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Italian Greenhouse Gas Inventory 1990-2008

National Inventory Report 2010

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

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

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Premessa

Nell’ambito degli strumenti e delle politiche per fronteggiare i cambiamenti climatici, un ruolo fondamentale è svolto dal monitoraggio delle emissioni dei gas 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 1990-2008. National Inventory Report 2010” descrive la comunicazione annuale italiana dell’inventario delle emissioni dei gas serra dal 1990 al 2008.

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

Nuove politiche e interventi a livello nazionale ed internazionale saranno, infatti, indispensabili per garantire nel futuro il rispetto degli obiettivi del Protocollo di Kyoto, dal momento che, come emerge dal rapporto, le emissioni totali dei gas serra (espressi in termini di CO_2 equivalente) sono aumentate, dal 1990 al 2008, del 4.7% a fronte di un impegno nazionale di riduzione pari al 6.5% entro il periodo 2008-2012.

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EXECUTIVE SUMMARY

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

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

This report is compiled according to the guidelines on reporting as specified in the document FCCC/SBSTA/2002/L.5. It provides an analysis of the Italian GHG emission inventory communicated to the Secretariat of the Climate Change Convention and to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism in the year 2010, including the update for the year 2008 and the revision of the entire time series 1990-2007.
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 and it has not changed from the previous submission.

Emission estimates comprise the six direct greenhouse gases under the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride) which contribute directly to climate change owing to their positive radiative forcing effect and four indirect greenhouse gases (nitrogen oxides, carbon monoxide, non-methane volatile organic compounds, sulphur dioxide).
This report, the CRF files and other related documents are available on website at the address http://www.sinanet.apat.it/it/sinanet/serie_storiche_emissioni.
The official inventory submissions can also be found at the UNFCCC website http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php.

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

Total greenhouse gas emissions, in CO_2 equivalent, excluding emissions and removals of CO_2 from land use, land use change and forestry, increased by 4.7% between 1990 and 2008 (from 517 to 541 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 86.4% of total emissions in CO_2 equivalent in 2008, showed an increase by 7.4% between 1990 and 2008. In the energy sector, specifically, emissions in 2008 were 8.9% greater than in 1990.
CH_4 and N_2O emissions were equal to 6.6% and 5.4%, respectively, of the total CO_2 equivalent greenhouse gas emissions in 2008. Both gases showed a decrease from 1990 to 2008, equal to 13.4% and 20.9% for CH_4 and N_2O, respectively.
Other greenhouse gases, HFCs, PFCs and SF_6, ranged from 0.04% to 1.4% 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 1990-2008, expressed in CO_2 equivalent terms, by substance and category.

GHG emissions	1990 base year	1995	2000	2005	2006	2007	2008
	CO_2 equivalent (Gg)						
CO_2 emissions including net CO_2 from LULUCF	370,777.23	363,376.59	387,566.60	398,470.82	393,899.41	424,264.64	380,718.29
CO_2 emissions excluding net CO_2 from LULUCF	435,775.28	445,861.39	463,602.86	490,476.80	486,342.51	476,749.38	468,067.67
CH_4 emissions including CH_4 from LULUCF	41,710.02	43,819.90	44,047.36	38,580.31	36,864.53	37,114.33	36,021.75
CH_4 emissions excluding CH_4 from LULUCF	41,563.78	43,788.40	43,962.86	38,541.79	36,833.91	36,917.58	35,975.56
N_2O emissions including N_2O from LULUCF	37,313.23	38,036.36	39,429.45	37,538.21	32,228.28	31,565.68	29,439.00
N_2O emissions excluding N_2O from LULUCF	37,218.42	38,030.41	39,420.87	37,534.30	32,225.17	31,545.71	29,434.32
HFCs	351.00	671.29	1,985.67	5,267.03	5,956.20	6,700.69	7,379.22
PFCs	1,807.65	490.80	345.85	352.62	282.30	287.78	194.41
SF_6	332.92	601.45	493.43	465.39	405.87	427.55	434.18
Total (including LULUCF)	**452,292.06**	**446,996.40**	**473,868.36**	**480,674.38**	**469,636.60**	**500,360.67**	**454,186.86**

GHG emissions	1990 base year	1995	2000	2005	2006	2007	2008
Total (excluding LULUCF)	**517,049.05**	**529,443.75**	**549,811.54**	**572,637.93**	**562,045.97**	**552,628.69**	**541,485.36**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990 base year	1995	2000	2005	2006	2007	2008
	CO_2 equivalent (Gg)						
1. Energy	418,576.51	431,427.80	450,807.70	473,902.36	469,217.22	459,055.94	452,907.35
2. Industrial Processes	37,507.63	34,945.96	35,189.63	40,945.63	36,420.18	36,944.47	34,099.10
3. Solvent and Other Product Use	2,455.02	2,239.03	2,302.43	2,138.67	2,140.82	2,104.18	1,999.47
4. Agriculture	40,576.24	40,348.91	39,939.85	37,204.45	36,620.96	37,222.47	35,865.15
5. Land Use, Land-Use Change and Forestry(5)	-64,756.99	-82,447.34	-75,943.18	-91,963.55	-92,409.37	-52,268.02	-87,298.51
6. Waste	17,933.65	20,482.04	21,571.93	18,446.81	17,646.79	17,301.63	16,614.29
7. Other	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 2008, of 83.6%. Emissions from this sector increased by about 8.2% from 1990 to 2008. Substances with the highest increase rates were CO_2, whose levels increased by 8.9% from 1990 to 2008 and accounts for 97.5% of the total in the energy sector, and N_2O which showed an increase of 11.1% but its share out of the sectoral total is only 1.1%; CH_4, on the other hand, showed a decrease of 27.0% from 1990 to 2008 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 20.4%, 16.5% and 10.5%, respectively; in 2008 these sectors, altogether, account for 81.8% of total emissions.

For the industrial processes sector, emissions showed a decrease of 9.1% from the base year to 2008. Specifically, by substance, CO_2 emissions account for 73.2% and showed a decrease by about 11.6%, CH_4 decreased by 43.9%, but it accounts only for 0.2%, while N_2O, whose levels share 3.1% of total industrial emissions, decreased by 84.0%. The decrease in emissions is mostly due to a decrease in chemical industry (due to the fully operational abatement technology in the adipic acid industry) and metal production emissions. A considerable increase was observed in F-gas emissions (about 221.4%), whose level on total sectoral emissions is 23.5%.

Emissions from the solvent and other product use sector, which refer to CO_2 and N_2O emissions except for gases other than greenhouse, decreased by 18.6% from 1990 to 2008. The reduction is mainly to be attributed to a decrease by 22.6% in CO_2 emissions, which account for 63.6% of the sector. As regards CO_2, emission levels from paint application sector, which accounts for 53.1% of total CO_2 emissions from this sector, decreased by 20.0%; 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 41.7% of the total, show a decrease of 14.7%. Finally, CO_2 emissions from metal degreasing and dry cleaning activities, decreased by 62.3% but they account for only 5.2% of the total.

The level of N_2O emissions shows a decrease of 10.5%, accounting for 36.4% of total emissions in 2008.

For agriculture, emissions refer to CH_4 and N_2O levels, which account for 42.6% and 57.4% of the sectoral total, respectively. The decrease observed in the total emissions (-11.6%) was mostly due to the decrease of CH_4 emissions from enteric fermentation (-10.3%), which account for 30.4% of sectoral emissions and to the decrease of N_2O (-13.6%) from agricultural soils, which accounts for 46.8% of sectoral emissions.

As regards land use, land-use change and forestry, from 1990 to 2008 total removals in CO_2 equivalent increase of 34.8%; CO_2 accounts for more than 99% of total emissions and removals of the sector.

Finally, emissions from the waste sector decreased by 7.4% from 1990 to 2008, mainly due to a decrease in the emissions from solid waste disposal on land ((-16.7%), which account for 66.7% of waste emissions.. The most important greenhouse gas in this sector is CH_4 which accounts for 85.5% of the sectoral emissions and shows a decrease of 8.0% from 1990 to 2008. N_2O levels increased by 10.6%, whereas CO_2 decreased by 53.5%; these gases account for 13.0% 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**	**2005**	**2006**	**2007**	**2008**
1A. Energy: fuel combustion	**407,815**	**421,370**	**441,798**	**466,079**	**461,872**	**451,865**	**445,534**
CO_2: 1. Energy Industries	136,503	139,841	151,894	160,423	162,269	161,590	159,145
CO_2: 2. Manufacturing Industries and Construction	86,528	86,088	83,758	80,487	79,131	75,848	72,804
CO_2: 3. Transport	101,269	111,446	120,103	125,831	127,151	127,215	122,475
CO_2: 4. Other Sectors	76,677	76,090	78,596	91,831	85,958	79,895	84,161
CO_2: 5. Other	1,046	1,440	806	1,198	982	896	738
CH_4	1,375	1,516	1,347	1,197	1,210	1,302	1,305
N_2O	4,416	4,949	5,294	5,113	5,171	5,119	4,907
1B2. Energy: fugitives from oil & gas	**10,762**	**10,057**	**9,010**	**7,823**	**7,345**	**7,191**	**7,373**
CO_2	3,341	3,174	2,585	2,112	2,189	2,176	2,258
CH_4	7,420	6,882	6,424	5,710	5,155	5,014	5,113
N_2O	1	1	1	1	1	1	1
2. Industrial processes	**37,508**	**34,946**	**35,190**	**40,946**	**36,420**	**36,944**	**34,099**
CO_2	28,231	25,831	24,383	27,036	27,063	27,573	24,965

CH_4	108	113	63	64	66	65	61
N_2O	6,676	7,239	7,918	7,760	2,647	1,891	1,066
HFCs	351	671	1,986	5,267	5,956	6,701	7,379
PFCs	1,808	491	346	353	282	288	194
SF_6	333	601	493	465	406	428	434
3. Solvent and other product use	**2,455**	**2,239**	**2,302**	**2,139**	**2,141**	**2,104**	**1,999**
CO_2	1,643	1,467	1,276	1,315	1,332	1,316	1,272
N_2O	812	772	1,027	823	808	788	727
4. Agriculture	**40,576**	**40,349**	**39,940**	**37,204**	**36,621**	**37,222**	**35,865**
CH_4: Enteric fermentation	12,179	12,267	12,165	10,841	10,626	11,024	10,921
CH_4: Manure management	3,462	3,286	3,278	3,149	3,028	3,054	2,961
CH_4: Rice Cultivation	1,562	1,657	1,382	1,472	1,477	1,523	1,396
CH_4: Field Burning of Agricultural Residues	13	13	12	13	13	13	14
N_2O: Manure management	3,921	3,782	3,862	3,709	3,601	3,779	3,775
N_2O: Agriculture soils	19,435	19,340	19,237	18,017	17,873	17,826	16,795
N_2O: Field Burning of Agricultural Residues	4	4	4	4	4	4	4
5A. Land-use change and forestry	**-64,757**	**-82,447**	**-75,943**	**-91,964**	**-92,409**	**-52,268**	**-87,299**
CO_2	-64,998	-82,485	-76,036	-92,006	-92,443	-52,485	-87,349
CH_4	146	31	85	39	31	197	46
N_2O	95	6	9	4	3	20	5
6. Waste	**17,934**	**20,482**	**21,572**	**18,447**	**17,647**	**17,302**	**16,614**
CO_2	537	483	202	245	267	240	250
CH_4	15,445	18,055	19,292	16,095	15,259	14,924	14,205
N_2O	1,952	1,944	2,079	2,107	2,120	2,137	2,159
TOTAL EMISSIONS (with LULUCF)	***452,292***	***446,996***	***473,868***	***480,674***	***469,637***	***500,361***	***454,187***
TOTAL EMISSIONS (without LULUCF)	***517,049***	***529,444***	***549,812***	***572,638***	***562,046***	***552,629***	***541,485***

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 2008 are summarised. All gases showed a significant reduction in 2008 as compared to 1990 levels. The highest reduction is observed for SO_2 (-83.7%), while CO and NO_X emissions reduced by about 57.7% and 47.9% respectively, NMVOC levels showed a decrease by 43.8%.

Indirect greenhouse gases and SO_2	**1990**	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
	ktons										
NO_X	2,035	1,911	1,448	1,419	1,365	1,342	1,306	1,221	1,167	1,132	1,061
CO	7,176	7,166	4,961	4,673	4,269	4,058	3,886	3,482	3,283	3,163	3,032
NMVOC	2,004	2,076	1,595	1,511	1,443	1,375	1,322	1,248	1,217	1,182	1,126
SO_2	1,794	1,319	749	697	616	518	480	401	379	335	293

Table ES.3. Total emissions of indirect greenhouse gases and SO_2 (1990-2008) (Gg)

Sommario (*Italian*)

Nel documento "Italian Greenhouse Gas Inventory 1990-2008. National Inventory Report 2010" si descrive la comunicazione annuale italiana dell'inventario delle emissioni dei gas serra in accordo a quanto previsto nell'ambito della Convenzione Quadro sui Cambiamenti Climatici delle Nazioni Unite (UNFCCC), del protocollo di Kyoto. Tale comunicazione è anche trasmessa all'Unione Europea nell'ambito del Meccanismo di Monitoraggio dei Gas Serra.

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

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

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

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

Da una analisi di sintesi della serie storica dei dati di emissione dal 1990 al 2008, si evidenzia che le emissioni nazionali totali dei sei gas serra, espresse in CO_2 equivalente, sono aumentate del 4.7% nel 2008 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'86.4% del totale e risultano nel 2008 superiori del 7.4% rispetto al 1990, mentre le emissioni relative al solo settore energetico sono aumentate del 8.9%. Le emissioni di metano e di protossido di azoto sono pari rispettivamente a circa il 6.6 % e 5.4% del totale e presentano andamenti in diminuzione sia per il metano (-13.4%) che per il protossido di azoto (-20.9%). Gli altri gas serra, HFC, PFC e SF_6, hanno un peso complessivo sul totale delle emissioni che varia tra lo 0.04% e l'1.4%; le emissioni degli HFC evidenziano una forte crescita, mentre le emissioni di PFC decrescono e quelle di SF_6 mostrano un minore incremento. Sebbene al momento tali variazioni non risultino determinanti ai fini del conseguimento degli obiettivi di riduzione delle emissioni, la significatività del trend degli HFC potrebbe renderli sempre più importanti nei prossimi anni.

PART I: ANNUAL INVENTORY SUBMISSION

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, 2007).

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 2008 Italian GHG emission inventory, and a revision of the entire time series 1990-2007, communicated in the framework of the annual submission under the Climate Change Convention and the Kyoto Protocol. It is also the annual submission to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism.

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

Regarding the selection of LULUCF activities under Article 3, paragraph 4, of the Kyoto Protocol for the commitment period 2008-2012, Italy has elected forest management and intends to account for Article 3.3 and 3.4 elected activities for the entire period.

Emission estimates comprise the six direct greenhouse gases under the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride) which contribute directly to climate change owing to their positive radiative forcing effect and four indirect greenhouse gases (nitrogen oxides, carbon monoxide, non-methane volatile organic compounds, sulphur dioxide).
The CRF files, the national inventory reports and other related documents are available at the address http://www.sinanet.apat.it/it/sinanet/serie_storiche_emissioni. Information on accounts, legal entities, Art.6 projects, holdings and transactions is publicly available at www.greta-public.sinanet.apat.it.

The official inventory submissions can also be found at the UNFCCC website http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/4303.php.

1.2 Description of the institutional arrangement for inventory preparation

1.2.1 National Inventory System

The Legislative Decree 51 of March 7th 2008 instituted the National System for the Italian Greenhouse Gas Inventory.
As required by article 5.1 of the Kyoto Protocol, Annex I Parties shall have in place a National System by the end of 2006 at the latest for estimating anthropogenic greenhouse gas emissions by sources and removals by sinks and for reporting and archiving inventory information according to the guidelines specified in the UNFCCC Decision 20/COP.7. In addition, the Decision of the

European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions (EC, 2005) requires that Member States establish a national greenhouse gas inventory system by the end of 2005 at the latest and that the Commission adopts the EC's inventory system by 30 June 2006.
The 'National Registry for Carbon sinks', instituted by a Ministerial Decree on 1st April 2008, is part of the Italian National System and includes information on units of lands subject of activities under Article 3.3 and activities elected under Article 3.4 and related carbon stock changes. The National Registry for Carbon sinks is the instrument to estimate, in accordance with the COP/MOP decisions, the IPCC Good Practice Guidance on LULUCF and every relevant IPCC guidelines, the greenhouse gases emissions by sources and removals by sinks in forest land and related land-use changes and to account for the net removals in order to allow the Italian Registry to issue the relevant amount of removal units (RMUs). Detailed information on the Registry is included in Annex 10, whereas additional information on activities under Article 3.3 and Article 3.4 is reported in paragraph 1.2.2.

The Italian National System, currently in place, is fully described in the document 'National Greenhouse Gas Inventory System in Italy' (ISPRA, 2010 [a]). No changes with respect to the last year submission occurred in the National System.
A summary picture is reported herebelow.

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

The Institute prepares annually a national system document which includes all updated information on institutional, legal and procedural arrangements for estimating emissions and removals of greenhouse gases and for reporting and archiving inventory information. The reports are publicly available at http://www.apat.gov.it/site/it-IT/APAT/Pubblicazioni/Altre_Pubblicazioni.html.
A specific unit of the Institute is responsible for the compilation of the Italian Atmospheric Emission Inventory and the Italian Greenhouse Gas Inventory in the framework of the Convention on Climate Change and the Convention on Long Range Transboundary Air Pollution. The whole inventory is compiled by the Institute; scientific and technical institutions and consultants may help in improving information both on activity data and emission factors of some specific activities. All the measures to guarantee and improve the transparency, consistency, comparability, accuracy and completeness of the inventory are undertaken.
ISPRA bears the responsibility for the general administration of the inventory, co-ordinates participation in reviews, publishes and archives the inventory results.
Specifically, ISPRA is responsible for all aspects of national inventory preparation, reporting and quality management. Activities include the collection and processing of data from different data sources, the selection of appropriate emissions factors and estimation methods consistent with the IPCC Guidelines, the IPCC Good Practice Guidance and Uncertainty management and the IPCC Good Practice Guidance for land use, land-use change and forestry, the compilation of the inventory following the QA/QC procedures, the assessment of uncertainty, the preparation of the National

Inventory Report and the reporting through the Common Reporting Format, the response to the review process, the updating and data storage.

Different institutions are responsible for statistical basic data and data publication, which are primary to ISPRA for carrying out emission estimates. These institutions are part of the National Statistical System (Sistan), which provides national official statistics, and therefore are required to periodically update statistics; moreover, the National Statistical System ensures the homogeneity of the methods used for official statistics data through a coordination plan, involving the entire public administration at central, regional and local levels.
The National Statistical System is coordinated by the Italian National Institute of Statistics (ISTAT) whereas other bodies, joining the National Statistical System, are the statistical offices of ministries, national agencies, regions and autonomous provinces, provinces, municipalities, research institutes, chambers of commerce, local governmental offices, some private agencies and private subjects who have specific characteristics determined by law.
The Italian statistical system was instituted on 6th September 1989 by the Legislative Decree n. 322/89, which established guiding principles and criteria for reforming public statistics. This decree addresses to all public statistical bodies and agencies which provide official statistics both at local, national and international level in order to assure homogeneity of the methods and comparability of the results. To this end, a national statistical plan which defines surveys, data elaborations and project studies for a three-year period shall be drawn up and updated annually, as established in the Decree n. 322/89. The procedures to be followed with relation to the annual fulfilment as well as the forms to be filled in for census, data elaborations and projects, and how to deal with sensitive information are also defined.
The plan is deliberated by the Committee for addressing and coordinating statistical information (Comstat) and forwarded to the Commission for the assurance of statistical information; the Commission adopts the plan after endorsement of the Guarantor of the privacy of personal data.
Finally, the plan is approved by a Prime Ministerial Decree after consideration of the Interministerial Committee for economic planning (Cipe). The latest Prime Ministerial Decree, which approved the three-year plan for 2008-2010, was issued on 6th August 2008; an update of the plan for 2009-2010 was approved by a Prime Ministerial Decree on 3rd August 2009. Statistical information and results deriving from the completion of the plan are of public domain and the system is responsible for wide circulation.
Ministries, public agencies and other bodies are obliged to provide the data and information specified in the annual statistical plan; the same obligations regard the private entities. All the data are protected by the principles of statistical disclosure control and can be distributed and communicated only at aggregate level even though microdata can circulate among the subjects of the Statistical System.
Sistan activity is supervised by the Commission for Guaranteeing Statistical Information (CGIS) which is an external and independent body. In particular, the Commission supervises: the impartiality and completeness of statistical information, the quality of methodologies, the compliance of surveys with EU and international directives. The Commission, established within the Presidency of the Council of Ministers, is composed of high-profile university professors, directors of statistical or research institutes and managers of public administrations and bodies, which do not participate at Sistan.

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

- National Statistical Yearbooks, Monthly Statistical Bulletins, by ISTAT (National Institute of Statistics);
- Annual Report on the Energy and Environment, by ENEA (Agency for New Technologies, Energy and the Environment);

- National Energy Balance (annual), Petrochemical Bulletin (quarterly publication), by MSE (Ministry of Economic Development);
- Transport Statistics Yearbooks, by MINT (Ministry of Transportation);
- Annual Statistics on Electrical Energy in Italy, by TERNA (National Independent System Operator);
- Annual Report on Waste, by ISPRA;
- National Forestry Inventory, by MIPAAF (Ministry of Agriculture, Food and Forest Policies).

The national emission inventory itself is a Sistan product.
Other information and data sources are used to carry out emission estimates, which are generally referred to in Table 1.1 of the following section 1.4

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

The 'National Registry for Carbon sinks' has been instituted by a Ministerial Decree on 1st April 2008 and is part of the National Greenhouse Gas Inventory System in Italy (ISPRA, 2010 [a]). In 2009, a technical group, formed by experts from different institutions (ISPRA, Ministry of the Environment, Land and Sea, Ministry of Agriculture, Food and Forest Policies and University of Tuscia), set up the methodological plan of the activities necessary to implement the registry and defined the relative funding. Some of these activities are planned to be completed by 2010, which should supply data useful to update and improve the estimations. For this year submission, emissions and removals from 3.3 and 3.4 activities have been estimated on the basis of data and methodologies used for the inventory under the Convention.
Italy has chosen to elect Forest Management (FM) as an activity under Article 3.4. In accordance with the Annex to Decision 16/CMP.1, credits from Forest Management are capped in the first commitment period. Following the Decision 8/CMP.2, the cap is equal to 2.78 Mt C (10.19 MtCO_2) per year, or 13.9 Mt C (50.97 MtCO_2) for the whole commitment period.
The description of the main elements of the institutional arrangement under Article 3.3 and activities elected under Article 3.4 is detailed in Annex 10.
Italy has decided to account for Article 3.3 and 3.4 elected activities at the end of the commitment period; information on accounting for activities under art. 3.3 and 3.4 of the Kyoto Protocol, for the year 2008, is reported in Table 11.1 (par. 11.6), while detailed information on supplementary information under art. 3.3 and 3.4 of the Kyoto Protocol is reported in Chapter 10 KP-LULUCF.

1.2.3 National Registry System

The Italian National Registry is operated and maintained by ISPRA (former APAT) under the supervision of the national Competent Authority for the implementation of directive 2003/87/CE, jointly established by the Ministry for Environment, Land and Sea and the Ministry for Economic Development. ISPRA, as Registry Administrator, becomes responsible for the management and functioning of the Registry, including Kyoto protocol obligations. The registry was connected to the international transaction log (ITL) of the UNFCCC secretariat in October 2008.

A full description of the Italian registry system is presented in Annex 11.

Information on accounting of Kyoto Protocol units, including a summary of information reported in the standard electronic format (SEF) tables is provided in Chapter 11, while information on changes in the National Registry is reported in Chapter 13.

SEF tables including all data referring to units holdings and transactions during year 2009 can be found in Annex 8.

1.3 Brief description of the process of inventory preparation

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

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

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

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

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

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

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

1.4 Brief general description of methodologies and data sources used

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

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

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

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

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

SUMMARY 3 SUMMARY REPORT FOR METHODS AND EMISSION FACTORS USED												
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2		CH_4		N_2O		HFCs		PFCs		SF_6	
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor
1. Energy	**D,M,T1, T2,T3**	**CS,D**	**D,M,T1, T2,T3**	**CR,CS,D**	**D,M,T1, T2,T3**	**CR,CS,D**						
A. Fuel Combustion	D,M,T1, T2,T3	CS	D,M,T1, T2,T3	CR,CS,D	D,M,T1, T2,T3	CR,CS,D						
1. Energy Industries	T3	CS	T3	CR,D	T3	CR,D						
2. Manufacturing Industries and Construction	T2	CS	T2	CR,D	T2	CR,D						
3. Transport	D,M,T1, T2	CS	D,M,T1, T2	CR,CS	D,M,T1, T2	CR,CS						
4. Other Sectors	T2	CS	T2	CR	T2	CR						
5. Other	T2	CS	T2	CR	T2	CR						
B. Fugitive Emissions from Fuels	T1,T2	CS,D	T1,T2	CR,CS,D	T1	D						
1. Solid Fuels	NA	NA	T1	CR,CS,D	NA	NA						
2. Oil and Natural Gas	T1,T2	CS,D	T1,T2	CS,D	T1	D						
2. Industrial Processes	**D,T2**	**CR,CS,D, PS**	**D**	**CR,CS,PS**	**D**	**D,PS**	**CS,D,T2**	**CS,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	NA	NA	T2	D,PS	D	PS
D. Other Production	NA	NA										
E. Production of Halocarbons and SF_6							NA	NA	NA	NA	NA	NA
F. Consumption of Halocarbons and SF_6							CS,T2	CS,D,PS	CS	PS	CS,T3	CS,PS
G. Other	NA	NA	NA	NA	NA	NA	D	PS	NA	NA	NA	NA
3. Solvent and Other Product Use	**CR,CS**	**CR,CS**			**CS**	**CS**						
4. Agriculture			**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,T**	**CS,D**	**T1**	**D**	**T1**	**D**						
A. Forest Land	T1,T2,T3	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								
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	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, resp **CR** (CORINAIR)
RA (Reference Approach) **T2** (IPCC Tier 2) **CS** (Country Specific)
T1 (IPCC Tier 1) **T3** (IPCC Tier 3) **OTH** (Other)

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

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

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

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

Table 1.2 Methods and emission factors used in the inventory preparation

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

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

Data from the Italian Emissions Trading Scheme database are incorporated into the national inventory whenever the sectoral coverage is complete; in fact, not always do ETS data entirely cover the energy categories whereas national statistics, such as national energy balance and the energy production and consumption statistics, provide the complete basic data needed for the Italian emission inventory. Nevertheless, ETS data are always used to develop country-specific emission factors and check activity data levels.

For the industrial sector, the annual production data are provided by national and international statistical yearbooks. Emission data collected through the National Pollutant Emission Register (EPER/E-PRTR) are also used in the development of emission estimates or taken into account as a verification of emission estimates for some specific categories. According to the Italian Decree of 23 November 2001, data from the Italian E-PRTR are validated and communicated by ISPRA to the Ministry for the Environment, Land and Sea and to the European Commission within October of the current year for data referring to the previous year. These data are used for the compilation of the inventory whenever they are complete in terms of sectoral information; in fact, industries communicate figures only if they exceed specific thresholds; furthermore, basic data such as fuel consumption are not supplied and production data are not split by product but reported as an overall value. Anyway, E-PRTR is a good basis for data checks and a way to facilitate contacts with industries which, in many cases, supply, under request, additional information as necessary for carrying out sectoral emission estimates.
In addition, final emissions are checked and verified also taking into account figures reported by industries in their annual environmental reports.
Both for energy and industrial processes, emissions of large industrial point sources are registered individually; communication also takes place in the framework of the European Directive on Large Combustion Plants, based upon detailed information such as fuel consumption. Other small plants communicate their emissions which are also considered individually.
ISPRA personally collects data from the industrial associations under the ETS and other European directives, Large Combustion Plant and EPER/E-PRTR, and makes use of these data in the preparation of the national inventory ensuring the consistency of time series.

For the other sectors, i.e. for solvents, the amount of solvent use is provided by environmental publications of sector industries and specific associations as well as international statistics.
For agriculture, annual production data and number of animals are provided by the National Institute of Statistics and other sectoral associations.
For land use, land use change and forestry, forest and soil surfaces are provided by the National Institute of Statistics while statistics on forest fires are supplied by the State Forestry Corps.
For waste, the main activity data are provided by the Institute for Environmental Protection and Reserach and the Waste Observatory.
In case basic data are not available proxy variables are considered; unpublished data are used only if supported by personal communication and confidentiality of data is respected.
All the material and documents used for the inventory emission estimates are stored at the Institute for Environmental Protection and Research. The inventory is composed by spreadsheets to calculate emission estimates; activity data and emission factors as well as methodologies are referenced to their data sources. A ‘reference’ database has also been developed to increase the transparency of the inventory.

1.5 Brief description of key categories

A key category analysis of the Italian inventory is carried out according to the 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, 18 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, 28 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	L2
CO_2 Mobile combustion: Waterborne Navigation	L1
CO_2 Limestone and dolomite use	L1
CO_2 Ammonia production	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

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

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

Key categories (including the LULUCF sector)	
Indirect N_2O from Nitrogen used in agriculture	L
CH_4 from Solid waste Disposal Sites	L
CO_2 Forest land remaining Forest land	L
CO_2 Cropland remaining Cropland	L
CO_2 Grassland remaining Grassland	L
CO_2 Land converted to Forest Land	L2
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
CO_2 Ammonia production	L1
N_2O from animal production	L2
CH_4 Emissions from Wastewater Handling	L2
CO_2 Emissions from solvent use	L2
N_2O Emissions from Wastewater Handling	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 2008 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, T
CO_2 Fugitive emissions from Oil and Gas Operations	L2, T2
N_2O stationary combustion	L
N_2O Adipic Acid	T
CO_2 stationary combustion other fuels	L1, T
CO_2 Emissions from solvent use	L2, T2
N_2O from animal production	L2, T2
CH_4 Emissions from Wastewater Handling	L, T2
N_2O Emissions from Wastewater Handling	L2, T2
CO_2 Mobile combustion: Waterborne Navigation	L1
CO_2 Iron and steel production	T1
CO_2 Ammonia production	T1
PFC Aluminium production	T1
N_2O Nitric Acid	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 2008

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 2008.

Considering the LULUCF activities under the Kyoto Protocol, CO_2 emissions/removals from 3.4, forest management, has been identified as a key category; forest management is associated with the Forest land remaining Forest land category in the UNFCCC inventory.

The key category analysis is used to prioritize improvements that should be taken into account for the next inventory submissions. First of all, it is important that emissions of key categories, being the most significant in terms of absolute weight and/or combined uncertainty, are estimated with a high level of accuracy. For the Italian inventory, it should be noted that higher tiers are mostly used for calculating emissions from these categories as requested by the Good Practice Guidance (IPCC, 2000) and the use of country specific emission factors is extensive. As reported in Table 1.2, there are only a few key categories which estimates do not meet these quality objectives, such as some categories in the LULUCF sector, in terms of the methodology and emission factors used, some emission estimates from the consumption of F-gases and CH_4 and N_2O emissions from stationary combustion, because of the application of default emission factors. Among these categories, prioritization is made on account of the actual absolute weight, the expected future relevance, the level of uncertainty and a cost-effectiveness analysis. Therefore improvements have been planned for the LULUCF sector. In addition to this evaluation, also categories estimated with higher tiers but affected by a high level of uncertainty are considered in the prioritization plan; for instance, activities are planned for direct N_2O emissions from agricultural soils and indirect N_2O from nitrogen used in agriculture in order to improve the accuracy of the Italian inventory and reduce the overall uncertainty.

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

ISPRA has elaborated an inventory QA/QC plan which describes specific QC procedures to be implemented during the inventory development process, facilitates the overall QA procedures to be conducted, to the extent possible, on the entire inventory and establishes quality objectives.
Particularly, an inventory QA/QC procedures manual (APAT, 2006 [a]) has been drawn up which describes QA/QC procedures and verification activities to be followed during the inventory compilation and helps in the inventory improvement. Furthermore, specific QA/QC procedures and different verification activities implemented thoroughly the current inventory compilation, as part of the estimation process, are figured out in the annual QA/QC plans (APAT, 2005; APAT, 2006 [b]; APAT, 2007 [a]; APAT, 2008 [b]; ISPRA, 2009 [a], ISPRA, 2010 [b]). These documents are publicly available at ISPRA website http://www.apat.gov.it/site/it-IT/APAT/Pubblicazioni/Altre_Pubblicazioni.html.

Quality control checks and quality assurance procedures together with some verification activities are applied both to the national inventory as a whole and at sectoral level. Future planned improvements are prepared for each sector, by the relevant inventory compiler; each expert identifies areas for sectoral improvement based on his own knowledge and in response to inventory UNFCCC reviews and taking into account the result of the key category assessment.
The quality of the inventory has improved over the years and further investigations are planned for all those sectors relevant in terms of contribution to total CO_2 equivalent emissions and with a high uncertainty.

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

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

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

Even though official independent and public reviews prior to the Italian inventory submission are not implemented yet, emission figures are subjected to a process of re-examination once the inventory, the inventory related publications and the national inventory reports are posted on website, specifically www.isprambiente.it, and from the communication of data to different institutions and/or at local level.
In some cases, sectoral major recalculations are presented and shared with the relevant stakeholders prior to the official submission.
For istance this year, there has been a revision of activity data in the LULUCF sector, such as forest area surfaces in consideration of the Kyoto Protocol definition, harvesting activity data, and Land use matrices presented in different expert group meetings.

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

Generally, in the last years ISPRA has held different meetings with the industrial associations in the context of different European directives. ISPRA personally collects data from the industrial associations under the ETS and other European directives, as Large Combustion Plant and E-PRTR. The inventory team manages all these data and makes use of them in the preparation of the national inventory ensuring the consistency of time series among data by the comparison of the information collected under the directives with other sources available before the first available years of data collected (2000 and 2002, first years of data collected from ETS plants and EPER/E-PRTR, respectively).Figures submitted under the ETS, both emissions and activity data, are mandatorily subject to verification procedures, as requested and specified by the European Directive 2003/87/EC (art. 15 and Annex V). Also the quality of E-PRTR data is guaranteed by art.9 of the Regulation 2006/166/EC.
In addition, ISPRA is building a unique database with all this information to help in highlighting the main discrepancies among data, and improving the management of the time series consistency.

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

In 2008, ISPRA finalised the provincial inventory at local scale for the years 1990, 1995, 2000 and 2005; in fact, every 5 years, in the framework of the Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) under the Convention on Long-range Transboundary Air Pollution (CLTRAP), Parties has to report their national air emissions disaggregated on a 50*50 km grid. Specifically, ISPRA has applied a top-down approach to estimate emissions at provincial areas

based on proxy variables. The results were checked out by regional and local environmental agencies and authorities; data are available at ISPRA web address http://www.sinanet.apat.it/it/inventaria and a report which describes detailed methodologies to carry out estimates has been published (Liburdi et al., 2004; ISPRA, 2009 [b]).
Additional comparisons between top-down and local inventories have been carried out during the last year; results are shared among the 'local inventories' expert group and usually lead to an improvement in methodologies for both the inventories whenever large differences occur.

The inventory is also presented to a Technical Committee on Emissions (CTE), coordinated by the Ministry for the Environment, Land and Sea, where all the relevant Ministries and local authorities are represented; within this task emission figures and results are shared and discussed. Especially in the last years, there has been an intensification of these activities in order to establish national policies and measures to meet the 2020 EU target and implement national programmes for the post Kyoto period. In this regard, and as a basis for emission scenarios, the importance of the emission inventory is primary.
Expert peer reviews of the national inventory also occur annually within the UNFCCC process, whose results and suggestions can provide valuable feedback on areas where the inventory should be improved. Specifically, in June 2007, Italy was subjected by the UNFCC Secretariat to the in-country review of the national initial report and the GHG inventory submitted in 2006, which results and recommendations can be found on website at the addresses http://unfccc.int/resource/docs/2007/arr/ita.pdf, http://unfccc.int/resource/docs/2007/irr/ita.pdf, (UNFCCC, 2007 [a]; UNFCCC, 2007 [b]). The results of the last centralised reviews are reported in UNFCCC (2009) and UNFCCC (2010).

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

An official review, apart from those by the UNFCCC, was performed by Ecofys, in 2000, in order to verify of the effectiveness of policies and measures undertaken by Italy to reduce greenhouse gas emissions to the levels established by the Kyoto Protocol. In this framework an independent review and checks on emission levels were carried out as well as controls on the transparency and consistency of methodological approaches (Ecofys, 2001).
More recently, VITO, Öko-Institut and the Institute for European Environmental Policy, for DG Environment, undertook a review on the methodologies and EU Member States best practices used for GHG projections to indentify possible ways to improve GHG projections and ensure consistency across the EU. The results were presented in 2008 at the Workshop 'Assessing and improving methodologies for GHG projections'. Further analyses were presented in the Workshop on 'Quantification of the effects on greenhouse gas emissions of policies and measures'.

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

trends of these indicators are explained in the reports 'Carbon Dioxide Intensity Indicators' (APAT, 2007 [b], APAT, 2008 [c]). Also these documents are posted on ISPRA website http://www.apat.gov.it/site/it-IT/APAT/Pubblicazioni/Altre_Pubblicazioni.html.

Comparisons between national activity data and data from international databases are usually carried out in order to find out the main differences and an explanation to them (ENEA/MAP/APAT, 2004). Emission intensity indicators among countries (e.g. emissions per capita, industrial emissions per unit of value added, road transport emissions per passenger car, emissions from power generation per kWh of electricity produced, emissions from dairy cows per tonne of milk produced) can also be useful to provide a preliminary check and verification of the order of magnitude of the emissions. This is carried out at European and international level by considering the annual reports compiled by the EC and the UNFCCC as well as related documentation available from international databases and outcome of relevant workshops.
Additional comparisons between emission estimates from industrial sectors and those published by the industry itself in their Environmental reports are carried out annually in order to assess the quality and the uncertainty of the estimates.
The quality of the inventory has also improved by the organization and participation in sector specific workshops. Follow-up processes are also set up in the framework of the WGI under the EC Monitoring Mechanism, which addresses to the improvement of different inventory sectors. Specifically in the last years, two workshops were held, one related to the management of uncertainty in national inventories and problems on the application of higher methodologies to calculate uncertainty figures, the other on how to use data from the European emissions trading scheme in the national greenhouse gas inventories. Previous workshops addressed methodologies to estimate emissions from the agriculture and LULUCF sectors, involving the Joint Research Centre, from the waste sector, involving the European Topic Center on Resource and Waste Management, as well as from international bunkers, involving the International Energy Agency and EUROCONTROL. Presentations and documentation of the workshops are available on the website at the address: http://air-climate.eionet.europa.eu/meetings/past_html.
A national conference on the Italian emission inventory was organized by ISPRA in October 2006. Methodologies used to carry out national figures and results of time series from 1990 to 2004 were presented detailing explanations for each sector. More than one hundred participants from national and local authorities, Ministries, Industry, Universities and Research organizations attended the two days meeting.
In 2007, in the context of the national conference on climate change a specific session was dedicated to the national emission inventory. In addition, a specific event was held on the results of the 2005 national GHG inventory. In 2010 the time series of emission figures 1990-2008 will be present in a specific national Kyoto Protocol event.
A specific procedure undertaken for improving the inventory regards the establishment of national expert panels (in particular, in road transport, land use change and forestry and energy sectors) which involve, on a voluntary basis, different institutions, local agencies and industrial associations cooperating for improving activity data and emission factors accuracy. Specifically, for the LULUCF sector, following the election of the 3.3 and 3.4 activities and on account of an in-depth analysis on the information needed to report LULUCF under the Kyoto Protocol, a Scientific Committee, *Comitato di Consultazione Scientifica del Registro dei Serbatoi di Carbonio Forestali*, constituted by the relevant national experts has been established by the Ministry for the Environment, Land and Sea in cooperation with the Ministry of Agriculture, Food and Forest Policies.
In addition to these expert panels, ISPRA participates in technical working groups within the National Statistical System. These groups, named *Circoli di qualità*, coordinated by the National Institute of Statistics, are constituted by both producers and users of statistical information with the aim of improving and monitoring statistical information in specific sectors such as transport,

industry, agriculture, forest and fishing. As reported in previous sections, these activities improve the quality and details of basic data, as well as enable a more organized and timely communication.

A summary of all the main QA/QC 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 2010' (ISPRA, 2010 [b]).

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

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

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

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

The 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.

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 2008 total emission figures without LULUCF, an uncertainty of 3.2% in the combined global warming potential (GWP) total emissions, whereas for the trend between 1990 and 2008 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 7.2% for the year 2008, whereas the uncertainty for the trend is estimated to be 6.2%.

The differences in the uncertainty levels, including the LULUCF sector, as compared the 2009 submission, are due to the different weights of the categories and their uncertainties as a consequence of the recalculation in the LULUCF sector.

The assessment of uncertainty has also been applied to the base year emission levels. The results show an uncertainty of 3.5% in the combined GWP total emissions, excluding emissions and removals from LULUCF, whereas it increases to 6.6% 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 uncertainty estimations are based on are documented for each category. Figures used to draw up uncertainty analysis are checked both with the relevant analyst experts and literature references and are consistent with the IPCC Good Practice Guidance (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, and even in this case the uncertainty may be assumed lower than the predetermined level. Since the overall uncertainty of the Italian inventory is relatively low due to the prevalence of the energy sector sources, which estimates derive from accurate parameters, out of the total, it has been decided to use conservative figures; this occurs especially for energy and industrial sectors.

The results of the uncertainty analysis, generally associated with a key category assessment following the Tier 2 approach, are used to prioritize improvements for the next inventory submissions.

Emissions of key categories are usually estimated with a high level of accuracy in terms of the methodology used and characterised by a low uncertainty; some exceptions may occur and categories estimated with higher tiers may be affected by a high level of uncertainty. For istance, in the agriculture sector, direct N_2O emissions from agricultural soils and indirect N_2O from nitrogen used in agriculture are affected by a high level of uncertainty especially in the emission factors notwithstanding the advanced tiers used.

For the categories with a high uncertainty, generally, further improvements are planned whenever sectoral studies can be carried out. For this year, LULUCF and specific agriculture activities are planned to improve the accuracy of the Italian inventory and reduce the overall uncertainty.

1.8 General assessment of the completeness

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

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.C2 Multilateral Operations	Information and statistical data are not available
CO2	1 Energy	1.C2 Multilateral Operations	Information and statistical data are not available
N2O	1 Energy	1.C2 Multilateral Operations	Information and statistical data are not available

Table 1.7 Source and sinks not estimated in the 2008 inventory

Details are reported in Table 1.7 and Table 1.8. Sectoral and background tables of CRF sheets are complete as far as details of basic information are available. For instance, multilateral operations emissions are not estimated because no activity data are available. With respect to the last year submission, improvements concerned the estimation of emissions from the combustion of biomass in the pulp and paper industry and emissions from the use of N_2O in explosives also in response to the recommendations of the last UNFCCC review.
Allocation of emissions is not consistent with the IPCC Guidelines only where there is no data available to split the information. For instance, for fugitive emissions, CO_2 and CH_4 emissions from oil and natural gas exploration and venting are included in those from oil production because no detailed information is available. CH_4 emissions from other leakage emissions are included in distribution emission estimates. N_2O emissions from oil and natural gas exploration and refining and storage activities are reported under category 1.B.2.C oil flaring. Further investigation will be carried out closely with industry about these figures. For industrial processes, emissions from soda ash use are included in glass production emissions because the use of soda is part of that specific production process.

Sources and sinks reported elsewhere (IE)[3]				
GHG	**Source/sink category**	**Allocation as per IPCC Guidelines**	**Allocation used by the Party**	**Explanation**
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 emission from coke production are fugitive emissions due to the door leakage during the solid transformation and are reported under the 1.B.1.b category, fugitive emissions from solid fuel
CH4	6.B.1 Industrial Wastewater	6.B.1 Industrial Wastewater/Sludge	6.B.1 Industrial Wastewater/Wastewater	Emissions are reported under 6.B.1 Industrial Wastewater/Wastewater
CH4	1.AA.3.B Road Transportation	1.AA.3B biomass	1.AA.3B liquid fuel	Emissions are included in liquid fuel - gasoil/diesel category
CO2	1.B.2.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	Emission 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	Emission from soda ash use are included in other processes (glass, paper,etc).
CO2	5.A.1 Forest Land remaining Forest Land	5.A.1. - 5(V) - Biomass Burning - Wildfires	5.A.1 Carbon stock change	CO2 emissions due to wildfires in forest land remaining forest land are included in table 5.A.1, Carbon stock change in living biomass, Losses
CO2	5.B.1 Cropland remaining Cropland	5 (IV) CO2 emissions from agricultural lime application - Dolomite CaMg $(CO_3)_2$	IE in 5 (IV) CO2 emissions from agricultural lime application - Limestone $Ca(CO_3)$	CO2 emissions from agricultural dolomite $CaMg(CO_3)_2$ application have been included in CO2 emissions from Limestone application, as national statistics on amount of lime applied don't allow to disaggregate the two component (limestone and dolomite)

Table 1.8 Source and sinks reported elsewhere in the 2008 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 1990-2008 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 4.7% between 1990 and 2008, varying from 517 to 541 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 86.4% of total emissions in CO_2 equivalent, shows an increase by 7.4% between 1990 and 2008. In the energy sector, in particular, emissions in 2008 are 8.9% greater than in 1990.
CH_4 and N_2O emissions are equal, respectively, to 6.6% and 5.4% of the total CO_2 equivalent greenhouse gas emissions. CH_4 emissions have decreased by 13.4% from 1990 to 2008, while N_2O has decreased by 20.9%.
Other greenhouse gases, HFCs account for 1.4% of total emissions, PFCs and SF_6 are equal to 0.04% and 0.1% of total emissions respectively; HFC emissions show a strong increase, while PFC emissions show a decrease and SF_6 emissions show a lighter increase. Although at present, variations in these gases are not relevant to reaching the emission reduction objectives, the meaningful increasing trend of HFCs will make them even more important in next years.
Figure 2.1 illustrates the national trend of greenhouse gases for 1990-2008, 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.

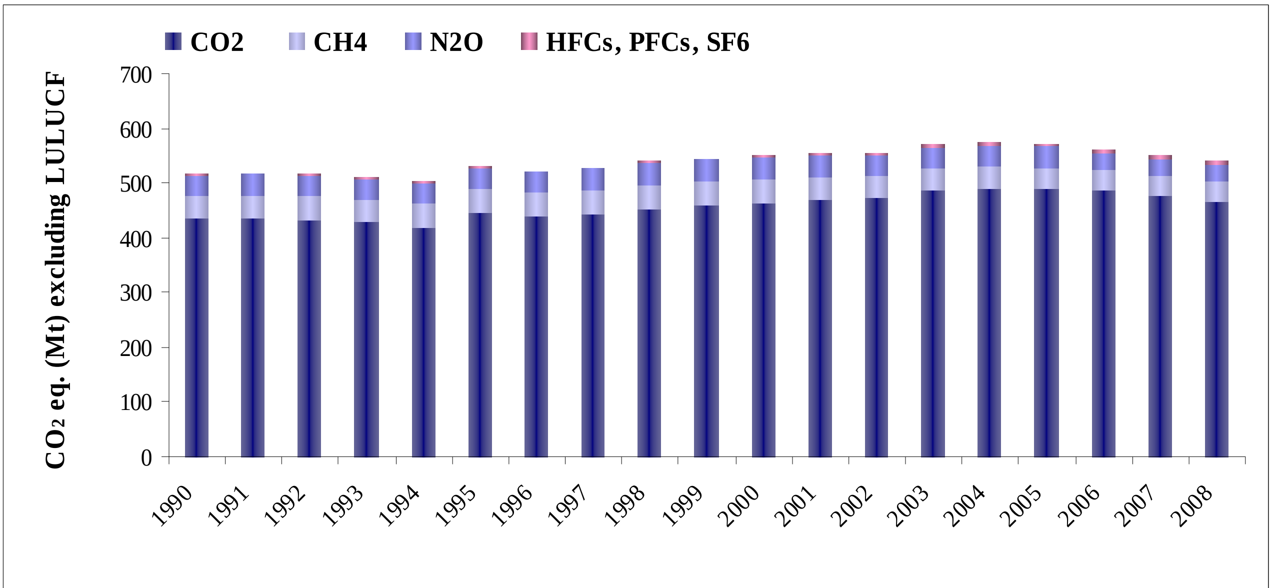


Figure 2.1 National greenhouse gas emissions from 1990 to 2008 (without LULUCF) (Mt CO_2 eq.)

The share of the different sectors in terms of total emissions remains nearly unvaried over the period 1990-2008. Specifically for the year 2008, the greatest part of the total greenhouse gas emissions is to be attributed to the energy sector, with a percentage of 83.6%, followed by agriculture and industrial processes, accounting respectively for 6.6% and 6.3% of total emissions, waste contributing with 3.1% and use of solvents with 0.4%.

Considering total greenhouse gas emissions with emissions and removals from LULUCF, the energy sector accounts, in 2008, for 72.0% of total emissions and removals, as absolute weight, followed by the LULUCF sector which contributes with 13.9%.

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

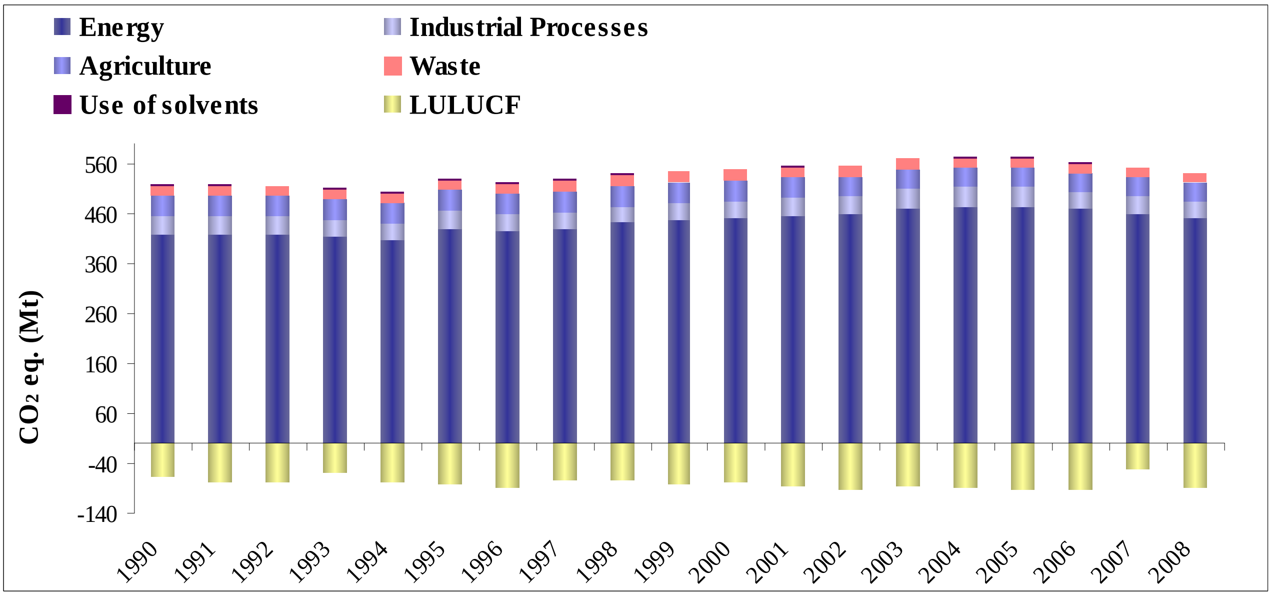


Figure 2.2 Greenhouse gas emissions and removals from 1990 to 2008 by sector (Mt CO_2 eq.)

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 7.4% from 1990 to 2008, ranging from 436 to 468 million tons.

The most relevant emissions derive from the energy industries (34.0%) and transportation (26.2%). Non-industrial combustion accounts for 18.1% and manufacturing and construction industries for 15.6%, while the remaining emissions derive from industrial processes (5.3%) and other sectors (0.8%).

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

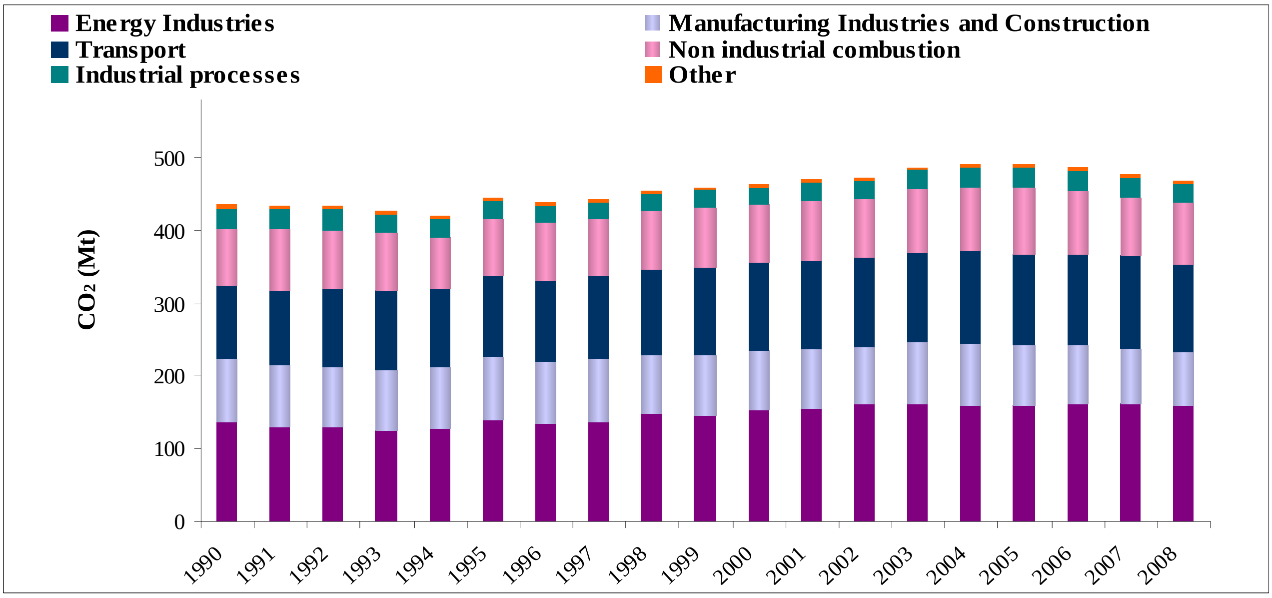


Figure 2.3 National CO_2 emissions by sector from 1990 to 2008 (Mt)

The main sectors responsible for the increase of CO_2 emissions are transport and energy industries; in particular, emissions from transport have increased by 20.9% from 1990 to 2008 while those from energy industries increased by 16.6%. Non industrial combustion emissions have raised by 9.2% and those from industrial processes decreased by 11.6%; emissions from manufacturing industries and construction show a decrease of about 15.9%, emissions in the ‘Other’ sector, mostly fugitive emissions from oil and natural gas and emissions from solvent and other product use, reduced by 31.5%.

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.

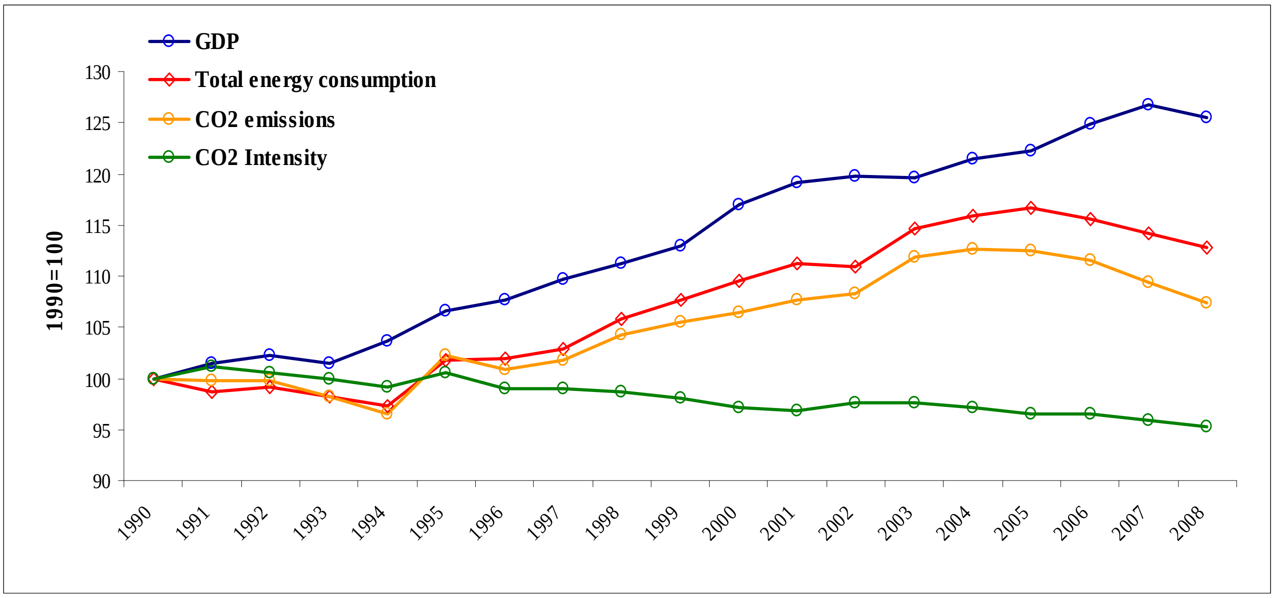


Figure 2.4 Energy-related and economic indicators and CO_2 emissions

2.2.2 Methane emissions

Methane emissions (excluding LULUCF) in 2008 represent 6.6% of total greenhouse gases, equal to 36.0 Mt in CO_2 equivalent, and show a decrease of approximately 5.6 Mt (-13.4%) as compared to 1990 levels.

CH_4 emissions, in 2008, are mainly originated from agriculture which accounts for 42.5 % of total methane emissions, as well as from the waste sector (39.5%) and energy (17.8%).

Activities typically leading to emissions in the waste-management sector are the operation of dumping sites and the treatment of industrial waste-water. The waste sector shows a decrease in emission levels, 8.0% compared to 1990; the solid waste disposal on land, which represents the largest emission sectoral share (78.0%), decreases of 16.7%, while the highest increases concern waste-water handling (42.8%) and waste incineration (75.6%) subcategories.

Emissions in the agricultural sector regard mainly the enteric fermentation (71.4%) and manure management (19.4%) categories. The agriculture sector shows a decrease of emissions equal to 11.2% as compared to 1990.

In terms of CH_4 emissions in the energy sector, the reduction (-27.0%) is the result of two contrasting factors: on the one hand there has been a considerable reduction in emissions deriving from energy industries, manufacturing industries and construction, transport, fugitive emissions from fuels (caused by leakage from the extraction and distribution of fossil fuels, due to the gradual replacement of natural-gas distribution networks), on the other hand a strong increase in the civil sector can be observed, as a result of increased use of methane in heating systems.

Figure 2.5 shows the emission figures by sector.

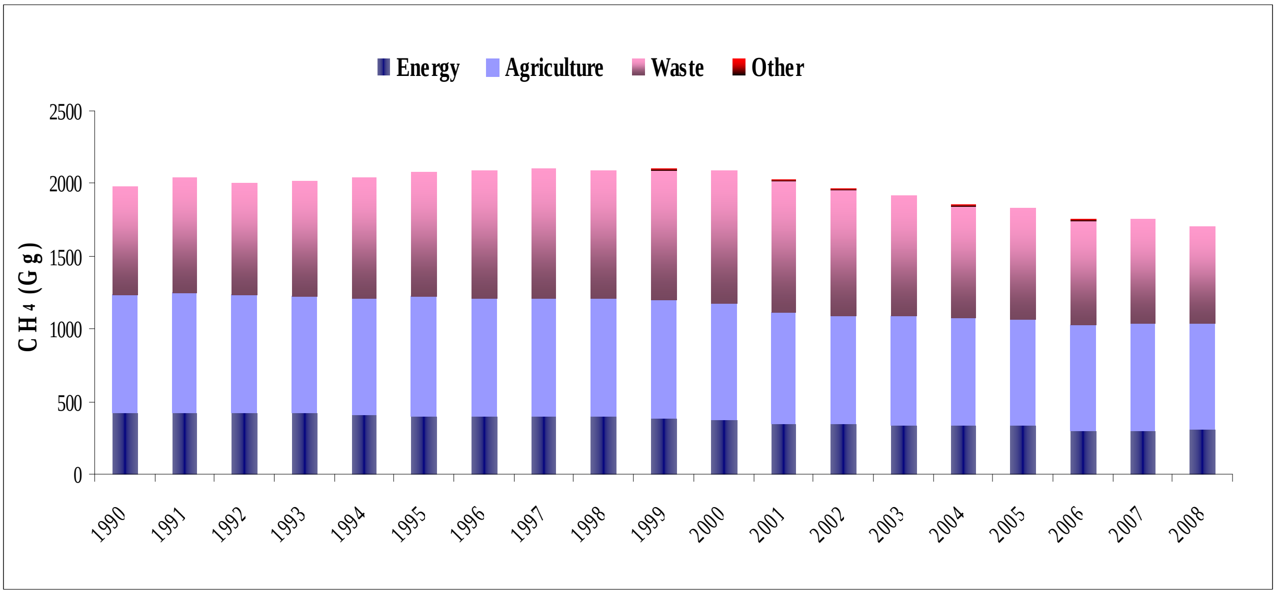


Figure 2.5 National CH_4 emissions by sector from 1990 to 2008 (Gg)

2.2.3 Nitrous oxide emissions

In 2008 nitrous oxide emissions (excluding LULUCF) represent 5.4% of total greenhouse gases, with a a decrease of 20.9% between 1990 and 2008, from 37.2 to 29.4 Mt CO_2 equivalent.
The major source of N_2O emissions is the agricultural sector (69.9%), in particular the use of both chemical and organic fertilisers in agriculture, as well as the management of waste from the raising of animals. These emissions show a decrease of 11.9% during the period 1990-2008.
Emissions in the energy-use sector (16.7% of the total) show an increase by 11.1% from 1990 to 2008; 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 2008 of 82.8%; emissions from production of adipic acid show an increase from 1990 to 2005 of 32.6% and a decrease from 2005 to 2008 of 88.4% because of the introduction of an abatement technology, showing a global reduction of 84.6% (joint emissions in 2005 accounted for 20.7% and in 2008 for 3.6% of total emissions).
Other emissions in the waste sector primarily regard the processing of industrial and domestic waste-water (6.9% of national emissions).
Figure 2.6 shows national emission figures by sector.

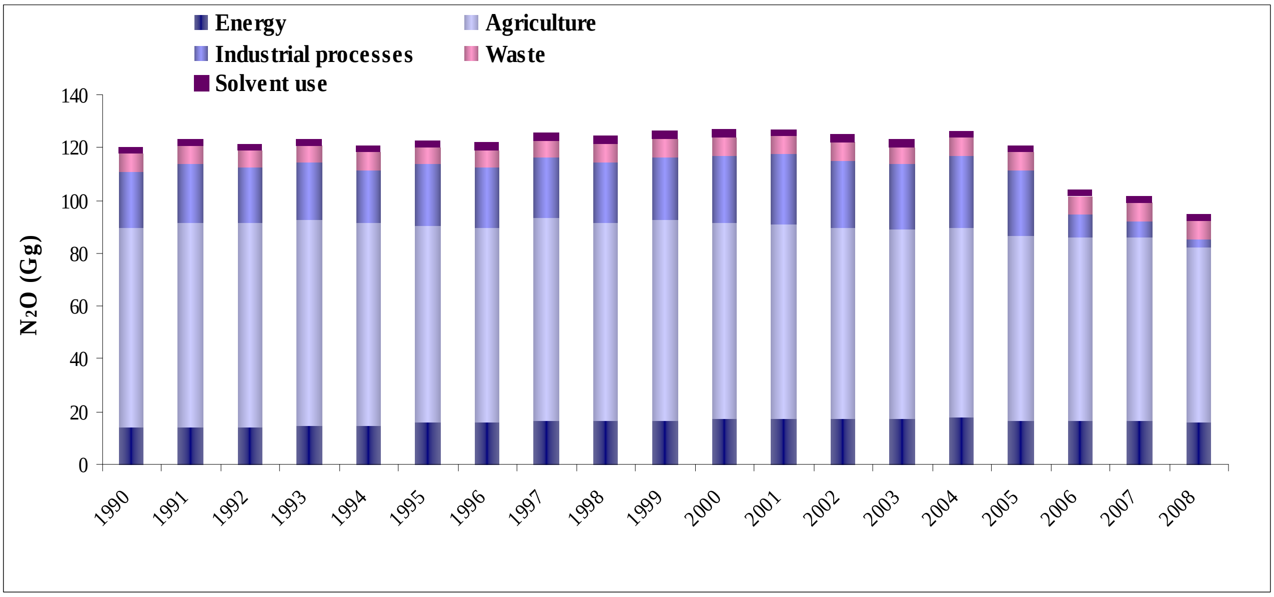


Figure 2.6 National N_2O emissions by sector from 1990 to 2008 (Gg)

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 1.5% of total greenhouse gases in CO_2 equivalent in 2008, and they show an increase of 221.4% between 1990 and 2008. This increase is the result of different features for the different gases.

HFCs, for instance, have increased considerably from 1990 to 2008, from 0.4 to 7.4 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 89.2% from 1990 to 2008. The level of these emissions in 2008 is 0.2 Mt in CO_2 equivalent, and it it is due to the use of the gases in the production of aluminium (57.2%) and in the production of semiconductors (42.8%). 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 2008, with an increase of 30.4% as compared to 1990 levels. 2.4% of SF_6 emissions derive from the use of gas in aluminium and magnesium foundries, 90.7% from the gas contained in electrical equipments, 6.9% from the gas use in the semiconductors manufacture. From 2005 to 2006, emissions of SF_6 have fallen of 12.8%, showing between 2006 and 2008 an increase of 7.0%.

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.

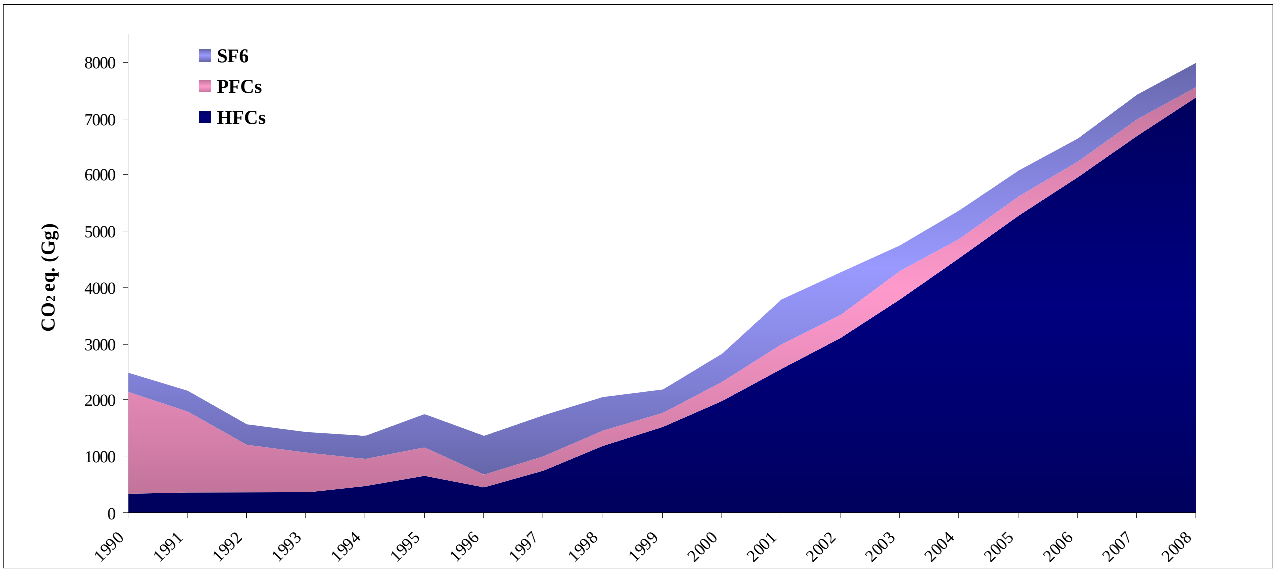


Figure 2.7 National emissions of fluorinated gases by sector from 1990 to 2008 (Gg CO_2 eq.)

2.3 Description and interpretation of emission trends by source

2.3.1 Energy

Emissions from the energy sector account for 83.6% of total national greenhouse gas emissions, excluding LULUCF.
Emissions in CO_2 equivalent from the energy sector are reported in Table 2.1 and Figure 2.8.

	1990	1995	2000	2005	2006	2007	2008
	Gg CO_2 eq						
Total emissions	**418,577**	**431,428**	**450,808**	**473,902**	**469,217**	**459,056**	**452,907**
Fuel Combustion (Sectoral Approach)	*407815*	*421370*	*441798*	*466079*	*461872*	*451865*	*445534*
Energy Industries	137214	140541	152556	161146	162983	162289	159838
Manufacturing Industries and Construction	88200	87637	85323	82174	80827	77529	74372
Transport	102894	113700	122408	127351	128733	128753	123879
Other Sectors	78387	77982	80660	94116	88270	82325	86644
Other	1120	1511	851	1291	1058	969	801
Fugitive Emissions from Fuels	*10762*	*10057*	*9010*	*7823*	*7345*	*7191*	*7373*
Solid Fuels	122	65	73	69	54	84	73
Oil and Natural Gas	10640	9993	8936	7755	7292	7107	7300

Table 2.1 Total emissions in CO_2 equivalent from the energy sector by source (1990-2008) (Gg CO_2 eq.)

An upward trend is noted from 1990 to 2004, total greenhouse gas emissions, in CO_2 equivalent, show an increase by 13.3%, while between 2004 and 2008 emissions have decreased by 4.5%, showing from 1990 to 2008 an increase of about 8.2%.
Substances with the highest impact are CO_2, whose levels have increased by 8.9% from 1990 to 2008 and account for 97.5% of the total, and N_2O which shows an increase of 11.1% but its share out of the total is only 1.1%; CH_4, on the other hand, shows a decrease of 27.0% from 1990 to 2008 but this is not relevant on total emissions, accounting only for 1.4%.
It should be noted that from 1990 to 2008 the most significant increase, in terms of total CO_2 equivalent, is observed in transport, in the energy industries and in the other sectors, about 20.4%,

16.5% and 10.5%, respectively; in 2008 these sectors, altogether, account for 81.8% of total emissions.
Details on these figures are described in the specific chapter.

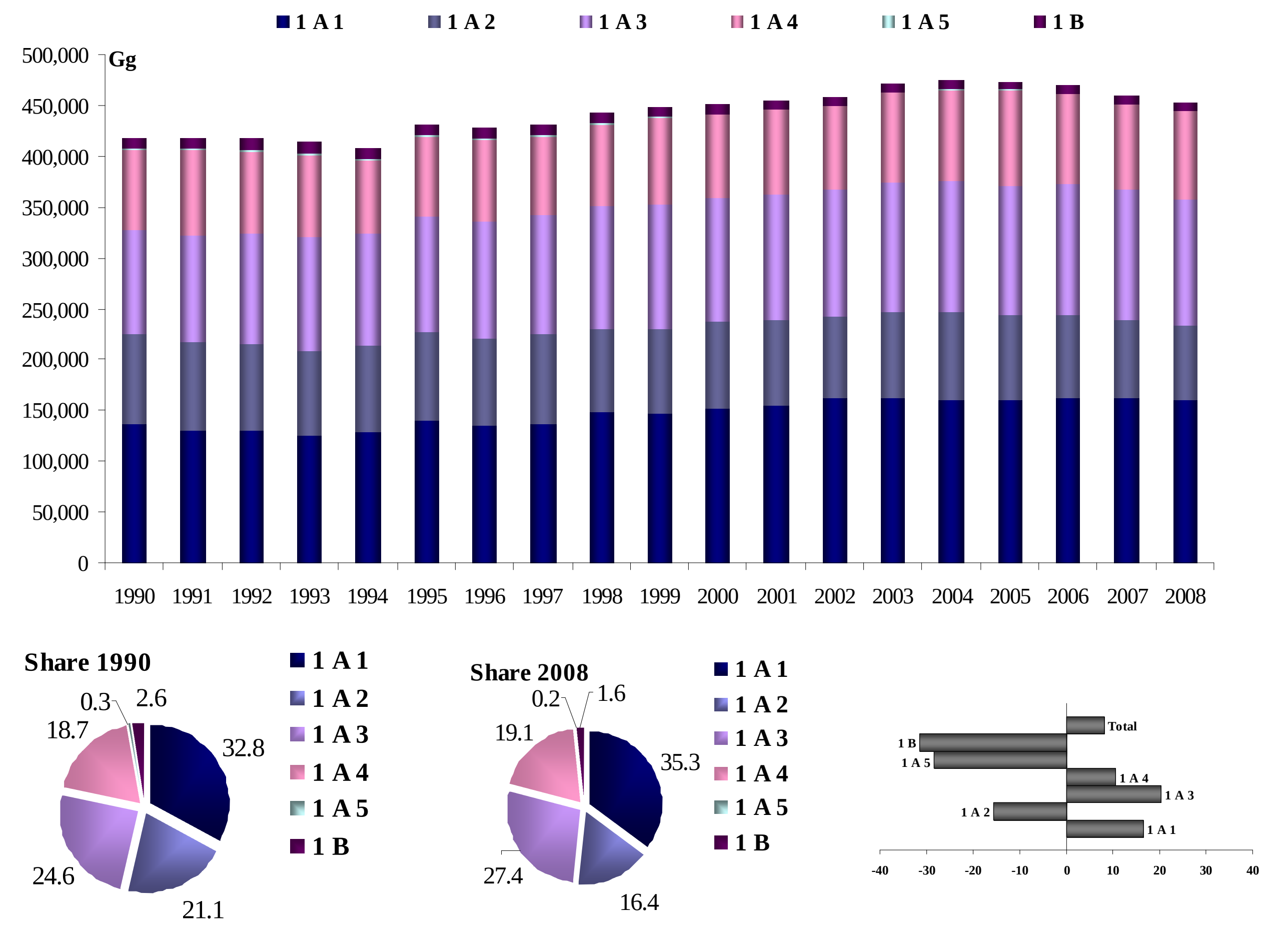


Figure 2.8 Trend of total emissions in CO_2 equivalent from the energy sector by gas (1990-2008) (Mt CO_2 eq.)

2.3.2 Industrial processes

Emissions from industrial processes account for 6.3% 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 9.1%, from the base year to 2008. Taking into account emissions by substance, CO_2 level decreased by 11.6%, while N_2O level decreased by 84.0%; these two substances account altogether for about 76.3% of the total emissions from industrial processes (CO_2 for 73.2% and N_2O for 3.1%). CH_4 decreased by 43.9%, but it accounts only for 0.2%. The decrease in emissions is mostly due to a decrease in chemical industry and metal production emissions. The decrease of GHG emissions in the chemical industry (-74.4%) is due to the decreasing trend of the emissions deriving from nitric acid and adipic acid production (as regards the last one, due to a fully operational abatement technology). Emissions from metal production decreased by 61.6% mostly for the different materials used in the pig iron and steel production processes.
A considerable increase is observed in F-gas emissions (221.4%), whose share on total emissions is 23.5%.

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

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008
						Gg CO_2 eq					
Total	**37508**	**34946**	**35190**	**37247**	**37394**	**38720**	**41042**	**40946**	**36420**	**36944**	**34099**
CO_2	28231	25831	24383	25160	25172	26344	27173	27036	27063	27573	24965
CH_4	108	113	63	59	57	58	61	64	66	65	61
N_2O	6676	7239	7918	8232	7902	7557	8443	7760	2647	1891	1066
F-gases	2492	1764	2825	3796	4263	4761	5365	6085	6644	7416	8008
HFCS	351	671	1986	2550	3100	3796	4515	5267	5956	6701	7379
PFCS	1808	491	346	451	424	498	348	353	282	288	194
SF_6	333	601	493	795	740	468	502	465	406	428	434

Table 2.2 Total emissions in CO_2 equivalent from the industrial processes sector by gas (1990-2008)

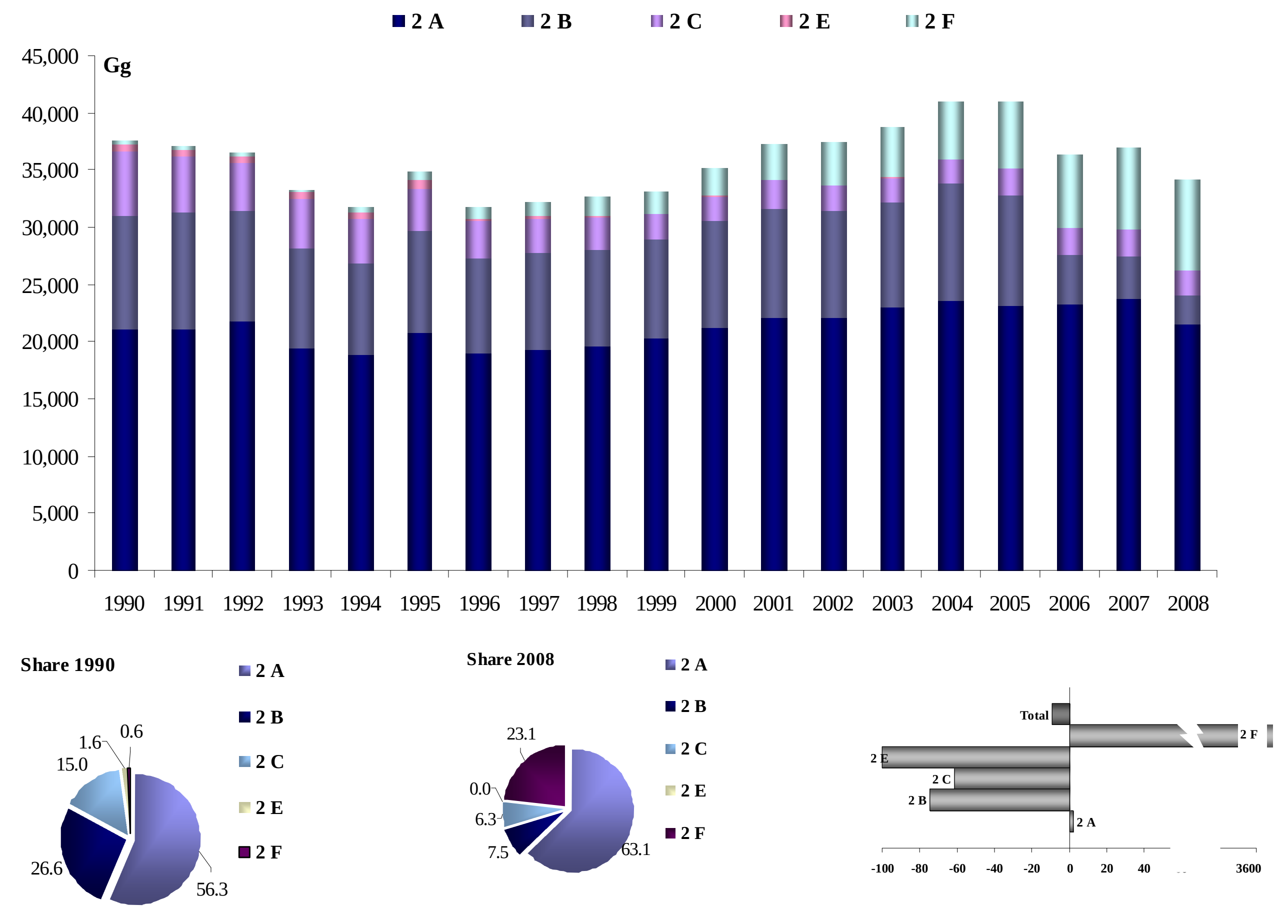


Figure 2.9 Trend of total emissions in CO_2 equivalent from industrial processes by gas (1990-2008) (Mt CO_2 eq.)

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

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008
	Gg CO_2 eq										
Total emissions	**2455**	**2239**	**2302**	**2217**	**2219**	**2168**	**2144**	**2139**	**2141**	**2104**	**1999**
CO_2	1643	1467	1276	1286	1290	1296	1300	1315	1332	1316	1272
N_2O	812	772	1027	931	929	873	845	823	808	788	727

Table 2.3 Total emissions in CO_2 equivalent from the solvent and other product use sector by gas (1990-2008)

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 63.6% out of the total, while N_2O emissions represent 36.4% of the sectoral total; a decrease by 18.6% is noted from this sector from 1990 to 2008, which is to be attributed to different sources. As regards CO_2, emission levels from paint application sector, which accounts for 53.1% of total CO_2 emissions from this sector, decreased by 20.0%; 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 41.7% of the CO_2 total emissions, show a decrease of 14.7%. Finally, CO_2 emissions from metal degreasing and dry cleaning activities, decreased by 62.3% but they account for only 5.2% of the total.

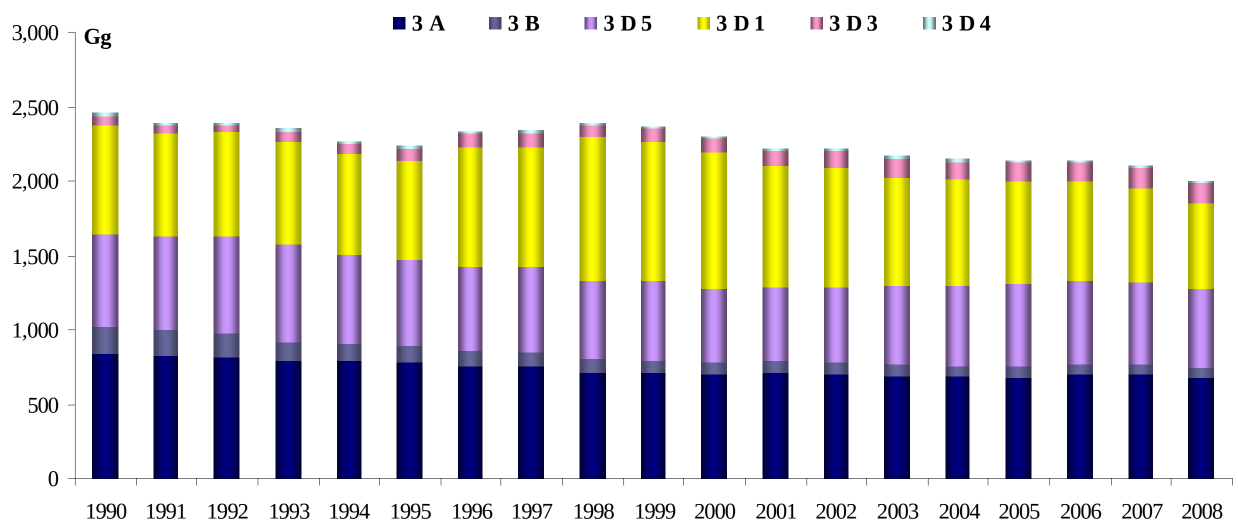
In 2008, solvent use is responsible for 0.4% of the total CO_2 equivalent emissions (excluding LULUCF) and for 42.9% of the total NMVOC emissions, and represents the second source of anthropogenic NMVOC national emissions.

N_2O emissions from this sector, in 2008, represent 2.5% 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 80.1% and 94.8% of the sectoral total, respectively.

From 1990 to 1995, a quite stable level of N_2O emissions is observed, afterwards from 1995 to 1998 emissions increased by 36.7%; From 1999 onwards, there appears to be a reduction in N_2O emissions (from 1990 to 2008, emissions decrease of 10.5%), 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.



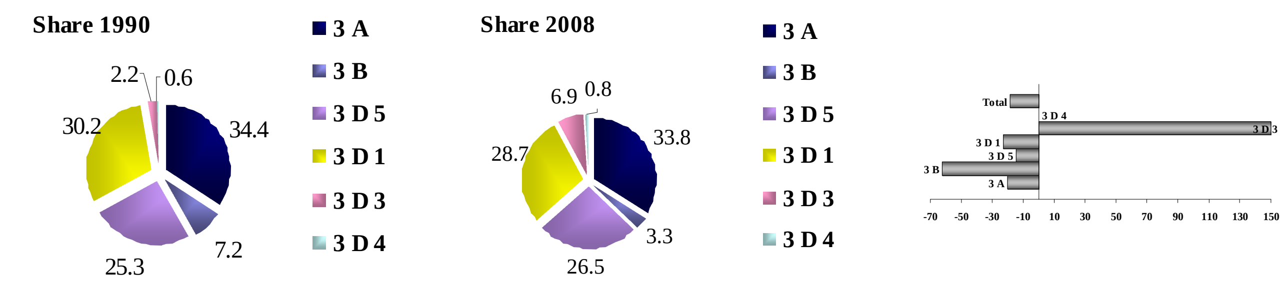


Figure 2.10 Trend of total emissions in CO_2 equivalent from the solvent and other product use sector (1990-2008) (Mt CO_2 eq.)

2.3.4 Agriculture

Emissions from the agriculture sector account for 6.6% of total national greenhouse gas emissions, excluding LULUCF.
Emissions from the agriculture sector are reported in Table 2.4 and Figure 2.11.

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008
	Gg CO_2 eq										
Total emissions	**40576**	**40349**	**39940**	**38957**	**38259**	**38116**	**37883**	**37204**	**36621**	**37222**	**35865**
Enteric Fermentation	12179	12267	12165	11340	11031	11057	10834	10841	10626	11024	10921
Manure Management	7383	7068	7140	7344	7115	7075	6868	6857	6629	6833	6736
Rice Cultivation	1562	1657	1382	1382	1420	1463	1534	1472	1477	1523	1396
Agricultural Soils	19435	19340	19237	18877	18677	18506	18628	18017	17873	17826	16795
Field Burning of Agricultural Residues	17	17	16	15	17	15	18	17	17	17	18

Table 2.4 Total emissions in CO_2 equivalent from the agricultural sector by source (1990-2008) (Gg CO_2 eq.)

Emissions refer to CH_4 and N_2O levels, which account for 42.6% and 57.4% of the total emission of the sector, respectively. The decrease observed in the total emissions (-11.6%) is mostly due to the decrease of CH_4 emissions from enteric fermentation (-10.3%) and to the decrease of N_2O (-13.6%) from agricultural soils, which account for 30.4% and 46.8% of the total emissions, respectively. Detailed comments can be found in the specific chapter.

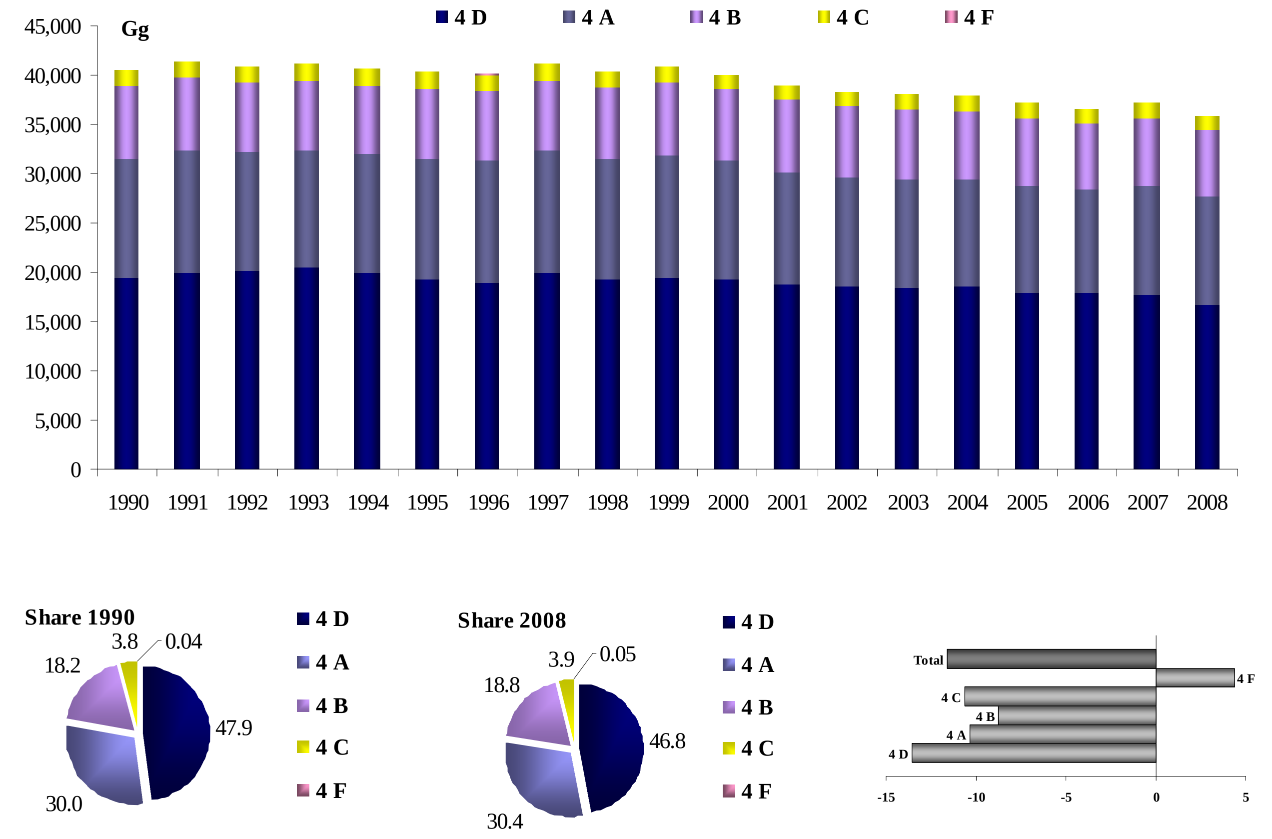


Figure 2.11 Trend of total emissions in CO_2 equivalent from agriculture (1990-2008) (Mt CO_2 eq.)

2.3.5 LULUCF

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

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008
	Gg CO_2 eq										
Total emissions	**-64757**	**-82447**	**-75943**	**-85500**	**-93560**	**-84908**	**-88948**	**-91964**	**-92409**	**-52268**	**-87299**
Forest Land	-42723	-63220	-53358	-63106	-70353	-62458	-68496	-70186	-69876	-32752	-64642
Cropland	-20029	-14921	-14586	-14258	-14722	-14191	-11857	-13071	-13080	-13223	-13239
Settlements	2151	2145	2329	3190	3194	3204	3202	3215	3237	3235	3253
Grassland	-4156	-6451	-10329	-11326	-11680	-11463	-11796	-11921	-12690	-9528	-12671
Wetlands											
Other Land											
Other											

Table 2.5 Total emissions in CO_2 equivalent from the LULUCF sector by source/sink (1990-2008) (Gg CO_2 eq.)

Total removals, in CO_2 equivalent, in the LULUCF sector, show from the base year to 2008, an increase of 34.8%.
CO_2 accounts for more than 99% of total emissions and removals of the sector.
Further details for LULUCF emissions and removals can be found in the specific chapter.

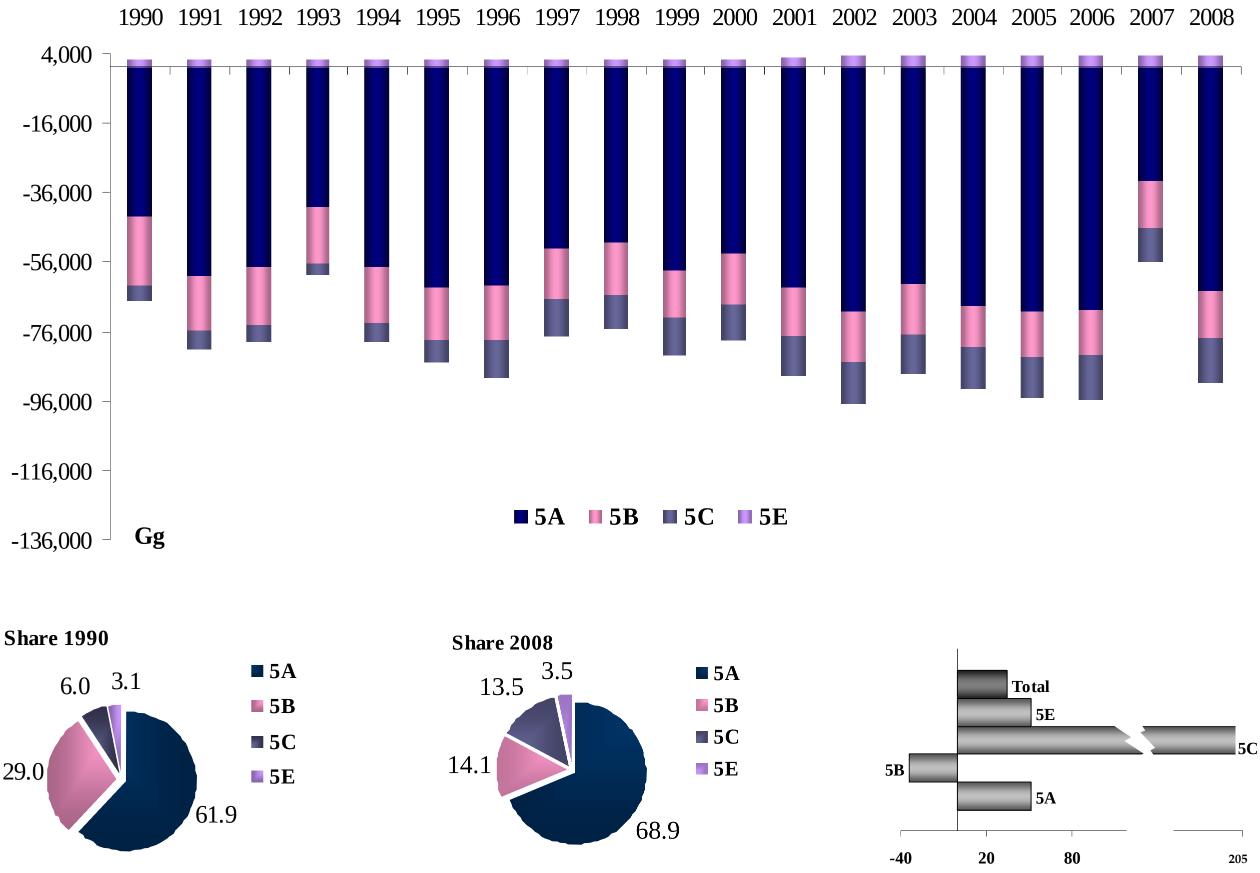


Figure 2.12 Trend of total emissions and removals in CO_2 equivalent from LULUCF (1990-2008) (Mt CO_2 eq.)

2.3.6 Waste

Emissions from the waste sector account for 3.1% of total national greenhouse gas emissions, excluding LULUCF.

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

Total emissions in CO_2 equivalent decreased by 7.4% from 1990 to 2008. The decrease is mainly due to the decrease in emissions from solid waste disposal on land (-16.7%), accounting for 66.7% of the total.

Considering emissions by gas, the most important greenhouse gas is CH_4 which accounts for 85.5% of the total and shows a decrease of 8.0% from 1990 to 2008. N_2O levels have increased by 10.6% while CO_2 decreased by 53.5%; these gases account for 13.0% and 1.5%, respectively.

Further details can be found in the specific chapter.

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008
	Gg CO_2 eq										
Total emissions CO_2 equivalent	**17934**	**20482**	**21572**	**21297**	**20500**	**19639**	**18641**	**18447**	**17647**	**17302**	**16614**
Solid Waste Disposal on Land	13294	15566	16682	16303	15430	14537	13382	13133	12234	11845	11076
Waste-water Handling	3854	4032	4324	4375	4440	4493	4571	4639	4734	4823	4879
Waste Incineration	785	884	564	617	627	604	686	671	675	630	655
Other	0	0	2	3	3	4	4	4	4	5	4

Table 2.6 Total emissions in CO_2 equivalent from the waste sector by source (1990-2008) (Gg CO_2 eq.)

