAUs**	**ERUs**	**RMUs**	**CERs**	**tCERs**	**lCERs**
Issuance pursuant to Article 3.7 and 3.8	2416277898											
Non-compliance cancellation							NO	NO	NO	NO		
Carry-over	NO	NO		NO								
Sub-total	2416277898	NO		NO			NO	NO	NO	NO		
Annual transactions												
Year 0 (2007)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 1 (2008)	20292957	NO	NO	19276322	NO	NO	3804703	NO	NO	9973920	NO	NO
Year 2 (2009)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 3 (2010)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 4 (2011)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sub-total	20292957	NO	NO	19276322	NO	NO	3804703	NO	NO	9973920	NO	NO
Total	2436570855	NO	NO	19276322	NO	NO	3804703	NO	NO	9973920	NO	NO

Table 5 (b). Summary information on replacement

	Requirement for replacement		Replacement					
	Unit type		Unit type					
	tCERs	**lCERs**	**AAUs**	**ERUs**	**RMUs**	**CERs**	**tCERs**	**lCERs**
Previous CPs			NO	NO	NO	NO	NO	NO
Year 1 (2008)		NO	NO	NO	NO	NO	NO	NO
Year 2 (2009)		NO	NO	NO	NO	NO	NO	NO
Year 3 (2010)		NO	NO	NO	NO	NO	NO	NO
Year 4 (2011)		NO	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO	NO	NO
Total	NO	NO	NO	NO	NO	NO	NO	NO

Table 5 (c). Summary information on retirement

	Retirement					
	Unit type					
Year	**AAUs**	**ERUs**	**RMUs**	**CERs**	**tCERs**	**lCERs**
Year 1 (2008)	NO	NO	NO	NO	NO	NO
Year 2 (2009)	NO	NO	NO	NO	NO	NO
Year 3 (2010)	NO	NO	NO	NO	NO	NO
Year 4 (2011)	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO
Total	NO	NO	NO	NO	NO	NO