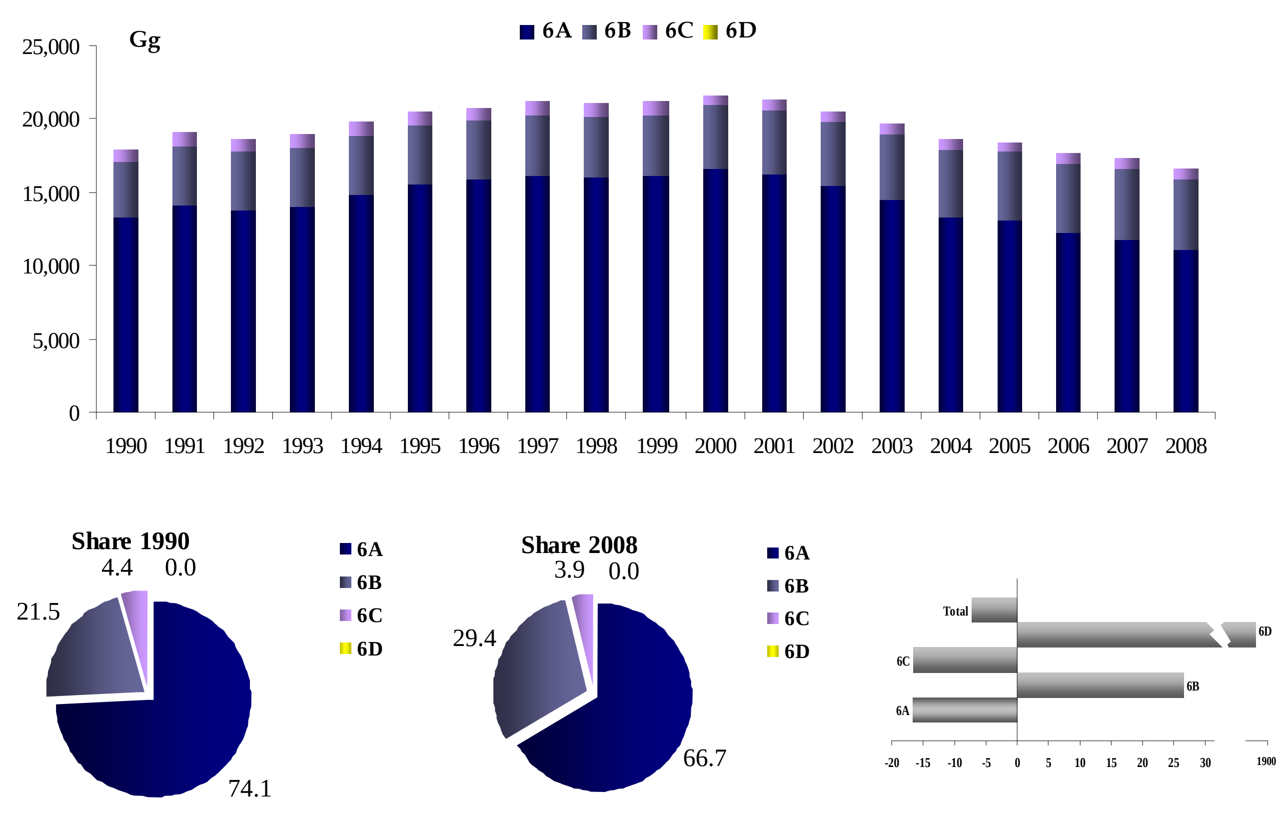


Figure 2.13 Trend of total emissions in CO_2 equivalent from waste (1990-2008) (Mt CO_2 eq.)

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 2008 are presented in Table 2.7 and Figure 2.14.

Indirect greenhouse gases and SO_2	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008
kt											
NO_X	2,041	1,916	1,455	1,426	1,371	1,349	1,312	1,227	1,173	1,140	1,067
CO	7,236	7,178	4,994	4,694	4,279	4,083	3,899	3,496	3,293	3,242	3,049
NMVOC	2,013	2,077	1,600	1,514	1,444	1,378	1,324	1,249	1,217	1,194	1,128
SO_2	1,795	1,320	750	697	616	518	480	402	380	337	294

Table 2.7 Total emissions for indirect greenhouse gases and SO_2 (1990-2008) (kt)

All gases show a significant reduction in 2008 as compared to 1990 levels. The highest reduction is observed for SO_2 (-83.6%), CO levels have reduced by 57.9%, while NO_X and NMVOC show a decrease by 47.7% and 44.0%, respectively. A detailed description of the trend by gas and sector as well as the main reduction plans can be found in the Italian National Programme for the progressive reduction of the annual national emissions of SO_2, NO_X, NMVOC and NH_3, as requested by the Directive 2001/81/EC.

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

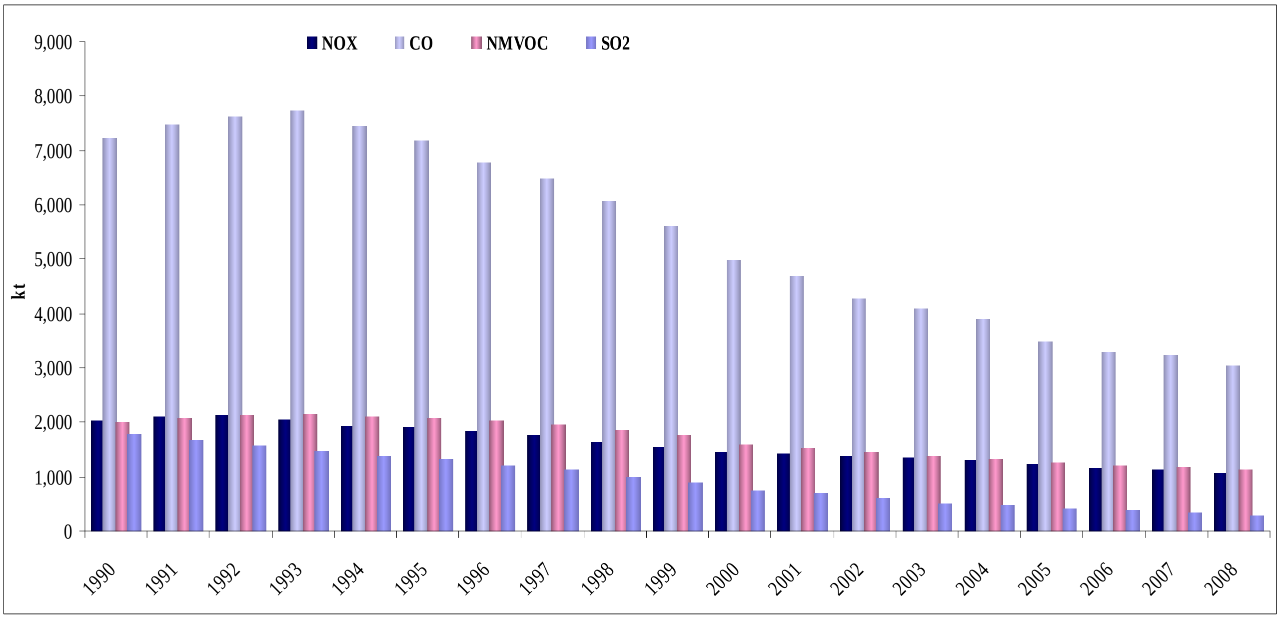


Figure 2.14 Trend of total emissions for indirect greenhouse gases and SO_2 (1990-2008) (kt)

Chapter 3: ENERGY [CRF sector 1]

3.1 Sector overview

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

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

The national emission inventory is prepared using energy consumption information available from national statistics and an estimate of the actual use of the fuels. The latter information is available at sectoral level in a different number of publications and the evaluation of emissions of methane and nitrous oxide is needed. Those emissions are related to the actual physical conditions of the combustion process and to environmental conditions.

The continuous monitoring of GHG emissions in Italy is not regular especially in some sectors; hence, information is not often available on actual emissions over a specific period from an individual emission source. Therefore, the majority of emissions are estimated from different information such as fuel consumption, distance travelled or some other statistical data related to emissions.

Estimates for a particular source sector are calculated by applying an emission factor to an appropriate statistic. That is:

Total Emission = Emission Factor x Activity Statistic

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

For some categories, emissions data are available at individual site. Hence, emissions for a specific category can be calculated as the sum of the emissions from these point sources. That is:

Emission = Σ Point Source Emissions

However, it is necessary to carry out an estimate of the fuel consumption associated with these point sources, so that emissions from non-point sources can be estimated from fuel consumption data without double counting. In general, point source approach is applied to specific point sources (e.g. power stations, cement kilns, refineries). Most non-industrial sources are estimated using emission factors.

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

- Other Industry;
- Other Industry Off-road (see paragraph 3.6);
- Iron & Steel (Combustion, Blast Furnaces, Sinter Plant);
- Petrochemical industries (Combustion);
- Other combustion with contact industries: glass and tiles;
- Other industries (Metal works factories, food, textiles, others);
- Ammonia Feedstock (natural gas only);
- Ammonia (Combustion) (natural gas only);
- Cement (Combustion);
- Lime Production (non-decarbonising).

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

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

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

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

Emissions from waste incineration facilities with energy recovery are reported under category 1.A.4.a (Combustion activity, commercial/institutional sector), whereas emissions from other types of waste incineration facilities are reported under category 6.C (Waste incineration). In fact, energy recovered by these plants is mainly used for district heating of commercial buildings. In particular, for 2008, 95% of the total amount of waste incinerated is treated in plants with energy recovery system. To estimate CO_2 emissions, considering the total amount of waste incinerated in plants with energy recovery, carbon content is calculated, as described in paragraph 8.4.2, in the waste chapter; the value is considered constant for the whole time series. Different emission factors for municipal, industrial and oils, hospital waste, and sewage sludge are applied, as reported in the waste chapter, Tables 8.23-8.26. Waste amount is then converted in energy content applying an emission factor equal to 9.2 GJ/t of waste. In 2008, the resulting average emission factor is equal to 114.0 kg CO_2/GJ.
Emissions from landfill gas recovered are used for heating and power in commercial facilities and reported under 1.A.4.a. Biogas recovered from the anaerobic digester of animal waste is used for utilities in the agriculture sector and relative emissions are reported under 1.A.4.c.

In consideration of the increasing of the share of waste used to produce electricity, we plan to revise the allocation of these emissions under category 1.A.1.a.

Emission trends

In 2008, the energy sector accounts for 94.3% of CO_2 emissions, 17.8% of CH_4 and 16.7% of N_2O. In terms of CO_2 equivalent, the energy sector shares 83.6% of total national greenhouse gas emissions excluding LULUCF.

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

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
	Mt CO_2 eq																		
Total	***418.6***	***418.1***	***417.4***	***413.9***	***407.8***	***431.4***	***427.3***	***431.5***	***442.9***	***448.1***	***450.8***	***455.6***	***457.7***	***472.1***	***474.4***	***473.9***	***469.2***	***459.1***	***452.9***
CO_2	405.4	404.9	403.9	400.6	394.5	418.1	414.0	418.1	429.4	434.8	437.7	442.9	445.2	459.6	461.9	461.9	457.7	447.6	441.6
CH_4	8.8	8.8	8.9	8.8	8.6	8.4	8.2	8.2	8.3	8.1	7.8	7.4	7.2	7.1	7.0	6.9	6.4	6.3	6.4
N_2O	4.4	4.4	4.5	4.5	4.7	4.9	5.1	5.1	5.2	5.3	5.3	5.3	5.3	5.4	5.5	5.1	5.2	5.1	4.9

Source: ISPRA elaborations

Table 3.1 GHG emission trends in the energy sector 1990-2008 (Mt CO_2 eq.)

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

From 2004, GHG emissions from the sector are decreasing as a result of the policies adopted at European and national level to implement the production of energy from renewable sources. From the same year, a further shift from petrol products to natural gas in producing energy has been observed as a consequence of the starting of the EU greenhouse gas Emission Trading Scheme (EU ETS) in January, 1st 2005.

In Table 3.2, the electricity production distinguished by source for the whole time series is reported on the basis of data supplied by the national grid operator (ENEL, several years, TERNA, several years).

Source	1990	1995	2000	2005	2006	2007	2008
Hydroelectric	35,079	41,907	50,900	42,927	43,425	38,481	47,227
Thermoelectric	178,382	195,754	219,669	251,956	261,137	264,743	260,412
- solid fuels	32,042	24,122	26,272	43,606	44,207	44,112	43,074
- natural gas	39,082	46,442	97,607	149,259	158,079	172,646	172,697
- derivated gases	3,552	3,443	4,252	5,837	6,251	5,645	5,543
- oil products	102,718	120,783	85,878	35,846	33,830	22,865	19,195
- other fuels	988	964	5,660	17,408	18,769	19,474	19,903
Geothermic	3,222	3,436	4,705	5,325	5,527	5,569	5,520
Eolic and Photovoltaic	0	14	569	2,347	2,973	4,073	5,054
Total	***216,683***	***241,111***	***275,843***	***302,555***	***313,063***	***312,867***	***318,213***

Source: Terna

Table 3.2 Production of electricity by sources 1990-2008 (GWh)

More in general the share of the total energy consumption by primary sources in the period 1990-2008, reported in Table 3.3, shows an evident change from oil products to natural gas while the consumption of solid fuels and electricity maintain their share constant.

Fuel	1990	1995	2000	2005	2006	2007	2008
	%						
solid fuels	9.7	8.0	8.0	10.6	10.9	11.4	11.5
natural gas	23.9	26.0	31.4	36.0	35.5	36.1	36.5
crude oil	56.6	55.5	49.5	43.1	43.4	42.5	41.4
primary electricity	9.8	10.6	11.1	10.3	10.1	10.1	10.7

Source: Ministry Economic Development

Table 3.3 Total energy consumptions by primary sources 1990-2008 (%)

Recalculations

In 2010 submission, main recalculations in this sector regarded the transport sector, 1.A.3. The whole time series of road transport emissions has been recalculated because of the updated version of the model/software, COPERT4 version 7.1, used to estimate emissions. Recalculation affected mainly CH_4 and N_2O emissions. Detailed information is reported in paragraph 3.5.3.
For the whole energy sector, natural gas CO_2 emission factors have been updated for 2007 because of additional information collected on the chemical composition of natural gas imported.
Coal CO_2 average emission factors have also been revised from 2005 based on an analysis of the information collected by the plants in the framework of EU ETS and additional information on coals imported.
Fuel oil CO_2 average emission factors have been recalculated from 2005 taking into account the percentage of low-sulphur fuel out of the total fuel oil consumed and its specific characteristics, on the basis of detailed information supplied by Terna with reference to 2008 energy production data.
The CO_2 emission factor of synthesis gas from heavy residual (syngas) used in refineries to produce energy and heat has been changed from 1999, on the basis of the information collected in the framework of EU ETS. It has been calculated as the average value of syngas consumptions and emissions reported to the EU ETS.
Moreover coking coal losses in coke oven furnaces previously reported in the iron and steel sector (1.A.2.a) have been reallocated in the 1.A.1.c sector and CH_4 and N_2O emissions from biomass in the pulp and paper industry have been estimated from this submission.
Small changes in activity data in 2007, for oil production, and update of distribution of natural gas fuel consumption between commercial and residential sectors, have led to recalculations of fugitive emissions, reported in 1.B.2.

Recalculations affected the whole time series 1990-2007 for all gases. The following table shows the percentage differences between the 2010 and 2009 submissions for the total energy sector and by gas. Recalculation resulted for the energy sector in a reduction of GHG emissions in the base year of 0.09% and an increase in 2007 of 0.08% mainly due to the update of the COPERT4 model for road transport estimates, which revised CH_4 and N_2O emission factors, and the update of CO_2 emission factors, from 2005, for the main fuels.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	%																	
Energy	***-0.09***	***-0.09***	***-0.10***	***-0.10***	***-0.11***	***-0.12***	***-0.13***	***-0.13***	***-0.12***	***-0.07***	***0.02***	***0.06***	***0.10***	***0.10***	***0.14***	***-0.13***	***-0.08***	***0.08***
CO_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.14	0.18	0.21	0.21	0.24	-0.03	0.02	0.20
CH_4	-1.93	-2.05	-2.12	-2.19	-2.20	-2.16	-2.31	-2.18	-2.11	-2.02	-1.85	-1.96	-1.86	-1.68	-1.30	-1.60	-2.23	-2.58
N_2O	-4.28	-4.56	-4.72	-4.99	-5.56	-6.60	-6.41	-6.70	-6.47	-6.66	-6.49	-6.22	-6.38	-6.36	-6.19	-6.38	-6.00	-5.93

Source: ISPRA elaborations

Table 3.4 Emission recalculations in the energy sector 1990-2007 (%)

Key categories

Key category analysis, for the years 1990 and 2008, identified 10 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 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, half of the key categories (n. 1, 2, 3, 5, and 10) are linked to stationary combustion and to the same set of energy data: the energy sector CRF table 1.A.1, the industrial sector, table 1.A.2 and the civil sector tables 1.A.4a and 1.A.4b. Four out of five key categories

refer to CO_2 emissions. All these sectors refer to the national energy balance (MSE, several years [a]) for the basic energy data and the distribution among various subsectors, even if more accurate data for the electricity production sector can be found in Terna publications (Terna, several years). Evolution of energy consumptions/emissions is linked to the activity data of each sector; see paragraph 3.3, 3.4 and 3.6 and Annex 2 for the detailed analysis of those sectors.
Electricity production is the most “dynamic” sector and most of the emissions increase from 1990 to 2008, for CO_2, N_2O and CH_4, is due to the increase of thermoelectric production, see Tables A2.1 and A2.4 for more details.
In the following table key category emissions are summarized. From 1990 to 2008, 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	**2008**
CO_2 stationary combustion liquid fuels, Gg	153,467	84,009
CO_2 stationary combustion solid fuels, Gg	59,397	65,128
CO_2 stationary combustion gaseous fuels, Gg	85,066	162,029
CO_2 stationary combustion other fuels, Gg	1,779	4,943
N_2O stationary combustion, Mg	3,445	3,768

Source: ISPRA elaborations
Table 3.5 Stationary combustion, GHG emissions in 1990 and 2008

Another group of key categories (n. 4, 6, 8) 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 3.5, transport, for an accurate analysis of these key sources. This sector also shows a remarkable increase in emissions, in particular CO_2 from air transport and road transport, as can be seen in Table 3.18 and Table 3.27, respectively. The trend of N_2O and CH_4 emissions is linked to technological changes occurred in the period.

Finally, the last two key categories (n.7, 9) refer to oil and gas operations. For this sector basic overall production data are reported in the national balance but emissions are calculated with more accurate data published or delivered to ISPRA by the relevant operators, see paragraph 3.9.

Most of the categories described are also key categories for the years 1990 and 2008 taking into account LULUCF emissions and removals.

Key-categories identification in the energy sector with the IPCC Tier1 and Tier2 approaches for 2008

KEY CATEGORIES	**TIER**	**with LULUCF**	**Relevant paragraphes**	**Notes**
1. CO_2 stationary combustion liquid fuels	L,T	X	3.3, 3.4 and 3.6	Table 3.8-3.11
2. CO_2 stationary combustion solid fuels	L,T	X	3.3, 3.4 and 3.6	Table 3.8-3.11
3. CO_2 stationary combustion gaseous fuels	L,T	X	3.3, 3.4 and 3.6	Table 3.8-3.11
4. CO_2 mobile combustion: Road Vehicles	L,T	X	3.5 and 3.5.3	Tables 3.26, 3.27
5. N_2O stationary combustion	L	X	3.3, 3.4 and 3.6	Table 3.8-3.11
6. CO_2 mobile combustion: Waterborne Navigation	L1	X	3.5.4	Table 3.28
7. CH_4 fugitive emissions from Oil and Gas Operations	L,T	L1,T	3.9	Table 3.40
8. N_2O mobile combustion: Road Vehicles	L2		3.5 and 3.5.3	Tables 3.26, 3.27
9. CO_2 fugitive emissions from Oil and Gas Operations	L2,T2		3.9	Table 3.40
10. CO_2 stationary combustion other fuels	L1,T	L1,T1	3.3, 3.4 and 3.6	Table 3.8-3.11

3.2 Methodology description

Emissions are calculated by the equation:

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

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

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

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

The carbon factors used are based on national sources and are appropriate for Italy. Most of the emission factors have been crosschecked with the results of specific studies that evaluate the carbon content of the imported/produced fossil fuels at national level. A comparison of the current national factors with the IPCC ones has been carried out; the results suggest quite limited variations in liquid fuels and some differences in natural gas, explained by basic hydrocarbon composition, and in solid fuels. In case of differences between IPCC and national emission factors, the latter have been usually preferred.
Monitoring of the carbon content of the fuels nationally used is an ongoing activity at ISPRA. The principle is to analyse regularly the chemical composition of the used fuel or relevant activity statistics, to estimate the carbon content and the emission factor. National emission factors are reported in Table 3.12 and Table 3.21. The specific procedure followed for each primary fuel (natural gas, oil, coal) is reported in Annex 6.

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

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

- transportation fuels have shown a significant variation around the year 2000 due to the reformulation of gasoline and diesel to comply with the EU directive, see Table 3.21;
- the most important imported fuels, natural gas, fuel oil and coal show variations of carbon content from year to year, due to changes in the origin of imported fuel supply; a methodology has been set up to evaluate annually the carbon content of the average fuel used in Italy, see Annex 6 for details.

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

(BEN) and the energy production and consumption statistics supplied by Terna, provide the complete basic data needed for the emission inventory.

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

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

The energy balances of fuels used in Italy, published by the Ministry of Economic Development (MSE, several years [a]), compare total supply based on production, exports, imports, stock changes and known losses with the total demand; the difference between total supply and demand is reported as 'statistical difference'. In Annex 5, 2008 data are reported, while the full time series is available on website: http://dgerm.sviluppoeconomico.gov.it/dgerm/ben.asp.

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

The inventory includes also emissions from the combustion of lubricants based on data collected from waste oil recyclers and quoted in the BEN; from 2002 onwards, this estimate is included in the column “Refinery feedstock”, row “Productions”, see Annex 5, Table A5.1- National energy balance, year 2008, Primary fuels. From 2004 onwards, it has been necessary to use also those quantities to calculate emissions in the reference approach, so as to minimize differences with sectoral approach. From 2004, the energy balances prepared by MSE do include those quantities in the input while estimating final consumption; this procedure summarizes a complex stock change reporting by operators.

3.3 Energy industries

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

3.3.1 Public Electricity and Heat Production

3.3.1.1 Source category description

This paragraph refers to the main electricity producers that produce electricity for the national grid. From 1998 onwards, the expansion of the industrial cogeneration of electricity and the split of the national monopoly have transformed many industrial producers into "independent producers", regularly supplying the national grid. Those producers account in 2008 for 91.9% of all electricity produced with combustion processes in Italy.
No data on consumption / emissions from heat production is reported in this section. In Italy, only limited data do exist about producers working for district heating grids; most of the cogenerated heat is produced and used on the same site by industrial operators. Therefore data on heat production is not reported here but in Table1.A (a) s2 for industry and Table1.A (a) s4 for district heating. In Terna yearly publication, heat cogenerated while producing electricity is reported separately. Unfortunately, no details are reported on the final use of cogenerated heat, so it can be used in the inventory preparation just to cross check the total fuel amount with other sources as EU ETS or the consumption of fuels in the industry reported in BEN.

3.3.1.2 Methodological issues

The data source on fuel consumption is the annual report "Statistical data on electricity production and power plants in Italy" ("Dati statistici sugli impianti e la produzione di energia elettrica in Italia"), edited from 1999 by the Italian Independent System Operator (Terna, several years). The reports refer to the total of producers and the estimate of the part belonging to public electricity production is made by the inventory team on the basis of detailed electricity production statistics by industrial operators. Data on total electricity production for the year 2008 are reported in Annex 2. For the time series, see previous NIR reports. The emission factors used are listed in Table 3.12.
Another source of information is the National Energy Balance (MSE, several years [a]), which contains data on the total electricity producing sector. The data of the National Energy Balance (BEN) are also used to address the statistical survey of international organizations, IEA and Eurostat. Both BEN and Terna publications could be used for the inventory preparation, as they are part of the national statistical system and published regularly.
A detailed analysis of both sources is reported in Annex 2; Terna data appears to be more suitable for inventory preparation. From year 2005 onwards a valuable source of information is given by the reports prepared for each industrial installation subject to EU ETS scheme. Those reports are prepared by independent qualified verifiers and concern the CO_2 emissions, emission factors and activity data, including fuel used. ISPRA receives copy of the reports from the competent authority (Ministry of Environment) and has been able to extract the information relative to electricity production. The information available is very useful but not fully covering the electricity production sector or the public electricity production. The EU ETS does not include all installations, only those above 20 MWe, it is made on a point source basis so the data include electricity and heat production while the corresponding data from Terna, concerning only the fuel used for electricity production, are commercially sensitive, confidential and they are not available to the inventory team. Anyway

the comparison of data collected by TERNA with those submitted to the EU ETS allows identifying possible discrepancies in the different datasets and thus providiving the Ministry of Economic Development experts with useful suggestions to improve the energy balance.

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

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

Source: ISPRA elaborations

Table 3.6 Public electricity and heat production: Energy data (TJ) and GHG emissions (Mt), 1990-2008

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

3.3.2 Refineries

3.3.2.1 Source category description

This subsector covers the energy emissions from the national refineries (16 plants), including the energy used to generate electricity for internal use and exported to the national grid by power plants that directly use off-gases or other residues of the refineries. Those power plants are generally owned by other companies but are located inside the refinery premises or just sideway. In 2008 the power plants included in this source category have generated 4.9% of all electricity produced with combustion processes in Italy.
The energy consumption and emissions are reported in CRF table 1.A.1.b. Parts of refinery losses, flares, are reported in CRF table 1.B.2.a and c, using IPCC emission factors.

3.3.2.2 Methodological issues

The consumption data used for refineries come from BEN (MSE, several years [a]); the same data are also reported by Unione Petrolifera, the industrial category association (UP, several years). From 2005 onwards, also the EU ETS “verifier’s reports” cover almost the entire sector, for energy consumptions, combustion emissions and process emissions. Other sources of information are the yearly surveys performed for the large combustion plants European Directive (LCP) and the E-PRTR registry; both surveys include most of refineries but not all emission sources.

The available data in BEN specify the quantities of refinery gas, petroleum coke and other liquid fuels. They are reported in Annex 5, Table A5.6.
For the part of the energy and related emissions due by the power plants the source is Terna and please refers to Annex 2 for further details. The quota of the total energy consumption from electricity production included in source category 1.A.1.b is estimated by the electricity production model on the basis of fuels used and plant location.
All the fuel used in boilers and processes, the refinery "losses" and the reported losses of crude oil and other fuels (that are mostly due to statistical discrepancies) are considered to calculate emissions. Fuel lost in the distribution network is accounted for here and not in the individual end use sector. From 2002 particular attention has been paid to avoid double counting of CO_2 emissions checking if the refinery reports of emissions already include losses in their energy balances. IPCC Tier 2 emission factors and national emission factors are used as reported in Table 3.12.

In Table 3.7, a sample calculation for the year 2008 is reported, with energy and emission data.

	Consumption, TJ				CO_2 emissions, Gg			
REFINERIES	Petroleum coke	Refinery gas	Liquid fuels	Natural gas	Petroleum coke	Refinery gas	Liquid fuels	Natural gas
energy			100,351	22,986			9,330	1,308
furnaces	34,917	128,578	70,822		3,512	7,982	5,324	
TOTAL				357,654				27,456

Source: APAT elaborations
Table 3.7 Refineries, CO_2 emission calculation, year 2008

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

3.3.2.3 Uncertainty and time-series consistency

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

In Table 3.8 GHG emissions from the sector in the years 1990, 1995, 2000, 2005-2008 are reported.

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

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

An upward trend in emission levels is observed from 1990 to 2008 explained by the increasing quantities of crude oil processed and the complexity of process used to produce more environmentally friendly transportation fuels. Fuel consumptions have reached a plateau in 2005 and they are now in a downward trend that is expected to continue, due to the reduced quantities of crude oil processed and electricity produced.

3.3.2.4 Source-specific QA/QC and verification

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

3.3.2.5 Source-specific recalculations

There has been an overall recalculation of CO_2 emissions from the sector due to the update, for the years 2005-2007, of CO_2 fuel oil emission factor, on the basis of detailed Terna reports on high and low sulphur fuel oil consumption figures. For 2008, Terna modified the detailed table of fuel consumption and related energy produced introducing a more complete list of fuels. Aim of the change was to revise the consumption values of waste fuels which are very important for estimating the contribution of renewable to electricity production and consequently greenhouse gases.
Moreover the average emission factor of syngas, obtained from the gasification of heavy residual and used to produce energy in some refineries, has been updated on the basis of emission factors communicated, for 2007 and 2008, by operators in the framework of the EU ETS scheme. The 2008 emission factor, equal to 96.979 t CO_2/TJ, is largely higher than the previous one, equal to 80.189 t CO_2/TJ. Then the emission factor has been updated from 1999, that is the first year in which this fuel has been used.
Recalculations affected only CO_2 emissions time series from 1999 to 2007 with differences ranging from 1.2% in 1999 to 5.4% in 2007 and 2008, with respect to earlier submissions.

3.3.2.6 Source-specific planned improvements

No specific improvements are planned for the next submission.

3.3.3 Manufacture of Solid Fuels and Other Energy Industries

3.3.3.1 Source category description

In Italy, all the iron and steel plants are integrated, therefore there is no separated reporting for the different part of the process. A few coke and “manufactured gas” producing plants were operating in the early nineties and they have been reported here. Only one small manufactured gas producing plant is still in operation from 2002.
In this section, emissions from power plants, which use coal gases, are also reported. In particular, we refer to the electricity generated in the iron and steel plant sites (using coal gases and other fuels). In 2008 the power plants included in this source category have generated 2.2% of all electricity produced with combustion processes in Italy.

3.3.3.2 Methodological issues

Fuel consumption data for the sector are reported in the BEN (MSE, several years [a]). Fuels used to produce energy are also reported at more detail fuel disaggregation level by Terna (Terna, several years). From 2005 onwards, also the EU ETS “verifier’s reports” cover almost the entire sector, for energy consumptions, combustion emissions and process emissions. Other sources of information are the yearly surveys performed for the large combustion plants European Directive (LCP) and the E-PRTR registry; both surveys include most of the iron and steel integrated plants and the only coke producing plant but not all emission sources. A carbon balance is done, as suggested by the IPCC

good practice guidance, to avoid over or under estimation from the sector. In Annex 3 further details on carbon balances of solid fuels and derived gases used are reported.
The high-implied emission factor for solid fuels is due to the large use of derived steel gases and in particular blast furnace gas to produce energy. These gases are assimilated to the renewable sources and incentives are provided for their use.
Other fuels are used in co-combustion with coal gases to produce electricity and they are reported by Terna, see Annex 2. From 2008, natural gas and fuel oil consumptions reported in the CRF for this sector, are those communicated by the operators of the plants included in the sector in the framework of the EU ETS scheme. The consumptions of these fuels, especially for natural gas, are higher those reported for the previous years. Fuel consumption reported in the sector is subtracted from the total fuel consumption to produce energy, guaranteeing that over and under estimation are avoided.

3.3.3.3 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions from integrated iron and steel plants is estimated to be about 4.2% in annual emissions; a higher uncertainty, equal to 50.1%, is calculated for CH_4 and N_2O emissions on account of the uncertainty levels attributed to the related emission factors.
In Table 3.9 GHG emissions from the sector in the years 1990, 1995, 2000, 2005-2008 are reported.

	1990	1995	2000	2005	2006	2007	2008
CO_2 emissions, Mt	13.0	11.8	14.4	13.8	15.0	14.0	15.4
CH_4 emissions, Gg	4.9	4.0	2.3	1.2	1.0	0.7	0.7
N_2O emissions, Gg	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total, Mt CO_2 eq	13.2	11.9	14.5	13.8	15.0	14.1	15.5

Source: ISPRA elaborations

Table 3.9 Manufacture of solid fuels, GHG emission time series

An upward trend in emission levels is observed from 1990 to 2008, especially for the last years. That is explained by the increasing quantities of steel production, from 25.5 Mt in 1990 to 30.6 Mt in 2008 and siderurgical products, from 25.0 Mt in 1990 to 35.0 Mt in 2008, and the specialisation of the national industry in high quality steel products, more energy intensive.

3.3.3.4 Source-specific QA/QC and verification

Basic data to estimate emissions have been reported by national energy balance and the national grid administrator. Data collected by other surveys that include integrated iron and steel plants, such as EU ETS Directive, LCP and E-PRTR surveys, have been used to cross-check the energy balance data, fuels used and emission factors. Differences and problems have been analysed in details and solved together with Ministry of Economic Development experts, which are in charge to prepare the National Energy Balance. In particular, in the E-PRTR registry the integrated plants report every year the CO_2 emitted at each stage of the process, coke production, sinter production and iron and steel production, which result from separate carbon balances calculated in each phase of the production process. Moreover, total CO_2 emissions reported in the E-PRTR by the operators are equal to those reported under the EU ETS scheme.
The detailed analysis and comparison of the different data reported improved the allocation of fuel consumption and CO_2 emissions between 1.A.1.c and 1.A.2.a sectors. In 2010 submission, in fact,

coking coal losses for transformation process and related emissions have been reallocated under 1.A.1.c instead of 1.A.2.a.

3.3.3.5 Source-specific recalculations

In 2010 submission, GHG emissions of the sector have been changed and recalculated for the whole time series. The more relevant change, affecting the whole time series, consisted in the reallocation of coking coal losses and related emissions from the iron and steel sector, 1.A.2.a, to this sector, as already explained in the previous paragraph.
In addition, average CO_2 emission factors for coal and fuel oil have been updated for years 2005-2007 and for natural gas for 2007, as specified in Annex 6.
These recalculation affected CO_2 emissions with differences ranging from 22.7% in 1990 to 25.3% in 2008 and N_2O emissions from 44.1% in 1990 to 54.5% in 2008, with respect to earlier submissions.
CH_4 emissions from cookeries are estimated on the basis of production data to take in account additional volatile emissions due to the specific process. They have been recalculated for the years 2006 and 2007, based on updated information supplied by the most important integrated iron and steel plant, located in Taranto, in the south of Italy, producing more than 70% of total national coke. Emission reduced of 20.7% in 2006 and 47.5% in 2007 with respect to earlier submissions. The strong reduction of CH_4 emissions from coke production in the last years is the result of the renewal of the coke production plants in Taranto, started in 2005, and the implementation of best available technologies to reduce volatile organic compounds.

3.3.3.6 Source-specific planned improvements

No specific improvements are planned for the next submission.

3.4 Manufacturing industries and construction

3.4.1 Overview of sector

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

In 2008, energy use in industry account for 15.6% of total national CO_2 emissions, 0.4% of CH_4, 4.9% of N_2O. In term of CO_2 equivalent, manufacturing industry share 13.7% of total national greenhouse gas emissions.

Five key categories have been identified for this sector, as for the energy industries, for level and trend assessment, using both the IPCC Tier 1 and Tier 2 approaches:
CO_2 Stationary combustion liquid fuels (L, T);
CO_2 Stationary combustion solid fuels (L, T);
CO_2 Stationary combustion gaseous fuels (L, T);
CO_2 Stationary combustion other fuels (L1, T);
N_2O Stationary combustion (L).

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

In the following Table 3.10, GHG emissions connected to the use of fossil fuels, process emissions excluded, are reported for the years 1990, 1995 and 2000-2008. Industrial emissions show oscillations, related to economic cycles.

	1990	1995	2000	2005	2006	2007	2008
CO_2 emissions, Gg	86,528	86,088	83,758	80,487	79,131	75,848	72,804
CH_4 emissions, Mg	6,819	7,021	5,723	6,276	6,243	6,526	6,246
N_2O emissions, Mg	4,931	4,519	4,662	5,019	5,050	4,981	4,638
Total, Gg CO_2 eq	88,200	87,637	85,323	82,174	80,827	77,529	74,372

Source: ISPRA elaborations

Table 3.10 Manufacturing industry, GHG emission time series

In Table 3.11 emissions are reported by pollutant for all the subsectors included in the sector.
A general trend of reduction in emissions is observed from 1990 to 2008; some sub sectors reduced sharply (steel, chemical), other sub sectors (pulp and paper, food) increased their emissions.

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008
CO_2 (Gg)							
1.A.2.a Iron and Steel	18,320	18,919	13,594	14,539	13,966	14,344	13,112
1.A.2.b Non-Ferrous Metals	738	907	1,252	1,167	1,173	1,142	1,096
1.A.2.c Chemicals	20,052	18,059	13,497	12,017	11,709	11,313	10,634
1.A.2.d Pulp, Paper and Print	3,076	4,163	4,223	4,563	4,563	5,194	4,289
1.A.2.e Food	3,853	5,062	6,238	6,441	5,688	5,429	5,568
1.A.2.f Other	40,489	38,978	44,954	41,759	42,031	38,426	38,105
CH_4 (Mg)							
1.A.2.a Iron and Steel	3,795	4,226	3,093	3,304	3,275	3,592	3,521
1.A.2.b Non-Ferrous Metals	13	16	27	24	25	23	22
1.A.2.c Chemicals	798	677	318	340	323	301	231
1.A.2.d Pulp, Paper and Print	77	94	91	104	114	124	115
1.A.2.e Food	105	127	175	410	390	428	455
1.A.2.f Other	2,031	1,880	2,019	2,094	2,116	2,057	1,901
N_2O (Mg)							
1.A.2.a Iron and Steel	362	370	302	330	326	316	295
1.A.2.b Non-Ferrous Metals	13	16	25	23	23	22	21
1.A.2.c Chemicals	346	285	159	152	148	143	125
1.A.2.d Pulp, Paper and Print	64	82	81	89	90	101	84
1.A.2.e Food	52	53	76	91	87	81	81
1.A.2.f Other	4,093	3,712	4,020	4,335	4,375	4,317	4,032

Source: ISPRA elaborations

Table 3.11 Trend in greenhouse gas emissions from the manufacturing industry sector, 1990-2008

3.4.2 Source category description

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

Iron and steel
The main processes involved in iron and steel production are those related to sinter and blast furnace plants, to basic oxygen and electric furnaces and to rolling mills.
Most of emissions are connected to the integrated steel plants, while for the other plants, the main energy source is electricity (accounted for in 1.A.1.a) and the direct use of fossil fuels is limited to heating – re heating of steel in the intermediate part of the process.
There were four integrated steel plants in 1990 that from 2005 are reduced to two, with another plant that still has a limited production of pig iron. Nevertheless, the steel production has not changed significantly in the 1990-2008 period due to an expansion in capacity of the two plants. The maximum production was around 11 Mt/y in 1990, 1995 and in 2005-2008, with lower values in other years and the lowest of 9 Mt in 2002.
It has to be underlined that the integrated steel plants include also the cogeneration of heat and electricity using the recovered "coal gases" from various steps of the process, including steel furnace gas, BOF gas and coke oven gas. All emissions due to the "coal gases" used to produce electricity are included in the electricity grid operator yearly reports and are accounted in the category 1.A.1.c. No detailed info is available for the heat produced, so the emissions are included in source category 1.A.2.a.

Non-Ferrous Metals
In Italy there is a production of primary aluminium (232 Gg in 1990 and 180 Gg in 2008) and of secondary aluminium (350 Gg in 1990 and 700 Gg in 2008). Those productions however use electricity as the primary energy source so the emissions due to the direct use of fossil fuels are limited, about 23% of the total emissions of source 1.A.2.b in 2008. At present in Italy, there are two primary aluminium production plants.
The sub sector comprises also the production of other non-ferrous metals, both primary and secondary copper, lead, zinc and others; but also those productions have a limited share of emissions, about 19% in 2008. The bulk of emissions are due to foundries that prepare mechanical pieces for the engineering industry or the market, using all kinds of alloys, including aluminium, steel and iron.

Chemicals
CO_2, CH_4 and N_2O emissions from chemical and petrochemical plants are included in this sector.
In Italy there are petrochemical plants integrated with a nearby refinery and stand alone plants that get the inputs from the market. Main products are Ethylene, Ethylene oxide, Propylene, Styrene.
In particular, ethylene and propylene are produced in petrochemical industry by steam cracking. Ethylene is used to manufacture ethylene oxide, styrene monomer and polyethylene. Propylene is used to manufacture polypropylene but also acetone and phenol. Styrene, also known as vinyl benzene, is produced on industrial scale by catalytic dehydrogenation of ethyl benzene. Styrene is used in the rubber and plastic industry to manufacture through polymerisation processes such products as polystyrene, ABS, SBR rubber, SBR latex. Except for ethylene oxide production, which has stopped since 2002, the other productions of the above mentioned chemicals still occur in Italy. Activity data are stable from 1990 to 2008, with limited yearly variations.
Chemical industry includes non organic chemicals as chlorine/soda, sulphuric acid, nitric acid, ammonia. A limited production of fertilizers is also present in Italy. From 1990 to 2008 the production has been greatly reduced, with less than half of the 1990 production still occurring in 2008.
This source category does include some emissions from the cogeneration of electricity. Due to the transformation of some of those plants in power plants directly connected to the grid (and so reported in category 1.A.1.a) the percentage of the category 1.A.2.c CO_2 emissions due to electricity generation has changed from 22% in 1990 to 18% in 2008.

Pulp, Paper and Print

Emissions from the manufacturing of paper are included in this source category. In Italy the manufacture of virgin paper pulp is rather limited, with a production feeding less than 5% of the paper produced in 2008. Most of the pulp was imported in 1990, while in 2008 nearly half of the pulp used is produced locally form recycled paper. The paper production is expanding and activity data (total paper produced) was 6.3 Mt in 1990 and 9.5 Mt in 2008. The printing industry represents a minor part of the source category emissions.

This source category includes also the emissions from the cogeneration of electricity. Due to the transformation of some of those plants in power plants directly connected to the grid (and so reported in category 1.A.1.a), the percentage of the category 1.A.2.d CO_2 emissions due to electricity generation has changed from 13% in 1990 to 2.5% in 2008.

Food

Emissions from the food production are included in this source category. In Italy the industrial food production is expanding. A comprehensive activity data for this sector is not available; energy consumption was estimated to be 137 PJ in 1990 and 200 PJ in 2008. Value added in constant money has increased of 0.6% per years from 1990 to 2003 and of 0.3% yearly from 2004 to 2008.

This source category also includes emissions from the cogeneration of electricity. Due to the transformation of those plants in power plants directly connected to the grid (and so reported in category 1.A.1.a) the percentage of the category 1.A.2.e CO2 emissions due to electricity generation has changed from 3% in 1990 to 0.0% in 2008.

Other

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

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

Another sub sector, construction materials, is also included here and it is also quite significant in terms of emissions due to the energy intensity of the processes involved. Construction materials subsector includes the production of cement, lime, bricks, tiles and glass. It comprises thousands of small and medium size enterprises, with only a few large operators, mainly connected to cement production. Some of the production is also exported. The description of the process used to produce cement, lime and glass is reported in chapter 4, industrial processes.

The fabrication of bricks is a rather standard practice in most countries and does not need additional description; fossil source is mainly natural gas. A peculiar national circumstance is the fabrication of tiles, in which are involved many specialised “industrial districts” where many different independent small size enterprises are able to manufacture world level products for both quality and style, exported everywhere. Generally speaking, the process implemented is efficient with reference to the average European level and those processes use mostly natural gas as the main fossil source since the year 2000.

The remaining “other industries” include furniture and other various “made in Italy” products that produce not negligible amounts of emissions.

The activity data of industries oriented to so different markets are, of course, peculiar to each subsector and it is difficult to identify a common trend. The productions of cement, lime and glass are the most relevant from the emissions point of view.

This short preface is needed to understand the reasons because this subsector is a key sector and accounts, in 2008, for 52.3% of the total source 1.A.2 CO_2 emissions, and for 7.0 % of the total national emissions.

This source category includes also emissions from the cogeneration of electricity. Due to the transformation of some of those plants in power plants directly connected to the grid (and so reported in category 1.A.1.a) the percentage of the category 1.A.2.f CO_2 emissions due to electricity generation has changed from 1.9% in 1990 to 0.6% in 2008.

3.4.3 Methodological issues

Energy consumption for this sector is reported in the BEN (see Annex 5, Tables A5.9 and A5.10). The data comprise specification of consumption for 13 sub-sectors and more than 25 fuels. Those very detailed data, combined with industrial production data, allow for a good estimation of all the fuel used by most industrial sectors, with the details required by CRF format. With reference to coal used in the integrated steel production plants the quantities reported in BEN are not used as such but a procedure has been elaborated to estimate the carbon emissions linked to steel production and those attributable to the coal gases recovered for electricity generation, as already mentioned in paragraph 3.4.1. The detailed calculation procedure is described in Annex 3. Moreover, a part of the fuel input is considered in the estimation of process emissions, see chapter 4 for further details.
The balance of fuel (total consumption minus industrial processes consumption) is considered in the emission estimate; the emission factors used are listed in Table 3.12. The procedure used to estimate the national emission factors is described in Annex 6. These factors account for the fraction of carbon-oxidised equal to 0.98 for solid fuels, 0.99 for liquid fuels and 0.995 for natural gas, as suggested by the 1996 IPCC guidelines (IPCC, 1997).

	t CO_2 / TJ	t CO_2 / t	t CO_2 / toe
Liquid fuels			
Crude oil	72.549	3.035	3.035
Jet gasoline	70.000	3.075	2.929
Jet kerosene	71.500	3.111	2.992
Petroleum Coke	100.573	3.493	4.208
Orimulsion	77.733	2.177	3.252
Synthesis gas from heavy residual	96.879		
Gaseous fuels, national data			
Natural gas, 2008 average	56.915	1.950 (sm^3)	2.381
Solid fuels			
Steam coal, 2008 average	96.224	2.348	4.026
"sub-bituminous" coal	96.234	2.557	4.026
Lignite	99.106	1.037	4.147
Coke	108.161	3.168	4.525
Biomass			
Solid Biomass		(1.124)	(4.495)
Derived Gases, national data			
Refinery Gas	62.080	3.117	2.597
Coke Gas	41.900	0.375	1.753
Blast furnace – oxygen converter Gas	261.711	1.293	10.950
Fossil fuels, national data			
Fuel oil , 2008 average	75.629	3.110	3.164
Coking coal	95.702	2.963	4.004
Other fuels			
Municipal solid waste	47.877	0.718	2.003

Source: ISPRA elaborations

Table 3.12 Emission Factors for Power, Industry and Civil sector

Starting from 2008, the oxidation factors for petroleum coke and coal have been modified based on the data reported by operators under the EU ETS scheme. The reporting operators cover almost 100% of solid fuels used. Weighted average of oxidation factor reported for petroleum coke is 0.998 and for steam coal is 0.986.

During the revision of the aviation sector, for jet gasoline and jet kerosene, a fraction of carbon oxidised equal to 1 has been applied, as reported in the 2006 IPCC guidelines (IPCC, 2006), for the whole time series, on the basis of expert judgement.

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

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

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

Chemicals
The use of EU ETS data for this subsector is rather complex because generally chemical plants are excluded from EU ETS while petrochemical plants are included. All plants reports under the E-PRTR. In this case, the latter data set is used for cross checking BEN data. As mentioned in paragraph 3.4.1, also a small amount of emissions connected to the production of electricity for the onsite use is reported in source 1.A.2.c, basic data are taken from Terna reports and the relative subsector amount is estimated with a model.

Pulp, Paper and Print
Most of the operators in the paper and pulp sector are included in EU ETS, while only a few of the printing installations are included. The problem for the EU ETS data source for this subsector is that the data are reported on a point source basis, including the production of electricity. The ETS data

contain info on the energy and emissions relative to electricity, but this data are not subject to verification and appear not reliable.
On the other hand, the inventory team has no access to the detailed, plant by plant, database of electricity producing plants so the emissions reported in the ETS survey cannot be divided between those belonging to table 1.A.1.a and table 1.A.2.d.
In 2010 submission CH_4 and N_2O emissions from biomass fuel consumption in the sector, in previous submissions not estimated, have been added to the inventory on the basis of the biomass fuel consumption reported in the annual environmental report by the industrial association (ASSOCARTA, several years). Statistics on biomass fuel consumption appears from 1998; for the years from 1990 to 1997 the use of biomass for energy purposes in the pulp and paper industry has been assumed not occurring.

Food
Emissions from the food production are included in this source category. A comprehensive activity data for this sector is not available; the subsector comprises many small and medium size enterprises, with thousands of different products. No info on this sector can be found in ETS survey, the sector is not included in the scope of ETS.

Other
This sector comprises emissions from many different industrial subsectors, some of which are subject to EU ETS and some not. Construction material subsector is energy intensive and it is subject to EU ETS. In the national energy database (BEN), the data for construction material are reported separately and they can be cross cheeked with ETS survey. However, in the construction material subsector, there are many small and medium size enterprises, so the operators subject to ETS are only a part of the total.

3.4.4 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions in Industry is estimated to be about 4% in annual emissions; a higher uncertainty is calculated for CH_4 and N_2O emissions on account of the uncertainty levels attributed to the related emission factors and the difference in emission factors between the industrial subsectors, sources 1.a.2.a-f.
Estimates of fuel consumption for industrial use in 2008 are reported in Annex 5, Tables A5.9 and A5.10. Time series of the industrial energy consumption data are contained in the BEN time series and in the CRFs and are reported in the following table.

	1990	1995	2000	2005	2006	2007	2008
1.A.2 Manufacturing Industries and Construction	**1,265,428**	**1,308,830**	**1,305,795**	**1,258,635**	**1,240,363**	**1,186,848**	**1,112,682**
a. Iron and Steel	271,413	273,216	230,835	250,701	245,646	240,587	222,893
b. Non-Ferrous Metals	12,067	15,145	20,609	19,950	20,010	19,545	18,371
c. Chemicals	290,074	269,682	203,069	180,188	176,096	172,116	154,054
d. Pulp, Paper and Print	50,520	70,371	74,175	79,633	79,610	91,069	73,674
e. Food Processing, Beverages and Tobacco	62,141	85,138	103,552	108,371	94,999	91,438	92,042
f. Other (please specify)	579,213	595,277	673,555	619,793	624,002	572,093	551,647

Source: ISPRA elaborations
Table 3.13 Fuel consumptions for Manufacturing Industry sector, 1990-2008 (TJ)

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

3.4.5 Source-specific QA/QC and verification

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

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

3.4.6 Source-specific recalculations

There has been an overall recalculation of emissions from the sector, due to the update of the emission factor based on detailed EU ETS operator's reports for year 2008 (paragraph 3.1). The recalculation refers to the years 2005-2007 for fuel oil and coal CO_2 emission factors and to 2007 for natural gas CO_2 emission factor.
Coking coal losses in coke oven furnaces previously reported in the iron and steel sector (1.A.2.a) have been reallocated in the 1.A.1.c sector, for the whole time series.
CH_4 and N_2O emissions from biomass in the pulp and paper industry have been estimated from this submission for the whole time series; emissions start from 1998, while for years 1990-1997 they were not occurring.
The recalculation affected the whole time series for CO_2 emissions with differences ranging from -2.7% to -3.8%, with respect to earlier submissions. CH_4 and N_2O emissions have been changed from 1998 with differences ranging from 0.01% to 0.28% for CH_4, and 0.002% to 0.05% for N_2O emissions, with respect to earlier submissions

3.4.7 Source-specific planned improvements

No specific improvements are planned for the next submission.

3.5 Transport

This sector shows a pronounced increase in emissions over time, reflecting the huge increase in fuel consumption for road transportation. The mobility demand and, particularly, the road transportation share have constantly increased in the period from 1990 to 2007, while in 2008 shows a noticeable decrease.
The time series of CO_2, CH_4 and N_2O emissions, in Mt CO_2 equivalent, is reported in Table 3.14; figures comprise all the emissions reported in table 1.A.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 million vehicles in 2008) that use gasoline and is increasing every year since 1990. Only a small part of this fleet complies with strict VOC emissions controls.

		1990	1995	2000	2005	2006	2007	2008
CO_2	Mt	101.3	111.4	120.1	125.8	127.2	127.2	122.5
CH_4	Mt	0.72	0.80	0.60	0.39	0.37	0.35	0.33
N_2O	Mt	0.90	1.45	1.70	1.13	1.21	1.19	1.08
Total, CO_2 eq.	Mt	102.9	113.7	122.4	127.4	128.7	128.8	123.9

Source: ISPRA elaborations

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

CO_2 and N_2O from road vehicles and CO_2 from waterborne navigation are key categories both in 1990 and in 2008.

3.5.1 Aviation

3.5.1.1 Source category description

The IPCC requires the estimation of emissions for category 1.A.3.a.i International Aviation and 1.A.3.a.ii Domestic Aviation, including figures both 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 contributes mainly in rising CO_2 emissions. CH_4 and N_2O emissions also occur and are estimated in this category but their contribution is insignificant.
In 2008 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 2008, GHG emissions from the sector increased by 43% due to the expansion of the aviation transport mode. Therefore, emission fluctuations over time are mostly dictated by the growth rates in the number of flights.
Specifically, in 2008 GHG emissions were about 5% higher than 2007.
Civil aviation is not a key category in the Italian inventory.

3.5.1.2 Methodological issues

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

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

the statistics yearbooks (ISTAT, several years [a]), Ministry of Transport in the national transport statistics yearbooks (MINT, several years) and the Italian civil aviation in the national aviation statistics yearbooks (ENAC/MINT, several years).

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

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

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

Data on domestic and international aircraft movements from 1990 to 2008 are shown in Table 3.15 where domestic flights are those entirely within Italy. Emission factors are reported in Table 3.16 and Table 3.17. Total fuel consumptions, both domestic and international, are reported by LTO and cruise in Table 3.18.
Emissions from military aircrafts are also estimated and reported under category 1.A.5 Other.
The methodology to estimate military aviation emissions is simpler than the one described for civil aviation since LTO data are not available in this case.

As for activity data, total consumption for military aviation is published in the petrochemical bulletin (MSE, several years [b]) by fuel.
Emission factors are those provided in the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2007). Therefore, emissions are calculated by multiplying military fuel consumption data for the EMEP/CORINAIR default emission factors shown in Table 3.17.

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

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

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

a Emission factor as kg carbon/t.
Table 3.16 CO_2 and SO_2 emission factors for Aviation (kg/t) 1990-2008

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

a EMEP/CORINAIR, 2007
Table 3.17 Non-CO_2 Emission Factors for Aviation (2008)

	1990	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**
				Gg			
Domestic LTO	121	129	198	150	153	160	153
International LTO	123	162	250	195	212	232	223
Domestic cruise	387	385	464	588	590	587	544
International cruise	1,215	1,662	2,327	2,733	2,948	3,120	3,019

Source: ISPRA elaborations
Table 3.18 Aviation jet fuel consumptions for domestic and international flights (Gg)

3.5.1.3 Uncertainty and time-series consistency

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

Time series of domestic emissions from the aviation sector is reported in Table 3.19.
An upward trend in emission levels is observed from 1990 to 2008 which is explained by the increasing number of LTO cycles.
Nevertheless, the propagation of more modern aircraft in the fleet slows down the trend in the last years.

		1990	1995	2000	2005	2006	2007	2008
CO_2	Gg	1,613	1,709	2,649	2,204	2,291	2,428	2,301
CH_4	Mg	32	33	63	112	98	72	66
N_2O	Mg	45	48	74	62	64	68	64

Source: ISPRA elaborations

Table 3.19 GHG emissions from domestic aviation

3.5.1.4 Source-specific QA/QC and verification

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

Specifically, the outcome of the estimation method derived from the 2009 research, applied at national and airport level, has 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.

3.5.1.5 Source-specific recalculations

In the last submission, in 2009, there was 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, 2007; 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, in 2009, 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 aviation gasoline. For these fuels, an oxidation factor equal to 1 has been judged more appropriate, in consideration of information derived by sectoral experts.
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 guidelines (EMEP/CORINAIR, 2007; IPCC, 1997; 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, 1997; IPCC, 2006). This revision leaded to an emission factor generally lower than the previous one.

In 2010 submission, recalculations regarded only the distribution of domestic and international flights in 2002; this update affected only CH_4 and N_2O emissions, with an increase of 5.3% and 5.6% respectively in 2002, with respect to earlier submissions. This revision has lead to a recalculation of international bunkers, accordingly.

3.5.1.6 Source-specific planned improvements

No specific improvements are planned for the next submission.

3.5.2 Railways

The electricity used by the railways for electric traction is supplied from the public distribution system, so the emissions arising from its generation are reported under category 1.A.1.a Public Electricity.
Emissions from diesel trains are reported under the IPCC category 1.A.3.c Railways. 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 3.20 are aggregate factors so that all factors are reported on the common basis of fuel consumption.

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

Source: EMEP/CORINAIR, 2007

Table 3.20 Emission Factors for railway (Gg/Mt)

GHG emissions from railways accounted in 2008 for less than 0.2% of the total transport sector emissions. In 2010, no recalculation affected this category source. No specific improvements are planned for the next submission.

3.5.3 Road Transport

3.5.3.1 Source category description

The IPCC requires the estimation of emissions for category 1.A.3.b Road transportation.
In 2008, total GHG emissions from this category were about 93.0% of the total national emissions from transport, 25.1% of the energy sector and about 21.3% of the GHG national total.
From 1990 to 2008, GHG emissions from the sector increased by 21.5% 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 2008, GHG emissions from road transport started to decrease and were about 4.1% lower than those of 2007 were.
CO_2 emissions from road transport are a key category in 2008 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 not key category.
Emissions from road transport are calculated either from a combination of total fuel consumption data and fuel properties or from a combination of drive related emission factors and road traffic data.

3.5.3.2 Methodological issues

According to the IPCC Guidelines and Good Practice Guidance (IPCC, 1997; IPCC, 2000) 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. In the 2010 submission, the new version of COPERT 4 (EEA, 2010) has been used, in particular the version 7.1 which upgrade the methodology, the software and fixed some bugs in the model, determining a recalculation of emission estimates.
Methodologies are described in the following, distinguishing emissions calculated from fuel consumption and traffic data.

3.5.3.2.1 Fuel-based emissions

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

Emissions of CO_2, expressed as kg carbon per tonne of fuel, are based on the H/C ratio of the fuel; emissions of SO_2 are based on the sulphur content of the fuel. Values of the fuel-based emission factors for CO_2 from consumption of petrol and diesel fuels are shown in Table 3.21. These factors account for the fraction of carbon oxidised for liquid fuels equal to 0.99, as suggested by the 1996 IPCC guidelines (IPCC, 1997).

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

National emission factors	Mg CO_2 / TJ	Mg CO_2 / Mg
Mtbe	73.121	-
Gasoline, 1990-'99, interpolated emission factor	71.034	3.121
Gasoline, test data, 2000-08[b]	71.145	3.109
Gas oil, 1990-'99, IPCC OECD[a]	73.274	3.127
Gas oil, engines, test data, 2000-08[b]	73.153	3.138
LPG, 1990-'99, IPCC[a] Europe	64.350	3.000
LPG, test data, 2000-08[b]	64.936	2.994
Natural gas (dry) 1990	55.328	-
Natural gas (dry) 2008	56.915	-

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

Table 3.21 Fuel-Based Emission Factors for Road Transport

Emissions of CO_2 and SO_2 can be broken down by vehicle type based on estimated fuel consumption factors and traffic data in a manner similar to the traffic-based emissions described below for other pollutants. The 2008 inventory used fuel consumption factors expressed as g of fuel per kilometre for each vehicle type and average speed calculated from the emission functions and speed-coefficients provided by the model COPERT 4 (EEA, 2010). The updated version of the model has been used for the whole time series. As reported more in details in the following, the updated version of the model revised NMVOC, CH_4 and N_2O emission factors; the application to Italian data resulted in a further decrease of CH_4 and N_2O emissions and an increase of NMVOC emissions for the whole time series, with respect to the previous submission.

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

SNAP CODE	Sub sector	Type of fuel	Mg of fuel consumed	Mileage, km_kVeh
070101	PC Hway	diesel	3,731,700	66,608,639
070101	PC Hway	gasoline	2,159,782	43,383,668
070101	PC Hway	lpg	326,487	5,019,739
070102	PC rur	diesel	5,702,891	113,307,524
070102	PC rur	gasoline	3,218,426	74,494,816
070102	PC rur	lpg	302,330	6,692,986
070103	PC urb	diesel	2,241,279	29,529,328
070103	PC urb	gasoline	3,682,100	47,525,929
070103	PC urb	lpg	375,206	5,019,739
070201	LDV Hway	diesel	1,355,924	13,229,522
070201	LDV Hway	gasoline	50,984	736,589
070202	LDV rur	diesel	2,193,220	36,381,184
070202	LDV rur	gasoline	143,796	2,025,621
070203	LDV urb	diesel	1,791,805	16,536,902
070203	LDV urb	gasoline	149,066	920,737
070301	HDV Hway	diesel	3,841,610	19,606,409
070301	HDV Hway	gasoline	825	5,002
070302	HDV rur	diesel	2,569,150	13,347,185
070302	HDV rur	gasoline	2,251	15,005
070303	HDV urb	diesel	1,424,759	4,534,501
070303	HDV urb	gasoline	1,125	5,002
070400	mopeds	gasoline	388,709	17,564,218
070501	Moto Hway	gasoline	66,198	1,699,413
070502	Moto rur	gasoline	347,491	11,895,888
070503	Moto urb	gasoline	615,730	20,392,950
Total				550,478,494

Source: ISPRA elaborations

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

Table 3.22 Average fuel consumption and mileage for main vehicle category and road type, year 2008

3.5.3.2.2 Traffic-based emissions

Emissions of NMVOC, NO_X, CO, CH_4 and N_2O are calculated from emission factors expressed in grams per kilometre and road traffic statistics estimated by ISPRA on account of data released from

Ministry of Transport (MINT, several years). The emission factors are based on experimental measurements of emissions from in-service vehicles of different types driven under test cycles with different average speeds calculated from the emission functions and speed-coefficients provided by COPERT 4 (EEA, 2010). This source provides emission functions and coefficients relating emission factors (in g/km) to average speed for each vehicle type and Euro emission standard derived by fitting experimental measurements to polynomial functions. These functions were then used to calculate emission factor values for each vehicle type and Euro emission standard at each of the average speeds of the road and area types.

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

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

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

Emissions are calculated from vehicles of the following types:
- Gasoline passenger cars;
- Diesel passenger cars;
- Gasoline Light Goods Vehicles (Gross Vehicle Weight (GVW) <= 3.5 tonnes);
- Diesel Light Goods Vehicles (Gross Vehicle Weight (GVW) <= 3.5 tonnes);
- Rigid-axle Heavy Goods Vehicles (GVW > 3.5 tonnes);
- Articulated Heavy Goods Vehicles (GVW > 3.5 tonnes);
- Buses and coaches;
- Mopeds and motorcycles.

Basic data derive from different sources. Detailed data on the national fleet composition is found in the yearly report from ACI (ACI, several years). The National Association of Cycle-Motorcycle Accessories (ANCMA, several years) supplies useful information on mopeds fleet composition and mileages. The Ministry of Transport in the national transport yearbook (MINT, several years) reports passenger car mileages time series. The National Institute of Statistics carries out annually a survey on heavy goods vehicles, including annual mileages (ISTAT, several years [b]). The National Association of concessionaries of motorways and tunnels produces monthly statistics on highway mileages by light and heavy vehicles (AISCAT, several years). The National General Confederation of Transport and Logistics (CONFETRA, several years) and the national Central Committee of road transporters (Giordano, 2007) supplied useful information and statistics about heavy goods vehicles fleet composition and mileages.

In the following Tables 3.23, 3.24 and 3.25 detailed data on the relevant vehicle mileages in the circulating fleet between 1990 and 2008 are reported, subdivided according to the main emission regulations.

	1990	1995	2000	2008
pre-1972, PRE ECE	0.05	0.03	0.01	0.01
1972 -1977, ECE 15.00/.01	0.11	0.04	0.01	0.003
1978 -1986, ECE 15.02/.03	0.32	0.15	0.03	0.01
1987 -1992, ECE 15.04	0.52	0.56	0.29	0.08
91/441/EC, from 1/1/93, euro I	0.001	0.22	0.27	0.09
94/12/ EC, from 1-1-97 , euro II			0.37	0.29
98/69/EC, from 1/1/2001, euro III				0.20
98/69/EC, from 1/1/2006, euro IV, V				0.32
Total	1.00	1.00	1.00	1.00

Source: ISPRA elaborations on ACI data

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

	1990	1995	2000	2008
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	0.12
98/69/EC, from 1/1/2001, euro III				0.36
98/69/EC, from 1/1/2006, euro IV, V				0.48
Total	1.00	1.00	1.00	1.00

Source: ISPRA elaborations on ACI data

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

	1990	1995	2000	2008
pre -1996	1.00	0.93	0.60	0.10
from 1/1/96, Dir. 91/542 EEC, euro I		0.07	0.21	0.09
from 1/1/97, Dir. 91/542 EEC, euro II			0.18	0.25
from 1/1/2001, Dir. 99/96, euro III				0.35
from 1/1/2006, Dir. 99/96, euro IV, V				0.20
Total	1.00	1.00	1.00	1.00

Source: ISPRA elaborations on ACI data

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

Average emission factors are calculated for average speeds by three driving modes, urban, rural and motorway, combined with the vehicle kilometres travelled and vehicle categories.
ISPRA estimates total annual vehicle kilometres for the road network in Italy by vehicle type, see Table 3.26, based on data from various sources:

- Ministry of Transport (MINT, several years) for rural roads and on other motorway; the latter estimates are based on traffic counts from the rotating census and core census surveys of ANAS;

- highway industrial association for fee-motorway (AISCAT, several years);
- local authorities for built-up areas (urban).

	1990	1995	2000	2005	2006	2007	2008
All passenger vehicles, total mileage (10^9 veh-km/y)	304	362	390	416	421	417	395
Car fleet (10^6)	27	30	32	34	35	35	36
Moto, total mileage (10^9 veh-km/y)	31	39	45	49	50	51	52
Moto fleet (10^6)	7	7	9	10	10	10	10
Goods transport, total mileage (10^9 veh-km/y)	69	75	90	98	100	103	104
Truck fleet (10^6), including LDV	2	3	3	4	4	5	5

Source: ISPRA elaborations

Table 3.26 Evolution of fleet consistency and mileage

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

3.5.3.3 Uncertainty and time-series consistency

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

The following Table 3.27 summarizes the time series of GHG emissions in CO2 equivalent from road transport, highlighting the evolution of this growing source. An upward trend in CO_2 emission levels is observed from 1990 to 2007, which is explained by the increasing of the fleet, total mileages, and fuel consumptions. Nevertheless, the propagation of the number of vehicles, with low fuel consumption per kilometre, slows down the tendency in the last years. In 2008, with respect to 2007, a reduction in total mileages, especially for passenger cars, fuel consumptions and consequently CO_2 emissions has been noted. CH_4 and N_2O emission reductions result from the penetration of new technologies according to the main emission regulations.

		1990	1995	2000	2005	2006	2007	2008
CO_2	kt	93,387	103,554	110,379	117,035	118,268	118,724	113,945
CH_4	kt	694	771	567	360	338	317	296
N_2O	kt	786	1,335	1,577	1,017	1,093	1,079	978
Total	**kt**	**94,867**	**105,660**	**112,523**	**118,412**	**119,699**	**120,120**	**115,219**

Source: ISPRA elaborations

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

3.5.3.4 Source-specific QA/QC and verification

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

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

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

3.5.3.5 Source-specific recalculations

In 2009 submission, the transition from COPERT III to COPERT 4 was the occasion for a general review of input data, as activity data, model parameters and emission factors. The new version revised both the estimation methodology and the software.
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.

The most recent update of the software is COPERT 4, version 7.1 since February 2010 (EEA, 2010), which is a user-friendly version enhancing import/export capabilities and the management of time series of estimates. The new version of the model upgraded the methodology, the software and fixed some bugs, and it has been used to estimate emissions in the 2010 submission determining a recalculation of emission estimates, with respect to the previous submission.
Methodological updates of the software regarded mileage degradation parameters, new hot emission factors for motorcycles, new CH_4 cold emission factors for EURO5 gasoline passenger cars and light duty vehicles, and the update of CO, NO_X, NMVOC, CH_4, PM and NH_3 emission factors especially for LPG fuelled passenger cars especially from EURO3 to EURO6.
Regarding the software, the new version enhances export capabilities and the management of time series of estimates. Moreover, important bugs of the software have been corrected. The more relevant concerns the calculation of N_2O, NH_3 and CH_4 hot and cold emissions. Because of this bug there was a misallocation between the hot and cold emissions of these pollutants. Furthermore, the N_2O cold emissions were stored in place of NH_3 cold emissions and vice versa. These updates resulted in a further reduction of CH_4 and N_2O emission levels and an increase of NMVOC emissions, with respect to previous submission.

LPG gasoline fuel consumptions, for road transport, have been revised in order to avoid double counting for some years of consumptions of gasoline for motor boating and LPG for fishing, which are included in the road transport row in the National Energy Balance (MSE, several years [a]). In particular, LPG activity data have been updated for small amounts in 2000 and in 2007 while gasoline only in 2003, while no changes occurred for diesel, natural gas and biomass activity data.

Recalculations, in the total road transport GHG emissions, account for -0.4% in 1990 and 2007. Higher discrepancies are observed for methane (ranging from -20.0% in 1990 to -23.7% in 2007) and nitrous oxide (ranging from -21.0% in 1990 to -24.0% in 2007); carbon dioxide values varied from 0.0001% in 1990 to 0.003% in 2007.

3.5.3.6 Source-specific planned improvements

No specific improvements are planned for the next submission.

3.5.4 Navigation

3.5.4.1 Source category description

This source category includes all emissions from fuels delivered to water-borne navigation.
Mainly CO_2 emissions derive from this category, whereas CH_4 and N_2O emissions are less important.
Emissions from navigation constituted 4.2% of the total GHG in the transport sector in 2008 and 1.0 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 5.7% from 1990 to 2008, although an increase in the number of movements is observed, because of the reduction in fuel consumed in harbour and navigation activities.

Navigation is a key category with respect to CO_2 emissions in level with Tier1.

3.5.4.2 Methodological issues

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

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

- Total deliveries of fuel oil, gas oil and marine diesel oil to marine transport are given in national energy balance (MSE, several years [a]) but the split between domestic and international is not provided;

- Naval fuel consumption for inland waterways, ferries connecting mainland to islands and leisure boats, is also reported in the national energy balance as it is the fuel for shipping (MSE, several years [a]);
- Data on annual arrivals and departures of domestic and international shipping calling at Italian harbours are reported by the National Institute of Statistics in the statistics yearbooks (ISTAT, several years [a]) and Ministry of Transport in the national transport statistics yearbooks (MINT, several years).

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

National average emissions and consumption factors were therefore estimated for harbour and cruise activities both for domestic and international shipping from 1990 to 1999. In 2009 submission, as in the case of aviation, the study was updated for the years 2004, 2005 and 2006 in order to consider most recent trends in the maritime sector both in terms of modelling between domestic and international consumptions and improvements of operational activities in harbour (TECHNE, 2009). On the basis of the results, national average emissions and consumption factors were updated from 2000.

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

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

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

The fuel split between national and international fuel use in maritime transportation is then supplied to the Ministry of the Economical Development to be included in the official international submission of energy statistics to the IEA in the framework of the Joint Questionnaire OECD/Eurostat/IEA compilation together with other energy data.

3.5.4.3 Uncertainty and time-series consistency

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

Estimates of fuel consumption for domestic use, in the national harbours or for travel within two Italian destinations, and bunker fuels used for international travels are reported in Table 3.28. Time series of domestic GHG emissions for waterborne navigation are also shown in the same table.

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

	1990	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**
Fuel in domestic travels (Gg)	778	706	811	740	709	673	702
Fuel in harbours (dom+int ships) (Gg)	748	693	818	759	727	690	717
Fuel in international Bunkers (Gg)	1,398	1,286	1,333	2,203	2,369	2,468	2,622
CO_2 (Gg)	5,420	5,117	5,842	5,403	5,204	4,970	5,111
CH_4 (Gg CO_2 eq.)	29	32	32	30	29	29	28
N_2O (Gg CO_2 eq.)	39	37	43	39	38	36	37

Source: ISPRA elaborations

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

3.5.4.4 Source-specific QA/QC and verification

Basic data to estimate emissions 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, which are collected from maritime operators with a yearly survey and communicated at international level to EUROSTAT. Differences and problems have been analysed in details and solved together with ISTAT experts.

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.

3.5.4.5 Source-specific recalculations

In 2009 submission there was 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 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, 2007; 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.

In 2010 submission, the only recalculation regarded the update of activity data for gasoline fuel consumption in recreational craft activities for 2003.
The recalculation affected only slightly GHG emissions in 2003 with an increase equal to 0.06% of emissions, with respect to earlier submissions.

3.5.4.6 Source-specific planned improvements

Further improvements will regard a verification of activity data on ship movements for the last 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 in the last years.

3.6 Other sectors

3.6.1 Overview of sector

Iin this paragraph sectoral emissions are reported, which originate from energy use in the civil sector included in category 1.A.4. Commercial, institutional, residential, agriculture/fisheries, and emissions from military mobile activities which are also included in category 1.A.5. All greenhouse gases as well as CO, NOx, NMVOC and SO_2 emissions are estimated.

In 2008, energy use in other sectors account for 18.1% of CO_2 emissions, 2.0% of CH_4, 6.2% of N_2O emissions. In term of CO_2 equivalent, other sectors share 16.1% of total national greenhouse gas emissions and 19.3 of total GHG emissions of the energy sector.

The trends of greenhouse gas emissions are summarised in Table 3.29. Emissions are reported in Gg for CO_2, and in Mg for CH_4 and N_2O. An increase in emissions is observed from 1990 to 2000, due to increase in activity data (numbers and size of building with heating); a sharp increase can be observed in 2005 due to exceptionally cold weather conditions. CH_4 and N_2O emissions increase in the period due to the crescent use of woody biomass for heating.

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008
CO_2 (Gg)							
1.A.4.a Commercial/ Institutional	16,187	17,240	20,407	26,120	25,479	25,589	26,823
1.A.4.b Residential	52,118	50,103	50,159	57,340	52,240	46,457	49,745
1.A.4.c Agriculture/ Forestry/ Fisheries	8,372	8,747	8,030	8,371	8,239	7,849	7,593
1.A.5 Other (Not elsewhere specified)	1,046	1,440	806	1,198	982	896	738
CH_4 (Mg)							
1.A.4.a Commercial/ Institutional	1,079	1,308	2,231	3,388	3,572	3,711	3,960
1.A.4.b Residential	12,382	15,756	18,129	19,528	21,029	25,811	27,004
1.A.4.c Agriculture/ Forestry/ Fisheries	1,269	947	2,449	2,616	2,847	3,516	3,663
1.A.5 Other (Not elsewhere specified)	173	223	126	160	127	114	74
N_2O (Mg)							
1.A.4.a Commercial/ Institutional	428	500	694	978	965	969	998
1.A.4.b Residential	1,570	1,625	1,730	1,894	1,873	1,980	2,074
1.A.4.c Agriculture/ Forestry/ Fisheries	2,520	2,756	2,687	2,772	2,761	2,653	2,591
1.A.5 Other (Not elsewhere specified)	225	215	135	291	239	227	199

Source: ISPRA elaborations

Table 3.29 Trend in greenhouse gas emissions from the other sectors, 1990-2008

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

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

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

3.6.2 Source category description

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

Commercial/ Institutional
Emissions from this sector arise from the energy used directly in the institutional, service and commercial buildings, mainly for heating. Additionally this category includes all emissions due to the non-renewable part of wastes used in electricity generation.
In 2008, this sector has a share of 5.0% of total GHG national emissions.

Residential
Emissions from this sector arise from the energy used directly in residential buildings, mainly for heating. The sector includes emission from off-road household and gardening machinery.
In 2008, this sector has a share of 9.4% of total GHG national emissions.

Agriculture/ Forestry/ Fisheries
This subsector include all emissions due to the direct fossil fuel use in agriculture, mainly to produce mechanical energy, the fuel use in fisheries and for the machinery used in the forestry sector.
In 2008, this sector has a share of 1.6% of total GHG national emissions.

Others
Emissions from military aircraft and naval vessels are reported under 1A.5.b Mobile.
The methods of estimation are discussed in paragraphs 3.5.1 and 3.5.4 for aviation and maritime respectively.
In 2008, this sector has a share of 0.1% of total GHG national emissions.

3.6.3 Methodological issues

For this sector, energy consumptions are reported in the BEN (see Annex 5, Tables A5.9 and A5.10, in physical units, row "DOMESTIC AND COMMERCIAL USES", subtracting the quantities for military use in diesel oil and off-road uses in petrol). The BEN does separate energy consumption between civil and agriculture-fisheries, but it does not distinguish between Commercial – Institutional and Residential.

The total consumption of each fuel is therefore subdivided between commercial and residential on the basis of the estimations reported by ENEA in its annual energy report (ENEA, several years).
Emissions from 1.A.4.b Residential and 1.A.4.c Agriculture/Forestry/Fishing are disaggregated into those arising from stationary combustion and those from off-road vehicles and other machinery. The estimation of emissions from off-road sources is discussed in paragraph 3.7.2 *Others*. Emissions from fishing vessels are estimated from fuel consumption data (MSE, several years [a]). Emission factors are shown in Table 3.12.

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

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

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

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

where

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

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

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

where

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

Population data have been revised based on a survey of machinery sales (Frustaci, 1999). Machinery lifetime is estimated on the European averages, see EMEP/CORINAIR (EMEP/CORINAIR, 2007), the annual usage data were taken either from industry or published data (EEA, 2000). The emission factors used came mostly from EMEP/CORINAIR and from Samaras (EEA, 2000). The load factors were taken from Samaras (EEA, 2000).
It was possible to calculate fuel consumptions for each class based on fuel consumption factors given in EMEP/CORINAIR (EMEP/CORINAIR, 2007). Comparison with known fuel consumption for certain groups of classes (e.g. agriculture and construction) suggested that the population method overestimated fuel consumption by factors of 2-3, especially for industrial vehicles.
Estimates were derived for fuel consumptions for the years 1990-2008 for each of the main categories:

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

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

3.6.4 Uncertainty and time-series consistency

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

Estimates of fuel consumption used by other sectors in 2008 are reported in Annex 5, Tables A5.9 and A5.10, in physical units, row “DOMESTIC AND COMMERCIAL USES”. Time series of the other sectors energy consumption data are contained in the BEN time series and reported in Table 3.30.

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

Source: ISPRA elaborations

Table 3.30 Trend in fuel consumption for the other sector, 1990-2008 (TJ)

In the following Table 3.31, total GHG emissions connected to the use of fossil fuels and waste derived fuels are reported for the years 1990, 1995 and 2000-2008. Total emissions from the sector are reported in Gg for CO_2, and in Mg for CH_4 and N_2O. An increase in emissions is observed from 1990 to 2000, due to increase in activity data (numbers and size of building with heating); a sharp increase can be observed in 2005 due to exceptionally cold weather conditions. CH_4 and N_2O emissions increase in the period due to the crescent use of woody biomass for heating.

	1990	1995	2000	2005	2006	2007	2008
CO_2 (Gg)	77,723	77,530	79,402	93,028	86,940	80,791	84,899
CH_4 (Mg)	14,903	18,233	22,936	25,693	27,575	33,151	34,701
N_2O (Mg)	4,743	5,096	5,247	5,935	5,838	5,828	5,862
GHG (Gg CO2 eq)	79,507	79,493	81,510	95,408	89,329	83,294	87,445

Source: ISPRA elaborations

Table 3.31 Other sectors, GHG emission time series 1990-2008

In Table 3.32, other sectors emissions are summarized according to key categories. From 1990 to 2008, 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	2008
CO_2 stationary combustion liquid fuels	Gg	38,770	20,952
CO_2 stationary combustion solid fuels	Gg	920	21
CO_2 stationary combustion gaseous fuels	Gg	36,418	60,179
CO_2 stationary combustion other fuels	Mg	569	3,009
N_2O stationary combustion	Mg	4,518	5,663

Source: ISPRA elaborations

Table 3.32 Others, GHG emissions in 1990 and 2008

3.6.5 Source-specific QA/QC and verification

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

- the overall sum of residential and institutional/service/commercial energy consumption is quite reliable and their uncertainty is the same of the BEN; the quantities of fuels used for those economic sector are routinely reported by main suppliers and the data are well documented.
- the energy consumption for agriculture and fisheries is also routinely reported by energy statistics and the underlying data are quite reliable because the energy use for those sector has special taxation regimes and they are accounted for separately.
- The energy use for military and off roads is instead partly reported and partly estimated with models, as described in paragraph 3.7.2 *others.*

3.6.6 Source-specific recalculations

There has been an overall recalculation of emissions from the sector, due to the update of the CO_2 fuel oil emission factors, based on updated Terna reports for year 2008. Recalculation refers to the years 2005-2007. Moreover, CO2 natural gas emission factor has been updated for 2007, see paragraph 3.1. In addition, from 2002 to 2007, the distribution between residential and commercial fuel consumptions has been updated by ENEA, not affecting the total emission estimation.
The recalculation affected only slightly the time series of CO_2 emissions from 2005 to 2007, with differences ranging from -0.01% in 2005 to 0.19% in 2007, with respect to earlier submissions.

3.6.7 Source-specific planned improvements

No specific improvements are planned for the next submission.

3.7 International Bunkers

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

3.8 Feedstock and non-energy use of fuels

3.8.1 Source category description

In Table 3.33 and 3.34 detailed data on petrochemical and other non-energy use for the year 2008 are given. The table refers to all products produced starting from fossil fuels, solid, gas or liquid, and used for "non energy" purposes. A national methodology is used for reporting and estimation of avoided emissions.

3.8.2 Methodological issues

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

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

National energy balances include only the input and output quantities from the petrochemical plants; so the output quantity could be greater than the input quantity, due to internal transformation. Therefore it is possible to have negative values for some products (mainly gasoline, refinery gas, fuel oil).

The quantities of fuels stored in products, in percentage on net and gross petrochemical input, are estimated with these data, see Table 3.34 for details by product and Table 3.33 for the overall figure. The amount of quantity stored in products for each fuel is calculated as the difference between input (petrochemical input) and output (returns to refinery and internal consumption and losses); these amounts are transformed in carbon stored by the emission factors reported in Table 3.34. Non-energy products quantity amount stored are reported in the BEN and the carbon stored is estimated with emission factors reported in Table 3.35. Fuel quantity reported in TJ in Table 1.A(d) of the CRF are the amount of fuels stored; for this matter the fractions of carbon stored are all equal to 1.

As can be seen from the value reported for the year 2008, 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 3.35. The resulting estimate of about 5,940 Gg of products for the year 2008, is almost 50% bigger than the quantities reported, 4,040 Gg, see Table 3.33.

BREAKDOWN OF TOTAL PETROCHEMICAL FLOW				
	Petroch. Input	Returns to refin./market	Internal consumption / losses	Quantity stored in products
ALL ENERGY CARRIERS, kt	9,119	2,546	2,533	4,040
% of total input		27.9%	27.8%	44.3%
% of net input			38.5%	61.5%

Source: ISPRA elaborations

Table 3.33 Other non-energy uses, year 2008

FUEL TYPE	**Petroch. Input**	**Returns to refinery/ market**	**Internal consumption / losses**	**Quantity stored in products**	**% on gross input**	**% on net input**	**Emission factor (IPCC)**
	Gg	**Gg**	**Gg**	**Gg**			**Mg C / Mg**
LPG	554	514	444	-404			0.8137
Refinery gas	106	54	624	-572			0.8549
Virgin naphtha	4,804	0	0	4,804			0.8703
Gasoline	1,036	1,324	63	-350			0.8467
Kerosene	360	262	0	98			0.8485
Gas oil	635	181	0	454			0.8569
Fuel oil	562	144	419	-1			0.8678
Petroleum coke	0	0	0	0			0.955
Others (feedstock)	128	67	50	11			0.8368
Losses			0	0			0.8368
Natural gas	934	0	934	0			0.727
total	9,119	2,546	2,533	4,040	44%	61%	

Source: ISPRA elaborations

Table 3.34 Petrochemical, detailed data from MSE, year 2008 (MSE, detailed petrochemical breakdown)

NON ENERGY FROM REFINERIES	**Quantity stored in products**	**Energy content IPCC '96**	**Emission factor**	**Total energy content, IPCC values**
	Gg		**t C / t**	**TJ**
Bitumen + tar	3,808	40.19	0.8841	153.0
lubricants	1,205	40.19	0.8038	48.4
recovered lubricant oils	177	40.19	0.8038	7.1
paraffin	89	40.19	0.8368	3.6
others (benzene, others)	661	40.19	0.8368	26.6
Totals	5,940			238.7

Source: ISPRA elaborations

Table 3.35 Other non-energy uses, year 2008, MSE several years [a]

At national level, this methodology seems the most precise according to the available data. The European Project "Non Energy use-CO_2 emissions" ENV4-CT98-0776 has analysed our

methodology performing a mass balance between input fuels and output products in a sample year. The results of the project confirm the reliability of the reported data (Patel and Tosato, 1997).
With reference to the data of Table 3.35, those non-energy products are mainly outputs of refineries. The estimate refers to quantities produced that are reported by manufacturers and summarized by BEN. The data should not be controversial.
Minor differences in the overall energy content of those products do occur if the calculation is based on national data or IPCC default values.

3.8.3 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions in “Other sectors” is estimated to be about 4% in annual emissions.
In Annex 4 the time series for comparison between reference and sectoral approach are reported showing percentage differences in a limited range.

3.8.4 Source-specific QA/QC and verification

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

3.8.5 Source-specific recalculations

No recalculations have been performed for those sources.

3.8.6 Source-specific planned improvements

No specific improvements are planned for the next submission.

3.9 Fugitive emissions from solid fuels, oil and natural gas

3.9.1 Source category description

Fugitive emissions of GHG arise during the stages of fuel production, from extraction of fossil fuels to their final use. Emissions are mainly due to leaks or other irregular releases of gases from the production and transformation of solid fuels, the production of oil and gas, the transmission and distribution of gas and from oil refining.
Solid fuels category implies mainly methane emissions, while oil and natural gas categories include carbon dioxide and nitrous oxide too.
In 2008, GHG emissions from this source category account for 1.6% out of the total emissions in the energy sector. Trends in fugitive emissions are summarised in Table 3.40.

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

Key-category identification in the fugitive sector with the IPCC 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, T2)

Specifically, methane emissions from oil and gas operations are a key category source according to the trend assessment with Tier 1 and Tier 2 approaches, either including or excluding LULUCF emissions and removals. As regard level assessment, methane emissions are key category sources

with Tier 1 and Tier 2 approaches without LULUCF, while they are key category sources only with Tier 1 with LULUCF.
CO_2 emissions from oil and gas operations are a key category for level and trend assessment with Tier 2 approaches, without LULUCF; these emissions are no more key categories when including LULUCF. Both categories are key categories for the year 1990, either including or excluding LULUCF emissions and removals.

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

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

CH_4 emissions reported in 1.B.2 refer mainly to the production of oil and natural gas and to the transmission in pipelines and distribution of natural gas.

For the completeness of the related CRF tables, in particular 1.B.2, the rationale beyond the values reported and not reported is explained below.
CO_2 and CH_4 fugitive emissions from oil exploration are included in those from production because no detailed information is available. N_2O emissions from flaring in oil exploration 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.
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 3.36.

1.B. 2.a. Oil		
i. Exploration	CO_2,CH_4	Included in 1.B.2.a production
i. Exploration	N_2O	Included in 1.B.2.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 3.36 Completeness of CO_2 CH_4 and N_2O fugitive emissions

3.9.2 Methodological issues

CH_4 emissions from coal mining have been estimated on the basis of activity data published on the National Energy Balance (MSE, several years [a]) and emission factors provided by the IPCC guidelines (IPCC, 1997). CH_4 emissions from coke production have been estimated on the basis of activity data published in the national statistical yearbooks (ISTAT, several years [a]) and emission factors reported in the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2007).

Emissions in refineries have been estimated on the basis of activity data published in the National Energy Balance (MSE, several years [a]) or supplied by oil and gas industry association (UP, several years) and operators especially in the framework of the European emissions trading scheme, and emission factors published on the IPCC Good Practice Guidance (IPCC, 2000).
In Table 3.38, the time series of crude oil losses published in the BEN and crude oil processed in Italian refineries are shown.

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

Source: MSE, UP
Table 3.37 Refineries activities and losses

CH_4 emissions from the production of oil and natural gas have been calculated according with activity data published on National Energy Balance (MSE, several years [a]), data by oil and gas industry association (UP, several years), and data supplied by operators, and emission factors published on the IPCC Good practice Guidance (IPCC, 2000). 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).
In Table 3.38, the time series of national production of oil and gas are reported. Natural gas production should further reduce in the next years.

	1990	1995	2000	2005	2006	2007	2008
Oil (Gg)	4,641	5,208	4,555	6,084	5,757	5,838	5,220
Natural gas (Mm^3)	17,296	20,383	16,766	11,963	10,837	9,596	9,070

Source: MSE
Table 3.38 National production of oil and natural gas

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 on: the amount of natural gas distributed (ENI, several years [a]); length of pipelines, distinct by low, medium and high pressure and by type, cast iron, grey cast iron, steel or polyethylene pipelines (AEEG, several years); natural gas losses reported in the national energy balance (MSE, several years [a]); methane emissions reported by operators in their environmental reports (ENI, several years [b]; EDISON, several years). Estimates include emissions emitted in the different phases of distribution and transmission of gas including losses in pumping stations and in reducing pressure stations. Table 3.39 provides the trend of natural gas distribution network with length for each pipeline material and the average CH_4 emission factor.

Material	1990	1995	2000	2005	2008
Steel and cast iron	102.061	131.271	141.848	154.886	191.567
Grey cast iron	24.164	23.229	21.314	15.080	5.036
Polyethylene	775	7.300	12.550	31.530	45.570
Total	**127.000**	**161.800**	**175.712**	**201.496**	**242.173**
CH_4 Emission Factors (m^3/km)	**2.634**	**1.929**	**1.762**	**1.394**	**1.014**

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

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

3.9.3 Uncertainty and time-series consistency

The uncertainty in CH_4, N_2O and CO_2 emissions from oil and gas operations is estimated to be 25% as a combination of 3% and 25% for activity data and emission factors, respectively.
The uncertainty in methane emissions from coal mining and handling is estimated to be 200% as combination of 3% and 200% for activity data and emission factors, respectively.

Fugitive emissions, in CO_2 equivalent, account for 1.6% out of the total emissions in the energy sector in 2008. Both CH_4 and CO_2 emissions show a reduction from 1990 to 2008 by 31% and 32%, respectively.
The decrease of CO_2 fugitive emissions is driven by the reduction in crude oil losses in refineries. Fugitive emissions from solid fuels are not relevant.
The trend of CH_4 fugitive emissions from solid fuels is related to the extraction of coal and lignite that in Italy is quite low. The decrease of CH_4 fugitive emissions from oil and natural gas is due to the reduction of losses for gas transportation and distribution, because of the gradual replacement of old grey cast iron pipelines with steel and polyethylene pipelines for low and medium pressure network.
As regard the flaring activity from oil and gas production, the N_2O emissions account for less than 1.5 Gg of CO_2 equivalent in the whole time series.

Fugitive emissions since 1990 are reported in Table 3.40.

	1990	1995	2000	2005	2006	2007	2008
			Gg CO_2 eq.				
CO_2							
Oil and natural gas	3,341	3,265	3,212	3,380	3,226	3,174	3,035
CH_4							
Solid fuels	122	65	73	69	54	84	73
Oil and natural gas	7,298	6,817	6,351	5,641	5,102	4,930	5,041
N_2O							
Oil and natural gas	1.2	1.3	1.1	1.5	1.4	1.4	1.2
Total emissions	10,762	10,057	9,010	7,823	7,345	7,191	7,373

Table 3.40 Fugitive emissions from oil and gas 1990-2008 (Gg CO_2 eq.)

3.9.4 Source-specific QA/QC and verification

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

Concerning CO_2 fugitive emissions from refineries activities the estimates are balanced with the amount of crude oil losses reported in the national Energy Balance (MSE, several years [a]).

CH_4 emissions from transmission and distribution of natural gas are verified considering emission factors reported in literature and detailed information supplied by the main operators (ENI, several years [b]; Riva, 1997).

3.9.5 Source-specific recalculations

In the 2010 submission, only few recalculations affected emission estimates of the sector.
A recalculation occurred, from 2002, for natural gas transmission and distribution (1.B.2.b) because of changes in the share between domestic and tertiary natural gas consumptions, as updated by ENEA (ENEA, several years). This resulted in a change of CH_4 emission in a range between -1.3% and +0.4%. Moreover, CH_4 emissions from the production of oil in 2007 were updated because of new activity data. This recalculation resulted in an increase of emissions of 0.4% in the same year.

3.9.6 Source-specific planned improvements

As previously described, CO_2 and CH_4 fugitive emissions from oil exploration and production are not distinct because no detailed information is available. N_2O emissions from flaring by oil exploration and refining activities are reported under oil flaring. No emissions occur from oil transport and distribution. CO_2 and CH_4 emissions from gas exploration and production are not distinct and CH_4 emissions from other leakage are included in distribution emission estimates. Further investigations will be carried out with industry about these figures.

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 1.A.2. All greenhouse gases as well as CO, NO_x, NMVOC and SO_2 emissions are estimated.
In 2008 industrial processes account for 5.3% of CO_2 emissions, 0.2% of CH_4, 3.6% of N_2O, 100% of PFCs, HFCs and SF_6. In terms of CO_2 equivalent, industrial processes share 6.3% 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 2008, while CO_2 emissions from chemical and metal industry reduced sharply.

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008
CO_2 (Gg)							
2A. Mineral Products	21,100	20,768	21,268	23,235	23,296	23,795	21,501
2B. Chemical Industry	3,254	1,659	1,362	1,784	1,727	1,759	1,488
2C. Metal Production	3,878	3,403	1,754	2,018	2,040	2,019	1,976
CH_4 (Gg)							
2B. Chemical Industry	2.45	2.65	0.40	0.33	0.32	0.34	0.30
2C. Metal Production	2.71	2.71	2.61	2.72	2.81	2.75	2.60
N_2O (Gg)							
2B. Chemical Industry	21.54	23.35	25.54	25.03	8.54	6.10	3.44
HFCs (Gg CO_2 eq.)	351	671	1,986	5,267	5,956	6,701	7,379
PFCs (Gg CO_2 eq.)	1,808	491	346	353	282	288	194
SF_6 (Gg CO_2 eq.)	333	601	493	465	406	428	434

Table 4.1 Trend in greenhouse gas emissions from the industrial process sector, 1990-2008 (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)
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)
2B	N_2O	Emissions from nitric acid production	Key (T1)

CO_2 emissions from cement are included in category 2A; N_2O emissions from adipic acid, nitric acid and CO_2 emissions from ammonia refer to 2B; 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 are also key category sources including the LULUCF estimates in the assessment, even if N_2O emissions from adipic acid production is a key category only with the Tier 1 approach including LULUCF.
In addition CO_2 emissions from limestone and dolomite use is a key category in the base year at level assessment with the Tier 1 approach including and excluding LULUCF.

4.2 Mineral Products (2A)

4.2.1 Source category description

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

Cement

Cement production (2A1) is the main source of CO_2 emissions in this sector. As already mentioned, it is a key source both at level (with both the Tier 1 and Tier 2 approaches) and trend assessment (with the Tier 2 approach) and accounts for 3.45% 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 27 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. In 2008 the larger size cement plants (i.e. with cement production capacity > 1 Mt/y) contributed with about 25% tothe national cement production. In Italy different types of cement are produced; as for 2008 AITEC, the national cement association, has characterised the national production as follows: 75% is CEM II (Portland composite cement); 11.5% is CEM IV (pozzolanic cement); 7.8% is CEM I (ordinary Portland Cement) and 4.6% is CEM III (blastfurnace cement). The decrease in clinker production in 2008 (about 10%) led to a decrease in the CO_2 emission from cement production.

Lime

CO_2 emissions occur also from processes where lime is produced and account for 0.49% 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, 38 plants in 2008 (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 0.47% 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. A decrease in the use of limestone in the relevant production processes in 2008 led to a decrease (-12%) in CO_2 emissions.

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

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

The formulated batch is generally melted in continuous furnaces, whose size and features are related to the types of glass production. In Italy 80% of the glass industry production is carried out using natural gas as fuel, other fossil fuels consumption is limited to low sulphur content oil. Emissions 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; IPCC, 2006).

Activity data are supplied in the national statistical yearbooks (ISTAT, several years) and by industries. Emission factors are those provided by the IPCC Guidelines (IPCC, 1997; IPCC, 2000; IPCC, 2006), by the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2007) or by other international Guidebooks (USEPA, 1997).

Cement

CO_2 emissions from cement production are estimated 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 emissions trading scheme. In this latter context, all cement production plants reported fuel consumption and emissions, split between combustion process and decarbonising process. For the years from 1990 up to 2003 the resulting emission factor for cement production was equal to 540 kg CO_2/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 are based on the data reported within the frame of the EPER/EPRTR and of the European Emissions Trading scheme. The EF resulted in 518 kg CO_2/ton clinker in 2008, 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; 707 kg CO_2/ton lime production in 2007 and 710 kg CO_2/ton lime production in 2008.

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, several years; Federchimica, several years; SITEB, several years) and default emission factors (EMEP/CORINAIR, 2007).

4.2.3. Uncertainty and time-series consistency

The uncertainty in CO_2 emissions from cement, lime, limestone and dolomite use and glass production is estimated to be equal to 10.4% from each activity, 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	2005	2006	2007	2008
				(kt)			
Cement production (decarbonizing)	29,786	28,778	29,816	33,122	33,210	33,742	31,119
Glass (decarbonizing)	3,779	4,259	4,930	5,328	5,327	5,385	5,365
Lime (decarbonizing)	2,583	2,873	2,760	3,344	3,496	3,444	3,206
Limestone and dolomite use	5,397	4,907	4,848	5,797	5,752	5,717	5,014
Soda ash production and use	610	1,070	1,000	915	883	874	836

Table 4.2 Production of mineral products, 1990 – 2008 (kt)

CO_2 EMISSIONS	1990	1995	2000	2005	2006	2007	2008
				(Gg)			
Cement production (decarbonizing)	16,084	15,540	16,101	17,403	17,474	17,914	16,127
Glass (decarbonizing)	416	468	549	645	618	663	627
Lime (decarbonizing)	2,042	2,279	2,185	2,361	2,426	2,434	2,276
Limestone and dolomite use	2,375	2,159	2,133	2,550	2,531	2,515	2,206
Soda ash production and use	183	321	300	275	247	268	265

Table 4.3 CO_2 emissions from mineral products, 1990 – 2008 (Gg)

Emission trends are related to the production level, which is 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.

Under the EU-ETS, operators are requested to report activity data and CO_2 emissions as information verified and certified by auditors who check for consistency to the reporting criteria.
Activity data and emissions reported under EU-ETS and EPER/EPRTR are compared to the information provided by the industrial associations. The general outcome of this verification step shows consistency among the information collected under different pieces of legislations and the information provided by the relevant industrial associations. In particular, comparisons can be carried out for cement, lime, limestone and dolomite, and glass sectors.

4.2.5. Source-specific recalculations

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

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.

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 2.40% in 2008 because the technology to reduce N_2O emissions has become fully operational at the existing producing facility since 2007.
N_2O emissions have relevantly decreased thanks to the implementation of a catalytic abatement system (pilot scale plant). The use of thermally stable catalysts in the pilot plant has allowed the treatment of highly N_2O concentrated flue gas from the adipic acid production plant, thus reducing the volumes of treated gas and the size of the pilot plant itself. The abatement system is generally run together with the adipic acid production process. In 2004 this system was tested for one month resulting in complete decomposition of N_2O, in 2005 the catalytic process was started only at the end of the year because of technical changes in the system; in 2006 the abatement system had been operating continuously for 9 months (three months were needed for maintenance and technical changes) leading to the decomposition of 95% (efficiency of the abatement system while in operation) of N_2O emissions. In 2007 and 2008 the operating time was 11 months (about one month was needed for maintenance operations) and the abatement rate for N_2O emissions was 90% (efficiency of the abatement system while in operation) (Radici Chimica, several years).

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 largest 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. Part of CO_2 is recovered as a by-product and part is released to atmosphere. Recovered CO_2 can either be used as input for different production processes (UREA or Calcium nitrate lines) on site or can be sold to technical gas manufacturers. The results of the investigation concerning the recovered CO_2 are accounted for in this submission: operators provided the information used to revise both the emission and the EF time series (YARA, several years). CO_2 emissions from ammonia production are also a key source, at trend assessment with the Tier 1 approach.

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. Moreover, as far as YARA is concerned, the decrease in N_2O emissions is also related to the implementation of catalytic N_2O decomposition in the oxidation reactor (YARA De-N_2O patented technology, based on the use of CeO_2 catalyst) (YARA, several years).

Carbon black

Three facilities have been carrying out this production which consists basically on cracking of feedstock oil (a mixture of PAH) at 1200 – 1900 °C. Together with black carbon, tail gas is a by product of the process. Tail gas is a mixture of CO, H_2, H_2O, NO_x, SO_x and H_2S; it is generally 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. Since 2007 Polimeri Europa has become the main producer for those products, while it has been the main producer of styrene since 2002.

Titanium dioxide

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

Caprolactame production

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

Calcium carbide production

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

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

In Italy CARBITALIA SPA is the only facility which can operate calcium carbide production (CARBITALIA SPA, 2009). It produced calcium carbide up to 1995, when it 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. The abatement system is generally run together with the adipic acid production process. In 2004, the N_2O catalytic decomposition abatement technology has been tested so that the value of emission factor has been reduced taking into account the efficiency and the time, one month, that the technology operated. From the end of 2005 the abatement technology is fully operational; the average emission factor in 2006 is equal to 0.05 kg N_2O/kg adipic acid produced and the abatement system had been operating continuously for 9 months; since 2007 the average emission factor has been 0.03 kg N_2O/kg adipic acid produced and the operating time of the abatement system was 11 months both in 2007 and in 2008. Improving the efficiency in operation, the technology system it is expected to reach 95% of abatement rate in the future with respect to the default emission factor 300 kg /tonne adipic acid produced. The EFs reported for the last years are also consistent to figures resulting from the calculations based on efficiency and utilization details provided by the operator, as shown in the following box.

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

Year	A	EFp	T
2007	0.90	0.3	11/11
2008	0.90	0.3	11/11

Values resulting according to the following formula

$$A*EFp*T = EFs$$

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

Ammonia

Ammonia production data are published in the international industrial statistical yearbooks (UN, several years), national statistical yearbooks (ISTAT, several years) and from 2002 they have been checked with information reported in the national EPER/E-PRTR registry. Recovered CO_2 has been investigated with the cooperation of the operators and the resulting information has been used to revise the whole CO_2 emission time series and the emission factors in this submission. The result of this investigation is that CO_2 emissions recovered from ammonia production are used to produce urea and technical gases. According to IPCC Guidelines this CO_2 recovered should be accounted for emission and included in the estimate. Differently from the previous submissions the resulting average CO_2 emission factors are found to be higher than the IPCC defaults. In particular, for the years 1990-2001, CO_2 emission factor has been calculated on the basis of information reported by the production plants for 2002 and 2003 in the framework of the national EPER/E-PRTR registry and considering also the amounts of CO_2 recovered since the beginning of the recovery operations. CO_2 reported to the national EPER/E-PRTR registry has been used for the previous years in consideration that, as communicated by the operators, no modifications to the production plants have occurred along the period (YARA, 2007). For the years 2002-2007, the average emission factors have been revised too: they result from data reported by the plants in the national EPER/E-PRTR and they account for the recovered CO_2 data too. As for 2008 the average emission factor is 1.85 t CO_2/t ammonia production. Natural gas is used as feedstock in the ammonia production plants and the amount of fuel used is included in the energy balance under the no energy final consumption sector (see Annex 5), therefore double counting does not occur. The following box shows the revised time series for the average CO_2 emission factor.

Ammonia production, revised time series for the average CO_2 EF (t CO_2/t ammonia production)								
	1990-2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
EF (t CO_2/t ammonia production)	1.90	1.90	1.93	1.94	1.93	1.92	1.90	1.86

Nitric acid

With regard to nitric acid production (2B2), production figures at national level are published in the national statistical yearbooks (ISTAT, several years), while at plant level they have been collected from industry (Norsk Hydro, several years; Yara, several years; Radici Chimica, several years). In 1990 there were seven production plants in Italy; three of them closed between 1992 and 1995, and another one closed in 2004. 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. Further decrease in N_2O emission factor is also related to the implementation of catalyst N_2O decomposition technology at the manufacturing plants (Yara, several years), the implied emission factor for 2008 is in fact 2.29 kg N_2O/Mg nitric acid production (the abatement rate in one plant was 82% so far).

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 2008 it is 2.59 t CO_2/t carbon black production.

Calcium carbide

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

4.3.3. Uncertainty and time-series consistency

The uncertainty in N_2O emissions from adipic and nitric acid and caprolactame production and in CO_2 emissions from ammonia and for other chemical production is estimated by 10.4%, for each activity, as combination of uncertainties 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.

In general, total emission trends for all the chemical productions have been affected by reductions in productions, whenever abatement technologies or closures of plants cannot be regarded to as the specific causes for the decreasing emissions.

ACTIVITY DATA	1990	1995	2000	2005	2006	2007	2008
				(kt)			
Adipic acid	49	64	71	75	84	84	76
Ammonia	1,455	592	414	607	559	578	474
Calcium carbide	12	7	-	-	-	-	-
Caprolactame	120	120	111	-	-	-	-
Carbon black	184	208	221	214	226	234	210
Ethylene	1,466	1,807	1,771	1,721	1,639	1,797	1,465
Ethylene oxide	61	54	13	-	-	-	-
Nitric acid	1,037	588	556	572	526	505	505
Propylene	774	693	690	1.037	988	971	843
Styrene	365	484	613	520	558	549	504
Titanium dioxide	58	69	72	60	68	72	59

Table 4.4 Production of chemical industry, 1990 – 2008 (kt)

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

Table 4.5 CO_2, CH_4 and N_2O emissions from chemical industry, 1990 – 2008 (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 ammonia production process have been revised for the whole time series in order to account for recovered CO_2. So, in terms of (%), the whole time series for the Chemical industry shows increases reported in the following box.

Recalculations (%) in CO_2 emissions time series for the Chemical industry, 1990-2007

GAS/SUBSOURCE	1990	1991	1992	1993	1994	1995	1996	1997	1998
CO_2									
2B. Chemical Industry	0.32420	0.32441	0.32293	0.30328	0.26875	0.25868	0.23044	0.23806	0.22173

GAS/SUBSOURCE	1999	2000	2001	2002	2003	2004	2005	2006	2007
CO_2									
2B. Chemical Industry	0.21729	0.22032	0.23176	0.24181	0.25965	0.27798	0.26168	0.24263	0.25467

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 2008, for 0.4% of the national total CO_2 emissions, and 7.9% of the total CO_2 from industrial processes.
The share of CH_4 emissions is, in 2008, 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 1.5% (0.02% of the national total greenhouse gas emissions) in the year 2008.

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 2008, there are only three of the above mentioned plants, one of which lacks sintering facilities. Oxygen steel production represents about 36% of the total production and the arc furnace steel the remaining 64% (FEDERACCIAI, several years).
Currently, long products represent about 50% of steel production in Italy, flat products about 40% and pipes the remaining 10%. Almost the whole flat production derives from one only integrated iron and steel plant while, in steel plants equipped with electric ovens, almost all located in the northern regions, long products are produced (e.g carbon steel, stainless steels) and seamless pipes (only one plant) (FEDERACCIAI, several years).
CO_2 emissions from steel production refer to carbonates used in basic oxygen furnaces and crude iron and electrodes in electric arc furnaces. CO_2 emissions from pig iron production refer to carbonates used in sinter and pig iron production. CO_2 emissions from iron and steel production due to the fuel consumption in combustion processes are estimated and reported in the energy sector (1A2a) to avoid double counting.

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

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

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

Since then the technology implemented has been upgraded from Side Work Prebake to Point Fed Prebake; while three old plants stopped the operations in 1991 (Bolzano) and in 1992 (Fusina 2 and Porto Marghera). Since 2000 Alcoa has replaced ENIRISORSE in operating the plants.
At present in Italy two primary aluminium production plants are left, which use a prebake technology with point feeding, characterised by low emissions. Primary aluminium production passed from 232 kt in 1990 to 186 kt in 2008.

Magnesium foundries
In the magnesium foundries, SF_6 is used as a cover gas to prevent oxidation of molten magnesium. In Italy there is only one plant, located in the north, which started its activity in September 1995. Since the end of 2007, SF_6 has been replaced by HFC 125, due to the enforcement of fluorinated gases regulation (EC, 2006) which, however, allows for the use of SF_6 in annual amounts less than 850 kg.

4.4.2. Methodological issues

CO_2 and CH_4 emissions from the sector have been estimated on the basis of activity data published in the national statistical yearbooks (ISTAT, several years), data reported in the framework of the national EPER/E-PRTR registry and the European emissions trading scheme, and supplied by industry (FEDERACCIAI, several years). 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 1990-2008.

Activity data are supplied by official statistics published in the national statistics yearbook (ISTAT, several years) and by the sectoral industrial association (FEDERACCIAI, several years).
For the integrated plants, emission and production data have been communicated by the two largest plants for the years 1990-1995 in the framework of the CORINAIR emission inventory, distinguished by sinter, blast furnace and BOF, and by combustion and processes emissions. From 2000 CO_2 emissions and production data have been supplied by all the plants in the framework of the ETS scheme, for the years 2000-2004 disaggregated for sinter, blast furnace and BOF plants, from 2005 specifying carbonates and fuels consumption and related CO_2 emissions. For 2002-2006 data have also been supplied by all the four integrated iron and steel plants in the framework of the European EPER/E-PRTR registry not distinguished for combustion and processes. Qualitative information and documentation available on the plants allowed reconstructing their history including closures or modifications of part of the plants; additional qualitative information regarding the plants collected and checked for other environmental issues or directly asked to the plant permitted to individuate the main driving of the emission trends for pig iron and steel productions.
Time series of carbonates used in basic oxygen furnaces have been reconstructed on the basis of the above mentioned information resulting in no emissions in the last years. Indeed, as regards the largest Italian producer of pig iron and steel, lime production has increased significantly from 2000 to 2008 by about 250,000 over 410,000 tonnes and the amount introduced in basic oxygen furnaces was, in 2004, about 490,000 tonnes (ILVA, 2006). Emissions from lime production in steel making industries are reported in 1A2 Manufacturing Industries and Construction.
Concerning the electric arc furnaces, additional information on the consumption of scraps, pig iron, graphite and electrodes and their average carbon content has been supplied together with the steel production by industry for a typical plant in 2004 (FEDERACCIAI, 2004) and checked with other sectoral study (APAT, 2003). On the basis of these figures an average emission factor has been calculated.
On account of the amount of carbonates estimated in sinter plants, average emission factor was equal in 1990 to 0.15 t CO_2/t pig iron production, while in 2008 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 2008, 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 specific IPPC BREF Report (IPPC, 2001 available at http://eippcb.jrc.es), sectoral study (APAT, 2003) and the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2007) and refer to blast furnace, basic oxygen furnace, electric furnaces and rolling mills.

Ferroalloys
CO_2 emissions from ferroalloys have been estimated on the basis of activity data published in the national statistical yearbooks (ISTAT, several years) until 2001. Time series of ferroalloys activity

data have been estimated 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 since 2007.
The average emission factor has been calculated according to the IPCC Guidelines (IPCC, 2006) taking into consideration the different types of ferroalloys produced. The splitting up of national production in different types of ferroalloys was obtained from U. S. Geological Survey (USGS, several years) as reported in the box below. Emission factors reported in 2006 guidelines were used because of the upgrade as compared to the previous edition. Furthermore, suggestions from the inventory review processes have been considered and the resulting average emission factors were checked with those resulting from the information on the carbon content (coke + electrodes) obtained by the IPPC permit of the sole producer regarding activity data of 2004.

Splitting up of ferroalloys national production and IPCC 2006 emission factors

Ferroalloy	*1990*	*1995*	*2000*	*2005*	*2006*	*2007*	*2008*		IPCC 2006 EF kg/t
FeCr	0.30	0.26	-	-	-	-	-		1300
FeMn	0.24	0.10	0.28	0.23	0.11	0.13	0.13		1500
FeSi	0.02	-	-	-	-	-	-		5000
SiMn	0.32	0.53	0.62	0.70	0.81	0.79	0.79		1400
Si-Metal	0.06	0.05	0.03	-	-	-	-		5000
Other	0.07	0.06	0.07	0.07	0.08	0.08	0.08		5000

Implied emission factors for ferroalloys reduced from 1.91 to 1.71 t CO_2/t ferroalloys production, from 1990 to 2008, 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 395 Gg in 1990 to 182 Gg in 2008.

<u>*Aluminium production*</u>
PFC emissions from aluminium production, key source at trend assessment calculated with Tier 1, have been estimated using both Tier 1 and IPCC Tier 2 methodologies. The Tier 1 has been used to calculate PFC emissions from 1990 to 1999, while Tier 2 has been used since 2000; the use of different methods along the period is due to the lack of detailed data for the years previous to 2000. Although 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). However, in response to the last review, the possibility to find hystorical data was explored once again, but Alcoa could not provide data from the previous operator.

PFC emissions, specifically CF_4 and C_2F_6, have been calculated on the basis of information provided by national statistics (ENIRISORSE, several years; ASSOMET, several years) and the national primary aluminium producer (ALCOA, several years), with reference to the document drawn up by the International Aluminium Institute (IAI, 2003) and the IPCC Good Practice Guidance (IPCC, 2000).

Tier 1 method has been used to calculate PFC emissions related to the entire period 1990-1999. The emission factors for CF_4 and C_2F_6 were provided by the main national producer (ALCOA, 2004) based on the IAI document (IAI, 2003).
The Tier 1 method used by ALCOA is based on the IAI methodology, which collected AED data from 1990 up to 2000, accounting also for reductions in specific emission for all technology

categories (specific factors for Point Fed Prebake cells have been considered to estimate emissions). In 1990 at the five production sites the following technologies were implemented:

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

The EFs for PFCs were then calculated by ALCOA as weighted arithmetic mean values of EFs for the different technologies (IAI, 2003), the weights representing the technologies implemented.

In the following tables (Tables 4.6, 4.7) the emission factors and the default parameters used are reported; site specific values are confidential but they have been supplied to the inventory team.

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

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

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

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

PFC emissions for the period from the year 2000 result from the more accurate IPCC Tier 2 method, based on default technology specific slope factors and facility specific anode effect minutes. AED calculated from 2000 are reported in the following box.

Anode effects minutes per cell-day

2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
0.972	1.159	0.969	1.300	0.748	0.871	0.739	1.024	0.548

Site-specific values (CF_4 and C_2F_6 emissions) and, where these were not available, default coefficients (slope coefficients for CF_4 and C_2F_6) were provided by the main national producer (ALCOA, 2004).

In Table 4.8 the IPCC recommended slope values have been included.

Type of Cell	**CF4**	**C2F6**
	Slope Factor (kg PFC/tAl/AE-minutes/cell day)	
Center Work Prebake	0.14	0.018

Table 4.8 Historical default Tetrafluoromethane (CF_4) emission values by reduction technology type (IAI, 2003)

PFC emissions in 2003 are relatively high as a result of a conservative approach adopted by ALCOA to assess the AED to be considered for that year: the AED in minutes was calculated as a mean value over 9 months because the implementation of a new automation system caused the lack of information for a three month period.

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. Emission factors from aluminium production have been updated since 2002 on account of new information from the relevant plant in the framework of EPER/PRTR registry.
In the following tables (Tables 4.9, 4.10) the emission factors and the default parameters used are reported; site specific values are confidential but they have been supplied to the inventory team.

	Baked Anode Properties (weight percent)		
	Sulphur	**Ash**	**Impurities**
Portovesme	ssv*	ssv	DV** = 0.4
Fusina	DV = 1.6	ssv	DV = 0.4

* site specific value
** default value

Table 4.9 Coefficients used for estimation of CO_2 from aluminium production process 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 4.10 Coefficients used for estimation of CO_2 from aluminium production process with the Tier 2 methodology by plant

Magnesium foundries
For SF_6 used in magnesium foundries, according to the IPCC Guidelines (IPCC, 1997), emissions are estimated from consumption data made available by the company (Magnesium products of Italy, several years), assuming that all SF_6 used is emitted. In 2007, SF_6 has been used partially, replaced in November by HFC 125, due to the enforcement of fluorinated gases regulation (EC, 2006). This regulation allows for the use of SF_6 in annual amounts less than 850 kg starting from 1 January 2008, that’s why in 2008 SF_6 was still reported together with HFC125 emissions. HFC125 emissions have been reported in the CRF sector 2G OTHER.

4.4.3. Uncertainty and time-series consistency

The combined uncertainty in PFC emissions from primary aluminium production is estimated to be about 11% in annual emissions, 5% and 10% concerning respectively activity data and emission factors; the uncertainty for SF_6 emissions from magnesium foundries is estimated to be about 7%, 5% for both activity data and emission factors. The uncertainty in CO_2 emissions from the sector is estimated to be 10.4%, for each activity, while for CH_4 emissions about 50%.
In Table 4.10 emission trends of CO_2, CH_4 and F-gases from metal production are reported. The decreasing of CO_2 emissions from iron and steel sector is driven by the use of lime instead of limestone and dolomite to remove impurities in pig iron and steel while CO_2 emissions from aluminium and ferroalloys are driven by the production levels.
In Table 4.11 the emission trend of F-gases per compound from metal production is given. PFC emissions from aluminium production decreased because of the closure of three old plants in 1991 and 1992 and the update of technology for the two plants still operating. The decreasing of SF_6 consumption in the magnesium foundry from 2003 is due to the abandonment of recycling plant and the optimisation of mixing parameters.

EMISSIONS	1990	1995	2000	2005	2006	2007	2008
CO_2 (Gg)							
Iron and steel	3,124	2,898	1,230	1,533	1,562	1,485	1,424
Aluminium production	359	276	294	304	297	348	370
Ferroalloys	395	230	229	180	181	186	182
CH_4 (Gg)							
Pig iron	2.13	2.10	2.02	2.06	2.07	2.00	1.87
Steel	0.58	0.60	0.60	0.67	0.74	0.75	0.73
PFC (Gg CO_2 eq.)							
Aluminium production	1,673	298	199	181	154	200	111
SF_6 (Gg)							
Magnesium foundries	-	-	0.0072	0.0035	0.0026	0.0023	0.0004

Table 4.10 CO_2, CH_4 and F-gas emissions from metal production, 1990 – 2008 (Gg)

COMPOUND	1990	1995	2000	2005	2006	2007	2008
Gg CO_2 eq.							
CF_4 (PFC-14)	1,289.2	235.8	168.1	153.0	130.6	170.9	94.9
C_2F_6 (PFC-16)	384.1	61.7	30.6	27.8	23.8	29.3	16.3
Total PFC emissions from aluminium production	*1,673.4*	*297.5*	*198.7*	*180.8*	*154.4*	*200.1*	*111.2*
Total SF_6 emissions from magnesium foundries	-	-	*172.1*	*84.7*	*61.2*	*53.9*	*10.5*
Total F-gas emissions from metal production	1,673.4	297.5	370.8	265.5	215.6	254.0	121.7

Table 4.11 Actual F-gas emissions per compound from metal production in Gg CO_2 equivalent, 1990 – 2008

As for PFC emissions from aluminium production, 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 response to the last review process (UNFCCC, 2010) a more robust Tier 1 comparison is planned for the next submission in order to strengthen the conservativeness of combined Tier 1 and Tier 2 approaches.

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 Emissions 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 2007, emission factors from aluminium production since 2002 and ferroalloys emission factors have been updated.
Emission factors from aluminium production have been updated since 2002 on account of new information from the relevant plant in the framework of EPER/PRTR registry. This review process has resulted in an increase of 0.23% in 2002 and of 20.21% in 2007.

Emission factors from ferroalloys production have been updated for the whole time series on the basis of new information about the types of ferroalloys produced. In terms of CO_2 emissions from ferroalloys production, recalculation results in a decrease of 3.42% in 1990 and an increase of 6.57% in 2007.

Additional data supplied by the integrated iron and steel plants allowed to improve 2007 estimates. This review process has resulted in an increase of CO_2 emissions in iron and steel equal to 0.12% for 2007. CH_4 emissions from iron and steel production show an increase of 0.05% in 2007.

4.4.6. Source-specific planned improvements

The average emission factor of CO_2 from electric arc furnaces will be checked with ETS data communicated for the years 2005, 2006 and 2007 in the next submission.
As for aluminium production a more robust Tier 1 comparison is planned for the next submission in order to strengthen the conservativeness of combined Tier 1 and Tier 2 approaches.

4.5 Other production (2D)

4.5.1. Source category description

Only indirect gases and SO_2 emissions occur from these sources.
In this sector, non-energy emissions from pulp and paper as well as food and drink production, especially wine and bread, are reported. CO_2 from food and drink production (e.g. CO_2 added to water or beverages) can be of biogenic or non-biogenic origin but only information on CO_2 emissions of non-biogenic origin should be reported in the CRF.
According to the information provided by industrial associations, CO_2 emissions do not occur, but only NMVOC emissions originate from these activities.
CO_2 emissions from food and beverages do not occur since they originated from sources of carbon that are part of a closed cycle.
As regards the pulp and paper production, NO_X and NMVOC emissions as well as SO_2 are estimated. Emissions refer to the paper and pulp production from acid sulphite and neutral sulphite semichemical processes; activity data and emissions are provided by the two Italian production plants.

4.6 Production of halocarbons and SF_6 (2E)

4.6.1. Source category description

The sub-sector production of halocarbons and SF_6 consists of two sources, “By-product emissions” and “Fugitive emissions”, identified as non-key sources. Only two production plants are present in Italy, they are 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. In particular, production of HFC 227ea only occurred in 1999; while CFC115 and SF_6 production stopped in 1998 and in 2005, respectively. Since 2004 the plant in Spinetta Marengo has not been producing halocarbons and SF_6 any longer and in the first quarter of 2008 even the production of HFC in Porto Marghera has stopped.

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, 0.25% in 2007 and is zero in 2008; the share in the national total greenhouse gas emissions was 0.12% in the base-year and 0.003% in 2007 and zero in 2008.

4.6.2. Methodological issues

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

4.6.3. Uncertainty and time-series consistency

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

HFC-23 emissions from HCFC-22 had already been drastically reduced in 1996 due to the installation of a thermal afterburner in the plant located in Spinetta Marengo. Productions and emissions from 1990 to 1995 are constant as supplied by industry; from 1996, untreated leaks have been collected and sent to the thermal afterburner, thus allowing reduction of emissions to zero.
This information is yearly directly updated by the producer, and it is also reported in the framework of the European EPER registry, confirming that the technology is fully operating. Further information on the operating regime has been requested to the industry, contacts with the operator are still going on. Anyway in the first quarter of 2008 the production of HCFC and other products has stopped.
PFC by-product emissions and SF_6 fugitive emissions, from the same plant, are constant from 1990 to 1995 and from 1996 to 1998, reducing to zero from 1999 due to the stop of the CFC 115 production and the use of the thermal afterburner mentioned above. Besides SF_6 production stopped from the 1st of January 2005.
Regarding fugitive emissions, emissions of HFC-125 and HFC-134a have been cut in 1999 thanks to a rationalisation in the new production facility located in Porto Marghera, whereas HFC-143 released as by-products from the production of HFC-134a has been recovered and commercialised.

COMPOUND	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**
				Gg CO_2 eq.			
HFC 23	351.0	351.0	0.0	0.0	0.0	0.0	0.0
HFC 143a	0.0	22.8	3.8	4.2	4.6	4.6	0.0
CF_4	97.5	97.5	0.0	0.0	0.0	0.0	0.0
PFC C2÷C3 (C_2F_6)	36.8	36.8	0.0	0.0	0.0	0.0	0.0
Total F-gas by product emissions	*485.3*	*508.1*	*3.8*	*4.2*	*4.6*	*4.6*	*0.0*
HFC 125	0.0	28.0	2.8	3.4	3.9	5.0	0.0
HFC 134a	0.0	39.0	15.6	12.6	12.4	8.8	0.0
HFC 227ea	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
Total F-gas fugitive emissions	*119.5*	*186.5*	*18.4*	*16.0*	*16.3*	*13.9*	*0.0*
Total F-gas emissions from production of halocarbons and SF_6	604.8	694.6	22.2	20.2	20.8	18.4	0.0

Table 4.12 Actual emissions of F-gases per compound from production of halocarbons and SF_6 in Gg CO_2 equivalent, 1990 – 2008

In Table 4.12 an overview of the emissions from production of halocarbons and SF_6 is given for the 1990-2008 period, per compound.

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

A more detailed breakdown of the activity data and emission factors for table 2.(II).F will be considered if enough data are avalaible.

4.7 Consumption of halocarbons and SF_6 (2F)

4.7.1. Source category description

The sub-sector consumption of halocarbons and SF_6 consists of three sources, “HFC, PFC emissions from ODS substitutes”, key category at level and trend assessment, both Tier 1 and 2 approaches, “PFC, HFC, SF_6 emissions from semiconductor manufacturing”, “SF_6 emissions from electrical equipment”, that are non-key categories.
Potential emissions are also reported in this section. The share of F-gas emissions from the consumption of halocarbons and SF_6 in the national total of F-gases was 8.6% in the base-year 1990 and 98.4% in 2008; the share in the national total greenhouse gas emissions was 0.04% in the base-year and 1.5% in 2008.

4.7.2. Methodological issues

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

Sub-sources of F-gas emissions and calculation methods

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

Basic data have been supplied by industry: specifically, for the mobile air conditioning equipment the national motor company and the agent’s union of foreign motor-cars vehicles have provided the yearly consumptions (FIAT, several years; IVECO, several years; UNRAE, several years; CNH, several years); for the other air conditioning equipment the producers supply detailed table of consumption data by gas (Solvay, several years); pharmaceutical industry has provided aerosols/metered dose inhaler data (Sanofi Aventis, several years; Boehringer Ingelheim, several years; Chiesi Farmaceutici, several years; GSK, several years; Lusofarmaco, several years; Menarini, several years); the semiconductor manufacturing industry has supplied consumption data for four national plants (ST Microelectronics, several years; MICRON, several years; Numonyx, 2009); finally, for the sub-source fire extinguishers, the European Association for Responsible Use of HFCs in Fire Fighting was contacted (ASSURE, 2005).

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

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

In general, concerning the air-conditioning and refrigeration sector the emissions from equipment disposal have been included into the emissions during the product's life for the whole time series.

SF_6 emissions from electrical equipment have been estimated according to the IPCC Tier 2a approach from 1990 to 1994, and IPCC Tier 3c from 1995 (for both medium and high voltage electrical equipment).Tier 3b is applied for the part of emissions from the energy production plant during services. SF_6 leaks from installed equipment have been estimated on the basis of the total amount of sulphur hexafluoride accumulated and average leakage rates; leakage data published in environmental reports have also been used for major electricity producers (ANIE, several years). Additional data on SF_6 used in high voltage gas-insulated transmission lines have been supplied by the main energy distribution companies (ACEA, 2009; A2A, 2009; AEM, several years; EDIPOWER, several years; EDISON, several years; ENDESA, 2004; ENDESA, several years [a] and [b]; ENEL, several years; TERNA, several years).

The IPCC Tier 1a method has been used to calculate potential emissions, using production, import, export and destruction data provided by the national producer (Solvay, several years; ST Microelectronics, several years; MICRON, several years, Numonyx, 2009). Since 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 in the next years (General Gas, 2009; Mariel, 2009; Safety Hi Tech, 2009; Solvay, 2009; Tazzetti, 2009; Sinteco, 2009; Synthesis Chimica Srl, 2009). 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 manufacturers, that use these substances.

4.7.3. Uncertainty and time-series consistency

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

In Table 4.13 an overview of the emissions from consumption of halocarbons and SF_6 is given for the 1990-2008 period, per compound.
HFC emissions from refrigeration and air conditioning equipment increased from 1994 driven by the increase of their consumptions, especially HFC 134a consumption for mobile air conditioning. HFC emissions from ODS substitutes started in 1996 and they have been increasing since then, especially HFC 134a from foam blowing and aerosols. Emissions from semiconductor manufacturing are driven by the consumption data provided by the producers, three companies are currently operating in Italy: ST Microelectronics (since 1995); Micron (since 1998) and Numonyx (since 2008). SF_6 emissions from electrical equipment increased from 1995 to 1997 and decreased in the following years; from 2004 emissions are enough stable: they are driven by emissions from manufacturing due to the amount of fluid filled in the new manufacturing products while emissions from stocks are slightly increasing.

COMPOUND	1990	1995	2000	2005	2006	2007	2008
				Gg CO_2 eq.			
HFC 23	0.0	1.6	7.1	17.0	19.2	20.8	22.7
HFC 32	0.0	0.0	52.6	235.3	276.5	316.7	355.1
HFC 125	0,0	1.8	371.5	1,643.2	1,932.3	2,215.3	2,488.5
HFC 134a	0,0	224.3	1,128.6	1,888.8	2,056.4	2,221.0	2,380.0
HFC 143a	0,0	2.7	206.3	901.5	1,062.0	1,220.7	1,377.9
Total HFC emissions from refrigeration and air conditioning equipment	*0.0*	*230.5*	*1,766.1*	*4,685.7*	*5,346.4*	*5,994.6*	*6,624.2*
HFC 134a emissions from foam blowing	0.0	0.0	64.2	234.1	247.4	259.0	268.9
HFC 227ea emissions from fire extinguishers	0.0	0.0	19.6	79.9	97.7	114.6	130.6
HFC 134a emissions from aerosols/metered dose inhalers	0.0	0.0	108.4	240.2	237.3	307.7	341.1
Total HFC emissions from ODS substitutes	*0.0*	*0.0*	*192.2*	*554.2*	*582.4*	*681.3*	*740.5*
HFC 23	0.0	0.0	5.1	7.0	6.5	5.4	8.0
HFC 134a	0.0	0.0	0.1	0.0	0.0	0.0	0.0
CF_4	0.0	24.4	64.8	96.8	87.0	71.5	55.4
C_2F_6	0.0	34.6	82.0	62.8	30.8	11.4	12.9
C_3F_8	0.0	0.0	0.0	3.5	3.5	0.1	0.1
C_4F_8	0.0	0.0	0.4	8.7	6.6	4.6	14.8
SF_6	0.0	0.0	20.9	61.5	46.5	36.3	30.0
Total PFC. HFC. SF_6 *emissions from semiconductor manufacturing*	*0.0*	*59.0*	*173.2*	*240.4*	*181.0*	*129.4*	*121.2*
SF_6 emissions from electrical equipment	*213.4*	*482.0*	*300.4*	*319.1*	*298.1*	*337.4*	*393.7*
Total F-gas emissions from consumption of halocarbons and SF_6	**213.4**	**771.4**	**2,432.0**	**5,799.4**	**6,408.0**	**7,142.6**	**7,879.6**

Table 4.13 Actual F-gas emissions per compound from the consumption of halocarbons and SF_6 in Gg CO_2 equivalent. 1990-2008

In Table 4.14 an overview of the potential emissions is given for the 1990-2008 period. per compound. In some years import data for HFC compounds are equal to zero while exports are greater than production data because of stocks availability thus leading to negative values for HFC compounds: in fact, the formula suggested by the UNFCCC guidelines to calculate potential emissions does not consider stock variations.

COMPOUND	1990	1995	2000	2005	2006	2007	2008
			Gg CO_2 eq.				
HFC 32	0.0	0.0	10.4	31.9	129.4	139.1	184.0
HFC 125	0.0	148.4	268.8	1,131.2	1,456.0	4,704.0	-1,551.2
HFC 134a	0.0	1,739.4	2,107.3	5,575.7	6,026.8	5,825.3	3.5
HFC 143a	0.0	11.4	68.4	801.8	1,691.0	1,417.4	2,200.2
HFC 227ea	0.0	0.0	72.5	0.0	0.0	0.0	0.0
Total HFC potential emissions	*0.0*	*1,899.2*	*2,527.4*	*7,540.6*	*9,303.2*	*12,085.8*	*836.5*
CF_4	0.0	0.0	55.8	148.9	159.9	141.3	112.3
C_2F_6	0.0	0.0	65.5	111.4	67.8	54.9	67.0
C_3F_8	0.0	0.0	0.0	17.9	17.9	1.5	1.5
C_4F_8	0.0	0.0	0.5	29.0	28.8	53.5	59.2
Total PFC potential emissions	*0.0*	*0.0*	*121.8*	*307.2*	*274.4*	*251.2*	*239.9*
SF_6	*3,752.3*	*3,675.8*	*3,919.6*	*1,541.8*	*2,182.9*	*1,985.9*	*1,881.6*
Total F-gas potential emissions	**3,752.3**	**5,575.0**	**6,568.8**	**9,389.6**	**11,760.5**	**14,322.9**	**2,957.9**

Table 4.14 Potential F-gas emissions per compound from the consumption of halocarbons and SF_6. in Gg CO_2 equivalent. 1990 – 2008

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

No recalculations have occurred for this source category.

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 addition, emissions from the use of N_2O in explosives have also been included in this year submission.

In 2008, solvent use is responsible for 0.27% of the total CO_2 emissions (excluding LULUCF) and 42.91% of total NMVOC emissions, and represents the second source of anthropogenic NMVOC national emissions.
N_2O emissions, in 2008, share 2.47% of the total N_2O national emissions.

The sector is responsible, in 2008, for 0.37% of the total CO_2 equivalent emissions (excluding LULUCF).

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008
NMVOC (Gg)							
3A. Paint application	270.79	252.60	226.07	219.24	223.47	224.16	216.54
3B. Degreasing and dry cleaning	56.66	34.12	26.40	23.10	22.50	21.92	21.36
3C. Chemical products	77.21	88.25	103.64	72.70	78.08	79.35	75.00
3D. Other	199.59	184.07	156.88	179.61	181.52	176.17	170.25
CO_2 (Gg)							
3A. Paint application	844.07	787.35	704.65	683.37	696.57	698.72	674.95
3B. Degreasing and dry cleaning	176.62	106.34	82.27	72.01	70.14	68.33	66.56
3D. Other	622.12	573.75	489.00	559.84	565.78	549.13	530.68
N_2O (Gg)							
3D. Other (use of N_2O for anaesthesia, aerosol cans and explosives)	2.62	2.49	3.31	2.66	2.61	2.54	2.35

Table 5.1 Trend in NMVOC, CO_2 and N_2O emissions from the solvent use sector, 1990 – 2008 (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, aerosol cans and explosives 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. 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, aerosol cans and explosives (3D) have been estimated. Emissions of N_2O from fire extinguishers do not occur.

5.3 Methodological issues

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

Emissions from domestic solvent use have been calculated using a detailed methodology, based on VOC content per type of consumer product.

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

Emissions of N_2O have been estimated taking into account information available by industrial associations. Specifically, the manufacturers and distributors association of N_2O products has supplied data on the use of N_2O for anaesthesia from 1994 to 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).
For the estimation of N_2O emissions from explosives, data on the annual consumption of explosives have been obtained by a specific study on the sector (Folchi and Zordan, 2004); as stated in the document, this figure is believed to be constant for all the time series with a variation within a range of 30%. As for the emission factor, the estimated N_2O emissions represent the theoretically maximum emittable amount; in fact, no figures are available on the amount of N_2O emissions actually emitted upon detonations and the value of 3,400 Mg N_2O/Mg explosive use is provided by a German reference (Benndford, 1999) which corresponds to the assumption of 68 g N_2O per kg ammonium nitrate.

N_2O emissions have been calculated multiplying activity data, total quantity of N_2O used for anaesthesia, total aerosol cans and explosives, by the related emission factors.

5.4 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions from solvent use is estimated equal to 58% due to an uncertainty by 30% and 50% in activity data and emission factors, respectively. For N_2O emissions, the uncertainty is estimated equal to 51% due to an uncertainty in activity data of N_2O use of 50% and 10% in the emission factors.
The decrease in NMVOC emission levels from 1990 to 2008 is about 20%, 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, in January 2004 and in March 2006 respectively, establishing a reduction of the solvent content in products. Figure 5.1 shows emission trends from 1991 to 2008 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.

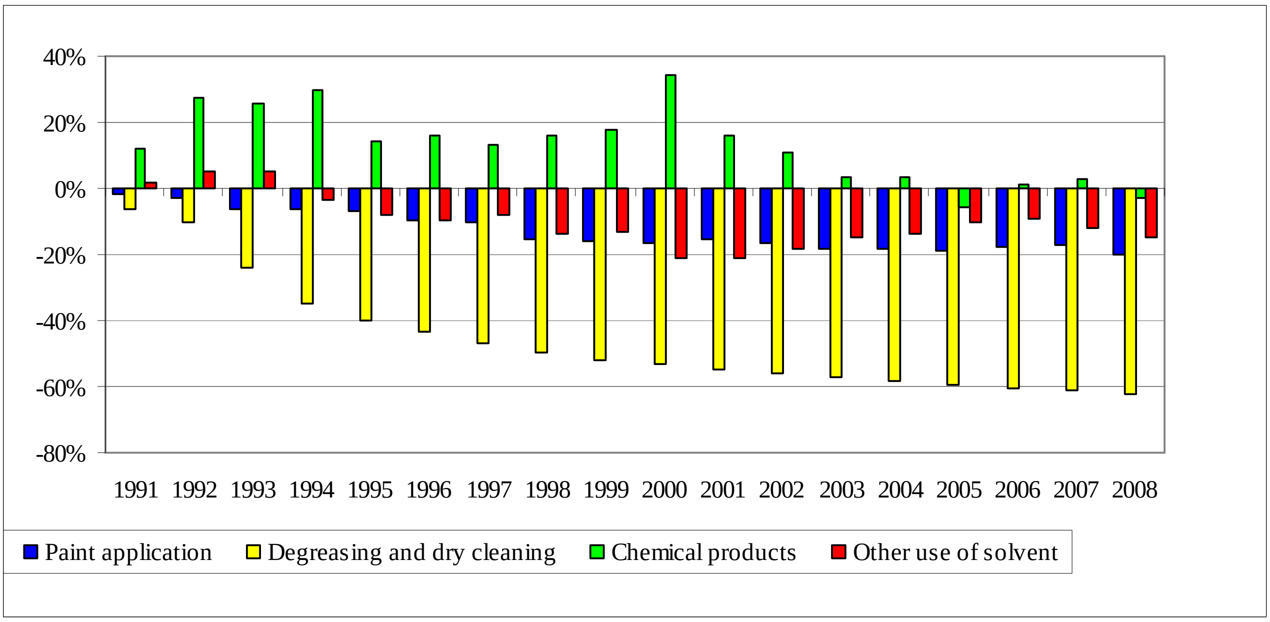


Figure 5.1 Trend of NMVOC emissions from 1991 to 2008 as compared to 1990

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 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 of CO_2 and N_2O emissions between the actual and previous submission is given in percentages from 1990 to 2007.

The main modification occurred in category 3D where NMVOC emission factors for the category dish cleaning in domestic solvent use have been changed for the whole time series on the basis of new information communicated by the industrial association. For 2006 and 2007 activity data of fat edible and non edible oil have been updated by FAO. Other modifications from 1998 regarded activity data on room deodorisers and air fresheners. These recalculations affected CO_2 emissions.
A new category has been added to improve the completeness of the Italian inventory, N_2O emissions from explosives which were estimated for the entire time series.

Year	SUBSOURCE	
	CO_2	N_2O
	3D. Other	3D. Other use of solvents
1990	7.75%	1.99%
1991	7.39%	2.11%
1992	6.95%	2.11%
1993	7.01%	2.09%
1994	7.61%	2.12%
1995	8.19%	2.09%
1996	8.15%	1.76%
1997	8.31%	1.75%
1998	1.71%	1.52%
1999	1.03%	1.55%
2000	0.43%	1.56%
2001	-1.79%	1.73%
2002	-3.01%	1.73%
2003	-2.65%	1.85%

Year	SUBSOURCE	
	CO_2	N_2O
	3D. Other	3D. Other use of solvents
2004	-2.78%	1.91%
2005	-2.82%	1.96%
2006	-3.67%	1.99%
2007	-7.49%	2.05%

Table 5.2 Differences in CO_2 and N_2O emissions between the updated time series and the 2009 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[1] (CRF), is given. Emissions from enteric fermentation (4A), manure management (4B), rice cultivation (4C), agriculture soils (4D) and field burning of agriculture residues (4F) are included in this sector. Methane (CH_4) and nitrous oxide (N_2O) emissions are estimated and reported. Savannas areas (4E) are not present in Italy. Emissions from other sources (4G) have not been estimated. CO_2 and F-gas emissions do not occur.
To provide update information on the characteristics of the agriculture sector in Italy, figures from the Farm Structure Survey 2007 (FSS 2007) are reported. In Italy, there are 1.7 millions of agricultural holdings with a Utilized Agricultural Area (UAA) of 12.7 million hectares, +0.3% more than FSS 2005. Between 2000 (Agricultural Census) and 2007, agricultural holdings have decreased by 22% (474,000 units). At national level, the average size of the agricultural holdings varied from 7.4 hectares in 2005 to 7.6 hectares in 2007. With respect to 2000 Agricultural Census, holdings have gained 1.5 hectares of UAA. The distribution of agricultural holdings by type confirms a typical family conduction system, which characterized the Italian agriculture. Direct conduction of holdings by farmers is around 1.6 million (93.9% of total agricultural holdings with UAA) which hold 10 million hectares of UAA (78.8% of total) (EUROSTAT, 2007[a], [b]; ISTAT, 2008[a]). Updated figures of the agriculture sector such as added value, employment, productivity among others are available in English (INEA, 2008).

6.1.1 Emission trends

Emission trends per gas
In 2008, 6.6% of the Italian GHG emissions, excluding emissions and removals from LULUCF, (7.8% in 1990) originated from the agriculture sector, which is the second source of emissions, after the energy sector which accounts for 84%. For the agriculture sector, the trend of GHGs from 1990 to 2008 shows a decrease of 11.6% due to reduction in activity data, such as the number of animals and cultivated surface/crop production (see Figure 6.1). CH_4 and N_2O emissions have decreased by 11.2% and 11.9%, respectively (see Table 6.1). In 2008, the agriculture sector has been the dominant national source for CH_4 and N_2O emissions, sharing 43% and 70%, respectively.

	1990	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
					(Gg CO_2 eq.)						
CH_4	17,216	17,223	16,837	16,076	15,727	15,785	15,535	15,475	15,144	15,613	15,291
N_2O	23,360	23,126	23,103	22,881	22,531	22,331	22,348	21,729	21,477	21,609	20,574
Total	**40,576**	**40,349**	**39,940**	**38,957**	**38,259**	**38,116**	**37,883**	**37,204**	**36,621**	**37,222**	**35,865**

Table 6.1 GHG emissions and trend from 1990 to 2008 for the agriculture sector (Gg CO_2 eq.)

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

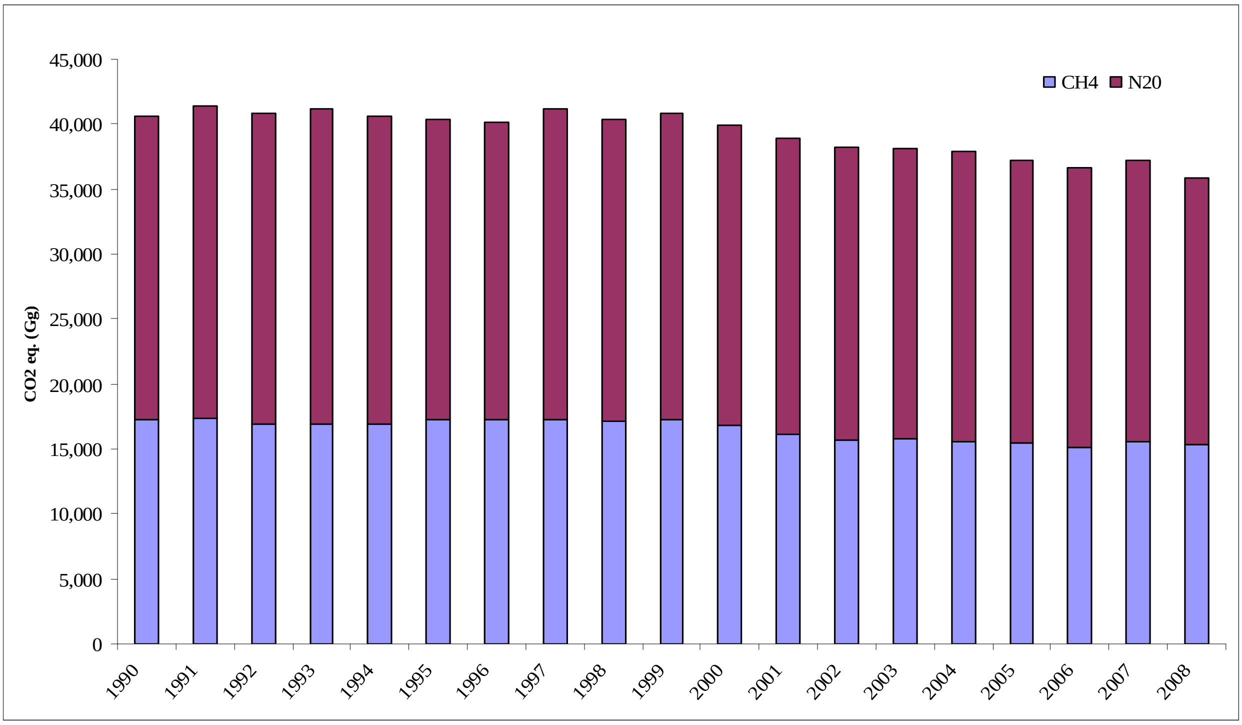


Figure 6.1 Trend of GHG emissions for the agriculture sector from 1990 to 2008 (Gg CO_2 eq.)

Emission trends per sector

Total GHG emissions and trends by sub category from 1990 to 2008 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 2008, their individual share in national GHG emissions excluding LULUCF was 2.0% and 3.1 %, respectively.

Year	**GHG emissions (Gg CO_2 eq.) by sub category**					
	4A	4B	4C	4D	4F	**TOTAL**
1990	12,179	7,383	1,562	19,435	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	7,344	1,382	18,877	15	**38,957**
2002	11,031	7,115	1,420	18,677	17	**38,259**
2003	11,057	7,075	1,463	18,506	15	**38,116**
2004	10,834	6,868	1,534	18,628	18	**37,883**
2005	10,841	6,857	1,472	18,017	17	**37,204**
2006	10,626	6,629	1,477	17,873	17	**36,621**
2007	11,024	6,833	1,523	17,826	17	**37,222**
2008	10,921	6,736	1,396	16,795	18	**35,865**

Table 6.2 Total GHG emissions from 1990 to 2008 for the agriculture sector (Gg CO_2 eq.)

6.1.2 Key categories

In 2008, N_2O from agricultural soils, both direct and indirect emissions, CH_4 from enteric fermentation, N_2O and CH_4 from manure management were ranked among the top-10 level key sources with the Tier 2 analysis, including the uncertainty (L2). CH_4 enteric fermentation and N_2O from agricultural soils, both direct and indirect emissions are ranked among the top-10 trend key sources with 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, 2010]). Moreover, an internal report describes the procedure for preparing the agriculture UNFCCC/CLRTAP national emission inventory, previsions for 2009, and emission scenarios (Cóndor, 2010).

In the last years, results from different research projects have improved the quality of the agriculture national inventory (MeditAIRaneo project and Convention signed between ISPRA and the Ministry for the Environment, Land and Sea; CRPA, 2006[a], CRPA, 2006[b]). Furthermore, suggestions from the inventory review processes have been considered (UNFCCC, 2009; UNFCCC, 2010; ISPRA, 2010). Methodologies for the preparation of agriculture national inventory under the Convention on Long-Range Transboundary Air Pollution (CLRTAP) and the United Nations Framework Convention on Climate Change (UNFCCC) are consistent. Synergies among international conventions and European directives while preparing the agriculture inventory are implemented (Cóndor, 2006; Cóndor and De Lauretis, 2007; Cóndor *et al.*, 2007[b]; Cóndor *et al.*, 2008[b]; Cóndor and De Lauretis, 2009).

The national agriculture UNFCCC/CLRTAP emission inventory is used, every 5 years, to prepare a more disaggregated inventory by region and province as requested by CLRTAP (Cóndor *et al.*, 2008[c]). A database with the time series for all sectors and pollutants is available (ISPRA, 2008[a], [b]; ISPRA, 2009). Furthermore, for estimating emission scenarios and projections for the years 2010, 2015 and 2020 the same methodologies used for the inventory are used (MINAMBIENTE, 2007; MINAMBIENTE, 2010).

6.1.4 Agricultural statistics

The Italian National Statistical System (SISTAN[2]) revises every year the National Statistical Plan that covers three years and includes, among others, the system of agricultural statistics. In this framework, the Agriculture, Forestry and Fishing Quality Panel has been established under coordination of the Agriculture service of ISTAT where those who produce and use agricultural statistics (mainly public institutions) meet every year in order to monitor and improve national statistics. ISTAT plays a major role in the agricultural sector collecting comprehensive data through different surveys (Greco and Martino, 2001):

- Structural surveys (Farm Structure Survey, survey on economic results of the farm, survey on the production means);
- Conjunctural surveys[3] (survey on the area and production of the cultivation, livestock number, milk production, slaughter, etc.);
- General Agricultural Census[4], 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[5] (ISTAT, 2008[a]; ISTAT, 2007[a]; ISTAT, 2006[a]). ISTAT has provided the quality reports of the FSS 2005 and FSS 2007 (ISTAT, 2008[b]; ISTAT, 2007[e]). The main agricultural statistics used for the agriculture emission inventory, are available on-line and a new database was launched in April 2009. Detailed information is provided in the following box:

Main activity data sources used for the Agriculture emission inventory

Agricultural statistics	Time series	Web site
Livestock number	Table 6.3; 6.4; 6.7	http://agri.istat.it/jsp/Introduzione.jsp
Milk production	Table 6.3	http://agri.istat.it/jsp/Introduzione.jsp
Fertilizers	Table 6.30	http://agri.istat.it/jsp/Introduzione.jsp
Crops production/surface	Table 6.26; 6.32; 6.33	http://agri.istat.it/jsp/Introduzione.jsp

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 2008, CH_4 emissions from this category were 520.04 Gg which represents 71.4% of CH_4 emissions for the agriculture sector (70.7% in 1990) and 30.4% for national CH_4 emissions (29.3% in 1990). Methane emissions from this source consist mainly of cattle emissions: dairy cattle (209.99 Gg) and non-dairy cattle (197.94 Gg). These sub-categories sources represented 40.4% (42.3% in 1990) and 38.1% (40.2% in 1990), respectively, of total enteric fermentation emissions.

[2] SISTAN, *Sistema Statistico Nazionale* (http://www.sistan.it/)
[3] http://www.istat.it/agricoltura/datiagri/
[4] http://www.census.istat.it/
[5] Indagine sulla struttura e produzione delle aziende agricole (SPA), survey carried out every two years in agricultural farms.

6.2.2. Methodological issues

Methane emissions from enteric fermentation are estimated by defining an emission factor for each livestock category, which is multiplied by the population of the same category. Data for each livestock category are collected from ISTAT (several years [a], [b], [c], [f]; ISTAT, 1991; 2007[a],[b]; 2010[a]). Livestock categories provided by ISTAT are classified according to the type of production, slaughter or breeding, and the age of animals. In the following box, livestock categories and source of information are provided. Parameters for the livestock categories are shown in Table 6.20. In order to have a consistent time series, it was necessary to reconstruct the number of animals for some categories. The reconstruction used information available from other official sources such as FAO and UNA (FAO, 2010; UNA 2010).

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, 2010)
(c) For 1990 data from the census and reconstruction based on a production index (ISTAT, 2007[b]; 2010[f])

Dairy cattle

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

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

Parameters	Value	Reference
Average weight (kg)	602.7	CRPA, 2006[a]
Coefficient NE_m (dairy cattle)	0.335	NRC, 2001; IPCC, 2000
Pasture (%)	5	CRPA, 2006[a]; ISTAT, 2003
Weight gain (kg day^{-1})	0.051	CRPA, 2006[a]; CRPA, 2004[b]
Milk fat content (%)	3.59-3.72	ISTAT, several years [a], [b], [d], [e]; ISTAT, 2010[b]
Hours of work per day	0	CRPA, 2006[a]
Portion of cows giving birth	0.90-0.97	AIA, 2009
Milk production (kg $head^{-1}$ day^{-1})	11.5-17.7	CRPA, 2006[a]; ISTAT, 2010[b]; OSSLATTE/ISMEA, 2003; ISTAT, several years [a], [b], [c] [d], [e],[f] OSSLATTE, 2001
Digestibility of feed (%)	65	CRPA, 2006[a]; CRPA, 2005
Methane conversion rate (%)	6	CRPA, 2006[a]
MJ/kg methane	55.65	IPCC, 2000

Milk production national statistics were analysed (Cóndor *et al.*, 2005). Milk used for dairy production and milk used for calf feeding contributes to total milk production. This last value was reconstructed with national and ISTAT publications (ISTAT, 2010[b]). For calculating milk production (kg $head^{-1}$ d^{-1}), total production is divided by the number of animals and by 365 days, as suggested by the IPCC (IPCC, 2000). Therefore, lactating and non-lactating periods are included in the estimation of the CH_4 dairy cattle EF (CRPA, 2006[a]). In Table 6.3, the time series of the dairy cattle population, fat content in milk, portion of cows giving birth and milk production are shown. Further information on parameters used for dairy cattle estimations is reported in Annex 7.1.
In Table 6.6, the time series of the dairy cattle emission factors (EF) is presented. In 2008, the CH_4 dairy cattle EF was 114.71 kg CH_4 $head^{-1}$ $year^{-1}$ with an average milk production of 6,470 kg $head^{-1}$ $year^{-1}$ (17.7 kg $head^{-1}$ day^{-1}). IPCC report a default EF of 109 kg CH_4 $head^{-1}$ $year^{-1}$ with a milk production of 6,000 kg $head^{-1}$ $year^{-1}$ (IPCC, 2006).

Year	Dairy cattle (head)	Fat content in milk (%)	Portion of cows giving birth	Milk production yield (kg $head^{-1}$ d^{-1})
1990	2,641,755	3.59	0.973	11.5
1991	2,339,520	3.59	0.971	13.0
1992	2,146,398	3.59	0.961	13.9
1993	2,118,981	3.63	0.955	13.8
1994	2,011,919	3.64	0.963	14.5
1995	2,079,783	3.64	0.948	14.8
1996	2,080,369	3.65	0.948	15.2
1997	2,078,388	3.66	0.946	15.5
1998	2,116,176	3.71	0.931	15.3
1999	2,125,571	3.69	0.919	15.3
2000	2,065,000	3.65	0.926	15.1
2001	2,077,618	3.65	0.915	14.9
2002	1,910,948	3.67	0.913	16.2
2003	1,913,424	3.67	0.913	16.2
2004	1,838,330	3.71	0.899	16.8
2005	1,842,004	3.71	0.910	17.2
2006	1,821,370	3.69	0.901	17.4
2007	1,838,783	3.71	0.897	17.3
2008	1,830,711	3.72	0.897	17.7

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

Non-dairy cattle

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

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

Year	<1 year		1-2 years Males		1-2 years Females		>2 years Males	>2 years Females			TOTAL
	for slaughter	others	breeding	for slaughter	breeding	for slaughter	all	breeding	for slaughter	others	
						(heads)					
1990	300,000	2,127,959	72,461	708,329	749,111	186,060	128,958	467,216	57,654	312,649	5,110,397
1991	300,000	2,060,091	71,191	732,421	1,077,802	197,078	82,957	498,136	59,281	503,041	5,581,998
1992	300,000	2,036,527	65,656	654,622	1,019,928	197,507	102,182	464,814	49,749	534,632	5,425,617
1993	300,000	2,002,856	63,214	639,922	995,481	175,146	95,929	449,996	47,921	551,683	5,322,148
1994	300,000	1,794,806	63,926	651,708	1,040,424	145,475	107,640	451,864	31,569	569,429	5,156,841
1995	458,936	1,796,034	27,871	783,300	684,881	154,548	155,116	430,564	40,198	657,856	5,189,304
1996	405,986	1,802,849	29,877	721,711	700,560	166,137	119,478	416,038	34,167	696,760	5,093,563
1997	354,006	1,910,283	62,983	600,315	699,133	160,238	162,187	413,383	63,765	668,553	5,094,846
1998	392,432	1,865,075	25,454	611,973	677,915	166,266	115,269	413,456	60,962	684,530	5,013,332
1999	385,251	1,807,169	28,133	655,749	708,152	179,488	101,922	410,062	46,392	713,872	5,036,190
2000	408,000	1,783,000	27,521	641,479	736,000	160,000	93,000	500,000	51,000	588,000	4,988,000
2001	496,264	1,498,068	25,528	595,029	709,941	181,550	75,365	591,000	46,000	442,525	4,661,270
2002	409,970	1,617,127	26,194	610,550	647,656	176,481	65,948	541,233	59,582	444,408	4,599,149
2003	412,682	1,594,994	27,598	643,277	673,246	158,094	78,890	520,237	48,873	433,388	4,591,279
2004	445,231	1,509,387	28,458	663,316	648,308	149,053	71,762	460,765	38,385	451,606	4,466,271
2005	500,049	1,418,545	26,424	615,921	588,660	181,971	102,081	466,566	37,971	471,733	4,409,921
2006	540,223	1,407,401	26,091	608,152	584,680	182,719	78,328	395,066	54,022	419,083	4,295,765
2007	519,034	1,410,357	26,852	625,902	593,369	189,704	79,936	498,091	59,961	440,845	4,444,051
2008	502,391	1,401,501	26,908	627,186	630,194	196,936	74,059	469,074	48,075	372,051	4,348,375

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

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

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

Table 6.5 Main parameters used for non-dairy cattle 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 2008, the non dairy-cattle EF was 45.52 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 and an increase in the number of the '*less than 1 year for the slaughter*' category (no emissions) (see Table 6.4).

Buffalo

Data collected in the framework of the MeditAIRaneo project allowed the implementation of the Tier2 approach for the buffalo category (IPCC, 2000). Two different country-specific CH_4 EFs, for cow buffalo and other buffaloes, were developed. Detailed description of the methodology are reported in Cóndor *et al*. (Cóndor *et al*., 2008[a]). In 2008, the cow buffalo CH_4 EF was 71.91 kg CH_4 head^{-1} year^{-1} and for other buffaloes the value was 56.0 kg CH_4 head^{-1} year^{-1}. The CRF IEF is an average value for the two categories (65.68 kg CH_4 head^{-1} year^{-1}). In the following boxes, parameters used for the Tier 2 approach are shown:

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

Parameters	Value	Reference
Average body weight (kg)	630	Infascelli, 2003; Consorzio per la tutela del formaggio mozzarella di bufala campana, 2002
Coefficient 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 (%)	7.73-7.78	ISTAT, several years [a], [b], [d], [e]; ISTAT, 2010[b]
Hours of work per day	0	Our estimation
Proportion of calving cows	0.89-0.84	Barile, 2005; De Rosa and Trabalzi, 2004
Milk production (kg head^{-1} day^{-1})	1.9-3.3	ISTAT, 2010[b]; OSSLATTE/ISMEA, 2003; ;OSSLATTE, 2001; ISTAT, several years [a], [b], [c] [d], [e], [f]
Digestibility of feed (%)	65	Infascelli, 2003; Masucci *et al*., 1997, 1999;
Methane conversion rate (%)	6	CRPA, 2006[a]
MJ/kg methane	55.65	IPCC, 2000

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

Parameter	Calves (3 months-1 year)	Sub-adult buffaloes (1-3 years)
Average body weight (kg)	130	405
Dry matter intake (% of body weight head^{-1} day^{-1})	3.0	2.5
Dry matter intake (kg head^{-1} day^{-1})	3.9	10.1
Gross Energy (MJ head^{-1} day^{-1})	71.68	186.58
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, a value of 0.6% has been assumed as CH_4 conversion rate (CRPA, 2004[c]).

Other livestock categories

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

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sheep	Goats	Horses	Mules and asses	Sows	Other swine	Rabbits
	Enteric Fermentation: average CH_4 EF (kg CH_4 head^{-1} year^{-1})									
1990	92.8	45.6	61.7	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1991	97.7	47.5	62.9	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1992	100.9	47.5	62.4	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1993	100.6	47.4	65.5	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1994	103.4	48.7	65.6	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1995	104.3	47.4	63.2	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1996	105.8	47.5	62.4	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1997	106.7	47.8	62.9	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1998	106.4	47.0	62.0	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1999	106.3	47.3	64.9	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2000	105.3	47.0	65.7	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2001	104.6	46.7	68.2	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2002	109.1	46.5	66.4	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2003	109.0	46.6	66.2	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2004	111.5	46.3	68.3	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2005	112.9	46.4	71.0	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2006	113.2	44.7	69.7	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2007	113.2	46.1	67.1	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2008	114.7	45.5	65.7	8.0	5.0	18.0	10.0	1.5	1.5	0.08

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

Year	Buffalo	Sheep	Goats	Horses	Mules and asses	Sows	Other swine	Rabbits	Poultry
	(heads)								
1990	94,500	8,739,253	1,258,962	287,847	83,853	650,919	7,755,602	14,893,771	173,341,562
1991	83,300	8,397,070	1,260,980	314,125	66,255	711,500	7,837,300	15,877,391	173,060,622
1992	103,200	8,460,557	1,355,485	315,848	56,946	691,400	7,553,000	16,398,563	172,683,589
1993	100,900	8,669,560	1,408,767	323,305	49,383	702,900	7,645,200	16,530,691	173,261,404
1994	108,300	9,964,108	1,658,051	323,986	43,063	677,100	7,346,300	16,905,054	178,659,192
1995	148,404	10,667,971	1,372,937	314,778	37,844	689,846	7,370,830	17,110,587	184,202,416
1996	171,558	10,943,457	1,419,225	312,080	34,120	726,155	7,444,937	17,433,566	183,044,930
1997	161,491	10,893,711	1,351,003	313,000	30,000	693,366	7,599,426	17,609,737	186,815,499
1998	186,276	10,894,264	1,331,077	290,000	33,500	707,644	7,614,981	17,705,163	198,799,819
1999	200,481	11,016,784	1,397,329	288,000	33,000	691,590	7,722,893	18,020,802	196,573,062
2000	192,000	11,089,000	1,375,000	280,000	33,000	708,000	7,599,000	17,873,993	176,722,211
2001	193,774	8,311,383	1,024,769	285,000	33,000	697,491	8,068,771	18,494,839	209,187,654
2002	185,438	8,138,309	987,844	277,819	28,913	751,159	8,415,099	18,852,530	205,566,136
2003	222,268	7,950,981	960,994	282,936	28,507	736,637	8,420,087	18,866,643	196,511,409
2004	210,195	8,106,043	977,984	277,767	28,932	724,891	8,247,181	19,654,694	191,315,963

Year	Buffalo	Sheep	Goats	Horses	Mules and asses	Sows	Other swine	Rabbits	Poultry
	(heads)								
2005	205,093	7,954,167	945,895	278,471	30,254	721,843	8,478,427	20,504,282	188,595,022
2006	230,633	8,227,185	955,316	287,123	31,013	771,751	8,509,352	20,238,089	177,274,561
2007	293,947	8,236,668	920,085	315,725	34,557	753,721	8,519,214	20,964,928	188,871,886
2008	307,149	8,175,196	957,248	332,496	36,239	756,345	8,496,102	19,515,455	197,298,265

Table 6.7 Time series of number of animals from 1990 to 2008 (heads)

6.2.3. Uncertainty and time-series consistency

Uncertainty related to CH_4 emissions from enteric fermentation was 28% for annual emissions, resulting from the combination of 20% of uncertainty for both activity data and emission factors.
In 2008, livestock CH_4 emissions from enteric fermentation were 10.3% (520.04 Gg) lower than in 1990 (579.93 Gg). Between 1990 and 2008 cattle livestock has decreased by 20% (from 7,752,152 to 6,179,086 heads). Dairy cattle and non-dairy cattle have decreased by 31% (from 2,641,755 to 1,830,711) and 15% (from 5,110,397 to 4,348,375), respectively. The reduction in number of cattle is the main driving force for the reduction in CH_4 emissions, particularly as emissions per head from cattle are 10 times greater than emissions per head of sheep or goat. In 2008, cattle contribute with 78.4% 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 2010, are represented by ‘other swine’ and ‘sow’ (13.88 Gg).

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sheep	Goats	Horses	Mules and asses	Sows	Other swine	Rabbits	TOTAL
	(Gg)										
1990	245.11	233.00	5.83	69.91	6.29	5.18	0.84	0.98	11.63	1.16	**579.93**
1991	228.61	265.10	5.24	67.18	6.30	5.65	0.66	1.07	11.76	1.23	**592.81**
1992	216.49	257.52	6.44	67.68	6.78	5.69	0.57	1.04	11.33	1.27	**574.81**
1993	213.23	252.38	6.61	69.36	7.04	5.82	0.49	1.05	11.47	1.28	**568.74**
1994	207.94	251.21	7.10	79.71	8.29	5.83	0.43	1.02	11.02	1.31	**573.87**
1995	216.88	246.22	9.38	85.34	6.86	5.67	0.38	1.03	11.06	1.33	**584.15**
1996	220.10	241.79	10.71	87.55	7.10	5.62	0.34	1.09	11.17	1.35	**586.80**
1997	221.80	243.78	10.15	87.15	6.76	5.63	0.30	1.04	11.40	1.37	**589.39**
1998	225.18	235.38	11.54	87.15	6.66	5.22	0.34	1.06	11.42	1.38	**585.33**
1999	225.85	238.33	13.00	88.13	6.99	5.18	0.33	1.04	11.58	1.40	**591.84**
2000	217.40	234.48	12.61	88.71	6.88	5.04	0.33	1.06	11.40	1.39	**579.30**
2001	217.22	217.91	13.22	66.49	5.12	5.13	0.33	1.05	12.10	1.44	**540.01**
2002	208.45	213.95	12.31	65.11	4.94	5.00	0.29	1.13	12.62	1.46	**525.27**
2003	208.65	214.17	14.71	63.61	4.80	5.09	0.29	1.10	12.63	1.47	**526.52**
2004	204.92	206.60	14.36	64.85	4.89	5.00	0.29	1.09	12.37	1.53	**515.89**
2005	207.95	204.65	14.57	63.63	4.73	5.01	0.30	1.08	12.72	1.59	**516.24**
2006	206.26	192.10	16.08	65.82	4.78	5.17	0.31	1.16	12.76	1.57	**506.01**
2007	208.13	205.03	19.72	65.89	4.60	5.68	0.35	1.13	12.78	1.63	**524.93**
2008	209.99	197.94	20.17	65.40	4.79	5.98	0.36	1.13	12.74	1.52	**520.04**

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

In 2010 submission update information for the number of rabbits (2001-2007) was obtained from ISTAT (ISTAT, 20010[f]). Also poultry information was updated for the years 2002 and 2006 (UNA, 2010). These recalculations have not changed estimations significantly. In Table 6.10, previous and current dairy cattle and buffalo EFs are shown.

Sub category	**Parameter**	**Year of submission** 2010	2011	**Activities**
Dairy cattle	Fat content	√		Data from 2008 fat parameter has been collected (ISTAT new database, on-line)
Dairy cattle	Portion cow giving birth	√		Data from 2008 has been collected (AIA, 2009)
Dairy cattle/buffalo	Milk production	√		Data from 2008 on milk production has been collected (ISTAT new database, on-line)

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

	Dairy cattle		**Buffalo**	
Year	**EF 2009 submission**	**EF 2010 submission**	**EF 2009 submission**	**EF 2010 submission**
	(kg head^{-1} year^{-1})			
1990	92.8	92.8	61.7	61.7
1991	97.7	97.7	62.9	62.9
1992	100.9	100.9	62.4	62.4
1993	100.6	100.6	65.5	65.5
1994	103.4	103.4	65.6	65.6
1995	104.3	104.3	63.2	63.2
1996	105.8	105.8	62.4	62.4
1997	106.7	106.7	62.9	62.9
1998	106.4	106.4	62.0	62.0
1999	106.3	106.3	64.9	64.9
2000	105.3	105.3	65.7	65.7
2001	104.6	104.6	68.2	68.2
2002	109.1	109.1	66.4	66.4
2003	109.0	109.0	66.2	66.2
2004	111.5	111.5	68.3	68.3
2005	112.9	112.9	71.0	71.0
2006	113.2	113.2	69.7	69.7
2007	113.2	113.2	67.1	67.1
2008	-	114.7	-	65.7

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

6.2.6. Source-specific planned improvements

In the framework of the collaboration between ISPRA and ISTAT (Agriculture Service) we expect to continuously update and improve activity data. Every year agricultural statistics from other sources are also updated (UNA, 2010; FAO, 2010).

6.3. Manure management (4B)

6.3.1 Source category description

In 2008, CH_4 emissions from manure management were 140.99 Gg, which represents 19.4% of CH_4 emissions for the agriculture sector (20.1% in 1990) and 8.2% of national CH_4 emissions (8.3% in 1990). CH_4 emissions from swine were 64.22 Gg and from cattle were 53.43 Gg. These sub-categories represented 46% and 38%, respectively, of total CH_4 manure management emissions.
In 2008, N_2O emissions from manure management were 12.18 Gg, which represents 18% of total N_2O emissions for the agriculture sector (17% in 1990) and 12.8% of national N_2O emissions (10.5% in 1990). In 2008, N_2O emissions from this source mainly consist of the solid storage source (10.71 Gg), accounting for 88% of the N_2O manure management source.
Since 2006 submission, parameters related to the estimation of CH_4 and N_2O emissions have been updated: average weight, production of slurry and solid manure and the nitrogen excretion rates. The source for updating these parameters was the Nitrogen Balance Inter-regional Project and other national studies; references are provided in this section.
CH_4 and N_2O emissions from manure management are key sources at level, following the Tier 1 and Tier 2 approaches, and trend (Tier 2).

6.3.2. Methodological issues

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

Methane emissions (cattle and buffalo)

Method 1: Regional basis

Methane emission estimations for manure management are drawn up on a regional basis and depend on specific manure management practices and environmental conditions (Safley *et al*., 1992; Steed and Hashimoto, 1995; Husted, 1994). The following factors are used: average regional monthly temperatures (UCEA, 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 starts with the calculation of the *methane emission rate* (g CH_4 m^{-3} day^{-1}), which is obtained from an equation for slurry (Husted, 1994) and solid manure (Husted, 1993). Then, the *methane emission rate* is transformed to g m^{-3} $month^{-1}$. Equations are presented below (CRPA, 2006[a]; CRPA, 1997[a]):
For slurry:

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

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 were estimated assuming a distribution of housing systems in Italy, which will be updated with information coming from the 2010 Agricultural Census. Emission factors for slurry and solid manure (g CH_4 $head^{-1}$ $month^{-1}$) are calculated for each month, and were obtained with the *methane emission rates* (Eq. 6.1 and 6.2), and the volume of slurry and solid manure produced. The annual EF for each livestock category is the sum of slurry and solid manure EFs (kg CH_4 $head^{-1}$ $year^{-1}$). In order to correlate CH_4 emission production and volatile solid (VS) production, a *specific conversion factor* was estimated. Later, this '*conversion factor'* is used for the simplified methodology (*Method 2*). The *specific conversion factor* values for slurry and solid manure are 15.32 g CH_4/kg VS and 4.80 g CH_4/kg VS, respectively.

Method 2: National basis

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

EF slurry = 15.32 gCH_4/Kg VS • 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*)	5.08	3.50	**8.58**
Female cattle (*bovine*)	2.86	4.13	**6.99**
Other dairy cattle (*altre vacche*)	4.01	6.65	**10.66**
Dairy cattle (*vacche da latte*)	5.64	9.41	**15.04**

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})
Cow buffalo (*bufale*)	4.99	10.26	**15.25**
Other buffaloes (*altri bufalini*)	3.13	3.16	**6.29**

Table 6.11 Methane manure management EFs for cattle and buffalo in 2008 (kg CH_4 head^{-1} yr^{-1})

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

Year	Calf	Cattle	Female cattle	Other dairy cattle	Dairy cattle	Cow buffalo	Other buffaloes
	(kg CH_4 head^{-1} yr^{-1})						
1990	6.22	8.11	6.71	10.66	15.04	15.25	6.34
1991	6.22	8.06	6.91	10.66	15.04	15.25	6.34
1992	6.22	8.01	6.86	10.66	15.04	15.25	6.34
1993	6.22	7.99	6.83	10.66	15.04	15.25	6.33
1994	6.22	8.20	6.93	10.66	15.04	15.25	6.33
1995	6.22	8.56	6.71	10.66	15.04	15.25	6.33
1996	6.22	8.29	6.76	10.66	15.04	15.25	6.32
1997	6.22	8.33	6.62	10.66	15.04	15.25	6.32
1998	6.22	8.16	6.65	10.66	15.04	15.25	6.32
1999	6.22	8.22	6.71	10.66	15.04	15.25	6.31
2000	6.22	8.27	6.80	10.66	15.04	15.25	6.31
2001	6.22	8.48	7.07	10.66	15.04	15.25	6.31
2002	6.22	8.23	6.99	10.66	15.04	15.25	6.30
2003	6.22	8.38	6.94	10.66	15.04	15.25	6.30
2004	6.22	8.34	6.98	10.66	15.04	15.25	6.30
2005	6.22	8.61	6.95	10.66	15.04	15.25	6.30
2006	6.22	8.52	6.87	10.66	15.04	15.25	6.29
2007	6.22	8.56	7.05	10.66	15.04	15.25	6.29
2008	6.22	8.58	6.99	10.66	15.04	15.25	6.29

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

Since 2006 submission, a reduction of CH_4 emissions has been introduced in the manure management category (4B) in order to consider the biogas production. A national census on biogas production/technology can be found in CRPA and CRPA/AIEL (CRPA, 2008; CRPA/AIEL 2008). Biogas production data are collected every year from the National Electric Network (TERNA, 2010). See Annex 7.2 for further information on biogas activity data.

Reduction of CH_4 emissions related to biogas recovery are assumed for cattle and swine livestock categories, and distributed according to the contribution of emissions from each category. This reduction is evident in the IEF reported in the CRF. In 2008, the CRF IEFs, for dairy cattle and non-

dairy cattle, were 13.17 kg CH_4 head^{-1} year^{-1}, and 6.74 kg CH_4 head^{-1} year^{-1}, respectively. IPCC default EFs for cool temperature are 14 kg CH_4 head^{-1}year^{-1} and 6 kg CH_4 head^{-1}year^{-1}, respectively (IPCC, 1997).
The IEF for non-dairy cattle and buffalo represents a weighted average. The non-dairy cattle IEF includes: calf, cattle, female cattle and other dairy cattle. The buffalo category includes: cow buffalo and other buffaloes categories. In the following box, EFs and IEFs are shown. Differences, as mentioned before, are related to the amount of CH_4 reductions from biogas recovery. Moreover, interannual decrease 2005/2006 of the non-dairy IEF reflects the strong increase of biogas recovery.

Livestock category	EF (kg CH_4 head^{-1} yr^{-1})	IEF(*) (kg CH_4 head^{-1} yr^{-1})
Dairy cattle	15.04	13.17
Non-dairy cattle	7.70	6.74
Buffalo	11.75	11.75

(*) IEF as reported in the CRF submission 2010

For reporting purposes, the CH_4 producing potential (Bo) is estimated with Equation 4.17 from IPCC (IPCC, 2000). The average methane conversion factors (MCF), for each manure management system (classified by climate), was estimated with data coming from the Agriculture Census from 1990 and 2000 and the FSS 2005 (ISTAT, 2007[a]). Average MCFs were not used for estimating manure management EF, but they are useful to verify the EF accuracy. In the following box, estimated country-specific VS and Bo parameters, and IPCC default values are shown. Differences are mainly attributed to country-specific characteristics.

Livestock category	VS country-specific (*) (kg dm head^{-1} yr^{-1})	VS IPCC default (kg DM head^{-1} yr^{-1})	Bo country-specific (*) (CH_4 m^3/kg VS)	Bo IPCC default (CH_4 m^3/kg VS)
Dairy cattle	6.37	4.13	0.14	0.24
Non-dairy cattle	2.82	2.68	0.13	0.17
Buffalo	5.03	2.68	0.13	0.10
Swine	0.32	0.50	0.46	0.46

(*) IEF as reported in the CRF submission 2010

Methane emissions (swine)

For the estimation of CH_4 emissions for swine, a country-specific *methane emission rate* was experimentally determined by the Research Centre on Animal Production (CRPA, 1996). The estimation of the EF considers: the structure of the storage for slurry (tank and lagoons), type of breeding and seasonal production of biogas.
Different parameters were considered, such as the livestock population, average weight for fattening swine and sows, and *methane emission rate*. Methane emission rates used are 41 normal litre CH_4/100 kg live weight/day for fattening swine, and 47 normal litre CH_4/100 kg live weight/day for sows including piglets (CRPA, 1997[a]). Then, a reduction of emissions of 8% for covered storage structures is applied to the *methane emission rate*. In Table 6.13, characteristics of swine breeding and EFs are shown.

In the 2006 submission, parameters such as: average weight of sows, production of slurry (t year^{-1} per t live weight) and volatile solid content in the slurry (g SV/kg slurry w.b.) were updated. The slurry production considered the different swine categories (classified by weight and housing characteristics). Volatile solid content were determined experimentally from 598 measurements carried out by CRPA (CRPA, 2006[a]).
In 2008, the EF from sow was 22.14 kg CH_4 head^{-1}year^{-1}, and for the other swine category was 8.32 kg CH_4 head^{-1} year^{-1} (average swine EF is 7.93 kg CH_4 head^{-1}year^{-1}). In Table 6.14 the time series of EFs for the swine category (sow and other swine) are shown. The CRF IEF reported is 6.94 kg CH_4

head^{-1} year^{-1}. The difference between the EF and the IEF is due to the reduction in CH_4 because of biogas recovery.
For reporting purposes, the VS daily excretion and Bo is estimated and is useful to verify the EF accuracy. The VS daily excretion was estimated for each sub-category with the following parameters: animal number, production of slurry (t/a/t live weight) and the volatile solids content in the slurry (g VS/kg slurry w.b.). Methane producing potential (Bo) is estimated with Equation 4.17 from the IPCC (IPCC, 2000).

Livestock category	Average weight (kg)	Breed live weight (t)	Methane emission rate with 8% emission reduction (nl CH_4/100 kg live weight)	Emission factor (kg CH_4 head^{-1} yr^{-1})
Other swine	**84**	**570,003**	**13,768**	**8.32**
20-50 kg	35	64,835	13,768	3.48
50-80 kg	65	99,718	13,768	6.46
80-110 kg	95	136,900	13,768	9.44
110 kg and more	135	263,714	13,768	13.41
Boar	200	4,836	13,768	19.86
Sow	**172**	**147,076**	**15,783**	**22.14**
Piglets	10	16,909	15,783	1.14
Sow	172.1	130,167	15,783	19.60
			TOTAL	**7.93**

Table 6.13 Methane manure management parameters and emission factors for swine in 2008

The fundamental characteristic of Italian swine production is the high live weight of the animals slaughtered as related to age; the optimum weight for slaughtering to obtain meat suitable for producing the typical cured meats is between 155 and 170 kg of live weight. Such a high live weight must be reached in no less than nine months of age. Other characteristics are the feeding situation, to obtain high quality meat, and the concentration of Italian pig production, limited to a small area (*Lombardia, Emilia-Romagna, Piemonte* and *Veneto*), representing 75% of national swine resources (Mordenti *et al*., 1997). These peculiarities of swine production influence the methane EF for manure management as well as nitrogen excretion factors used for the estimation of N_2O emissions.

Other livestock categories

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

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

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sows	Other swine
	(kg CH_4 head^{-1} year^{-1})				
1990	15.04	7.47	12.17	22.14	8.54
1991	15.04	7.61	11.94	22.03	8.42
1992	15.04	7.59	12.02	22.01	8.41
1993	15.04	7.59	11.93	22.05	8.43
1994	15.04	7.73	11.90	21.96	8.42
1995	15.04	7.82	11.95	21.96	8.52
1996	15.04	7.79	11.92	21.95	8.54
1997	15.04	7.70	11.90	22.05	8.34
1998	15.04	7.66	12.06	22.04	8.36
1999	15.04	7.72	12.12	22.12	8.44
2000	15.04	7.67	11.71	21.97	8.43
2001	15.04	7.72	13.74	22.20	8.55
2002	15.04	7.66	14.07	22.27	8.21
2003	15.04	7.69	12.98	22.19	8.20
2004	15.04	7.73	12.87	22.22	8.27
2005	15.04	7.78	12.29	22.30	8.35
2006	15.04	7.67	11.96	22.16	8.35
2007	15.04	7.77	11.97	22.21	8.33
2008	15.04	7.70	11.75	22.14	8.32

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

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

Nitrous oxide emissions

As suggested in the IPCC (IPCC, 2000) N_2O emissions were estimated with equation 4.18 from IPCC. Different parameters were used for the estimation: number of livestock species, country-specific nitrogen excretion rates per livestock category, the fraction of total annual excretion per livestock category related to a manure management system and EFs for manure management systems (IPCC, 1997).
Liquid system, solid storage and other management systems (chicken-dung drying process system) are considered according to their significance and major distribution in Italy. For these management systems, the following EFs are used: 0.001 kg N_2O-N/kg N excreted, 0.02 kg N_2O-N/kg N excreted and 0.02 kg N_2O-N/kg N excreted, respectively (CRPA, 2000; CRPA, 1997[b]). The chicken-dung drying process system is considered since 1995, since it has become increasingly common (CRPA, 2000; CRPA, 1997[b]).

When estimating emissions from manure management, the amount related to manure excreted while grazing is subtracted and reported in 'Agricultural soils' under soil emissions - animal production (see Table 6.15). In the 2006 submission, different parameters such as the nitrogen excretion rates (CRPA, 2006[a]; GU, 2006; Xiccato *et al*., 2005), the slurry and solid manure production, and the average weight (CRPA, 2006[a]; GU, 2006; Regione Emilia Romagna, 2004) were updated. In Table 6.15, nitrogen excretion rates used for the estimation of N_2O are shown. The nitrogen excretion rate for swine is 11.70 kg head^{-1} yr^{-1}. This last parameter is a weighted average: sow (28.09 kg head^{-1} yr^{-1}) and other swine (12.79 kg head^{-1} yr^{-1}).

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	379	48.52	1.24	**49.76**
Dairy cattle	603	110.20	5.80	**116.00**
Buffalo	506	88.414	2.69	**91.05**
Other swine	84	12.79	0.00	**12.79**
Sow	172	28.09	0.00	**28.09**
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**

Table 6.15 Average weight and nitrogen excretion rates in 2008

Since 2006 submission, with results obtained from the Nitrogen Balance Inter-regional Project, country-specific annual nitrogen excretion rates have been incorporated. This project involved *Emilia Romagna*, *Lombardia*, *Piemonte* and *Veneto* regions, where animal breeding is concentrated. The nitrogen alance methodology was followed, as suggested by the IPCC. As a result, estimations of nitrogen excretion rates[6] and net nitrogen arriving to the field[7] were obtained. In order to get reliable information on feed consumption and characteristics, and composition of the feed ratio, the project considered territorial and dimensional representativeness of Italian breeding. Final annual nitrogen excretion rates used for the UNFCCC/CLRTAP agriculture national inventory are reported in a report from CRPA (CRPA, 2006[a]). In Table 6.16, nitrogen excretion rates for the main livestock categories are shown for the whole time series. In the CRF the swine nitrogen excretion rate is represented by sows and ‘other swines’ (11.7 kg head^{-1} year^{-1}). For the other livestock categories nitrogen excretion is the same for the whole time series, as shown below:

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

For the dairy cattle category the same nitrogen excretion rate is applied for the whole time series. This figure is the result of the Nitrogen Balance Inter-regional Project. Further explanation on the efforts to improve the modelling of nitrogen excretion is given in the following section 6.3.6.

[6] Nitrogen excretion = N consumed – N retained
[7] Net nitrogen to field= (N consumed – N retained) – N volatilized

Year	Dairy cattle	Non-dairy cattle	Buffalo	Other swine	Sows
	(kg N head^{-1} yr^{-1})				
1990	116.0	50.00	93.94	13.13	28.10
1991	116.0	51.43	92.27	12.94	27.94
1992	116.0	50.97	92.89	12.93	27.92
1993	116.0	50.82	92.24	12.97	27.97
1994	116.0	51.83	92.04	12.95	27.85
1995	116.0	49.86	92.42	13.10	27.86
1996	116.0	49.83	92.17	13.12	27.84
1997	116.0	49.81	92.04	12.82	27.98
1998	116.0	49.19	93.21	12.86	27.96
1999	116.0	49.62	93.68	12.98	28.06
2000	116.0	50.08	90.76	12.96	27.87
2001	116.0	50.69	105.23	13.14	28.17
2002	116.0	50.39	107.58	12.61	28.27
2003	116.0	50.53	99.82	12.60	28.16
2004	116.0	50.04	99.01	12.72	28.20
2005	116.0	49.76	94.91	12.84	28.30
2006	116.0	48.52	92.59	12.84	28.12
2007	116.0	49.84	92.61	12.81	28.18
2008	116.0	49.76	91.05	12.79	28.09

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

Since 2006 submission, new average weight data have been used for UNFCCC/CLRTAP agriculture national inventory. For verification purpose, a time series reported by ISTAT in the yearbooks (animal weight before slaughter) was collected (CRPA, 2006[a]). For the specific case of sheep and goats, a detailed analysis was applied with information coming from the National Association for Sheep Farming[8] (ASSONAPA, 2006). In order to estimate the average weight for sheep and goats, breed distribution in Italy and consistency for each breed were considered (CRPA, 2006[a]; PROINCARNE, 2005). Slurry and solid manure production parameters were updated in the 2006 submission. These parameters consider characteristics from Italian breeding, for slurry and solid manure effluents, housing systems and the distribution for the different animal categories (CRPA, 2006[a]; Bonazzi *et al*., 2005; APAT, 2004[a]; APAT, 2004[b]).

6.3.3. Uncertainty and time-series consistency

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

In 2008, livestock CH_4 emissions from manure management were 14.5% (140.99 Gg CH_4) lower than in 1990 (164.86 Gg CH_4). From 1990 to 2008, dairy and non-dairy cattle livestock population decreased by 31% and 15%, respectively, whereas swine increased by 9%. Consequently, the reduction in the number of cattle has mainly driven down manure management emissions. Cattle CH_4 emissions contribute with 38% (in 1990 with 47%) to total CH_4 manure management

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

emissions and swine with 46% (in 1990 with 41%). 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.

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sows	Other swine	Sheep	Goats	Horses	Mules and asses	Poultry	Rabbits	TOTAL
	(Gg)											
1990	39.74	38.18	1.15	14.41	53.78	1.90	0.18	0.43	0.07	13.82	1.19	**164.86**
1991	35.12	42.40	0.99	15.64	53.06	1.83	0.18	0.46	0.06	13.80	1.27	**164.82**
1992	32.26	41.15	1.24	15.20	51.18	1.84	0.20	0.47	0.05	13.77	1.31	**158.67**
1993	31.86	40.36	1.20	15.49	51.67	1.89	0.20	0.48	0.04	13.82	1.32	**158.32**
1994	29.93	39.40	1.29	14.70	49.50	2.17	0.24	0.48	0.04	14.24	1.35	**153.34**
1995	30.85	40.01	1.77	14.94	49.85	2.32	0.20	0.47	0.03	14.67	1.36	**156.48**
1996	30.88	39.14	2.04	15.73	50.08	2.38	0.21	0.46	0.03	14.57	1.39	**156.90**
1997	30.89	38.76	1.92	15.11	50.25	2.37	0.20	0.46	0.03	14.87	1.40	**156.26**
1998	31.52	38.00	2.25	15.44	50.46	2.37	0.19	0.43	0.03	15.85	1.41	**157.94**
1999	31.62	38.47	2.43	15.13	51.67	2.40	0.20	0.43	0.03	15.67	1.44	**159.48**
2000	30.80	37.92	2.25	15.42	51.14	2.41	0.20	0.41	0.03	14.09	1.42	**156.10**
2001	30.78	35.43	2.66	15.25	54.51	1.81	0.15	0.42	0.03	16.68	1.47	**159.19**
2002	28.17	34.54	2.61	16.40	53.46	1.77	0.14	0.41	0.02	16.39	1.50	**155.42**
2003	28.11	34.47	2.89	15.96	53.97	1.73	0.14	0.42	0.02	15.68	1.50	**154.89**
2004	26.73	33.38	2.70	15.57	52.58	1.76	0.14	0.41	0.02	15.27	1.57	**150.14**
2005	26.44	32.74	2.52	15.36	53.87	1.73	0.14	0.41	0.03	15.05	1.63	**149.93**
2006	25.21	30.31	2.76	15.73	52.04	1.79	0.14	0.42	0.03	14.15	1.61	**144.20**
2007	25.05	31.28	3.52	15.16	51.26	1.79	0.13	0.47	0.03	15.07	1.67	**145.43**
2008	24.11	29.32	3.61	14.66	49.56	1.78	0.14	0.49	0.03	15.74	1.56	**140.99**

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

In 2008, N_2O emissions from manure management were 4% (12.18 Gg N_2O) lower than in 1990 (12.65 Gg N_2O). The major contribution is given by the ‘solid storage system’ with 88% (in 1990 with 95%). In Table 6.18, N_2O emissions are shown.

Year	Liquid system	Solid storage	Other	TOTAL
	(Gg)			
1990	0.62	12.03	0.00	**12.65**
1991	0.62	12.01	0.00	**12.63**
1992	0.59	11.50	0.00	**12.09**
1993	0.59	11.39	0.00	**11.98**
1994	0.57	11.37	0.00	**11.93**
1995	0.57	11.54	0.09	**12.20**
1996	0.56	11.61	0.17	**12.34**
1997	0.56	11.63	0.25	**12.44**
1998	0.56	11.72	0.42	**12.70**
1999	0.56	11.80	0.53	**12.89**
2000	0.54	11.36	0.56	**12.46**
2001	0.54	11.59	0.78	**12.91**
2002	0.52	11.05	0.84	**12.42**
2003	0.52	10.92	0.89	**12.33**

Year	Liquid system	Solid storage	Other	TOTAL
	(Gg)			
2004	0.51	10.59	0.89	**11.98**
2005	0.51	10.49	0.97	**11.96**
2006	0.50	10.16	0.95	**11.61**
2007	0.51	10.73	0.94	**12.19**
2008	0.51	10.71	0.96	**12.18**

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

Category/sub category	Parameter	Year of submission 2010	2011	Activities
Dairy cattle	N excretion		√	A query on the type of housing of different livestock categories has been introduced in the Farm and structure survey 2005. Results have been analysed. According to experts from CRPA, information collected from SPA 2005 (housing data) needs to be validated with information from the Agricultural Census (CRPA, 2010).
Livestock categories	Type of housing		√	We are analysing and verifying information coming from the Farm and Structure Survey 2007, where a query related to storage facilities for slurry and solid manure was incorporated.
Livestock categories	Slurry and solid manure storage facilities		√	Different queries have been incorporated in an specific section of the 2010 Agricultural Census. Grazing, housing, storage systems and land spreading information will be collected.
Livestock categories	Production methods	√		Data on biogas from 2008 has been collected (web site TERNA)
Livestock categories	Biogas	√		A query on the type of housing of different livestock categories has been introduced in the Farm and structure survey 2005. Results have been analysed. According to experts from CRPA, information collected from SPA 2005 (housing data) needs to be validated with information from the Agricultural Census (CRPA, 2010).

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 2010 submission are shown. In the 2010 submission, update information for the number of rabbits (2001-2007) was obtained from ISTAT (ISTAT, 20010[f]). Also poultry information was updated for the years 2002 and 2006 (UNA, 2010). Recalculations affected both CH_4 and N_2O emissions for this category.

6.3.6. Source-specific planned improvements

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

For the dairy cattle category, the suggestions by the review process (UNFCCC, 2009) have been taken into consideration. Nitrogen excretion in Italy has been evaluated through a Nitrogen Balance Inter-regional Project (nitrogen balance in animal farms), funded by the Regional Governments of the most livestock-intensive Italian Regions. The N-balance methodology has been applied in real case farms, monitoring their normal feeding practice, without specific diet adaptation. In the project, the most relevant dairy cattle production systems in Italy have been considered. Contrary to what is normally found in European milk production systems, poor correlation between the N excretion and milk production has been found. Probably there are two reasons for explaining the absence of correlation: a) extreme heterogeneity in the protein content of the forage and in the use of the feed; b) the non optimisation of the protein diet of less productive cattle (De Roest and Speroni, 2005; CRPA, 2010). Still further efforts on theoretical assessment of nitrogen excretion data will be done based on nitrogen balance methodology (Gruber and Pötsch, 2006).

Livestock category			Average weight (kg) Submission 2010	N excretion (kg N $head^{-1}$ yr^{-1}) Submission 2010
DAIRY CATTLE (*vacche da latte*)			603	116
NON- DAIRY CATTLE				
Less than 1 year (*)			212(**)	25.1 (**)
From 1 year - less than 2 years				
	Male	for reproduction	557	66.8
		for slaughter	557	66.8
	Female	for breeding	405	67.6
		for slaughter	444	53.3
From 2 years and more				
	Male	for reproduction	700	84.0
		for slaughter and work	700	84.0
	Female	Breeding heifer (*manze da allevamento*)	540	90.2
		Slaughter heifer (*manze da macello*)	540	64.8
		Other dairy cattle (*altre vacche)*	557	54.1
BUFFALO		Cow buffalo (*bufale*)	630	116
		Other buffaloes (*altri bufalini*)	313	52.2
OTHER SWINE	Weight less than 20 kg		10	
	From 20 kg weight and under 50 kg		35	5.3
	From 50 kg and more			
		Boar (*verri*)	200	30.5
		For slaughter (*macello*)		
		from 50 to 80 kg	65	9.9
		from 80 to 110 kg	95	14.5
		from 110 kg and more	135	20.6
SOW (*scrofe*)			172.1	28.1 (**)
SHEEP	Sheep (*pecore*)		51	16.2
	Other sheep (*altri ovini*)		21	16.2
GOAT	Goat (*capre*)		54	16.2
	Other goat (*altri caprini*)		15	16.2
EQUINE	Horses (*cavalli*)		550	50.0
	Mules and asses (*altri equine*)		300	50.0
POULTRY	Broilers (*polli da carne*)		1.2	0.36
	Hen (*galline da uova*)		1.8	0.66
	Other poultry (*atri avicoli*)		3.3	0.83
RABBIT	Female rabbits (f*attrici*)		4	2.5
	Other rabbit (*altri conigli*)		1.3	0.8

Table 6.20. Parameters used for the different livestock categories in 2010 submission

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

6.4. Rice cultivation (4C)

6.4.1. Source category description

For the rice cultivation category, only CH_4 emissions are estimated, other GHGs do not occur; N_2O from fertilisation during cultivation was estimated and reported in "Agricultural soils" under direct soil emissions - synthetic fertilizers. In 2008, CH_4 emissions from rice cultivation were 66.47 Gg, which represent 9.1 % of CH_4 emissions for the agriculture sector (9.1% in 1990) and 3.9% for national CH_4 emissions (3.8% 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 (12.89 Gg) and multiple aeration (53.58 Gg) categories.
In response to UNFCCC review processes from 2004 and 2005 (UNFCCC, 2005; UNFCCC, 2004) and in consultation with an expert in CH_4 emissions and rice cultivation (Wassmann, 2005), a detailed methodology was developed. New activity data and parameters are used for the estimation of CH_4 emissions (Cóndor *et al*., 2007[a]). For this purpose, an expert group on rice cultivation together with the C.R.A. – Experimental Institute of Cereal Research – Rice Research Section of Vercelli was established. Different national experts from the rice cultivation sector were also contacted[9].
The quality of the Italian rice emission inventory was verified with the DNDC[10] model. Initial results have found a high correspondence between the EFs used for the Italian inventory and those simulated with DNDC model (Leip and Bocchi, 2007).

6.4.2. Methodological issues

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

Parameters used for the calculation of CH_4 emissions from rice cultivation

Parameters	Reference
Cultivated surface with "dry-seeded" technique (%)	Centro Ricerche sul Riso, 2007
Cultivated surface – national (ha)	ISTAT, 2010[d],[e]; 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, 2010[d],[e]
Yield (t ha^{-1})	Estimations based on cultivated surface and crop production data
Straw incorporation (%)	Expert judgement (Tinarelli, 2005; Lupotto *et al*., 2005)
Agronomic practices (%)	ISTAT, 2006[b]; Tinarelli, 2005; Lupotto *et al*., 2005; Zavattaro et. al, 2004; Baldoni & Giardini, 1989; Tinarelli, 1973; 1986
Scaling factors (SFw, SFp, SFo)	IPCC, 2006; Yan et. al, 2005

9 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).
10 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 and Regis, 2002). In Table 6.21, water regimes descriptions are presented. Normally, the aeration periods are very variable in number and time, depending on different circumstances, as for example, the type of herbicide, which is used (Baldoni and Giardini, 1989). Another water regime system, present in southern Italy, is the sprinkler irrigation, which exists only on experimental plots and could contribute to the diffusion of rice cultivation in areas where water availability is a limiting factor (Spanu *et al*., 2004; Spanu and Pruneddu, 1996).

Type of seeding	**April**	**May**	**June**	**July**	**August**	**September-October**	**Description**
Wet-seeded “classic”	15-30 April Flooding and wet-seeded (*)	10 may	Herbicide treatment	Fertilizer application (1/3), soil is saturated but not flooded. Panicle formation	Final aeration	Harvest	2 aeration periods during rice cultivation, as minimum, not including the final aeration IPCC classification: Intermittently flooded – multiple aeration
		1ºaeration - AR	2º aeration- AA		3º final aeration		
Wet-seeded “red rice control”	15 April Flooding and wet-seeded (*)	First application of herbicides, the soil is dry. Approximately, on 15 may flooding and after some days seeding	At the end of June, fertilization treatment	Fertilizer application (1/3), soil is saturated but not flooded. Panicle formation	Final aeration	Harvest	2 aeration periods during rice cultivation, as minimum, not including the final aeration. In some cases, between April and May, even 3 aeration periods are practised. IPCC classification: Intermittently flooded – multiple aeration
		1° aeration – AC Approx. after 10 days 2° aeration - AR	3ºaeration - AA		Final aeration		
Dry-seeded with delay flooding	15 April Dry-seeded	Approximately, on 15 may flooding	Herbicide treatment	Fertilizer application (1/3), soil is saturated but not flooded. Panicle formation		Harvest	1 aeration period during rice cultivation, as minimum, not including the final aeration. IPCC classification: Intermittently flooded – single aeration
			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 to 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 and Nguyen, 2004; Russo, 1994).
During the cultivation period, water is commonly kept at a depth of 4-8 cm, and drained away 2-3 times during the season to improve crop rooting, to reduce algae growth and to allow application of herbicides. Rice fields are drained at the end of August to allow harvesting, once in a year (Ferrero and Nguyen, 2004; Baldoni and Giardini, 1989; Tinarelli, 1973; 1986).
Nitrogen is generally the most limiting plant nutrient in rice production and is subject to losses because of the reduction processes (denitrification) and leaching. Sufficient nitrogen should be applied pre-plant or pre-flood to assure that rice plant needs no additional nitrogen until panicle initiation or panicle differentiation stage. When additional nitrogen is required, it should be top-dressed at either of these plant stages or whenever nitrogen deficiency symptoms appear. The above-mentioned applications are usually used in two or three periods; the first period is always before sowing, that is on dry soil, while the others occur during the growing season (Russo, 2001; Russo, 1993; Russo *et al.*, 1990; Baldoni and Giardini, 1989).
In Italy, another type of fertilization practise is the incorporation of straw. The incorporation period can vary according to weather conditions, but probably mainly incorporated approximately one month before flooding (Russo, 1988; Russo 1976). Rice straw are often burned in the field, otherwise incorporated into the soil or buried. For other agronomic practice, a national publication has been considered for understanding fertilizer and crop residues management (Zavattaro *et al.*, 2004).

Methane emission factor

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

The estimation of CH_4 emissions for the rice cultivation category considers an irrigated regime, which includes intermittently flooded with single aeration and multiple aeration regimes. The CH_4 emission factor is adjusted with the following parameters: daily integrated emission factor for continuously flooded fields without organic fertilizers, scaling factor to account for the differences in water regime in the rice growing season (*SFw*), scaling factor to account for the differences in water regime in the preseason status (*SFp*) and scaling factor which varies for both types and amount of amendment applied (*SFo*). Scaling factor parameters have been updated according to literature (Yan *et al.*, 2005) and the IPCC 2006 Guidelines (IPCC, 2006). Assumptions of agronomic practices are described in Table 6.21. Parameters used for CH_4 emission estimations are shown in Table 6.22. Total emissions for rice cultivation were 66.47 Gg.

Rice cultivation water regimes: Intermittently flooded	**Single aeration**	**Multiple aeration**	**Multiple aeration**
Type of seeding	Dry-seeded	Wet-seeded (classic)	Wet-seeded (*red rice control*)
Surface (ha)	55,140	76,076	92,981
Daily EF (g CH_4 m^{-2} d^{-1})	0.20	0.28	0.28
SFw	0.60	0.52	0.52
SFp	0.68	0.68	0.68
SFo	2.1	2.1	2.1
Adjusted daily EF (g CH_4 m^{-2} d^{-1})	0.17	0.20	0.20
Days of cultivation (days)	138	156	1556
Seasonal EF (g CH_4 m^{-2} yr^{-1})	23.37	31.69	31.69
Methane emissions (Gg)	**12.89**	**24.11**	**29.47**

Table 6.22 Parameters used for estimating CH_4 emissions from rice cultivation in 2008

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 2008, CH_4 emissions from rice cultivation were 11% (66.47 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 (lower CH_4 emission factor). Methane emissions have decreased by 11% and the harvest area has increased by 4%, from 215,442 ha $year^{-1}$ in 1990 to 224,198 ha $year^{-1}$ in 2008. The percentage of single aerated surface has increased from 1% (1990) to 24.6% (2008). Water regime trends were estimated 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** 2010	2011	**Activities**
Activity data	Days of cultivation and cultivars	√		Data from 2008 and provisional data from 2009 have been uploaded .
Rice	Emission factor	√	√	We have contact EC - 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 from 2007. Data is still not available. Probably in 2010 a publication will be available.

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

6.4.5. Source-specific recalculations

In Table 6.24, CH_4 emissions from 2009 and 2010 submissions are shown. No recalculations were done for this submission.

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

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

6.4.6. Source-specific planned improvements

Lack of experimental data and knowledgement about the occurrence and duration of drainage periods in Italy is the major cause of uncertainty. Moreover, it is not easy to quantify the surface where the traditional or the different number of aerations is practiced, which depends on the degree and the type of infestation, and the positive or negative results of the herbicide treatment application (Spanu, 2006). In Table 6.21, a general classification has been done for the most common agronomic practices in Italy. Since the 2006 submission, a trend in water regime has been calculated together with expert judgement expertise (Tinarelli, 2005; Lupotto *et al*., 2005) and available statistics (Centro Ricerche sul Riso, 2007). Provincial estimations on the basis of the relation between emissions and temperature would result in further possible improvements, even if enhancement would be limited since the largest Italian rice production is in the Po valley, where monthly temperatures of the rice paddies are similar. In 1990, *Piemonte* and *Lombardia* regions represented 95% of the national surface area of rice cultivation, while in 2008 they represented 94% (ENR, 2009; Confalonieri and Bocchi, 2005).

6.5. Agriculture soils (4D)

6.5.1. Source category description

In 2008, N_2O emissions from agricultural soils were 54.18 Gg, representing 82% of emissions for the agriculture sector (83% in 1990) and 57.1% for national N_2O emissions (52.2% in 1990). N_2O emissions from this source consist of direct soil (26.20 Gg), animal production (5.06 Gg) and indirect soil (22.92 Gg) emissions.

Direct N_2O emissions from agricultural soils are key sources at level and trend assessment, both with Tier 1 and Tier 2 approaches. Indirect N_2O emissions are key sources at level for Tier 1 and Tier 2, and trend assessment (Tier 2). Animal Production is a key source at level and trend assessment with the Tier 2 approach, taking into account the uncertainty.

In Italy, agricultural soil emissions are estimated for direct and indirect soils and animal production. For direct soil emissions the following sources are estimated: synthetic fertilizers, animal waste applied to soil, N-fixing crops and cultivation of histosols. For indirect soil emissions, atmospheric deposition and nitrogen leaching and run-off are estimated. Nitrous oxide emissions from Animal Production are calculated together with the manure management category on the basis of nitrogen excretion, and reported in agricultural soils under "Animal Production".

ISPRA (former APAT) is in charge of collecting, elaborating and reporting the UNFCCC/CLRTAP agriculture national emission inventory (APAT, 2005), thus, consistency among methodologies and parameters is verified. Since 2006 submission, the UNFCCC/CLRTAP inventory has updated country-specific nitrogen excretion rates and EFs. The nitrogen balance coming from the CLRTAP emission inventory feeds the UNFCCC inventory, specifically for the estimation of $FRAC_{GASM}$ and $FRAC_{GASF}$ parameters, used for calculating F_{AM} and F_{SN}.

6.5.2. Methodological issues

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

Data used for estimating agricultural soil emissions

Data	Reference
Fertilizer distributed (t/yr)	ISTAT, 2010[c]; ISTAT, several years [a], [b]
Nitrogen content (%)	ISTAT, 2010[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, 2010[d],[e]; ISTAT, several years [a], [b]
Annual crop production (t yr^{-1})	ISTAT, 2010 [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, 2010[a]; ISTAT, several years [a], [b]

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

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

Direct emissions

Synthetic fertilizers (F_{SN})
The total use of synthetic fertilizer (expressed in t N year^{-1}) is estimated for each type of fertilizer (see Table 6.25). The calculation of synthetic fertilizer use (F_{SN}**)** is obtained by multiplying the total use of fertilizer by (1- $FRAC_{GASF}$). $FRAC_{GASF}$ parameter is estimated for the whole time series, following the IPCC definition, where the total N-NH_3 and N-NOx emissions from fertilizers are divided by the total nitrogen content of fertilizers. N_2O emissions for synthetic fertilizers is obtained multiplying F_{SN} by the emission factor, 0.0125 kg N-N_2O/kg N (IPCC, 1997). In 2008, the total use of synthetic fertilizers was 659,922 t N, while F_{SN} parameter was 595,641 t N (see Table 6.27). In the 2008 submission, a specification for "Other nitrogenous fertilizers" was introduced (ENEA, 2006). This improvement was introduced since 1998, because activity data is available from that year. In Table 6.30, the time series of nitrogen content of fertilizers is shown.

Type of fertilizers	Fertilizers distributed (t/yr)	Nitrogen content (%)	Nitrogen content of synthetic fertilizers (t N yr^{-1})
Ammonium sulphate	137,637	20.7%	28,431
Calcium cianamide	18,161	19.8%	3,595
Ammonium nitrate < 27%	**245,170**	29.8%	73,156
Ammonium nitrate > 27%	**202,301**	26.5%	53,608
Calcium nitrate	**47,314**	18.9%	8,946
Urea	679,390	46.0%	312,427
Other nitric nitrogen (*Altri azotati nitrico*)	144,709	27.8%	3,952
Other ammoniacal nitrogen (*Altri azotati ammoniacale*)	-	-	15,620
Other amidic nitrogenous (*Altri azotati ammidico*)	-	-	20,634
Phosphate nitrogen	225,820	13.2%	29,702
Potassium nitrogen	100,486	16.8%	16,887
NPK nitrogen	715,549	8.9%	63,712
Organic mineral	307,001	9.5%	29,254
TOTAL	**2,823,538**		**659,922**

Table 6.25 Total use of synthetic fertilizer in 2008 (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}), is calculated with the IPCC methodology (IPCC, 1997). It uses country-specific nitrogen excretion rates (CRPA, 2006[a]; GU, 2006; Xiccato *et al.*, 2005). A country-specific $FRAC_{GASM}$ parameter is estimated and used for the calculation of the animal waste applied to soil. The $FRAC_{GASM}$(direct) and $FRAC_{GASM}$(indirect) parameters are reported in Table 6.27. The estimation has followed the IPCC definition; therefore, NH_3 and NO_x emissions from animal manure are divided by the total nitrogen excreted. The F_{AM} (t yr^{-1}) value is estimated by summing the F_{AM} for each livestock category; then emissions are calculated with emission factor 0.0125 kg N-N_2O/kgN (IPCC, 1997). In 2008, F_{AM} parameter was 445,723 t N. In the 2010 submission the time series of F_{AM} was updated due to a revision of CLRTAP-NH_3 agriculture inventory (see section 6.5.5).

N-fixing crops (F_{BN})

Nitrogen input from N-fixing crops (F_{BN}, kg N yr^{-1}) is calculated with a country-specific methodology. Peculiarities that are present in Italy were considered: N-fixing crops and legumes forage. F_{BN} is calculated with two parameters: cultivated surface and nitrogen fixed per hectare (Erdamn 1959 in Giardini, 1983). Emissions are calculated using the default emission factor 0.0125 kg N_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 shown. In 2008, F_{BN} parameter was 160,572 t N (see Table 6.27).

Crop residues (F_{CR})

For the estimation of nitrogen input from crop residues (FCR), a country-specific methodology is used. The total amount of crop residues is estimated (t dry matter yr-1) by using the following parameters: annual crop production (t yr-1), residue/crop product ratio, and dry matter content by type of crop (%), while, when cultivated surface (ha) is the available activity data, only the crop residue production (t dry matter ha-1 yr-1) parameter is used to assess total amount of crop residues. The nitrogen content from cereals, legumes, tubers and roots and legumes forages crop residues (t N yr-1) are estimated by multiplying the total amount of crop residue as dry matter with the reincorporated fraction (1- $FRAC_{BURN}$, where $FRAC_{BURN}$ is the fraction of crop residue that is burned rather than left on field equal to 0.1 kg N/kg crop-N), and the nitrogen content for each crop type. The nitrogen content is obtained converting protein content in dry matter, dividing by factor 6.25. The F_{CR} parameter is obtained by adding the nitrogen content of cultivars crop residues. In 2008, F_{CR} parameter was 126,115 t N (see Table 6.27). Emissions are calculated with emission factor 0.0125 kg N-N_2O/kg N (IPCC, 1997). The crop residues production is shown in Table 6.32.

	Nitrogen fixed	1990	1995	2000	2006	2007	2008
	(kg N $ha^{-1}yr^{-1}$)			(ha)			
Bean, fresh seed (*fagiolo*)	**40**	**29,096**	**23,943**	**23,448**	**22,017**	**22,130**	**20,736**
Bean, dry seed (*fagiolo*)	**40**	**23,002**	**14,462**	**11,046**	**8,179**	**6,923**	**5,972**
Broad bean, fresh seed (*fava*)	**40**	**16,564**	**14,180**	**11,998**	**9,694**	**9,792**	**9,547**
Broad bean, dry seed (*fava*)	**40**	**104,045**	**63,257**	**47,841**	**44,617**	**49,972**	**54,310**
Pea, fresh seed (*pisello*)	**50**	**28,192**	**21,582**	**11,403**	**12,589**	**11,805**	**12,854**
Pea, dry seed (*pisello*)	**72**	**10,127**	**6,625**	**4,498**	**13,625**	**12,957**	**10,378**
Chickpea (*cece*)	**40**	**4,624**	**3,023**	**3,996**	**5,188**	**5,299**	**5,265**
Lentil (*lenticchia*)	**40**	**1,048**	**1,038**	**1,016**	**1,738**	**1,806**	**1,821**
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**	**176,134**	**130,335**	**107,795**
Alfalfa (*erba medica*)	**194**	**987,000**	**823,834**	**810,866**	**766,316**	**705,370**	**712,674**
Clover grass (*trifoglio*)	**103**	**224,087**	**125,009**	**114,844**	**101,499**	**98,772**	**98,301**
TOTAL		1,958,025	1,301,746	1,307,102	1,171,097	1,064,660	1,049,153

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

Cultivation of histosols (F_{os})

In Italy, the area of organic soils cultivated annually (histosols) is estimated to be 9,000 hectares (CRPA, 1997[b]). This value is multiplied by 8 kg N-N_2O ha^{-1} yr^{-1}, as suggested by IPCC (IPCC, 2000). The data for surface area, reproduced in the national soil map of the year 1961, were supplied by the Experimental Institute for the study and protection of soil in Florence (ISSDS).

These values have been verified with related data for Emilia Romagna region, where this type of soil is most prevalent.

Year	F_{SN} (t N)	F_{AM} (t N)	F_{BN} (t N)	F_{CR} (t N)	F_{os} (ha)	$FRAC_{GASF}$	$FRAC_{GASM}$ (direct)	$FRAC_{GASM}$ (indirect) (*)
1990	691,723	473,798	254,654	147,541	9,000	0.087	0.319	0.328
1991	764,911	473,322	240,032	149,041	9,000	0.087	0.319	0.328
1992	808,237	454,546	228,560	152,456	9,000	0.086	0.315	0.324
1993	860,390	451,431	211,235	141,823	9,000	0.090	0.311	0.321
1994	795,479	445,195	201,884	141,799	9,000	0.091	0.301	0.311
1995	726,343	453,396	191,018	142,216	9,000	0.089	0.298	0.308
1996	691,890	454,382	190,601	145,826	9,000	0.085	0.295	0.305
1997	782,973	456,903	194,257	147,351	9,000	0.086	0.293	0.303
1998	703,640	463,904	202,718	150,090	9,000	0.089	0.292	0.302
1999	716,405	469,740	191,722	150,228	9,000	0.091	0.290	0.300
2000	715,366	457,669	189,545	144,372	9,000	0.089	0.286	0.296
2001	737,063	467,361	182,928	137,779	9,000	0.089	0.299	0.307
2002	745,286	453,308	177,529	142,457	9,000	0.090	0.297	0.305
2003	750,296	452,998	175,154	119,184	9,000	0.090	0.296	0.304
2004	765,064	440,098	172,532	143,172	9,000	0.091	0.293	0.302
2005	710,888	439,882	176,624	145,247	9,000	0.088	0.292	0.301
2006	713,369	430,604	175,243	128,431	9,000	0.092	0.290	0.299
2007	694,048	446,953	160,575	124,377	9,000	0.093	0.292	0.301
2008	595,641	445,723	160,572	126,115	9,000	0.097	0.291	0.300

(*) $FRAC_{GASM}$(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 shown. N_2O emissions are estimated with the total nitrogen excreted from grazing (include all livestock categories), number of animals, and an EF of 0.02 kg N_2O-N/kg N excreted (IPCC, 1997).

Indirect emissions

For indirect emissions from agricultural soils the following parameters are estimated:

- Atmospheric deposition
- Nitrogen leaching and run-off

For estimating of N_2O emissions due to atmospheric deposition of NH_3 and NO_x the IPCC approach was followed (IPCC, 1997). Parameters which are used are the: total use of synthetic fertilizer, t N yr^{-1}, $FRAC_{GASF}$ emission factor, total N excreted by livestock (kg head^{-1}yr^{-1}), $FRAC_{GASM}$ emission factor (see Table 6.27) and emission factor 0.01 kg N_2O-N per kg NH_3-N + NO_x-N emitted (IPCC, 2000; IPCC, 1997).

The estimation of N_2O emissions due to nitrogen leaching and run-off has followed the IPCC approach (IPCC, 1997). Parameters which are used are the: total use of synthetic fertilizer, t N yr^{-1} (see Table 6.25), total N excreted by livestock (kg $head^{-1}$ yr^{-1}), $FRAC_{LEACH}$ emission factor 0.3 N/kg nitrogen of fertilizer or manure and the emission factor 0.025 Kg N_2O-N per kg nitrogen leaching/run-off (IPCC, 2000; IPCC, 1997). As mentioned before, the $FRAC_{LEACH}$ IPCC default value was compared with the country-specific $FRAC_{LEACH}$ parameter (ADBPO, 2001; ADBPO, 1994).
In the 2010 submission the time series 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	25.28	**60.25**
2003	29.53	4.93	25.23	**59.70**
2004	29.99	4.98	25.12	**60.09**
2005	29.04	4.90	24.18	**58.12**
2006	28.55	5.02	24.09	**57.65**
2007	28.12	5.06	24.32	**57.50**
2008	26.20	5.06	22.92	**54.18**

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

In 2008, N_2O emissions from agricultural soils were 14% (54.18 Gg N_2O) lower than in 1990 (62.69 Gg N_2O). In 2008, major contributions were from direct soil emissions (26.20 Gg) and indirect soil emissions (22.92 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 (17.87 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 in the number of animals.
In 2008, the second individual source with respect to total N_2O emissions was the direct emissions of synthetic fertilizers with 11.70 Gg (22%), followed by animal wastes applied to soils, with 8.76

Gg (16%). In Table 6.29, a time series of N_2O emissions is presented. Between 1996 and 1997 there was a high increase in the use of nitrogen fertilizers in Italy, thus, emissions could be identified as outlier (see Table 6.30).

	Direct N_2O emissions						**Indirect N_2O emissions**	
Year	Synthetic fertilizer	Animal Wastes Applied to Soils	N-fixing Crops	Crop Residue	Cultivation of Histosols	**Animal Production**	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	5.49	20.16
2002	14.64	8.90	3.49	2.80	0.11	5.03	5.35	19.93
2003	14.74	8.90	3.44	2.34	0.11	4.93	5.31	19.92
2004	15.03	8.64	3.39	2.81	0.11	4.98	5.22	19.90
2005	13.96	8.64	3.47	2.85	0.11	4.90	5.07	19.11
2006	14.01	8.46	3.44	2.52	0.11	5.02	5.03	19.05
2007	13.63	8.78	3.15	2.44	0.11	5.06	5.18	19.14
2008	11.70	8.76	3.15	2.48	0.11	5.06	5.05	17.87

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, 2010). 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

As requested by the Expert Review Team (ERT) from the UNFCCC, we report in this section recalculations. In 2010 submission update information for the number of rabbits (2001-2007) was obtained from ISTAT (ISTAT, 20010[f]) and poultry information was updated for the years 2002 and 2006 (UNA, 2010). These updatings did not lead to relevant changes in estimations. Moreover, due to the revision of NH_3 estimates in the CLRTAP-NH_3 agriculture inventory, recalculations of N_2O emissions occurred. EFs 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, thus N_2O emissions, for the sub-categories animal waste applied to soil and atmospheric deposition (volatized nitrogen from fertilizers, animal manures and other) have also changed. Finally, information of 'organic mineral' fertilizers (nitrogen content) for 2006 and 2007 has been updated.

Year	National data (t N)	FAO database (Nitrous fertilizer consumption, Mt)
1990	757,509	878,960
1991	837,402	906,720
1992	884,121	910,000
1993	945,290	917,900
1994	875,536	879,200
1995	797,500	875,000
1996	756,057	876,000
1997	856,945	855,000
1998	772,227	845,000
1999	788,243	868,000
2000	785,593	828,000
2001	808,964	773,161
2002	819,352	785,314
2003	824,649	Not available
2004	841,363	Not available
2005	779,846	Not available
2006	785,265	Not available
2007	765,490	Not available
2008	659,922	Not available

Table 6.30 Total annual N content in fertilizer applied from 1990 to 2008

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
2008	1,220,887	68,460,866	19,416,555

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

Category/sub category	Parameter	Year of submission 2010	2011	Activities
Direct emissions	Sewage sludge		√	Italy is aware that sewage sludge is applied to soils but no reliable information is available to estimate emissions in the agriculture sector.
Activity data	Fertilizer		√	Verify results obtained from the research study on land spreading (CRPA, 2009).

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 2008, CH_4 emissions from this source were 0.65 Gg, representing 0.09% of emissions for the agriculture sector. N_2O emissions were 0.013 Gg, representing 0.02% of emissions for the agriculture sector.

6.6.2. Methodological issues

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

Data used for estimating field burning of agriculture residues emission

Data	Reference
Annual crop production	ISTAT, 2010[d], [e]; ISTAT, several years [a], [b]
Removable residues/product ratio	CESTAAT, 1988
Fixed residues/removable residues ratio	ENEA, 1994
Fraction of dry matter in residues	IPCC, 1997; CRPA/CNR, 1992; CESTAAT, 1988; Borgioli, 1981
Fraction of the field where “fixed” residues are burned	ANPA-ONR, 2001; CESTAAT, 1988; IPCC, 1997
Fraction of residues oxidized during burning	IPCC, 1997
Fraction of carbon from the dry matter of residues	IPCC, 1997
Raw protein content from residues (dry matter fraction)	CESTAAT, 1988; Borgioli, 1981
IPCC Default Emission rates (CH_4, N_20)	IPCC, 1997

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

Year	Wheat	Barley	Maize	Oats	Rye	Rice	Sorghum
	(t)						
1990	8,108,500	1,702,500	5,863,900	298,400	20,800	1,290,700	114,200
1991	9,415,700	1,792,900	6,237,700	359,400	18,800	1,235,600	149,500
1992	8,938,400	1,742,087	7,394,100	333,100	22,586	1,271,600	178,700
1993	8,169,800	1,634,200	8,028,900	372,200	22,800	1,305,100	226,800
1994	8,251,401	1,467,378	7,483,438	354,660	20,295	1,360,519	236,060
1995	7,946,081	1,387,069	8,454,164	301,322	19,780	1,320,851	214,802
1996	8,424,492	1,350,494	9,547,541	351,622	20,400	1,359,697	209,191
1997	6,758,351	1,179,575	10,004,700	310,706	19,000	1,442,400	173,570
1998	8,338,301	1,359,076	9,054,600	362,627	20,100	1,407,100	159,872
1999	7,742,782	1,313,323	10,017,178	331,150	12,363	1,427,130	202,370
2000	7,427,660	1,261,560	10,139,639	317,926	10,292	1,245,555	215,200
2001	6,413,329	1,125,720	10,556,185	310,087	8,588	1,272,952	213,992
2002	7,547,763	1,190,326	10,554,423	328,759	9,631	1,378,796	215,072
2003	6,229,454	1,020,838	8,702,289	306,425	6,941	1,448,212	158,217
2004	8,638,721	1,156,620	11,368,007	337,694	7,851	1,525,509	215,394
2005	7,717,129	1,214,054	10,427,930	429,153	7,876	1,444,818	184,915
2006	7,181,720	1,297,395	9,626,373	394,866	8,590	1,449,973	221,392
2007	7,170,181	1,225,282	9,809,265	361,148	8,954	1,540,097	193,243
2008	8,859,410	1,236,711	9,722,910	356,094	10,756	1,332,974	224,557

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

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

a) Amount of “fixed” burnable residues[11] (t), estimated with annual crop production, removable residues/product ratio, and “fixed” residue/removable residues ratio.
b) Amount of dry residues in “fixed” residue[12] (t dry matter), calculated with amount of burnable residues and fraction of dry matter.
c) Amount of “fixed” dry residues oxidized[13] (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[14] (t C), calculated with the amount of “fixed” dry residue oxidized and the fraction of carbon from the dry matter of residues.
e) $C\text{-}CH_4$ from stubble burning[15] (t $C\text{-}CH_4$), calculated with the amount of carbon from stubble burning release in air and default emissions rate for $C\text{-}CH_4$, equal to 0.005 (IPCC, 1997).

In 2008, final CH_4 emissions from on field burning of agriculture residues (0.65 Gg CH_4) have been estimated multiplying the $C\text{-}CH_4$ value (0.489 Gg $C\text{-}CH_4$) by the coefficient 16/12. In Table 6.34, parameters used for estimating of CH_4 emissions from on field burning of agriculture residues are shown.

[11] Quantità di residuo "fisso" bruciabile (produzione totale) (ton)
[12] Quantità di residuo secco nel residuo "fisso" (tonnellate di sostanza secca)
[13] Quantità residuo secco "fisso" ossidato (ton di sost. secca)
[14] Quantità di carbonio rilasciato in aria dalla combustione delle stoppie (tonnellate di carbonio)
[15] 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*)	8,859	1,528	1,303	114	55	277
Rye (*segale*)	11	2	2	0	0	0
Barley (*orzo*)	1,236	247	212	19	7	35
Oats (*avena*)	356	62	54	5	2	10
Rice (*riso*)	1,333	223	168	75	31	156
Maize (*granoturco)*	9,723	972	405	0	0	0
Sorghum (*sorgo da granella*)	225	79	65	6	2	11
TOTAL	**21,743**	**3,114**	**2,209**	**219**	**98**	**489**

Table 6.34 Parameters used for the estimation of CH_4 emissions from agriculture residues in 2008

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

a) Amount of nitrogen from stubble burning release in air[16] (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[17] (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 2008, 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 (0.009 Gg N) with the coefficient 44/28. Table 6.35 shows the parameters for the estimation of CH_4 emissions from field burning of agriculture residues.

Crop	Amount of "fixed" dry residue oxidized (t 1000 dry matter)	Raw protein content from residues (dry matter fraction)	Fraction of nitrogen from the dry matter of residues	Amount of nitrogen from stubble burning (t 1000 N)	N-N_2O from stubble burning (t N-N_2O)
Wheat (*frumento*)	114	0.030	0.005	0.548	3.8
Rye (*segale*)	0	0.036	0.006	0.001	0.01
Barley (*orzo*)	19	0.037	0.006	0.113	0.8
Oats (*avena*)	5	0.04	0.006	0.031	0.2
Rice (*riso*)	75	0.041	0.007	0.494	3.5
Maize (*granoturco)*	0		0.007	0.000	0.0
Sorghum (*sorgo da granella*)	6	0.037	0.006	0.035	0.2
TOTAL	**219**			**1.122**	**8.6**

Table 6.35 Parameters used for the estimation of nitrous oxide from agriculture residues in 2008

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 2008, CH_4 emissions from field burning of agriculture residues were 0.65Gg emissions of CH_4 and 0.013Gg

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

emissions of N_2O emissions (see Table 6.36). Variation in emissions trend is related to cereal production trends.

Year	CH_4 (Gg)	N_2O (Gg)
1990	0.623	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
2008	0.652	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 (FSS 2003). ISTAT provided information regarding the regional practise of field burning (cereals). We have confirmed the assumption with data coming from national agricultural statistics (ISTAT, 2007[c]).

6.6.5. Source-specific recalculations

For the 2010 submission no recalculations were done.

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 forestry. The sector is responsible for 87.3 Mt of CO_2 removals from the atmosphere in 2008.
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 2008 are shown in Figure 7.1:

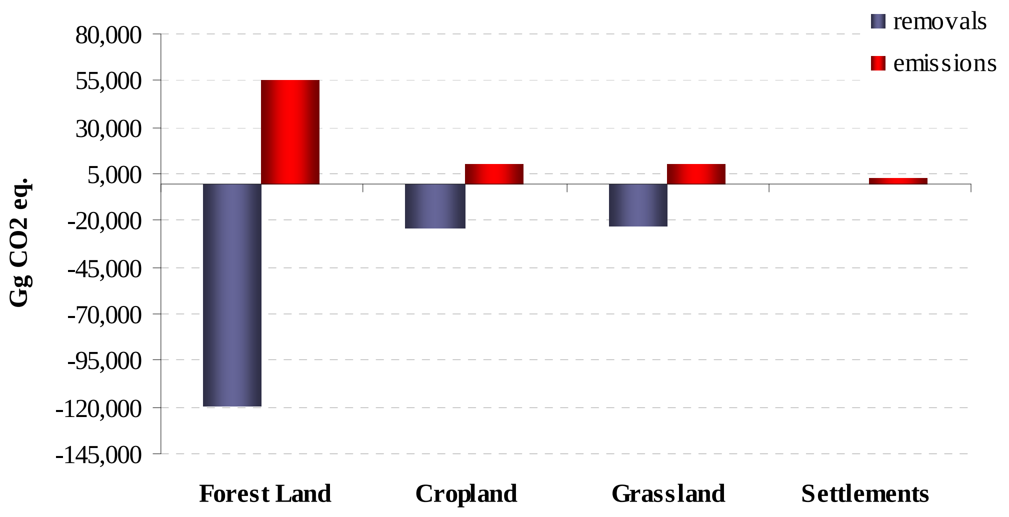


Figure 7.1 Greenhouse gas removals and emissions in LULUCF sector in 2008 [Gg CO_2 eq.]

In Table 7.1 emissions and removals time series is reported.

GHG Gas Source and Sink Categories	1990	1995	2000	2005	2006	2007	2008
CO_2	**-64,998**	**-82,485**	**-76,036**	**-92,006**	**-92,443**	**-52,485**	**-87,349**
A. Forest Land	-42,884	-63,255	-53,451	-70,229	-69,910	-32,969	-64,693
B. Cropland	-20,109	-14,924	-14,586	-13,071	-13,080	-13,223	-13,239
C. Grassland	-4,156	-6,451	-10,329	-11,921	-12,690	-9,528	-12,671
D. Wetlands	NO	NO	NO	NO	NO	NO	NO
E. Settlements	2,151	2,145	2,329	3,215	3,237	3,235	3,253
F. Other Land	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA
CH_4	**6.96**	**1.50**	**4.02**	**1.83**	**1.46**	**9.37**	**2.20**
A. Forest Land	**6.96**	1.50	4.02	1.83	1.46	9.37	2.20
B. Cropland	NO	NO	NO	NO	NO	NO	NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO
F. Other Land	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA
N_2O	**0.31**	**0.02**	**0.03**	**0.01**	**0.01**	**0.06**	**0.02**
A. Forest Land	0.05	0.01	0.03	0.01	0.01	0.06	0.02
B. Cropland	0.26	0.01	NO	NO	NO	NO	NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO
F. Other Land	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA
LULUCF (*Gg CO2 equivalent*)	**-64,757**	**-82,447**	**-75,943**	**-91,964**	**-92,409**	**-52,268**	**-87,299**

Table 7.1 Trend in greenhouse gas emissions from the LULUCF sector in the period 1990-2008

CO_2 emissions and removals in LULUCF sector, in the period 1990-2008, are shown in Figure 7.2:

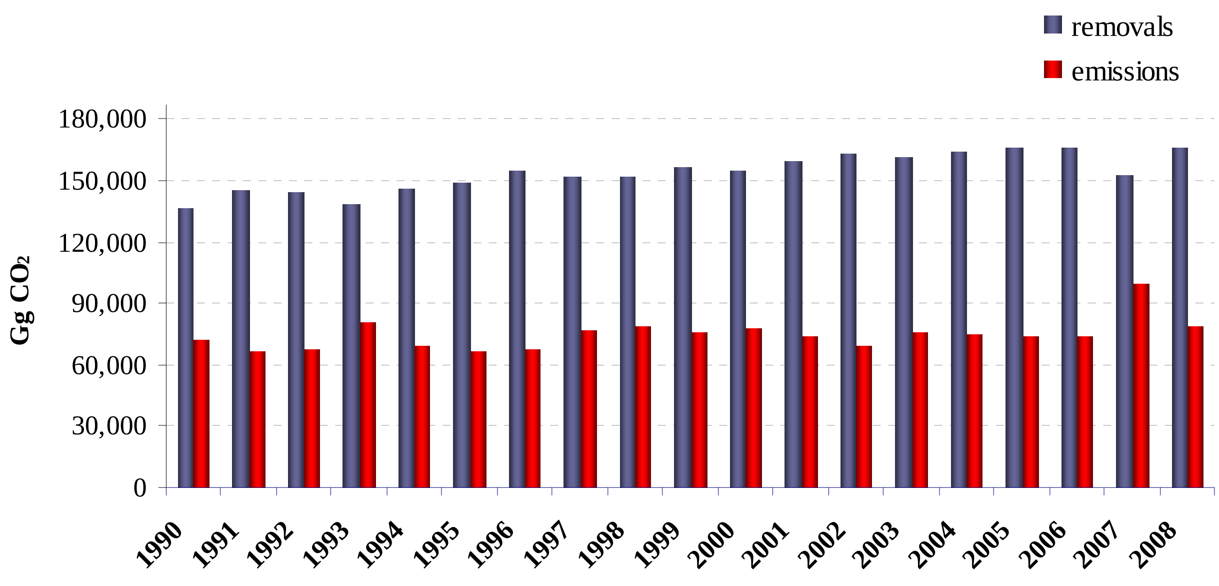


Figure 7.2 CO_2 removals and emissions in LULUCF sector in the period 1990-2008 [Gg CO_2]

The outcome of the key category analysis for 2008, according to level and/or trend assessment (*IPCC Tier 1 and Tier 2 approaches*), is listed in Table 7.2. CO_2 emissions and removals from forest land remaining forest land, cropland remaining cropland and grassland remaining grassland have been identified as key categories, at Tier 1, both in level and in trend assessement. Land converted to grassland and land converted to settlements have resulted key categories at Tier 1, for level assessement, and at Tier 2 concerning trend assessement. CO_2 emissions and removals from land converting forest land have been indentified as key category only at Tier 2, both in level and in trend assessement. Concerning CH_4 or N_2O emissions, no categories have resulted as a key source.

	gas	*categories*	2008
5.A.1	CO_2	Forest land remaining forest land	key (L, T)
5.B.1	CO_2	Cropland remaining cropland	key (L, T)
5.C.1	CO_2	Grassland remaining Grassland	key (L, T)
5.C.2	CO_2	Land converted to Grassland	key (L, T2)
5.E	CO_2	Land converted to Settlements	key (L,T2)
5.A.2	CO_2	Land converted to forest land	key (L2, T2)
5.B.2	CO_2	Land converted to cropland	Non-key
5.D	CO_2	Wetlands	Non-key
5.E	CO_2	Settlements remaining Settlements	Non-key
5.A.1	CH_4	Forest land remaining forest land	Non-key
5.A.1	N_2O	Forest land remaining forest land	Non-key
5.B.2	N_2O	Land converted to cropland	Non-key

Table 7.2 Key categories identification in 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 1990–2008 have been assembled based on time series of national land use statistics for forest lands, croplands, grasslands, wetlands and settlement areas. Annual figures for areas in transition between different land uses have been derived by a hierarchy of basic assumptions (informed by expert judgement) of known patterns of land-use changes in Italy as well as the need for the total national area to remain constant. Growth in forest land area as detected by the National Forest Inventories is used as the basis. The rule then assumes that new forest land area can only come from grassland; settlements area can only come from grassland or cropland; new cropland area can only come from grassland area, as new grassland area can only come from cropland area.

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

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

In the following Table 7.3, the land use matrices for each year of the period 1990–2008 are reported.

	1989						
	Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
1990	7,374	9,460	11,015	57	1,340	887	*30,134*
Forest	**7,374**						*7,374*
Grassland	77	**9,460**	12		8		*9,460*
Cropland		0	**11,015**		0		*11,015*
Wetland				**57**			*57*
Settlements					**1,340**		*1,340*
Other Land						**887**	*887*
Final sum	*7,451*	*9,363*	*11,028*	*57*	*1,348*	*887*	30,134

	1990						
	Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
1991	7,451	9,363	11,028	57	1,348	887	*30,134*
Forest	**7,451**						*7,451*
Grassland	77	**9,363**	0		7.0881		*9,363*
Cropland		0	**11,028**		1		*11,028*
Wetland				**57**			*57*
Settlements					**1,348**		*1,348*
Other Land						**887**	*887*
Final sum	*7,528*	*9,279*	*11,027*	*57*	*1,356*	*887*	30,134

	1991						
	Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
1992	7,528	9,279	11,027	57	1,356	887	*30,134*
Forest	**7,528**						*7,528*
Grassland	77	**9,279**	0		7.0881		*9,279*
Cropland		0	**11,027**		1		*11,027*
Wetland				**57**			*57*
Settlements					**1,356**		*1,356*
Other Land						**887**	*887*
Final sum	*7,605*	*9,194*	*11,025*	*57*	*1,365*	*887*	30,134

	1992						
	Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
1993	7,605	9,194	11,025	57	1,365	887	*30,134*
Forest	**7,605**						*7,605*
Grassland	77	**9,194**	0		7		*9,194*
Cropland		0	**11,025**		1		*11,025*
Wetland				**57**			*57*
Settlements					**1,365**		*1,365*
Other Land						**887**	*887*
Final sum	*7,682*	*9,110*	*11,024*	*57*	*1,373*	*887*	30,134

	1993						
	Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
1994	7,682	9,110	11,024	57	1,373	887	*30,134*
Forest	**7,682**						*7,682*
Grassland	77	**9,110**	0		7		*9,110*
Cropland		0	**11,024**		1		*11,024*
Wetland				**57**			*57*
Settlements					**1,373**		*1,373*
Other Land						**887**	*887*
Final sum	*7,759*	*9,026*	*11,023*	*57*	*1,381*	*887*	30,134

	1994						
	Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
1995	7,759	9,026	11,023	57	1,381	887	*30,134*
Forest	**7,759**						*7,759*
Grassland	77	**9,026**	0		7		*9,026*
Cropland		0	**11,023**		1		*11,023*
Wetland				**57**			*57*
Settlements					**1,381**		*1,381*
Other Land						**887**	*887*
Final sum	*7,836*	*8,942*	*11,022*	*57*	*1,389*	*887*	30,134

	1995						
	Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
1996	7,836	8,942	11,022	57	1,389	887	*30,134*
Forest	**7,836**						*7,836*
Grassland	77	**8,942**	0		0		*8,942*
Cropland		104	**11,022**		8		*11,022*
Wetland				**57**			*57*
Settlements					**1,389**		*1,389*
Other Land						**887**	*887*
Final sum	*7,913*	*8,969*	*10,909*	*57*	*1,398*	*887*	30,134

	1996						
	Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
1997	7,913	8,969	10,909	57	1,398	887	*30,134*
Forest	**7,913**						*7,913*
Grassland	77	**8,969**	0		0		*8,969*
Cropland		104	**10,909**		8		*10,909*
Wetland				**57**			*57*
Settlements					**1,398**		*1,398*
Other Land						**887**	*887*
Final sum	*7,990*	*8,997*	*10,797*	*57*	*1,406*	*887*	30,134

	1997						
	Forest	Grassland	Cropland	Wetland	Settlements	Other Land	*Initial sum*
1998	7,990	8,997	10,797	57	1,406	887	*30,134*
Forest	**7,990**						*7,990*
Grassland	77	**8,997**	0		0		*8,997*
Cropland		104	**10,797**		8		*10,797*
Wetland				**57**			*57*
Settlements					**1,406**		*1,406*
Other Land						**887**	*887*
Final sum	*8,067*	*9,024*	*10,684*	*57*	*1,414*	*887*	30,134

	1998						
	Forest	Grassland	Cropland	Wetland	Settlements	Other Land	*Initial sum*
1999	8,067	9,024	10,684	57	1,414	887	*30,134*
Forest	**8,067**						*8,067*
Grassland	77	**9,024**	0		0		*9,024*
Cropland		104	**10,684**		8		*10,684*
Wetland				**57**			*57*
Settlements					**1,414**		*1,414*
Other Land						**887**	*887*
Final sum	*8,144*	*9,051*	*10,572*	*57*	*1,422*	*887*	30,134

	1999						
	Forest	Grassland	Cropland	Wetland	Settlements	Other Land	*Initial sum*
2000	8,144	9,051	10,572	57	1,422	887	*30,134*
Forest	**8,144**						*8,144*
Grassland	77	**9,051**	0		0		*9,051*
Cropland		104	**10,572**		8		*10,572*
Wetland				**57**			*57*
Settlements					**1,422**		*1,422*
Other Land						**887**	*887*
Final sum	*8,221*	*9,079*	*10,459*	*57*	*1,431*	*887*	30,134

	2000						
	Forest	Grassland	Cropland	Wetland	Settlements	Other Land	*Initial sum*
2001	8,221	9,079	10,459	57	1,431	887	*30,134*
Forest	**8,221**						*8,221*
Grassland	77	**9,079**	0		0		*9,079*
Cropland		112	**10,459**		11		*10,459*
Wetland				**57**			*57*
Settlements					**1,431**		*1,431*
Other Land						**887**	*887*
Final sum	*8,298*	*9,113*	*10,336*	*57*	*1,442*	*887*	30,134

	2001						
	Forest	Grassland	Cropland	Wetland	Settlements	Other Land	*Initial sum*
2002	8,298	9,113	10,336	57	1,442	887	*30,134*
Forest	**8,298**						*8,298*
Grassland	77	**9,113**	0		0		*9,113*
Cropland		112	**10,336**		11		*10,336*
Wetland				**57**			*57*
Settlements					**1,442**		*1,442*
Other Land						**887**	*887*
Final sum	*8,375*	*9,148*	*10,213*	*57*	*1,453*	*887*	30,134

		2002						
		Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
	2003	8,375	9,148	10,213	57	1,453	887	*30,134*
2003	**Forest**	**8,375**						*8,375*
	Grassland	77	**9,148**	0		0		*9,148*
	Cropland		112	**10,213**		11		*10,213*
	Wetland				**57**			*57*
	Settlements					**1,453**		*1,453*
	Other Land						**887**	*887*
	Final sum	*8,452*	*9,182*	*10,090*	*57*	*1,464*	*887*	30,134

		2003						
		Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
	2004	8,452	9,182	10,090	57	1,464	887	*30,134*
2004	**Forest**	**8,452**						*8,452*
	Grassland	77	**9,182**	0		0		*9,182*
	Cropland		112	**10,090**		11		*10,090*
	Wetland				**57**			*57*
	Settlements					**1,464**		*1,464*
	Other Land						**887**	*887*
	Final sum	*8,529*	*9,217*	*9,967*	*57*	*1,476*	*887*	30,134

		2004						
		Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
	2005	8,529	9,217	9,967	57	1,476	887	*30,134*
2005	**Forest**	**8,529**						*8,529*
	Grassland	77	**9,217**	0		0		*9,217*
	Cropland		112	**9,967**		11		*9,967*
	Wetland				**57**			*57*
	Settlements					**1,476**		*1,476*
	Other Land						**887**	*887*
	Final sum	*8,606*	*9,252*	*9,844*	*57*	*1,487*	*887*	30,134

		2005						
		Forest	**Grassland**	**Cropland**	**Wetland**	**Settlements**	**Other Land**	*Initial sum*
	2006	8,606	9,252	9,844	57	1,487	887	*30,134*
2006	**Forest**	**8,606**						*8,606*
	Grassland	78	**9,252**	0		0		*9,252*
	Cropland		128	**9,844**		11		*9,844*
	Wetland				**57**			*57*
	Settlements					**1,487**		*1,487*
	Other Land						**887**	*887*
	Final sum	*8,683*	*9,302*	*9,705*	*57*	*1,498*	*887*	30,134

2007	2006 Forest	Grassland	Cropland	Wetland	Settlements	Other Land	*Initial sum*
2007	8,683	9,302	9,705	57	1,498	887	*30,134*
Forest	**8,683**						*8,683*
Grassland	78	**9,302**	0		0		*9,302*
Cropland		128	**9,705**		11		*9,705*
Wetland				**57**			*57*
Settlements					**1,498**		*1,498*
Other Land						**887**	*887*
Final sum	*8,761*	*9,353*	*9,566*	*57*	*1,510*	*887*	30,134

2007	2007 Forest	Grassland	Cropland	Wetland	Settlements	Other Land	*Initial sum*
2008	8,761	9,353	9,566	57	1,510	887	*30,134*
Forest	**8,761**						*8,761*
Grassland	78	**9,353**	0		0		*9,353*
Cropland		128	**9,566**		11		*9,566*
Wetland				**57**			*57*
Settlements					**1,510**		*1,510*
Other Land						**887**	*887*
Final sum	*8,839*	*9,403*	*9,426*	*57*	*1,521*	*887*	30,134

Table 7.3 Land use change matrices for the years 1990-2008

7.2 Forest Land (5A)

7.2.1 Description

Under this category, CO_2 emissions from living biomass, dead organic matter and soils, from forest land remaining forest land and from land converted in forest land have been reported.
Forest land removals share 69% of total CO_2 2008 LULUCF emissions and removals, while the mean forest land removals for the years 1990-2008 is 68% of total mean CO_2 LULUCF emissions and removals; in particular the living biomass removals represent 48%, while the removals from dead organic matter and soils stand for 8% and 43% of total 2008 forest land CO_2 removals, respectively.

Forest Land	**1990**	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
- living biomass	*41*	*45*	*45*	*48*	*50*	*48*	*49*	*49*	*50*	*35*	*48*
- dead organic matter	*9*	*8*	*9*	*9*	*8*	*9*	*8*	*8*	*8*	*10*	*8*
-soils	*50*	*44*	*46*	*44*	*42*	*44*	*43*	*43*	*42*	*56*	*43*

Table 7.4 Percentage contribution of carbon pools to forest land category, in 1990-2008

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 both in level and in trend assessment (Tier 2);
Concerning CH_4 or N_2O emissions, neither forest land nor land converting to forest land have resulted as a key source.

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

In 2010 submission, forest definition adopted by Italy in the framework of application of elected 3.4 activity, under Kyoto Protocol, has been fully implemented also in the LULUCF sector of inventory under the Convention, in order to maintain coherence and congruity between the two forest-related reporting. Therefore plantations and shrublands, that don't fullfill national forest definition, have been moved from forest land category into cropland category (plantations) and in grassland category (shrublands).
For the land use conversion, land use change matrices have been used; as abovementioned, LUC matrices for each year of the period 1990–2008 have been assembled based on time series of national land use statistics for forest lands, croplands, grasslands, wetlands and settlement areas. Annual figures for areas in transition between different land uses have been derived by a hierarchy of basic assumptions (informed by expert judgement) of known patterns of land-use changes in Italy as well as the need for the total national area to remain constant. Growth in forest land area as detected by the First Italian National Forest Inventory (IFN) and the Inventory of Forests and Carbon pools (INFC) was used as the basis. It was assumed that new forest land area can only come from grassland.
The Italian Ministry of Agriculture and Forests (MAF) and the Experimental Institute for Forest Management (ISAFA) carried out the first National Forest Inventory in 1985. As a result of the first IFN based on a regular sampling grid of 3 km by 3 km, the global Italian extent of forest resources was about 8.7 million hectares (MAF/ISAFA, 1988). A second national forest inventory, using a grid of 1 km by 1 km, had been launched in 2001. A first inventory phase, consisting in interpretation of orthophotos, was followed by a ground survey, in order to assess the forest use, and to detect the main attributes of Italian forests. The final result, regarding forest surfaces, has been used (INFC, 2007).

The estimation for 1990 was calculated through a linear interpolation between the 1985 and 2005 data. By assuming that the defined trend may well represent the near future, it was possible to extrapolate data for 2006-2008.
Additional source of information was the National Statistics Institute (ISTAT), which had provided annual data on forest area extent, till 2005. In 2006, the National Statistics Institute has officially recognized the INFC data, suspending the annual assessment on forest area extent.

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

In the current submission, forest definition adopted by Italy in the Framework of Kyoto Protocol has been adopted; the forest definition adopted by Italy agrees with the Food and Agriculture Organization of the United Nations definitions, therefore the threshold values for tree crown cover, land area and tree height are applied:

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

7.2.4 Methodological issues

Forest Land remaining Forest Land
All the data concerning the growing stock and the related carbon are assessed by a model (Federici et al., 2008), estimating the evolution in time of the Italian forest carbon pools, according to the GPG classification and definition: living biomass, both aboveground and belowground, dead organic matter, including dead wood and litter, and soils as soil organic matter.
The model has been applied at regional scale (NUTS2) because of availability of forest-related statistical data: the First Italian National Forest Inventory (IFN) data and the Inventory of Forests and Carbon pools (INFC) were input data for the forest area, per region and inventory typologies[18].
To estimate the growing stock of Italian forest, from 1990 to 2008, 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[19], for each forest typology by the Italian yield tables collection;

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[18]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*
[19] 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 represents the growing stock of the stand, while the dependent variable y is the correspondent increment computed with the Richards function - first derivative.

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

where the general constrain for the parameters are the following:

$$a,k>0 \quad -1 \le v \le \infty \text{ and } v \neq 0$$

The constant y_0 is derived from the data of age and volume reported in the yield tables: more precisely y_0 has the value of the volume for the age 1. After choosing the function, it is fitted to the measurements by non-linear regression. The minimization of

3. starting from 1986, for each year the growing stock per hectare [m^3 ha^{-1}] is computed, from the previous year growing stock volume, with the addition of the calculated increment ("y" value of the derivative Richards) for the current year and subtraction of the losses due to harvest, mortality and fire for the current year.

The relationship can be summarized as follows:

$$v_i = \frac{V_{i-1} + I_i - H_i - F_i - M_i - D_i}{A_i}$$

where:

$$I_i = f(v_{i-1}) \cdot A_{i-1}$$

in which the current increment is estimated year by year applying the 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]); several sources have considered data on biomass removed in commercial harvest published by ISTAT (disaggregated at NUTS2 level, in sectoral statistics (ISTAT, several years [a]) or at NUTS1 level for coppices and high forests in national statistics (ISTAT, several years [c])) underestimated, particularly concerning fuelwood consumption (APAT - ARPA Lombardia, 2007, UNECE – FAO, Timber Committee, 2008, Corona, 2007). In particular a specific survey conducted in the framework of the Inventory of Forests and Carbon pools (INFC) have done a regional assessment of the harvested biomass; these data were used to infer a correction factor, on regional basis, that was applied to the entire time series of commercial harvested wood. The computed figures have been subtracted, as losses, from growing stock volume, as mentioned above.
Carbon amount released by forest fires has been included in the overall assessment of carbon stocks change. Not having data on the fraction of growing stock oxidised as consequence of fires, the most conservative hypothesis has been adopted: all growing stock of burned forest areas has been assumed to be completely oxidised and so released. Moreover, not having data on forest typologies of burned areas, the total value of burned forest area coming from national

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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).

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.
A mismatching of official data, published by national statistics (ISTAT for the period 1990-2005; Italian National Forest Service from 2005 onward), with data published by the National Forest Service[20], the only entity in charge for the detection of the burned are, has been identified for the period 1990-2007. Mismatching are due to burnt areas that weren't classified (as forest, cropland or other land-use) and weren't consequentely reported. A revision process has reclassified all non-classified areas with an ex-post analysis, and an assignment to forest land was decided; resulting data were moreover reported to international entities (FAO-FRA2010). In the table 7.5 data referring to official statistics (ISTAT and National Forest Service) and data published by the National Forest Service, with related differences in absolute and percentage terms, are reported.

year	National Statistics (ISTAT-National Forest Service)	National Forest Service	Differences	
	ha	*ha*	*ha*	*%*
1990	96,157	98,410	2,253	2.3
1991	24,630	30,172	5,542	18.4
1992	40,549	44,522	3,973	8.9
1993	104,385	116,378	11,993	10.3
1994	41,019	47,099	6,080	12.9
1995	18,246	20,995	2,749	13.1
1996	15,008	20,329	5,321	26.2
1997	49,831	62,775	12,944	20.6
1998	58,741	73,017	14,276	19.6
1999	28,136	39,362	11,226	28.5
2000	59,957	58,234	-1,723	-3.0
2001	38,006	38,186	180	0.5
2002	20,218	20,218	0	0
2003	44,202	44,064	-138	-0.3
2004	18,874	20,866	1,992	9.5
2005	19,040	21,470	2,430	11.3
2006	16,422	16,422	0	0
2007	116,602	116,602	0	0

Table 7.5 Burnt areas according to national statistics National Forest Service, in 1990-2007

In Figure 7.3, losses of carbon due to harvest and forest fires, referred to forest land category and reported as percentage on total aboveground carbon, are shown.

[20] Data published by National Forest Service can be downloaded at: http://www3.corpoforestale.it/flex/cm/pages/ServeAttachment.php/L/IT/D/f%252F4%252F5%252FD.ebe1c5fcbc80652b4386/P/BLOB%3AID%3D340

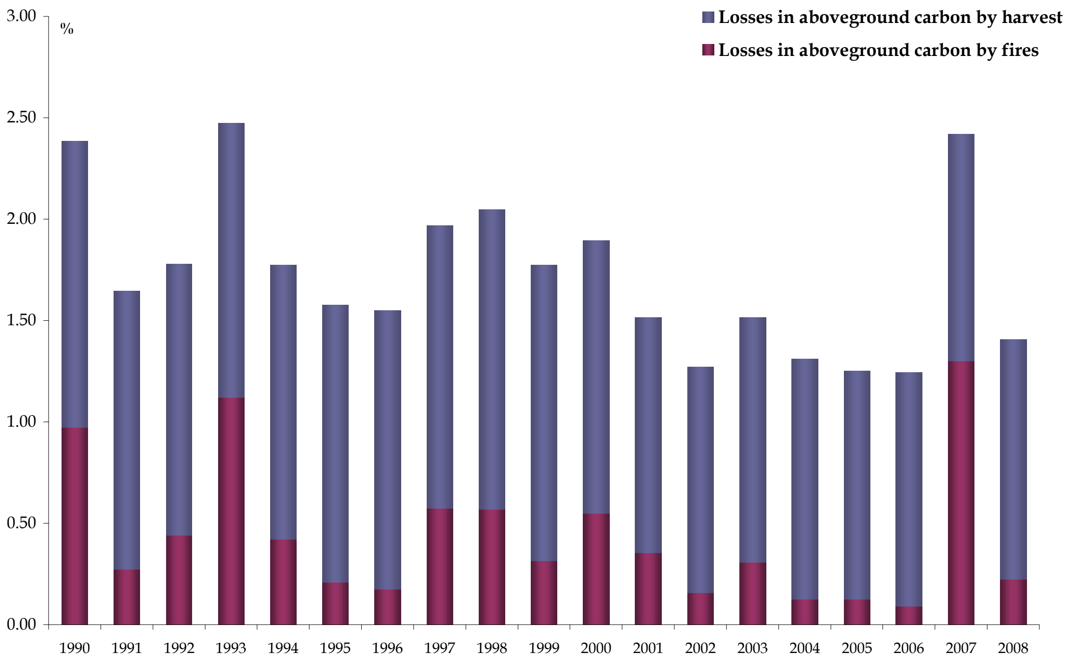

Figure 7.3 Losses by harvest and fires in relation to aboveground carbon

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

Year	**burned growing stock** *m^3*				**CO_2 released** *Gg*			
	stands	*coppice*	*protective*	*total*	*stands*	*coppice*	*protective*	*total*
1990	3,084,872	4,576,069	1,234,804	8,895,745	3,845	6,637	1,867	12,349
1991	904,285	1,134,048	414,816	2,453,149	1,129	1,642	627	3,398
1992	1,379,188	2,066,338	685,507	4,131,032	1,724	2,986	1,035	5,746
1993	3,947,394	4,011,861	1,739,571	9,698,826	4,938	5,789	2,624	13,351
1994	1,559,115	951,504	839,029	3,349,649	1,953	1,371	1,265	4,589
1995	694,318	1,196,839	266,702	2,157,859	871	1,722	402	2,995
1996	828,297	671,402	250,083	1,749,782	1,041	964	377	2,382
1997	2,224,862	2,999,851	751,992	5,976,705	2,800	4,304	1,132	8,237
1998	2,216,585	2,282,005	1,075,197	5,573,788	2,794	3,270	1,618	7,682
1999	891,669	1,615,923	511,254	3,018,845	1,126	2,313	769	4,208
2000	2,616,743	2,136,041	925,756	5,678,541	3,306	3,054	1,392	7,753
2001	1,636,143	1,503,021	612,685	3,751,848	2,070	2,147	921	5,137
2002	562,225	938,074	330,710	1,831,008	712	1,339	497	2,548
2003	1,085,231	1,595,838	595,853	3,276,922	1,376	2,275	895	4,546
2004	492,440	706,102	317,168	1,515,710	625	1,005	476	2,107
2005	389,649	849,656	307,450	1,546,755	495	1,209	461	2,166
2006	314,516	618,838	219,441	1,152,795	400	879	329	1,609
2007	7,148,996	5,939,606	2,325,931	15,414,533	9,104	8,432	3,489	21,025
2008	1,281,407	984,466	442,229	2,708,102	1,634	1,396	663	3,694

Table 7.6 Burned growing stocks and CO_2 released for the years 1990-2008

Once the growing stockis estimated, the amount of aboveground tree biomass (dry matter), belowground biomass (dry matter) and dead mass (dry matter), can be assessed, from 1990 to 2008. In the following, the default value of carbon fraction of dry matter (0.5 t d.m.) has been applied to obtain carbon amount from biomass.

With regard to the aboveground biomass:

1. starting from the 1985 growing stock data, reported in the IFN, the amount of aboveground woody tree biomass (d.m) [t] was calculated, for every forest typology, through the relation:

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

   where:
   GS = volume of growing stock (MATT/ISAFA, 1988) [m^3 ha-^{1}]
   BEF = Biomass Expansion Factors which expands growing stock volume to volume of aboveground woody biomass (ISAFA, 2004)
   WBD = Wood Basic Density for conversions from fresh volume to dry weight (d.m) [t m^{-3}] (Giordano, 1980)
   A = forest area occupied by specific typology [ha] (MATT/ISAFA, 1988)

   The BEF were derived for each forest typology and wood basic density (WBD) values were different for the main tree species:
2. starting from 1985, for each year, current increment per hectare [m^3 ha-^{1} y^{-1}] is computed with the derivative Richards function, for every specific forest typology by the Italian yield tables collection;
3. starting from 1986, for each year growing stock per hectare [m^3 ha^{-1}] is computed, from the previous year growing stock volume, adding the calculated increment ("y" value of the derivative Richards) for the current year and subtracting losses due to harvest, mortality and fire for the current year, as described above.
   Re-applying the relation:

   $$\text{Aboveground tree biomass} = GS \cdot BEF \cdot WBD \cdot A$$

   it is possible to obtain the aboveground woody tree biomass (d.m) [t] for each forest typology, for each year, starting from the 1986.

In Table 7.7 biomass expansion factors for the conversions of volume to aboveground tree biomass and wood basic densities are reported.

	Inventory typology	BEF *aboveground biomass / growing stock*	WBD *Dry weigth t/ fresh volume*
stands	norway spruce	1.29	0.38
	silver fir	1.34	0.38
	larches	1.22	0.56
	mountain pines	1.33	0.47
	mediterranean pines	1.53	0.53
	other conifers	1.37	0.43
	european beech	1.36	0.61
	turkey oak	1.45	0.69
	other oaks	1.42	0.67
	other broadleaves	1.47	0.53
coppices	european beech	1.36	0.61
	sweet chestnut	1.33	0.49
	hornbeams	1.28	0.66
	other oaks	1.39	0.65
	turkey oak	1.23	0.69
	evergreen oaks	1.45	0.72
	other broadleaves	1.53	0.53
	conifers	1.38	0.43
protective	rupicolous forest	1.44	0.52
	riparian forest	1.39	0.41

Table 7.7 Biomass Expansion Factors and Wood Basic Densities

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

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

where:
GS = volume of growing stock [m^3 ha^{-1}]
R = Root/Shoot ratio which converts growing stock biomass in belowground biomass
WBD = Wood Basic Density [t d.m. m^{-3}]
A = forest area occupied by specific typology [ha]
Also in this case, the BEFs and WBDs were derived for each forest typology:

	Inventory typology	R *Root/shoot ratio*	WBD *Dry weigth t/ fresh volume*
stands	norway spruce	0.29	0.38
	silver fir	0.28	0.38
	Larches	0.29	0.56
	mountain pines	0.36	0.47
	mediterranean pines	0.33	0.53
	other conifers	0.29	0.43
	european beech	0.20	0.61
	turkey oak	0.24	0.69
	other oaks	0.20	0.67
	other broadleaves	0.24	0.53
coppices	european beech	0.20	0.61
	sweet chestnut	0.28	0.49
	Hornbeams	0.26	0.66
	other oaks	0.20	0.65
	turkey oak	0.24	0.69
	evergreen oaks	1.00	0.72
	other broadleaves	0.24	0.53
	Conifers	0.29	0.43
protective	rupicolous forest	0.42	0.52
	riparian forest	0.23	0.41

Table 7.8 Root/Shoot ratio and Wood Basic Densities

The net carbon stock change of living biomass has been calculated according to the GPG for LULUCF (IPCC, 2003), from the aboveground tree biomass and belowground biomass:

$$\Delta C_{\text{Living biomass}} = \Delta C_{\text{Aboveground biomass}} + \Delta C_{\text{Belowground biomass}}$$

where the total amount of carbon has been obtained from the biomass (d.m.), multiplying by the conversion factor carbon content / dry matter.

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

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

where:
GS = volume of growing stock [m^3 ha^{-1}]
BEF = Biomass Expansion Factors which expands growing stock volume to volume of aboveground woody biomass
WBD = Wood Basic Density [t d.m. m^{-3}]
DCF = Dead mass Conversion Factor which converts aboveground woody biomass in dead mass
A = forest area occupied by specific typology [ha]

The total litter carbon amount is estimated from the aboveground carbon amount with linear relations, deduced from the results of the European project CANIF[21] (*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 7.9 the different relations used to obtain litter carbon amount per ha [t C ha^{-1}] from the aboveground carbon amount per ha [t C ha^{-1}] have been reported:

	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	$y = 0.0659 \cdot x + 1.5045$
protective	rupicolous forest	$y = -0.0165 \cdot x + 7.3285$
	riparian forest	$y = -0.0299 \cdot x + 9.3665$

Table 7.9 Relations litter - aboveground carbon per ha

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

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

The total amount of carbon for dead organic matter has been obtained from the dead organic matter (d.m.), multiplying by the conversion factor carbon content / dry matter.

The total soil carbon amount is estimated from the aboveground carbon amount, with linear relations, deduced from national CONECOFOR Programme data (Corpo Forestale, 2005; Cutini, 2002), per forestry use – stands (resinous, broadleaves, mixed stands) and coppices. In Table 7.10 the different relations used to obtain soil carbon amount per ha [t C ha^{-1}] from the aboveground carbon amount per ha [t C ha^{-1}] have been reported:

[21] CANIF project: http://www.bgc-jena.mpg.de/bgc-processes/research/Schulze_Euro_CANIF.html

	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	$y = 0.4041 \cdot x + 57.874$
protective	rupicolous forest	$y = 0.7647 \cdot x + 33.638$
	riparian forest	$y = 0.9843 \cdot x + 5.0746$

Table 7.10 Relations soil - aboveground carbon per ha

Land converted in Forest Land

The area of land converted to forest land is always coming from grassland. There is no occurrence for other conversion. Carbon stocks change due to grassland converting to forest land has been estimated and reported.

The carbon stock change of living biomass has been calculated taking into account the increase and the decrease of carbon stock related to the areas in transition to forest land. Net carbon stock change in dead organic matter and soil has been calculated as well. SOC reference value for grassland has been 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 7.11 carbon stock changes due to conversion to forest land, for the living biomass, dead organic matter and soil pools, have been reported:

	Carbon stock change in living biomass			Net C stock change in dead organic matter	Net C stock change in mineral soils
	Increase	*Decrease*	*Net change*		
year			*Gg C*		
1990	197.8	-151.1	46.7	10.3	148.4
1991	198.5	-122.0	76.5	13.8	163.7
1992	199.0	-128.2	70.8	13.2	176.1
1993	199.2	-157.7	41.6	10.4	175.4
1994	199.6	-129.1	70.4	13.4	187.2
1995	199.9	-121.4	78.5	13.9	203.7
1996	200.2	-122.9	77.2	13.6	219.8
1997	200.4	-141.5	58.8	11.4	228.6
1998	200.4	-144.6	55.8	11.1	235.4
1999	200.5	-133.3	67.2	12.7	247.7
2000	200.7	-141.0	59.7	11.8	255.9
2001	200.9	-126.8	74.1	13.3	270.9
2002	201.1	-116.2	84.8	14.4	290.1
2003	201.2	-129.7	71.5	12.9	304.2
2004	201.3	-121.7	79.7	13.8	322.0
2005	201.5	-119.8	81.7	13.9	340.6
2006	201.5	-119.9	81.6	13.8	361.4
2007	204.0	-177.9	26.1	7.7	354.2
2008	203.8	-130.1	73.7	12.6	368.3

Table 7.11 Carbon stock changes in land converting to forest land

CO_2 emissions due to wildfires in forest land remaining forest land are included in Table 5.A.1, carbon stocks change in living biomass, decrease.
Values of burned growing stocks and respective CO_2 released, for different categories (stands, coppices, protective forests), are reported in the previous Table 7.6.

7.2.5 Uncertainty and time-series consistency

Estimates of removals by forest land are based on application of the above-described model. To assess the overall uncertainty related to the year 1990–2008, 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 7.12 the relations for assessing the overall uncertainties associated to the carbon pools have been reported:

Carbon pool	Relation for uncertainty assessing
Aboveground	$E_{AG_{1985}} = \sqrt{E_{NFI}^2 + E_{BEF_1}^2 + E_{BD}^2 + E_{CF}^2}$
Belowground	$E_{BG_{1985}} = \sqrt{E_{NFI}^2 + E_{BEF_2}^2 + E_{BD}^2 + E_{CF}^2}$
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 7.12 Relations for assessing uncertainties of the C pools

where the term E_{NFI} stands for the uncertainty associated to the growing stock data given by the first National Forest Inventory, E_{BEF_1} points to uncertainty related to biomass expansion factors for the aboveground biomass, E_{BD} is the basic density uncertainty and the term E_{CF} indicates the conversion factor uncertainty, where GPG default values have been used (IPCC, 2003). In the relation for the belowground carbon pool, the term E_{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[22] 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 7.13, the values of carbon stocks in the five pools, for the 1985, and the abovementioned uncertainties are reported:

[22] 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)[23]	E_{NFI}	51.6%
	Harvest[24]	E_H	30%
	Fire[25]	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 7.13 Carbon stocks and uncertainties for year 1985 and current increment related uncertainty

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

Aboveground biomass	E_{AG}	42.59%
Belowground biomass	E_{BG}	42.59%
Dead mass	E_D	52.10%
Litter	E_L	161.22%
Soil	E_S	152.05%
Overall uncertainty	$\mathbf{E_{1985}}$	**84.91%**

Table 7.14 Uncertainties for the year 1985

The overall uncertainty related to 1985 (the year of the first National Forest Inventory) has been propagated through the years, till 2008, 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:

[23] 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
[24] Good Practice Guidance default value (IPCC, 2003)
[25] 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 7.15:

Aboveground biomass	E_{AG}	42.68%
Belowground biomass	E_{BG}	42.68%
Dead mass	E_D	52.17%
Litter	E_L	161.22%
Soil	E_S	152.05%
Overall uncertainty	E_{1986}	84.81%

Table 7.15 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 7.16 the uncertainties of the 1985-2008 period are reported.

1985	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008
					%						
84.9	88.2	87.7	87.2	87.07	86.87	86.7	86.59	86.4	86.3	86.3	86.3

Table 7.16 Overall uncertainties 1985 - 2008

The overall uncertainty in the model estimates between 1990 and 2008 has been assessed with the following relation:

$$E_{1990-2008} = \frac{\sqrt{(E_{1990}\cdot V_{1990})^2+(E_{2008}\cdot V_{2008})^2}}{\left|V_{1990}+V_{2008}\right|}$$

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 1990–2008 is equal to 61.69%. The table reporting the uncertainties referring to all the categories (Forest Land, Cropland, Grassland, Wetlands, Settlements, Other Land) is shown in Annex 1.
A comparison between carbon in the aboveground biomass pool, estimated with the described methodology, and INFC data about 2006 aboveground carbon stock of the whole Italian forest results in 11% difference (Table 7.17).

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

Table 7.17 Comparison between estimated and INFC preliminary 2006 aboveground carbon stock

7.2.6 Category-specific QA/QC and verification

Systematic quality control activities have been carried out in order to ensure completeness and consistency in time series and correctness in the sum of sub-categories; where possible, activity data comparison among different sources (FAO database[26], ISTAT data[27]) 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[28], 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.

7.2.7 Category-specific recalculations

Recalculations of emissions and removals have been carried out on the basis of the IPCC Good Practice Guidance for LULUCF (IPCC, 2003). Several differences from previous submissions are caused by the implementation of forest definitions and Kyoto rules, in order to be coherent with the reporting of the additional information under art. 3.3 and 3.4 of Kyoto Protocol. Specifically reallocation of the plantantions (in cropland category) and shrubland (in grassland category) have produced remarkable changes in the reported forested areas, and, consequently, in C stock changes, for the different pools.
Moreover the application of correction factor to harvest data and revision of time series of areas covered by fires have resulted in a deviation of estimated carbon stock changes from previous submissions.
Deviations from the prevoius sectoral estimates are equal to an average decrease of 29%, concerning the whole forest land category. As well regards the different carbon pools, a decrease of 30% in living biomass pool of 26% in dead organic matter and 29% in soils carbon pools estimates, have to be noticed, as shown in the Figure 7.4.

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[26] FAO, 2005. FAOSTAT, http://faostat.fao.org
[27] ISTAT, several years [a], [b], [c]
[28] INEMAR: INventario EMissioni Aria: http://www.ambiente.regione.lombardia.it/inemar/e_inemarhome.htm

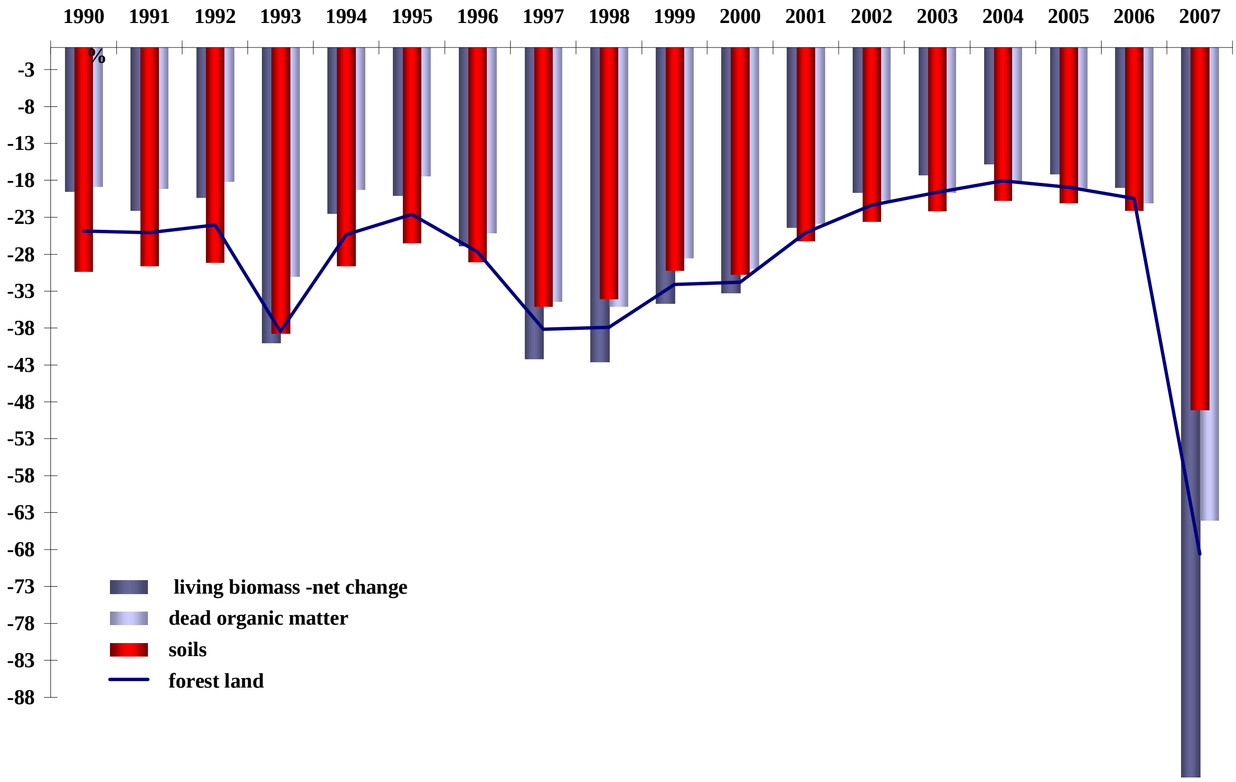


Figure 7.4 Difference between current and 2007 submission carbon pools estimates

7.2.8 Category-specific planned improvements

The INFC data related to the soils survey, expected at the end of 2010, will definitely constitute a robust database, allowing for refined estimates and lower related uncertainty. The 'National Registry for Carbon sinks', instituted by a Ministerial Decree on 1st April 2008, is part of National Greenhouse Gas Inventory System in Italy (ISPRA, 2010 [a]) and includes information on units of lands subject of activities under Article 3.3 and activities elected under Article 3.4 and related carbon stock changes. The National Registry for Carbon sinks is the instrument to estimate, in accordance with the COP/MOP decisions, the IPCC Good Practice Guidance on LULUCF and every relevant IPCC guidelines, the greenhouse gases emissions by sources and removals by sinks in forest land and related land-use changes and to account for the net removals in order to allow the Italian Registry to issue the relevant amount of RMUs. In 2009, a technical group, formed by experts from different istitutions (ISPRA; Ministry of the Environment, Land and Sea; Ministry of Agriculture, Food and Forest Policies and University of Tuscia), set up the methodological plan of the activities necessary to implement the registry and defined the relative fundings. Some of these activies which are planned to be completed by 2010, are expected to supply data useful to update and improve the estimations. Activities planned in the framework of the National Registry for Forest Carbon Sinks should also provide data to improve estimate of carbon sequestration due to Afforestation/reforestation activities (with a special focus on soil organic content), and should allow to refine the estimate of forest land category. Specifically, for the LULUCF sector, following the election of 3.4 activities and on account of an in-depth analysis on the information needed to report LULUCF under the Kyoto Protocol, a Scientific Committee, *Comitato di Consultazione Scientifica del Registro dei Serbatoi di Carbonio Forestali*, constituted by the relevant national experts has been established by the Ministry for the Environment, Land and Sea in cooperation with the Ministry of Agriculture, Food and Forest Policies.

An expert panel on forest fires has been set up, in order to obtain geographically referenced data on burned area; the overlapping of land use map and georeferenced data should assure the

estimates of burned areas in the different land uses. The fraction of CO_2 emissions due to forest fires, now included in the estimate of the forest land remaining forest land, will be pointed out.
In addition to these expert panels, ISPRA participates in technical working groups, denominated *Circoli di qualità*, within the National Statistical System (Sistan). Concerning LULUCF sector, this group, coordinated by the National Institute of Statistics, is constituted by both producers and users of statistical information with the aim of improving and monitoring statistical information for forest sector. These activities should improve the quality and details of basic data, as well as enable a more organized and timely communication.
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 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 14.1% of total CO_2 LULUCF emissions and removals, in particular the living biomass removals represent 95%, while the emissions and removals from soils stand for 5% 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 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

In 2010 submission, forest definition adopted by Italy in the framework of application of elected 3.4 activity, under Kyoto Protocol, has been fully implemented also in the LULUCF sector of inventory under the Convention, in order to maintain coherence and congruity between the two forest-related reporting. As a consequence, plantations, that don't fullfill national forest definition, have been moved from forest land category into cropland category.
For the land use conversion, land use change matrices have been used; as abovementioned, LUC matrices for each year of the period 1990–2008 have been assembled based on time series of national land use statistics for forest lands, croplands, grasslands, wetlands and settlement areas. Annual figures for areas in transition between different land uses have been derived by a hierarchy of basic assumptions (informed by expert judgement) of known patterns of land-use changes in Italy as well as the need for the total national area to remain constant. Concerning cropland category, it has been assumed that only transition from grassland to cropland occurs.
In response to ERT remark in the last review, land use changes have been derived, by the way of LU matrices, smoothing the amount of changes over a 5 year period, harmonizing the whole time series, resulting in a constant amount of C stock change in the 5 year period.

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

Cropland areas have been determinated on the basis of nationa statistics (ISTAT, [b], [c]) related to annual crops and perennial woody crops. The subcategory “plantations” has been added; plantation areas have been derived from national forest inventories (IFN, IFNC), through a linear interpolation between the 1985 and 2005 data, extrapolating data for period 2006-2008. National statistics on cropland areas have been used, in order to derive the land in conversion from grassland to cropland, by the way of LU matrix, following the assumption that transition into cropland category occurs only from grassland category.

7.3.4 Methodological issues

Cropland remaining Cropland

Cropland includes all annual and perennial crops; the change in biomass has been estimated only for perennial crops, since, for annual crops, the increase in biomass stocks in a single year is assumed equal to biomass losses from harvest and mortality in that same year. Activity data for cropland remaining cropland have been subdivided into annual and perennial crops. The perennial crops have been further subdivided into woody crops and plantations.

Perennial – woody crops

Concerning woody crops, estimates of carbon stocks changes are applied to aboveground biomass only, according to the GPG (IPCC, 2003), as there is not sufficient information to estimate carbon stocks change in dead organic matter pools. To assess change in carbon in cropland biomass, the Tier 1 based on highly aggregated area estimates for generic perennial woody crops, has been used; therefore default factors of aboveground biomass carbon stock at harvest, harvest/maturity cycle, biomass accumulation rate, biomass carbon loss, for the temperate climatic region have been applied, even though they are not very representative of the Mediterranean area, where the most common woody crops are crops like olive groves or vineyards that have, for instance, different harvest/maturity cycles.

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

Net changes in cropland C stocks obtained are equal to 4.693 Tg C for 1990, and 3.033 Tg C for 2008, as far as living biomass pool is concerned.

According to the LULUCF GPG (IPCC, 2003), the change in soil C stocks (Equation 3.3.4) is the result of a change in practices or management between the two time periods and concentration of soil carbon is only driven by the change in practice or management. It wasn’t possible to point out different sets of relative stock change factors [F_{LU} (land use), F_{MG} (management), F_I (input factor)] for the period 1990-2008 under investigation; therefore, as no management changes can be documented, resulting change in carbon stock has been reported as zero.

Perennial – plantations

Regarding plantations, growing stock and the related carbon are assessed by a model (Federici et al., 2008), estimating the evolution in time of the different pools and applied at regional scale (NUTS2). A detailed description of the model is reported in the par. 7.2.4. Total harvested wood for construction and energy purposes has been obtained from national statistics (ISTAT, several years [a]); these figures have been subtracted, as losses, from growing stock volume, as mentioned above.

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

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

where:
GS = volume of growing stock (MATT/ISAFA, 1988) [m^3 ha^{-1}]
BEF = Biomass Expansion Factors which expands growing stock volume to volume of aboveground woody biomass (ISAFA, 2004)
WBD = Wood Basic Density for conversions from fresh volume to dry weight (d.m) [t m^{-3}] (Giordano, 1980)
A = area occupied by specific typology [ha] (MATT/ISAFA, 1988)

In Table 7.18 biomass expansion factors for the conversions of volume to aboveground tree biomass and wood basic densities are reported.

	Inventory typology	BEF *aboveground biomass / growing stock*	WBD *Dry weigth t/ fresh volume*
plantations	eucalyptuses coppices	1.33	0.54
	other broadleaves coppices	1.45	0.53
	poplars stands	1.24	0.29
	other broadleaves stands	1.53	0.53
	conifers stands	1.41	0.43
	others	1.46	0.48

Table 7.18 Biomass Expansion Factors and Wood Basic Densities for plantations

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

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

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

In Table 7.19 Root/shoot ratio for the conversion of growing stock biomass in belowground biomass and wood basic densities for plantations typologies are reported.

	Inventory typology	R *Root/shoot ratio*	WBD *Dry weigth t/ fresh volume*
Plantations	eucalyptuses coppices	0.43	0.54
	other broadleaves coppices	0.24	0.53
	poplars stands	0.21	0.29
	other broadleaves stands	0.24	0.53
	conifers stands	0.29	0.43

Table 7.19 Root/Shoot ratio and Wood Basic Densities for plantations

Concerning Dead Organic Matter pool, only carbon amount contained in litter pool has been estimated, through linear relation established with aboveground carbon, on the basis of the outcomes of CANIF[29] project. 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). In Table 7.20 the different relations used to obtain soil carbon amount per ha [t C ha^{-1}] from the aboveground carbon amount per ha [t C ha^{-1}] have been reported.

	Inventory typology	Relation litter – aboveground C per ha	Relation soil – aboveground C per ha
plantations	eucalyptuses coppices	$y = -0.0299 \cdot x + 9.3665$	$y = 0.3922 \cdot x + 65.356$
	other broadleaves coppices	$y = -0.0299 \cdot x + 9.3665$	$y = 0.3922 \cdot x + 65.356$
	poplars stands	$y = -0.0299 \cdot x + 9.3665$	$y = 0.9843 \cdot x + 5.0746$
	other broadleaves stands	$y = -0.0299 \cdot x + 9.3665$	$y = 0.9843 \cdot x + 5.0746$
	conifers stands	$y = 0.0659 \cdot x + 1.5045$	$y = 0.4041 \cdot x + 57.874$

Table 7.20 Relations litter - aboveground carbon per ha and soil - aboveground carbon per ha for plantations

In table 7.21, plantations areas and net changes in carbon stock, for the different required pools, are reported, for the period 1990-2008.

	Area	Living biomass			Dead organic matter	Soil organic matter
		Increase	Decrease	Net Change		
	kha			*Gg C*		
1990	142	889	-304	585	1.9	474
1991	144	874	-326	548	3.0	443
1992	146	866	-353	513	4.0	414
1993	147	868	-366	502	2.4	415
1994	149	864	-395	468	4.0	384
1995	151	862	-421	440	6.2	353
1996	152	863	-363	499	4.7	400
1997	154	851	-379	472	5.5	376
1998	156	841	-411	430	5.8	347
1999	157	846	-467	379	7.2	306
2000	159	842	-408	434	6.1	348
2001	161	822	-323	498	4.9	398
2002	162	808	-326	482	6.0	381
2003	164	793	-323	470	5.6	373
2004	166	777	-324	453	6.9	354
2005	167	756	-311	445	7.3	346
2006	169	741	-348	393	8.7	296
2007	170	713	-371	343	8.1	271
2008	172	691	-312	379	9.2	284

Table 7.21 Change in carbon stock in living biomass, dead organic matter and soil organic matter in plantations

[29] CANIF project: http://www.bgc-jena.mpg.de/bgc-processes/research/Schulze_Euro_CANIF.html

CO_2 emissions from cultivated organic soils (CRPA, 1997) in cropland remaining cropland have been estimated, using default emission factor for warm temperate, reported in Table 3.3.5 of IPCC GPG; the IPCC default EF for cultivated organic soils is equal to 10 t C ha^{-1} y^{-1}.
CO_2 emissions from urea application have been estimated, and reported in the following Table 7.22; it has to be noticed that CRF Reporter doesn't allow to input such a contribution to overall emissions, and therefore these emissions are not included in the current submission.

	amount of urea	**EF**	**C emissions**	**CO_2 emissions**
	Mg	*t C^{-1}*	*Gg C*	*Gg C*
1990	633,873	0.20	127	465
1991	708,148	0.20	142	519
1992	731,357	0.20	146	536
1993	848,043	0.20	170	622
1994	802,345	0.20	160	588
1995	698,251	0.20	140	512
1996	598,943	0.20	120	439
1997	716,463	0.20	143	525
1998	717,711	0.20	144	526
1999	751,223	0.20	150	551
2000	716,412	0.20	143	525
2001	799,064	0.20	160	586
2002	863,113	0.20	173	633
2003	770,412	0.20	154	565
2004	785,515	0.20	157	576
2005	691,255	0.20	138	507
2006	735,487	0.20	147	539
2007	732,213	0.20	146	537
2008	679,390	0.20	136	498

Table 7.22 CO_2 emissions from urea application

Land converted to Cropland

In accordance with the GPG methodology, estimates of carbon stock change in living biomass have been provided, since there is not sufficient information to estimate carbon stock change in dead organic matter pool. Concerning soil carbon pool, changes in carbon stocks associated with the transitions have been reported as a whole in a single year (i.e. the year of conversion): dynamics of soil carbon storage and release are complex and still not well understood, even if current approaches assume that after a cultivation of a forest or grassland, there is an initial carbon loss over the first years which rapidly reduces to a lower subsequent loss rate in the following years (Davidson and Ackerman 1993). On this basis and by considering the spatial resolution of data used, reasonable approach, in calculating the effect of transition to cropland, is assuming that the changes in carbon stocks occur in the first year after the land conversion, in spite of considering them over the time period (20 years as default) specified by IPCC GPG LULUCF (2003).
N_2O emissions arising from the conversion of land to cropland have been also estimated, and reported in Table 5(III) - N_2O emissions from disturbance associated with land-use conversion to cropland.
The carbon stocks change, for land converted to cropland, is equal to the carbon stocks change due to the removal of biomass from the initial land use plus the carbon stocks from one year of growth in cropland following the conversion.

The Tier 1 has been followed, assuming that the amount of biomass is cleared and some type of cropland system is planted soon thereafter. At Tier 1, carbon stocks in biomass immediately after the conversion are assumed to be zero.
The average area of land undergoing a transition from non cropland, only grassland as far as Italy is concerned, to cropland, during each year, from 1990 to 2008, has been estimated through the construction of the land use change matrices, one for each year. The GPG equation 3.3.8 (IPCC, 2003) has been used to estimate the change in carbon stocks resulting from the land use change.
The carbon stocks change per area for land converted to cropland is assumed, following the Tier1, equal to loss in carbon stocks in biomass immediately before conversion to cropland.
For the Italian territory, only conversion from grassland to cropland has occurred; therefore the default estimates for standing biomass grassland, as dry matter, reported in Table 3.4.2 of GPG (IPCC, 2003) for warm temperate – dry have been used, equal to 1.6 t d.m. ha^{-1}. Changes in carbon stocks from one year of cropland growth have been obtained by the default biomass carbon stocks reported in Table 3.3.8, for temperate region. In accordance to national expert judgement, it has been assumed that the final crop type, for the areas of transition land, is annual cropland.
As pointed out in the land use matrices reported above, in Table 7.3, conversion of lands into cropland has taken place only in a few years during the period 1990- 2008. C emissions [Gg C] due to change in carbon stocks in living biomass in land converted to cropland, are reported in Table 7.23.

	Conversion Area	**$\Delta C_{converted\ land}$**
year	*kha*	*Gg C*
1990	12.3	15.98
1991	0	0
1992	0	0
1993	0	0
1994	0	0
1995	0	0
1996	0	0
1997	0	0
1998	0	0
1999	0	0
2000	0	0
2001	0	0
2002	0	0
2003	0	0
2004	0	0
2005	0	0
2006	0	0
2007	0	0
2008	0	0

Table 7.23 Change in carbon stock in living biomass in land converted to cropland

Changes in carbon stocks in mineral soils in land converted to cropland have been estimated following land use changes, resulting in a change of the total soil carbon content. Initial land use soil carbon stock [$SOC_{(0-T)}$] and soil carbon stock in the inventory year [SOC_0] for the cropland area have been estimated from the reference carbon stocks.
SOC reference value for cropland has been set to 56.7 tC/ha on the basis of reviewed references. It replaces the previous value (44.5 tC/ha) set for cropland and grassland according to an expert judgement. This value has been drawn up by analysing a collection of the latest papers reporting

data on soil carbon under the most common agricultural practices in Italy, including woody cropland cultivations such as vineyards and olive orchards (Triberti *et al* 2008, Ceccanti *et al* 2008, Monaco *et al* 2008, Martiniello 2007, Lugato and Berti 2008, Francaviglia 2006, IPLA 2007, ERSAF 2008, Del Gardo *et al* 2003, Puglisi *et al*, 2008, Lagomarsino *et al* 2009, Perucci *et al* 2008).

Whenever the soil carbon stock was not reported in the papers, it has been calculated at the default depth of 30 cm from the soil carbon content, the bulk density, and the stoniness according to the following formula (Batjes 1996):

$$T_d = \sum_{i=1}^{K} \rho_i \cdot P_i \cdot D_i \cdot (1 - S_i)$$

where T_d is the overall soil carbon stock (gcm^{-2}) and, for each K layer of the soil profile, ρ_i is the soil bulk density (gcm^{-3}), P_i is the soil carbon content (gCg^{-1}), D_i is the layer thickness (cm), S_i is the 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):

$$\rho = \frac{100}{\left(\frac{X}{\rho_0}\right) + \left(\frac{100 - X}{\rho_m}\right)}$$

where ρ, soil bulk density (gcm^{-3}); *X*, percent by weight of organic matter; ρ_0, average bulk density of organic matter (0.224 gcm^{-3}) and ρ_m, bulk density of the mineral matter usually estimated at 1.33 gcm^{-3} or determined on the “mineral bulk density chart” (Rawls and Brakensiek, 1985).

Since soil carbon stocks are derived from experimental measurements under some representative cropland managements, the effect of the practices is intended to be included into the values and consequently no stock change factors (F_{LU}, F_{MG}, F_I) have been applied on the soil carbon stock. Each soil carbon stock was assigned to the geographical area where the relative soil carbon content has been measured and the overall values have been averaged by means of weights resulting from the proportional relevance of the investigated area (ha) over the entire Italian territory.

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 7.24.

year	Conversion Area *k ha*	Carbon stock *Gg C*
1990	12.30	-173.6
1991	0	0
1992	0	0
1993	0	0
1994	0	0
1995	0	0
1996	0	0
1997	0	0
1998	0	0
1999	0	0
2000	0	0
2001	0	0
2002	0	0
2003	0	0
2004	0	0
2005	0	0
2006	0	0
2007	0	0
2008	0	0

Table 7.24 Change in carbon stock in soil in land converted to cropland

7.3.5 Category-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 on the basis of changes in management practices have been deleted because not related to a real change in carbon content in soils. Notable deviations from the previous sectoral estimates occurred, essentially due to inclusion, in cropland category, of plantations, previously reported in forest land category. Reporting of CO_2 emissions from lime application have a very limited effect on the overall emissions and removals of the category. The comparison with the previous sectoral estimates results in mean increase of 26.3% in cropland category, in the period 1990-2007.

7.3.6 Category-specific planned improvements

Additional researches will be made to collect more country-specific data on woody crops. Improvements will concern the implementation of the estimate of carbon change in cropland biomass at a higher 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 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 12,671 Gg of CO_2 removals in 2008, with 1,041 Gg of CO_2 removals due to living biomass poo, 743 Gg CO_2 removals due to dead organic matter pool and 10,886 Gg of CO_2 removals due the soils pool. In the period 1990-2008 mean grassland emissions share 13.5% of absolute CO_2 LULUCF emissions and removals, in particular the living biomass emissions represent 8%, while the removals from dead organic matter pool share for 6% and removals from soils stand for 86% of absolute total grassland CO_2 emissions and removals.
CO_2 emissions and removals from grassland remaining grassland have been identified as key category in level and in trend assessment (Tier 1), while CO_2 emissions and removals from land converting to grassland have resulted as key category at Tier 1, concerning level analysis, and at Tier 2 relating to trend assessment. Concerning N_2O emissions, the category land converting to cropland has not resulted as a key source.

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

In 2010 submission, forest definition adopted by Italy in the framework of application of elected 3.4 activity, under Kyoto Protocol, has been fully implemented also in the LULUCF sector of inventory under the Convention, in order to maintain coherence and congruity between the two forest-related reporting. As a consequence, shrublands, that don't fullfill national forest definition, have been moved from forest land category into grassland category.
For the land use conversion, land use change matrices have been used; as mentioned above, LUC matrices for each year of the period 1990–2008 have been assembled based on time series of national land use statistics for forest lands, croplands, grasslands, wetlands and settlement areas. Annual figures for areas in transition between different land uses have been derived by a hierarchy of basic assumptions (informed by expert judgement) of known patterns of land-use changes in Italy as well as the need for the total national area to remain constant. Concerning grassland category, it has been assumed that only transition from cropland to grassland occurs.
In response to ERT remark in the last review, land use changes have been derived, by the way of LU matrices, smoothing the amount of changes over a 5 year period, harmonizing the whole time series, resulting in a constant amount of C stock change in the 5 year period.

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

Grassland areas have been determinated on the basis of national statistics (ISTAT, [b], [c]) related to grazing lands, forage crops, permanent pastures, and lands once used for agriculture purposes, but in fact set-aside since 1970. The subcategory "shrublands" has been added; shrublands areas have been derived from national forest inventories (IFN, IFNC), through a linear interpolation between the 1985 and 2005 data, extrapolating data for period 2006-2008. National statistics on cropland areas have been used, in order to derive the land in conversion from cropland to grassland, by the way of LU matrix, following the assumption that transition into cropland category occurs only from grassland category.

7.4.4 Methodological issues

Grassland remaining Grassland

Grassland includes all grazing land and other wood land that don't fullfill forest definition (as shrublands); the change in biomass has been estimated only for subcategory "other wooded land", since, for grazing land, the increase in biomass stocks in a single year is assumed equal to biomass losses from harvest and mortality in that same year. Activity data for grassland remaining grassland have been subdivided into grazing land and other wooded land.

Grazing land

To assess change in carbon in grassland biomass, the Tier 1 has been used; therefore no change in carbon stocks in the living biomass pool has been assumed; in accordance to the GPG no data regarding the dead organic matter pool have been provided, since not enough information is available.

According to the LULUCF GPG (IPCC, 2003), the estimation method is based on changes in soil C stocks over a finite period following changes in management that impact soil C (Equation 3.4.8). Soil C concentration for grassland systems is driven by the change in practice or management, reflecting in different specific climate, soil and management combination, applied for the respective time points. It wasn't possible to point out different sets of relative stock change factors [F_{LU} (land use), F_{MG} (management), F_I (input factor)] for the period 1990-2008 under investigation; therefore, as no management changes can be documented, resulting change in carbon stock has been reported as zero.

No CO_2 emissions from organic soils or from application of carbonate containing lime have occurred.

Other wooded land

Regarding shrublands, growing stock and the related carbon are assessed by a model (Federici et al., 2008), estimating the evolution in time of the different pools and applied at regional scale (NUTS2). A detailed description of the model is reported in the par. 7.2.4..

5. The aboveground biomass was calculated, for shrublands, through the relation:

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

where:
GS = volume of growing stock (MATT/ISAFA, 1988) [m^3 ha-^{1}]
BEF = Biomass Expansion Factors which expands growing stock volume to volume of aboveground woody biomass (ISAFA, 2004)
WBD = Wood Basic Density for conversions from fresh volume to dry weight (d.m) [t m^{-3}] (Giordano, 1980)
A = area occupied by specific typology [ha] (MATT/ISAFA, 1988)

In Table 7.25 biomass expansion factors for the conversions of volume to aboveground tree biomass and wood basic densities are reported.

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

Table 7.25 Biomass Expansion Factors and Wood Basic Densities for shriblands

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

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

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

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

In Table 7.26 Root/shoot ratio for the conversion of growing stock biomass in belowground biomass and wood basic densities for plantations typologies are reported.

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

Table 7.26 Root/Shoot ratio and Wood Basic Densities for shrubland

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

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

where:
GS = volume of growing stock [m^3 ha^{-1}]
BEF = Biomass Expansion Factors which expands growing stock volume to volume of aboveground woody biomass
WBD = Wood Basic Density [t d.m. m^{-3}]
DCF = Dead mass Conversion Factor which converts aboveground woody biomass in dead mass
A = area occupied by specific typology [ha]

Carbon amount contained in litter pool has been estimated, through linear relation established with aboveground carbon, on the basis of the outcomes of CANIF[30] project. 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). In Table 7.27 the different relations used to obtain soil carbon amount per ha [t C ha^{-1}] from the aboveground carbon amount per ha [t C ha^{-1}] have been reported.

Inventory typology	**Relation litter – aboveground C per ha**	**Relation soil – aboveground C per ha**
shrublands	$y = -0.0299 \cdot x + 9.3665$	$y = 0.3922 \cdot x + 65.356$

Table 7.27 Relations litter - aboveground carbon per ha and soil - aboveground carbon per ha for plantations

In table 7.28, other wooded land areas and net changes in carbon stock, for the different required pools, are reported, for the period 1990-2008.

[30] CANIF project: http://www.bgc-jena.mpg.de/bgc-processes/research/Schulze_Euro_CANIF.html

	Area	Living biomass			Dead organic matter	Soil organic matter
		Increase	Decrease	Net Change		
	kha			*Gg C*		
1990	1,561	2,476	-2,560	-84.39	153.25	1,065
1991	1,578	2,515	-2,352	163.12	172.49	1,133
1992	1,595	2,559	-2,497	61.63	164.60	1,103
1993	1,612	2,610	-2,829	-218.78	142.80	1,021
1994	1,629	2,650	-2,495	154.99	171.86	1,126
1995	1,646	2,683	-2,300	382.74	189.57	1,187
1996	1,663	2,715	-2,326	388.95	190.05	1,186
1997	1,680	2,752	-2,496	255.64	179.69	1,145
1998	1,697	2,793	-2,673	119.86	169.13	1,106
1999	1,714	2,826	-2,449	376.64	189.09	1,176
2000	1,731	2,862	-2,612	250.43	179.28	1,138
2001	1,748	2,895	-2,511	384.11	189.68	1,176
2002	1,766	2,925	-2,469	456.16	195.28	1,195
2003	1,783	2,957	-2,541	416.36	192.18	1,179
2004	1,800	2,987	-2,503	484.01	197.44	1,197
2005	1,817	3,016	-2,505	511.00	199.54	1,202
2006	1,834	3,044	-2,499	544.55	202.15	1,176
2007	1,851	3,090	-3,202	-111.54	152.85	1,019
2008	1,868	3,119	-2,589	530.42	202.76	1,185

Table 7.28 Change in carbon stock in living biomass, dead organic matter and soil organic matter in other wooded land

Land converted to Grassland

The assessment of emissions and removals of carbon due to conversion of other land uses to grassland requires estimates of the carbon stocks prior to and following conversion and the estimates of land converted during the period over which the conversion has an effect.

In accordance with the GPG methodology, estimates of carbon stock change in living biomass has been provided, since there is not sufficient information to estimate carbon stock change in dead organic matter pool. Concerning soil carbon pool, changes in carbon stocks associated with the transitions have been reported as a whole in a single year (i.e. the year of conversion), assuming, as for the other categories in transition, that changes in carbon stocks occur in the first year after the land conversion, in spite of considering them over the time period (20 years as default) specified by IPCC GPG LULUCF (2003). As a result of conversion to grassland, it is assumed that the dominant vegetation is removed entirely, after which some type of grass is planted or otherwise established; alternatively grassland can result from the abandonment of the preceding land use, and the area is taken over by grassland. The Tier 1 has been followed, assuming that carbon stocks in biomass immediately after the conversion are equal to 0 t C ha^{-1}.

The annual area of land undergoing a transition from non grassland, only cropland as far as Italy is concerned, to grassland during each year has been pointed out, from 1990 to 2008, for each initial and final land use, through the use of the land use change matrices, one for each year. Changes in biomass carbon stocks have been accounted for in the year of conversion. The GPG equation 3.4.13 (IPCC, 2003) has been used to estimate the change in carbon stocks, resulting from the land use change. Concerning Italian territory, only conversion from cropland to grassland has occurred; therefore the default biomass carbon stocks present on land converted to grassland, as dry matter, as supplied by Table 3.4.9 of the GPG for warm temperate – dry, have been used, equal to 6.1 t d.m. ha^{-1}. Since, according to national expert judgement, it has been assumed that lands in conversion to grassland are mostly annual crops, carbon stocks in biomass

immediately before conversion have been obtained by the default values reported in Table 3.3.8 of the GPG, for annual cropland.
As pointed out above in the land use matrices, see Table 7.3, the conversion of lands into grassland has taken place only in a few years during the period 1990-2008. C emissions [Gg C] due to change in carbon stocks in living biomass in land converted to grassland, are reported in Table 7.29.

	Conversion Area	**C** $_{before}$	ΔC_{growth}	ΔC
year	*kha*	*t C ha*$^{-1}$	*t C ha*$^{-1}$	*Gg C*
1990	0	5	3.05	0
1991	0	5	3.05	0
1992	0	5	3.05	0
1993	0	5	3.05	0
1994	0	5	3.05	0
1995	0	5	3.05	0
1996	104	5	3.05	-203.4
1997	104	5	3.05	-203.4
1998	104	5	3.05	-203.4
1999	104	5	3.05	-203.4
2000	104	5	3.05	-203.4
2001	112	5	3.05	-217.8
2002	112	5	3.05	-217.8
2003	112	5	3.05	-217.8
2004	112	5	3.05	-217.8
2005	112	5	3.05	-217.8
2006	128	5	3.05	-249.7
2007	128	5	3.05	-249.7
2008	128	5	3.05	-249.7

Table 7.29 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 reviewed 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). This value has been drawn up by analysing a collection of the latest papers reporting data on soil carbon in mountain meadows, pastures, set-aside lands as well as soil not disturbed since the agricultural abandonment in Italy (Viaroli and Gardi 2004, CRPA 2009, IPLA 2007, ERSAF 2008, Del Gardo *et al* 2003, LaMantia *et al* 2007, Benedetti *et al* 2004, Masciandaro and Ceccanti 1999, Xiloyannis 2007).
Whenever the soil carbon stock was not reported in the papers, it has been calculated at the default depth of 30 cm from the soil carbon content, the bulk density, and the stoniness according to the following formula (Batjes 1996):

$$T_d = \sum_{i=1}^{K} \rho_i \cdot P_i \cdot D_i \cdot (1 - S_i)$$

where T_d is the overall soil carbon stock (gcm^{-2}) and, for each K layer of the soil profile, ρ_i is the soil bulk density (gcm^{-3}), P_i is the soil carbon content (gCg^{-1}), D_i is the layer thickness (cm),

S_i is the 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):

$$\rho = \frac{100}{\left(\frac{X}{\rho_0}\right) + \left(\frac{100 - X}{\rho_m}\right)}$$

where ρ, soil bulk density (gcm^{-3}); *X*, percent by weight of organic matter; ρ_0, average bulk density of organic matter (0.224 gcm^{-3}) and ρ_m, bulk density of the mineral matter usually estimated at 1.33 gcm^{-3} or determined on the "mineral bulk density chart" (Rawls and Brakensiek, 1985).

Since soil carbon stocks are derived from experimental measurements under some representative cropland managements, the effect of the practices is intended to be included into the values and consequently no stock change factors (F_{LU}, F_{MG}, F_I) have been applied on the soil carbon stock. Each soil carbon stock was assigned to the geographical area where the relative soil carbon content has been measured and the overall values have been averaged by means of weights resulting from the proportional relevance of the investigated area (ha) over the entire Italian territory.

With the stock change factors, the grassland soil carbon stock [t C] for the inventory year [SOC_0] and the cropland land use soil carbon stock [$SOC_{(0-T)}$] have been estimated, starting from the soil carbon stock for unit of area [t C ha^{-1}]. The inventory time period has been established, as abovementioned, in 1 year. The annual change in carbon stocks in mineral soils has been, at last, assessed as described in the equation 3.3.3 of the GPG, only for the years where conversion has taken place. C emissions [Gg C] due to change in carbon stocks in soils in land converted to grassland, are reported in Table 7.30:

	Conversion Area	**Carbon stock**
year	*kha*	*Gg C*
1990	0	0
1991	0	0
1992	0	0
1993	0	0
1994	0	0
1995	0	0
1996	104	1,473
1997	104	1,473
1998	104	1,473
1999	104	1,473
2000	104	1,473
2001	112	1,577
2002	112	1,577
2003	112	1,577
2004	112	1,577
2005	112	1,577
2006	128	1,808
2007	128	1,808
2008	128	1,808

Table 7.30 Change in carbon stock in soils

7.4.5 Category-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 on the basis of 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 previous sectoral estimates occurred, essentially due to inclusion, in grassland category, of shrublands, previously reported in forest land category. This results in a mean increase of 59% in grassland category, in the period 1990-2007.

7.4.6 Category-specific planned improvements

Concerning land in transition to grassland, further investigation will be made to obtain additional information about different types of management activities on grassland, and the crop types of land converting to grassland, to obtain a more accurate estimate of the carbon stocks change.
Activities planned in the framework of the National Registry for Forest Carbon Sinks should also provide data to improve estimate of carbon sequestration due to Afforestation/reforestation activities (with a special focus on soil organic content), and should allow to refine the estimate of soil organic content in grassland category.

7.5 Wetlands (5D)

7.5.1 Description

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

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

For the land use conversion, land use change matrices have been used; as abovementioned, LUC matrices for each year of the period 1990–2008 have been assembled based on time series of national land use statistics for forest lands, croplands, grasslands, wetlands and settlement areas. Annual figures for areas in transition between different land uses have been derived by a hierarchy of basic assumptions (informed by expert judgement) of known patterns of land-use changes in Italy as well as considering the need for the total national area to remain constant. Concerning land converted to wetland, during the period 1990-2008, it has been assumed that no land has been in transition to wetlands.

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

Lands covered or saturated by water, for all or part of the year, which harmonize with the definitions of the Ramsar Convention on Wetlands[31] 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.

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

7.5.4 Methodological issues

No estimates related to emissions of CO_2, CH_4 and N_2O from flooded lands have been supplied, as very few information on this source is available. Concerning land converted to wetland, no land in transition to wetlands has occurred in 1990-2008

7.5.5 Category-specific planned improvements

Improvements will concern the acquirement of data about flooded lands and the implementation of the GPG method to estimate CO_2, CH_4 and N_2O emissions from flooded lands.

7.6. Settlements (5E)

7.6.1 Description

Under this category, activity data from settlements and from land converted to settlements are reported; CO_2 emissions, from living biomass and soil, from land converted in settlements have been also reported. In the period 1990-2008 mean settlements emissions share 3.5% of absolute CO_2 LULUCF emissions and removals.

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

For the land use conversion, land use change matrices have been used; as abovementioned, LUC matrices for each year of the period 1990–2008 have been assembled based on time series of national land use statistics for forest lands, croplands, grasslands, wetlands and settlement areas.
Settlements time series has been developed through a linear interpolation between the 1990, 2000 and 2006 data, obtained by the Corine Land Cover[32] 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 2007-2008. The average area of land undergoing a transition from non-settlements to settlements during each year, from 1990 to 2008, has been estimated with the land use change matrices that have also permitted to specify the initial and final land use.
In response to ERT remark in the last review, land use changes have been derived, by the way of LU matrices, smoothing the amount of changes over a 5 year period, harmonizing the whole time series, resulting in a constant amount of C stock change in the 5 year period.

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

All artificial surfaces, transportation infrastructures (urban and rural), power lines and human settlements of any size, comprising also parks, have been included in this category.

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

7.6.4 Methodological issues

Settlements remaining Settlements

CO_2 estimates on the carbon stocks changes in living biomass, dead organic matter and soil for settlements remaining settlements haven't been submitted, due to the lack of information and data related to urban tree formations. Therefore only activity data have been reported.

Land converted to Settlements

The GPG equation 3.6.1 approach (IPCC, 2003) has been used to estimate the change in carbon stocks, resulting from the land use change.

The annual change in carbon stocks, for land converted to settlements, is assumed equal to carbon stocks in living biomass immediately following conversion to settlements minus the carbon stocks in living biomass in land immediately before conversion to settlements, multiplied for the area of land annually converted. The default assumption, for Tier 1, is that carbon stocks in living biomass following conversion are equal to zero.

As reported in Table 7.3, only conversions from grassland and cropland to settlements have occurred in the 1990-2008 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 7.31:

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

Table 7.31 Stock change factors for cropland

In Table 7.32 C stocks [Gg C] related to change in carbon stocks in living biomass in cropland (annual and perennial) converted to settlements are reported.

Year	annual crops to settlements Conversion Area	annual crops to settlements Carbon stock	perennial crops to settlements Conversion Area	perennial crops to settlements Carbon stock	*Total Carbon stock*
	kha	*Gg C*	*kha*	*Gg C*	*Gg C*
1990	0	0	0	0	0
1991	0.86	-4.32	0	-19	-23.7
1992	0.87	-4.33	0	-19	-23.6
1993	0.87	-4.35	0	-19	-23.4
1994	0.87	-4.37	0	-19	-23.1
1995	0.88	-4.40	0	-18	-22.7
1996	6.29	-31.43	1.97	-124.4	-155.8
1997	6.22	-31.10	2.04	-128.5	-159.6
1998	6.24	-31.20	2.02	-127.3	-158.5
1999	6.14	-30.70	2.12	-133.5	-164.2
2000	6.18	-30.92	2.07	-130.7	-161.6
2001	8.41	-42.05	2.87	-180.8	-222.9
2002	8.39	-41.97	2.89	-181.9	-223.9
2003	8.35	-41.75	2.93	-184.7	-226.5
2004	8.36	-41.81	2.92	-184.0	-225.8
2005	8.30	-41.52	2.98	-187.6	-229.1
2006	8.21	-41.03	3.08	-193.8	-234.8
2007	8.22	-41.09	3.06	-193.0	-234.1
2008	8.17	-40.84	3.11	-196.1	-236.9

Table 7.32 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 7.33 soil C stocks [Gg C] of cropland (annual and perennial) and grassland converted to settlements are reported.

Year	annual crops to settlements ***Conversion Area***	annual crops to settlements ***Carbon stock***	perennial crops to settlements ***Conversion Area***	perennial crops to settlements ***Carbon stock***	grassland to settlements ***Conversion Area***	grassland to settlements ***Carbon stock***
	kha	*Gg C*	*kha*	*Gg C*	*kha*	*Gg C*
1990	0	0	0	0	8.28	-586.68
1991	0.86	-48.94	0.31	-17.5	7.09	-501.96
1992	0.87	-49.05	0.31	-17.4	7.09	-501.96
1993	0.87	-49.30	0.30	-17.1	7.09	-501.96
1994	0.87	-49.59	0.30	-16.8	7.09	-501.96
1995	0.88	-49.91	0.29	-16.5	7.09	-501.96
1996	6.29	-356.37	1.97	-111.9	0	0
1997	6.22	-352.65	2.04	-115.6	0	0
1998	6.24	-353.75	2.02	-114.5	0	0
1999	6.14	-348.16	2.12	-120.1	0	0
2000	6.18	-350.67	2.07	-117.6	0	0
2001	8.41	-476.86	2.87	-162.8	0	0
2002	8.39	-475.89	2.89	-163.7	0	0
2003	8.35	-473.39	2.93	-166.2	0	0
2004	8.36	-474.07	2.92	-165.6	0	0
2005	8.30	-470.78	2.98	-168.8	0	0
2006	8.21	-465.22	3.08	-174.4	0	0
2007	8.22	-465.89	3.06	-173.7	0	0
2008	8.17	-465.22	3.11	-176.5	0	0

Table 7.33 Change in carbon stocks in soil in cropland and grassland converted to settlements

7.6.5 Category-specific recalculations

Estimates of soil carbon stock changes resulting from transition of cropland and grassland to settlements have been provided. Moderate deviations from the previous sectoral estimates occurred, essentially due to the procedure followed in building the land use matrices, with the smoothing of the sum of a 5 years changes over a 5-year period, harmonizing the cropland and grassland time series.
The comparison with previous submission results in mean decrease of emissions equal to 9% in settlements category, in the period 1990-2007.

7.6.6 Category -specific planned improvements

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

7.7 Other Land (5F)

Under this category, CO_2 emissions, from living biomass, dead organic matter and soils, from land converted in other land should be accounted for; no data is reported since the conversion to other land is not occurring.

7.8 Direct N_2O emissions from N fertilization (5(I))

N_2O emissions from N fertilization of cropland and grassland are reported in the agriculture sector; therefore only forest land should be included in this table; no data have been reported, since no fertilizers are applied to forest land.

7.9 N_2O emissions from drainage of soils (5(II))

As regards N_2O emissions from N drainage of forest or wetlands soils no data have been reported, since no drainage is applied to forest or wetlands soils.

7.10 N_2O emissions from disturbance associated with land-use conversion to Cropland (5(III))

7.10.1 Description

Under this category, N_2O emissions from disturbance of soils associated with land-use conversion to cropland are reported, according to the GPG (IPCC, 2003). N_2O emissions from cropland remaining cropland are included in the agriculture sector of the good practice guidance. The good practice guidance provides methodologies only for mineral soils.

7.10.2 Methodological issues

N_2O emissions from land use conversions are derived from mineralization of soil organic matter resulting from conversion of land to cropland. The average area of land undergoing a transition from non-cropland to cropland during each year, from 1990 to 2008, has been estimated with the land use change matrices; as mentioned above, only conversion from grassland to cropland has occurred in the Italian territory. The GPG equation 3.3.14 has been used to estimate the emissions of N_2O from mineral soils, resulting from the land use change.
Changes in carbon stocks in mineral soils in land converted to cropland have been estimated following land use changes, resulting in a change of the total soil carbon content. Assuming the GPG default values, 15 and 0.0125 kg N_2O-N/kg N for the C/N ratio and for calculating N_2O emissions from N in the soil respectively, N_2O emissions have been estimated.
In Table 7.34 N_2O emissions resulting from the disturbance associated with land-use conversion to cropland are reported:

Year	**Conversion Area** *k ha*	**Carbon stock** *Gg C*	**$N_{net-min}$** *kt N*	**N_2O $_{net-min}$ -N** *kt N_2O-N*	**N_2O emissions** *Gg N_20*
1990	12.30	174	11.6	0.145	0.227
1991	0	0	0	0	0
1992	0	0	0	0	0
1993	0	0	0	0	0
1994	0	0	0	0	0
1995	0	0	0	0	0
1996	0	0	0	0	0
1997	0	0	0	0	0
1998	0	0	0	0	0
1999	0	0	0	0	0
2000	0	0	0	0	0
2001	0	0	0	0	0
2002	0	0	0	0	0
2003	0	0	0	0	0
2004	0	0	0	0	0
2005	0	0	0	0	0
2006	0	0	0	0	0
2007	0	0	0	0	0
2008	0	0	0	0	0

Table 7.34 N_2O emissions from land-use conversion to cropland

7.10.3 Category-specific recalculations

Several differences are recognisable in the comparison between current and previous submission, essentially due to to the procedure followed in building the land use matrices, with the smoothing of the sum of a 5 years changes over a 5-year period, harmonizing the cropland and grassland time series. This results in a mean decrease of emissions equal to 41%, in the period 1990-2007.

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

7.11.1 Description

CO_2 emissions from application of carbonate containing lime and dolomite to agricultural soils have been estimated for the period 1998-2008, since data on agricultural lime application have been becomed available only for that period; moreover CO_2 emissions from agricultural dolomite application have been included in CO_2 emissions from limestone application, as national statistics on amount of lime applied don't allow to disaggregate the two components (limestone and dolomite). CO_2 emissions from agricultural lime application are reported in the Table5(IV) - CO_2 emissions from agricultural lime application.

7.11.2 Methodological issues

Tier 1 approach, hypothesising that total amount of carbonate containing lime is applied annually to cropland soil, has been followed; an overall emission factor of 0.12 t C (t limestone or dolomite)$^{-1}$ has been used to estimate CO_2 emissions, without differentiating between variable compositions of lime material. The GPG equation 3.3.6 has been used to estimate CO_2 emissions, without disaggregration between calcic limestone and dolomite, as national statistics report an aggregate annual amount of lime.

7.11.3 Category-specific planned improvements

Improvements will concern the acquirement of data about annual amount of lime applied in the period 1990-1997; consideration will be focussed onto the acquisition of disaggregated data on calcic limestome and dolomite agricultural application.

7.12 Biomass Burning (5(V))

7.12.1 Description

Under this source category, CH_4 and N_2O emissions from forest fires are estimated, in accordance with the IPCC method.
National statistics on areas affected by fire per region and forestry use, high forest (resinous, broadleaves, resinous and associated broadleaves) and coppice (simple, compound and degraded), were used (ISTAT, several years [a]).
CO_2 emissions due to forest fires in forest land remaining forest land are included in table 5.A.1 of the CRF, under carbon stock change in living biomass - decrease.

7.12.2 Methodological issues

In Italy, in consideration of national legislation[33], 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.

[33] Legge 21 novembre 2000, n. 353 - "Legge-quadro in materia di incendi boschivi" art. 10, comma 1 - http://www.camera.it/parlam/leggi/00353l.htm

IPCC method was followed for CH_4 and N_2O emissions, multiplying the amount of C released from 1990 to 2008, calculated on the basis of regional parameters (Bovio, 1996), by the emission factors suggested in the IPCC guidelines (IPCC, 1997).
In Table 7.35 CH_4 and N_2O emissions resulting from biomass burning are reported:

year	**CH_4 emissions** *Gg*	**N_2O emissions** *Gg*
1990	6.964	0.048
1991	2.131	0.015
1992	3.158	0.022
1993	8.007	0.055
1994	3.327	0.023
1995	1.500	0.010
1996	1.430	0.010
1997	4.444	0.031
1998	5.104	0.035
1999	2.828	0.019
2000	4.024	0.028
2001	2.640	0.018
2002	1.473	0.010
2003	3.084	0.021
2004	1.822	0.013
2005	1.834	0.013
2006	1.458	0.010
2007	9.369	0.064
2008	2.199	0.015

Table 7.35 CH_4 and N_2O emissions from biomass burning

7.12.3 Category-specific planned improvements

An expert panel on forest fires has been set up, in order to obtain geographically referenced data on burned area; the overlapping of land use map and georeferenced data should assure the estimates of burned areas in the different land uses, with a particular focus on grassland fires in order to provide estimates of CO_2 emissions. Activities planned in the framework of the National Registry for Forest Carbon Sinks should also provide data to improve estimate of emissions by biomass burning.

7.12.4 Category-specific recalculations

Variations of CH_4 and N_2O emissions from forest fires between current and previous submission are noticeable, due to revision of the whole time series of burnt areas, as described in par. 7.2.4. The average difference between the last submissions are equal to 10%, both for CH_4 and N_2O emissions.

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 3.07% (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.
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	2005	2006	2007	2008
CO_2 (Gg)							
6C. Waste incineration	536.90	483.02	201.57	244.69	267.49	240.20	249.88
CH_4 (Gg)							
6A. Solid waste disposal on land	633.04	741.22	794.38	625.38	582.58	564.03	527.43
6B. Wastewater handling	94.76	105.62	112.24	126.73	130.36	133.53	135.36
6C. Waste incineration	7.65	12.91	11.94	14.14	13.47	12.89	13.43
6D. Other (compost production)	0.01	0.02	0.10	0.20	0.21	0.22	0.21
N_2O (Gg)							
6B. Wastewater handling	6.01	5.85	6.35	6.38	6.44	6.51	6.57
6C. Waste incineration	0.28	0.42	0.36	0.42	0.40	0.38	0.40

Table 8.1 Trend in greenhouse gas emissions from the waste sector 1990 – 2008 (Gg)

In the following box, key and non-key sources of the waste sector are presented based on level, trend or both. Methane emissions from landfills result as a key source at level and trend assessment calculated with Tier 1 and Tier 2; methane emission from wastewater handling is a key source at level assessment with Tier 1 and Tier 2, whereas at trend assessment taking into account uncertainty; 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, whereas methane emission from wastewater handling is a key source at level and trend assessment only with Tier 2 and 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, T)
6B	CH_4	Emissions from wastewater handling	Key (L, 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 total national methane is presently 30.79% (and was 31.98% 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 49% in 2008. 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 2008, the percentage of municipal solid waste separate collection is 30.6%, but still far from legislative targets (fixed 45% in 2008).

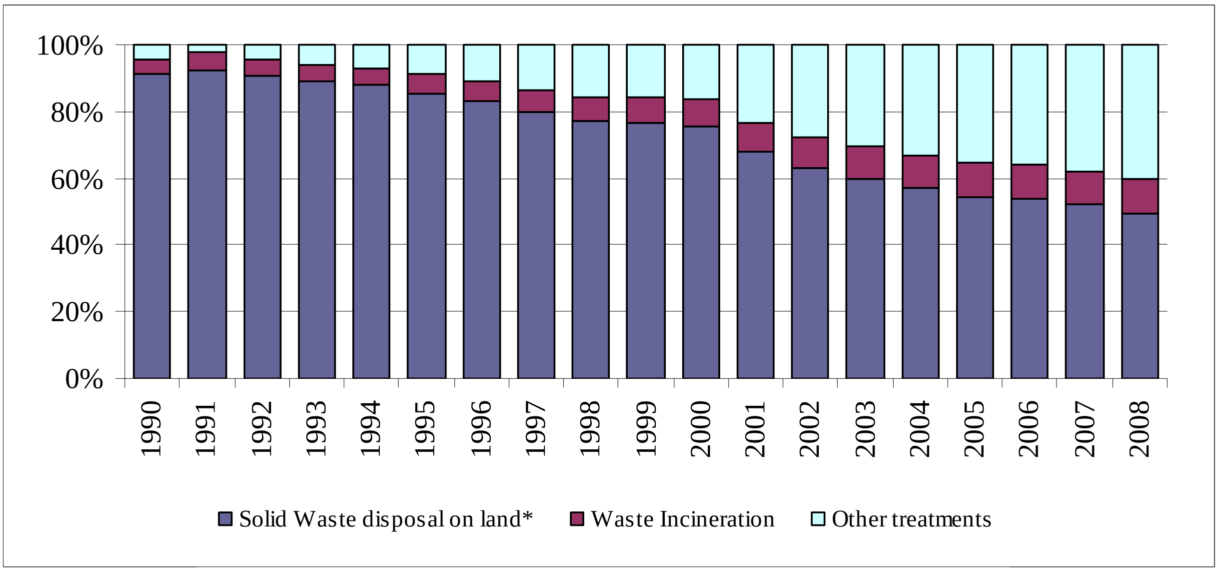


Figure 8.1 Percentage of municipal solid waste treatment and disposal, 1990 – 2008 (%)
*except sludge

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 2008, the MSW landfills in Italy dispose 15,981 kt of wastes.
Since 1999, the number of MSW landfills decreased by more than 500 plants, despite the decrease of the amount of wastes disposed of is less strong. This because both uncontrolled landfills and small controlled landfills have been progressively closed, especially in the south of the country, preferring the use of modern and larger plants, which cover large territorial areas.

Concerning the composition of waste which is disposed in municipal landfills, this has been changed within the years, because of the modification of waste production due to the life-style changing and not for a forceful policy on waste management.

The Landfill European Directive (EC, 1999) has been transposed into national decree only in 2003 by the Legislative Decree 13 January 2003, n. 36 and applied to the Italian landfills since July 2005, but the effectiveness of the policies will be significant in the future. Moreover, a following law decree (Law Decree 30 December 2008, n.208) moved to December 2009 the end of the temporary condition regarding waste acceptance criteria, thus the composition of waste accepted in landfills is 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 other wastes disposed in urban landfills 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; ISPRA, several years).

For inventory purposes, a database of waste production, waste disposal in managed and unmanaged landfills and sludge disposal in landfills was created and it has been assumed that waste landfilling started in 1950.

The complete database from 1975 of waste production, waste disposal in managed and unmanaged landfills and sludge disposal in landfills is reconstructed on the basis of different sources (MATTM, several years; FEDERAMBIENTE, 1992; AUSITRA-Assoambiente, 1995; ANPA-ONR, 1999 [a], [b]; APAT, 2002; APAT-ONR, several years; ISPRA, several years), national legislation (Legislative Decree 5 February 1997, n.22), and regression models based on population (Colombari et al, 1998).

Since waste production data are not available before 1975, they have been reconstructed on the basis of proxy variables. Gross Domestic Product data have been collected from 1950 (ISTAT, several years [a]) and a correlation function between GDP and waste production has been derived from 1975; thus, the exponential equation has been applied from 1975 back to 1950.

Consequently the amount of waste disposed into landfills has been estimated, assuming that from 1975 backwards the percentage of waste landfilled is constant and equal to 80%; this percentage has been derived from the analysis of available data. As reported in the Figure 8.2, 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%.

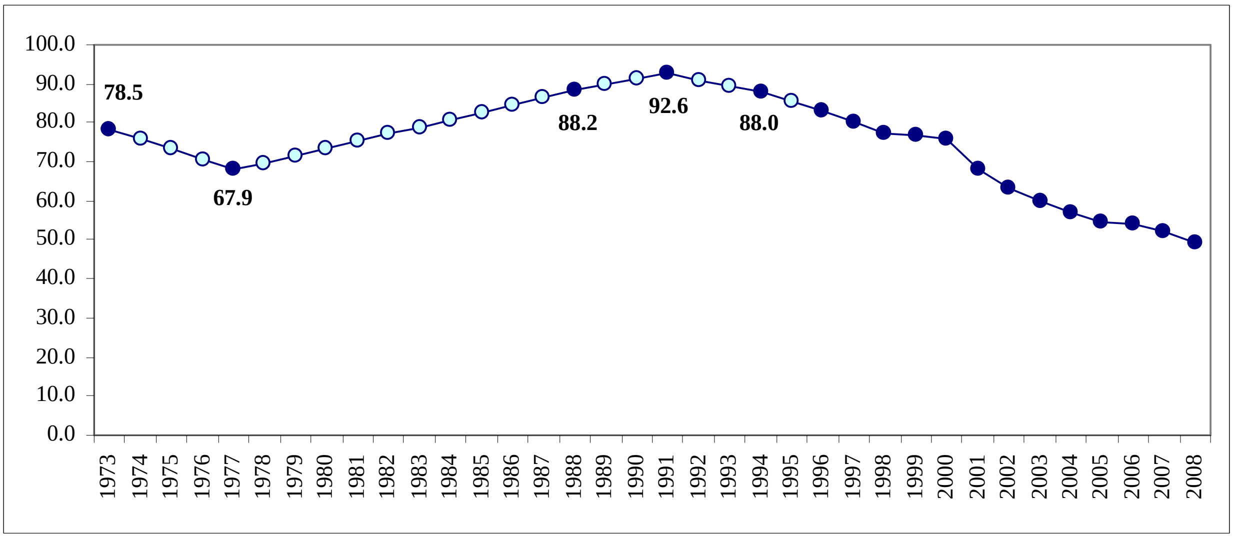


Figure 8.2 Percentage of MSW disposal on land (%)

In Table 8.2, the time series of activity data from 1990 is reported.

ACTIVITY DATA	1990	1995	2000	2005	2006	2007	2008
MSW Production (Gg)	22,231	25,780	28,959	31,664	32,511	32,542	32,472
MSW Disposed of (%)	91.1	85.5	75.7	54.4	53.9	52.0	49.2
- in managed landfills	62.1	70.6	75.7	54.4	53.9	52.0	49.2
MSW Disposed in managed landfills (Gg)	13,797	18,196	21,917	17,226	17,526	16,912	15,981
MSW Disposed in unmanaged landfills (Gg)	6,462	3,849	0	0	0	0	0
Total MSW to landfills (Gg)	20,260	22,044	21,917	17,226	17,526	16,912	15,981

Table 8.2 Trend of MSW production and MSW disposed in landfills, 1990 – 2008

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 8% in 2008.

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; ISPRA, 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	2005	2006	2007	2008
Total equivalent inhabitants (*1000)	46,509	60,114	69,008	93,869	98,841	103,813	108,785
Equivalent inhabitants treated with primary system (*1000)	2,105	3,235	4,893	6,656	7,009	7,361	7,714
Equivalent inhabitants treated with secondary system (*1000)	44,404	56,879	64,114	87,212	91,832	96,451	101,071
Primary sludge production (kt)	28	44	54	61	64	67	70
Secondary sludge production (kt)	891	1,142	891	1,062	1,118	1,175	1,231
Total sludge production (kt)	920	1,186	945	1,123	1,182	1,242	1,301
Total sludge production - 25% dry solid (kt)	3,679	4,742	3,780	4,492	4,729	4,967	5,205
Sewage sludge landfilled (kt)	2,745	3,416	1,929	544	525	407	427

Table 8.3 Trend of equivalent inhabitants treated in urban wastewater plants and sludge production, 1990 – 2008

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 – 2008) 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 1991-2008 (FERRARI, 1996)

Since sludge are 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 waste bulk is estimated based on the composition of waste and can be calculated from a weighted average of the degradable carbon content of various components of the waste stream. The following equation estimates DOC using default carbon content values.

$$DOC = \Sigma_i (DOC_i * W_i)$$

Where:
DOC = fraction of degradable organic carbon in bulk waste, kg C/kg of wet waste
DOC_i = fraction of degradable organic carbon in waste type *i*,
W_i = fraction of waste type *i* by waste category

Degradable organic carbon in waste type *i* can be caluculated as following:

$$DOC_i = C_i * (1-u_i) * W_i$$

Where:
C_i = organic carbon content in dry waste type *i*, kg C/ kg of waste type *i*
u_i= moisture content in waste type *i*
W_i = fraction of waste type *i* by waste category

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%	89.20
Sludge	*12.1%*	*75%*	*48%*	14.51
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	23.7%	60%	48%	45.49
Garden and park	4.0%	50%	48%	9.68
Paper, paperboard	27.1%	8%	44%	109.84
Textile, leather	4.6%	10%	55%	22.87
Sludge	*10.0%*	*75%*	*48%*	11.94
DOC				**199.82**

Table 8.10 Degradable Organic Carbon calculation, 1991-2008

Once known the degradable organic carbon, the methane generation potential value (L_0) is calculated as following:

$$L_0 = MCF * DOC * DOC_F * F * 16/12$$

Where:
MCF = methane correction factor
DOC_F = fraction of DOC dissimilated
F = fraction of methane in landfill gas

Fraction of degradable organic carbon (DOC_F) is an estimate of the fraction of carbon that is ultimately degraded and released from landfill, and reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the landfill.
DOC_F value is dependent on many factors like temperature, moisture, pH, composition of waste: the default value 0.5 has been used.
The methane correction factor (MCF) accounts for that unmanaged SWDS (solid waste disposal site) produce less CH_4 from a given amount of waste than managed SWDS, because a larger fraction of waste decomposes aerobically in the top layers of managed SWDS. The MCF, in relation to solid waste management, is specific to that area and should be interpreted as the

'waste management correction factor', which reflects the management aspect that it encompasses.
The MCF value used for unmanaged landfill is the default IPCC value reported for uncategorised landfills: in fact, in Italy, before 2000 existing unmanaged landfills were mostly shallow, because they resulted in uncontrolled waste dumping instead of real deep unmanaged landfills. To be conservative, the default IPCC value reported for uncategorised landfills has been used.
It is assumed that landfill gas composition is 50% carbon dioxide and 50% methane.
The following Table 8.11 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 - 2008
Rapidly biodegradable			
- Managed landfill	90.5	85.1	84.1
- Unmanaged landfill	54.3	51.1	50.5
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

Finally, oxidation factors have been assumed equal to 0.1 for managed landfills and 0 for unmanaged according to the IPCC Good Practice Guidance where 0.1 is suggested for well managed landfills.

Methane generation rate constant (k)

The methane generation rate constant *k* in the FOD method is related to the time taken for DOC in waste to decay to half its initial mass (the 'half life' or t½).
The maximum value of *k* applicable to any single SWDS is determined by a large number of factors associated with the composition of the waste and the conditions at the site. The most rapid rates are associated with high moisture conditions and rapidly degradable material such as food waste. The slowest decay rates are associated with dry site conditions and slowly degradable waste such as wood or paper. Thus, for each rapidly, moderately and slowly biodegradable fraction, a different maximum methane generation rate constant has been assigned, as reported in Table 8.12.
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.
The amount of methane recovery in landfills has increased as a result of the implementation of the European Directive on the landfill of waste (99/31/EC); the amounts of methane recovered and flared have been estimated taking into account the amount of energy produced, the energy efficiency of the methane recovered, the captation efficiency and the efficiency in recovering methane for energy purposes assuming that the rest of methane captured is flared.
The total CH_4 recovered is the sum of methane flared and methane used for energy purposes (see figure 8.3). The methane used for energy production is estimated starting from the electricity produced (GWh) annually by landfills (TERNA, several years) assuming an energy conversion efficiency equal to 0.3. The methane flared has been estimated for the years 1990-1997 on the basis of information supplied by the plants (De Poli and Pasqualini, 1991); for the following years the methane flared has been estimated on the basis of information supplied by the main operators (Asja, 2003 and Acaia, 2004) regarding the efficiency in recovering methane for energy purposes with respect to the total methane collected. This value increased from 60% of the total, in 1998, to 70% since 2002.

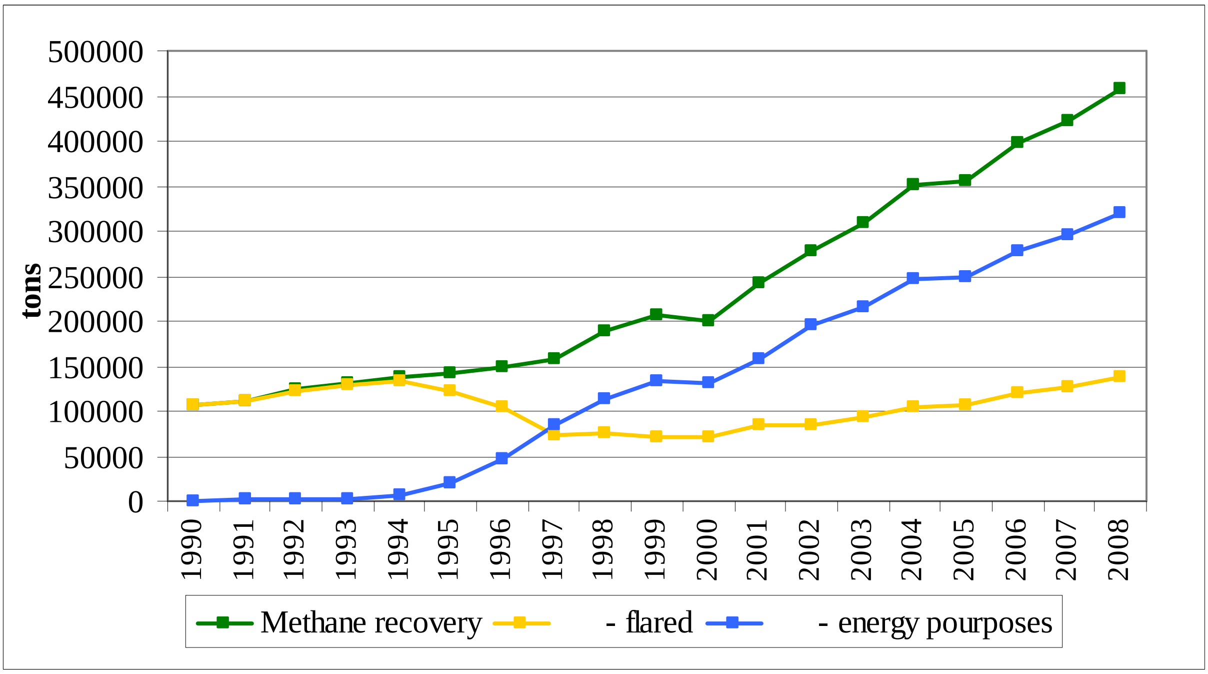


Figure 8.3 Methane recovery distinguished in flared amount and energy purposes (tons)

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	2005	2006	2007	2008
Managed Landfills							
Methane produced (Gg)	574.9	761.2	957.3	967.3	966.7	974.6	974.6
Methane recovered (Gg)	107.4	142.3	200.8	355.8	397.9	421.8	458.2
Methane recovered (%)	18.7	18.7	21.0	36.8	41.2	43.3	47.0
CH_4 net emissions (Gg)	414.0	548.2	669.7	539.0	500.6	486.1	453.3
NMVOC net emissions (Gg)	5.5	7.2	8.8	7.1	6.6	6.4	6.0
Unmanaged Landfills							
Methane produced (Gg)	222.0	195.6	126.3	87.5	83.0	78.9	75.1
Methane recovered (Gg)	0	0	0	0	0	0	0
CH_4 net emissions (Gg)	219.1	193.1	124.7	86.4	82.0	77.9	74.1
NMVOC net emissions (Gg)	2.9	2.5	1.6	1.1	1.1	1.0	1.0

Table 8.13 Methane produced, recovered and CH_4 and NMVOC net emissions, 1990 – 2008 (Gg)

Whereas waste production continuously increases, from 2001 solid waste disposal on land has decreased as a consequence of waste management policies (see Table 8.2). At the same time, the increase in the methane-recovered percentage has led to a reduction in net emissions.
Further reduction is expected in the future because of the increasing in waste recycling.

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

Recalculations in the sector have been done because the quantity of sludge disposed of in landfills has been updated since 2001 (APAT-ONR, several years; ISPRA, 2008). Consequently, the entire series of methane emissions has been changed because the waste composition 1991-2008 has been modified. This review process has resulted in a decrease of 0.04% in 1990 and of 12.90% in 2007 for managed landfills (see Table 8.14) in methane emissions.

EMISSIONS	1990	1995	2000	2005	2006	2007
Managed Landfills						
CH_4 net emissions (Gg)	-0,04%	-1,42%	-1,10%	-10,46%	-11,91%	-12,90%
Unmanaged Landfills						
CH_4 net emissions (Gg)	0,00%	-0,56%	0,54%	1,01%	1,02%	1,03%

Table 8.14 Differences in percentages between time series reported in the updated time series and 2009 submission

The use of updated data was necessary because the current regulations have led to a significant reduction of biodegradable substance and sludge in landfills after 1996 (for 1996 the most recent waste composition is available: Ferrari, 1996).

8.2.6. Source-specific planned improvements

Improvements are expected due to the entry 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.
Moreover, a preliminary investigation on waste composition has been going on (see par. 8.2.5) and a single database has been constructed from the 30 local databases containing information about landfilled waste. The large amount of data requires further analysis with the experts on waste management in order to provide valid results.

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 8.15 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 8.15 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. The bad management of aerobic process is assumed equal to 5% as a conservative estimation.

For high strength organic waste, such as some industrial wastewater, anaerobic process is recommended also for wastewater besides sludge treatment.
It is assumed that industrial wastewaters are treated 85% aerobically and 15% anaerobically (IRSA-CNR, 1998).
Emissions from methane recovered, used for energy purposes, in wastewater treatment plants are estimated and reported under category 1A4a.
A percentage of 1.7% of domestic and commercial wastewater is currently treated in Imhoff tanks, where the digestion of sludge occurs anaerobically without gas recovery. Therefore, very few emissions from sludge disposal do occur.

8.3.2. Methodological issues

Regarding N_2O emissions, 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 $N\text{-}N_2O$ kg^{-1} N produced have been used, whereas the time series of the protein intake is from the yearly FAO Food Balance (FAO, several years).
N_2O emissions from industrial wastewater have been estimated on the basis of the emission factors equal to 0.25 g N_2O/m^3 of wastewater production (EMEP/CORINAIR, 2007). The waste water production is resulting from the model for the estimation of methane emissions from industrial waste water.

The methane estimation concerning industrial wastewaters makes use of the IPCC method based on wastewater output and the respective degradable organic carbon for each major industrial wastewater source. No country specific emission factors of methane per Chemical Oxygen Demand (COD) are available so the default value of 0.25 kg CH_4 kg^{-1} COD, suggested in the IPCC Good Practice Guidance (IPCC, 2000), has been used for the whole time series.

As recommended by the IPCC Good Practice Guidance (IPCC, 2000) for key source categories, data have been collected for several industrial sectors (iron and steel, refineries, organic chemicals, food and beverage, paper and pulp, textiles and leather industry). The total amount of organic material, for each industry selected, has been calculated multiplying the annual production (t $year^{-1}$) by the amount of wastewater consumption per unit of product (m^3 t^{-1}) and by the degradable organic component (kg COD $(m^3)^{-1}$). Moreover, the fraction of industrial degradable organic component removed as sludge has been assumed equal to zero. The yearly industrial productions are reported in the national statistics (ISTAT, several years [a], [b] and [c]), whereas the wastewater consumption factors and the degradable organic component are either from Good Practice Guidance (IPCC, 2000) or from national references. National data have been used in the calculation of the total amount of both COD produced and wastewater output specified as follows: refineries (UP, several years), organic chemicals (FEDERCHIMICA, several years), beer (Assobirra, several years), wine, milk and sugar sectors (ANPA-ONR, 2001), pulp and paper sector (ANPA-FLORYS, 2001; Assocarta, several years), and leather sector (ANPA-FLORYS, 2000; UNIC, several years).

In Table 8.16 detailed references for 2008 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, several years	4.18	UNIC, several years

Table 8.16 Wastewater generation and COD values, 2008.

CH_4 emissions from sludge generated by domestic and commercial wastewater treatment have been calculated using the IPCC default method on the basis of national information on anaerobic sludge treatment system (IPCC, 1997; IPCC 2000). All the anaerobic digestion systems are equipped with systems to collect the methane produced. The methane collected is partly flared and partly used for energy purposes. The total methane recovered is estimated on the basis of the methane production and the efficiency of captation. Where anaerobic digestion of sludge is used, the reactors are covered and provided of gas recovery and the efficiency of captation is equal to 100%; so the methane recovered and reported in the CRFs is equal to the methane production.

A recent survey by the National Institute of Statistics (ISTAT, 2004) has provided information on urban wastewater treatment plants in Italy for the year 1999: an investigation on previous references has been done and data on primary treatment plants using Imhoff tanks are also available for 1987 (ISTAT, 1991; ISTAT, 1993) and 1993 (ISTAT, 1998 [a] and [b]).

CH_4 emissions have been calculated on the basis of the equivalent inhabitants treated in Imhoff tanks, the organic loading in biochemical oxygen demand per person equal to 60 g BOD_5 $capita^{-1}$ d^{-1}, as defined by national legislation and expert estimations (Legislative Decree 11 May 1999, no.152; Masotti, 1996; Metcalf and Eddy, 1991), the fraction of BOD_5 that readily settles equal to 0.3 (ANPA, 2001; Masotti, 1996), and the IPCC emission factor default value of 0.6 g CH_4 g^{-1} BOD_5.

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 8.17; 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 8.18, whereas the emission trend for N_2O emissions both from industrial wastewater handling and human sewage is shown in Table 8.19.
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 8.20.

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**	**2005**	**2006**	**2007**	**2008**
Iron and steel	9,534	7,778	6,756	6,861	7,032	7,091	6,728
Oil refinery	NA	NA	NA	NA	NA	NA	NA
Organic chemicals	210,936	212,317	215,049	214,735	214,972	215,265	214,747
Food and beverage	179,120	177,383	182,736	185,657	182,693	180,401	180,057
Pulp and paper	377,167	402,952	387,285	366,025	365,649	368,979	346,504
Textile industry	108,460	103,047	101,572	75,492	78,272	79,796	68,768
Leather industry	23,623	25,002	27,216	19,229	19,254	18,366	16,804
Total	908,840	928,479	920,614	868,000	867,872	869,898	833,607

Table 8.17 Total industrial wastewater production by sector, 1990 – 2008 (1000 m^3)

CH_4 Emissions (Gg)	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**
Iron and steel	0.036	0.029	0.025	0.026	0.026	0.027	0.025
Oil refinery	5.850	5.625	4.250	4.750	4.750	4.750	4.750
Organic chemicals	23.794	23.911	24.173	24.177	24.227	24.274	24.180
Food and beverage	22.946	22.112	22.871	23.197	23.220	23.085	22.751
Pulp and paper	0.923	0.986	1.055	0.997	0.996	1.005	0.944
Textile industry	4.067	3.864	3.809	2.831	2.935	2.992	2.579
Leather industry	3.192	3.378	3.677	2.901	3.122	3.100	2.632
Total	60.81	59.91	59.86	58.88	59.28	59.23	57.86

Table 8.18 CH_4 emissions from anaerobic industrial wastewater treatment, 1990 – 2008 (Gg)

N_2O Emissions (Gg)	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**
Industrial Wastewater	0.227	0.232	0.230	0.217	0.217	0.217	0.208
Human Sewage	5.787	5.619	6.115	6.162	6.222	6.294	6.360
Total	6.01	5.85	6.35	6.38	6.44	6.51	6.57

Table 8.19 N_2O emissions from industrial wastewater handling and human sewage, 1990 – 2008 (Gg)

Domestic and Commercial Wastewater	1990	1995	2000	2005	2006	2007	2008
Wastewater (5% treated anaerobically)							
Organic loading in wastewater (t $year^{-1}$)	49.80	63.75	73.22	100.73	106.18	111.64	117.11
CH_4 emissions (Gg)	29.88	38.25	43.93	60.44	63.71	66.99	70.27
Sludge (generated by Imhoff tanks)							
Eq. inhabitants treated in Imhoff tanks (10^3 millions)	1,033	1,893	2,144	1,880	1,870	1,855	1,834
Organic loading in sludge (t $year^{-1}$)	6,787	12,435	14,087	12,352	12,287	12,187	12,050
CH_4 emissions (Gg)	4.07	7.46	8.45	7.41	7.37	7.31	7.23

Table 8.20 CH_4 emissions from sludge generated by domestic and commercial wastewater treatment, 1990 – 2008 (Gg)

8.3.5. Source-specific recalculations

Recalculations in the sector have been done because the activity data regarding equivalent inhabitants served by treatment systems have been updated. Methane emissions from domestic and commercial wastewater showed changes reported in table 8.21.

Domestic and Commercial Wastewater	1990	1995	2000	2005	2006	2007
Wastewater (5% treated anaerobically)						
Organic loading in wastewater (t $year^{-1}$)	-0,07%	-0,12%	6,36%	33,56%	34,61%	35,59%
CH_4 emissions (Gg)	-0,07%	-0,13%	6,34%	33,56%	34,61%	35,60%
Sludge (generated by Imhoff tanks)						
Eq. inhabitants treated in Imhoff tanks (10^3 millions)	2,80%	4,10%	0,01%	0,00%	0,01%	-0,01%
Organic loading in sludge (t $year^{-1}$)	2,75%	4,12%	0,00%	0,00%	0,00%	0,00%
CH_4 emissions (Gg)	2,84%	4,05%	0,03%	0,02%	0,03%	0,03%

Table 8.21 Differences in percentages between time series reported in the updated time series and 2009 submission

Other minor recalculations due to some updated data published occur (i.e. leather industry). 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 2008, about 95% of the total amount of waste incinerated is treated in plants with energy recovery system.
A complete database of the incineration plants is now available, updated with the information reported in the yearly report on waste production and management published by ISPRA (APAT-ONR, several years; ISPRA, several years).
Emissions from removable residues from agricultural production are included in the IPCC category 6C: the total residues amount and carbon content have been estimated by both IPCC and national factors. The detailed methodology is reported in Chapter 6 (6.6.2).
CH_4 emissions from biogenic, plastic and other non-biogenic wastes have been calculated.

8.4.2. Methodological issues

Regarding GHG emissions from incinerators, the methodology reported in the IPCC Good Practice Guidance (IPCC, 2000) has been applied, combined with that reported in the CORINAIR Guidebook (EMEP/CORINAIR, 2007). 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, except CH_4 emission factor that is derived from EMEP Corinair (EMEP/CORINAIR, 2007).

Specifically:

1. for municipal waste, emission data from a large sample of Italian incinerators were used (FEDERAMBIENTE, 1998);
2. for industrial waste and waste oil, emission factors have been estimated on the basis of the allowed levels authorized by the Ministerial Decree 19 November 1997, n. 503 of the Ministry of Environment;

3 for hospital waste, which is usually disposed of alongside municipal waste, the emission factors used for industrial waste were also applied;
4 for sewage sludge, in absence of specific data, reference was made to the emission limits prescribed by the Guidelines for the authorisation of existing plants issued on the Ministerial Decree 12 July 1990.

In Table 8.22, 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 8.22 Waste incineration emission factors

Here below (Tables 8.23, 8.24, 8.25, 8.26), detail data and calculation for specific emission factors are reported. Emission factors have been estimated on the basis of a study conducted by ENEA (De Stefanis, 1999), based on emission data from a large sample of Italian incinerators (FEDERAMBIENTE, 1998; AMA-Comune di Roma, 1996), legal thresholds (Ministerial Decree 19 November 1997, n. 503 of the Ministry of Environment; Ministerial Decree 12 July 1990) and expert judgements.
In detail, as regard CO_2 emission factor for municipal waste, it has been calculated considering a carbon content equal to 23%; moreover, on the basis of the IPCC Guidelines (IPCC, 1997) and referring to the average content analysis on a national scale (FEDERAMBIENTE, 1992), a distinction was made between CO_2 from fossil fuels (generally plastics) and CO_2 from renewable organic sources (paper, wood, other organic materials). Only emissions from fossil fuels, which are equivalent to 35% of the total, were included in the inventory. This fraction is not expected to change significantly because of the energy characteristics required for the waste incinerated.
CO_2 emission factor for industrial, oils and hospital waste has been derived as the average of values of investigated industrial plants. On the other hand, CO_2 emissions from the incineration of sewage sludge were not included at all, while all emissions relating to the incineration of hospital and industrial waste were considered.

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 8.23 Municipal waste emission factors

Industrial and oil waste	Average concentration values (mg/Nm³)	Standard specific flue gas volume (Nm³/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 8.24 Industrial waste and oils emission factors

Hospital waste	Average concentration values (mg/Nm³)	Standard specific flue gas volume (Nm³/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 8.25 Hospital waste emission factors

Sewage sludge	Average concentration values (mg/Nm³)	Standard specific flue gas volume (Nm³/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 8.26 Sewage sludge emission factors

In Table 8.27 activity data are reported by type of waste.

	1990	1995	2000	2005	2006	2007	2008
	(t)						
Total waste	**1,716,348**	**2,209,330**	**3,061,678**	**4,966,180**	**5,066,369**	**5,145,312**	**5,287,347**
with energy recovery	946,567	1,593,742	2,751,913	4,707,447	4,800,240	4,897,692	5,034,413
without energy recovery	769,781	615,588	309,765	258,733	266,129	247,620	252,934
Urban waste	**1,025,594**	**1,436,620**	**2,324,876**	**3,219,871**	**3,269,338**	**3,299,375**	**3,354,546**
with energy recovery	626,395	1,185,491	2,161,367	3,167,942	3,246,463	3,270,911	3,329,981
without energy recovery	399,200	251,128	163,509	51,929	22,875	28,465	24,564
Industrial waste	**690,754**	**772,710**	**736,802**	**1,746,309**	**1,797,031**	**1,845,936**	**1,932,801**
other waste	529,221	593,580	604,162	1,603,841	1,625,278	1,687,210	1,771,481
hospital waste	138,151	154,542	110,318	126,204	145,343	131,916	134,974
sludge	20,723	23,181	21,501	15,599	25,976	26,057	26,057
oil	2,659	1,407	821	665	433	753	290

Table 8.27 Amount of waste incinerated by type

CH_4 and N_2O emissions from agriculture residues removed, collected and burnt 'off-site', as a way to reduce the amount of waste residues, are reported in the waste incineration sub-sector.

Removable residues from agriculture production are estimated for each crop type (cereal, green crop, permanent cultivation) taking into account the amount of crop produced, the ratio of removable residue in the crop, the dry matter content of removable residue, the ratio of removable residue burned, the fraction of residues oxidised in burning, the carbon and nitrogen content of the residues. Most of these wastes refer especially to the prunes of olives and wine, because of the typical national cultivation. Emissions due to stubble burning, which are emissions only from the agriculture residues burned on field, are reported in the agriculture sector, under 4.F. Under the waste sector the burning of removable agriculture residues that are collected and could be managed in different ways (disposed in landfills, used to produce compost or used to produce energy) is reported. Different percentages of the removable agriculture residue burnt for different residues are assumed, varying from 10% to 90%, according to national and international literature. Moreover, these removable wastes are assumed to be all burned in open air (e.g. on field) or in fireplaces without abatement technology control, taking in consideration the higher available CO, NMVOC, PM, PAH and dioxins emission factors. The amount of these wastes treated differently are not supplied, but they are included in the respective sectors (landfill, composting,etc.).

The methodology is the same used to calculate emissions from residues burned on fields, in the category 4F, described in details in Chapter 6.

On the basis of carbon and nitrogen content of the residues, CH_4 and N_2O emissions have been calculated, both accounting nearly for 100% of the whole emissions from waste incineration. CO_2 emissions have been calculated but not included in the inventory as biomass. All these parameters refer both to the IPCC Guidelines (IPCC, 1997) and country-specific values (CESTAAT, 1988; Borgioli, 1981).

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 8.28; CO_2 emission trends for each type of waste category are reported in Table 8.29, both for plants without energy recovery, reported under 6C, and plants with energy recovery, reported under 1A4a. In Table 8.30 N_2O and CH_4 emissions are summarized, including those from open burning.

In the period 1990-2008, total CO_2 emissions have increased by 194.8%, but whereas emissions from plants with energy recovery have increased by nearly 429%, emissions from plants without energy recovery decreased by 53.5%. While CO_2 emission trend reported in 6C is influenced by the amount of waste incinerated in plant without energy recovery, CH_4 and N_2O emission trend are related to the open burning, as already reported above.

SUBSOURCE	1990	1995	2000	2005	2006	2007	2008
MSW Production (Gg)	22,231	25,780	28,959	31,664	32,511	32,542	32,472
MSW Incinerated (%)	4.6%	5.6%	8.0%	10.2%	10.1%	10.1%	10.3%
- in energy recovery plants	2.8%	4.6%	7.5%	10.0%	10.0%	10.1%	10.3%
MSW to incineration (Gg)	1,026	1,437	2,325	3,220	3,269	3,299	3,355
Industrial, Sanitary, Sewage Sludge and Waste Oil to incineration (Gg)	691	773	737	1,746	1,797	1,846	1,933
Total Waste to incineration (6C and 1A4a) (Gg)	**1,716**	**2,209**	**3,062**	**4,966**	**5,066**	**5,145**	**5,287**

Table 8.28 Waste incineration activity data, 1990 – 2008 (Gg)

SUBSOURCE	1990	1995	2000	2005	2006	2007	2008
Incineration of domestic or municipal wastes (Gg)	115.47	72.64	47.30	15.02	6.62	8.23	7.11
Incineration of industrial wastes (except flaring) (Gg)	283.31	272.85	113.09	185.58	200.31	164.83	176.05
Incineration of hospital wastes (Gg)	135.46	136.12	40.36	43.72	60.33	66.72	66.72
Incineration of waste oil (Gg)	2.66	1.41	0.82	0.36	0.24	0.41	0.00
Waste incineration (6C) (Gg)	537	483	202	245	267	240	250
Waste incineration reported under 1A4a (Gg)	569	835	1,331	2,765	2,804	2,899	3,009
Total waste incineration (Gg)	1,105	1,318	1,532	3,009	3,072	3,140	3,259

Table 8.29 CO_2 emissions from waste incineration (without and with energy recovery), 1990 – 2008 (Gg)

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008
N_2O (Gg)							
Waste incineration (6C)	0.28	0.42	0.36	0.42	0.40	0.38	0.38
MSW incineration reported under 1A4a	0.05	0.08	0.13	0.26	0.27	0.28	0.28
CH_4 (Gg)							
Waste incineration (6C)	7.65	12.91	11.94	14.14	13.47	12.89	12.89
MSW incineration reported under 1A4a	0.03	0.05	0.08	0.16	0.16	0.17	0.17

Table 8.30 N_2O and CH_4 emissions from waste incineration, 1990 – 2008 (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 2007, 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; ISPRA, several years). The main differences are related to CO_2 emissions and account for 11.1%.
Minor recalculations due to 2006 open burning occur. However, the recalculation is not relevant.

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 2008 (from 363,319 tons to 7,166,890 tons).
Information on input waste to composting plants are published yearly by ISPRA since 1996, including data for 1993 and 1994 (ANPA, 1998; APAT-ONR, several years; ISPRA, several years), while for 1987 and 1995 only data on compost production are available (MATTM, several years; AUSITRA-Assoambiente, 1995); on the basis of this information the whole time series has been reconstructed.

8.5.2. Methodological issues

The composting plants are classified in two different kinds: the plants that treat a selected waste (food, market, garden waste, sewage sludge and other organic waste, mainly from the agro-food industry); and the mechanical-biological treatment plants, that treat the unselected waste to produce compost, refuse derived fuel (RDF), and a waste with selected characteristics for landfilling or incinerating system.
It is assumed that 100% of the input waste to the composting plants from selected waste is treated as compost, while in mechanical-biological treatment plants 30% of the input waste is treated as compost on the basis of national studies and references (Favoino and Cortellini, 2001; Favoino and Girò, 2001).
For these emissions, literature data (Hogg, 2001) have been used for the emission factor, 0.029 g CH_4 kg^{-1} treated waste, equivalent to compost production.
NMVOC emissions have also been estimated: emission factor (51 g NMVOC kg^{-1} treated waste) is from international scientific literature too (Finn and Spencer, 1997).
In Table 8.31, activity data, CH_4 and NMVOC emissions are reported.

	1990	1995	2000	2005	2006	2007	2008
Waste treated in composting plants (t)	363,319	784,648	3,302,113	6,819,624	7,256,526	7,488,147	7,166,890
CH_4 (Gg)							
Compost production (6D)	0.011	0.023	0.097	0.200	0.213	0.220	0.210
NMVOC (Gg)							
Compost production (6D)	0.018	0.040	0.168	0.346	0.369	0.380	0.364

Table 8.31 CH_4 and NMVOC emissions from compost production, 1990 – 2008 (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 10^{th} 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 2007 have been submitted as well as the CRF for the year 2008 and recalculation tables of the CRF have been filled in. Explanatory information on the major recalculations between the 2009 and 2010 submissions for the year 2007 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 2009 submission and this year (2010 submission) are summarised in Table 9.2 by gas; differences in emission levels due to recalculations are also reported.
Improvements in the calculation of emission estimates have led to a recalculation of the entire time series of the national inventory. Considering total GHG emissions without LULUCF, emission levels show a minor increase in comparison with the last year submission, equal to +0.14% for the base year and a decrease of -0.03% for 2007. Considering the national total with the LULUCF sector, the base year has increased by 0.77% and the 2007 emission levels by 3.84%.
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 a revision of emissions from the road transport sector specifically, on account of the application of the updated version of COPERT 4 which affected CH_4 and N_2O emissions. In the industrial sector, revisions are due the availability of new information on emission factors for ferroalloys and the estimation of CO_2 recovered from the ammonia production process. The LULUCF sector was also affected by an update in methodology to derive Land use changes by the way of LU matrices and the availability of new information on forest fires areas and harvesting.

For 2007, changes regarded the energy sector, due to the methodological revision already explained involving the road transport, and to the update of emission factors for fuel oil, syngas from heavy residuals, natural gas and coal. In the industrial sector, revisions are due to the estimation of the amount of CO_2 recovered in the ammonia production process. The LULUCF sector was also affected by the same revisions, as for 1990. In the waste sector, the revision regarded the update of of the amount of sludge waste landfilled and of the equivalent inhabitants served by treatment system.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	RECALCULATIONS Please tick where this is also reflected in recalculations compared to the previous year CRF	REFERENCE If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc
Total (Net Emissions)		×	CH4 and N2O from 1A3b (Copert4, model update)
		×	CO2 from1A1, 1A2, 1A4, EF update of fuel oil, syngas from heavy residuals, natural gas and coal
	×	×	CO2 from 2B1, EF revision of CO2 recovered in the ammonia production process
	×	×	CO2 and N2O emission and removal from 5A, 5B, 5C, 5E, forest area surfaces update in consideration of the Kyoto Protocol definition, update of harvesting activity data, update of Land use matrices
		×	CH4 from 6A, update of sludge in landfills AD
1. Energy		×	CH4 and N2O from 1A3b (Copert4, model update)
		×	CO2 from 1A1, 1A2, 1A4, EF update of fuel oil, syngas from heavy residuals, natural gas and coal
	×		Update of the energy sector chapter following the NIR annotated outline, in response to the review process
A. Fuel Combustion (Sectoral Approach)		×	CH4 and N2O from 1A3b (Copert4, model update)
		×	CO2 from 1A1, 1A2, 1A4, EF update of fuel oil, syngas from heavy residuals, natural gas and coal
1. Energy Industries		×	CO2 EF update of fuel oil, syngas from heavy residuals, natural gas and coal
2. Manufacturing Industries and Construction		×	CO2 EF update of natural gas, fuel oil and coal
3. Transport		×	CH4 and N2O from 1A3b (Copert4, model update)
4. Other Sectors		×	CO2 EF update of fuel oil, coal and natural gas
5. Other			
B. Fugitive Emissions from Fuels			
1. Solid Fuels			
2. Oil and Natural Gas			
2. Industrial Processes	×	×	CO2 from 2B1 EF revision of CO2 recovered in the ammonia production process
A. Mineral Products			
B. Chemical Industry	×	×	CO2 from 2B1 EF revision of CO2 recovered in the ammonia production process
C. Metal Production			
D. Other Production			
E. Production of Halocarbons and SF6			
F. Consumption of Halocarbons and SF6			
G. Other			

Table 9.1 Explanations of the main recalculations in the 2010 submission (year 2007) (continued)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	Please tick where this is also reflected in recalculations compared to the previous year CRF	If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc
3. Solvent and Other Product Use			
4. Agriculture			
A. Enteric Fermentation			
B. Manure Management			
C. Rice Cultivation			
D. Agricultural Soils			
E. Prescribed Burning of Savannas			
F. Field Burning of Agricultural Residues			
G. Other			
5. Land Use, Land-Use Change and Forestry	× × ×	× × ×	CO2 removal from 5A, 5B, 5C, update of forest area surfaces according to the Kyoto Protocol definition. CO2 losses from 5A, update of harvesting activity data. CO2 and N2O emissions, land use changes have been derived, by the way of LU matrices, smoothing the amount of changes over a 5 year period.
A. Forest Land	× ×	× ×	CO2 removal, update of forest area surfaces in accord with the Kyoto Protocol definition. CO2 losses, update of harvesting activity data.
B. Cropland	× ×	× ×	CO2 and N2O emissions, land use changes have been derived, by the way of LU matrices, smoothing the amount of changes over a 5 year period. CO2 removal, according to the Kyoto protocol definition plantations have been moved from forest to cropland.
C. Grassland	× ×	× ×	CO2 and N2O emissions, land use changes have been derived, by the way of LU matrices, smoothing the amount of changes over a 5 year period. CO2 removal, according to the Kyoto protocol definition shrublands have been moved from forest to grassland.
D. Wetlands			
E. Settlements	×	×	CO2 and N2O emissions, land use changes have been derived, by the way of LU matrices, smoothing the amount of changes over a 5 year period
F. Other Land			
G. Other			
6. Waste			
A. Solid Waste Disposal on Land		×	CH4, update of sludge amount disposal in landfills.
B. Waste-water Handling			
C. Waste Incineration			
D. Other			
7. Other (as specified in Summary 1.A)			
Memo Items:			
International Bunkers			
Aviation			
Marine			
Multilateral Operations			
CO2 Emissions from Biomass			

Table 9.1 Explanations of the main recalculations in the 2010 submission (year 2007)

	subm	1990	1995	2000	2005	2006	2007
Net CO_2 emissions/removals (Gg CO_2-eq.)	2009	367,037	359,585	383,389	394,682	395,617	404,176
	2010	370,777	363,377	387,567	398,471	393,899	424,265
Difference		*1.02%*	*1.05%*	*1.09%*	*0.96%*	*-0.43%*	*4.97%*
CO_2 emissions (without LULUCF) (Gg CO_2-eq.)	2009	434,688	445,401	462,715	490,056	485,754	475,302
	2010	435,775	445,861	463,603	490,477	486,343	476,749
Difference		*0.25%*	*0.10%*	*0.19%*	*0.09%*	*0.12%*	*0.30%*
CH_4 emissions (Gg CO_2-eq.)	2009	41,882	44,185	44,284	39,679	38,075	38,414
	2010	41,710	43,820	44,047	38,580	36,865	37,114
Difference		*-0.41%*	*-0.83%*	*-0.53%*	*-2.77%*	*-3.18%*	*-3.38%*
CH_4 emissions (without LULUCF) (Gg CO_2-eq.)	2009	41,739	44,158	44,197	39,645	38,044	38,217
	2010	41,564	43,788	43,963	38,542	36,834	36,918
Difference		*-0.42%*	*-0.84%*	*-0.53%*	*-2.78%*	*-3.18%*	*-3.40%*
N_2O emissions (Gg CO_2-eq.)	2009	37,415	38,563	39,781	37,902	32,842	31,856
	2010	37,313	38,036	39,429	37,538	32,228	31,566
Difference		*-0.27%*	*-1.37%*	*-0.88%*	*-0.96%*	*-1.87%*	*-0.91%*
N_2O emissions (without LULUCF) (Gg CO_2-eq.)	2009	37,400	38,364	39,772	37,899	32,540	31,836
	2010	37,218	38,030	39,421	37,534	32,225	31,546
Difference		*-0.49%*	*-0.87%*	*-0.88%*	*-0.96%*	*-0.97%*	*-0.91%*
HFCs (Gg CO_2-eq.)	2009	351	671	1,986	5,267	5,956	6,701
	2010	351	671	1,986	5,267	5,956	6,701
Difference		*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*
PFCs (Gg CO_2-eq.)	2009	1,808	491	346	353	282	288
	2010	1,808	491	346	353	282	288
Difference		*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*
SF_6 (Gg CO_2-eq.)	2009	333	601	493	465	406	428
	2010	333	601	493	465	406	428
Difference		*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*
Total (with LULUCF) (Gg CO_2-eq.)	2009	448,825	444,096	470,279	478,349	473,178	481,862
	2010	452,292	446,996	473,868	480,674	469,637	500,361
Difference		*0.77%*	*0.65%*	*0.76%*	*0.49%*	*-0.75%*	*3.84%*
Total (without LULUCF) (Gg CO_2-eq.)	2009	516,318	529,686	549,509	573,685	562,982	552,771
	2010	517,049	529,444	549,812	572,638	562,046	552,629
Difference		*0.14%*	*-0.05%*	*0.05%*	*-0.18%*	*-0.17%*	*-0.03%*

Table 9.2 Differences in time series between the 2010 and 2009 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 2009, emission levels of the base year, total emissions in CO_2 equivalent without LULUCF, slightly changed (+0.14%) due to a revision in the energy and industrial sectors as previously described.
If considering emission levels with LULUCF, an increase by 0.77% is observed between the 2009 and 2010 total figures in CO_2 equivalent, mainly due to the update of forest areas.
In 2007, considering emission figures without LULUCF, changes affected positively CO_2 (+0.30%), and negatively CH_4 and N_2O levels (-3.40%, -0.91%, respectively).
The trend 'base year- year 2007' does not show a significant change from the previous to this year submission.
Figure 9.1 shows the time series of the range of total national GHG emissions due to recalculations in the last ten years and the 2010 emission estimates. Values of the coefficient of variation are also illustrated which show that the first years of the time series were mostly affected by recalculation in terms of variability whereas lower values are observed for the last years. This is to show that improvements in methodologies used to compile the inventory guarantee accurate estimates and minor changes from one year to another for the entire time series.

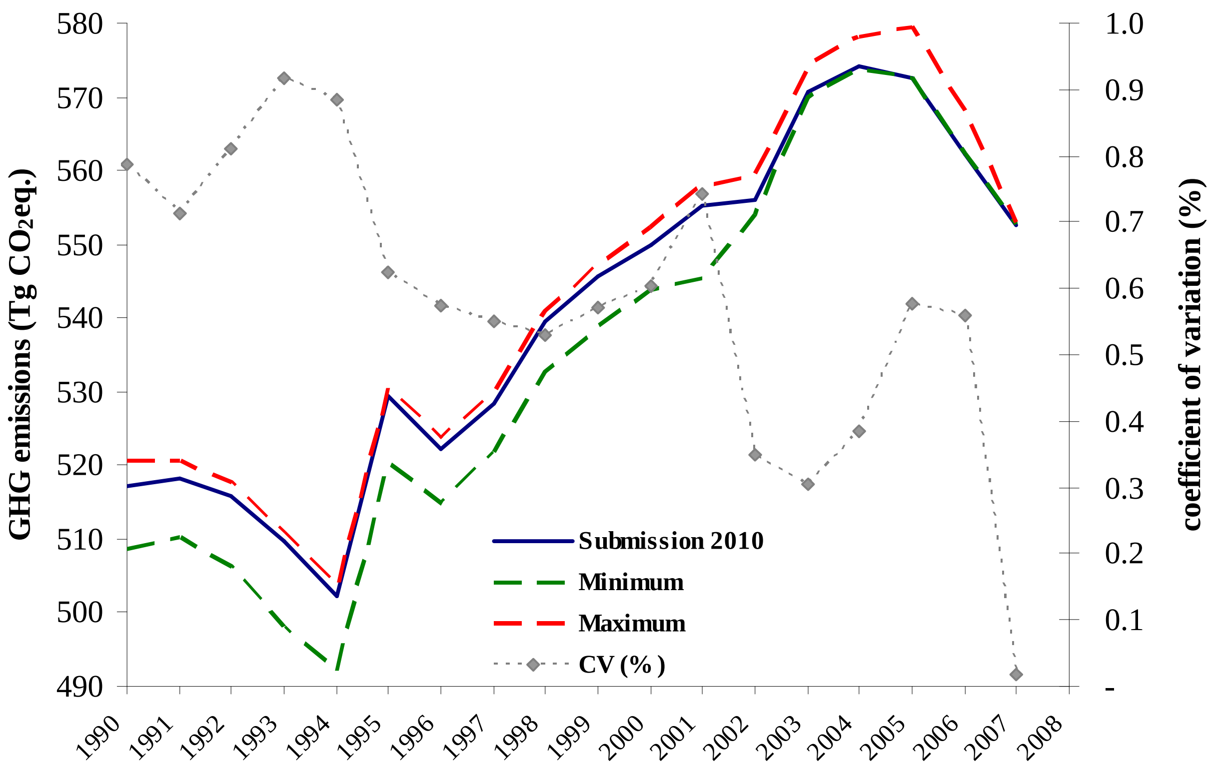


Figure 9.1 Range of national GHG emissions (Tg CO_2 eq.) in the 2001-2010 submissions and coefficient of variation (%)

9.4 Recalculations, response to the review process and planned improvements

This chapter summarises the recalculations and improvements made to the Italian GHG inventory since the 2009 submission.
In addition to a new year, the inventory is updated annually by a revision of the existing activity data and emission factors in order to include new information available; the update could also reflect the revision of methodologies. Revisions always apply to the whole time series.

The inventory may also be expanded by including categories not previously estimated if sufficient information on activity data and suitable emission factors have been identified and collected.

9.4.1 Recalculations

The key differences in emission estimates occurred since the last year submission are reported in Table 9.1 and Table 9.2.
Besides the usual updating of activity data, recalculations may be distinguished in methodological changes, source allocation and error corrections.
All sectors were involved in methodological changes. Specifically:
Energy. The whole time series of road transport emissions has been recalculated using the updated version of the model COPERT 4 affecting CH_4 and N_2O emissions. In addition, CO_2 emission factors for fuel oil, syngas from heavy residuals, natural gas and coal were revised on account of additional information collected from the EU emissions trading scheme and the National Grid Administrator (Terna).
Industrial sector. Recalculations are due to new information available in relation to the amount of CO_2 recovered in the ammonia production process. In addition, there has been an update of CO_2 emission factor for felloalloy for new available references, and a revision of CO_2 emission factors for aluminium and glass production on account of new information from the industry.
Solvent and other product use sector. A new category has been added, N_2O emissions from the use of explosives. Also a minor update of activity data and a revision of CO_2 emission factor for domestic use occurred in this sector.
Agriculture. Besides the update of different basic data, a minor revision concerned some parameters used to calculate emissions of buffalo and non dairy cattle for land spreading.
LULUCF. The main changes concerned the application of Kyoto definition and rules to estimate emissions and removals from this sector; for forest land, there has been an update of forest areas surfaces in accord with the Kyoto Protocol definition affecting CO_2 removal estimates. CO_2 losses have also been recalculated due to the update of harvesting activity data.
Waste. A revision concerned the update of the amount of sludge disposed in landfills.

9.4.2 Response to the UNFCCC review process

In 2009, the Italian GHG inventory was subject to the centralised review of the 2009 inventory submission.
Following the recommendations of the review processes different improvements have been carried out. A complete list of responses to the latest recommendations of the UNFCCC review is reported in Annex 12.

The main improvements regarded the completeness and transparency of the information reported in the NIR.
New categories have been added, emissions from biomass fuel consumption in pulp and paper industry have been estimated and N_2O emissions from use of explosives have been estimated and reported under the category 3 D other uses of N_2O.
Information on LULUCF activities under Article 3, paragraphs 3 and 4 of the Kyoto Protocol, has been supplied and KP tables have been filled in for all carbon pools.

There has been an overall revision of the energy sector chapter.
The transparency of data and information has improved by a proper presentation of the tables, as requested by the review process.

Verification and QA/QC procedures were explained more in detail for the energy sector, and for all the other sectors especially for those mostly affected by recalculations. The use of data collected in the context of the European emissions trading scheme data and other directives and/or regulations in the national inventory has been extensively described.

More details on how the key category and uncertainty analyses help in prioritizing and planning the Italian inventory improvements have been reported in the NIR to clarify the issue.

The description of country specific methods and the rationale behind the choice of emission factors, activity data and other related parameters should have improved the transparency of the present NIR.

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

The main institutional and legal arrangements required under the Kyoto Protocol have been finalized. Some problems still regard the implementation of national registry for forest carbon sinks to identify areas of land and land-use change in accordance with paragraph 20 of the annex to decision 16/CMP.1, and to provide information, including estimates of emissions/removals, on activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol. However, actions to solve the question have been undertaken by the institutions involved; at the end of 2009 and in the beginning of 2010 fundings have been available from the Ministry of Environment to start with some of the activities planned in the national registry for forest carbon sinks to improve the knowledge and the estimate of emissions and removals. A protocol between the Ministry of Environment and the Ministry of Agriculture is under approval and it will permit to start with the new 2012 forest inventory.

General priority will concern the improvement of the transparency in the NIR.
Other sector specific improvements are identified in the relevant chapters and specified in the 2010 QA/QC plan; they can be summarized in the following.

For the energy and industrial sectors, the database where information collected in the framework of different directives, Large Combustion Plant, E-PRTR and Emissions Trading, is under finalisation. The database has helped highlighting the main discrepancies in information and detecting potential errors leading to a better use of these data in the national inventory.
For the agriculture and waste sectors, improvements will be related to the availability of new information on emission factors, activity data as well as parameters necessary to carry out the estimates; specifically, improvements are expected for the review of nitrous oxide emission factors in the agricultural soil emissions and availability of information on waste composition and other parameters following the entering into force of the European landfill directive.
For the LULUCF; activities planned in the framework of the National Registry for Forest Carbon Sinks should provide data to improve estimate of emissions by biomass burning and the final results of the INFC data related to the soils survey will definitely constitute a robust database for forest fires, allowing refined estimates and lower related uncertainty.
Additional studies will regard the comparison between local inventories and national inventory and exchange of information with the ‘local inventories’ national expert group. Researches are carried out also in the context of the European Commission initiative ‘Covenant of Mayors’ which is a commitment by signatory towns and cities to go beyond the objectives of EU energy policy in terms of reduction in CO_2 emissions, i.e 20% by 2020.

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.

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

Chapter 10: KP-LULUCF

10.1 General information

Under Article 3, paragraph 3, of the Kyoto Protocol (KP), Italy reports emissions and removals from afforestation (A), reforestation (R) and deforestation, and under Article 3, paragraph 4 emissions and removals from forest management (FM). The estimates for emissions and removals under Articles 3.3 and 3.4 are consistent with the IPCC GPG LULUCF 2003 and Decisions 15/CMP.1 and 16/CMP.1 of the KP.

10.1.1 Definition of forest and any other criteria

Forest is defined by Italy under the Kyoto Protocol reporting using the same definition applied by the Food and Agriculture Organization of the United Nations for its Global Forest Resource assessment (FAO FRA 2000). This definition is consistent with definition given in Decision 16/CMP.1. Forest is a land with following threshold values for tree crown cover, land area and tree height:

d. a minimum area of land of 0.5 hectares;
e. tree crown cover of 10 per cent;
f. minimum tree height of 5 meters.

Forest roads, cleared tracts, firebreaks and other open areas within the forest as well as protected forest areas are included in forest

10.1.2 Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

Italy has chosen to elect *Forest Management* (FM) as an activity under Article 3.4. In accordance with the Annex to Decision 16/CMP.1, credits from Forest Management are capped in the first commitment period. Following the Decision 8/CMP.2, the cap is equal to 2.78 Mt C (10.19 $MtCO_2$) per year, or to 13.9 Mt C (50.97 $MtCO_2$) for the whole commitment period.

10.1.3 Description of how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time

Afforestation and *reforestation* areas have been estimated on the basis of data of the two last Italian National Forest Inventories (IFN1985 and IFNC2005). *Deforestation* data have been derived from administrative records at NUT2 level collected by the National Institute of Statistics.

The definition of *forest management* is interpreted in using the broader approach as described in the GPG LULUCF 2003. All forests fulfilling the definition of forest, as given above, are considered as managed and are under forest management. Therefore Italy’s forest area is the total eligible area under *forest management* activity, since the entire Italian forest area has to be considered managed forest lands.

Concerning *deforestation* activities, in Italy land use changes from forest to other land use categories are allowed in very limited circumstances, as stated in art. 4.2 of the Law Decree n. 227 of 2001.

10.1.4 Description of precedence conditions and/or hierarchy among Article 3.4 activities, and how they have been consistently applied in determining how land was classified

As Italy has elected only *forest management* under Article 3.4 activities, there is no need to build up a hierarchy between *forest management* and other Article 3.4 activities.

10.2 Land-related information

Italy implements the Reporting Method 1 for lands subject to Article 3.3 and Article 3.4 activities. The reporting area boundaries have been identified with the administrative boundaries of Italian regions (NUTS2 level). These areas include multiple units of land subject to *afforestation/reforestation* and *deforestation* and land areas subject to *forest management*. In the reporting, the same geographical boundaries were used for Article 3.3 and Article 3.4 activities. Approach 2 has been used for representing land areas.
Data for land use and land-use changes were obtained by the National Forest Inventories ((IFN1985 and IFNC2005). IFN1985 was accomplished by means of systematic sampling with a single phase of information gathering on the ground. The sampling points were identified in correspondence to the nodes of a grid with a mesh of 3 km superimposed on the official map of the State on a scale of 1:25.000. Each point therefore represents 900 ha, for a total of 33,500 points distributed within the national territory. IFNC2005 has a three-phase sampling design; the sampling units were 300,000 and were identified in correspondence to the nodes of a grid with a mesh of 1 km superimposed on the official map of the State. A first inventory phase, consisting in interpretation of 1m resolution orthophotos, dated from 2002 to 2003, was followed by a ground surveys, in order to assess the forest use, and to detect the main qualitative attributes of Italian forests. The phase 3 has consisted in ground surveys to estimate the values of the main quantitative attributes of forest stands (i.e. volume of growing stock, tree density, annual growth, aboveground biomass, carbon stock, deadwood volume and biomass). The phase 3 is currently elaborating data on soils, gained by 1500 sampling areas selected in the IFNC2005 original grid.

10.2.1 Spatial assessment unit used for determining the area of the units of land under Article 3.3

The spatial assessment unit to determine the area of units of land under Article 3.3 is 0.5 ha, which is the same as the minimum area of forest.

10.2.2 Methodology used to develop the land transition matrix

The land transition matrix is shown in Table NIR-2 (Table 10.1). The same data sources are used for the UNFCCC greenhouse gas inventory and for the estimates of emissions and removals under Articles 3.3 and 3.4.
LUC matrices for each year of the period 1990–2008 have been assembled based on time series of national land use statistics for forest lands, croplands, grasslands, wetlands and settlement areas. Annual figures for forest land area, and consequently for *afforestation/reforestation* areas, were estimated on the basis of the forest area increase as detected by the National Forest Inventories. It has been assumed that new forest land area can only come from grassland.
Deforestation data have been derived from administrative records at NUT2 level collected by the National Institute of Statistics. Since the activities planned in the framework of the registry for carbon sinks are still in progress, for the current submission no detailed information was available

on the land use of the deforested area; consequently, a conservative approach was applied hypothesising that the total deforested area is converted into settlements. In addition, it should be noted that land use changes due to wildfires are not allowed by national legislation (Law Decree 21 November 2000, n. 353, art.10.1).

		Art 3.3		Art. 3.4		
	kha	**Aff. / Ref.**	**Deforestation**	**FM**	**Other**	*total (beginning of 2008)*
Art 3.3	**Aff. / Ref.**	**1,387**				*1,387*
	Deforestation		**12**			*12*
Art. 3.4	**FM**		0.72	7,451		*7,451*
	Other	78			**21,205**	*21,283*
	Total (end of 2008)	*1,465*	*13*	*7,451*	*21,205*	**30,134**

Table 10.1 Land transition matrix - Areas and changes in areas between the previous and the current inventory year (2008) [kha]

10.2.3 Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

The Italian regions have been used as the geographical units for reporting (Figure 10.1); boundaries of reporting areas have been identified with the administrative boundaries of Italian regions (NUTS2 level). ID-codes have been assigned following the denomination of the different regions.

Figure 10.1 Geographical locations of the reporting regions and their identification codes

10.3 Activity-specific information

10.3.1 Methods for carbon stock change and GHG emission and removal estimates

10.3.1.1 Description of the methodologies and the underlying assumptions used

Methods for estimating carbon stock changes in forests (for Article 3.3 *afforestation/reforestation* and Article 3.4 *forest management*) are the same as those used for the UNFCCC greenhouse gas inventory: details are given in par. 7.2.4. A growth model, For-est[34], is used to estimate the net change of carbon in the five reporting pools: aboveground and belowground biomass, dead wood and litter, and soils as soil organic matter. The model has been applied at regional scale (NUTS2); input data for the forest area, per region and inventory typologies, were the First Italian National Forest Inventory (IFN1985) data and the Inventory of Forests and Carbon pools (INFC2005).

In the KP CRF tables changes in carbon stock are reported in terms of gains and losses, for aboveground and belowground biomass, and net carbon stock change for the remaining pools (dead wood, litter, soils).

Concerning carbon stock changes resulting from *deforestation* activities, for the current submission no detailed information was available on the land use of the deforested area, since the activities planned in the framework of the registry for carbon sinks are still in progress; consequently, a conservative approach was applied, hypothesising that the total deforested area is converted into settlements. In addition, it should be noted that land use changes due to wildfires are not allowed by national legislation (Law Decree 21 November 2000, n. 353, art.10, comma 1).

The loss, in terms of carbon, due to deforested area is computed assuming that the total amount of carbon, existing in the different pools before deforestation, is lost.

GHG emissions from biomass burning were estimated with the same method as described in par. 7.12.2. CO_2 emissions due to forest fires in areas subject to art. 3.3 and art 3.4 activities have been included in corresponding tables: in particular, CO_2 emissions from biomass burning in land subject to art 3.3 activities are included in table 5(KP-I)A.1.1, Losses (Aboveground and belowground pools), while CO2 emissions from burnt areas under *forest management* are included in table 5(KP-I)B.1, Forest Management, Losses (Aboveground and belowground pools).

10.3.1.2 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

Table 5(KP-I)A.1.3 Article 3.3 activities: Afforestation and Reforestation. Units of land otherwise subject to elected activities under Article 3.4 (information item)

According to the fact that all Italian forests are managed, the whole area subject to *afforestation/reforestation* should be reported here since otherwise subject to *forest management.*

Table 5(KP-I)A.2.1 Article 3.3 activities: Deforestation. Units of land otherwise subject to elected activities under Article 3.4 (information item)

Only *forest management* has been elected under Article 3.4. As *Deforestation* is a permanent loss of forest cover, any unit of land that has been deforested under Article 3.3 cannot also be subject to *forest management* under Article 3.4.

Table 5(KP-II)1. Direct N_2O emissions from N fertilization

No N fertilization is applied to Italian forests, so emissions are reported as not occurring.

[34] Federici S, Vitullo M, Tulipano S, De Lauretis R, Seufert G, 2008. An approach to estimate carbon stocks change in forest carbon pools under the UNFCCC: the Italian case. iForest 1: 86-95 URL: http://www.sisef.it/iforest/

Table 5(KP-II)2. N_2O emissions from drainage of soils

Reporting of these emissions is not mandatory so no estimates are made. There is no activity data on the extent of drainage under *forest management* areas but this is currently under investigation.

Table 5(KP-II)3. N_2O emissions from disturbance associated with land use conversion to cropland.

Deforestation to Cropland has been supposed as not occurring in Italy, as total deforested area was assumed in transition into settlements. New data will become available in 2010, from the activities planned in the framework of the registry for carbon sinks; this will enable this assumption to be re-examined and new estimates to be produced if necessary.

Table 5(KP-II)4. Carbon emissions from lime application

No lime is applied to Italian forests, so emissions are reported as not occurring. This is consistent with UNFCCC reporting, where all liming is assumed to occur in Cropland remaining Cropland.

10.3.1.3 Information on whether or not indirect and natural GHG emissions and removals have been factored out

Italy has not factored out removals from elevated carbon dioxide concentrations, indirect nitrogen deposition or the dynamic effects of age structure resulting from activities prior to 1 January 1990, considering also that GPG do not give methods for factoring out. For the first commitment period, the effect of indirect and natural removals will be considered through the cap under Article 3.4 credits from *forest management*. For Italy the cap is 2.78 Mt C per year.

10.3.1.4 Changes in data and methods since the previous submission (recalculations)

This is the first official submission of Article 3.3 and Article 3.4 estimates, so any recalculations will be reported from the next submission onwards.

10.3.1.5 Uncertainty estimates

It was assumed that uncertainty estimates for forest land also apply for lands under FM (par. 7.2.5). The uncertainties related to the different pools are reported, for 2008, in the table 10.2.

Aboveground biomass	E_{AG}	93.84%
Belowground biomass	E_{BG}	93.84%
Dead mass	E_D	97.82%
Litter	E_L	161.22%
Soil	E_S	152.05%
Overall uncertainty	E_{2008}	86.27%

Table 10.2 Uncertainties for the year 2008

The uncertainties for Article 3.3 activities estimates are expected to be higher. It can be assumed that the given uncertainty analysis in table 10.2 cover the uncertainty of all gains and all losses in living tree biomass under FM and ARD. The method for uncertainty analysis will be further developed.

10.3.1.6 Information on other methodological issues

Italy has decided to account for the emissions and removals under Article 3 paragraphs 3 and 4 at the end of the commitment period. Activities planned in the framework of the registry for carbon sinks are still in progress, therefore methodologies for area changes detection and the related uncertainties will be further developed. Moreover at the end of 2010, data on the last phase of national forest inventory, covering litter and soils pools, at NUT2 level, will be released, allowing Italy to report estimates of emissions and removals from litter and soils pools with a lower uncertainty.
On these bases, estimates presented in current submission for 2008 may change for the final report of the commitment period.

10.3.1.7 The year of the onset of an activity, if after 2008

Not applicable as the reporting is for the year 2008.

10.4 Article 3.3

Italy reports all emissions by sources and removals by sinks from AR activities in the table 5(KP-I)A.1.1 - Afforestation/Reforestation: units of land not harvested. Italy has interpreted harvesting as clear cutting done on short rotation forests, coherently with statements reported in the par. 4.2.5.3.2 of IPCC GPG LULUCF 2003.

10.4.1 Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are direct human-induced

Changes in forest area were detected on the basis of national forest inventories data.
The following *afforestation/reforestation* activities that occurred or could have occurred on or after 1990 (Table 10.3) are included in the reporting of these activities:

- Planted or seeded croplands;
- Planted or seeded grasslands;
- Abandoned arable lands which are naturally forested

In Italy all land use categories (cropland, grazing land, forest) are to be considered managed; therefore any land use change occurs between managed lands and, consequently, is direct human-induced.
Afforested/reforested areas are to be considered legally bound by national legislation[35]. Usually these activities have resulted from a decision to change the land use by planting or seeding. Abandoned arable lands are left to forest naturally.
On the basis of the definitions provided in the Decision 19/CMP.1[36], natural afforestation and reforestation occurred on abandoned agricultural lands have to be included in the art. 3.3: a frequent forest management strategy, in Italy, consists, in fact, in the exploitation of natural re-growth caused, for instance, by the seed of adjacent trees. In addition these transitions are essentially due to political decisions under the EEC Regulations 2080/92 and 1257/99 (art.10.1 and 31.1), therefore induced by man.

[35] In particular: Law Decree n. 227/2001; Law n. 353/2000; Law 1497/1939; Law Decree n. 3267/1923; 985, Law n. 431
[36] “Afforestation” is the direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources;
“Reforestation” is the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but that has been converted to non-forested land. For the first commitment period, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989.

Afforestation/Reforestation	1990	2008
	kha	*kha*
Abruzzo	4.7	89.8
Basilicata	2.4	46.3
Calabria	1.5	28.9
Campania	2.8	54.3
Emilia-Romagna	7.1	135.7
Friuli-Venezia Giulia	3.5	66.5
Lazio	6.1	116.6
Liguria	0.0	0.9
Lombardia	4.0	75.9
Marche	3.9	74.5
Molise	0.8	15.6
Piemonte	9.8	186.8
Puglia	1.2	23.4
Sardegna	5.3	99.9
Sicilia	2.9	55.6
Toscana	7.8	147.7
Trentino	5.0	95.0
Bolzano-Bozen	*2.3*	*43.3*
Trento	*2.7*	*51.7*
Umbria	2.6	49.3
Valle d'Aosta	1.0	19.4
Veneto	4.4	82.9
Italia	**77**	**1,465**

Table 10.3 Area estimates for 1990 and cumulative for 1990-2008 (kha) under Article 3.3 activities Afforestation/Reforestion.

Concerning *deforestation* activities, as mentioned above, in Italy land use changes from forest to other land use categories are allowed in very limited circumstances, as stated in art. 4.2 of the Law Decree n. 227 of 2001.
As for current submission no detailed information was available on the land use of the deforested area, a conservative approach was followed, hypothesising that the total deforested area is converted into settlements.

10.4.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

Extensive forest disturbances have been rare in Italy, except for wildfires. Land-use changes after damage do not occur; concerning wildfires, national legislation (Law n. 353 of 2000, art.10.1) doesn't allow any land use change after a fire event for 15 years.
Harvesting is regulated through regional rules, which establish procedures to follow in case of harvesting. Although different rules exist at regional level, a common denominator is the requirement of an explicit written communication with the localization and the extent of area to be harvested, existing forest typologies and forestry treatment. *Deforestation* is allowed only in very limited circumstances (i.e. in construction of railways the last years) and has to follow several administrative steps before being legally permitted. In addition, clear-cutting is a not allowed practice (Law Decree n. 227 of 2001, art. 6.2).

10.4.3 Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

Restocking is assumed for forest areas that have lost forest cover through harvesting or forest disturbance, unless there is *deforestation* as described above. As such, information on the size and location of forest areas that have lost forest cover is not explicitly collected on an annual basis.

10.5 Article 3.4

10.5.1 Information that demonstrates that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced

Forests in 1 January 1990 were under *forest management*, since Italy considers all forest land managed, and, therefore, human-induced.

10.5.2 Information relating to Forest Management

Italian forest resources are totally legally bound; the two main constraints, provided by the laws n. 3267 of 1923 and n. 431 of 1985, compel private and public owners to strictly respect limitations concerning use of their forest resources. As a matter of fact, each exploitation of forest resources must not compromise their perpetuation and therefore, any change of land use, for hydro-geological, landscape and environmental protection in general (the same limitations apply also to burnt areas, following the law n. 353 on forest fires approved in 2000). Consequently unplanned cuttings are always forbidden and local prescriptions fix strict rules to be observed for forestry.

10.6 Other information

10.6.1 Key category analysis for Article 3.3 activities and any elected activities under Article3.4

Key category analysis for KP-LULUCF was performed according to section 5.4 of the IPCC GPG for LULUCF (IPCC 2003).
Only total CO_2 emissions and removals from *forest management* (art. 3.4) has been assessed as key category, in accordance with the IPCC good practice guidance for LULUCF section 5.4.4. The value has been compared with Table 1.6 Key categories for the latest reported year (2008) based on level of emissions (including LULUCF).

Article 3.3 Afforestation and reforestation (CO_2): The associated UNFCCC subcategory CO_2 emissions and removals from *land converting to forest land* have identified as key category only following the Tier 2 approach, both in level and trend assessment. Moreover, total CO_2 emissions and removals from *Afforestation and reforestation* (art. 3.3) is not larger than the smallest UNFCCC key category. Therefore AR is stated to be not a key category.

Article 3.4 Forest management (CO_2): The associated UNFCCC subcategory *Forest land remaining Forest land* is a key category in level and in trend assessment (Tier 1);. The *forest management* category contribution is also greater than other categories in the UNFCCC key category.

10.7 Information relating to Article 6

Italy is not participating in any project under Article 6 (Joint Implementation).

Chapter 11: Information on accounting of Kyoto units

11.1. Background information

The SEF tables are included in the submission as an Excel file named SEF_IT_2010_1_19-25-41 9-4-2010.xls. These tables report information on unit holdings in the Italian registry as well as on transfers of these units in 2009 to and from other Parties of the Kyoto Protocol.

11.2. Summary of information reported in the SEF tables

At the beginning of 2009, there were 2,432,766,152 AAUs in the IT registry of which 2,232,035,444 were in the party holding accounts and 200,730,708 in the entity holding accounts. The registry also contained a total of 9,302,402 CERs in the entity holding accounts.

At the end of 2009, there were 2,426,381,281 AAUs in the IT registry of which 2,215,257,469 were in the party holding accounts and 211,123,812 in the entity holding accounts.
The registry contained a total of 27,724,196 CERs: 7,411,755 in the Party holding accounts and 20,312,441 in the entity holding accounts.

The registry did not contain any ERUs, RMUs, t-CERs or l-CERs.

The total amount of the units in the registry corresponded to 2,454,105,477 tonnes CO2 eq. Italy's assigned amount is 2,416,277,898 tonnes CO_2 eq.

In total for 2009, the IT Registry received 20,116,642 AAUs and 22792461 CERs. Conversely, 26,501,513 AAUs and 4,370,667 CERs were externally transferred to other national registries. There were no transactions of any kind involving RMUs, tCERs or lCERs.

Full details are available in the SEF tables reported in Annex 8.

11.3. Discrepancies and notifications

During the reporting period (1st January 2009 - 31st December 2009), no invalid units have been detected, no non-replacements occurred, no notifications were received from the ITL. For a list of discrepant transactions, please refer to Table R-2 in the Excel file included with this submission with the name “SIAR Reports 2010-IT v1.2.xls”.

11.4. Publicly accessible information

Public information required by Decision 13/CMP.1 (account information, JI projects in Italy, holdings and transactions of units, authorised legal entities) is available on the registry website at http://www.greta-public.sinanet.apat.it

11.5 Calculation of the commitment period reserve (CPR)

The commitment period reserve for Italy is 2,174,650,108 tonnes of CO_2 equivalent (or assigned amount units). The CPR has not changed since 2009 submission since it is based on the assigned amount and not on the most recent inventory.

11.6 KP-LULUCF accounting

Italy has decided to account for Article 3.3 and 3.4 LULUCF activities at the end of the commitment period, therefore no information on KP-LULUCF accounting is included in the SEF tables.
In Table 11.1 information on accounting for the KP-LULUCF activities based on the reporting for the year 2008 are given.

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Net emissions/removals(1)		Accounting Parameters(7)	Accounting Quantity (8)
	2008	Total(6)		
A. Article 3.3 activities				
A.1. Afforestation and Reforestation				-1,718.05
A.1.1. Units of land not harvested since the beginning of the commitment period(2)	-1,718.05	-1,718.05		-1,718.05
A.1.2. Units of land harvested since the beginning of the commitment period(2)				
A.2. Deforestation	386.44	386.44		386.44
B. Article 3.4 activities				
B.1. Forest Management (if elected)	-50,730.65	-50,730.65		-50,730.65
3.3 offset(3)			0.00	0.00
FM cap(4)			50,966.67	-50,730.65

(1) All values are reported in table 5(KP) of the CRF for the relevant inventory year as reported in the current submission and are automatically entered in this table.
(2) In accordance with paragraph 4 of the annex to decision 16/CMP.1, debits resulting from harvesting during the first commitment period following Afforestation and Reforestation since 1990 shall not be greater than credits accounted for on that unit of land.
(3) In accordance with paragraph 10 of the annex to decision 16/CMP.1, for the first commitment period, a Party included in Annex I that incurs a net source of emissions under the provisions of Article 3.3 may account for anthropogenic greenhouse gas emissions by sources and removals by sinks in areas under Forest Management under Article 3.4, up to a level that is equal to the net source of emissions under the provisions of Article 3.3, but not greater than 9.0 megatonnes of carbon times five, if the total anthropogenic greenhouse gas emissions by sources and removals by sinks in the managed forest since 1990 is equal to, or larger than, the net source of emissions incurred under Article 3.3.
(4) In accordance with paragraph 11 of the annex to decision 16/CMP.1, for the first commitment period only, additions to and subtractions from the assigned amount of a Party resulting from Forest Management under Article 3.4, after the application of paragraph 10 of the annex to decision 16/CMP.1 and resulting from Forest Management project activities undertaken under Article 6, shall not exceed the value inscribed in the appendix of the annex to decision 16/CMP.1, times five.
(5) Net emissions and removals in the Party's base year, as established by decision 9/CP.2.
(6) Cumulative net emissions and removals for all years of the commitment period reported in the current submission.
(7) The values in the cells "3.3 offset" and "FM cap" are absolute values.
(8) The accounting quantity is the total quantity of units to be added to or subtracted from a Party's assigned amount for a particular activitity in accordance with the provisions of Article 7.4 of the Kyoto Protocol.

Table 11.1 Information table on accounting for activities under art. 3.3 and 3.4 of the Kyoto Protocol, year 2008

Chapter 12: Information on changes in national system

No changes with respect to the last year submission occurred in the Italian National System.

Chapter 13: Information on changes in national registry

According to decision 15 CMP/1, Annex II.E, the only relevant change has been in the name and contact information of the registry administrator designated by Italy to maintain the national registry. The new contact person is

Mr Riccardo Liburdi

Postal address:	Viale Cesare Pavese, 313 - 00144 Rome, Italy
Phone number:	+39 06 5007 2544
Fax number:	+39 06 5007 2657
e-mail address:	riccardo.liburdi@isprambiente.it

In addition, there were two upgrades to the Italian registry in 2009 to improve the system reliability and performance. Version 4.0 and eventually version 4.1 of the Greta software have been installed in order to include requirements specified in the EU Registry Regulation and resolve application bugs.

Chapter 14: Information on minimization of adverse impacts in accordance with Article 3, paragraph 14

14.1 Overview

In the framework of the EU Burden Sharing Agreement, Italy has committed to reduce its GHG emissions by 6.5% below base-year levels (1990) over the first commitment period, 2008-2012. After the review of the initial report of Italy under the Kyoto Protocol (KP), the Kyoto objective was fixed in 483.255 $MtCO_2$ per year for each year of the "commitment period" (UNFCCC, 2007; Minambiente, 2009).

In this section Italy provides an overview of its commitments under Article 3.1, and specifically how it is striving to implement **individually** its commitment under Article 3 paragraph 14 of the KP. Under Article 3.14 of the KP:
"**Each Party** included in Annex I shall strive to implement the commitments mentioned in paragraph 1[37] above in such a way as to minimize adverse **social, environmental and economic** impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9[38], of the Convention. In line with relevant decisions of the Conference of the Parties on the implementation of those paragraphs, the Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, consider what actions are necessary to minimize the adverse effects of climate change and/or the impacts of **response measures** on Parties referred to in those paragraphs. Among the issues to be considered shall be the establishment of **funding, insurance and transfer of technology**.

For the preparation of this Chapter Ispra (ex-APAT) has collected information through the revision of peer review international articles on sustainable development (SD) of ex-ante/ex-post assessments related to activities on climate change mitigation, and through personal communication with people/institutions involved in project/programs/policy implementation of climate change activities. Moreover, experts from the Italian Ministry for the Environment, Land and Sea (IMELS) and the Directorate General for Development Co-operation (DGCS) from the Ministry of Foreign Affairs were contacted.

As the reporting obligation related to Article 3, paragraph 14 does not include an obligation to report on each specific mitigation policy, Italy briefly described how EU is striving to minimize adverse impacts, because Italy is member of the European Union, thus incorporated into its European legal system to implement directives/policies; and individually how Italy it is striving to implement Article 3.14 with specific examples.
Two main parts are requested under Article 3.14 for reporting purposes: commitments to minimize adverse effects (section 14.2, 14.3) and priority actions (section 14.4, 14.5). Future improvements/research activities are expected for next submissions (section 14.6).

[37] **Kyoto Protocol, Art. 3 Par. 1 "**The Parties included in Annex I shall, individually or jointly, ensure that their aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amounts, calculated pursuant to their quantified emission limitation and reduction commitments inscribed in Annex B and in accordance with the provisions of this Article, with a view to reducing their overall emissions of such gases by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012."

[38] **UNFCCC, Art 4. Par 8.** "In the implementation of the commitments in this Article, the Parties shall give full consideration to what actions are necessary under the Convention, including actions related to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures, especially on: (a) Small island countries; (b) Countries with low-lying coastal areas; (c) Countries with arid and semi-arid areas, forested areas and areas liable to forest decay; (d) Countries with areas prone to natural disasters; (e) Countries with areas liable to drought and desertification; (f) Countries with areas of high urban atmospheric pollution; (g) Countries with areas with fragile ecosystems, including mountainous ecosystems; (h) Countries whose economies are highly dependent on income generated from the production, processing and export, and/or on consumption of fossil fuels and associated energy-intensive products; and (i) Landlocked and transit countries. Further, the Conference of the Parties may take actions, as appropriate, with respect to this paragraph." **UNFCCC Art 4. Par. 9**. "The Parties shall take full account of the specific needs and special situations of the least developed countries in their actions with regard to funding and transfer of technology."

14.2 European Commitment under Art 3.14 of the Kyoto Protocol

At European level, impact assessments (IA) are required for most important Commission **initiatives, policy and programs** and those which will have the most far-reaching impacts. In 2009, IA was adopted, replacing the previous Guidelines 2005 and also the 2006 update. In general, the IA evidence advantages and disadvantages of possible policy options by assessing their potential impacts. Among different issues, it should be assessed which are the likely **social, environmental** and **economic** impacts of those options (European Commission, 2009[a]). Since 2003 all IA of EU policies are listed and published by subject online (European Commission, 2010[a]).

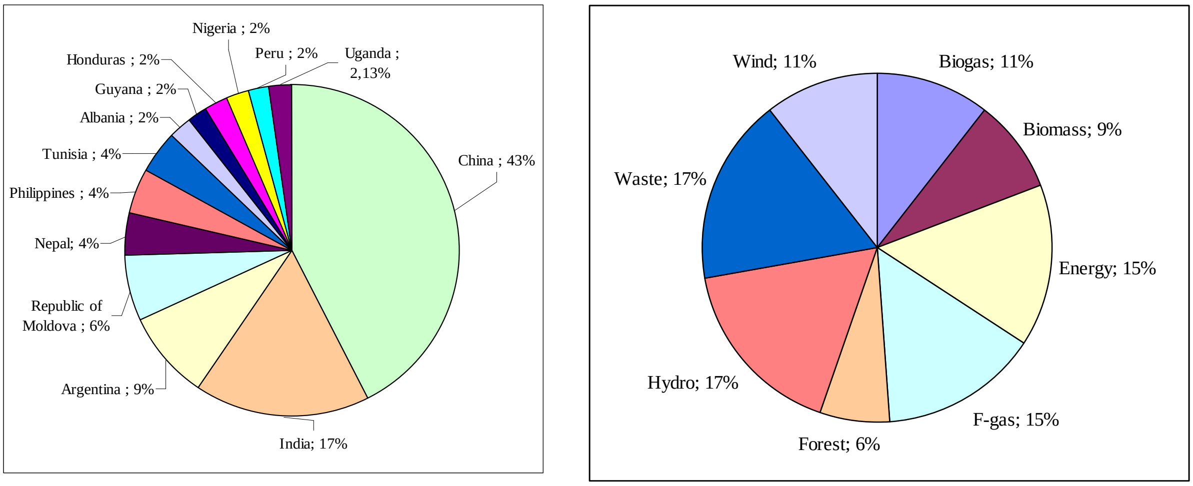
A review of European **response measures** for two EU policies were chosen for further description because the IA identified potential impacts on thirds countries. These measures are the Directive 2009/28/EC on the promotion of the use of renewable energy, and the EU emission trading scheme for the inclusion of the aviation. Information is further provided in European Commission (2009[b]) and European Commission (2010[b]). However, many developing countries and least developed countries (LDC) are based on the agricultural production, therefore, it will be important to understand how the *EU Common Agricultural Policy (CAP) Health Check*, together with the new targets on climate change and renewable energies will potentially influence developing countries. Some information on cereal intervention options on third parties have been identified (European Commission, 2008). Some studies on impact of agricultural policies are also available (Schmidhuber, 2009; Hallam, 2010).

14.3 Italian commitment under Art 3.14 of the Kyoto Protocol

Article 3, paragraph 14 of the KP is related to Annex I Parties' way of implementing commitments under Article 3.1 of the KP. Therefore, it addresses the implementation of the quantified emission limitation and reduction objectives (QELROs) under Article 3.1, the implementation of LULUCF activities under Article 3 paragraphs 3 and 4, the use of Emission Reduction Units (ERUs) and Certified Emission Reductions (CERs) under Article 3 paragraphs 10, 11, and 12.
Italy is aware of the potential direct and indirect impact of measures/policies and tries to ensure that the implementation of national mitigation policies under the KP does not impact other parties. Minimizing adverse effects of policies/measures are described in Chapter 4.6 in the Fifth National Communication (Minambiente, 2009). Information of activities under Article 3 paragraphs 3 and 4 of the KP is described in 'Chapter 10' KP-LULUCF' of this report.

National and sectoral Italian policies are expected to have no direct impacts in developing countries. Policies and measures in the Italian energy sector aim to increase energy efficiency and develop a low-carbon energy system but in the context of a global energy scenarios that do not foresee a decline in income for fossil fuel exporting countries (IEA, World Energy Outlook 2008). Direct impacts are only expected with measures undertaken with the Kyoto mechanism.
At international level, efforts to tackle adverse **social, economic,** and **environmental** impacts of mitigation actions have been concretely assessed in the framework of the Kyoto Mechanisms. Hence, this section has concentrated efforts to analyze the specific context of the Kyoto flexible mechanisms in order to provide response to reporting requirements under Article 3.14 of KP.

For this section, information was collected from the Clean Development Mechanism (CDM) Project Search Database of the UNFCCC[39]. Direct contact with experts involved in the CDM project cycle and peer review article were revised.
By the time CDM database was consulted, Italy as investor Party, contributes with 1.87% of world-wide CDM project portfolio (UNFCCC, 2010). Information of the **47 registered** CDM projects, in which Italy is involved, is shown in Annex 8. Projects are for the 38% small scale projects; 34% consolidated methodologies; 21% large scale; and 6% afforestation/reforestation (A/R) projects. Italy is the only proposer for 36% of the CDM projects. In Figure 14.1 the distribution of CDM projects by Host country and type is presented. CDM projects are mainly located in China (n◦20), India (n◦8), Argentina (n◦4) and Republic of Moldova (n◦3) representing 74% of the total. Projects by type are mainly related with renewable energies (64%).



Source: UNFCCC (2010)
Figure 14.1 Italian CDM projects by Host country and type (by 16/03/2010)

Procedure for assessing sustainability at local and national level

Countries should follow a project cycle to propone CDM projects (first designing phase and realization phase). During the first phase, among other activities, Parties participating in the CDM shall designate a national authority (DNA). Each Host Party has implemented a procedure for assessing CDM projects. The DNA evaluates project documentation against a set of pre-defined criteria, which tend to encompass **social, environmental** and **economic** aspects. For instance, India has SD criteria such as the social, economic, environmental and technological 'well-being'. Instead, China discriminated projects by priority area and by gas based-approach (Olsen and Fenhann, 2008; Boyd et al., 2009).
Most of the CDM projects (if large-scale) are subject to ex-ante assessments. For instance, environmental impact assessments (EIA) are required. In other cases, because of the size of the project, EIA are not necessary. Still some CDM projects have performed voluntary EIA. This is the case for the *Santa Rosa* Hydroelectric CDM project (Peru)[40] (see Annex 8). After, a second evaluation is performed by the DNA as described previously. For example, in the Peruvian DNA, the process follows the: submission of the project to the Ministry of competence on the activities, a site visit of the project done by the Ministry of Environment, and the conformation of an *ad hoc*

[39] World-wide seventy four (74%) percent of CDM projects are represented by China (37%), India (23%), Mexico (8%) and Brazil (6%). Seventy nine (79%) of the distribution of registered projects by scope is represented by energy industries - renewable/non renewable sources - (61%) and waste handling and disposal (18%). Fifteen percent (15%) is given by manufacturing industries (5%), fugitive emissions from fuels (5%), and agriculture projects (5%).
[40] Personal communication, Claudia Monsalve/Lorenzo Eguren – *Endesa Carbono* (29/03/2010).

committee that evaluate projects considering legal, **social, environmental** and **economic** criteria[41]. Thus, possible impacts of the CDM projects are mainly subject to local and national verification.
In some cases, an ex-post assessment could be also performed by the Designated Operational Entities (DOE), which validated CDM projects and certifies as appropriate and requests the Board to issue CERs. For some CDM projects, for instance, *Poechos I* Hydroelectric project (Peru), CERs are approve only if the project complies also with **social** and **environmental** conditions [41].

Another feedback for participating to CDM project with SD characteristics comes from the carbon funds. For instance, Italy participates to the *BioCarbon Fund* (BCF), the *Community Development Carbon Fund* (CDCF) and the *Italian Carbon Fund* (ICF). Specifically, the first two funds aim to finance projects with strong **social** impact at local level, that combine community development attributed with emission reductions and will significantly improve the live of the poor and their local environment [42].
In addition Italy agreed to accept in principle common guidelines for approval of large hydropower project activities. EU Member States have arrived at uniform guidelines on the application of Article 11b(6) of the Directive 2004/101/EC to ensure compliance (of such projects) with the international criteria and guidelines, including those contained in the World Commission on Dams 2000 Report. It aims to ensure that hydro projects are developed along the SD and the not damaging to the environment (exploring possible alternatives) and addressing such issues as gaining public acceptance, and fair and equitable treatment of stakeholders, including local and indigenous people[43].
Regarding the Joint Implementation (JI) activities, the Italian Carbon Fund has the 'Russian Federation: Rosneft Associated Gas Recovery Project for the Komsomolskoye Oild Field' under the validation phase (Carbon Finance, 2010).

Assessment of social, environmental, and economic effects of CDM projects

The assessment of adverse **social, environmental,** and **economic** impacts contribution of CDM projects has been concentrated in the energy sector (or **non-forestry** CDM projects). Relevant literature is presented in this section. Most common used methodologies for assessing sustainability are checklists and multicriteria assessments (Olsen 2007). For instance, Sirohi (2007) has qualitatively analyzed and discussed the Project Design Document (PDD) of 65 CDM projects covering all the types of CDM project activity in **India**. Results from this paper show that the benefits of the projects focusing on improving energy efficiency in industries, fossil fuel switching in industrial units and destruction of HFC-23 would remain largely "firm-specific" and are unlikely to have an impact on rural poverty. Boyd et al. (2009) have chosen randomly 10 CDM projects that capture diversity of project types and regions. Environment and development benefits (environment, economic, technology transfer, health, employment, education and other social) were assessed qualitatively. This review shows divergences and no causal relationship between project types and SD outcomes.
Sutter and Parreño (2007) assessed CDM projects in terms of their contribution to employment generation, equal distribution of CDM returns, and improvement of local air quality. The multi-attribute assessment methodology (MATA-CDM) for non-forestry CDM projects was used for assessing 16 CDM projects registered at UNFCCC as of August 30, 2005. Results indicated that projects might contribute to one of the two CDM objectives (GHG emission reductions and SD in the Host country), but neither contributes strongly to both objectives. Uruguay's DNA has adopted this tool for approval of CDM projects.

[41] Personal communication, Laura Reyes – CDM expert, *Dirección General de Cambio Climático,Desertificación y Recursos Hídricos, Ministerio del Ambiente – MINAM* (22/03/2010).
[42] Personal communication, Vanessa Leonardi, CDM expert, Department for Sustainable Development, Climate Change and Energy, Italian Ministry for the Environment, Land and Sea (01/04/2010).

Nussbaumer (2009) has presented a multicriteria assessment of 39 CDM projects. Label CDM projects ('Gold Standard' label rewards best-practice and Community Development Carbon Fund focuses activities in underprivileged communities) were compared to similar non-labeled CDM projects. Results show that labeled CDM activities tend to slightly outperform comparable projects, although not unequivocally.
Some studies have also addressed the assessment of **forestry** CDM projects. Olsen and Fenhann (2008) have developed a taxonomy for sustainability assessment based on PDD text analysis. A study, for the first time, has addressed the choice of an appropriate method for measuring **strong sustainability**. In a decision-making process, an ex-ante assessment of 10 CDM forestry projects were assessed in a comprehensive way through decision criteria that reflect global and local interests using a non-compensatory multicriteria method (Cóndor et al., 2010).

Thirty-eight percent (38%) of CDM projects in which Italy has participated were also subject to international analysis. In Annex 8 CDM projects analyzed in research studies are shown. For instance, two (out from three) CDM forestry projects in which Italy is the only proposer (Assisted Natural Regeneration of Degraded Lands in Albania) and the one proposed with Spain (Facilitating Reforestation for Guangxi Watershed Management in China) were identified as 'reasonably synergistic' (Cóndor et al., 2010).

14.4 Funding, strengthening capacity and transfer of technology

According to Art 3.14 of the KP information on funding and transfer of technology need to be described, thus, brief information is provided in this section.

Between 2006 and 2008 the Italian Ministry of Foreign Affairs has contributed with around 30 million EUR in **bilateral** and **multilateral** cooperation with developing countries for climate change related activities. In order to contribute to the implementation of the commitment foreseen in the "Bonn Declaration", since 2002 the Italian Ministry for the Environment, Land and Sea (IMELS), has been authorized to finance bilateral and multilateral activities in developing countries for 55.1 million EUR/year as of 2008 (Minambiente, 2009). A recent peer review report of the Development Assistance Committee (DAC) describes bilateral and multilateral cooperation funding activities in Italy. The Directorate General for Development Co-operation (DGCS) from the Ministry of Foreign Affairs in collaboration with other players in Italian Co-operation is in charge of implementing recommendations (OECD, 2009). The most important institutional actor is the Ministry for the Environment, Land and Sea, because of its contribution to implementing the Kyoto Protocol and other Rio conventions in developing countries. Programming guidelines and Directions of Italian Development Co-operation 20010-2012 are available (DGCS, 2010[a]). The aid **effectiveness** as a top priority for cooperation as described in the 'Italian Aid Effectiveness Action Plan' (DGCS, 2009).
The Ministry of foreign Affairs has a database of environmental projects available online (DGCS, 2010[b]). The ecosystem approach management is a strategy adopted by Italian cooperation. In the environment field, projects that have been monitored by the Central Technical Unit/DGCS - Ministry of foreign Affairs, are subject to field visit and ex-post assessments in order to verify compliance in the framework of climate change activities[43].

[43] Personal communication, Alfredo Guillet/Giorgio Grussu, DGCS/Central Technical Unit of the Ministry of Foreign Affairs.

Italian multilateral cooperation on climate change has been performed with different United Nations organizations, funds, and institutions[44]. Cooperation has involved from the supply of financial resources, to the design and implementation of programmes and projects, the promotion of transfer of environmentally-sound technologies aiming at reducing the impacts of human activities on climate change, and support to adaptation measures. **Italian bilateral** cooperation continues activities described in the Fourth National Communication to the UNFCCC and has implemented new projects on climate change. Focus is given to different geographical regions world-wide[45]. Funding climate change and related topics in developing countries has different and ambitious objective: efficient use of energy, implementation of innovative financial mechanisms, efficient water management, carbon sequestration, professional training, and exchange of know-how, promotion of eco-efficient technologies. Further detailed description is given in 'Chapter 7 Financial assistance and Technology Transfer' of the Fifth National Communication from Italy (Minambiente, 2007; 2009; 2010).
The DGCS of the Ministry of Foreign Affairs is contributing with bilateral projects in the energy sector, for example, in Albania, Bangladesh, Sierra Leone and Palestinian territories (improvement of electric system or hydroelectric power generation) (DGCS, 2010[b]). An example is the hydroelectric project in Ethiopia that has been supported by the Ministry of Foreign Affairs. Next step of this project will be an ex-post assessment of adverse effects through the use of the OECD-DAC guidelines[46]. These guidelines include the assessment of the relevance, effectiveness, efficiency, impact (positive/negative) and **sustainability** of the activities (OECD, 2008).

Evidence of technology transfer activities has been found is the context of the Kyoto Mechanisms. A recent study has analyzed comprehensively technology transfer in the CDM: 3296 registered and proposed projects (Seres et al., 2009). Results address that roughly 36% of the projects accounting for 59% of the annual emission reductions claim to involve technology transfer. Authors also concluded that as the number of projects increases, technology transfer occurs beyond the individual projects. This is observed for several of the most common project types in China and Brazil with the result that the rate of technology transfer for new projects in those countries has fallen significantly.

14.5 Priority actions in implementing commitments under Article 3 paragraph 14

For the purposes of completeness in reporting, and according to the reporting guidelines for supplementary information (UNFCCC, 2002), specific information in the way Italy is striving to minimize adverse impacts are described in Table 14.1. The preparation of this table was discussed with an expert in the energy sector/emission scenarios from Italy[47].

[44] Italian multilateral cooperation with the United Nations Educational, Scientific and Cultural Organization (UNESCO), United Nations Industrial Development Organization (UNIDO), Food and Agriculture Organization of the United Nations (FAO), the Regional Environmental Centre for Central and Eastern Europe (REC), the Global Environment Facility (GEF), the World Bank (WB), International Union for Conservation of Nature (IUCN), the United Nations Environment Programme (UNEP), United Nations Development Programme (UNDP) and the Mediterranean Action Plan (MAP).
[45] Italian bilateral cooperation with the Asian and Middle East countries (China, Iraq, Thailand and India), Mediterranean and African region (Algeria, Egypt, Israel, Tunisia, Morrocco), Central and Eastern European countries (Albania, Bosnia, Croatia, Bulgaria, Serbia, Montenegro, Macedonia, Poland, Romania, Turkey, Hungary, Kyrgyzstan and Tajikistan), and Latin America, the Caribean and the Pacific Islands (Belize, Argentina, Mexico, Cuba, Brazil, 14 countries of the South Pacific Small Islands Developing States).
[46] Giancarlo Palma, DGCS/ Central Technical Unit of the Ministry of Foreign Affairs
[47] Personal communication, Mario Contaldi - expert in the energy sector and emission scenarios from Ispra, ex-APAT (12/04/2010).

Actions	References
(a) The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities;	EU emission trading scheme, promotion of biomass and biofuel, Common Agricultural Policy can potentially have impacts in developing countries. See European Commission, 2009[b]; 2010[b]. Italy is subject to the European legal system, it will implement the EU legislation; it is not planned to further increase biomass – biofuel objectives.
(b) Removing subsidies associated with the use of environmentally unsound and unsafe technologies;	Council regulation EC No 1407/2002 rules for granting state aid to contribute to restructure coal industry. See European Commission, 2010[b]. Italy has a negligible domestic coal production.
(c) Cooperating in the technological development of non-energy uses of fossil fuels, and supporting developing country Parties to this end;	At the national as well as European level, 'non-energy uses of fossil fuels' is not a current research priority.
(d) Cooperating in the development, diffusion, and transfer of less greenhouse gas emitting advanced fossil-fuel technologies, and/or technologies relating to fossil fuels that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other non-Annex I Parties in this effort;	The ongoing activities on multilateral and bilateral Italian cooperation are coordinated through the Ministry of Foreign Affairs and the Ministry for the Environment, Land and Sea, see Minambiente (2009).
(e) Strengthening the capacity of developing country Parties identified in Article 4, paragraphs 8 and 9, of the Convention for improving efficiency in upstream and downstream activities relating to fossil fuels, taking into consideration the need to improve the environmental efficiency of these activities;	The ongoing activities on multilateral and bilateral Italian cooperation are coordinated through the Ministry of Foreign Affairs and the Ministry for the Environment, Land and Sea, see Minambiente (2009).
(f) Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies.	The ongoing activities on multilateral and bilateral Italian cooperation are coordinated through the Ministry of Foreign Affairs and the Ministry for the Environment, Land and Sea, see Minambiente (2009).

Table 14.1 Priority actions under in implementing commitments under Article 3.14

14.6 Future activities related to the commitment of Article 3.14 of the Kyoto Protocol

Italy is aware of its commitments under Article 3.14 of KP. Different national and international mechanisms and guidelines are guiding the prevention of adverse effects while implementing projects in developing countries. Different activities have been identified for future commitments under Art 3.14. For instance, priority actions need to be further classified into positive and negative, direct and indirect, and social, environmental and economic features. Another activity could be to identify and collect information related to climate change mitigation activities being implemented by private Italian companies world-wide. Therefore, direct contact with the private sector could be important. For instance, in its sustainable report ENI (private Italian energy company) has addressed GHG emission reduction objectives (ENI, 2008). Another private company is Enel[48], the Italy's largest power company that is one of the main worldwide operators applying the CDM which incentivize action on climate in favor of the transfer of technologies in developing countries (Enel, 2008). Finally, projects from decentralized development cooperation (regions) need to be taken into account for future activities (OICS, 2010).

[48] Personal communication, Giuseppe Montesano - Head of Environmental Policies, Regulation and Environment, Enel spa (12/04/2010).

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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 2008, 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, 18 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, 28 categories were selected jointly by the Tier 1 and the Tier 2.
For the year 2008, 17 sources were individuated by the Tier 1 approach accounting for 95% of the total emissions, without LULUCF; for the trend 15 key sources were selected. Jointly for both the Tier 1 level and trend, 22 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 2008, and, in trend assessment, 20 key categories are observed. Jointly for both the Tier 1 level and trend, 25 key categories were totally individuated.

The application of the Tier 2 to the 2008 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 2008, accounting for the 95% of the total levels uncertainty; for the trend analysis including LULUCF categories, the key categories were also 21 with some differences with respect to the previous list. Jointly for both the level and trend, 23 key categories were totally individuated.

A1.2 Tier 1 key category assessment

As described in the IPCC Good Practice Guidance (IPCC, 2000; IPCC, 2003), 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:

$$\text{Key Category Level Assessment} = \frac{|\text{Source or Sink Category Estimate}|}{\text{Total Contribution}}$$

$$L_{x,t}^{*} = \left| E_{x,t}^{*} / E_{t}^{*} \right|$$

where
$L_{x,t}^{*}$ = level assessment for source or sink x in year t;
$E_{x,t}^{*} = |E_{x,t}|$ absolute value of emission and removal estimate of source or sink category x in year t;
$E_{t}^{*} = \sum_{x} |E_{x,t}|$ total contribution, which is the sum of the absolute values of emissions and removals
in year t.
The asterics (*) indicates that the contribution of all categories (including LULUCF categories) are entered as absolute values.

Therefore, key categories are those which, when summed in descending order of magnitude, add up to over 95% of the total 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:

$$\text{Source or Sink Category Trend Assessment} =$$
$$(\text{Source or Sink Category Level Assessment}) \cdot |\text{Source or Sink Category Trend - Total Trend}|$$

$$T_{x,t}^{*} = E_{x,t}^{*} / E_{t} \cdot \left| \left[(E_{x,t} - E_{x,0}) / E_{x,t} \right] - \left[(E_{t} - E_{0}) / E_{t} \right] \right|$$

where
$T_{x,t}^{*}$ = trend assessment, which is the contribution of the source or sink category trend to the overall inventory trend;
$E_{x,t}^{*} = |E_{x,t}|$ absolute value of emission and removal estimate of source or sink category *x* in year *t*;
$E_{x,t}\ and\ E_{x,0}$ = real values of estimates of source or sink category *x* in years *t* and 0, respectively;
$E_{t}\ and\ E_{0} = \sum_{x} E_{x,t}\ and \sum_{x} E_{x,0}$ total inventory estimates in years *t* and 0, respectively.

The source or sink category trend is the change in the category emissions over time, computed by subtracting the base year estimate for a generic category from the 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. In circumstances where the current year emissions for a given vategory are zero, the expression is reformulated to avoid zero in the denominator

$$T_{x,t}^{*} = \left| E_{x,0} / E_t \right|$$

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 2008 inventory.

The results of the Tier 1 method are shown in Table A1.1 and Table A1.2, reporting level and trend assessment without LULUCF categories. Results of the key categories analysis with the LULUCF categories are reported in Table A1.3 and Table A1.4.

CATEGORIES	2008 Gg CO_2eq	Level assessment	Cumulative Percentage
CO2 stationary combustion gaseous fuels	162,029	0.299	0.30
CO2 Mobile combustion: Road Vehicles	113,945	0.210	0.51
CO2 stationary combustion liquid fuels	84,009	0.155	0.66
CO2 stationary combustion solid fuels	65,128	0.120	0.79
CO2 Cement production	16,127	0.030	0.81
CH4 from Solid waste Disposal Sites	11,076	0.020	0.84
CH4 Enteric Fermentation in Domestic Livestock	10,921	0.020	0.86
Direct N2O Agricultural Soils	8,122	0.015	0.87
HFC, PFC substitutes for ODS	7,371	0.014	0.88
Indirect N2O from Nitrogen used in agriculture	7,104	0.013	0.90
CO2 Mobile combustion: Waterborne Navigation	5,111	0.009	0.91
CH4 Fugitive emissions from Oil and Gas Operations	5,041	0.009	0.92
CO2 stationary combustion other fuels	4,943	0.009	0.93
N2O Manure Management	3,775	0.007	0.93
N2O stationary combustion	3,768	0.007	0.94
CH4 Manure Management	2,961	0.005	0.94
CH4 Emissions from Wastewater Handling	2,843	0.005	0.95
CO2 Mobile combustion: Aircraft	2,301	0.004	0.95
CO2 Lime production	2,276	0.004	0.96
CO2 Fugitive emissions from Oil and Gas Operations	2,258	0.004	0.96
CO2 Limestone and Dolomite Use	2,206	0.004	0.97
CO2 Other industrial processes	2,050	0.004	0.97
N2O Emissions from Wastewater Handling	2,036	0.004	0.97
CO2 Mobile combustion: Other	1,856	0.003	0.98
N2O from animal production	1,569	0.003	0.98
CO2 Iron and Steel production	1,424	0.003	0.98
CH4 from Rice production	1,396	0.003	0.99
CO2 Emissions from solvent use	1,272	0.002	0.99
N2O Mobile combustion: Road Vehicles	978	0.002	0.99
CH4 stationary combustion	977	0.002	0.99
CO2 Ammonia production	882	0.002	0.99
N2O Emissions from solvent use	727	0.001	0.99
N2O Adipic Acid	707	0.001	1.00
SF6 Electrical Equipment	394	0.001	1.00
N2O Nitric Acid	358	0.001	1.00
CH4 Mobile combustion: Road Vehicles	296	0.001	1.00
CH4 Emissions from Waste Incineration	282	0.001	1.00
CO2 Emissions from Waste Incineration	250	0.000	1.00
N2O Emissions from Waste Incineration	123	0.000	1.00
PFC, HFC, SF6 Semiconductor manufacturing	121	0.000	1.00
PFC Aluminium production	111	0.000	1.00
N2O Mobile combustion: Other	104	0.000	1.00
CH4 Fugitive emissions from Coal Mining and Handling	73	0.000	1.00
CH4 Industrial Processes	61	0.000	1.00
N2O Mobile combustion: Waterborne Navigation	37	0.000	1.00
CH4 Mobile combustion: Waterborne Navigation	28	0.000	1.00
N2O Mobile combustion: Aircraft	20	0.000	1.00
CH4 Agricultural Residue Burning	14	0.000	1.00
SF6 Magnesium production	11	0.000	1.00
CH4 Emissions from Other Waste	4.4	0.000	1.00
N2O Agricultural Residue Burning	4.2	0.000	1.00
CH4 Mobile combustion: Other	2.7	0.000	1.00
CH4 Mobile combustion: Aircraft	1.4	0.000	1.00
N2O Fugitive emissions from Oil and Gas Operations	1.2	0.000	1.00
N2O Other industrial processes	0.0	0.000	1.00
SF6 Production of SF6	0.0	0.000	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.0	0.000	1.00

Table A1.1 Results of the key categories analysis without LULUCF. Tier 1 Level assessment, year 2008

CATEGORIES	Contribution to trend (%)	Cumulative Percentage
CO2 stationary combustion liquid fuels	0.37	0.37
CO2 stationary combustion gaseous fuels	0.35	0.71
CO2 Mobile combustion: Road Vehicles	0.08	0.79
HFC, PFC substitutes for ODS	0.03	0.82
N2O Adipic Acid	0.02	0.84
CO2 stationary combustion other fuels	0.01	0.86
CO2 stationary combustion solid fuels	0.01	0.87
CH4 from Solid waste Disposal Sites	0.01	0.89
CH4 Fugitive emissions from Oil and Gas Operations	0.01	0.90
CO2 Ammonia production	0.01	0.91
Direct N2O Agricultural Soils	0.01	0.92
CO2 Iron and Steel production	0.01	0.93
CH4 Enteric Fermentation in Domestic Livestock	0.01	0.93
N2O Nitric Acid	0.01	0.94
PFC Aluminium production	0.01	0.95
Indirect N2O from Nitrogen used in agriculture	0.01	0.96
CO2 Fugitive emissions from Oil and Gas Operations	0.01	0.96
CH4 Emissions from Wastewater Handling	0.00	0.97
CO2 Cement production	0.00	0.97
CH4 Manure Management	0.00	0.97
CO2 Mobile combustion: Aircraft	0.00	0.98
CO2 Mobile combustion: Waterborne Navigation	0.00	0.98
CO2 Emissions from solvent use	0.00	0.98
CH4 Mobile combustion: Road Vehicles	0.00	0.98
HFC-23 from HCFC-22 Manufacture and HFCs fugiti	0.00	0.98
N2O Manure Management	0.00	0.99
CO2 Emissions from Waste Incineration	0.00	0.99
CH4 stationary combustion	0.00	0.99
CO2 Limestone and Dolomite Use	0.00	0.99
N2O from animal production	0.00	0.99
CH4 from Rice production	0.00	0.99
SF6 Electrical Equipment	0.00	0.99
N2O stationary combustion	0.00	0.99
N2O Mobile combustion: Road Vehicles	0.00	1.00
CO2 Lime production	0.00	1.00
CO2 Mobile combustion: Other	0.00	1.00
SF6 Production of SF6	0.00	1.00
N2O Emissions from solvent use	0.00	1.00
CO2 Other industrial processes	0.00	1.00
CH4 Emissions from Waste Incineration	0.00	1.00
N2O Emissions from Wastewater Handling	0.00	1.00
CH4 Fugitive emissions from Coal Mining and Handli	0.00	1.00
CH4 Industrial Processes	0.00	1.00
N2O Mobile combustion: Other	0.00	1.00
N2O Emissions from Waste Incineration	0.00	1.00
N2O Other industrial processes	0.00	1.00
N2O Mobile combustion: Aircraft	0.00	1.00
CH4 Emissions from Other Waste	0.00	1.00
N2O Mobile combustion: Waterborne Navigation	0.00	1.00
CH4 Mobile combustion: Waterborne Navigation	0.00	1.00
CH4 Mobile combustion: Other	0.00	1.00
CH4 Mobile combustion: Aircraft	0.00	1.00
N2O Agricultural Residue Burning	0.00	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.00	1.00
CH4 Agricultural Residue Burning	0.00	1.00
SF6 Magnesium production	0.00	1.00
PFC, HFC, SF6 Semiconductor manufacturing	0.00	1.00

Table A1.2 Results of the key categories analysis without LULUCF. Tier 1 Trend assessment, 1990- 2008

CATEGORIES	2008 Gg CO_2eq	Level assessment	Cumulative Percentage
CO2 stationary combustion gaseous fuels	162,029	0.255	0.26
CO2 Mobile combustion: Road Vehicles	113,945	0.179	0.43
CO2 stationary combustion liquid fuels	84,009	0.132	0.57
CO2 stationary combustion solid fuels	65,128	0.103	0.67
CO2 Forest land remaining Forest Land	63,026	0.099	0.77
CO2 Cement production	16,127	0.025	0.79
CO2 Cropland remaining Cropland	13,239	0.021	0.81
CH4 from Solid waste Disposal Sites	11,076	0.017	0.83
CH4 Enteric Fermentation in Domestic Livestock	10,921	0.017	0.85
Direct N2O Agricultural Soils	8,122	0.013	0.86
HFC, PFC substitutes for ODS	7,371	0.012	0.87
Indirect N2O from Nitrogen used in agriculture	7,104	0.011	0.88
CO2 Grassland remaining Grassland	7,032	0.011	0.90
CO2 Land converted to Grassland	5,639	0.009	0.90
CO2 Mobile combustion: Waterborne Navigation	5,111	0.008	0.91
CH4 Fugitive emissions from Oil and Gas Operations	5,041	0.008	0.92
CO2 stationary combustion other fuels	4,943	0.008	0.93
N2O Manure Management	3,775	0.006	0.93
N2O stationary combustion	3,768	0.006	0.94
CO2 Land converted to Settlements	3,253	0.005	0.95
CH4 Manure Management	2,961	0.005	0.95
CH4 Emissions from Wastewater Handling	2,843	0.004	0.95
CO2 Mobile combustion: Aircraft	2,301	0.004	0.96
CO2 Lime production	2,276	0.004	0.96
CO2 Fugitive emissions from Oil and Gas Operations	2,258	0.004	0.97
CO2 Limestone and Dolomite Use	2,206	0.003	0.97
CO2 Other industrial processes	2,050	0.003	0.97
N2O Emissions from Wastewater Handling	2,036	0.003	0.98
CO2 Mobile combustion: Other	1,856	0.003	0.98
CO2 Land converted to Forest Land	1,667	0.003	0.98
N2O from animal production	1,569	0.002	0.98
CO2 Iron and Steel production	1,424	0.002	0.99
CH4 from Rice production	1,396	0.002	0.99
CO2 Emissions from solvent use	1,272	0.002	0.99
N2O Mobile combustion: Road Vehicles	978	0.002	0.99
CH4 stationary combustion	977	0.002	0.99
CO2 Ammonia production	882	0.001	0.99
N2O Emissions from solvent use	727	0.001	1.00
N2O Adipic Acid	707	0.001	1.00
SF6 Electrical Equipment	394	0.001	1.00
N2O Nitric Acid	358	0.001	1.00
CH4 Mobile combustion: Road Vehicles	296	0.000	1.00
CH4 Emissions from Waste Incineration	282	0.000	1.00
CO2 Emissions from Waste Incineration	250	0.000	1.00
N2O Emissions from Waste Incineration	123	0.000	1.00
PFC, HFC, SF6 Semiconductor manufacturing	121	0.000	1.00
PFC Aluminium production	111	0.000	1.00
N2O Mobile combustion: Other	104	0.000	1.00
CH4 Fugitive emissions from Coal Mining and Handling	73	0.000	1.00
CH4 Industrial Processes	61	0.000	1.00
CH4 Forest land remaining Forest Land	46	0.000	1.00
N2O Mobile combustion: Waterborne Navigation	37	0.000	1.00
CH4 Mobile combustion: Waterborne Navigation	28	0.000	1.00
N2O Mobile combustion: Aircraft	20	0.000	1.00
CH4 Agricultural Residue Burning	14	0.000	1.00
SF6 Magnesium production	11	0.000	1.00
N2O Forest land remaining Forest Land	4.7	0.000	1.00
CH4 Emissions from Other Waste	4.4	0.000	1.00

Table A1.3 Results of the key categories analysis with LULUCF. Tier1 Level assessment, year 2008

CATEGORIES	Contribution to trend (%)	Cumulative Percentage
CO2 stationary combustion gaseous fuels	0.31	0.31
CO2 stationary combustion liquid fuels	0.29	0.60
CO2 Forest land remaining Forest Land	0.08	0.69
CO2 Mobile combustion: Road Vehicles	0.08	0.77
CO2 Cropland remaining Cropland	0.03	0.80
HFC, PFC substitutes for ODS	0.03	0.83
CO2 stationary combustion solid fuels	0.02	0.85
N2O Adipic Acid	0.02	0.87
CO2 stationary combustion other fuels	0.01	0.88
CO2 Grassland remaining Grassland	0.01	0.89
CH4 Fugitive emissions from Oil and Gas Operations	0.01	0.90
CH4 from Solid waste Disposal Sites	0.01	0.91
CO2 Ammonia production	0.01	0.92
N2O Nitric Acid	0.01	0.93
CO2 Iron and Steel production	0.01	0.93
PFC Aluminium production	0.01	0.94
Direct N2O Agricultural Soils	0.01	0.95
CH4 Enteric Fermentation in Domestic Livestock	0.01	0.95
CO2 Fugitive emissions from Oil and Gas Operations	0.00	0.96
CO2 Land converted to Settlements	0.00	0.96
Indirect N2O from Nitrogen used in agriculture	0.00	0.97
CO2 Land converted to Forest Land	0.00	0.97
CH4 Emissions from Wastewater Handling	0.00	0.97
CO2 Mobile combustion: Aircraft	0.00	0.98
CO2 Land converted to Cropland	0.00	0.98
CH4 Manure Management	0.00	0.98
CH4 Mobile combustion: Road Vehicles	0.00	0.98
CO2 Emissions from solvent use	0.00	0.98
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.00	0.98
CO2 Mobile combustion: Waterborne Navigation	0.00	0.99
CH4 stationary combustion	0.00	0.99
N2O stationary combustion	0.00	0.99
CO2 Emissions from Waste Incineration	0.00	0.99
CO2 Lime production	0.00	0.99
CO2 Other industrial processes	0.00	0.99
N2O Mobile combustion: Road Vehicles	0.00	0.99
SF6 Electrical Equipment	0.00	0.99
CO2 Limestone and Dolomite Use	0.00	0.99
N2O from animal production	0.00	0.99
CH4 from Rice production	0.00	1.00
N2O Emissions from Wastewater Handling	0.00	1.00
N2O Manure Management	0.00	1.00
CH4 Emissions from Waste Incineration	0.00	1.00
SF6 Production of SF6	0.00	1.00
CH4 Forest land remaining Forest Land	0.00	1.00
N2O Emissions from solvent use	0.00	1.00
N2O Land converted to Cropland	0.00	1.00
CH4 Fugitive emissions from Coal Mining and Handling	0.00	1.00
CH4 Industrial Processes	0.00	1.00
CO2 Mobile combustion: Other	0.00	1.00
N2O Emissions from Waste Incineration	0.00	1.00
N2O Mobile combustion: Other	0.00	1.00
CO2 Cement production	0.00	1.00
N2O Other industrial processes	0.00	1.00
N2O Forest land remaining Forest Land	0.00	1.00
N2O Mobile combustion: Aircraft	0.00	1.00
CH4 Emissions from Other Waste	0.00	1.00
N2O Mobile combustion: Waterborne Navigation	0.00	1.00

A1.4 Results of the key categories analysis with LULUCF. Tier 1 Trend assessment, 1990-2008

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 15 with some differences with respect to the previous list (Tables A1.1, A1.2).
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 (Tables A1.3, A1.4).

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 2008 inventory.
The results of the approach are reported in Table A1.5, for the year 2008, 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 Table A1.6, results by category, concerning only CO_2 emissions and removals, are reported whereas in Table A1.7, results include CO_2, CH_4, N_2O emissions and removals. Finally, in Table A1.8 figures of inventory total uncertainty, including the LULUCF sector, are shown.

IPCC	Gas	Emissions		Uncertainty		Combined uncertainty		Sensitivity		Trend uncertainty		
Source category		1990	2008	AD	EF	%	% of total national emissions 2008	Type A	Type B	in national emissions introduced by EF uncertainty	in national emissions introduced by AD uncertainty	in total national emissions
		Gg	Gg									
CO2 stationary combustion liquid fuels	CO2	153,467	84,009	3%	3%	0.042	0.007	-0.148	0.162	-0.004	0.007	0.008
CO2 stationary combustion solid fuels	CO2	59,397	65,128	3%	3%	0.042	0.005	0.006	0.126	0.000	0.005	0.005
CO2 stationary combustion gaseous fuels	CO2	85,066	162,029	3%	3%	0.042	0.013	0.141	0.313	0.004	0.013	0.014
CO2 stationary combustion other fuels	CO2	1,779	4,943	3%	3%	0.042	0.000	0.006	0.010	0.000	0.000	0.000
CH4 stationary combustion	CH4	647	977	3%	50%	0.501	0.001	0.001	0.002	0.000	0.000	0.000
N2O stationary combustion	N2O	3,445	3,768	3%	50%	0.501	0.003	0.000	0.007	0.000	0.000	0.000
CO2 Mobile combustion: Road Vehicles	CO2	93,387	113,945	3%	3%	0.042	0.009	0.031	0.220	0.001	0.009	0.009
CH4 Mobile combustion: Road Vehicles	CH4	694	296	3%	40%	0.401	0.000	-0.001	0.001	0.000	0.000	0.000
N2O Mobile combustion: Road Vehicles	N2O	786	978	3%	50%	0.501	0.001	0.000	0.002	0.000	0.000	0.000
CO2 Mobile combustion: Waterborne Navigation	CO2	5,420	5,111	3%	3%	0.042	0.000	-0.001	0.010	0.000	0.000	0.000
CH4 Mobile combustion: Waterborne Navigation	CH4	29	28	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Waterborne Navigation	N2O	39	37	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion: Aircraft	CO2	1,613	2,301	3%	3%	0.042	0.000	0.001	0.004	0.000	0.000	0.000
CH4 Mobile combustion: Aircraft	CH4	1	1	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Aircraft	N2O	14	20	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion: Other	CO2	1,894	1,856	3%	5%	0.058	0.000	0.000	0.004	0.000	0.000	0.000
CH4 Mobile combustion: Other	CH4	5	3	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Other	N2O	131	104	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	73	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	2,258	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	5,041	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

Table A1.5 Results of the uncertainty analysis excluding LULUCF (Tier1). Year 2008 (continued)

IPCC	Gas	Emissions		Uncertainty		Combined uncertainty		Sensitivity		Trend uncertainty		
Source category		1990	2008	AD	EF	%	% of total national emissions 2008	Type A	Type B	in national emissions introduced by EF uncertainty	in national emissions introduced by AD uncertainty	in total national emissions
		Gg	Gg									
CO2 Cement production	CO2	16,084	16,127	3%	10%	0.104	0.003	-0.001	0.031	0.000	0.001	0.001
CO2 Lime production	CO2	2,042	2,276	3%	10%	0.104	0.000	0.000	0.004	0.000	0.000	0.000
CO2 Limestone and Dolomite Use	CO2	2,375	2,206	3%	10%	0.104	0.000	-0.001	0.004	0.000	0.000	0.000
CO2 Iron and Steel production	CO2	3,124	1,424	3%	10%	0.104	0.000	-0.004	0.003	0.000	0.000	0.000
CO2 Ammonia production	CO2	2,765	882	3%	10%	0.104	0.000	-0.004	0.002	0.000	0.000	0.000
CO2 Other industrial processes	CO2	1,842	2,050	3%	10%	0.104	0.000	0.000	0.004	0.000	0.000	0.000
N2O Adipic Acid	N2O	4,579	707	3%	10%	0.104	0.000	-0.008	0.001	-0.001	0.000	0.001
N2O Nitric Acid	N2O	2,086	358	3%	10%	0.104	0.000	-0.004	0.001	0.000	0.000	0.000
N2O Other industrial processes	N2O	11	0	3%	10%	0.104	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Industrial Processes	CH4	108	61	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
PFC Aluminium production	PFC	1,673	111	5%	10%	0.112	0.000	-0.003	0.000	0.000	0.000	0.000
SF6 Magnesium production	SF6	0	11	5%	5%	0.071	0.000	0.000	0.000	0.000	0.000	0.000
SF6 Electrical Equipment	SF6	213	394	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	121	30%	50%	0.583	0.000	0.000	0.000	0.000	0.000	0.000
HFC, PFC substitutes for ODS	HFC	134	7,371	30%	50%	0.583	0.008	0.014	0.014	0.007	0.006	0.009
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	HFC	351	0	5%	10%	0.112	0.000	-0.001	0.000	0.000	0.000	0.000
CH4 Enteric Fermentation in Domestic Livestock	CH4	12,179	10,921	20%	20%	0.283	0.006	-0.004	0.021	-0.001	0.006	0.006
CH4 Manure Management	CH4	3,462	2,961	20%	100%	1.020	0.006	-0.001	0.006	-0.001	0.002	0.002
N2O Manure Management	N2O	3,921	3,775	20%	100%	1.020	0.007	-0.001	0.007	-0.001	0.002	0.002
CH4 Agricultural Residue Burning	CH4	13	14	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
N2O Agricultural Residue Burning	N2O	4	4	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
Direct N2O Agricultural Soils	N2O	9,581	8,122	20%	100%	1.020	0.015	-0.004	0.016	-0.004	0.004	0.006
Indirect N2O from Nitrogen used in agriculture	N2O	8,118	7,104	20%	100%	1.020	0.013	-0.003	0.014	-0.003	0.004	0.005
CH4 from Rice production	CH4	1,562	1,396	3%	20%	0.202	0.001	0.000	0.003	0.000	0.000	0.000
N2O from animal production	N2O	1,736	1,569	20%	100%	1.020	0.003	0.000	0.003	0.000	0.001	0.001
CH4 from Solid waste Disposal Sites	CH4	13,294	11,076	20%	30%	0.361	0.007	-0.006	0.021	-0.002	0.006	0.006
CH4 Emissions from Wastewater Handling	CH4	1,990	2,843	100%	30%	1.044	0.005	0.001	0.005	0.000	0.008	0.008

Table A1.5 Results of the uncertainty analysis excluding LULUCF (Tier1). Year 2008 (continued)

IPCC	Gas	Emissions		Uncertainty		Combined uncertainty		Sensitivity		Trend uncertainty		
Source category		1990	2008	AD	EF	%	% of total national emissions 2008	Type A	Type B	in national emissions introduced by EF uncertainty	in national emissions introduced by AD uncertainty	in total national emissions
		Gg	Gg									
CO2 Emissions from Waste Incineration	CO2	537	250	5%	25%	0.255	0.000	-0.001	0.000	0.000	0.000	0.000
CH4 Emissions from Waste Incineration	CH4	161	282	5%	20%	0.206	0.000	0.000	0.001	0.000	0.000	0.000
N2O Emissions from Waste Incineration	N2O	88	123	5%	100%	1.001	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Emissions from Other Waste	CH4	0	4	10%	100%	1.005	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Emissions from solvent use	CO2	1,643	1,272	30%	50%	0.583	0.001	-0.001	0.002	0.000	0.001	0.001
N2O Emissions from solvent use	N2O	812	727	50%	10%	0.510	0.001	0.000	0.001	0.000	0.001	0.001
TOTAL		**517,049**	**541,485**				***0.032***					***0.026***

Table A1.5 Results of the uncertainty analysis excluding LULUCF (Tier1). Year 2008

IPCC	Gas	Emissions		Uncertainty		Combined uncertainty		Sensitivity		Trend uncertainty		
Source category		1990	2008	AD	EF		% of total LULUCF emissions 2008	Type A	Type B	in LULUCF emissions introduced by EF uncertainty	in LULUCF emissions introduced by AD uncertainty	in total LULUCF emissions
		Gg CO2 eq	Gg CO2 eq									
A. Forest Land	CO2	-42,884	-64,693	*30%*	*54%*	61%	45%	11%	100%	6%	42%	43%
B. Cropland	CO2	-20,109	-13,239	*75%*	*75%*	106%	16%	-21%	20%	-16%	22%	27%
- *living biomass*	CO2	*-19,417*	*-12,511*	*75%*	*75%*	*106%*	15%	-21%	19%	-16%	20%	26%
- *soils*	CO2	*-685*	*-712*	*75%*	*75%*	*106%*	1%	0%	1%	0%	1%	1%
C. Grassland	CO2	-4,156	-12,671	*75%*	*75%*	106%	15%	11%	19%	8%	21%	22%
- *living biomass*	CO2	*62*	*-1,041*	*75%*	*75%*	106%	1%	2%	2%	1%	2%	2%
- *soils*	CO2	*-447*	*-10,886*	*75%*	*75%*	106%	13%	16%	17%	12%	18%	21%
D. Wetlands	CO2	0	0			0%	0%	0%	0%	0%	0%	0%
E. Settlements	CO2	2,151	3,253	*75%*	*75%*	106%	4%	-1%	5%	0%	5%	5%
F. Other Land	CO2	0	0			0%	0%	0%	0%	0%	0%	0%
G. Other	CO2	0	0			0%	0%	0%	0%	0%	0%	0%
TOTAL		**-64,998**	**-87,349**				**51%**					**55%**

[a] the combined uncertainty has been calculated as explained in Chapter 7, 7.2.3 Uncertainty and time series consistency; in order to provide estimate of uncertainties in trend in national emissions introduced by emission factor and activity data, values for the uncertainty related to activity data and emission factor have been assigned by expert judgment, taking into account the final combined uncertainty

Table A1.6 Results of the uncertainty analysis for the LULUCF sector – CO_2 (Tier1)

IPCC	Gas	Emissions		Uncertainty		Combined uncertainty		Sensitivity		Trend uncertainty		
Source category		1990	2008	AD	EF		% of total LULUCF emissions 2008	Type A	Type B	in LULUCF emissions introduced by EF uncertainty	in LULUCF emissions introduced by AD uncertainty	in total LULUCF emissions
		Gg CO2 eq	Gg CO2 eq									
A. Forest Land	CO2 eq	-42,723	-64,642	*30%*	*54%*	61%	45%	0%	100%	0%	42%	42%
B. Cropland	CO2 eq	-20,029	-13,239	*75%*	*75%*	106%	16%	0%	20%	0%	22%	22%
- *living biomass*	CO2 eq	*-19,417*	*-12,511*	*75%*	*75%*	*106%*	15%	0%	19%	0%	20%	20%
- *soils*	CO2 eq	*-605*	*-712*	*75%*	*75%*	*106%*	1%	0%	1%	0%	1%	1%
C. Grassland	CO2 eq	-4,156	-12,671	*75%*	*75%*	106%	15%	0%	20%	0%	21%	21%
- *living biomass*	CO2 eq	*309*	*-1,041*	*75%*	*75%*	106%	1%	0%	2%	0%	2%	2%
- *soils*	CO2 eq	*-3,903*	*-10,886*	*75%*	*75%*	106%	13%	0%	17%	0%	18%	18%
D. Wetlands	CO2 eq	0	0			0%	0%	0%	0%	0%	0%	0%
E. Settlements	CO2 eq	2,151	3,253	*75%*	*75%*	106%	4%	0%	5%	0%	5%	5%
F. Other Land	CO2 eq	0	0			0%	0%	0%	0%	0%	0%	0%
G. Other	CO2 eq	0	0			0%	0%	0%	0%	0%	0%	0%
TOTAL		**-64,757**	**-87,299**				**51%**					**52%**

Table A1.7 Results of the uncertainty analysis for the LULUCF sector – CO_2, CH_4, N_2O (Tier1)

IPCC	Gas	Emissions		Uncertainty		Combined uncertainty		Sensitivity		Trend uncertainty		
Source category		1990	2008	AD	EF	%	% of total national emissions 2008	Type A	Type B	in national emissions introduced by EF uncertainty	in national emissions introduced by AD uncertainty	in total national emissions
		Gg	Gg									
CO2 stationary combustion liquid fuels	CO2	153,467	84,009	3%	3%	0.042	0.006	-0.139	0.143	-0.004	0.006	0.007
CO2 stationary combustion solid fuels	CO2	59,397	65,128	3%	3%	0.042	0.004	0.002	0.111	0.000	0.005	0.005
CO2 stationary combustion gaseous fuels	CO2	85,066	162,029	3%	3%	0.042	0.011	0.119	0.276	0.004	0.012	0.012
CO2 stationary combustion other fuels	CO2	1,779	4,943	3%	3%	0.042	0.000	0.005	0.008	0.000	0.000	0.000
CH4 stationary combustion	CH4	647	977	3%	50%	0.501	0.001	0.000	0.002	0.000	0.000	0.000
N2O stationary combustion	N2O	3,445	3,768	3%	50%	0.501	0.003	0.000	0.006	0.000	0.000	0.000
CO2 Mobile combustion: Road Vehicles	CO2	93,387	113,945	3%	3%	0.042	0.008	0.022	0.194	0.001	0.008	0.008
CH4 Mobile combustion: Road Vehicles	CH4	694	296	3%	40%	0.401	0.000	-0.001	0.001	0.000	0.000	0.000
N2O Mobile combustion: Road Vehicles	N2O	786	978	3%	50%	0.501	0.001	0.000	0.002	0.000	0.000	0.000
CO2 Mobile combustion: Waterborne Navigation	CO2	5,420	5,111	3%	3%	0.042	0.000	-0.001	0.009	0.000	0.000	0.000
CH4 Mobile combustion: Waterborne Navigation	CH4	29	28	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Waterborne Navigation	N2O	39	37	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion: Aircraft	CO2	1,613	2,301	3%	3%	0.042	0.000	0.001	0.004	0.000	0.000	0.000
CH4 Mobile combustion: Aircraft	CH4	1	1	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Aircraft	N2O	14	20	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion: Other	CO2	1,894	1,856	3%	5%	0.058	0.000	0.000	0.003	0.000	0.000	0.000
CH4 Mobile combustion: Other	CH4	5	3	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Other	N2O	131	104	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	73	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	2,258	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	5,041	3%	25%	0.252	0.002	-0.005	0.009	-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

Table A1.8 Results of the uncertainty analysis including LULUCF (Tier1). Year 2008 (continued)

IPCC Source category	Gas	Emissions 1990 Gg	Emissions 2008 Gg	Uncertainty AD	Uncertainty EF	Combined uncertainty %	Combined uncertainty % of total national emissions 2008	Sensitivity Type A	Sensitivity Type B	Trend uncertainty in national emissions introduced by EF uncertainty	Trend uncertainty in national emissions introduced by AD uncertainty	Trend uncertainty in total national emissions
CO2 Cement production	CO2	16,084	16,127	3%	10%	0.104	0.003	-0.002	0.027	0.000	0.001	0.001
CO2 Lime production	CO2	2,042	2,276	3%	10%	0.104	0.000	0.000	0.004	0.000	0.000	0.000
CO2 Limestone and Dolomite Use	CO2	2,375	2,206	3%	10%	0.104	0.000	-0.001	0.004	0.000	0.000	0.000
CO2 Iron and Steel production	CO2	3,124	1,424	3%	10%	0.104	0.000	-0.003	0.002	0.000	0.000	0.000
CO2 Ammonia production	CO2	2,765	882	3%	10%	0.104	0.000	-0.004	0.001	0.000	0.000	0.000
CO2 Other industrial processes	CO2	1,842	2,050	3%	10%	0.104	0.000	0.000	0.003	0.000	0.000	0.000
N2O Adipic Acid	N2O	4,579	707	3%	10%	0.104	0.000	-0.007	0.001	-0.001	0.000	0.001
N2O Nitric Acid	N2O	2,086	358	3%	10%	0.104	0.000	-0.003	0.001	0.000	0.000	0.000
N2O Other industrial processes	N2O	11	0	3%	10%	0.104	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Industrial Processes	CH4	108	61	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
PFC Aluminium production	PFC	1,673	111	5%	10%	0.112	0.000	-0.003	0.000	0.000	0.000	0.000
SF6 Magnesium production	SF6	0	11	5%	5%	0.071	0.000	0.000	0.000	0.000	0.000	0.000
SF6 Electrical Equipment	SF6	213	394	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	121	30%	50%	0.583	0.000	0.000	0.000	0.000	0.000	0.000
HFC, PFC substitutes for ODS	HFC	134	7,371	30%	50%	0.583	0.007	0.012	0.013	0.006	0.005	0.008
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	HFC	351	0	5%	10%	0.112	0.000	-0.001	0.000	0.000	0.000	0.000
Fermentation in Domestic Livestock	CH4	12,179	10,921	20%	20%	0.283	0.005	-0.004	0.019	-0.001	0.005	0.005
CH4 Manure Management	CH4	3,462	2,961	20%	100%	1.020	0.005	-0.001	0.005	-0.001	0.001	0.002
N2O Manure Management	N2O	3,921	3,775	20%	100%	1.020	0.006	-0.001	0.006	-0.001	0.002	0.002
CH4 Agricultural Residue Burning	CH4	13	14	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
N2O Agricultural Residue Burning	N2O	4	4	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
Direct N2O Agricultural Soils	N2O	9,581	8,122	20%	100%	1.020	0.013	-0.004	0.014	-0.004	0.004	0.005
Indirect N2O from Nitrogen used in agriculture	N2O	8,118	7,104	20%	100%	1.020	0.011	-0.003	0.012	-0.003	0.003	0.004
CH4 from Rice production	CH4	1,562	1,396	3%	20%	0.202	0.000	0.000	0.002	0.000	0.000	0.000
N2O from animal production	N2O	1,736	1,569	20%	100%	1.020	0.003	-0.001	0.003	-0.001	0.001	0.001
CH4 from Solid waste Disposal Sites	CH4	13,294	11,076	20%	30%	0.361	0.006	-0.006	0.019	-0.002	0.005	0.006
CH4 Emissions from Wastewater Handling	CH4	1,990	2,843	100%	30%	1.044	0.005	0.001	0.005	0.000	0.007	0.007
N2O Emissions from Wastewater Handling	N2O	1,864	2,036	30%	30%	0.424	0.001	0.000	0.003	0.000	0.001	0.001

Table A1.8 Results of the uncertainty analysis including LULUCF (Tier1). Year 2008 (continued)

IPCC	Gas	Emissions		Uncertainty		Combined uncertainty		Sensitivity		Trend uncertainty		
Source category		**1990**	**2008**	**AD**	**EF**	**%**	**% of total national emissions 2008**	**Type A**	**Type B**	**in national emissions introduced by EF uncertainty**	**in national emissions introduced by AD uncertainty**	**in total national emissions**
		Gg	**Gg**									
CO2 Emissions from Waste Incineration	CO2	537	250	5%	25%	0.255	0.000	-0.001	0.000	0.000	0.000	0.000
CH4 Emissions from Waste Incineration	CH4	161	282	5%	20%	0.206	0.000	0.000	0.000	0.000	0.000	0.000
N2O Emissions from Waste Incineration	N2O	88	123	5%	100%	1.001	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Emissions from Other Waste	CH4	0	4	10%	100%	1.005	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Emissions from solvent use	CO2	1,643	1,272	30%	50%	0.583	0.001	-0.001	0.002	0.000	0.001	0.001
N2O Emissions from solvent use	N2O	812	727	50%	10%	0.510	0.001	0.000	0.001	0.000	0.001	0.001
CO2 Forest land remaining Forest Land	CO2	42,131	63,026	30%	54%	0.613	0.061	0.030	0.107	0.016	0.045	0.048
CH4 Forest land remaining Forest Land	CH4	146	46	30%	54%	0.613	0.000	0.000	0.000	0.000	0.000	0.000
N2O Forest land remaining Forest Land	N2O	15	5	30%	54%	0.613	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Cropland remaining Cropland	CO2	20,765	13,239	75%	75%	1.061	0.022	-0.016	0.023	-0.012	0.024	0.027
CO2 Land converted to Forest Land	CO2	753	1,667	75%	75%	1.061	0.003	0.001	0.003	0.001	0.003	0.003
CO2 Land converted to Cropland	CO2	656	0	75%	75%	1.061	0.000	-0.001	0.000	-0.001	0.000	0.001
CO2 Grassland remaining Grassland	CO2	4,156	7,032	75%	75%	1.061	0.012	0.004	0.012	0.003	0.013	0.013
CO2 Land converted to Grassland	CO2	0	5,639	75%	75%	1.061	0.009	0.010	0.010	0.007	0.010	0.012
N2O Land converted to Cropland	N2O	80	0	75%	75%	1.061	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Land converted to Settlements	CO2	2,151	3,253	75%	75%	1.061	0.005	0.002	0.006	0.001	0.006	0.006
TOTAL		**587,902**	**635,392**				***0.072***					***0.062***

Table A1.8 Results of the uncertainty analysis including LULUCF (Tier1). Year 2008

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 67 categories. Uncertainties are therefore estimated for these categories. To estimate uncertainty for both activity data and emission factors, information provided in the IPCC Good Practice Guidance 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 2008, the Tier 1 approach suggests an uncertainty of 3.2% in the combined GWP total emissions. The analysis also estimates an uncertainty of 2.6 % in the trend between 1990 and 2008.
Specifically, for the LULUCF sector, the uncertainty value resulting from Tier 1 approach is 51% in the combined GWP total emissions for the year 2008, whereas the uncertainty in the trend is 52%. Similar values result from Tier 1 approach in uncertainty related to CO_2 total emissions for the year 2008, and uncertainty in the trend. Details of the figures are shown in Tables A1.6 and A1.7.
Including the LULUCF sector in the total uncertainty assessment, the Tier 1 approach shows an uncertainty of 7.2% in the combined GWP total emissions for the year 2008, whereas the uncertainty in the trend between 1990 and 2008 is equal to 6.2%. Results are shown in Table A1.8.

Further investigation is needed to better quantify the uncertainty values for some specific source, nevertheless it should be noted that a conservative approach has been followed.

A1.4 Tier 2 key category 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 2008 inventory whereas for the base year results of the analysis excluding and including LULUCF categories are reported in Table A1.13 and Table A1.14.
The results of the Tier 2 key category analysis, without LULUCF categories, are provided in Table A1.9, for 2008, while in Table A1.10 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 2008, the application of the Tier 2 gives as a result 20 key categories accounting for the 95% of the total levels uncertainty; when applying the trend analysis the key categories increased to 21 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 number of key categories is also equal to 21 with differences with respect to the previous list.

CATEGORIES	Level assessment with uncertainty	Relative level assessment with uncertainty	Cumulative Percentage
Direct N2O Agricultural Soils	0.015	0.123	0.12
Indirect N2O from Nitrogen used in agriculture	0.013	0.107	0.23
CO2 stationary combustion gaseous fuels	0.013	0.102	0.33
CO2 Mobile combustion: Road Vehicles	0.009	0.072	0.40
HFC, PFC substitutes for ODS	0.008	0.064	0.47
CH4 from Solid waste Disposal Sites	0.007	0.059	0.53
N2O Manure Management	0.007	0.057	0.58
CO2 stationary combustion liquid fuels	0.007	0.053	0.64
CH4 Enteric Fermentation in Domestic Livestock	0.006	0.046	0.68
CH4 Manure Management	0.006	0.045	0.73
CH4 Emissions from Wastewater Handling	0.005	0.044	0.77
CO2 stationary combustion solid fuels	0.005	0.041	0.81
N2O stationary combustion	0.003	0.028	0.84
CO2 Cement production	0.003	0.025	0.86
N2O from animal production	0.003	0.024	0.89
CH4 Fugitive emissions from Oil and Gas Operations	0.002	0.019	0.91
N2O Emissions from Wastewater Handling	0.002	0.013	0.92
CO2 Emissions from solvent use	0.001	0.011	0.93
CO2 Fugitive emissions from Oil and Gas Operations	0.001	0.008	0.94
N2O Mobile combustion: Road Vehicles	0.001	0.007	0.95
CH4 stationary combustion	0.001	0.007	0.95
N2O Emissions from solvent use	0.001	0.005	0.96
CH4 from Rice production	0.001	0.004	0.96
CO2 Lime production	0.000	0.004	0.97
CO2 Limestone and Dolomite Use	0.000	0.003	0.97
CO2 Mobile combustion: Waterborne Navigation	0.000	0.003	0.97
CO2 Other industrial processes	0.000	0.003	0.98
CO2 stationary combustion other fuels	0.000	0.003	0.98
CO2 Iron and Steel production	0.000	0.002	0.98
CH4 Fugitive emissions from Coal Mining and Handling	0.000	0.002	0.98
N2O Emissions from Waste Incineration	0.000	0.002	0.99
CH4 Mobile combustion: Road Vehicles	0.000	0.002	0.99
CO2 Mobile combustion: Other	0.000	0.002	0.99
N2O Mobile combustion: Other	0.000	0.002	0.99
CO2 Mobile combustion: Aircraft	0.000	0.001	0.99
CO2 Ammonia production	0.000	0.001	0.99
N2O Adipic Acid	0.000	0.001	0.99
PFC, HFC, SF6 Semiconductor manufacturing	0.000	0.001	1.00
CO2 Emissions from Waste Incineration	0.000	0.001	1.00
CH4 Emissions from Waste Incineration	0.000	0.001	1.00
SF6 Electrical Equipment	0.000	0.001	1.00
N2O Nitric Acid	0.000	0.001	1.00
N2O Mobile combustion: Waterborne Navigation	0.000	0.001	1.00

Table A1.9 Results of the key categories analysis without LULUCF. Tier 2 Level assessment, year 2008

CATEGORIES	Trend assessment with uncertainty	Relative Trend assessment with uncertainty	Cumulative Percentage
CO2 stationary combustion gaseous fuels	0.01	0.15	0.15
CO2 Mobile combustion: Road Vehicles	0.01	0.10	0.24
HFC, PFC substitutes for ODS	0.01	0.10	0.34
CO2 stationary combustion liquid fuels	0.01	0.09	0.43
CH4 Emissions from Wastewater Handling	0.01	0.08	0.51
CH4 from Solid waste Disposal Sites	0.01	0.07	0.58
CH4 Enteric Fermentation in Domestic Livestock	0.01	0.06	0.64
Direct N2O Agricultural Soils	0.01	0.06	0.70
CO2 stationary combustion solid fuels	0.01	0.06	0.76
Indirect N2O from Nitrogen used in agriculture	0.00	0.05	0.81
N2O Manure Management	0.00	0.02	0.83
CH4 Manure Management	0.00	0.02	0.85
N2O Emissions from Wastewater Handling	0.00	0.02	0.87
CO2 Cement production	0.00	0.01	0.88
CH4 Fugitive emissions from Oil and Gas Operations	0.00	0.01	0.90
CO2 Emissions from solvent use	0.00	0.01	0.91
N2O Emissions from solvent use	0.00	0.01	0.92
N2O from animal production	0.00	0.01	0.93
N2O Adipic Acid	0.00	0.01	0.94
CO2 Fugitive emissions from Oil and Gas Operations	0.00	0.01	0.94
CO2 stationary combustion other fuels	0.00	0.00	0.95
CO2 Mobile combustion: Waterborne Navigation	0.00	0.00	0.95
CO2 Ammonia production	0.00	0.00	0.96
CO2 Iron and Steel production	0.00	0.00	0.96
N2O Nitric Acid	0.00	0.00	0.96
N2O stationary combustion	0.00	0.00	0.97
CH4 Mobile combustion: Road Vehicles	0.00	0.00	0.97
PFC Aluminium production	0.00	0.00	0.97
CH4 stationary combustion	0.00	0.00	0.98
CH4 Fugitive emissions from Coal Mining and Handling	0.00	0.00	0.98
CO2 Mobile combustion: Aircraft	0.00	0.00	0.98
CO2 Limestone and Dolomite Use	0.00	0.00	0.98
CO2 Lime production	0.00	0.00	0.99
CO2 Other industrial processes	0.00	0.00	0.99
N2O Mobile combustion: Road Vehicles	0.00	0.00	0.99
CO2 Emissions from Waste Incineration	0.00	0.00	0.99
PFC, HFC, SF6 Semiconductor manufacturing	0.00	0.00	0.99
CO2 Mobile combustion: Other	0.00	0.00	0.99
CH4 from Rice production	0.00	0.00	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.00	0.00	1.00
N2O Mobile combustion: Other	0.00	0.00	1.00
SF6 Electrical Equipment	0.00	0.00	1.00
N2O Emissions from Waste Incineration	0.00	0.00	1.00

Table A1.10 Results of the key categories analysis without LULUCF. Tier 2 Trend assessment, 1990- 2008

CATEGORIES	Level assessment with uncertainty	Relative level assessment with uncertainty	Cumulative Percentage
CO2 Forest land remaining Forest Land	0.06	0.28	0.28
CO2 Cropland remaining Cropland	0.02	0.10	0.38
Direct N2O Agricultural Soils	0.01	0.06	0.44
CO2 Grassland remaining Grassland	0.01	0.05	0.49
Indirect N2O from Nitrogen used in agriculture	0.01	0.05	0.54
CO2 stationary combustion gaseous fuels	0.01	0.05	0.59
CO2 Land converted to Grassland	0.01	0.04	0.64
CO2 Mobile combustion: Road Vehicles	0.01	0.03	0.67
HFC, PFC substitutes for ODS	0.01	0.03	0.70
CH4 from Solid waste Disposal Sites	0.01	0.03	0.73
N2O Manure Management	0.01	0.03	0.76
CO2 stationary combustion liquid fuels	0.01	0.03	0.79
CO2 Land converted to Settlements	0.01	0.02	0.81
CH4 Enteric Fermentation in Domestic Livestock	0.00	0.02	0.83
CH4 Manure Management	0.00	0.02	0.85
CH4 Emissions from Wastewater Handling	0.00	0.02	0.88
CO2 stationary combustion solid fuels	0.00	0.02	0.90
N2O stationary combustion	0.00	0.01	0.91
CO2 Land converted to Forest Land	0.00	0.01	0.92
CO2 Cement production	0.00	0.01	0.93
N2O from animal production	0.00	0.01	0.95
CH4 Fugitive emissions from Oil and Gas Operations	0.00	0.01	0.95
N2O Emissions from Wastewater Handling	0.00	0.01	0.96
CO2 Emissions from solvent use	0.00	0.01	0.97
CO2 Fugitive emissions from Oil and Gas Operations	0.00	0.00	0.97
N2O Mobile combustion: Road Vehicles	0.00	0.00	0.97
CH4 stationary combustion	0.00	0.00	0.98
N2O Emissions from solvent use	0.00	0.00	0.98
CH4 from Rice production	0.00	0.00	0.98
CO2 Lime production	0.00	0.00	0.98
CO2 Limestone and Dolomite Use	0.00	0.00	0.98
CO2 Mobile combustion: Waterborne Navigation	0.00	0.00	0.99
CO2 Other industrial processes	0.00	0.00	0.99
CO2 stationary combustion other fuels	0.00	0.00	0.99
CO2 Iron and Steel production	0.00	0.00	0.99
CH4 Fugitive emissions from Coal Mining and Handling	0.00	0.00	0.99
N2O Emissions from Waste Incineration	0.00	0.00	0.99
CH4 Mobile combustion: Road Vehicles	0.00	0.00	0.99
CO2 Mobile combustion: Other	0.00	0.00	0.99
N2O Mobile combustion: Other	0.00	0.00	0.99
CO2 Mobile combustion: Aircraft	0.00	0.00	1.00
CO2 Ammonia production	0.00	0.00	1.00
N2O Adipic Acid	0.00	0.00	1.00
PFC, HFC, SF6 Semiconductor manufacturing	0.00	0.00	1.00
CO2 Emissions from Waste Incineration	0.00	0.00	1.00
CH4 Emissions from Waste Incineration	0.00	0.00	1.00
SF6 Electrical Equipment	0.00	0.00	1.00
N2O Nitric Acid	0.00	0.00	1.00
N2O Mobile combustion: Waterborne Navigation	0.00	0.00	1.00
CH4 Industrial Processes	0.00	0.00	1.00
CH4 Forest land remaining Forest Land	0.00	0.00	1.00
N2O Mobile combustion: Aircraft	0.00	0.00	1.00
CH4 Mobile combustion: Waterborne Navigation	0.00	0.00	1.00

Table A1.11 Results of the key categories analysis with LULUCF. Tier 2 Level assessment, year 2008

CATEGORIES	Trend assessment with uncertainty	Relative Trend assessment with uncertainty	Cumulative Percentage
CO2 Forest land remaining Forest Land	0.05	0.25	0.25
CO2 Cropland remaining Cropland	0.03	0.14	0.38
CO2 Grassland remaining Grassland	0.01	0.07	0.45
CO2 Land converted to Grassland	0.01	0.06	0.51
CO2 stationary combustion gaseous fuels	0.01	0.06	0.57
CO2 Mobile combustion: Road Vehicles	0.01	0.04	0.62
HFC, PFC substitutes for ODS	0.01	0.04	0.66
CO2 stationary combustion liquid fuels	0.01	0.04	0.70
CH4 Emissions from Wastewater Handling	0.01	0.03	0.73
CO2 Land converted to Settlements	0.01	0.03	0.76
CH4 from Solid waste Disposal Sites	0.01	0.03	0.79
Direct N2O Agricultural Soils	0.01	0.03	0.82
CH4 Enteric Fermentation in Domestic Livestock	0.01	0.03	0.85
CO2 stationary combustion solid fuels	0.00	0.02	0.87
Indirect N2O from Nitrogen used in agriculture	0.00	0.02	0.89
CO2 Land converted to Forest Land	0.00	0.02	0.91
N2O Manure Management	0.00	0.01	0.92
CH4 Manure Management	0.00	0.01	0.93
N2O Emissions from Wastewater Handling	0.00	0.01	0.94
CH4 Fugitive emissions from Oil and Gas Operations	0.00	0.01	0.94
CO2 Cement production	0.00	0.01	0.95
CO2 Emissions from solvent use	0.00	0.01	0.95
N2O from animal production	0.00	0.00	0.96
CO2 Land converted to Cropland	0.00	0.00	0.96
N2O Emissions from solvent use	0.00	0.00	0.97
N2O Adipic Acid	0.00	0.00	0.97
CO2 Fugitive emissions from Oil and Gas Operations	0.00	0.00	0.97
CO2 stationary combustion other fuels	0.00	0.00	0.98
CO2 Mobile combustion: Waterborne Navigation	0.00	0.00	0.98
CO2 Ammonia production	0.00	0.00	0.98
CO2 Iron and Steel production	0.00	0.00	0.98
N2O Nitric Acid	0.00	0.00	0.98
CH4 Mobile combustion: Road Vehicles	0.00	0.00	0.98
PFC Aluminium production	0.00	0.00	0.99
N2O stationary combustion	0.00	0.00	0.99
CH4 stationary combustion	0.00	0.00	0.99
CH4 Fugitive emissions from Coal Mining and Handling	0.00	0.00	0.99
CO2 Limestone and Dolomite Use	0.00	0.00	0.99
CO2 Mobile combustion: Aircraft	0.00	0.00	0.99
CO2 Lime production	0.00	0.00	0.99
CO2 Other industrial processes	0.00	0.00	0.99
CO2 Emissions from Waste Incineration	0.00	0.00	0.99
CH4 from Rice production	0.00	0.00	0.99
PFC, HFC, SF6 Semiconductor manufacturing	0.00	0.00	1.00
CO2 Mobile combustion: Other	0.00	0.00	1.00
N2O Mobile combustion: Road Vehicles	0.00	0.00	1.00
N2O Land converted to Cropland	0.00	0.00	1.00
CH4 Forest land remaining Forest Land	0.00	0.00	1.00
N2O Mobile combustion: Other	0.00	0.00	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.00	0.00	1.00
SF6 Electrical Equipment	0.00	0.00	1.00
CH4 Emissions from Waste Incineration	0.00	0.00	1.00
N2O Emissions from Waste Incineration	0.00	0.00	1.00

Table A1.12 Results of the key categories analysis with LULUCF. Tier 2 Trend assessment, 1990- 2008

CATEGORIES	Level assessment with uncertainty	Relative level assessment with uncertainty	Cumulative Percentage
Direct N2O Agricultural Soils	0.019	0.15	0.15
Indirect N2O from Nitrogen used in agriculture	0.016	0.12	0.27
CO2 stationary combustion liquid fuels	0.013	0.10	0.36
CH4 from Solid waste Disposal Sites	0.009	0.07	0.44
N2O Manure Management	0.008	0.06	0.49
CO2 Mobile combustion: Road Vehicles	0.008	0.06	0.55
CO2 stationary combustion gaseous fuels	0.007	0.05	0.61
CH4 Manure Management	0.007	0.05	0.66
CH4 Enteric Fermentation in Domestic Livestock	0.007	0.05	0.71
CO2 stationary combustion solid fuels	0.005	0.04	0.75
CH4 Emissions from Wastewater Handling	0.004	0.03	0.78
CH4 Fugitive emissions from Oil and Gas Operations	0.004	0.03	0.81
N2O from animal production	0.003	0.03	0.83
N2O stationary combustion	0.003	0.03	0.86
CO2 Cement production	0.003	0.02	0.88
CO2 Emissions from solvent use	0.002	0.01	0.90
CO2 Fugitive emissions from Oil and Gas Operations	0.002	0.01	0.91
N2O Emissions from Wastewater Handling	0.002	0.01	0.92
N2O Adipic Acid	0.001	0.01	0.93
N2O Emissions from solvent use	0.001	0.01	0.93
N2O Mobile combustion: Road Vehicles	0.001	0.01	0.94
CO2 Iron and Steel production	0.001	0.00	0.95
CH4 stationary combustion	0.001	0.00	0.95
CH4 from Rice production	0.001	0.00	0.96
CO2 Ammonia production	0.001	0.00	0.96
CH4 Mobile combustion: Road Vehicles	0.001	0.00	0.96
CO2 Limestone and Dolomite Use	0.000	0.00	0.97
CH4 Fugitive emissions from Coal Mining and Handling	0.000	0.00	0.97
CO2 Mobile combustion: Waterborne Navigation	0.000	0.00	0.97
N2O Nitric Acid	0.000	0.00	0.98
CO2 Lime production	0.000	0.00	0.98
CO2 Other industrial processes	0.000	0.00	0.98
PFC Aluminium production	0.000	0.00	0.99
CO2 Emissions from Waste Incineration	0.000	0.00	0.99
N2O Mobile combustion: Other	0.000	0.00	0.99
CO2 Mobile combustion: Other	0.000	0.00	0.99
N2O Emissions from Waste Incineration	0.000	0.00	0.99
HFC, PFC substitutes for ODS	0.000	0.00	0.99
CO2 stationary combustion other fuels	0.000	0.00	1.00
CO2 Mobile combustion: Aircraft	0.000	0.00	1.00
CH4 Industrial Processes	0.000	0.00	1.00
N2O Mobile combustion: Waterborne Navigation	0.000	0.00	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.000	0.00	1.00
CH4 Emissions from Waste Incineration	0.000	0.00	1.00
SF6 Electrical Equipment	0.000	0.00	1.00
CH4 Mobile combustion: Waterborne Navigation	0.000	0.00	1.00
N2O Mobile combustion: Aircraft	0.000	0.00	1.00
SF6 Production of SF6	0.000	0.00	1.00
CH4 Agricultural Residue Burning	0.000	0.00	1.00
CH4 Mobile combustion: Other	0.000	0.00	1.00
N2O Agricultural Residue Burning	0.000	0.00	1.00
N2O Other industrial processes	0.000	0.00	1.00
CH4 Mobile combustion: Aircraft	0.000	0.00	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.000	0.00	1.00
CH4 Emissions from Other Waste	0.000	0.00	1.00
SF6 Magnesium production	0.000	0.00	1.00
PFC, HFC, SF6 Semiconductor manufacturing	0.000	0.00	1.00

Table A1.13 Results of the key categories analysis without LULUCF. Tier 2 Level assessment, year 1990

CATEGORIES	Level assessment with uncertainty	Relative level assessment with uncertainty	Cumulative Percentage
CO2 Forest land remaining Forest Land	0.0440	0.209	0.21
CO2 Cropland remaining Cropland	0.0375	0.178	0.39
Direct N2O Agricultural Soils	0.0166	0.079	0.47
Indirect N2O from Nitrogen used in agriculture	0.0141	0.067	0.53
CO2 stationary combustion liquid fuels	0.0111	0.053	0.59
CH4 from Solid waste Disposal Sites	0.0082	0.039	0.62
CO2 Grassland remaining Grassland	0.0075	0.036	0.66
N2O Manure Management	0.0068	0.032	0.69
CO2 Mobile combustion: Road Vehicles	0.0067	0.032	0.72
CO2 stationary combustion gaseous fuels	0.0061	0.029	0.75
CH4 Manure Management	0.0060	0.029	0.78
CH4 Enteric Fermentation in Domestic Livestock	0.0059	0.028	0.81
CO2 stationary combustion solid fuels	0.0043	0.020	0.83
CO2 Land converted to Settlements	0.0039	0.018	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	0.90
N2O stationary combustion	0.0029	0.014	0.91
CO2 Cement production	0.0029	0.014	0.92
CO2 Emissions from solvent use	0.0016	0.008	0.93
CO2 Fugitive emissions from Oil and Gas Operations	0.0014	0.007	0.94
CO2 Land converted to Forest Land	0.0014	0.006	0.94
N2O Emissions from Wastewater Handling	0.0013	0.006	0.95
CO2 Land converted to Cropland	0.0012	0.006	0.96
N2O Adipic Acid	0.0008	0.004	0.96
N2O Emissions from solvent use	0.0007	0.003	0.96
N2O Mobile combustion: Road Vehicles	0.0007	0.003	0.97
CO2 Iron and Steel production	0.0006	0.003	0.97
CH4 stationary combustion	0.0006	0.003	0.97
CH4 from Rice production	0.0005	0.003	0.97
CO2 Ammonia production	0.0005	0.002	0.98
CH4 Mobile combustion: Road Vehicles	0.0005	0.002	0.98
CO2 Limestone and Dolomite Use	0.0004	0.002	0.98
CH4 Fugitive emissions from Coal Mining and Handlin	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 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
CH4 Forest land remaining Forest Land	0.0002	0.001	0.99
N2O Emissions from Waste Incineration	0.0001	0.001	1.00
N2O Land converted to Cropland	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 fugitiv	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

Table A1.14 Results of the key categories analysis with LULUCF. Tier 2 Level assessment, year 1990

ANNEX 2: ENERGY CONSUMPTION FOR POWER GENERATION

A2.1 Source category description

The main source of data on fuel consumption for the production of electricity is the annual report "Statistical data on electricity production and power plants in Italy" ("Dati statistici sugli impianti e la produzione di energia elettrica in Italia"), edited from 1999 by the Italian Independent System Operator (Terna), a public company that runs the high voltage transmission grid. For the period 1990-1998 the same data were published by ENEL (ENEL, several years), former monopolist of electricity distribution. The time series is available since 1963.
In these publications, consumptions of all power plants are reported, either public or privately owned. The base data are collected at plant level, on monthly basis. They include electricity production and estimation of physical quantities of fuels and the related energy content; for the biggest installations, the energy content is based on laboratory tests. Up to 1999, the fuel consumption was reported at a very detailed level, 17 different fuels, allowing a quite precise estimation of the carbon content. From 2000 onward, the published data aggregate all fuels in five groups that do not allow for a precise evaluation of the carbon content. In Table A2.1, the time series of fuel consumptions for power sector production is reported.

	1990	1995	2000	2005	2006	2007	2008
national coal	58	-	Solids	Solids	Solids	Solids	Solids
imported coal	10,724	8,216	9,633	16,253	16,587	16,886	16,878
lignite	1,501	380					
Natural gas, $10^6 m^3$	9,731	11,277	22,334	30,544	31,381	33,957	33,706
BOF(steel converter) gas, $10^6 m^3$	509	633	Coal	Coal	Coal	Coal	Coal
Blast furnace gas, $10^6 m^3$	6,804	6,428	gases	gases	gases	gases	gases
Coke gas, $10^6 m^3$	693	540	8,690	12,104	13,131	11,353	10,648
Light distillate	5	6	oil	oil	oil	oil	oil
Diesel oil	303	184	products	products	products	products	products
Heavy fuel oil	21,798	25,355	19,352	7,941	7,629	5,292	4,366
Refinery gas	211	378					
Petroleum coke	186	189					
Orimulsion	-	-					
Gases from chemical processes	444	803	Others	Others	Others	Others	Others
Tar	2	-		$10^6 m^3$=978	$10^6 m^3$=1,321	$10^6 m^3$=1,423	$10^6 m^3$=1,414
Heat recovered from Pyrite	146	3		Gg=15,460	Gg=16,253	Gg=17,490	Gg=16,520
Other fuels	344	697	5,153				

Source: Terna, several years

Table A2.1 Time series of power sector production by fuel, Gg or 10^6 m^3

Figures reported in the table show that natural gas substituted oil products, from 1990 to 2008, becoming the main fuel for electricity production while coal consumption has slightly increased in the last years compared to 1990.
For the purpose of calculating GHG emissions, a detailed list of 25 fuels was delivered to ISPRA by Terna for the years from 2000 to 2007. In 2008 the list of the fuel used to estimate emissions was expanded by Terna, up to 34 different fuels. It include many different types of renewable sources according to their composition and origin for the purpose to estimate the percentage of renewable sources used for electricity generation and to comply with national regulations of waste derived

fuels. A list of different quantities of fuel oil used according to the sulphur content was also added. Energy data of previous years have not been changed (see previous reports).
The detailed list is confidential and only the output of the simulation model used to calculate emissions for the years 2008 at an aggregated level is reported in the attached table A2.2. The consumption of municipal solid waste (MSW) / industrial wastes is separated from the biomass consumption, since the use of this fuel for electricity generation is expanding and EFs are different.
We underline that fuels used to cogenerate heat and electricity in some power plants are not included in Terna data, only the fuel used for electricity production is reported.
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) and those published by Unione Petrolifera, the Oil companies association (UP, several years). In the past also the association of the industrial electricity producers (UNAPACE, several years) up to the year 1998 and ENI, the former national oil company up to the year 2000, published production data with the associated fuel consumptions (ENI, several years).

A2.2 Methodological issues

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

- BEN data are prepared on the basis of Terna reports to IEA, so both data sets come from the same source;
- before being published in the BEN, Terna data are revised to be adapted to the reporting methodology: balance is done on the energy content of fuels and the physical quantities of fuels are converted to energy using standard conversion factors; so the total energy content of the fuels is the "right" information extracted from the Terna reports and the physical quantities are changed to avoid discrepancies; the resulting information cannot be cross checked with detailed plant data (point source evaluation) based on the physical quantities;
- the used fuel types are much more detailed in Terna database, 34 fuels as above mentioned, whereas in BEN all fuels are added up (using energy content) and reported together in 12 categories: emission factors for certain fuels (coal gases or refinery by-products) are quite different and essential information is lost with this process;
- finally, the two data sets are never the same, even considering the total energy values of fuels or the produced electricity, there are always small differences, less than 1%, that increase the already sizable discrepancy between the reference approach and the detailed approach; the BEN adjust the physical quantities according to fixed low heating values and this process combined with the reduction of fuel types from 17 to 12 adds rounding errors and this may be responsible for the small difference between the production of electricity of the two sources, 0.4% in 2008. The difference in the energy consumption value is negligible in 2008, thanks to the continuing efforts to improve the comparability of statistical data.

Table A2.2 reports the differences between the national energy balance and Terna data for 2008. For the other years, see previous NIR reports. In table A2.2, annual data from different sources are reported: detailed data reported by Terna is compared with data available in the national energy balance.
For each source, three types of data are presented: electricity production, physical quantities of fuel consumptions and amount of energy used.

Fuels	TERNA			BEN		
	GWe, gross	Gg / Mmc	Pj	GWe, gross	Gg/ Mmc	Pj
Coal	43,073.8	16,878	430.6	43,076.7	16,206	430.6
Coke oven gas	1,658.8	785	14.7	1,631.4	812	14.4
Blast furnace gas	3,726.6	9,608	32.8	3,727.9	8,728	32.9
Oxi converter gas	157.5	256	1.5	158.0		1.5
total derived gases	5,542.9	10,649	49.0	5,517.3	9,540	48.8
Coal	**48,616.7**		**479.6**	**48,594.0**		**479.4**
Light distillates	7.7	1	0.04	109.3	13	0.6
Light fuel oil	785.4	196	8.4	675.6	183	7.8
Fuel oil - high sulfur content	1,305	3,705	13.1	7,076.7	1,263	51.8
Fuel oil - low sulfur content	14,420.0		139.4	20,055.8	4,400	180.4
Refinery gas	1,917.8	292	14.0	1,855.8	270	13.6
Petroleum coke	759.5	172	5.9	762.8	172	6.0
Oriemulsion	0.0	0	0.0			
total fuel oil	*19,195.0*		*180.8*	*30,536.0*	*4,420*	*260.1*
Gas from chemical proc.	780.2	1,279	6.2	1,985.0	1,881	18.2
Heavy residuals/ tar	11,339.1	8,124	79.3			
Others	252.7		3.1			
total residual	*12,372.1*		*88.7*	*1,985.0*		*18.2*
Oil+residuals	**31,567.1**		**269.5**	**32,521.1**		**278.3**
Natural gas	**172,697.2**	33,706	**1,170.3**	**172,697.7**	33,904	**1,161.8**
Biogas	1,672.8	1,414	17.1			17.1
Biomass	2,746.1	2,778	33.5	4,404.7	4,464	33.2
Municipal waste	3,112.3	4,062	46.7	3,116.3	4,814	46.7
Grand total	**260,412**		**2,016.6**	**261,334**		**2,016.5**
Terna /BEN differences				-0.4%		0.0%

Source: ISPRA elaborations

Table A2.2 Energy consumption for electricity production, year 2008

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

To estimate CO_2 emissions, and also N_2O and CH_4 emissions, a rather complex calculation sheet is used (APAT, 2003). The data sheet summarizes all plants existing in Italy divided by technology, about 60 typologies, and type of fuel used; the calculation sheet can be considered a model of the national power system. The main scope of the model is to estimate the emissions of pollutants different from CO_2 that are technology dependent. For each year, a run estimates the fuel consumed by each plant type, the pollutant emissions and GHG emissions.

The model has many possible outputs; same of which are built up in such a way to reproduce the data available from statistical source, so it is possible to use almost any data available at national level. The model is revised every year to mirror the changes occurred in the power plants. Moreover, the model is also able to estimate the energy/emissions data related to the electricity produced and used on site by the main industrial producers. Those data are reported in the other energy industries, tables 1.A.1.b and 1.A.1.c of the CRF, and in the industrial sector section, tables 1.A.2 of the CRF.

The following Table A2.3 shows an intermediate step of the process, with all energy and emissions summarized by fuel and split in two main categories of producers: public services and industrial producers for the year 2008. Since 1998, expansion of industrial cogeneration of electricity and split of national monopoly has transformed many industrial producers into "independent producers", regularly supplying the national grid. So part of the energy/emissions of the industrial producers are added to table 1.A.1.a of the CRF, according to the best information available.

	TJ	C, Gg	CO_2, Gg
For table 1.A.1.a Public Electricity and Heat Production			
Liquid fuels	162,016	3,371	12,353
Solid fuels	430,518	11,306	41,426
Natural gas	1,119,754	17,393	63,730
Refinery gases	12,190	207	757
Coal gases	12,790	164	601
Biomass	71,051	2,024	7,417
Other fuels (incl.waste)	24,726	628	2,301
Total	**1,833,046**	**33,069**	**121,167**
Industrial producers (Table 1.A.1.b-c) and auto-producers (Table 1.A.2 Manufacturing Industries)			
Liquid fuels	4,750	103	377
Solid fuels	3	0	0
Natural gas	50,962	792	2,900
Refinery gases	1,810	31	112
Other refinery products	79,339	2,100	7,696
Coal gases	36,247	2,492	9,132
Biomass			
Other fuels (incl.waste)	7,933	465	1,705
Total	**181,043**	**5,983**	**21,923**
General total	**2,014,089**	**39,052**	**143,090**

Source: ISPRA elaborations

Table A2.3 Power sector, Energy/CO_2 emissions in CRF format, year 2008

In conclusion the main question of the accuracy of the underlying energy data of key sources is connected to the discrepancies between BEN and Terna in the estimates of electricity produced and of the energy content of the used fuels. The difference is small but it should not occur because both data sets 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.

A2.3 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions from electricity production is estimated to be about 4.2% in annual emissions; a higher uncertainty equal to 50.1% is calculated for CH_4 and N_2O emissions on account of the uncertainty levels attributed to the related emission factors.
Estimates of fuel consumption for electricity generation in 2008 are reported in Table A2.3.
In Table A2.4, the time series of the total CO_2 emissions from electricity generation activities is reported, including total electricity produced and specific indicators of CO_2 emissions for the total energy production and for the thermoelectric production respectively, expressed in grams of CO_2 per kWh.

The time series clearly shows that although the specific carbon content of the kWh generated in Italy has constantly improved over the years, total emissions have raised till 2006 due to the even bigger increase of electricity production. The decreasing trend of the last two years results from an increase in energy production from renewable sources combined with a further reduction in the use of oil products for electricity production.

	1990	1995	2000	2005	2006	2007	2008
Total gross electricity produced (TWh)	216.9	241.5	276.6	303.7	314.1	313.9	319.1
Total CO_2 emitted (Mt)	128.5	135.7	140.5	146.4	148.7	144.2	143.1
g CO_2 / kWh of gross thermo-electric production	720	693	645	596	578	553	559
g CO_2 / kWh of total gross production	592	562	508	482	474	459	448

Source: ISPRA elaborations

Table A2.4 Time series of CO_2 emissions from electricity production

The trend of CO_2 emissions per thermoelectric production are the result of an increase due to a growing coal share and reductions due to the entry into service of more efficient combined cycle plants. The downward trend takes into account the general increase in efficiency of the power plants.

A2.4 Source-specific QA/QC and verification

Basic activity data to estimate emissions from all operators are annually collected and reported by the national grid administrator (TERNA, several years). Other data are collected directly from operators for plants bigger than 20 MWh, with a yearly survey since 2005 and communicated at international level in the framework of the EU ETS scheme. Activity data and other parameters, as net calorific values, are compared every year at an aggregate level, by fuel; differences and problems have been identified, analysed in detail and solved with sectoral experts.
In addition, time series resulting from the recalculation have been presented to the national experts in the framework of an *ad hoc* working group on air emissions inventories. The group is chaired by ISPRA and includes participants from the local authorities responsible for the preparation of local inventories, sectoral experts, the Ministry of Environment, Land and Sea, and air quality model experts. Top-down and bottom-up approaches have been compared with the aim to identify the potential problems and future improvements to be addressed.

A2.5 Source-specific recalculations

There has been an overall recalculation of emissions from the sector due to the update based on detailed Terna report for year 2008 and data collected from the EU ETS scheme. In particular the recalculations refer to CO_2 emission factors for the years 2005-2007 for coal and fuel oil and 2007 for natural gas. Fuel oil CO_2 emission factors have been updated on the basis of detailed information supplied by Terna regarding the consumption of high and low sulphur fuel oil to produce electricity. Natural gas CO_2 emission factor has been updated for change of imported gas parameters. Coal CO_2 emission factor has been updated taking in account the information supplied by the plants in the framework of the EU ETS scheme for the same years. The recalculations affected only slightly the time series from 2005 to 2007 with differences ranging from -0.8% to -0.4%, with respect to earlier submission.

A.2.6 Source-specific planned improvements

No specific improvements are planned for the next submission.

ANNEX 3: ESTIMATION OF CARBON CONTENT OF COALS USED IN INDUSTRY

The preliminary use of the CRF software in 2001 underlined an unbalance of emissions in the solid fuel rows above 20%. A detailed verification pointed out to an already known fact for Italy: the combined use of standard IPCC emission factors for coals, national emission factors for coal gases and CORINAIR methodology emission factors for steel works processes produces double counting of emissions.
The main reason for this is the specific national circumstance of extensive recovery of coal gases from blast furnaces, coke ovens and oxygen converters for electricity generation. The emissions from those gases are separately accounted for and reported in the electricity generation section.
Another specific national circumstance is the concentration of steel works, since the year 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 emission factor developed for other industrial sites.

To avoid the double counting a specific methodology has been developed: it balances energy and carbon content of coking coals used by steelworks, industry, for non energy purposes and coal gasses used for electricity generation.
A balance is made between the coal used for coke production and the quantities of derived fuels used in various sectors. The iron and steel sector gets the resulting quantities of energy and carbon after subtraction of what is used for electricity generation, non energy purposes and other industrial sectors.
The base statistical data are all reported in the BEN (with one exception) and the methodology starts with a verification of the energy balance reported in the BEN, see also Annex 5, table A5.3/.4, that seldom presents problems, and then apply the standard emission factors to the energy carriers, trying to balance the carbon inputs with emissions. The exception mentioned refers to the recovered gases of BOFs (Basic Oxygen Furnace) that are used to produce electricity but were not accounted for by BEN from the year 1990 up to 1999. From the year 2000 those gases are (partially, only in one plant) included in the estimate of blast furnace gas. The data used to estimate the emissions from 1990 to 1999 are reported by GRTN – ENEL (Terna, several years). The consideration of the BOF gases does not change the following discussion, because its contribution to the total emissions is quite limited.

Table A3.1 summarises the quantities of coal and coal by-products used by the energy system in the year 2008, all the data mentioned can be found in “enclosures 1/a, 2/a and 3/a” of BEN, see also Annex 5 (MSE, several years)
In the first box from top of the table we can see the quantities of coke, coke gas and blast furnace gas uses by the different sectors. In the second box are reported the quantities of the same energy carriers that are self-used, used for the production of coke or wasted.
Then in the final part of the table, the two coloured groups of cells report the verification of the input-output of two processes, coke ovens and blast furnaces. The input –output is generally balanced for all the considered years; the small differences can be explained by statistical discrepancies. The following data are just memo summary of the quantities of fuels imported or exported by the system.

coke	coke gas	blast furnace gas	NOTES
7,707			For blast furnace
0	3,453	7,855	For electricity production
21,720	0	49	For steel industries
216	0	0	For other industries use
0	0		For domestic use
29,644	3,453	7,904	Total consumption
444	264	13	Consumption for production of secondary fuels
0	-2	-1	Losses of transformation
30,088	3,715	7,916	Total consumption + losses and prod.
Energy balance, coke ovens		**Energy balance, blast furnace gas**	
-828		25	Difference in energy consumption
-0,6%		0,1%	Unbalance in %
35,120			Coke oven output
6,653			Transformation losses, coke ovens
1,628			non energy use
43,401			sub total
43,401			Coking coal input to coke ovens
11,620			Blast furnace coal input
-1,639			import + stock change

Table A3.1 Energy balance, 2008, Tcal

In table A3.2, in the first two boxes from the top the same energy data of Table A3.1 valuated for their carbon content are reported, according to the standard emission factors reported in Table 3.12 of the NIR. In the coloured cells the balance of carbon inputs and outputs of two processes coke oven and blast furnaces are shown.

So in the end the methodology actually foresees as a first step the calculation of the total carbon inputs (imported fuels plus standard IPCC emission factors), see table A3.2 column “total according to BEN”. A second step foresees the use for the electric sector of the value directly calculated from the coal gasses used and the calculation of a “balance” quantity for blast furnaces, see column “total used for CRF” in Table A3.2. The balance is the resulting quantity of emissions after subtraction of carbon emissions estimated for coke ovens, electricity production, other coal uses and non energy uses.

The resulting carbon quantities are correct but, when reported in the CRF format, they seem to be produced using very low emission factors for coal produced CO_2, near to the natural gas emission factor, for the steel making process and quite high carbon emissions for the coal used to produce electricity.

Further investigations are planned, with a verification of the carbon content of the imported coals and of the coal gasses produced at various stages of the process, coke gas, blast furnace gas and BOF gas. Additional information from the operators on fuel consumptions and average emission factors is submitted in the framework of the EU ETS scheme and it is used to verify our calculation and CO_2 emissions at plant level.

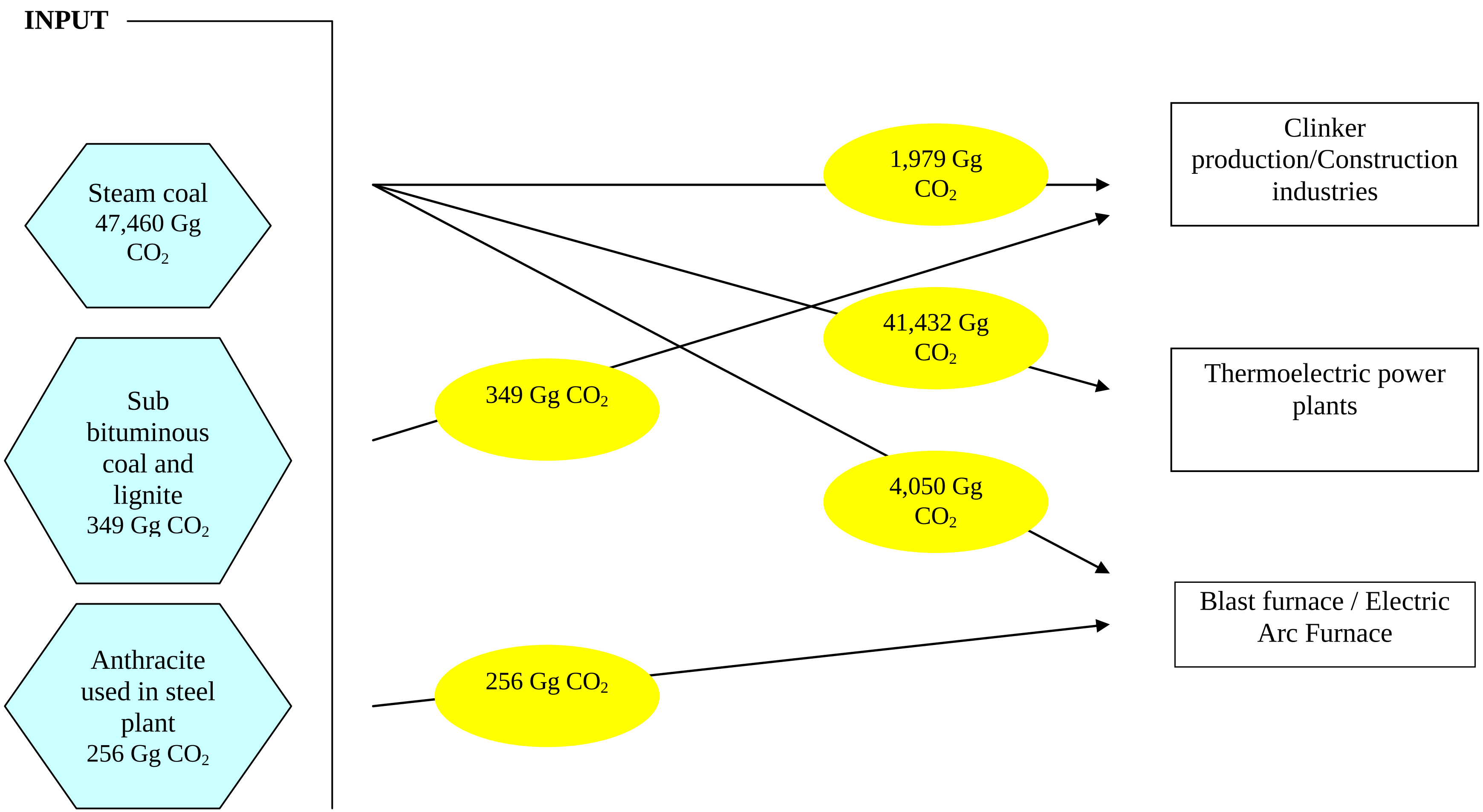
On the basis of the analysis of these data and comparison with figures reported in the National Energy Balance, in the 2010 submission coking coal consumptions due to losses during the transformation process in cookeries, and their related emissions, have been reallocated from the 1.A.2.a sector, iron and steel, to the 1.A.1.c sector, manufacture of solid fuels and other energy industries.

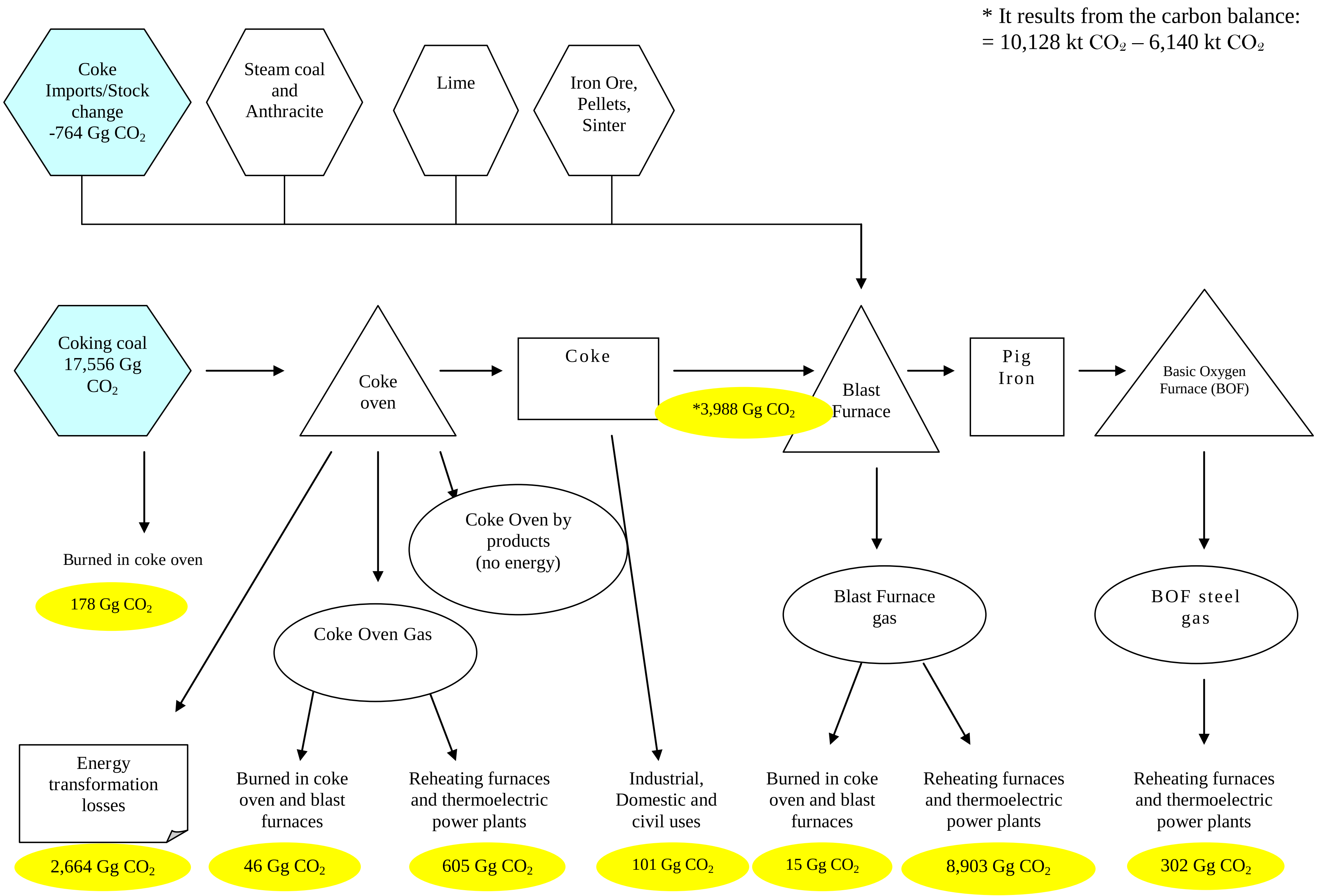
coke	coke gas	Blast furnace gas + oxi gas	NOTES	Total according to BEN	Total used for CRF
3.59			From blast furnace (no direct emissions, transformed in coal gasses)	3.59	
0.00	0.60	9.14	From electricity prod.	9.75	9.76
10.13	0.00	0.06	From steel industries	10.18	10.40
0.10	0.00	0.00	From other industries use	0.10	0.10
0.00	0.00		From domestic use	0.00	
13.82	0.60	9.20	Total emissions, final uses	23.62	20.27
0.18	0.05	0.01	Consumption for production of secondary fuels	0.24	
0.00	0.01	0.00	Losses of transformation	0.01	
14.00	0.67	9.21	Total consumption + losses and prod.	23.88	
Carbon balance, coke ovens		**Carbon balance, blast furnace**			
1.4		0.7	Difference in physical emissions		
10%		8%	Unbalance in %		
Emissions					
14.06			Carbon in produced coke		
2.66			Transformation losses		
0.65			non energy use	0.65	0.65
17.38			Coal input to coke ovens		
4.31			Coal input to blast furnace		
-0.76			Coke import + stock change		
20.92			Total carbon input		20.92

Table A3.2 Carbon balance, 2008, Mt CO_2

The flowchart of carbon cycle for the year 2008 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 2008.

CO_2 emission calculation
Year 2008




* It results from the carbon balance:
= 10,128 kt CO_2 – 6,140 kt CO_2
Coke Imports/Stock change -764 Gg CO_2
Steam coal and Anthracite
Lime
Iron Ore, Pellets, Sinter
Coking coal 17,556 Gg CO_2
Coke oven
Coke
*3,988 Gg CO_2
Blast Furnace
Pig Iron
Basic Oxygen Furnace (BOF)
Burned in coke oven
178 Gg CO_2
Coke Oven by products (no energy)
Coke Oven Gas
Blast Furnace gas
BOF steel gas
Energy transformation losses
2,664 Gg CO_2
Burned in coke oven and blast furnaces
46 Gg CO_2
Reheating furnaces and thermoelectric power plants
605 Gg CO_2
Industrial, Domestic and civil uses
101 Gg CO_2
Burned in coke oven and blast furnaces
15 Gg CO_2
Reheating furnaces and thermoelectric power plants
8,903 Gg CO_2
Reheating furnaces and thermoelectric power plants
302 Gg 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 follows the IPCC Guidelines (IPCC, 1997); table 1.A(b) of the Common Reporting Format “Sectoral background data for energy - CO_2 from Fuel Combustion Activities - Reference Approach” is a self sustaining explanation of the methodology.
However it was necessary to make a few adaptations to allow full use of the Italian energy and emission factor data (ENEA, 2002 [a]), and these are described in the following. The BEN (MSE, several years [a]) reports the energy balances for all primary and secondary fuels, with data on imports, exports and production. See Annex 5, Tables A5.1-A5.10, for an example of the year 2008 and to the web site of the Ministry of Economic Development for the whole time series http://dgerm.sviluppoeconomico.gov.it/dgerm/.

Starting from those data and using the emission factors reported in chapter 3, Table 3.12, it is possible to estimate the total carbon entering in the national energy system. It has been developed a direct connection between relevant cells of the CRF tables and the BEN tables and a procedure to insert some additional activity data needed.
The ‘missing’ data refer to import – export of lubricants, petrol additives, asphalt, other chemical products with energy content, energy use of exhausted lubricants and the evaluation of marine and aviation bunkers fuels used for national traffic.
Those ‘missing’ data are in fact reported in the BEN but all mixed up together with other substances as sulphur and petrochemicals. The aggregate data do not allow the use of the proper emission factor so inventory is based on more detailed statistics from foreign trade surveys.
The carbon stored in products is estimated according to the procedure illustrated in the paragraph 3.8 and directly subtracted to the emission balance by the CRF software in the current version used by Italy. It may be the case to underline that no direct subtraction of the energy content of the feedstock is performed by CRF. In the cases, as Italy, where those products are not considered in the energy balances this bring to an unbalanced control sheet, as discussed in the following.

With reference to table 1.A(b) of the CRF, we make reference to the BEN tables reported in Annex 5. In particular the following data are reported and used for the *Reference Approach*:
1) crude oil imports and production;
2) natural gas data import;
3) import-export data of petrol, aviation fuel, other kerosene, diesel, fuel oil, LPG and virgin naphtha;
4) import-export data of bitumen and motor oil derive from foreign trade statistics, estimated by an ENEA consultant for the period 1990-1998. BPT data (MSE, several years [b]) are used from 1999 onwards;
5) import-export data of petroleum coke and refinery feedstock are also found in BEN; it has to be underlined that the data reported as “feedstock production” have been ignored up to year 2003 because it is explicitly excluded by the IPCC methodology.

From 2004 onward a careful check with the team in charge to prepare the energy balances induced the inventory team to revise its position on this matter[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 emission factors estimate, see paragraph 3.8) are from foreign trade statistics or “Rete Gas”, the national gas grid monopoly, fiscal budgets; the estimated quantities of natural gas used by various sectors show not negligible variations from source to source, with particular reference to the underground stocked quantities; when available we use the estimates of AEEG (Authority for electricity and gas) for consumption of the distribution / storage system and BEN for final consumption;
8) from 1990 to 2008 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 2008 pending further investigations; the inventory follows the same methodology.

The following additional information is needed to complete table 1.A(b) of CRF and it is found in other sources:

1) Orimulsion, this fuel is mixed up with imported fuel oil (on the base of the energy content), the quantities used for electricity generation are reported by ENEL (ENEL, several years), the former electricity monopoly, presently the only user of this fuel, in their environmental report. This fuel is not used any more since 2004.
2) Motor oils and bitumen.
    a) Data on those materials are mixed up in the no energy use by BEN, while detailed data are available in BPT (MSE, several years [b]). The quantities of those materials are quite relevant for the no energy use of oil.
    b) In the BEN those materials are estimated in bulk with other products to have an energy content of about 5100 kcal/kg. Average OECD data are equal to 9000 kcal/kg for bitumen and 9800 kcal/kg for motor oils. In the CRF those products are estimated with the OECD energy content and this could explain part of the unbalance between imported oil and used products.

For further information see the paper by ENEA (ENEA, 2002 [b]) in Italian.

A4.2 Comparison of the sectoral approach with the reference approach

The detailed inventory contains a number of sources not accounted for in the IPCC Reference Approach and so gives a higher estimate of CO_2 emissions. The unaccounted sources are:

- Land use change and forestry
- Offshore flaring and well testing
- Waste incineration
- Non-Fuel industrial processes

[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 the Ministry of Economic Development has only a few details about the origin of those fuel streams returned to refineries. Since 2004 those fuel streams are needed to close the energy balances, which now are much more precise than before. Not considering them in the CRF as input will increase the difference between reference and sectoral approach in the oil section, while with those fuels as inputs the difference is nearly zero. The inventory team considers those fuels as “stock changes” of petrochemical input.

First of all, the IPCC Reference total can be compared with the IPCC Table 1A total. Results show the IPCC Reference totals are between 0-4 percent lower than the comparable 'bottom up' totals. The highest difference between the two approaches is observed in 1999 and is equal to 3.3%; input data have been checked in details, the difference could be attributed to higher thermo electric fuel input registered by ENEL/TERNA than the figure reported in the energy balance and higher quantities of pet coke calculated from cement production data than those reported in the energy balance.
Differences between emissions estimated by the reference and sectoral approach are reported in Table A4.1.

	1990	1995	2000	2005	2006	2007	2008
Sectoral approach	402.0	414.9	435.2	459.8	455.5	445.4	439.3
Reference approach	395.7	406.2	424.8	452.6	449.7	437.4	436.7
Δ %	-1.57%	-2.11%	-2.37%	-1.56%	-1.26%	-1.81%	-0.59%

Table A4.1 Reference and sectoral approach CO_2 emission estimates 1990-2008 (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 2008

The following table reproduces the part expressed in amount of energy consumed of the National Energy Balance (BEN) of the year 2008 (MSE, several years).

The complete balance, containing the physical quantities as well as the amount of energy and a consistent time series from the year 1998 onwards, is also available on the website: http://dgerm.sviluppoeconomico.gov.it/dgerm/.

Sectors and fuel definition have been translated here in English, but, of course, the tables on Internet are in Italian language. Definitions are very similar to their English equivalents so this should not be an obstacle to independent verifications of energy data sources for previous years.

The national energy balance is comprised of two "sets" of tables: from page 2 to page 10 the energy vectors are represented in physical quantities (Gg/Mmc) while from page 12 to page 20 they are expressed in energy equivalents (10^9 kcal).
Recalling what already said in Annex 2 related to the BEN reporting methodology (that prefers to use always the same lower heat value for each primary fuel in various years, to better follow the variable energy content of each shipment), we make reference here to the second set of tables. This means, for example, that the primary fuel quantities of two shipments of imported coal are "adjusted" using their energy content as the main reference (see Table A5.1) and the value reported in page 2 of the national energy balance (non reproduced here) is an "adjusted" quantity of Gg or Mmc. 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 2008, Primary fuels, 10^9 kcal

BALANCE	PRIMARY SOURCES															
	Coking coal	**Steam coal**	**Coal other uses**	**Lignite**	**Subproducts (a)**	**Natural Gas**	**Crude oil**	**Refinery feedstocks**	**Hydraulic Energy (e)**	**Geothermal Energy**	**Wind and Photovoltaic Energy**	**Waste**	**Wood**	**Biomass (f)**	**Biodiesel**	**TOTAL PRIMARY SOURCES**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Conversion factor (b)	*7,400*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*	*2,200*	*2,500*	*2,500*	*2,500*	*8,900*	
1. PRODUCTIONS (c)	0	743	0	0	4.703	75.798	52.200	23.020	91.570	12.145	11.119	11.159	19.338	12.035	5.946	319.776
2. IMPORTS	44.925	118.789	2.375	10	0	629.541	824.320	73.420	0	0	0	0	5.445	0	2.127	1.700.952
3. EXPORTS						1.720	9.780	11.670					35	0	961	24.166
4. Stock changes (d)	1.080	318	814	0	0	8.428	-2.700	-1.790	0	0	0	0	0	0	481	6.631
5. TOTAL RESOURCES	**43.845**	**119.214**	**1.561**	**10**	**4.703**	**695.192**	**869.440**	**86.560**	**91.570**	**12.145**	**11.119**	**11.159**	**24.748**	**12.035**	**6.631**	**1.989.932**
6. Transformations (Enclosure 1/a)	43.401	102.910		0	4.703	277.676	956.000	0	91.570	12.145	11.119	11.159	1.780	12.035	0	1.524.498
7. Consumptions and Losses (Encl.2/a)	444	0	0	0	0	12.234	0	0	0	0	0	0	0	0	0	12.678
8. Final Consumptions (Enclosure 3/a)	0	16.304	1.561	10	0	405.282	0	0				0	22.968	0	6.631	452.756
a) Agriculture	0	0	0	0	0	1.368	0	0	0	0	0	0	2.295	0	0	3.663
b) Industry	0	16.304	1.509	10	0	144.300		0				0	3.445	0	0	165.568
c) Services						5.495		0					0	0	6.622	12.117
d) Domestic and civil uses			52	0		247.166		0					17.228	0	9	264.455
Total (a+b+c+d)	**0**	**16.304**	**1.561**	**10**	**0**	**398.329**		**0**				**0**	**22.968**	**0**	**6.631**	**445.803**
e) Non energy uses						6.953	0	0	0	0	0	0	0	0	0	6.953
TOTAL ENERGY CONSUMPTIONS (7+8)	**444**	**16.304**	**1.561**	**10**	**0**	**417.516**	**0**	**0**	**0**	**0**		**0**	**22.968**	**0**	**6.631**	**465.434**
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**	**Wood**	**Biomass (f)**	**Biodiesel**	**TOTAL PRIMARY SOURCES**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Conversion factor (b)	*7,400*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*	*2,200*	*2,500*	*2,500*	*2,500*	*8,900*	
10. BUNKERS																
12. TOTAL USES	**43.845**	**119.214**	**1.561**	**10**	**4.703**	**695.192**	**956.000**	**0**	**91.570**	**12.145**	**11.119**	**11.159**	**24.748**	**12.035**	**6.631**	**1.989.932**

(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: biomass used by electric energy production

Table A5.2 -National Energy Balance, year 2008, Secondary fuels, 10^9kcal

BALANCE	SECONDARY SOURCES																		
	Electric Energy	**Char- coal**	**Coke**	**Coke oven gas**	**Blast furnace Gas (g)**	**Non energy use of coal products**	**Gas works Gas**	**L. P. G.**	**Refinery gas (h)**	**Light Distillates (naphtha)**	**Gasoline**	**Jet fuel**	**Kerosene**	**Gas Oil / Diesel Oil**	**Residual Oil, HS (i)**	**Residual Oil, LS**	**Petroleum Coke**	**Non energy use of petroleum products**	**TOTAL SECONDARY SOURCES**
	17	18	19	20	22	23	21	24	25	26	27	28	29	30	31	32	33	34	35
Conversion factor (b)	*0,86*	*7,500*	*6,975*	*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*	*5,986*	
1. PRODUCTIONS (c)	269.632	895	31.282	3.715	7.916	1.547	0	23.639	45.516	29.494	212.394	37.294	2.050	406.235	(g) 63.122	80.399	12.085	37.347	1.264.562
2. IMPORTS	37.352	510	1.590					17.919	0	18.720	1.649	7.592	670	18.748	(h) 8.291	15.562	25.224	5.208	159.035
3. EXPORTS	2.922	23	1.667			289		5.060		6.583	96.191	1.498	721	101.776	22.805	11.623	1.062	17.964	270.184
4. Stock changes (d)		0	1.562					902		-156	-1.838	1.071	-793	1.836	1.735	-5.645	-1.751	-521	-3.598
5. TOTAL RESOURCES	**304.062**	**1.382**	**29.643**	**3.715**	**7.916**	**1.258**	**0**	**35.596**	**45.516**	**41.787**	**119.690**	**42.317**	**2.792**	**321.371**	**46.873**	**89.983**	**37.998**	**25.112**	**1.157.011**
6. Transformations (Encl.1/a)			7.707	3.453	(c) 7.855	0		0	3.241	140	0	0	0	1.867	12.379	43.120	1.425	0	81.187

BALANCE	SECONDARY SOURCES																		
	Electric Energy	**Char- coal**	**Coke**	**Coke oven gas**	**Blast furnace Gas (g)**	**Non energy use of coal products**	**Gas works Gas**	**L. P. G.**	**Refinery gas (h)**	**Light Distillates (naphtha)**	**Gasoline**	**Jet fuel**	**Kerosene**	**Gas Oil / Diesel Oil**	**Residual Oil, HS (i)**	**Residual Oil, LS**	**Petroleum Coke**	**Non energy use of petroleum products**	**TOTAL SECONDARY SOURCES**
	17	18	19	20	22	23	21	24	25	26	27	28	29	30	31	32	33	34	35
Conversion factor (b)	*0,86*	*7,500*	*6,975*	*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*	*5,986*	
7. Consumptions and Losses (Encl.2/a)	38.049	0	0	262	12	0	0	462	30.731	182	73	0	1	70	5.850	10.291	8.345	24	94.344
8. Final Consumptions (Encl.3/a)	266.013	1.382	21.936	0	49	1.258	0	35.134	11.544	41.465	119.617	42.317	2.791	313.345	6.026	27.870	28.228	3.101	943.741
a) Agriculture	4.876							682	0	0	137	0	0	23.042	0	0	0	0	28.737
b) Industry	116.146	233	21.936	0	49		0	3.201	2.316	0	294	156	10	4.030	4.272	24.577	28.228	3.101	208.549
c) Services	39.081							11.066			115.532	42.161	0	251.644	0	0	0	0	459.484
d) Domestic and civil uses	105.910	1.149	0				0	20.185	0	0	0		103	25.092	0	882	0	0	153.321
Total (a+b+c+d)	**266.013**	**1.382**	**21.936**	**0**	**49**	**0**	**0**	**35.134**	**2.316**	**0**	**115.963**	**42.317**	**113**	**303.808**	**4.272**	**25.459**	**28.228**	**3.101**	**850.091**

BALANCE	SECONDARY SOURCES																		
	Electric Energy	**Char- coal**	**Coke**	**Coke oven gas**	**Blast furnace Gas (g)**	**Non energy use of coal products**	**Gas works Gas**	**L. P. G.**	**Refinery gas (h)**	**Light Distillates (naphtha)**	**Gasoline**	**Jet fuel**	**Kerosene**	**Gas Oil / Diesel Oil**	**Residual Oil, HS (i)**	**Residual Oil, LS**	**Petroleum Coke**	**Non energy use of petroleum products**	**TOTAL SECONDARY SOURCES**
	17	18	19	20	22	23	21	24	25	26	27	28	29	30	31	32	33	34	35
Conversion factor (b)	*0,86*	*7,500*	*6,975*	*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*	*5,986*	
e) No energetic uses				0		1.258		0	9.228	41.465	3.654	0	2.678	9.537	1.754	2.411	0	21.665	93.650
TOTAL ENERGY CONSUMPTIONS (7+8)	**304.062**	**1.382**	**21.936**	**262**	**61**	**1.258**	**0**	**35.596**	**42.275**	**41.647**	**119.690**	**42.317**	**2.792**	**313.415**	**11.876**	**38.161**	**36.573**	**3.125**	**1.016.428**
9. Non energy final uses		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21.663	21.663
10. BUNKERS		0	0	0	0	0	0	0	0	0	0	0	0	6.089	22.618	8.702	0	323	37.732
12. TOTAL USES	**304.062**	**1.382**	**29.643**	**3.715**	**7.916**	**1.258**	**0**	**35.596**	**45.516**	**41.787**	**119.690**	**42.317**	**2.792**	**321.371**	**46.873**	**89.983**	**37.998**	**25.112**	**1.157.011**
(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 2008, Primary fuels used by transformation industries, "Enclosure 1/a", 10^9kcal

TRANSFORMATIONS	PRIMARY SOURCES													
	Coking coal	**Steam coal**	**Coal other uses**	**Lignite**	**Subproducts (a)**	**Natural Gas**	**Crude oil**	**Refinery feedstocks**	**Hydraulic Energy (e)**	**Geothermal Energy**	**Wind and Photovoltaic Energy**	**Waste**	**Biomass**	**TOTAL PRIMARY SOURCES**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Conversion factor (b)	*7,400*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*	*2,200*	*2,500*	*2,500*	
1) INPUT QUANTITY														
a) Charcoal pit													1.780	1.780
b) Coking	43.401													43.401
c) Town gas Workshop														
d) Blast furnaces														
e) Petroleum refineries							956.000							956.000
f) Hydroelectric power plants									91.570					91.570
g) Geothermal power plants										12.145				12.145
h) Thermoelectric power plants		102.910			4.703	277.676						11.159	12.035	408.483
i) Wind / Photovoltaic power plants						-					11.119			11.119
TOTAL	**43.401**	**102.910**			**4.703**	**277.676**	**956.000**		**91.570**	**12.145**	**11.119**	**11.159**	**13.815**	**1.524.498**
2) OUTPUT QUANTITY														
A) Obtained sources														
a) Charcoal pit													890	890
b) Coking	35.120													35.120
c) Town gas Workshop							912.233							912.233
d) Blast furnaces								35.796						35.796
e) Petroleum refineries									4.747					4.747
f) Hydroelectric power plants														
g) Geothermal power plants														

TRANSFORMATIONS	PRIMARY SOURCES													
	Coking coal	**Steam coal**	**Coal other uses**	**Lignite**	**Subproducts (a)**	**Natural Gas**	**Crude oil**	**Refinery feedstocks**	**Hydraulic Energy (e)**	**Geothermal Energy**	**Wind and Photovoltaic Energy**	**Waste**	**Biomass**	**TOTAL PRIMARY SOURCES**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Conversion factor (b)	*7,400*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*	*2,200*	*2,500*	*2,500*	
h) Thermoelectric power plants		37.043			1.842	148.520						2.681	3.788	193.874
i) Wind / Photovoltaic power plants											4.347			4.347
Sub-Total A	**35.120**	**37.043**			**1.842**	**148.520**	**912.233**		**35.796**	**4.747**	**4.347**	**2.681**	**4.678**	**1.187.007**
B) Losses of transformation														
a) Charcoal pit													890	890
b) Coking	6.653													6.653
c) Town gas Workshop														
d) Blast furnaces														
e) Petroleum refineries							6.420							6.420
f) Hydroelectric power plants									55.774					55.774
g) Geothermal power plants										7.398				7.398
h) Thermoelectric power plants		65.867			2.861	129.156						8.478	8.247	214.609
i) Wind / Photovoltaic power plants											6.772			6.772
Sub-Total B	**6.653**	**65.867**			**2.861**	**129.156**	**6.420**		**55.774**	**7.398**	**6.772**	**8.478**	**9.137**	**298.516**
C) Non energy products														
a) Coke ovens (c)	1.628													1.628
b) Town Gas Workshop														
c) Petroleum refineries (d)							37.347							37.347
Sub-Total C	**1.628**						**37.347**							**38.975**
TOTAL A+B+C	**43.401**	**102.910**			**4.703**	**277.676**	**956.000**		**91.570**	**12.145**	**11.119**	**11.159**	**13.815**	**1.524.498**

TRANSFORMATIONS	PRIMARY SOURCES													
	Coking coal	**Steam coal**	**Coal other uses**	**Lignite**	**Subproducts (a)**	**Natural Gas**	**Crude oil**	**Refinery feedstocks**	**Hydraulic Energy (e)**	**Geothermal Energy**	**Wind and Photovoltaic Energy**	**Waste**	**Biomass**	**TOTAL PRIMARY SOURCES**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Conversion factor (b)	*7,400*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*	*2,200*	*2,500*	*2,500*	
(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 2008, Secondary fuels used by transformation industries, "Enclosure 1/a", 10^9kcal

TRANSFORMATIONS	SECONDARY SOURCES																		
	Electric Energy	**Char- coal**	**Coke**	**Coke oven gas**	**Blast furnace Gas**	**Non energy use of coal products**	**Gas works Gas**	**L. P. G.**	**Refinery gas**	**Light Distillates (naphtha)**	**Gasoline**	**Jet fuel**	**Kerosene**	**Gas Oil / Diesel Oil**	**Residual Oil, HS**	**Residual Oil, LS**	**Petroleum Coke**	**Non energy use of petroleum products**	**TOTAL SECONDARY SOURCES**
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor (b)	*0,860*	*7,500*	*6,975*	*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*	*5,986*	
1) INPUT QUANTITY																			
a) Charcoal pit																			
b) Coking																			
c) Town gas Workshop																			
d) Blast furnaces			7.916																7.916
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*	*6,975*	*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*	*5,986*	
f) Hydroelectr.power plants																			
g) Geothermal power plants																			
h) Thermoelectr.power plants				3.453	7.855				3.241	140				1.867	12.379	43.120	1.425		73.480
i) Wind / Photovoltaic power plants																			
TOTAL			**7.916**	**3.453**	**7.855**				**3.241**	**140**				**1.867**	**12.379**	**43.120**	**1.425**		**81.396**
2) OUTPUT QUANTITY																			
A) Obtained sources																			
a) Charcoal pit																			
b) Coking																			
c) Town gas Workshop																			
d) Blast furnaces			7.916																7.916
e) Petroleum refineries																			
f) Hydroelectric power plants																			
g) Geothermal power plants																			
h) Thermoelectric power plants					1.404	3.205				1.591	97				585	6.085	17.248	653	

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*	*6,975*	*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*	*5,986*	
i) Wind / Photovoltaic power plants																			
Sub-Total A			**7.916**	**1.404**	**3.205**				**1.591**	**97**				**585**	**6.085**	**17.248**	**653**		**38.784**
B) Losses of transformation																			
a) Charcoal pit																			
b) Coking																			
c) Town gas Workshop																			
d) Blast furnaces																			
e) Petroleum refineries																			
f) Hydroelectric power plants																			
g) Geothermal power plants																			
h) Thermoelectric power plants					2.049	4.650				1.650	43				1.282	6.294	25.872	772	
i) Wind / Photovoltaic power plants																			
Sub-Total B				**2.049**	**4.650**				**1.650**	**43**				**1.282**	**6.294**	**25.872**	**772**		**42.612**
C) Non energy products																			
a) Coking																			
b) Town Gas Workshop																			

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*	*6,975*	*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*	*5,986*	
c) Petroleum refineries																			
Sub-Total C																			
TOTAL A+B+C			**7.916**	**3.453**	**7.855**				**3.241**	**140**				**1.867**	**12.379**	**43.120**	**1.425**		**81.396**

Table A5.5 -National Energy Balance, year 2008, Primary fuels losses, "Enclosure 2/a", 10^9kcal

CONSUMPTIONS AND LOSSES (d)	PRIMARY SOURCES													
	Coking coal	**Steam coal**	**Coal other uses**	**Lignite**	**Subproducts (a)**	**Natural Gas**	**Crude oil**	**Refinery feedstocks**	**Hydraulic Energy**	**Geothermal Energy**	**Wind and Photovoltaic Energy**	**Waste**	**Biomass**	**TOTAL PRIMARY SOURCES**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Conversion factor (b)	*7,400*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*			*2,500*	
1) Consumptions for production														
of primary sources														
a) Biomass														
b) Coal														
c) Lignite														
d) Nuclear fuels														
e) Natural Gas						4.029								4.029
f) Natural gas liquids														
g) Crude oil														
h) Hydraulic Energy														
i) Geothermal Energy														
Sub-total						**4.029**								**4.029**
2) Consumptions for production														
of secondary sources (c)														
a) Charcoal pit														
b) Coke ovens	444													444
c) Town Gas Workshop														
d) Blast furnaces														
e) Petroleum refineries						3.702								3.702
f) Hydraulic power plants														

CONSUMPTIONS AND LOSSES (d)	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts (a)	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass	TOTAL PRIMARY SOURCES
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Conversion factor (b)	*7,400*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*			*2,500*	
g) Geothermal power plants														
h) Thermoelectric power plants														
i) Nuclear power plants														
Sub-total	**444**					**3.702**								**4.146**
3) Consumptions and Losses of														
transport and distribution						4.505								4.505
4) Differences :														
- Statistics														
- of conversion						-2								-2
TOTAL (1+2+3+4)	**444**					**12.234**								**12.678**

(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 2008, 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*	*6,975*	*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*	*5,986*	
1) Consumptions for production																			
of primary sources																			
a) Biomass																			
b) Coal	37																		37
c) Lignite	2																		2
d) Nuclear fuels	5																		5
e) Natural Gas	300																		300
f) Natural gas liquids																			
g) Crude oil																			
h) Hydraulic Energy	1.732	(d)																	1.732
i) Geothermal Energy	-																		
Sub-total	**2.076**																		**2.076**
2) Consumptions for production																			
of secondary sources (c)																			
a) Charcoal pit																			
b) Coke ovens	142			262	13														417
c) Town Gas Workshop	204																		204

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*	*6,975*	*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*	*5,986*	
d) Blast furnaces																			
e) Petroleum refineries	5.017							462	30.732	187	74			72	5.851	10.289	8.341	24	61.049
f) Hydraulic power plants	476																		476
g) Geothermal power plants	278																		278
h) Thermoelectric power plants	9.614																		9.614
i) Wind / Photovoltaic power plants	8																		
Sub-total	**15.739**			**262**	**13**			**462**	**30.732**	**187**	**74**			**72**	**5.851**	**10.289**	**8.341**	**24**	**72.038**
3) Consumptions and Losses of	20.234																		20.234
transport and distribution																			
4) Differences :																			
- Statistics	-																		
- of conversion					-1				-1	-5	-1		1	-2	-1	2	4		-4
TOTAL (1+2+3+4)	**38.049**			**262**	**12**			**462**	**30.731**	**182**	**73**		**1**	**70**	**5.850**	**10.291**	**8.345**	**24**	**94.344**

Table A5.7 -National Energy Balance, year 2008, Primary fuels used by end use sectors, "Enclosure 3/a", 10^9kcal

FINAL CONSUMPTIONS	PRIMARY SOURCES														
	Coking coal	**Steam coal**	**Coal other uses**	**Lignite**	**Subproducts**	**Natural Gas**	**Crude oil**	**Refinery feedstocks**	**Hydraulic Energy**	**Geothermal Energy**	**Wind and Photovoltaic Energy**	**Waste**	**Wood**	**Biodiesel**	**TOTAL PRIMARY SOURCES**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Conversion factor (a)	*7,400*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*	*2,200*	*2,500*	*2,500*	*8,900*	
1) AGRICULTURE AND FISHING															
I- Agriculture						1.368							2.295		3.663
II- Fishing															
Sub-Total						**1.368**							**2.295**		**3.663**
2) INDUSTRY															
I- Iron and steel industry		10.954	666			18.428									30.048
II- Other industry		5.350	843	10		125.872							3.445		135.520
a) Mining industry						385									385
b) Non-Ferrous Metals			37			3.710									3.747
c) Metal works factories						21.179									21.179
d) Food Processing, Beverages						14.988									14.988
e) Textile and clothing						8.108									8.108
f) Construction industries (cement, bricks)		5.350	776	10		6.847							3.445		16.428
g) Glass and pottery						22.850									22.850
h) Chemical			30			25.102									25.132
i) Petrochemical															
l) Pulp, paper and print						15.455									15.455

FINAL CONSUMPTIONS	PRIMARY SOURCES														
	Coking coal	**Steam coal**	**Coal other uses**	**Lignite**	**Subproducts**	**Natural Gas**	**Crude oil**	**Refinery feedstocks**	**Hydraulic Energy**	**Geothermal Energy**	**Wind and Photovoltaic Energy**	**Waste**	**Wood**	**Biodiesel**	**TOTAL PRIMARY SOURCES**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Conversion factor (a)	*7,400*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*	*2,200*	*2,500*	*2,500*	*8,900*	
m) Other industries						7.248									7.248
n) Building and civil works															
Sub-Total		**16.304**	**1509**	**10**		**144.300**							**3.445**		**165.568**
3) SERVICES															
I - Railways															
II - Navigation															
III - Road transportation						5.495								6.622	12.117
IV - Civil aviation															
V - Other transportation															
VI - Public Service															
Sub-Total						**5.495**								**6622**	**12.117**
4) DOMESTIC AND COMMERCIAL USES			52			247.166							17.228	9	264.455
TOTAL (1+2+3+4)		**16.304**	**1561**	**10**		**398.329**							**22.968**	**6631**	**445.803**
5) NON ENERGY USE (b)															
I - Chemical industry															
II - Petrochemical						6.953									6.953
III - Agriculture															
IV - Other sectors															
Sub-Total						**6.953**									**6.953**

FINAL CONSUMPTIONS	PRIMARY SOURCES														
	Coking coal	**Steam coal**	**Coal other uses**	**Lignite**	**Subproducts**	**Natural Gas**	**Crude oil**	**Refinery feedstocks**	**Hydraulic Energy**	**Geothermal Energy**	**Wind and Photovoltaic Energy**	**Waste**	**Wood**	**Biodiesel**	**TOTAL PRIMARY SOURCES**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Conversion factor (a)	*7,400*	*6,350*	*7,400*	*2,500*	*2,500*	*8,190*	*10,000*	*10,000*	*2,200*	*2,200*	*2,200*	*2,500*	*2,500*	*8,900*	
TOTAL (1+2+3+4+5)		**16.304**	**1561**	**10**		**405.282**							**22.968**	**6631**	**452.756**

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

(b) - Non energy uses of energetic sources

Table A5.8-National Energy Balance, year 2008, Secondary fuels used by end use sectors, "Enclosure 3/a", 10^9kcal

FINAL CONSUMPTIONS	SECONDARY SOURCES																		
	Electric Energy	**Char- coal**	**Coke**	**Coke oven gas**	**Blast furnace Gas**	**Non energy use of coal products**	**Gas works Gas**	**L. P. G.**	**Refinery gas**	**Light Distillates (naphtha)**	**Gasoline**	**Jet fuel**	**Kerosene**	**Gas Oil / Diesel Oil**	**Residual Oil, HS**	**Residual Oil, LS**	**Petroleum Coke**	**Non energy use of petroleum products**	**TOTAL SECONDARY SOURCES**
	16	17	18	19	21	22	20	23	24	25	26	27	28	29	30	31	32	33	34
Conversion factor	*0,860*	*7,500*	*6,975*	*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*	*5,986*	
1) AGRICULTURE AND FISHING																			
I- Agriculture	4.876							660			126			20.839					26.501
II- Fishing								22			11			2.203					2.236
Sub-Total	**4.876**							**682**			**137**			**23.042**					**28.737**
2) INDUSTRY																			
I- Iron and steel industry	18.597		21.720		49			220						71		686	8		41.351
II- Other industry	97.549	233	217					2.981	2.316		294	156	10	3.959	4.272	23.891	28.220	3.101	167.199
a) Mining industry	918							33						204	29	127			1.311
b) Non-Ferrous Metals	4.780		28					165						61		451			5.485
c) Metal works factories	23.552							660			294	156	10	1.224	1.068	3.234			30.198
d) Food Processing, Beverages	11.030	173						363						439	147	5.870			18.022
e) Textile and clothing	6.970							154						398	39	1.793			9.354
f) Construction industries (cement, bricks)	7.233		84					693						388	951	255	28.137	3.101	40.842
g) Glass and	4.784							572						143		2.479			7.978

FINAL CONSUMPTIONS	SECONDARY SOURCES																		
	Electric Energy	**Char- coal**	**Coke**	**Coke oven gas**	**Blast furnace Gas**	**Non energy use of coal products**	**Gas works Gas**	**L. P. G.**	**Refinery gas**	**Light Distillates (naphtha)**	**Gasoline**	**Jet fuel**	**Kerosene**	**Gas Oil / Diesel Oil**	**Residual Oil, HS**	**Residual Oil, LS**	**Petroleum Coke**	**Non energy use of petroleum products**	**TOTAL SECONDARY SOURCES**
	16	17	18	19	21	22	20	23	24	25	26	27	28	29	30	31	32	33	34
Conversion factor	*0,860*	*7,500*	*6,975*	*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*	*5,986*	
pottery																			
h) Chemical	20.202	60	28					44						204		1.303	83		21.924
i) Petrochemical	1.396							143	2.316						980	4.361			9.196
l) Pulp, paper and print	8.840							77						204		1.862			10.983
m) Other industries	6.220		77					77						286	1.058	2.156			9.874
n) Building and civil works	1.624													408					2.032
Sub-Total	**116.146**	**233**	**21.937**		**49**			**3201**	**2316**		**294**	**156**	**10**	**4.030**	**4272**	**24577**	**28228**	**3101**	**208.550**
3) SERVICES																			
I - Railways	4.721													714					5.435
II - Navigation	36													2.203					2.239
III - Road transportation	4.472							11.033			115.185			245.004					375.694
IV - Civil aviation	93										95	41.163							41.351
V - Other transportation	20.264																		20.264
VI - Public Service	9.495							33			252	998		3.723					14.501
Sub-Total	**39.081**							**11066**			**115532**	**42161**		**251.644**					**459.484**
4) DOMESTIC AND COMMERCIAL	105.910	1.149						20.185					103	25.092		882			153.321

FINAL CONSUMPTIONS	SECONDARY SOURCES																		
	Electric Energy	**Char- coal**	**Coke**	**Coke oven gas**	**Blast furnace Gas**	**Non energy use of coal products**	**Gas works Gas**	**L. P. G.**	**Refinery gas**	**Light Distillates (naphtha)**	**Gasoline**	**Jet fuel**	**Kerosene**	**Gas Oil / Diesel Oil**	**Residual Oil, HS**	**Residual Oil, LS**	**Petroleum Coke**	**Non energy use of petroleum products**	**TOTAL SECONDARY SOURCES**
	16	17	18	19	21	22	20	23	24	25	26	27	28	29	30	31	32	33	34
Conversion factor	*0,860*	*7,500*	*6,975*	*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*	*5,986*	
USES																			
TOTAL (1+2+3+4)	**266.013**	**1382**	**21.937**		**49**			**35134**	**2316**		**115963**	**42317**	**113**	**303.808**	**4272**	**25459**	**28228**	**3101**	**850.092**
5) NON ENERGY USE (b)																			
I - Chemical industry																			
II - Petrochemical									9.228	41.465	3.654		2.678	9.537	1.754	2.411		168	70.895
III - Agriculture						141													141
IV - Other sectors						1.117												21.497	22.614
Sub-Total						**1258**			**9228**	**41465**	**3654**		**2678**	**9.537**	**1754**	**2411**		**21665**	**93.650**
TOTAL (1+2+3+4+5)	**266.013**	**1382**	**21.937**		**49**	**1258**		**35134**	**11544**	**41465**	**119617**	**42317**	**2791**	**313.345**	**6026**	**27870**	**28228**	**24766**	**943.742**

(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 2008, 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						167							918	
II- Fishing														
Sub-Total	**0**	**0**	**0**	**0**	**0**	**167**	**0**	**0**	**0**	**0**			**918**	
2) INDUSTRY														
I- Iron and steel industry		1.725	90			2.250								
II- Other industry	0	843	114	4		15.369	0		0	0		0	1.378	
a) Mining industry						47								
b) Non-Ferrous Metals			5			453								
c) Metal works factories						2.586								
d) Food Processing, Beverages						1.830								
e) Textile and clothing						990								
f) Construction industries (cement, bricks)		843	105	4		836							1.378	
g) Glass and pottery						2.790								
h) Chemical			4			3.065								
i) Petrochemical						0								
l) Pulp, paper and print						1.887								
m) Other industries						885								
n) Building and civil works														
Sub-Total	**0**	**2568**	**204**	**4**	**0**	**17.619**	**0**	**0**	**0**	**0**		**0**	**1.378**	
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						671								
III - Road transportation													(b) 744	
IV - Civil aviation														
V - Other transportation														
VI - Public Service														
Sub-Total	**0**	**0**	**0**	**0**		**671**	**0**	**0**	**0**	**0**			**744**	
4) DOMESTIC AND COMMERCIAL USES			7			30179							(b) 6892	
TOTAL (1+2+3+4)	**0**	**2568**	**211**	**4**		**48.636**	**0**	**0**	**0**	**0**			**9.932**	
5) NON ENERGY USE (a)														
I - Chemical industry														
II - Petrochemical						849								
III - Agriculture														
IV - Other sectors														
Sub-Total	**0**	**0**	**0**	**0**		**849**	**0**	**0**	**0**	**0**			**-**	
TOTAL (1+2+3+4+5)	**0**	**2568**	**211**	**4**		**49.485**	**0**	**0**	**0**	**0**			**9.932**	

(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 2008, 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	5.670							60			12			2.043					
II- Fishing								22			1			216					
Sub-Total	**5.670**	**0**	**0**	**0**	**0**		**0**	**682**	**0**	**0**	**13**	**0**	**0**	**2.259**	**0**	**0**	**0**	**0**	
2) INDUSTRY																			
I- Iron and steel industry	21.625		3114		54			20						7		70	1		
II- Other industry	113.429	31	31	0	0	0	0	271	193	0	28	15	1	388	436	2.438	3.400	518	
a) Mining industry	1068							3						20	3	13			
b) Non-Ferrous Metals	5.558		4					15						6	0	46			
c) Metal works factories	27.386							60			28	15	1	120	109	330			
d) Food Processing, Beverages	12.826	23						33						43	15	599			
e) Textile and clothing	8.105							14						39	4	183			
f) Construction industries (cement, bricks)	8.410		12					63						38	97	26	3.390	518	

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	5.563							52						14	0	253			
h) Chemical	23.491	8	4					4						20	0	133	10		
i) Petrochemical	1.623							13	193					0	100	445			
l) Pulp, paper and print	10.279							7						20	0	190			
m) Other industries	7.232		11					7						28	108	220			
n) Building and civil works	1.888							0						40					
Sub-Total	**135.054**	**31**	**3.145**	**0**	**54**	**0**	**0**	**291**	**193**	**0**	**28**	**15**	**1**	**395**	**436**	**2.508**	**3.401**	**518**	
3) SERVICES																			
I - Railways	5.490													70					
II - Navigation	40													216					
III - Road transportation	5.200							1.003			(b) 10970		24.020						5.200
IV - Civil aviation	109										9	3.958							
V - Other transportation	23.563																		
VI - Public Service	11.041							(a) 3			24	96		(a) 365					
Sub-Total	**45.443**	**0**	**0**	**0**	**0**	**0**	**0**	**1.006**	**0**	**0**	**11.003**	**4.054**	**0**	**24.671**	**0**	**0**	**0**	**0**	
4) DOMESTIC AND COMMERCIAL	123.150	153						1.835					10	2.460		90			

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	
USES																			
TOTAL (1+2+3+4)	**309.317**	**184**	**3.145**	**0**	**54**	**0**	**0**	**3.194**	**193**	**0**	**11.044**	**4.069**	**11**	**29.785**	**436**	**2.598**	**3.401**	**518**	
5) NON ENERGY USE																			
I - Chemical industry																			
II - Petrochemical									769	3.987	348	0	260	935	179	246	0	28	
III - Agriculture						19													
IV - Other sectors						151												3.591	
Sub-Total	-	**0**	**0**	**0**	**0**	**170**	**0**	**0**	**769**	**3.987**	**348**	**0**	**260**	**935**	**179**	**246**	**0**	**3.619**	
TOTAL (1+2+3+4+5)	**309.317**	**184**	**3.145**	**0**	**54**	**170**	**0**	**3.194**	**962**	**3.987**	**11.392**	**4.069**	**271**	**30.720**	**615**	**2.844**	**3.401**	**4.137**	

(c) 48 kt of gas oil and 2 kt of LPG used for heating for Public Service

ANNEX 6: NATIONAL EMISSION FACTORS

Monitoring of the carbon content of the fuels used nationally is an ongoing activity at ISPRA. The purpose is to analyse regularly the chemical composition of the used fuel or relevant commercial statistics to estimate the carbon content / emission factor (EF) of the fuels. For each primary fuel (natural gas, oil, coal) a specific procedure has been established.

A6.1 Natural gas

The national market is characterized by the commercialisation of gases with different chemical composition in variable quantities from one year to the other. Since 1990 natural gas has been produced in Italy and imported by pipelines from Russia, Algeria and the Netherlands. Moreover an NGL facility is importing gas from Algeria and Libya. From 2003-2004 onwards Norway and Libya have also been added to the supply list, through new pipeline connections, and from 2008 a new NGL facility has entered into service, using mainly liquefied gas from Oman. There are also sizeable underground storage facilities and additional pipelines/NGL facilities are planned.
The estimation of an average EF for natural gas is the only way to calculate total emissions from this source in Italy, because the origin of the gas used by final consumers can not be tracked trough the national statistics and it is subject to variations during the year, according to supply. Only the main industrial installations perform routine checks to estimate the average chemical composition / energy content of natural gas used.
Another task connected to the use of natural gases of different origin and composition is linked to the estimation of an average content of methane to estimate fugitive emissions of this gas from the transmission / distribution network. Since the beginning of the inventory estimations, the average EF of the used gas in Italy has been estimated by the inventory team and it changes every year.
In the 2008 energy balance, BEN 2008, (MSE, several years [a]) some modifications have occurred; a new average lower heat value has been derived from Eurostat methodology. This new conversion factors did imply a methodological revision to estimate the average national EF. Additionally the new IPCC 2006 guidelines, see table A6.1, contains important information to consider: the recognition of a certain variability of the EF for this source; the estimation a lower and upper bound for the EFs; the link between energy content and EF; the statement that, by converting to energy units all EFs, their variability can be reduced. Moreover default oxidation factor is estimated to be 1 (full oxidation). The 2006 guidelines do not apply in the national inventory up to 2012, but some of the scientific information could and should be considered in the estimation of the national emission factors (IPCC, 2006).
Each of natural gases transmitted by the grid operator is regularly analysed at import gates, for budgetary reasons. Energy content for cubic meters, percentage of methane and other substances are calculated. For example methane content can considerably vary: national produced gas sold to the grid is almost 99% methane (% moles), the one coming from Algeria has less than 85% of methane and significant quantities of propane-butane. Also carbon content varies significantly.
Natural gas properties are more stable referring to the country of origin, with small variations in chemical composition from year to year. Speciation of gas from each import manifold is regularly published by national transmission grid operator (Snam Rete Gas, several years). Other information is also available from the main final users (TERNA, several years).
So, for each year, the average methane and carbon content of the natural gas used in Italy are estimated, using international trade statistical data, and a national emission factor is estimated.
The list of factors for the years of interest is reported in Table A6.1.
In the 2010 submission the average emission factor for the period 2005-2008 has been updated. As shown in the table the ranges of national EF are within the lower and upper threshold of IPCC 2006.

	$t\ CO_2$ / TJ (stechiometric)	$t\ CO_2$ / TJ (with oxidation factor equal to 0.995)	$t\ CO_2 / 10^3$ std cubic mt	$t\ CO_2$ / toe
Natural gas (dry) IPCC '96	56,061	55.780	1.925	2.334
Natural gas, IPCC '06 average	56,100			
lower	54,100			
upper	58,100			
National Emission Factors				
Natural gas , 1990	55,606	55.328	1.942	2.315
Natural gas, 1995	55,702	55.423	1.961	2.319
Natural gas , 2000	55,751	55.472	1.971	2.321
Natural gas , 2001	55,699	55.421	1.960	2.319
Natural gas , 2002	56,255	55.974	1.965	2.342
Natural gas, 2003	55,874	55.594	1.961	2.326
Natural gas, 2004	55,874	55.595	1.945	2.326
Natural gas, 2005	55,869	55.590	1.944	2.326
Natural gas, 2006	55,946	55.666	1.949	2.329
Natural gas, 2007	55,917	55.637	1.947	2.328
Natural gas, 2008	56,027	55,747	1,950	2,332
Natural gas, 2008, with 8190 lhv	57,201	56,915	1,950	2,381

Source: ISPRA elaborations

Table A6.1 Natural gas carbon emission factors

The methodology used to estimate the EF is based on the available data. Each year the quantities of natural gas imported or produced in Italy are published on the web by the MSE http://dgerm.sviluppoeconomico.gov.it/dgerm/bilanciogas.asp.Those data are produced by the national grid operator and are concerned on all imported gas by point of entrance in the country and all natural gas produced. To compare quantities of different gases, the physical quantities of imported/produced gas are normalized to a higher heat value (hhv) equal to 9100 kcal/m^3 and standard conditions. Other data input used in the estimation are the average chemical composition and the hhv of the gas at each import "gate" and for the national production. Those data are published by Snam Rete Gas in its yearly "Bilancio di Sostenibilità" (Snam Rete Gas, several years) and with them it is possible to estimate the average carbon content of the fuel. Those data are referred to the physical quantities of imported / produced gas.
So the total quantities of imported gas (normalized at the hhv of 9100) published by MSE are transformed back to the physical quantities of actually imported gas using the hhv ratio and then average carbon content of the total gas imported or produced in Italy can be estimated. Those data are then referred back to the normalized quantities of gas used in national statistics.

Data on final consumption of gas refers to the lower heat value (lhv). In particular the electricity production companies regularly estimate the actual lhv of the gas they are using and this data is published yearly by Terna. Operator's data are used to verify the calculation results. Weighted average lhv of the imported / produced natural gas in 2008 is 8362 kcal/m^3.
As mentioned above in the BEN 2008, the average lhv has been changed from 8250 kcal/m^3 (historical value) to 8190 kcal/m^3, to harmonize national data with Eurostat methodology. Eurostat consider the lhv as being 10% less than hhv, regardless of the actual value. As reported in table A6.1, this change influences the EF, if it is referred to the energy content (lhv) of the fuel, but it have no influence if the EF is referred to cubic meters. The total amount of carbon emitted by natural gas in Italy in 2008 do not change using both EFs reported in the table because the total energy content of the natural gas use changes according to the statistical methodology used.

A6.2 Diesel oil, petrol and LPG, national production

APAT (now ISPRA) has made an investigation of the carbon content of the main transportation fuels sold in Italy: petrol, diesel and LPG, with the aim of testing the average fuels sold in the year 2000 and collecting available information on previous year fuels. The goal of this work is the verification of CO_2 emission factors of Italian energy system, with a particular focus on the transportation sector. The results of analysis of fuel samples performed by "Stazione Sperimentale Combustibili" (APAT, 2003) were compared with emission factors used in Reference Approach of the Intergovernmental Panel for Climate Change (IPCC, 1997) and emission factors considered in the COPERT 4 programme of the European Environment Agency (EEA, 2010).
These two methodologies are widely used to prepare data at the international level but, when applied to the Italian data set produce results with significant differences, around 2- 4%. The reason has been traced back to the emission factors that are referred to the energy content of the fuel for IPCC and to the physical quantities for the COPERT methodology.
The results of the study link the chemical composition of the fuel to the lhv for a series of fuels representative of the national production in the years 2000-2001, allowing for more precise evaluations of the emission factors.

IPCC 1996 emission factors for diesel fuels and IPCC-Europe for LPG are almost identical to the experimental results (less than 1% difference), and it has been decided to use IPCC emission factors for the period 1990-1999 and the measured EF from the year 2000 onwards.
Relevant quantities of LPG used in Italy are imported. The measured values refer only to the products produced in Italy, IPCC emission factors is used as a default for the imported quantities.

Concerning petrol, instead, IPCC 1996 emission factors is quite low and it has to be updated, the reason may be linked to the extensive use of additives in recent years to reach a high octane number after the lead has been phased out. For 2000 and the following years the experimental factor will be used, for the period 1990-1999 it has been decided to use an interpolate factor between IPCC emission factors and the measured value, using the lhv as the link between the national products and the international database. No other information was available.

The list of emission factors for the different years is reported in Table A6.2.

	t CO_2 / TJ	t CO_2 / t	t CO_2 / toe
Petrol, IPCC / OECD	68.559	3.071	2.868
Petrol, IPCC Europe	72.270	3.148	3.024
Petrol (Italian National Energy Balance), interpolated emission factor 1990-1999	71.034	3.121	2.972
Petrol, experimental averages 2000-2008	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 2000-2008	73.153	3.138	3.061
Gas oil, heating, experimental averages 2000-2008	73.693	3.141	3.083
LPG, IPCC / OECD	62.392	2.952	2.610
LPG, IPCC / Europe	64.350	3.000	2.692
LPG, 1990 - 1999	64.350	3.000	2.692
LPG, experimental averages	64.936	2.994	2.717

Source: ISPRA elaborations

Table A6.2 Fuels, national production, carbon emission factors, with oxidation factor equal to 0.99

A6.3 Fuel oil, imported and produced

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

	t CO_2 / TJ (stechiometric)	t CO_2 / TJ (with oxidation factor equal to 0.99)	t CO_2 / t	t CO_2 / toe
Fuel oil , IPCC, 1996	77,310	76.539	3.148	3.202
Fuel oil , IPCC, 2006 average	77,400			
lower	75,200			
upper	79,600			
National emission factors				
Fuel oil, average 1990	77.339	76.565	3.111	3.203
Fuel oil, average 1995	77.425	76.650	3.127	3.207
Fuel oil, average 2000	76.665	75.898	3.124	3.176
Fuel oil, average 2001	76.665	75.889	3.122	3.175
Fuel oil, average 2002	76.709	75.942	3.125	3.177
Fuel oil, average 2003	76.921	76.151	3.131	3.186
Fuel oil, average 2004	76.939	76.170	3.132	3.187
Fuel oil, average 2005	75.875	75.116	3.110	3.143
Fuel oil, average 2006	75.952	75.193	3.111	3.146
Fuel oil, average 2007	76.326	75.562	3.113	3.162
Fuel oil, average 2008	76.393	75.629	3.111	3.164

Source: ISPRA elaborations

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

In 2010 submission emission factor has been slightly updated from 2005, on the basis of additional detailed data available on the amount of low and high sulphur fuel oil used in the energy sector (TERNA, several years).

Data for all years are within IPCC 2006 ranges, but it can be noticed that are on the lower side from year 2000 onwards. The change from an average to a low EF is due to the harmful emissions limits and fuel regulations introduced in Italy between 1990 and 2000. Most of the fuel used from 2000 onwards is not heavy, high sulphur, fuel oil but light type, low sulphur.

A6.4 Coal imports

Italy has only negligible national production of coal; most part is imported from various countries and there are differences in carbon content of coal mined in different parts of the world. The variations in carbon content can be linked to the hydrogen content and to the LHV of the coal.

An additional national circumstance refers to the absence of long term import contracts. The quantities shipped by the main exporters change considerably from year to year. Detailed data are available in BPT (MSE, several years [b]) supplied from the Ministry of Economic Development and reported for 2008 in Table A6.4.

Country	Coking coal	Coke	Steam coal	Lignite	Other	Total Coal	Pet-Coke
CYPRUS	0	0	110,650	0	0	110,650	0
FRANCE	0	0	0	0	190	190	0
GERMANY	0	0	218	4,968	252	5,438	0
SPAIN	0	0	1,645,655	0	0	1,645,655	0
TOTAL EU	**0**	**0**	**1,756,523**	**4,968**	**442**	**1,761,933**	**0**
AUSTRALIA	2,093,486	0	829,763	0	0	2,923,249	0
CANADA	983,710	0	0	0	0	983,710	0
CHINA	0	136,357	0	0	0	136,357	0
COLOMBIA	0	0	2,428,902	0	0	2,428,902	0
CROATIA	0	0	0	0	0	0	6,174
INDONESIA	0	0	7,212,015	0	0	7,212,015	0
KAZAKISTAN	0	0	8,410	0	0	8,410	0
RUSSIA	23,503	0	688,900	0	127,757	840,160	0
SOUTH AFRICA	0	0	4,595,901	0	0	4,595,901	0
UCRAINA	0	0	508,190	0	116,926	625,116	0
Former SOVIET UNION	0	0	38,746	0	39,114	77,860	0
U.S.A.	2,971,262	92,424	282,591	0	0	3,346,277	1,638,624
VENEZUELA	0	0	357,676	0	37,660	395,336	561,165
TOTAL NON-EU	**6,071,961**	**228,781**	**16,951,094**	**0**	**321,457**	**23,573,293**	**2,205,963**
TOTAL	**6,071,961**	**228,781**	**18,707,617**	**4,968**	**321,899**	**25,335,226**	**2,205,963**

Source: MSE, several years [b]

Table A6.4 – Coal imported by country in 2008 (Mg)

Therefore an attempt was made to find out a methodology allowing for a more precise estimation of the carbon content of this fuel. It is possible, using literature data for the coals and detailed statistical records of international trade, to find out the weighted average of carbon content and of the LHV of the fuel imported to Italy each year. The still unresolved problem is how to properly link statistical data, referred to the coal “as it is” without specifying moisture and ash content of the product, to the literature data, referring to sample coals.

We envisage improving the quality of the collected statistical data including moisture content of coals; currently we overcome this obstacle with the following procedure:

- using an ample set of experimental data on coals imported in a couple of years on an extensive series of samples, more than 200, analysed by ENEL (the main electricity producing company in Italy) it was possible to correlate “as it is” LHV and carbon content to the average properties of the coals imported in the same period of time and calculated from literature data (EMEP/CORINAIR, 2007);
- for each inventory year, it was possible to calculate the weighted average of LHV and carbon content of imported coals using available literature data;
- using this calculated data and the correlation found out, the estimate of carbon content of the average “as it is” coal reported in the statistics was possible.

Using this methodology and the available statistical data, it was possible to trace back to the year 1990 the average LHV of the imported coal and estimate average carbon EF for each year, see table A6.4 for detailed data. The results do not show impressive changes yearly; anyway a noticeable difference in the emission factor is highlighted in the table. In the table A6.5 updated coal EF from IPCC 2006 have been also reported. As can be seen, average values for steam coals have been slightly reduced in the updated methodology. National emission factors result in the range given by the old and new average values for “other bituminous coal”.

This methodology can be certainly improved; anyway, at present, its use, in our view, improves the quality of reporting.

In the 2010 submission, emission factors from 2005 have been updated on the basis of new information available regarding the amount of different coals imported. Moreover the value of the oxidation factor for 2008 has been updated from the default IPCC '96 value of 0.98 to the average value, reported by the operators subject to EU ETS scheme, equal to 0.986, resulting from the weighted average of reported values for the period 2005-2008.

	t CO2 / TJ (stechiometric)	t CO2 / TJ	t CO2 / t	t CO2 / toe
		(with oxidation factor 0.98 up to 2007, 0.986 for 2008)		
Sub bituminous coal, IPCC 1996	98.200	96.234	2.557	4.026
Other Bituminous coal, IPCC 2006, av	94.600			
lower	87.300			
upper	102.500			
National emission factors				
Steam coal, 1990	96.512	94.582	2.502	3.960
Steam coal, 1995	95.926	94.007	2.519	3.936
Steam coal, 2000	93.312	91.446	2.404	3.826
Steam coal, 2001	95.304	93.398	2.434	3.908
Steam coal, 2002	94.727	92.832	2.423	3.884
Steam coal, 2003	95.385	93.478	2.435	3.911
Steam coal, 2004	95.382	93.474	2.430	3.911
Steam coal, 2005	95.098	93.196	2.437	3.899
Steam coal, 2006	96.458	94.529	2.413	3.955
Steam coal , 2007	96.255	94.330	2.412	3.947
Steam coal , 2008	97.621	96.224	2.348	4.026

Source: ISPRA elaborations

Table A6.5 – Coal, average carbon emission factors

ANNEX 7: AGRICULTURE SECTOR

Additional information used for estimating categories 4A and 4B from the agriculture sector is reported in this section.

A7.1 Enteric fermentation (4A)

Following suggestions from the centralized review process (UNFCCC, 2009), the time series of the parameters used for estimating the Dairy Cattle EF using the Tier 2 approach, are reported in Table A.7.1. Information on the equations used for estimating the different net energy (NE_m, NE_g, etc.) is described in IPCC Good Practice (IPCC, 2000).

	NE_m (MJ/day)	NE_a (MJ/day)	NE_g (MJ/day)	NE_l (MJ/day)	NE_w (MJ/day)	NE_p (MJ/day)	NE_{ma}/DE	NE_{ga}/DE	GE (MJ/day)
1990	40.75	0.35	0.10	33.52	0.00	3.97	0.51	0.31	**235.77**
1991	40.75	0.35	0.10	37.71	0.00	3.96	0.51	0.31	**248.30**
1992	40.75	0.35	0.10	40.42	0.00	3.91	0.51	0.31	**256.30**
1993	40.75	0.35	0.10	40.25	0.00	3.89	0.51	0.31	**255.70**
1994	40.75	0.35	0.10	42.53	0.00	3.92	0.51	0.31	**262.63**
1995	40.75	0.35	0.10	43.38	0.00	3.86	0.51	0.31	**264.99**
1996	40.75	0.35	0.10	44.66	0.00	3.86	0.51	0.31	**268.84**
1997	40.75	0.35	0.10	45.46	0.00	3.85	0.51	0.31	**271.18**
1998	40.75	0.35	0.10	45.25	0.00	3.79	0.51	0.31	**270.40**
1999	40.75	0.35	0.10	45.17	0.00	3.75	0.51	0.31	**270.00**
2000	40.75	0.35	0.10	44.31	0.00	3.78	0.51	0.31	**267.52**
2001	40.75	0.35	0.10	43.74	0.00	3.73	0.51	0.31	**265.67**
2002	40.75	0.35	0.10	47.60	0.00	3.72	0.51	0.31	**277.19**
2003	40.75	0.35	0.10	47.57	0.00	3.72	0.51	0.31	**277.10**
2004	40.75	0.35	0.10	49.68	0.00	3.66	0.51	0.31	**283.26**
2005	40.75	0.35	0.10	50.84	0.00	3.71	0.51	0.31	**286.88**
2006	40.75	0.35	0.10	51.17	0.00	3.67	0.51	0.31	**287.76**
2007	40.75	0.35	0.10	51.15	0.00	3.65	0.51	0.31	**287.62**
2008	40.75	0.35	0.10	52.43	0.00	3.65	0.51	0.31	**291.48**

Source: ISPRA elaborations

Table A.7.1 Parameters used for the Tier 2 approach - dairy cattle

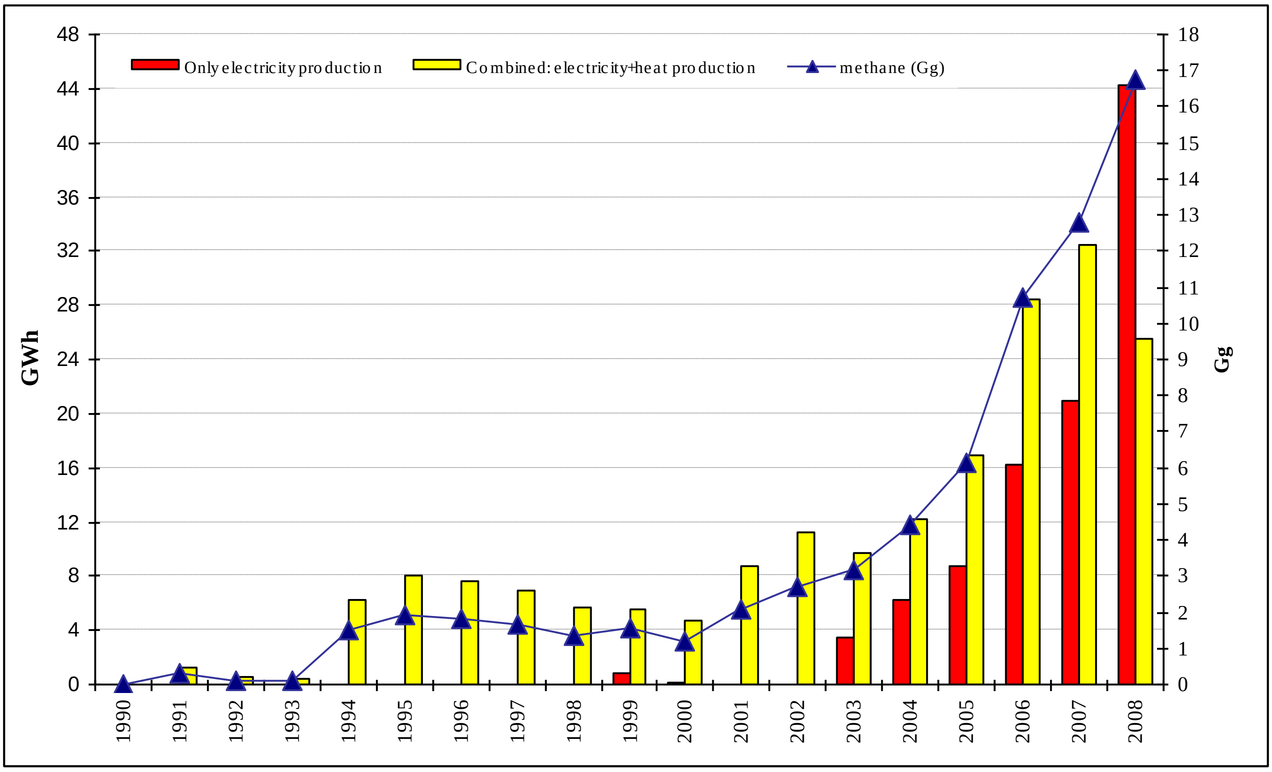
A7.2 Manure management (4B)

In this section the time series used to apply the methane emission reduction to the 4B Manure management category from the agriculture sector are reported. The source of information is the National Electric Network (TERNA, 2010). 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**
2008	44.3	25.5	69.8	**16.74**

Source: TERNA, 2010

Table A.7.2 Time series of gross production of biogas from animal manure



Source: adapted from Cóndor et al. 2008

Figure A7.1 Time series of gross production of biogas from animal manure

ANNEX 8: Additional information to be considered as part of the annual inventory submission and the *supplementary information required under Article 7, paragraph 1,* of the Kyoto Protocol or other useful reference information

A. 8.1: Annual inventory submission

This appendix shows a copy of Tables 10s1-10s5 from the Common Reporting Format 2008, submitted in 2010, in which time series of emission estimates for the following gases are reported:

- CO_2
- CH_4
- N_2O
- HFCs, PFCs, SF_6
- All gases and sources categories

Table A8.1.1.1 CO_2 emissions trends, CRF year 2008 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

CO_2

(Part 1 of 2)

Inventory
2008
Submission
2010 v1.4

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	**405,364.29**	**404,893.31**	**403,949.23**	**400,611.79**	**394,539.21**	**418,080.35**	**414,044.27**	**418,124.33**	**429,406.35**	**434,791.40**
A. Fuel Combustion (Sectoral Approach)	402,023.33	401,628.54	400,737.61	397,231.90	391,313.14	414,906.27	411,009.05	414,880.92	426,287.83	432,386.94
1. Energy Industries	136,502.92	130,586.47	130,325.22	124,848.67	127,316.71	139,841.41	135,043.26	137,027.71	148,064.92	145,892.04
2. Manufacturing Industries and Construction	86,528.37	83,810.76	82,288.61	82,810.80	83,980.95	86,088.23	84,175.54	87,013.83	80,702.20	82,735.65
3. Transport	101,268.85	103,786.58	108,033.55	109,632.46	109,241.78	111,446.31	112,671.24	114,359.93	118,143.83	119,688.97
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	**28,231.29**	**27,788.12**	**28,295.01**	**25,081.63**	**24,004.94**	**25,830.58**	**23,283.83**	**23,407.71**	**23,433.64**	**23,563.24**
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	3,253.76	3,110.90	3,048.80	2,115.60	1,650.97	1,659.19	1,250.42	1,358.27	1,337.32	1,224.53
C. Metal Production	3,877.87	3,625.53	3,382.99	3,558.73	3,440.21	3,403.31	2,957.64	2,729.04	2,520.69	1,954.89
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	1,642.80	1,628.14	1,629.14	1,577.88	1,505.56	1,467.44	1,421.03	1,422.70	1,337.14	1,336.49
4. Agriculture										

TABLE 10 EMISSION TRENDS
CO_2
(Part 1 of 2)

Inventory 2008
Submission 2010 v1.4
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)	**-64,998.05**	**-78,750.89**	**-76,874.99**	**-57,638.47**	**-77,023.94**	**-82,484.79**	**-87,146.26**	**-74,850.84**	**-73,047.99**	**-80,512.38**
A. Forest Land	-42,884.46	-59,983.16	-57,267.16	-40,318.08	-57,710.86	-63,254.92	-62,749.41	-52,075.82	-50,349.18	-58,391.34
B. Cropland	-20,108.81	-15,526.13	-16,878.65	-15,999.14	-16,130.09	-14,923.62	-15,652.13	-14,722.29	-15,320.71	-13,492.35
C. Grassland	-4,155.93	-5,386.28	-4,873.85	-3,465.92	-5,327.66	-6,450.93	-11,051.41	-10,373.34	-9,694.73	-10,966.82
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	2,151.16	2,144.67	2,144.67	2,144.67	2,144.67	2,144.67	2,306.68	2,320.61	2,316.62	2,338.12
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 2008
Submission 2010 v1.4
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	**370,777.23**	**356,120.89**	**357,560.82**	**370,154.00**	**343,549.88**	**363,376.59**	**352,074.99**	**368,611.64**	**381,633.56**	**379,572.21**
Total CO_2 emissions excluding net CO_2 from LULUCF	**435,775.28**	**434,871.79**	**434,435.80**	**427,792.47**	**420,573.81**	**445,861.39**	**439,221.26**	**443,462.49**	**454,681.56**	**460,084.59**
Memo Items:										
International Bunkers	**8,549.97**	**8,576.11**	**8,392.37**	**8,762.20**	**8,992.41**	**9,708.35**	**8,936.90**	**9,260.17**	**9,930.35**	**10,691.95**
Aviation	4,160.77	4,993.23	4,940.81	5,082.84	5,353.48	5,673.52	6,081.29	6,200.46	6,737.93	7,392.96
Marine	4,389.20	3,582.88	3,451.56	3,679.36	3,638.93	4,034.83	2,855.61	3,059.71	3,192.42	3,298.98
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass	5,243.86	5,962.78	6,286.98	6,209.51	7,215.92	7,076.58	7,063.49	7,702.89	7,574.50	8,899.16

Table A8.1.1.2 CO_2 emissions trends, CRF year 2008 (years 2000 – 2008)

TABLE 10 EMISSION TRENDS
CO_2
(Part 2 of 2)

Inventory 2008
Submission 2010 v1.4
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**437,742.26**	**442,856.69**	**445,156.80**	**459,598.82**	**461,908.86**	**461,880.79**	**457,679.12**	**447,620.07**	**441,580.70**	**8.93**
A. Fuel Combustion (Sectoral Approach)	435,157.54	440,416.61	442,896.28	456,764.72	459,756.71	459,768.76	455,490.43	445,444.38	439,322.31	9.28
1. Energy Industries	151,893.98	154,498.04	161,400.59	161,982.20	159,962.44	160,423.22	162,268.79	161,590.16	159,145.26	16.59
2. Manufacturing Industries and Construction	83,757.96	82,009.99	78,256.53	83,647.52	84,530.89	80,486.67	79,130.59	75,847.99	72,803.50	-15.86
3. Transport	120,103.35	122,181.49	124,143.31	125,105.90	127,090.91	125,830.60	127,151.19	127,215.49	122,474.64	20.94
4. Other Sectors	78,596.14	81,373.15	78,782.28	85,368.95	87,081.49	91,830.59	85,958.26	79,894.55	84,161.13	9.76
5. Other	806.10	353.94	313.56	660.15	1,090.98	1,197.69	981.61	896.19	737.77	-29.49
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	2,175.70	2,258.39	-32.40
1. Solid Fuels	NA	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	2,175.70	2,258.39	-32.40
2. Industrial Processes	**24,383.11**	**25,159.66**	**25,171.86**	**26,344.07**	**27,172.56**	**27,036.10**	**27,063.41**	**27,572.94**	**24,964.89**	**-11.57**
A. Mineral Products	21,267.93	22,097.80	22,090.20	22,987.83	23,555.54	23,234.86	23,296.47	23,794.51	21,500.80	1.90
B. Chemical Industry	1,361.64	1,345.67	1,426.49	1,679.37	1,838.90	1,783.68	1,727.00	1,759.05	1,488.19	-54.26
C. Metal Production	1,753.54	1,716.19	1,655.17	1,676.87	1,778.12	2,017.55	2,039.94	2,019.38	1,975.91	-49.05
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NA	NA	0.00
3. Solvent and Other Product Use	1,275.92	1,286.13	1,290.29	1,295.50	1,299.51	1,315.23	1,332.49	1,316.17	1,272.20	-22.56
4. Agriculture										

TABLE 10 EMISSION TRENDS

CO_2

(Part 2 of 2)

Inventory 2008
Submission 2010 v1.4
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(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)]	**-76,036.26**	**-85,560.92**	**-93,594.18**	**-84,979.77**	**-88,990.40**	**-92,005.98**	**-92,443.09**	**-52,484.74**	**-87,349.38**	**34.39**
A. Forest Land	-53,450.71	-63,167.55	-70,386.68	-62,529.66	-68,538.65	-70,228.72	-69,909.85	-32,968.57	-64,693.13	50.85
B. Cropland	-14,585.67	-14,257.84	-14,721.66	-14,191.07	-11,857.27	-13,070.66	-13,080.01	-13,223.24	-13,238.86	-34.16
C. Grassland	-10,329.28	-11,325.51	-11,679.85	-11,463.30	-11,796.43	-11,921.47	-12,689.97	-9,527.55	-12,670.73	204.88
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Settlements	2,329.40	3,189.98	3,194.01	3,204.25	3,201.94	3,214.87	3,236.73	3,234.62	3,253.34	51.24
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
6. Waste	**201.57**	**222.26**	**244.97**	**215.76**	**199.23**	**244.69**	**267.49**	**240.20**	**249.88**	**-53.46**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
B. Waste-water Handling										
C. Waste Incineration	201.57	222.26	244.97	215.76	199.23	244.69	267.49	240.20	249.88	-53.46
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00

TABLE 10 EMISSION TRENDS

CO_2

(Part 2 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(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**	**0.00**
Total CO_2 emissions including net CO_2 from LULUCF	**387,566.60**	**383,963.82**	**378,269.74**	**402,474.38**	**401,589.75**	**398,470.82**	**393,899.41**	**424,264.64**	**380,718.29**	**2.68**
Total CO_2 emissions excluding net CO_2 from LULUCF	**463,602.86**	**469,524.74**	**471,863.92**	**487,454.15**	**490,580.15**	**490,476.80**	**486,342.51**	**476,749.38**	**468,067.67**	**7.41**
Memo Items:										
International Bunkers	**12,196.09**	**12,824.92**	**12,862.42**	**14,809.34**	**15,426.56**	**16,029.88**	**17,274.95**	**18,185.82**	**18,327.16**	**114.35**
Aviation	8,015.50	8,011.06	7,312.69	8,526.80	8,620.09	9,110.86	9,833.14	10,430.30	10,087.15	142.43
Marine	4,180.59	4,813.86	5,549.73	6,282.54	6,806.47	6,919.02	7,441.81	7,755.53	8,240.01	87.73
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
CO_2 Emissions from Biomass	9,384.36	10,345.58	9,984.85	12,045.57	14,453.09	14,081.40	15,059.44	17,222.51	20,001.52	281.43

Table A8.1.2.1 CH4 emission trends, CRF year 2008 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

CH_4

(Part 1 of 2)

Inventory 2008
Submission 2010 v1.4
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	418.81	419.91	424.95	419.56	410.80	399.88	392.08	390.92	394.02	383.41
A. Fuel Combustion (Sectoral Approach)	65.49	68.52	71.16	71.28	71.55	72.17	69.65	70.21	69.13	67.94
1. Energy Industries	9.27	8.93	8.59	8.14	8.39	8.63	8.41	8.60	8.52	8.26
2. Manufacturing Industries and Construction	6.82	6.67	6.49	6.62	6.59	7.02	6.48	6.69	6.44	6.06
3. Transport	34.50	36.40	38.93	40.31	38.82	38.29	36.75	35.19	34.30	31.41
4. Other Sectors	14.73	16.33	16.95	15.98	17.54	18.01	17.82	19.56	19.72	22.04
5. Other	0.17	0.19	0.20	0.22	0.21	0.22	0.19	0.17	0.16	0.18
B. Fugitive Emissions from Fuels	353.33	351.38	353.80	348.28	339.25	327.71	322.44	320.72	324.89	315.47
1. Solid Fuels	5.79	5.33	5.31	3.90	3.39	3.07	2.88	2.85	2.63	2.52
2. Oil and Natural Gas	347.54	346.06	348.48	344.38	335.86	324.64	319.56	317.87	322.26	312.95
2. Industrial Processes	**5.16**	**4.95**	**4.83**	**4.87**	**5.07**	**5.36**	**2.99**	**3.23**	**3.10**	**3.05**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry	2.45	2.43	2.40	2.28	2.49	2.65	0.60	0.62	0.59	0.59
C. Metal Production	2.71	2.51	2.43	2.59	2.58	2.71	2.39	2.61	2.51	2.46
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use										
4. Agriculture	**819.80**	**829.39**	**807.99**	**805.18**	**807.07**	**820.15**	**821.62**	**823.14**	**816.91**	**823.22**

TABLE 10 EMISSION TRENDS

CH_4

(Part 1 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
A. Enteric Fermentation	579.93	592.81	574.81	568.74	573.87	584.15	586.80	589.39	585.33	591.84
B. Manure Management	164.86	164.82	158.67	158.32	153.34	156.48	156.90	156.26	157.94	159.48
C. Rice Cultivation	74.39	71.09	73.86	77.48	79.22	78.90	77.27	76.91	72.99	71.27
D. Agricultural Soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	0.62	0.68	0.66	0.64	0.64	0.62	0.64	0.57	0.64	0.62
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**6.96**	**2.13**	**3.16**	**8.01**	**3.33**	**1.50**	**1.43**	**4.44**	**5.10**	**2.83**
A. Forest Land	6.96	2.13	3.16	8.01	3.33	1.50	1.43	4.44	5.10	2.83
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**735.46**	**787.07**	**768.44**	**788.03**	**823.08**	**859.77**	**872.92**	**890.22**	**882.31**	**890.35**
A. Solid Waste Disposal on Land	633.04	673.65	655.01	670.67	705.41	741.22	755.54	769.09	762.23	767.22
B. Waste-water Handling	94.76	98.63	101.80	104.73	105.83	105.62	106.46	107.85	108.27	108.66
C. Waste Incineration	7.65	14.78	11.61	12.61	11.81	12.91	10.89	13.24	11.76	14.38
D. Other	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.05	0.06	0.08
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

TABLE 10 EMISSION TRENDS

CH_4

(Part 1 of 2)

Inventory
2008
Submission
2010 v1.4

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 CH_4 emissions including CH_4 from LULUCF	**1,986.19**	**2,043.44**	**2,009.38**	**2,025.64**	**2,049.34**	**2,086.66**	**2,091.05**	**2,111.96**	**2,101.46**	**2,102.85**
Total CH_4 emissions excluding CH_4 from LULUCF	**1,979.23**	**2,041.31**	**2,006.22**	**2,017.63**	**2,046.01**	**2,085.16**	**2,089.62**	**2,107.51**	**2,096.35**	**2,100.02**
Memo Items:										
International Bunkers	0.47	0.39	0.38	0.41	0.41	0.45	0.34	0.37	0.39	0.41
Aviation	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.08	0.09
Marine	0.42	0.34	0.33	0.35	0.35	0.39	0.27	0.29	0.31	0.32
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass										

Table A8.1.2.2 CH4 emission trends, CRF year 2008 (years 2000 – 2008)

TABLE 10 EMISSION TRENDS

CH_4

(Part 2 of 2)

Inventory 2008
Submission 2010
v1.4

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	370.03	351.29	345.17	338.94	332.38	328.92	303.12	300.74	305.64	-27.02
A. Fuel Combustion (Sectoral Approach)	64.14	62.31	57.73	57.82	59.34	57.02	57.63	61.98	62.16	-5.09
1. Energy Industries	6.85	5.95	5.92	6.14	6.21	6.34	6.17	5.72	5.65	-39.09
2. Manufacturing Industries and Construction	5.72	5.79	5.69	5.83	5.76	6.28	6.24	6.53	6.25	-8.40
3. Transport	28.63	26.68	24.85	22.89	20.70	18.72	17.65	16.59	15.56	-54.88
4. Other Sectors	22.81	23.82	21.21	22.86	26.53	25.53	27.45	33.04	34.63	135.08
5. Other	0.13	0.09	0.07	0.10	0.14	0.16	0.13	0.11	0.07	-57.32
B. Fugitive Emissions from Fuels	305.89	288.98	287.44	281.13	273.05	271.89	245.49	238.76	243.49	-31.09
1. Solid Fuels	3.48	3.85	3.72	4.50	3.05	3.27	2.56	4.00	3.45	-40.35
2. Oil and Natural Gas	302.41	285.13	283.72	276.62	270.00	268.62	242.93	234.76	240.03	-30.93
2. Industrial Processes	**3.01**	**2.83**	**2.71**	**2.77**	**2.91**	**3.06**	**3.14**	**3.08**	**2.90**	**-43.86**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
B. Chemical Industry	0.40	0.33	0.33	0.31	0.33	0.33	0.32	0.34	0.30	-87.92
C. Metal Production	2.61	2.50	2.38	2.46	2.58	2.72	2.81	2.75	2.60	-4.00
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NA	NA	0.00
3. Solvent and Other Product Use										

TABLE 10 EMISSION TRENDS
CH_4
(Part 2 of 2)

Inventory 2008
Submission 2010
v1.4

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
4. Agriculture	**801.77**	**765.53**	**748.91**	**751.65**	**739.75**	**736.90**	**721.12**	**743.49**	**728.15**	**-11.18**
A. Enteric Fermentation	579.30	540.01	525.27	526.52	515.89	516.24	506.01	524.93	520.04	-10.33
B. Manure Management	156.10	159.19	155.42	154.89	150.14	149.93	144.20	145.43	140.99	-14.48
C. Rice Cultivation	65.80	65.80	67.63	69.69	73.05	70.11	70.32	72.52	66.47	-10.64
D. Agricultural Soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field Burning of Agricultural Residues	0.58	0.53	0.60	0.55	0.67	0.62	0.60	0.61	0.65	4.66
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
5. Land Use, Land-Use Change and Forestry	**4.02**	**2.64**	**1.47**	**3.08**	**1.82**	**1.83**	**1.46**	**9.37**	**2.20**	**-68.42**
A. Forest Land	4.02	2.64	1.47	3.08	1.82	1.83	1.46	9.37	2.20	-68.42
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
6. Waste	**918.65**	**905.45**	**866.56**	**826.37**	**777.70**	**766.45**	**726.61**	**710.67**	**676.43**	**-8.03**
A. Solid Waste Disposal on Land	794.38	776.35	734.75	692.26	637.22	625.38	582.58	564.03	527.43	-16.68
B. Waste-water Handling	112.24	115.99	119.06	121.09	124.10	126.73	130.36	133.53	135.36	42.85
C. Waste Incineration	11.94	12.98	12.59	12.85	16.20	14.14	13.47	12.89	13.43	75.62

TABLE 10 EMISSION TRENDS
CH_4
(Part 2 of 2)

Inventory 2008
Submission 2010
v1.4

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
D. Other	0.10	0.12	0.16	0.18	0.18	0.20	0.21	0.22	0.21	1,872.62
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**
Total CH_4 emissions including CH_4 from LULUCF	**2,097.49**	**2,027.74**	**1,964.83**	**1,922.81**	**1,854.56**	**1,837.16**	**1,755.45**	**1,767.35**	**1,715.32**	**-13.64**
Total CH_4 emissions excluding CH_4 from LULUCF	**2,093.47**	**2,025.10**	**1,963.35**	**1,919.73**	**1,852.74**	**1,835.32**	**1,754.00**	**1,757.98**	**1,713.12**	**-13.44**
Memo Items:										
International Bunkers	0.51	0.58	0.65	0.74	0.80	0.83	0.88	0.87	0.91	95.34
Aviation	0.11	0.12	0.12	0.14	0.15	0.17	0.17	0.13	0.12	165.37
Marine	0.40	0.46	0.53	0.60	0.65	0.66	0.71	0.74	0.79	87.57
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
CO_2 Emissions from Biomass										

Table A8.1.3.1 N_2O emission trends, CRF year 2008 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

N_2O

(Part 1 of 2)

Inventory 2008
Submission 2010 v1.4
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	**14.25**	**14.20**	**14.47**	**14.57**	**15.00**	**15.97**	**16.35**	**16.58**	**16.71**	**16.94**
A. Fuel Combustion (Sectoral Approach)	14.25	14.20	14.47	14.56	15.00	15.96	16.35	16.57	16.70	16.94
1. Energy Industries	1.67	1.58	1.55	1.47	1.49	1.67	1.61	1.61	1.64	1.58
2. Manufacturing Industries and Construction	4.93	4.89	4.90	4.51	4.47	4.52	4.42	4.47	4.49	4.51
3. Transport	2.91	3.06	3.26	3.52	4.12	4.68	5.20	5.39	5.41	5.57
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	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	2.62	2.47	2.46	2.50	2.46	2.49	2.96	2.96	3.40	3.33
4. Agriculture	**75.36**	**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

TABLE 10 EMISSION TRENDS
N_2O
(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)
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	**0.31**	**0.02**	**0.03**	**0.06**	**0.03**	**0.02**	**0.01**	**0.03**	**0.04**	**0.02**
A. Forest Land	0.05	0.01	0.02	0.06	0.02	0.01	0.01	0.03	0.04	0.02
B. Cropland	0.26	0.01	0.01	0.01	0.01	0.01	NO	NO	NO	NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**6.30**	**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
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	**120.37**	**123.35**	**121.56**	**123.30**	**120.57**	**122.70**	**122.03**	**125.76**	**124.76**	**126.42**
Total N_2O emissions excluding N_2O from LULUCF	**120.06**	**123.33**	**121.53**	**123.23**	**120.54**	**122.68**	**122.02**	**125.73**	**124.72**	**126.40**

TABLE 10 EMISSION TRENDS
N_2O
(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)
Memo Items:										
International Bunkers	**0.23**	**0.21**	**0.22**	**0.24**	**0.24**	**0.26**	**0.25**	**0.27**	**0.29**	**0.31**
Aviation	0.12	0.12	0.13	0.14	0.15	0.16	0.18	0.19	0.21	0.23
Marine	0.11	0.09	0.09	0.09	0.09	0.10	0.07	0.08	0.08	0.08
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass										

Table A8.1.3.2 N2O emission trends, CRF year 2008 (years 2000 – 2008)

TABLE 10 EMISSION TRENDS

N_2O

(Part 2 of 2)

Inventory 2008
Submission 2010
v1.4

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**17.08**	**17.25**	**17.08**	**17.37**	**17.80**	**16.50**	**16.69**	**16.52**	**15.83**	**11.12**
A. Fuel Combustion (Sectoral Approach)	17.08	17.24	17.08	17.37	17.79	16.49	16.68	16.51	15.83	11.12
1. Energy Industries	1.67	1.75	1.82	1.84	1.91	1.90	1.89	1.87	1.85	11.33
2. Manufacturing Industries and Construction	4.66	4.74	4.77	4.93	5.03	5.02	5.05	4.98	4.64	-5.94
3. Transport	5.50	5.42	5.31	5.06	4.99	3.64	3.91	3.84	3.47	19.58
4. Other Sectors	5.11	5.30	5.15	5.41	5.59	5.64	5.60	5.60	5.66	25.34
5. Other	0.14	0.03	0.02	0.13	0.28	0.29	0.24	0.23	0.20	-11.57
B. Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.66
1. Solid Fuels	NA	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	0.00	6.66
2. Industrial Processes	**25.54**	**26.55**	**25.49**	**24.38**	**27.24**	**25.03**	**8.54**	**6.10**	**3.44**	**-84.04**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
B. Chemical Industry	25.54	26.55	25.49	24.38	27.24	25.03	8.54	6.10	3.44	-84.04
C. Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NA	NA	0.00
3. Solvent and Other Product Use	3.31	3.00	3.00	2.81	2.73	2.66	2.61	2.54	2.35	-10.46
4. Agriculture	**74.52**	**73.81**	**72.68**	**72.04**	**72.09**	**70.10**	**69.28**	**69.71**	**66.37**	**-11.93**

TABLE 10 EMISSION TRENDS
N_2O
(Part 2 of 2)

Inventory 2008
Submission 2010
v1.4

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
A. Enteric Fermentation										
B. Manure Management	12.46	12.91	12.42	12.33	11.98	11.96	11.61	12.19	12.18	-3.73
C. Rice Cultivation										
D. Agricultural Soils	62.06	60.89	60.25	59.70	60.09	58.12	57.65	57.50	54.18	-13.59
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field Burning of Agricultural Residues	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	3.46
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
5. Land Use, Land-Use Change and Forestry	**0.03**	**0.02**	**0.01**	**0.02**	**0.01**	**0.01**	**0.01**	**0.06**	**0.02**	**-95.06**
A. Forest Land	0.03	0.02	0.01	0.02	0.01	0.01	0.01	0.06	0.02	-68.42
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	-100.00
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NA	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**	**6.89**	**6.97**	**10.61**
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	6.57	9.23
C. Waste Incineration	0.36	0.39	0.38	0.38	0.47	0.42	0.40	0.38	0.40	39.95
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**

TABLE 10 EMISSION TRENDS
N_2O
(Part 2 of 2)

Inventory 2008
Submission 2010
v1.4

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Total N_2O emissions including N_2O from LULUCF	**127.19**	**127.28**	**124.90**	**123.29**	**126.67**	**121.09**	**103.96**	**101.82**	**94.96**	**-21.10**
Total N_2O emissions excluding N_2O from LULUCF	**127.16**	**127.26**	**124.89**	**123.27**	**126.66**	**121.08**	**103.95**	**101.76**	**94.95**	**-20.91**
Memo Items:										
International Bunkers	**0.35**	**0.36**	**0.35**	**0.37**	**0.38**	**0.39**	**0.41**	**0.44**	**0.44**	**92.09**
Aviation	0.25	0.24	0.21	0.21	0.21	0.21	0.22	0.24	0.24	96.31
Marine	0.11	0.12	0.14	0.16	0.17	0.18	0.19	0.20	0.21	87.57
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
CO_2 Emissions from Biomass										

Table A8.1.4.1 HFC, PFC and SF_6 emission trends, CRF year 2008 (1990 – 1999)

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 1 of 2)

Inventory 2008
Submission 2010 v1.4
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs(3) - (Gg CO_2 equivalent)	**351.00**	**355.43**	**358.78**	**355.42**	**481.90**	**671.29**	**450.33**	**755.74**	**1,181.72**	**1,523.65**
HFC-23	0.03	0.03	0.03	0.03	0.03	0.03	0.00	0.00	0.00	0.00
HFC-32	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00	0.02	0.05
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-125	NA,NO	0.00	0.00	0.00	0.00	0.01	0.01	0.04	0.05	0.08
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-134a	NA,NO	0.00	0.00	0.00	0.10	0.20	0.29	0.43	0.68	0.85
HFC-152a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.01	0.01	0.02	0.03	0.03
HFC-227ea	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00	0.00	0.01
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed HFCs(4) - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of PFCs(3) - (Gg CO_2 equivalent)	**1,807.65**	**1,451.54**	**849.56**	**707.47**	**476.84**	**490.80**	**243.39**	**252.08**	**270.43**	**258.00**
CF_4	0.21	0.17	0.10	0.08	0.06	0.06	0.03	0.03	0.03	0.03
C_2F_6	0.05	0.04	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
C_3F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 1 of 2)

Inventory 2008
Submission 2010 v1.4
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
c-C_4F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed PFCs(4) - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of SF6(3) - (Gg CO_2 equivalent)	**332.92**	**356.39**	**358.26**	**370.40**	**415.66**	**601.45**	**682.56**	**728.64**	**604.81**	**404.51**
SF_6	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.02

Table A8.1.4.2 HFC, PFC and SF_6 emission trends, CRF year 2008 (2000 – 2008)

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 2 of 2)

Inventory 2008
Submission
2010 v1.4

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(Gg)	(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**	**7,379.22**	**2,002.34**
HFC-23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-91.27
HFC-32	0.08	0.12	0.17	0.23	0.29	0.36	0.43	0.49	0.55	100.00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-125	0.13	0.20	0.28	0.38	0.48	0.59	0.69	0.79	0.89	100.00
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-134a	1.01	1.19	1.31	1.50	1.67	1.83	1.96	2.15	2.30	100.00
HFC-152a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-143a	0.06	0.08	0.11	0.15	0.19	0.24	0.28	0.32	0.36	100.00
HFC-227ea	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	100.00
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Unspecified mix of listed HFCs(4) - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	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**	**194.41**	**-89.25**
CF_4	0.04	0.05	0.04	0.05	0.04	0.04	0.03	0.04	0.02	-89.16
C_2F_6	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.00	0.00	-93.07
C_3F_8	NA,NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00

TABLE 10 EMISSION TRENDS
HFCs, PFCs and SF_6
(Part 2 of 2)

Inventory 2008
Submission
2010 v1.4

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
c-C_4F_8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Unspecified mix of listed PFCs(4) - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Emissions of SF6(3) - (Gg CO_2 equivalent)	**493.43**	**795.34**	**739.72**	**467.56**	**502.14**	**465.39**	**405.87**	**427.55**	**434.18**	**30.41**
SF_6	0.02	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	30.41

Table A8.1.5.1 Total emission trends, CRF year 2008 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

SUMMARY

(Part 1 of 2)

Inventory 2008
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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	370,777.23	356,120.89	357,560.82	370,154.00	343,549.88	363,376.59	352,074.99	368,611.64	381,633.56	379,572.21
CO_2 emissions excluding net CO_2 from LULUCF	435,775.28	434,871.79	434,435.80	427,792.47	420,573.81	445,861.39	439,221.26	443,462.49	454,681.56	460,084.59
CH_4 emissions including CH_4 from LULUCF	41,710.02	42,912.34	42,196.91	42,538.47	43,036.13	43,819.90	43,912.12	44,351.08	44,130.61	44,159.92
CH_4 emissions excluding CH_4 from LULUCF	41,563.78	42,867.58	42,130.60	42,370.32	42,966.26	43,788.40	43,882.08	44,257.76	44,023.42	44,100.52
N_2O emissions including N_2O from LULUCF	37,313.23	38,239.57	37,684.61	38,221.83	37,375.83	38,036.36	37,829.79	38,985.68	38,674.12	39,189.00
N_2O emissions excluding N_2O from LULUCF	37,218.42	38,232.27	37,675.12	38,202.01	37,365.98	38,030.41	37,826.74	38,976.21	38,663.24	39,182.97
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)	**452,292.06**	**439,436.16**	**439,008.94**	**452,347.59**	**425,336.23**	**446,996.40**	**435,193.17**	**453,684.85**	**466,495.25**	**465,107.29**
Total (excluding LULUCF)	**517,049.05**	**518,135.00**	**515,808.12**	**509,798.09**	**502,280.45**	**529,443.75**	**522,306.35**	**528,432.91**	**539,425.18**	**545,554.25**

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	418,576.51	418,114.75	417,359.53	413,937.61	407,816.73	431,427.80	427,347.72	431,473.21	442,859.66	448,094.39
2. Industrial Processes	37,507.63	37,126.31	36,506.84	33,329.37	31,797.09	34,945.96	31,747.91	32,274.70	32,704.25	33,116.25
3. Solvent and Other Product Use	2,455.02	2,393.84	2,392.69	2,351.69	2,268.63	2,239.03	2,337.53	2,339.40	2,391.80	2,369.79
4. Agriculture	40,576.24	41,371.33	40,862.45	41,162.90	40,640.81	40,348.91	40,096.87	41,150.14	40,418.36	40,795.02
5. Land Use, Land-Use Change and Forestry[(5)]	-64,756.99	-78,698.84	-76,799.18	-57,450.49	-76,944.22	-82,447.34	-87,113.18	-74,748.05	-72,929.92	-80,446.96

6. Waste	17,933.65	19,128.78	18,686.61	19,016.52	19,757.20	20,482.04	20,776.32	21,195.46	21,051.11	21,178.80
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)[(5)]	**452,292.06**	**439,436.16**	**439,008.94**	**452,347.59**	**425,336.23**	**446,996.40**	**435,193.17**	**453,684.85**	**466,495.25**	**465,107.29**

Table A8.1.5.2 Total emission trends, CRF year 2008 (years 2000 – 2008)

TABLE 10 EMISSION TRENDS
SUMMARY
(Part 2 of 2)

Inventory 2008
Submission 2010 v1.4
ITALY

GREENHOUSE GAS EMISSIONS	2000	2001	2002	2003	2004	2005	2006	2007	2008	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 equivalent (Gg)	(%)
CO_2 emissions including net CO_2 from LULUCF	387,566.60	383,963.82	378,269.74	402,474.38	401,589.75	398,470.82	393,899.41	424,264.64	380,718.29	2.68
CO_2 emissions excluding net CO_2 from LULUCF	463,602.86	469,524.74	471,863.92	487,454.15	490,580.15	490,476.80	486,342.51	476,749.38	468,067.67	7.41
CH_4 emissions including CH_4 from LULUCF	44,047.36	42,582.60	41,261.33	40,379.06	38,945.73	38,580.31	36,864.53	37,114.33	36,021.75	-13.64
CH_4 emissions excluding CH_4 from LULUCF	43,962.86	42,527.15	41,230.40	40,314.29	38,907.46	38,541.79	36,833.91	36,917.58	35,975.56	-13.44
N_2O emissions including N_2O from LULUCF	39,429.45	39,457.41	38,718.30	38,221.35	39,267.75	37,538.21	32,228.28	31,565.68	29,439.00	-21.10
N_2O emissions excluding N_2O from LULUCF	39,420.87	39,451.78	38,715.16	38,214.77	39,263.86	37,534.30	32,225.17	31,545.71	29,434.32	-20.91
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	7,379.22	2,002.34
PFCs	345.85	451.24	423.74	497.63	347.89	352.62	282.30	287.78	194.41	-89.25
SF_6	493.43	795.34	739.72	467.56	502.14	465.39	405.87	427.55	434.18	30.41
Total (including LULUCF)	**473,868.36**	**469,800.16**	**462,512.73**	**485,835.80**	**485,168.16**	**480,674.38**	**469,636.60**	**500,360.67**	**454,186.86**	**0.42**
Total (excluding LULUCF)	**549,811.54**	**555,300.00**	**556,072.84**	**570,744.23**	**574,116.41**	**572,637.93**	**562,045.97**	**552,628.69**	**541,485.36**	**4.73**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	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 equivalent (Gg)	(%)
1. Energy	450,807.70	455,580.63	457,700.82	472,101.40	474,406.38	473,902.36	469,217.22	459,055.94	452,907.35	8.20
2. Industrial Processes	35,189.63	37,247.42	37,393.79	38,720.21	41,041.61	40,945.63	36,420.18	36,944.47	34,099.10	-9.09
3. Solvent and Other Product Use	2,302.43	2,217.38	2,219.27	2,168.11	2,144.38	2,138.67	2,140.82	2,104.18	1,999.47	-18.56
4. Agriculture	39,939.85	38,957.36	38,258.62	38,116.00	37,882.54	37,204.45	36,620.96	37,222.47	35,865.15	-11.61
5. Land Use, Land-Use Change and Forestry(5)	-75,943.18	-85,499.84	-93,560.11	-84,908.43	-88,948.25	-91,963.55	-92,409.37	-52,268.02	-87,298.51	34.81
6. Waste	21,571.93	21,297.21	20,500.34	19,638.51	18,641.50	18,446.81	17,646.79	17,301.63	16,614.29	-7.36
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total (including LULUCF)(5)	**473,868.36**	**469,800.16**	**462,512.73**	**485,835.80**	**485,168.16**	**480,674.38**	**469,636.60**	**500,360.67**	**454,186.86**	**0.42**

A.8.2: Supplementary information under Article 7, paragraph 1

A8.2.1: KP-LULUCF

Table A8.2.1.1 Table NIR1. Summary Table

TABLE NIR 1. SUMMARY TABLE
Activity coverage and other information relating to activities under Article 3.3 and elected activities under Article 3.4

Activity		Change in carbon pool reported[1]					Greenhouse gas sources reported[2]						
		Above-ground biomass	Below-ground biomass	Litter	Dead wood	Soil	Fertilization[3]	Drainage of soils under forest management	Disturbance associated with land-use conversion to croplands	Liming	Biomass burning[4]		
							N_2O	N_2O	N_2O	CO_2	CO_2	CH_4	N_2O
Article 3.3 activities	Afforestation and Reforestation	R	R	R	R	R	NO			NO	IE	R	R
	Deforestation	R	R	R	R	R			NO	NO	NO	NO	NO
Article 3.4 activities	Forest Management	R	R	R	R	R	NO	NO		NO	IE	R	R
	Cropland Management	NA	NA	NA	NA	NA			NA	NA	NA	NA	NA
	Grazing Land Management	NA	NA	NA	NA	NA				NA	NA	NA	NA
	Revegetation	NA	NA	NA	NA	NA				NA	NA	NA	NA

Table A8.2.1.2 Table NIR2. Land Transition Matrix

Table NIR 2. LAND TRANSITION MATRIX

Areas and changes in areas between the previous and the current inventory year (1), (2), (3)

From previous inventory year \ To current inventory year		Article 3.3 activities: Afforestation and Reforestation	Article 3.3 activities: Deforestation	Article 3.4 activities: Forest Management (if elected)	Article 3.4 activities: Cropland Management (if elected)	Article 3.4 activities: Grazing Land Management (if elected)	Article 3.4 activities: Revegetation (if elected)	Other (5)	Total area at the beginning of the current inventory year(6)
		(kha)							
Article 3.3 activities	Afforestation and Reforestation	1,387.23	NO						1,387.23
	Deforestation		12.28						12.28
Article 3.4 activities	Forest Management (if elected)		0.72	7,450.57					7,451.29
	Cropland Management(4) (if elected)	NA	NA		NA	NA	NA		NA
	Grazing Land Management(4) (if elected)	NA	NA		NA	NA	NA		NA
	Revegetation(4) (if elected)	NA			NA	NA	NA		NA
Other (5)		77.89	0.00	0.00	0.00	0.00	0.00	21,204.92	21,282.81
Total area at the end of the current inventory year		1,465.12	13.00	7,450.57	0.00	0.00	0.00	21,204.92	30,133.60

Table A8.2.1.3 Table NIR3. Summary overview for key categories for LULUCF activities under Kyoto Protocol

TABLE NIR 3. SUMMARY OVERVIEW FOR KEY CATEGORIES FOR LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER THE KYOTO PROTOCOL

KEY CATEGORIES OF EMISSIONS AND REMOVALS	GAS	CRITERIA USED FOR KEY CATEGORY IDENTIFICATION			COMMENTS (3)
		Associated category in UNFCCC inventory(1) is key (indicate which category)	Category contribution is greater than the smallest category considered key in the UNFCCC inventory (1), (4) (including LULUCF)	Other (2)	
Specify key categories according to the national level of disaggregation used(1)					
Forest Management	CO2	Forest land remaining forest land	Yes	no	no

Table A8.2.1.4 Table 5(KP). Report of supplementary information for LULUCF activities under Kyoto Protocol

TABLE 5(KP). REPORT OF SUPPLEMENTARY INFORMATION FOR LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER THE KYOTO PROTOCOL [(1), (2)]

ITALY
Inventory 2008
Submission 2010 v1.4

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Net CO_2 emissions/ removals[(3), (4)]	CH_4 [(5)]	N_2O [(6)]	Net CO_2 equivalent emissions/removals
	(Gg)			
A. Article 3.3 activities				**-1,331.60**
A.1. Afforestation and Reforestation [(7)]	-1,736.00	0.78	0.01	-1,718.05
A.1.1. Units of land not harvested since the beginning of the commitment period	-1,736.00	0.78	0.01	-1,718.05
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA
A.2. Deforestation	386.44	NA	NA	386.44
B. Article 3.4 activities				**-50,730.65**
B.1. Forest Management (if elected)	-50,772.54	1.81	0.01	-50,730.65
B.2. Cropland Management (if elected)	NA	NA	NA	NA
B.3. Grazing Land Management (if elected)	NA	NA	NA	NA
B.4. Revegetation (if elected)	NA	NA	NA	NA

Information item:				
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA

A8.2.2: Standard electronic format

Table A8.2.2.1 Total quantities of Kyoto Protocol units by account type at beginning of reported year

Party	Italy
Submission year	2010
Reported year	2009
Commitment period	1

Table 1. Total quantities of Kyoto Protocol units by account type at beginning of reported year

Account type	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Party holding accounts	2.23E+09	NO	NO	NO	NO	NO
Entity holding accounts	2.01E+08	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	2.43E+09	NO	NO	9302402	NO	NO

Table A8.2.2.2.a Annual internal transactions

Party	Italy
Submission year	2010
Reported year	2009
Commitment period	1

Table 2 (a). Annual internal transactions

Transaction type	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Article 6 issuance and conversion												
Party-verified projects		NO					NO		NO			
Independently verifed projects		NO					NO		NO			
Article 3.3 and 3.4 issuance or cancellation												
3.3 Afforestation and reforestation			NO				NO	NO	NO	NO		
3.3 Deforestation			NO				NO	NO	NO	NO		
3.4 Forest management			NO				NO	NO	NO	NO		
3.4 Cropland management			NO				NO	NO	NO	NO		
3.4 Grazing land management			NO				NO	NO	NO	NO		
3.4 Revegetation			NO				NO	NO	NO	NO		
Article 12 afforestation and reforestation												
Replacement of expired tCERs							NO	NO	NO	NO	NO	
Replacement of expired lCERs							NO	NO	NO	NO		
Replacement for reversal of storage							NO	NO	NO	NO		NO
Replacement for non-submission of certification report							NO	NO	NO	NO		NO
Other cancellation							NO	NO	NO	NO	NO	NO
Sub-total		NO	NO				NO	NO	NO	NO	NO	NO

Transaction type	Retirement					
	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Retirement	NO	NO	NO	NO	NO	NO

Table A8.2.2.2.b Annual external transactions

Party	Italy
Submission year	2010
Reported year	2009
Commitment period	1

Table 2 (b). Annual external transactions

	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Transfers and acquisitions												
CDM	NO	NO	NO	17800214	NO	NO	NO	NO	NO	NO	NO	NO
AT	7462	NO	NO	342453	NO	NO	1262204	NO	NO	32009	NO	NO
BE	NO	NO	NO	25000	NO	NO	620000	NO	NO	NO	NO	NO
DK	5720000	NO	NO	762500	NO	NO	1613066	NO	NO	300000	NO	NO
FR	4002533	NO	NO	523296	NO	NO	9551871	NO	NO	407915	NO	NO
DE	613326	NO	NO	177188	NO	NO	1688973	NO	NO	15167	NO	NO
GR	359000	NO	NO	NO	NO	NO	60000	NO	NO	NO	NO	NO
HU	44100	NO	NO	53400	NO	NO	315000	NO	NO	10000	NO	NO
IE	8000	NO	NO	NO	NO	NO	932	NO	NO	NO	NO	NO
JP	NO	NO	NO	NO	NO	NO	NO	NO	NO	999999	NO	NO
NL	686521	NO	NO	442140	NO	NO	1174680	NO	NO	39000	NO	NO
PT	21522	NO	NO	NO	NO	NO	131522	NO	NO	NO	NO	NO
RO	32000	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
ES	69594	NO	NO	30000	NO	NO	475315	NO	NO	NO	NO	NO
SE	982	NO	NO	NO	NO	NO	982	NO	NO	NO	NO	NO
CH	NO	NO	NO	803104	NO	NO	NO	NO	NO	200000	NO	NO
GB	8551602	NO	NO	1833166	NO	NO	9606968	NO	NO	2366577	NO	NO
Sub-total	20116642	NO	NO	22792461	NO	NO	26501513	NO	NO	4370667	NO	NO

Additional information

Independently verified ERUs								NO				

A8.2.2.2.c Total annual transactions

Table 2 (c). Total annual transactions

Total (Sum of tables 2a and 2b)	20116642	NO	NO	22792461	NO	NO	26501513	NO	NO	4370667	NO	NO

Table A8.2.2.3 Expiry, cancellation and replacement

Party	Italy
Submission year	2010
Reported year	2009
Commitment period	1

Table 3. Expiry, cancellation and replacement

	Expiry, cancellation and requirement to replace		Replacement					
	Unit type		Unit type					
Transaction or event type	**tCERs**	**lCERs**	**AAUs**	**ERUs**	**RMUs**	**CERs**	**tCERs**	**lCERs**
Temporary CERs (tCERS)								
Expired in retirement and replacement accounts	NO							
Replacement of expired tCERs			NO	NO	NO	NO	NO	
Expired in holding accounts	NO							
Cancellation of tCERs expired in holding accounts	NO							
Long-term CERs (lCERs)								
Expired in retirement and replacement accounts		NO						
Replacement of expired lCERs			NO	NO	NO	NO		
Expired in holding accounts		NO						
Cancellation of lCERs expired in holding accounts		NO						
Subject to replacement for reversal of storage		NO						
Replacement for reversal of storage			NO	NO	NO	NO		NO
Subject to replacement for non-submission of certification report		NO						
Replacement for non-submission of certification report			NO	NO	NO	NO		NO
Total			NO	NO	NO	NO	NO	NO

Table A8.2.2.4 Total quantities of Kyoto Protocol units by account type at end of reported year

Party	Italy
Submission year	2010
Reported year	2009
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	2215257469	NO	NO	7411755	NO	NO
Entity holding accounts	211123812	NO	NO	20312441	NO	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	NO	NO		
Non-compliance cancellation accounts	NO	NO	NO	NO		
Other cancellation accounts	NO	NO	NO	NO	NO	NO
Retirement account	NO	NO	NO	NO	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	2426381281	NO	NO	27724196	NO	NO

Table A8.2.2.5.a Summary information on additions and subtractions

Party	Italy
Submission year	2010
Reported year	2009
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)	20116642	NO	NO	22792461	NO	NO	26501513	NO	NO	4370667	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	40409599	NO	NO	42068783	NO	NO	30306216	NO	NO	14344587	NO	NO
Total	2456687497	NO	NO	42068783	NO	NO	30306216	NO	NO	14344587	NO	NO

Table A8.2.2.5.b Summary information on replacement

Table 5 (b). Summary information on replacement

	Requirement for replacement		Replacement					
	Unit type		Unit type					
	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Previous CPs			NO	NO	NO	NO	NO	NO
Year 1 (2008)		NO	NO	NO	NO	NO	NO	NO
Year 2 (2009)		NO	NO	NO	NO	NO	NO	NO
Year 3 (2010)		NO	NO	NO	NO	NO	NO	NO
Year 4 (2011)		NO	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO	NO	NO
Total	NO	NO	NO	NO	NO	NO	NO	NO

Table A8.2.2.5.c Summary information on retirement

Table 5 (c). Summary information on retirement

	Retirement					
	Unit type					
Year	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Year 1 (2008)	NO	NO	NO	NO	NO	NO
Year 2 (2009)	NO	NO	NO	NO	NO	NO
Year 3 (2010)	NO	NO	NO	NO	NO	NO
Year 4 (2011)	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO
Total	NO	NO	NO	NO	NO	NO

A8.2.3 National registry

A8.2.3.1 Changes to national registry

The only relevant change has been in the name and contact information of the registry administrator. Information is reported in chapter 13.

A8.2.3.2 Reports:

i) **list of discrepancies**
   list of discrepancies is reported in the separate Annex to this document "SIAR Report 2010-Table R-2"

ii) **notifications from EB of CDM**
   no CDM notifications were received by the Registry during the reporting period

iii) **non-replacements**
   no non-replacements occurred during the reporting period

iv) **invalid units**
   no invalid units to list for the reporting period

A8.2.4 Adverse impacts under Article 3, paragraph 14 of the Kyoto Protocol

Chapter 14 presents information on the commitments to tackle adverse impacts under Article 3, paragraph 14, of the Kyoto Protocol. Additional information which can be added is the list of all registered CDM projects in which Italy is involved.

Table A8.2.3.1 Information of the CDM projects where Italy is involved (as for 16/03/ 2010)

Title	Host Parties	Other Parties	Impacts assessment
La Esperanza Hydroelectric Project	Honduras (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Austria, Luxembourg, Belgium, Sweden, Germany, Switzerland, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
Santa Rosa	Peru (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Austria, Luxembourg, Belgium, Sweden, Germany, Switzerland, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
DSL Biomass based Power Project at Pagara	India (a)	**Italy**, Germany, United Kingdom of Great Britain and Northern Ireland	Sirohi (2007)
GHG emission reduction by thermal oxidation of HFC 23 at refrigerant (HCFC-22) manufacturing facility of SRF Ltd	India (b)	Netherlands, **Italy,** France, Germany, United Kingdom of Great Britain and Northern Ireland, Switzerland	Sirohi (2007)
Biogas Support Program - Nepal (BSP-Nepal) Activity-1	Nepal (a)	Canada, Netherlands, **Italy,** Denmark, Finland, Sweden, Luxembourg, Switzerland, Austria, Germany, Belgium, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
Biogas Support Program - Nepal (BSP-Nepal) Activity-2	Nepal (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Sweden, Luxembourg, Switzerland, Austria, Germany, Belgium, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
Olavarría Landfill Gas Recovery Project	Argentina (c)	Canada, Netherlands, **Italy**, Denmark, Finland, Sweden, Luxembourg, Switzerland, Austria, Germany, Belgium, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
Moldova Biomass Heating in Rural Communities (Project Design Document No. 1)	Republic of Moldova (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Austria, Luxembourg, Belgium, Sweden, Germany, Switzerland, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
Moldova Biomass Heating in Rural Communities (Project Design Document No. 2)	Republic of Moldova (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Sweden, Luxembourg, Switzerland, Austria, Germany, Belgium, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
Moldova Energy Conservation and Greenhouse Gases Emissions Reduction	Republic of Moldova (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Sweden, Luxembourg, Switzerland, Austria, Germany, Belgium, Japan, Norway, Spain	-
Aleo Manali 3 MW Small Hydroelectric Project, Himachal Pradesh, India	India (a)	Switzerland, **Italy**, United Kingdom of Great Britain and Northern Ireland	Nussbaumer (2009),

			Sirohi (2007)
5 MW Wind Power Project at Baramsar and Soda Mada, district Jaisalmer, Rajasthan, India.	India (a)	**Italy**	Nussbaumer (2009), Sirohi (2007)
Landfill gas recovery at the Norte III Landfill, Buenos Aires, Argentina.	Argentina (b)	Switzerland, **Italy**	-
Project for GHG Emission Reduction by Thermal Oxidation of HFC23 in Jiangsu Meilan Chemical CO. Ltd., Jiangsu Province, China	China (b)	Canada, Netherlands, **Italy,** Denmark, Finland, France, Sweden, Germany, United Kingdom of Great Britain and Northern Ireland, Switzerland, Japan, Norway, Spain	-
Project for HFC23 Decomposition at Changshu 3F Zhonghao New Chemical Materials Co. Ltd, Changshu, Jiangsu Province, China	China (b)	Canada, Netherlands, **Italy**, Denmark, Finland, France, Sweden, Germany, United Kingdom of Great Britain and Northern Ireland, Switzerland, Japan, Norway, Spain	-
Puente Gallego Landfill gas recovery project, Gallego, Rosario, Argentina.	Argentina (b)	Switzerland, **Italy**	-
Djebel Chekir Landfill Gas Recovery and Flaring Project – Tunisia	Tunisia (c)	**Italy**	-
India - Vertical Shaft Brick Kiln Cluster Project	India (a)	Canada, Netherlands, **Italy**, Finland, Sweden, Luxembourg, Switzerland, Austria, Germany, Belgium, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
Project for HFC23 Decomposition at Zhejiang Dongyang Chemical Co., Ltd., China	China (b)	Switzerland, Netherlands, **Italy,** United Kingdom of Great Britain and Northern Ireland	-
Project for HFC23 Decomposition at Limin Chemical Co., Ltd. Linhai, Zhejiang Province, China	China (b)	Switzerland, Netherlands, **Italy**, United Kingdom of Great Britain and Northern Ireland	-
Recovery of associated gas that would otherwise be flared at Kwale oil-gas processing plant, Nigeria	Nigeria (b)	**Italy**	-
Facilitating Reforestation for Guangxi Watershed Management in Pearl River Basin	China (d)	**Italy**, Spain	Cóndor et al. (2010)
Landfill Gas Recovery and Flaring for 9 bundled landfills in Tunisia	Tunisia (c)	**Italy**	-
India-FaL-G Brick and Blocks Project No.1	India (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Luxembourg, Belgium, Sweden, Germany, Switzerland, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
Huadian Inner Mongolia Huitengxile 100.25MW Wind Farm Project	China (c)	**Italy**	Boyd et al. (2009)
Yunnan Whitewaters Hydropower Development Project	China (c)	**Italy**	Nussbaumer (2009)
Hebbakavadi Canal Based Mini Hydro Project in Karnataka, India	India (a)	Switzerland, **Italy**	-

Guangrun Hydropower Project in Hubei Province, P.R. China	China (c)	Canada, Netherlands, **Italy**, Finland, Luxembourg, Belgium, Sweden, Germany, Switzerland, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
HFC23 Decomposition Project at Zhonghao Chenguang Research Institute of Chemical Industry, Zigong, SiChuan Province, China	China (b)	Switzerland, Netherlands, **Italy**, United Kingdom of Great Britain and Northern Ireland	-
Allain Duhangan Hydroelectric Project (ADHP)	India (c)	**Italy**	-
Rongcheng Dongchudao Wind Farm	China (c)	**Italy**	-
Laizhou Diaolongzui Wind Farm	China (c)	**Italy**	-
Quezon City Controlled Disposal Facility Biogas Emission Reduction Project	Philippines (a)	Switzerland, **Italy**	-
Laguna de Bay Community Waste Management Project: Avoidance of methane production from biomass decay through composting -1	Philippines (a)	Canada, Netherlands, **Italy**, Denmark, Luxembourg, Belgium, Germany, Switzerland, Japan, Norway, Spain	-
Guyana Skeldon Bagasse Cogeneration Project	Guyana (c)	Canada, Netherlands, **Italy**, Denmark, Finland, Luxembourg, Belgium, Germany, Switzerland, Spain	-
Guizhou Zhenyuan Putian Hydropower Station	China (a)	**Italy**	-
Kunming Dongjiao Baishuitang LFG Treatment and Power Generation Project	China (c)	**Italy**	-
Shenyang Laohuchong LFG Power Generation Project	China (c)	**Italy**	-
Expansion Project of Huadian Inner Mongolia Huitengxile Wind Farm	China (c)	**Italy**	-
Hubei Eco-Farming Biogas Project Phase I	China (a)	Canada, Netherlands, **Italy**, Denmark, Luxembourg, Switzerland, Sweden, Belgium, Japan, Norway, Spain	-
Salta Landfill Gas Capture Project	Argentina (a)	Canada, Netherlands, **Italy**, Denmark, Luxembourg , Switzerland, Sweden, Belgium, Japan, Norway, Spain	-
Coke Dry Quenching (CDQ) Waste Heat Recovery for Power Generation Project of Wugang No. 9 and 10 Coke Ovens	China (c)	**Italy**	-
Yingpeng HFC23 Decomposition Project	China (b)	**Italy**, Ireland United Kingdom of Great Britain and Northern Ireland	-

Animal Manure Management System (AMMS) GHG Mitigation Project , Shandong Minhe Livestock Co. Ltd., Penglai, Shandong Province, P.R. of China	China (c)	Canada, Netherlands, **Italy**, Denmark, Finland, Luxembourg, Sweden, Germany, Belgium, Japan, Norway, Spain	-
Uganda Nile Basin Reforestation Project No.3	Uganda (d)	**Italy**	-
NISCO Converter Gas Recovery and Utilization for Power Generation Project	China (c)	**Italy**	-
Assisted Natural Regeneration of Degraded Lands in Albania	Albania (d)	**Italy**	Cóndor et al. (2010)

(a)AMS, Small scale; (b) AM - Large scale; (c) ACM - Consolidated Methodologies; (d) Afforestation/reforestation;

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 Construction												
a. Iron and Steel												

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	**Key source** (1)	**Method applied** (2)	**Activity data** (3)	**Emission factor** (4)	**Key source** (1)	**Method applied** (2)	**Activity data** (3)	**Emission factor** (4)	**Key source** (1)	**Method applied** (2)	**Activity data** (3)	**Emission factor** (4)
Liquid fuels	Yes	T2	NS	CS	No				No			
Solid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
b. Non-Ferrous Metals												
Solid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	No	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												
Jet kerosene	Yes	T1, T2	NS	CS	No				No			
b. Road												

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)**
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	Yes	COPERT IV	NS, AS	CS	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	Yes	T2	NS	C, CS	No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
c. Agriculture/Forestry /Fisheries												
Liquid fuels	Yes	T2	NS	CS	No				No			
Solid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	**Key source** (1)	**Method applied** (2)	**Activity data** (3)	**Emission factor** (4)	**Key source** (1)	**Method applied** (2)	**Activity data** (3)	**Emission factor** (4)	**Key source** (1)	**Method applied** (2)	**Activity data** (3)	**Emission factor** (4)
5. Other												
a. Stationary												
Solid fuels	Yes	NA	NA	NA	No				No			
b. Mobile												
Liquid fuels	Yes	T2	NS	CS	No				No			
B. Fugitive Emissions from Fuels												
1. Solid Fuels												
a. Coal Mining	No				Yes	T1	NS	D, CS	No			
b. Solid Fuel Transformation	No				No				No			
c. Other *(as specified in table 1.B.1)*	No				No				No			
2. Oil and Natural Gas												
a. Oil	Yes	T1, T2	NS	D, CS	No				No			
b. Natural Gas	No				Yes	T1, T2	NS	D, CS	No			
c. Venting and Flaring	Yes	T2	NS	CS	No				No			
d. Other *(as specified in table 1.B.2)*	No				No				No			

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

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O				HFCs				PFCs				SF_6			
CATEGORIES	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]
2. Industrial Processes																								
A. Mineral Products																								
1. Cement Production	Yes	T2	NS	CS, PS	No				No															
2. Lime Production	Yes	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	CO_2				CH_4				N_2O				HFCs				PFCs				SF_6			
CATEGORIES	**Key source (1)**	**Method applied (2)**	**Activity data (3)**	**Emission factor (4)**	**Key source (1)**	**Method applied (2)**	**Activity data (3)**	**Emission factor (4)**	**Key source (1)**	**Method applied (2)**	**Activity data (3)**	**Emission factor (4)**	**Key source (1)**	**Method applied (2)**	**Activity data (3)**	**Emission factor (4)**	**Key source (1)**	**Method applied (2)**	**Activity data (3)**	**Emission factor (4)**	**Key source (1)**	**Method applied (2)**	**Activity data (3)**	**Emission factor (4)**
5. Other *(as specified in table 2(I)A-G)*	No				No				No								No				No			
D. Other Production																								
1. Pulp and Paper	No																							
2. Food and Drink	No																							
E. Production of Halocarbons and SF_6																								
1. By-product Emissions													Yes	CS	PS	PS	No				Yes	CS	PS	PS
2. Fugitive Emissions													No				No				No			
3. Other *(as specified in table 2(II)*													Yes	NA	NA	NA	No				No			
F. Consumption of Halocarbons and SF_6																								
1. Refrigeration and Air Conditioning Equipment													Yes	CS	PS	CS	No				No			
2. Foam Blowing													Yes	CS	PS	CS	No				No			
3. Fire Extinguishers													No				No				No			
4. Aerosols/ Metered Dose Inhalers													Yes	CS	PS	CS	No				No			
5. Solvents													No				No				No			
6. Other applications using ODS substitutes													No				No				No			
7. Semiconductor Manufacture													No				No				No			
8. Electrical Equipment													No				No				No			
9. Other *(as specified in table 2(II)*													No				No				Yes	NA	NA	NA
G. Other																								

Table I -3: Community summary report for methods, activity data and emission factors used (Solvent and Other Product Use, Agriculture)

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)
3. Solvent and Other Product Use												
A. Paint Application	No								No			
B. Degreasing and Dry Cleaning	No								No			
C. Chemical Products, Manufacture and Processing	No								No			
D. Other	No								No			
4. Agriculture												
A. Enteric Fermentation												
1. Cattle					Yes	T2	NS	CS				
2. Buffalo					No							
3. Sheep					Yes	T1	NS	D				
4. Other					No							
B. Manure Management												
1. Cattle					Yes	T2	NS	CS	No			
2. Buffalo					No				No			
3. Sheep					No				No			
4. Other					No				No			
8. Swine					Yes	T2	NS	CS	No			
13. Solid Storage and Dry Lot					No				Yes	T2	NS	D, CS
C. Rice Cultivation												
D. Agricultural Soils												
1. Direct Soil Emissions	No				No				Yes	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 Land	Yes	T1, T2	NS	D, CS	No				No			
2. Land converted to Forest Land	Yes	T1, T2	NS	D, CS	No				No			
B. Cropland												
1. Cropland remaining Cropland	Yes	T1	NS	D, CS	No				No			
2. Land converted to Cropland	Yes	T1	NS	D, CS	No				No			
C. Grassland												
1. Grassland remaining Grassland	Yes	T1	NS	D, CS	No				No			
2. Land converted to Grassland	Yes	T1	NS	D, CS	No				No			
D. Wetlands												
1. Wetlands remaining Wetlands	No				No				No			
2. Land converted to Wetlands	No				No				No			
E. Settlements												
1. Settlements remaining Settlements	No				No				No			
2. Land converted to Settlements	Yes	T1	NS	D, CS	No				No			
F. Other Land												
1. Other Land remaining Other Land					No				No			
2. Land converted to Other Land	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				Yes	NA	NA	NA				
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			

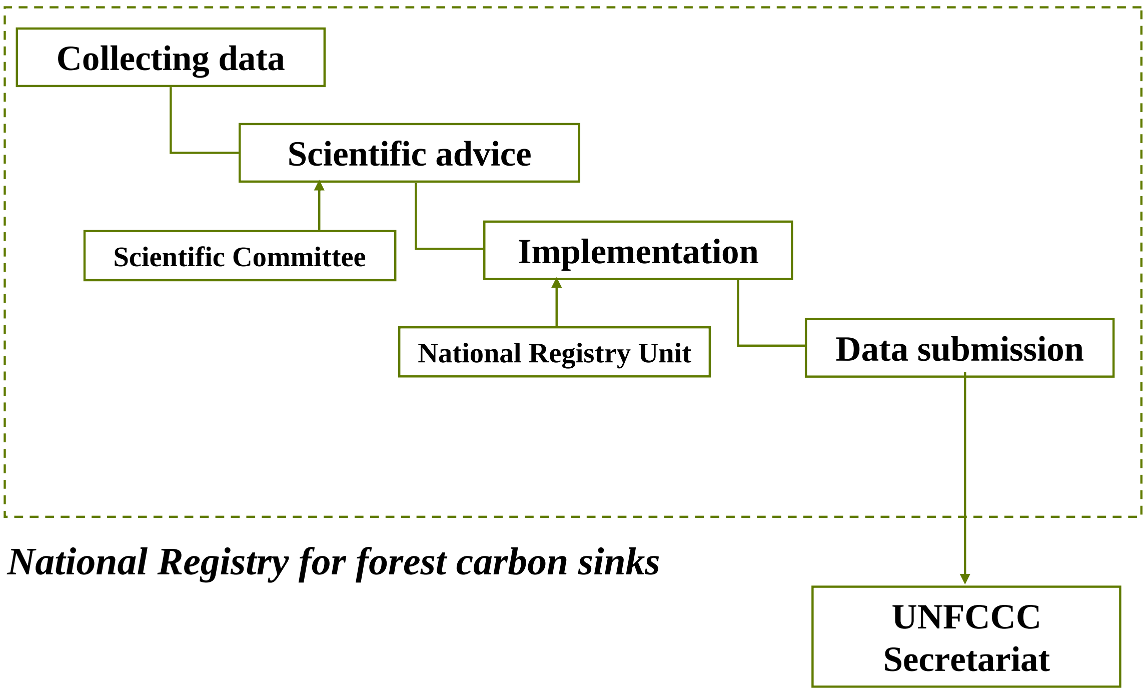
Legend for tables I -1 to I -4

(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.
Following the Decision 8/CMP.2, credits from *forest management* are capped, in the first commitment period, to 2,78 Mt C (10.19 $MtCO_2$) per year, or 13.9 Mt C (50.97 $MtCO_2$) the whole commitment period per year.
Italy intends to account for Article 3.3 and 3.4 activities at the end of the commitment period.
Considering that the entire Italian forest area is subject to the *forest management* activity, under Kyoto Protocol, accounting for carbon stocks changes (and the related non-CO_2 emissions) on the national forest area, and on deforested areas, occurring in the first Commitments Period, is required.
The key elements of the accounting system in the National Registry for forest carbon sinks are:

National Land-Use Inventory (IUTI)
aimed at identifying and quantifying:
- *forest land* areas;
- land in conversion from *forest land* category since 31 December 1989;
- land in conversion to *forest land* category since 31 December 1989.

National Inventory of Carbon Stocks (ISCI)
aimed at quantifying:
- carbon stocks and carbon stock changes in any land-use category in the first Commitments Period.

National Census of Forest Fires (CIFI)
aimed at identifying and quantifying:
- *forest land* areas affected by fires.

National Inventory of non-CO_2 emissions from forest fires (IEIF)
aimed at quantifying:
- non-CO_2 emissions from *forest land* areas affected by fires.

National Land-Use Inventory (IUTI)

The National Land-Use Inventory (IUTI) is aimed at identifying the land uses and land-use changes over the national territory. IUTI will supply data concerning areas under *forest land* category (art. 3.4 of KP) and of land in conversion to and from *forest land* categories (art. 3.3 of KP). IUTI is based on a survey of sample points throughout Italian national territory considered as a population of points, and on the classification of the land use coupled with the sampling points. By using on-screen interpretation of digital orthophotos (VOLOITALIA[2] and TERRAITALY[3]), land use is classified with a high degree of accuracy and precision, as required by IPCC standards.

Time:
IUTI will annually provide time-series of the areas devoted to any land-use category and any land-use change subcategory to and from *forest land* use, in the KP reporting. For the first Commitment Period accounting, the time series needed is related to the period 31/12/1989 - 1/1/2013; in particular the 31/12/1989 data are needed for identifying existing forest lands (*Forest Management*, art. 3.4) and setting land reference scenario for *Afforestation*, *Reforestation* and *Deforestation* (art. 3.3);

Space:
The sampling grid and the relative sample plots (1,200,000 sampling points) is uniformly distributed throughout the entire Italian national territory, using a non-aligned systematic statistical model. IUTI will supply data, at NUT2 level, of the investigated variables (i.e. *forest land* category and each subcategory in conversion to and from *forest land*). The analysis of sample plots is being carried on using remote sensed data.

Categories and subcategories:
Land use categories (Table A10.1) are defined according to IPCC Good Practice Guidance for LULUCF:

IPCC Category Level I	IUTI Category Level II	IUTI Subcategory Level III	Code
1. Forest land	*Woodland*		**1.1**
	Wooded land temporarily unstocked		**1.2**
2. Cropland	*Arable land and other herbaceous cultivations*		**2.1**
	Arboreal cultivations	*Fruit orchards and plant nurseries*	**2.2.1**
		Wood product plantations	**2.2.2**
3. Grassland	*Grassland, pastures and uncultivated herbaceous areas*		**3.1**
	Other wooded land		**3.2**
4. Wetlands	*Marshlands and open waters*		**4**

[2] http://www.cgrit.it/prodotti/voli_italia.html
[3] http://www.terraitaly.it/

5. Settlements	*Urban development*	**5**
6. Other land	*Non-productive areas or areas with scarce or absent vegetation*	**6**

Table A10.1: IUTI classification system

Quality assurance:
Data supplied by IUTI will be collected in the so-called "*National Registry for the forest carbon sinks*" of Kyoto Protocol, and have to fulfil quality requirements as stated by the IPCC and UNFCCC guidelines.

Classification methodology
The adopted classification methodology ensures that any unit of land could be classified univocally (exclusion of multiple classification of the same unit of land) under a category (exclusion of the null case), by means of*:*

– a systematic sampling design to select classification points;
– a list of land-use definitions as reported in the IPCC GPG land-use classification;
– a list of land-use indicators able to indicate the presence of a certain use on the land;
– a classification hierarchy to facilitate land use classification (Table A10.2)

Concerning land use classification, the first step is related to a land classification, following artificial land level; the aim is to discriminate between land areas significantly modified by human activity, with an evolution strongly conditioned by prevalently residential and productive activities, and land areas characterized by a high degree of naturalness, in which natural evolution, although conditioned by human action, still exercises a predominant effect in the determination of the prevalent characteristics of the land.
Distinctions are therefore made between urbanized and agricultural territories, and natural and semi-natural territories (forest, pre-forest and herbaceous formations, open water, rocky areas).
At the subsequent levels, the classification process follows the prevalent use of land in the category of artificial territories, while the discriminating element for natural and semi-natural territories is essentially given by the vegetative cover degree, considering canopy, shrub and herbaceous cover.

A. LAND WITH ITS ORIGINAL CHARACTERISTICS OF PHYSIOGNOMY AND VEGETATION SIGNIFICANTLY MODIFIED BY HUMAN ACTION, CULTIVATED, CLEARED OR SUBJECT TO URBANIZATION WORK, AND DOMINATED BY ANTHROPIC ARTEFACTS DUE TO RESIDENTIAL, INDUSTRIAL, SOCIO-CULTURAL AND AGRICULTURAL ACTIVITIES.

AI. **Land occupied by other agricultural cultivations**

AI1. Herbaceous cultivations in open fields, subject to regular rotation, for the production of cereals, pulses, other food products or forage.

ARABLE

AI2. Arboreal cultivations not subject to regular rotation, destined permanently to the production of fruit or wood products.

AI2a. *Arboreal cultivations destined prevalently to the production of fruit for nutritional purposes (apple orchards, vineyards, olive groves, etc) or for the production of arboreal or shrub species for ornamental purposes*

ORCHARDS and NURSERIES

AI2b. *Arboreal cultivations destined prevalently to the production of wood products or of woody biomass for energy generation purposes*

ARBOREAL CULTIVATIONS FOR WOOD PRODUCTS

AII. **Areas with residential and industrial buildings and services, transport routes, infrastructures and urban green areas (parks and gardens)**

SETTLEMENTS

B. NATURAL OR SEMI-NATURAL LAND NOT SIGNIFICANTLY MODIFIED BY HUMAN ACTION OR IN PHASE OF RENATURALIZATION.

BI. **Formations constituted by trees able to reach the height on maturity *in situ* of 5 m, but temporarily lacking in canopy cover following accidental events or anthropic action.**

WOODED LAND TEMPORARILY WITHOUT ABOVE-GROUND COVER

BII. **Formations constituted by trees able to reach the height on maturity *in situ* of 5 m and procuring a degree of canopy cover on the terrain of ≥ 5%.**

BII1. Formation with a degree of cover < 10%

OTHER WOODED AREAS

BII2. Formation with a degree of cover ≥ 10%

WOODLAND

BIII. **Formations never as above**

BIII1. Formations constituted by shrubs or trees not able to reach a height on maturity *in situ* of 5 m, and procuring a degree of canopy cover on the terrain of ≥ 10%

OTHER WOODED LAND

BIII2. Formations constituted by shrubs or trees not able to reach a height on maturity *in situ* of 5 m and procuring a degree of canopy cover on the terrain of < 10%, and silvi-pastural formations with canopy cover from trees able to reach a height on maturity *in situ* of 5 m but with cover < 5%

BIII2a. *Natural herbaceous formations of ground species with a degree of herbaceous cover of ≥ 40%.*

PASTURES, MEADOWS and UNCULTIVATED HERBACEOUS AREAS

BIII2b. *Natural herbaceous formations with a degree of herbaceous cover of < 40% or land completely lacking herbaceous cover*

BIII2b1. *Land without vegetation or with sporadic herbaceous vegetation. Rocky outcrops and beaches.*

OTHER LANDS

C. AREAS WITHOUT VEGETATION AND COVERED BY STILL OR FLOWING WATER OR AREAS OCCUPIED BY PARTICULAR ECOSYSTEMS OTHER THAN TERRESTRIAL ECOSYSTEMS (FLOATING VEGETATION, WET VEGETATION, SALTWATER VEGETATION, ETC).

MARSHLANDS AND OPEN WATERS

Table A10.2: Classification hierarchy

To achieve land use classification, a 0.5 ha neighbourhood of the sample plot is investigated. The operative procedure consists in digital orthophotos processing, considering sampling points: for each point identified on the territory by coordinates in a known reference system, the land use category, defined according to the classification system, must be established.
A grid, composed of 9 squares (3 x 3) of 2500 m² each, for an overall surface area of 22,500 m² is used. This graphic object, at the centre of which the sampling point must be situated, allows to assess whether area intercepted by the sampling point has an extension equal to or greater than the established threshold (equivalent to the surface area of 2 of the 9 cells displayed).
If the surface area value is very close to the threshold and the use of the cells still leaves doubts, a graphic tool for surface area measurement is used for the classification process. The contour of the polygon containing the sampling point is mapped, computing the extent of the area.
In figures A10.1, A10.2 and A10.3, examples from land use classification system are reported. In particular, in figure 1 the sampling point is classified as 3.1 Grassland, given that trees covering the sampling point have a surface area between 500 and 5000 m². In Figure A10.2, the sampling point is classified as 1.1 Woodland, while in Figure A10.3, the sampling point is classified as 3.1 Grassland.

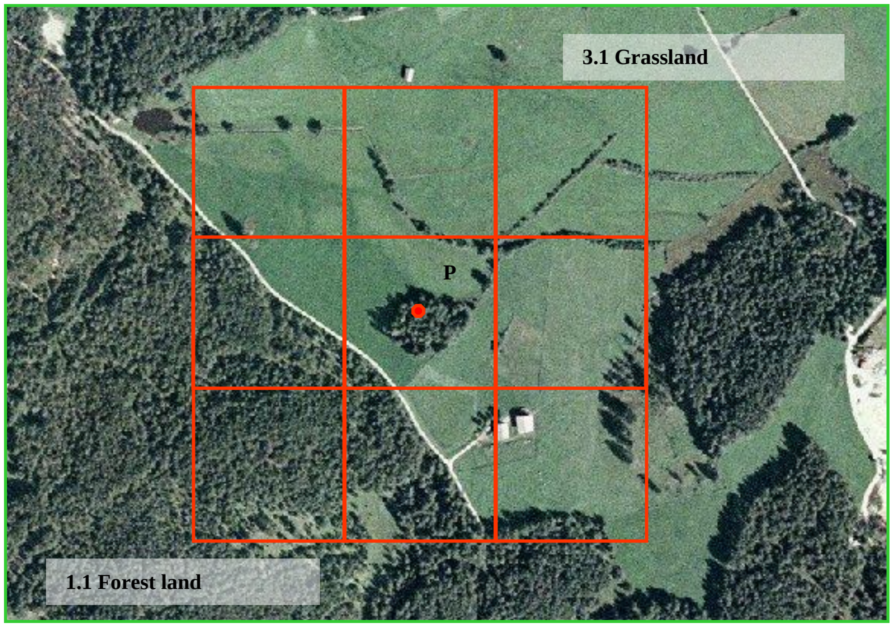


Figure A10.1: Land use classification system - grassland

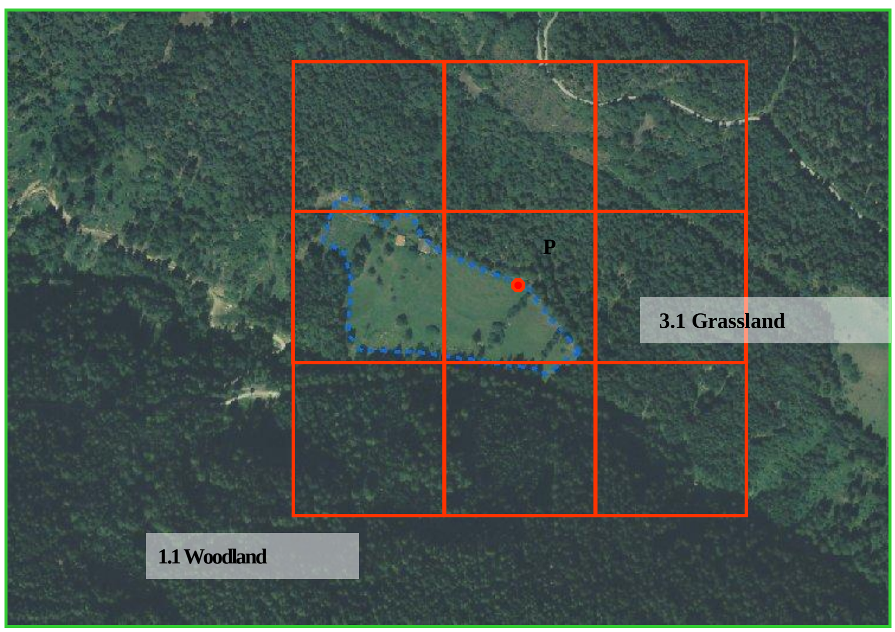


Figure A10.2: Land use classification system - Woodland

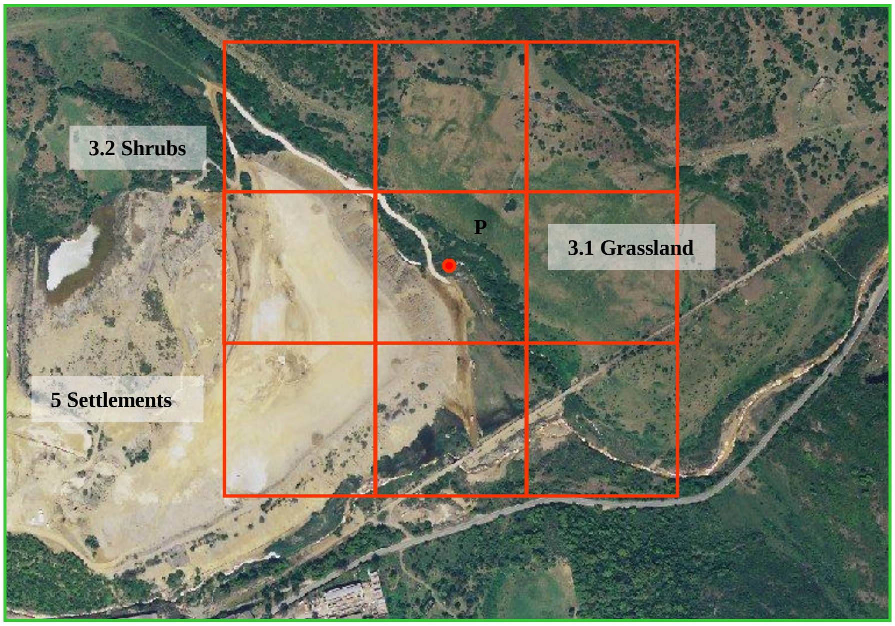


Figure A10.3: Land use classification system – grassland

National Inventory of Carbon Stocks (ISCI)

The National Inventory of the Carbon Stocks is a sampling of carbon stocks related to the different land-use categories.
The National Inventory of the Carbon Stocks includes:

- carbon stock changes in the land-use category forest land, the dataset is derived by the IFN data;
- carbon stock changes in the subcategories of the conversion to or from forest land to other predominant uses, the land in conversion to and from *forest land* to other uses require data integration with studies and additional surveys in order to estimate, at regional level, the C stock levels related to non-forest land uses(i.e. *settlements*, *cropland*, *grassland*, *wetlands*).

Time:
ISCI will annually provide time series of carbon stock levels and carbon stock changes for the category *forest land* and for the sub-categories land in conversion to and from *forest land* to other uses. For the Kyoto Protocol first Commitment Period accounting, the time series needed is related to the period 31/12/2007 - 1/1/2013.

Space:
Concerning the category *forest land* and any other category in conversion to and from *forest land,* the NFIs will assure the spatial coverage, providing carbon stocks data, at NUT2 level.

Quality assurance:
Data supplied by ISCI will be collected in the so-called "*National Registry for the forest carbon sinks*" of Kyoto Protocol, and have to fulfil quality requirements as stated by the IPCC and UNFCCC guidelines.

National Census of Forest Fires (CIFI)

The National Census of Forest Fires is a system aimed to detect, locate and classify *forest land* areas affected by fires; it will provide data on:
- forest areas affected by fires;
- forest typology and stand features;
- proxy parameters in order to estimate the initial C stock and losses by fire (e.g. vegetation height, altitude, slope, exposure).

Time:
CIFI will annually provide, from 01/01/2008, time series of forest areas affected by fires. For the Kyoto Protocol first Commitment Period accounting, the time series needed is related to the period 01/01/2008 - 31/12/2012 (because of the strong variability of the forest fires occurrence no interpolation of data is allowed).

Space:
CIFI will cover all the national territory and will provide geographically referenced data on burned *forest land remaining forest land* areas (art. 3.4) and on *land converted to forest land* burned areas (art. 3.3).

Key elements:
The key elements are:
- ground surveys that have to detect fires and record boundaries of burned areas. Additional data will concern collection of attributes as damage evaluation (percentage of oxidised biomass), forest typology (following NFI classification);
- remote sensed data will integrate data from ground surveys, in order to cross-check detected burned areas, at 0.5 ha spatial definition;
- digital terrain model;
- forest-non forest Boolean mask.

Quality assurance:
Data supplied by CIFI will be collected in the so-called "*National Registry for the forest carbon sinks*" of Kyoto Protocol, and have to fulfil quality requirements as stated by the IPCC and UNFCCC guidelines.

National Inventory of non-CO_2 emissions from forest fires (IEIF)

The Forest fires GHG emissions National Inventory is aimed at estimating non-CO_2 emissions from forest fires (CO_2 emissions are not taken into account, being already computed by National Inventory Carbon Stocks as decreases in carbon stocks). It will provide:

- emission figures of the land-use category *forest land*;
- emission figures of the land-use categories in conversion to or from *forest land* to other predominant uses.

Time:
The Forest fires GHG emissions National Inventory will annually provide time series of non-CO_2 emissions from forest fires. For the Kyoto Protocol first Commitment Period (CP) accounting, the needed time series is related to the period 01/01/2008 - 31/12/2012.

Space: IEIF will supply estimates of emissions released by fires detected by National Census of Forest Fires.

Key elements:
For any fire, once identified the prevalent forest typology and the damage of the stand (i.e. percentage of burned biomass) affected by fire, through the National Forest Service surveys, related carbon stocks are estimated by National Inventory Carbon Stocks. Emissions are calculated applying the damage coefficients and the emissions factors referenced or elaborated by research projects to the estimated carbon stocks.

Quality assurance:
Data supplied by IEIF will be collected in the so-called "*National Registry for the forest carbon sinks*" of Kyoto Protocol, and have to fulfil quality requirements as stated by the IPCC and UNFCCC guidelines.

ANNEX 11: THE NATIONAL REGISTRY

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 2009 are reported in the SEF submission; figures are included in tables A8.2.2.1 - A8.2.2.5c.

A11.1 Description of national registry

Since 2006 Italy has been operating a national registry under Article 19 of Directive 2003/87/CE establishing the European Emission Trading Scheme (EU ETS) and according to Regulation No. 2216/2004 of the European Commission. Italy has had such registry system tested successfully with the EU Commission on February the 6th 2006; the connection between the registry's production environment and the Community Independent Transaction Log (CITL) has been established on March the 13th 2006 and the Registry has since gone live, starting on 28 March 2006.
This registry is an electronic database for the administration of emissions allowances allocated to operators participating to the EU ETS and it's been developed according to the UN Data Exchange Standards document. As a consequence, the registry established under Directive 2003/87/CE can also be used as registry for the administration of Kyoto Protocol units. In fact, the Italian registry for the EU ETS has undergone an initialization process and a go-live phase with the UNFCCC in order to become part of the Kyoto system of registries. In particular, Italy successfully performed and passed

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

and submitted all required information through a complete Readiness questionnaire.
As a result, the Italian registry has fulfilled all of its obligations regarding conformity with the UN Data Exchange Standards. These obligations include having adequate transaction procedures; adequate security measures to prevent and resolve unauthorized manipulations; and adequate measures for data storage and registry recovery. The registry has been therefore deemed fully compliant with the registry requirements defined in decisions 13/CMP.1 and 5/CMP.1.
After successful completion of the go-live process on 16th October 2008, the Italian registry commenced live operations with the International Transaction Log (ITL) and it's been operational ever since, ensuring the precise tracking of holdings, issuances, transfers, cancellations and retirements of allowances and Kyoto units.

A11.2 Registry Administrator

The Italian Government modified the previous Legislative Decree 216/2006 which enforced 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. The reference person is Mr Riccardo Liburdi.
The Decree 51/2008 also establishes that the economic resources for the technical and administrative support of the Registry will be supplied to ISPRA by operators paying a fee for the use of the Registry. The amount of such a fee will be regulated by a future Decree.
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 maintain the Italian National Registry and, additionally, relays on the structure of the Institute 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

At present, Italy is also operating its registry under Article 19 of European Directive 2003/87/CE establishing the EU Emission Trading Scheme and according to Regulation No. 2216/2004 of the European Commission.
The Italian Registry is currently linked to the national registries of the 27 Member States of the European Union plus Iceland, Liechtenstein and Norway and to the European Commission CITL (Community Independent Transaction Log) by way of the UNFCCC ITL (International Transaction Log), in a consolidated system forming the European Emissions trading scheme (EU ETS).

A11.4 Database structure and capacity of the national registry

The Italian registry is based on the GRETA registry software developed by the provider Greta International Ltd (GIL) and used by many other Member States. The development of the Greta software adheres to the standards specified in Draft #7 of the UN DES document. The application has been developed using a 3-tier architecture model and is implemented in ".net" using a Microsoft SQL Server 2000 Enterprise Edition relational database management system with a dedicated data model for supporting registry operations. The SQL license adopted has no access limitations of simultaneous transactions. The application is hosted on a standard Microsoft environment running IIE server.
The actual production environment consists in: 1 Firewall server + 1 webserver + 2 DB servers 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, cancelling and retiring ERUs, CERs, AAUs, and/or RMUs will be transmitted from the national registry to the ITL in the format of the messages specified in the UN DES #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 Institute 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 publicly available on the registry web-site information on accounts, legal entities, Art. 6 projects, holdings and transactions. The following reports are accessible from the homepage of the registry:

a. User details – unchanged, updated, created
b. Account details – unchanged, updated, created
c. Operator holding account – unchanged, updated, created

The internet address of the interface to the Italian registry is: http://www.greta-public.sinanet.apat.it/.

A11.9 Integrity of data storage and recovery

In addition to disaster recovery in real time, 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 ISPRA 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).
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, and 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.

ANNEX 12: OVERVIEW OF THE LAST UNFCCC REVIEW PROCESS

In the following table, responses to the main questions raised during the last UNFCCC review process, related to the national inventory submitted in 2009, are described.

Review report para	Subject	Description	Response
9	General – Overview- Completeness	The ERT encourages Italy to explore the possibility of reporting CRF table 7 for all years of the time series.	Planned for the next submissions
10	General – Overview - Completeness	The ERT recommends that Italy improve the completeness of its inventory by the next annual submission, especially with regard to reporting on those categories in which emissions are known to occur in the country and for which methodologies to estimate emissions are available in the Revised 1996 IPCC Guidelines and/or the IPCC good practice guidance. The ERT also recommends that the Party, when reporting data on emissions for the first time for a given category, ensure that these data are provided for the entire inventory time series, and that the rationale for the choice of methods, emission factors (EFs) and other parameters is clearly explained in the NIR.	GHG emissions from Biomass fuel consumption in pulp and paper industry have been estimated; N_2O emissions from use of explosives have been estimated and reported under the category 3 D other uses of N_2O. The relevant information about methodologies used has been included and reported in the NIR.
11	General - Main findings - Transparency	However, the ERT found that Italy could improve the transparency of its inventory submission, by providing information in the NIR to explain and justify its use of EFs (e.g. for ferroalloys) and other parameters (e.g. oxidation factors for liquid fuels used in the energy sector (see para. 56 below)) from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (hereinafter referred to as the 2006 IPCC Guidelines). The ERT also found statements in the NIR clarifying that the Party had used data obtained from the European Union emissions trading scheme (EU ETS) to estimate emissions from a number of categories in the industrial processes sector and to improve EFs and verify activity data (AD) in the energy sector; however, the ERT concluded that the Party has not provided sufficient information in its	Additional information has been reported in the NIR with the aim to clarify the issues.

		NIR, particularly for the energy sector, to allow the ERT to verify: (a) Whether these data have been prepared and incorporated into the inventory submission in line with the IPCC good practice guidance; (b) Whether these data have been subjected to quality assessment (QA) and/or verification and how this relates to corresponding QA and/or verification procedures set out in the IPCC good practice guidance; (c) How time-series consistency has been ensured when using these data in the inventory, and the effect of the use of these data on the trend in emissions.	
16	General - Main findings – National System	The national system continues to perform its required functions as set out in the annex to decision 19/CMP.1. However, the ERT identified a potential problem that will need to be addressed by the Party in the preparation for its 2010 annual submission. This potential problem relates to the cut in the funding of the national system and the effect of this cut on the capacity of the Party's national registry for forest carbon sinks to identify areas of land and land-use change in accordance with paragraph 20 of the annex to decision 16/CMP.1, and to provide information, including estimates of emissions/removals, on activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol (see paras. 82, 83 and 84 below).	At the end of 2009 and in the beginning of 2010 fundings have been made available from the Ministry of Environment to start with some of the activities planned in the national registry for forest carbon sinks to improve the knowledge and the estimate of emissions and removals. A protocol between the Ministry of Environment and the Ministry of Agriculture is under approval and it will permit to start with the new 2012 forest inventory.
18	General - Main findings - Comparability	The ERT encourages Italy to explore the possibility of structuring its reporting, in its next annual submission, following the annotated outline of the NIR, and the guidance contained therein, that can be found on the UNFCCC website	The NIR has been modified in the way so as to follow the suggested structure.
25	General - Inventory planning – National System	The ERT strongly recommends that Italy ensure, by whatever available means, that its national system has the capacity and required resources to plan, prepare and manage an inventory for LULUCF activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol (hereinafter referred to as the KP-LULUCF inventory), noting that this reporting is mandatory under Article 7, paragraph 1,	See comment above on paragraph 16.

		of the Kyoto Protocol, commencing with the annual submission due on 15 April 2010.	
27	General - Inventory preparation – Key categories - Transparency	Detailed information on how the Party uses its key category analysis to prioritize improvements to its inventory submission has not been provided in the NIR. The ERT reiterates the recommendation of the previous ERT that Italy include this information in its NIR.	The key categories analysis with the TIER2, using uncertainties, is already used to prioritize and plan the inventory improvements. Additional information has been included in the NIR to clarify the issue.
29	General - Inventory preparation - Accuracy	The ERT encourages Italy to explore the possibility of increasing the coverage of categories of its tier 2 uncertainty analyses and to report thereon in its next annual submission.	Activities have been planned for the 2009 but postponed to 2010 for lack of time.
30	General - Inventory preparation - Transparency	The Party uses the uncertainty analysis to prioritize improvements to its inventory, especially with regard to those categories for which high uncertainties in AD, EFs or other parameters are observed (e.g. categories in the agriculture and LULUCF sectors and for fluorinated gases). However, the ERT recommends that Italy include a more detailed description of its use of the uncertainty analysis as a driver for prioritizing inventory improvements, in the relevant chapter of its NIR.	See the comment above on paragraph 27.
35	General - Inventory preparation - QA/QC	The ERT recommends that Italy explore the possibility of extending its use of EU ETS data for verification purposes to the energy sector.	EU- ETS data are already used for verification purposes also in the energy sector. Additional information has been added in the NIR to better clarify the use of these data.
36	General - Inventory preparation - Transparency	However, the ERT also identified areas for further improvement with regard to the transparency of the inventory, including the improvement of the presentation of some information tables in the NIR that are currently very condensed and difficult to read (e.g. table 1.7 Sources and sinks not estimated in the 2007 inventory, table 1.8 Sources and sinks reported elsewhere in the 2007 inventory, table 9.1 Explanations of the main recalculations in the 2009 submission, table 9.2 Comparison between the 2008 and 2009 submitted time series by gas and sector, and table A1.3 Results of the uncertainty analysis	The tables have been changed to improve the transparency of the NIR

		excluding LULUCF (tier 1)). The ERT recommends that Italy explore the possibility of improving its presentation of data and information in these tables for its next annual submission.	
38	General - Follow-up – QA/QC	However, the ERT also found that a number of the source/sink-related recommendations made in the previous review report had not been addressed by the Party in its 2009 annual submission, and these are discussed in the relevant sector chapters of this report (see paras. 53 –QC energy- and 86 – uncertainty lulucf).	Quality control in the energy sector has been improved introducing further checks of the information reported in the NIR. The uncertainty of LULUCF estimates will not change in a relevant way until the work planned in the sector finishes
40	General - Further improvements – By the ERT	The ERT identifies the following cross-cutting issues for improvement: (a) The improvement of the completeness of the inventory, specifically with regard to the reporting on all activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, for all carbon pools and GHGs (see paras. 82, 83 and 84 below); (b) The provision of information in the NIR on the use of EU ETS data, as outlined in paragraph 11 above; (c) The improvement of transparency, as detailed in paragraph 36 above; (d) The improved documentation of the uncertainty analysis, at least by improving the readability of the underlying information (see para. 36 above).	See comments above
43	Energy – Sector overview - Transparency	With respect to the UNFCCC reporting guidelines, the ERT identified areas for improvement, including that Italy enhance the discussion in the NIR on emission trends in the energy sector by referring to underlying or associated AD (e.g. in discussing the trends in the emissions from road transportation, vehicle numbers, changes in population, gross domestic product and heating or cooling days could be referred to). This additional information would help to validate the data on fuel consumption and aid understanding of the underlying emission trends that contribute to the overall emission trend in the energy sector.	Additional explanations of the trends in the sector have been reported in the NIR
46	Energy - Sector	The ERT recommends that Italy	The energy chapter has been

	overview - Transparency	document more explicitly category-specific QA/QC procedures for non-mobile energy categories, consistent with the UNFCCC reporting guidelines.	updated including a more detailed explanation of methodologies, the use of EU ETS data, QA/QC activities, recalculations and improvements planned especially for non-mobile energy sources
47	Energy - Sector overview - Transparency	In response to questions raised by the ERT during the review, the Party explained that EU ETS data are used to improve EFs and verify AD for the energy sector. The ERT recommends that this information be included in the Party's next annual submission, along with the information referred to in paragraph 11 (b) above.	See comment above on paragraph 46
48	Energy - Sector overview - Transparency	The ERT encourages the Party to include in its NIR planned improvements specific to all categories in the energy sector, including non-mobile categories. If there are no planned improvements then this should also be stated.	See comment above on paragraph 46
52	Energy – Feedstocks and non-energy use of fuel - Comparability	The ERT noted from CRF table 1.A(d) that a percentage value (100 per cent) had been reported by the Party for the fraction of carbon stored, whereas this should be a fraction value (1.0). Also, the carbon EF should be expressed in t C/TJ, whereas Italy has reported its values in kt C/TJ. In addition, the ERT concluded that the fraction of carbon stored reported by Italy for naphta was high when compared to other Parties. The ERT recommends that the Party, in its next annual submission, provide an explanation as to why this value is higher than the values of most other reporting Parties and describe how the fraction of carbon stored is estimated.	Percentage values have been changed, from 100 to 1. More detailed information has been included in the NIR to better explain the methodology to estimate the carbon stored in petrochemical sector including the calculation of carbon stored for naphta
53	Energy - Stationary combustion: solid fuels – CO_2 – Accuracy/Transparency/QC	The ERT recommends that Italy implement its planned improvements to the statistical data on coal and its estimation of the moisture content of the coal. The ERT also recommends that Italy explore the possibility of improving the transparency of the underlying data for this category by reporting its coal imports by source. In addition, the ERT reiterates the recommendation made in the previous review report that Italy implements improved QC procedures in order to reduce transcription errors in the	The NIR has been updated to take into account these remarks

		data for this category.	
55 and 57	Energy – Navigation and civil aviation: liquid fuels – CO_2 - Transparency	The ERT recommends that Italy improve the transparency of its recalculations for this categories (navigation and aviation) by providing, in future submissions, information on the impact of each recalculation (i.e. separate the effects of the recalculations on each mode of transport) for all GHGs, and information on how time-series consistency is ensured.	The NIR has been updated to take into account these remarks
56	Energy - Civil aviation: liquid fuels – CO_2 - Transparency	The ERT recommends that the Party, in its next annual submission, clearly document its justification for using an oxidation factor from the 2006 IPCC Guidelines, and also provide an explanation of the difference between the oxidation factors used in the sectoral and reference approaches. The ERT also recommends that Italy explore the possibility of implementing category-specific QA/QC procedures that could identify such discrepancies in the future.	The NIR has been updated to take into account these remarks
62	Industrial processes - Cement production – CO_2 - Transparency	The ERT noted that Italy had reported how data from industry were verified, but that the Party had not provided information in the NIR on the outcome of this verification. The ERT recommends that Italy provide improved information on the verification of these data in its next annual submission.	Additional information has been provided in the NIR.
63	Industrial processes - Adipic acid production – N_2O - Transparency	Italy has improved the transparency of the information in its NIR on the method and data used to estimate N_2O emissions from adipic acid production, particularly with regard to the use (operating time) of the abatement technology. The ERT recommends that Italy further improve transparency by including more information in its NIR on the efficiency of this abatement technology and an explanation of how this information is used, along with information on the use of the abatement technology and the default N_2O generation factor used to derive the EF for this category. The ERT noted that Italy provided much of this information during the review in response to questions of the ERT; however, the ERT calculated the post-control emission	Additional information has been provided in the NIR.

		rates using this information and it was found to be inconsistent with the value reported by Italy. This issue remains unresolved.	
64	Industrial processes - Aluminium production – PFCs - Transparency	For this category, emissions were estimated using a variant of the tier 1 methodology for 1990-1999 and a tier 2 methodology for 2000-2006. … … The ERT found that Italy did not provide in the NIR rationale for the use of two different approaches; however, in response to questions raised by the ERT during the review, Italy referred the ERT to a finding contained in document FCCC/ARR/2006/ITA which stated that a recalculation was not possible due to plant closures and upgrading of technology. The ERT recommends that Italy explore whether historical operating data (anode effect minutes and/or overvoltages) are available to extend the use of the tier 2 methodology to estimate emissions for the whole time series for smelters that remain in operation (these data were tracked by most smelters during the 1990s). If this is not feasible, the ERT recommends that Italy enhance the transparency of its inventory by adding more discussion as to why the current approach to estimating these emissions is conservative, including a comparison between the IPCC default EFs and the EFs used by Italy for 1990. … … The ERT further recommends that Italy explain in more detail in the NIR how the reporting company (Alcoa) estimated its PFC emissions (i.e. using technology-specific IPCC slope factors and facility-specific anode effect minutes) and why these emission estimates were higher for 2003 than for other recent years (i.e. because Alcoa used conservative assumptions to estimate the emissions for a three-month period for which no data were available).	Additional information has been provided in the NIR.
65	Industrial processes - Substitutes of ozone depleting substances –	The ERT recommends that Italy revise table 2(II).F to provide a more detailed breakdown of the AD and EFs for this category, and that the Party clarify that emissions from equipment disposal are	Activities have been planned for the next years. Notes under Table 2(II).F have been revised according to the remark.

	HFCs - Transparency	included with the emissions during the products' life.	
66	Industrial processes - Electrical equipment – SF_6 - Transparency	The method used to estimate recent emissions from electrical power systems has been indicated to be a tier 3c method (country-level mass-balance) in the Party's NIR; however, in response to questions raised by the ERT, Italy clarified that the tier 3c method was used only for medium voltage electrical equipment. Annual recharges were used to estimate emissions from electrical power systems. The ERT encourages Italy to clarify this in its NIR, including information on which IPCC method the Party's method corresponds to.	Additional information has been provided in the NIR.
67	Industrial processes - Production of hydrochlorofluo rocarbon-22 - HFC-23 - Transparency	Italy has reported zero emissions of HFC-23 from production of hydrochlorofluorocarbon-22 for the period 1996-2007, stating that untreated streams are collected and sent to a thermal afterburner. Because abatement devices are likely to experience downtime during which HFC-23 is emitted unabated, the ERT asked the Party, during the review, whether the Italian production plant had measures in place to prevent this (e.g. equipment to recapture the gas). In response to this question, Italy reiterated the plant's confirmation that the thermal oxidizer was fully operational, but the Party did not provide any additional information. The ERT urges Italy, in its next NIR, to include information on how the plant avoids emitting HFC-23 during the oxidizer's downtime.	Additional information has been provided in the NIR.
70	Agriculture – Sectoral overview	The ERT noted that Italy intends to update and improve AD by means of the collaborative actions of national and regional entities. The ERT encourages Italy to continue its efforts in this regard and to report thereon, including any recalculations, in its next annual submission.	Every year the time series of activity data is verified directly with the network of referents of agricultural statistics. For the 2010 submission some verification was also carried out with category associations from the agricultural sector for specific cultivations.
76	Agriculture - Agricultural soils N_2O – Sewage sludge -	The ERT recommends that Italy validate the AD from the aforementioned study and report thereon in its next annual submission. In addition, the Party should	Information regarding sewage sludge is not reliable enough for estimations at this detail level. N_2O emissions from sludge are

	Completeness	include the use of sewage sludge in its reporting on the agriculture sector in its next NIR.	anyway estimated in the waste sector.
86	Land use, land-use change and forestry - Forest land remaining forest land - CO_2 - Accuracy	The ERT noted that the uncertainty of the five forest carbon pools was estimated to be 84.9 per cent. The present ERT reiterates the identification of the previous ERT that this uncertainty estimate has changed little since 1990, and recommends that Italy prioritize, within this sector, the improvement of the uncertainty analysis for the forest carbon pools	The uncertainty of LULUCF estimates will not change in a relevant way until the work planned in the sector finishes. Because emission update will regard the whole time series, it is not expected that different uncertainties result for the last years of the time series with respect to 1990.
87	Land use, land-use change and forestry - Forest land remaining forest land - CO_2 - Transparency	Given the importance of forestry in Italy's LULUCF sector, and the role of the modelling system in estimating the annual pool-based carbon stock changes, the ER recommends that the Party provide in its next annual submission a transparent validation of this system's ability to estimate these annual carbon stock changes.	A detailed and transparent description of the modelling system will be provided in the NIR.
88	Land use, land-use change and forestry - Land converted to forest land - CO_2 - Transparency	The Party has described in general terms in its NIR how the carbon stock changes in living biomass in young forests were estimated. The ERT recommends that the Party provide in its next annual submission a more transparent description of this estimation.	A detailed and transparent description of the estimation of carbon stock changes will be provided in the NIR.
89	Land use, land-use change and forestry - Land converted to grassland - CO_2 - Consistency	A perturbation to the trend in the time series for CO2 emissions/removals from cropland converted to grassland occurred in 2003. In response to a question raised by the ERT on this matter, the Party stated that it was investigating how to smooth out this perturbation in order to harmonize the whole time series without compromising the integrity of the annual land-use matrices. The ERT recommends that the time series be harmonized for the Party's next annual submission.	In response to the ERT remark, land use changes have been derived, by the way of LU matrices, smoothing the amount of changes over a 5 year period, harmonizing the whole time series.
90	Land use, land-use change and forestry - Land converted to settlements - CO_2 - Consistency	The present ERT noted that the previous ERT had welcomed the Party's efforts to improve its land-use tracking system so that it could be more definitive about which land types were converted to settlements on an annual basis. The ERT recommends that Italy further develop its capacity to identify land-use conversions to settlements and report thereon in its	Concerning land-use conversions to settlements, data from CORINE LAND COVER 2006 (artificial surfaces) have been used to derive the increment of settlement's surface. More accurate and resolute data will outcome from the activities, in progress, related to the Kyoto

		next annual submission.	reporting system (National registry for carbon sinks).
92	Waste – Sector overview - Transparency	…The ERT welcomes the above-mentioned planned improvements and recommends that Italy incorporate these revised data into its inventory for the waste sector, and report thereon, in its next annual submission. This reporting should include the transparent documentation of the new data, and a description of the impact of subsequent recalculations on the emission trend and on time-series consistency.	A single database was constructed from the 30 local databases containing information about landfilled waste. The large amount of data requires further analysis with the experts on waste management in order to provide valid results. Subsequently, additional information will be provided in the NIR.
93	Waste - Sector overview – Consistency	…some key parameters, such as the fraction of anaerobically treated industrial wastewater (15 per cent) and domestic and commercial wastewater (5 per cent), and the fraction of domestic and commercial wastewater treated in Imhoff tanks (2.4 per cent), were assumed to be constant between 1990 and 2007. The ERT encourages Italy to consider updating these key parameters.	Italy will consider this suggestion.
95	Waste - Solid waste disposal on land – CH_4 - Transparency	…In response to a question raised by the ERT, Italy explained that the amount of CH_4 recovered was estimated from the amount of energy produced, the energy efficiency of the CH_4 recovered, the capitation efficiency, and the efficiency in recovering CH_4 for energy use. The ERT recommends that Italy include this information in its next annual submission.	Additional information has been provided in the NIR.
96	Waste - Solid waste disposal on land – CH_4 - Transparency	Oxidation factors for managed and unmanaged landfill sites have not been reported in the Party's NIR. The ERT recommends that Italy explain its use of oxidation factors in its next NIR.	Additional information has been provided in the NIR.
97	Waste - Wastewater handling – CH_4 and N_2O - Transparency	No information has been provided by the Party in its NIR on the estimation of CH_4 emissions from domestic and commercial wastewater treatment, N_2O emissions from industrial wastewater treatment and CH_4 recovery from domestic and commercial sludge treatment. However, this information was provided by the Party in response to questions of the ERT during the course of the review. The ERT recommends that Italy improve the transparency of its reporting by providing this information in its next annual	Additional information has been provided in the NIR.

		submission.	
98	Waste - Waste incineration – CO_2, CH_4 and N_2O - Transparency	Italy has reported emissions from waste incineration with energy recovery under the energy sector. However, the amount or fraction of incinerated industrial waste with and without energy recovery and the corresponding sources of information have not been reported by the Party. The ERT recommends that Italy provide information on the amount of incinerated industrial waste both with and without energy recovery, and provide sufficient relevant documentation, including references, in its next annual submission.	Additional information has been provided in the NIR.