ISPRA
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RAPPORTI

Italian Greenhouse Gas Inventory 1990 - 2010

National Inventory Report 2012

162 / 2012

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Rapporti 162/2012

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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 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 1990-2010. National Inventory Report 2012" descrive la comunicazione annuale italiana dell'inventario delle emissioni dei gas serra dal 1990 al 2010.

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

Nuove politiche e interventi a livello nazionale ed internazionale saranno, infatti, indispensabili per garantire nel futuro il rispetto degli obiettivi del Protocollo di Kyoto, dal momento che, come emerge dal rapporto, le emissioni totali dei gas serra (espressi in termini di CO_2 equivalente) sono diminuite, dal 1990 al 2010, del 3.5% 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 2012, including the update for the year 2010 and the revision of the entire time series 1990-2009.
The assigned amount for Italy, pursuant to Article 3, paragraphs 7 and 8 and calculated in accordance with the annex to decision 13/CMP.1, has been established together with the commitment period reserve (CPR), required in accordance with paragraph 18 of decision 15 CMP.1, during the last in country review in 2007. The calculated figures are reported in the document FCCC/IRR/2007/ITA and amount to 2,416,277,898 tonnes CO_2 eq. for the assigned amount and 2,174,650,108 tonnes of CO_2 eq. for the CPR. The CPR is calculated on the basis of the assigned amount and it has not changed from the previous submission.
Emission estimates comprise the six direct greenhouse gases under the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride) which contribute directly to climate change owing to their positive radiative forcing effect and four indirect greenhouse gases (nitrogen oxides, carbon monoxide, non-methane volatile organic compounds, sulphur dioxide).

This report, the CRF files and other related documents are available on website at the address http://www.sinanet.apat.it/it/sinanet/serie_storiche_emissioni.

The official inventory submissions can also be found at the UNFCCC website http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php.

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

Total greenhouse gas emissions, in CO_2 equivalent, excluding emissions and removals of CO_2 from land use, land use change and forestry, decreased by 3.5% between 1990 and 2010 (from 519 to 501 millions of CO_2 equivalent tons), whereas the national Kyoto target is a reduction of 6.5% as compared to the base year levels by the period 2008-2012.

The most important greenhouse gas, CO_2, which accounted for 85% of total emissions in CO_2 equivalent in 2010, showed a decrease by 2.1% between 1990 and 2010. In the energy sector, specifically, CO_2 emissions in 2010 reduced of 0.1% as compared those in 1990.

CH_4 and N_2O emissions were equal to 7.5% and 5.4%, respectively, of the total CO_2 equivalent greenhouse gas emissions in 2010. Both gases showed a decrease from 1990 to 2010, equal to 14.1% and 27.2% for CH_4 and N_2O, respectively.

Other greenhouse gases, HFCs, PFCs and SF_6, ranged from 0.1% to 1.7% of total emissions.

Table ES.1 illustrates the national trend of greenhouse gases for 1990-2010, expressed in CO_2 equivalent terms, by substance and category.

Table ES.1. Total greenhouse gas emissions and removals in CO2 equivalent (Gg CO2 eq)

GHG emissions	1990 base year	1995	2000	2005	2006	2007	2008	2009	2010
	CO_2 equivalent (Gg)								
CO_2 including net CO_2 from LULUCF	400,254	396,931	419,281	434,508	428,577	439,738	411,723	359,413	369,428
CO_2 excluding net CO_2 from LULUCF	435,012	445,151	462,485	488,163	483,614	475,486	463,962	415,434	426,087
CH_4 including CH_4 from LULUCF	43,878	44,330	45,905	41,303	39,769	39,779	38,485	38,327	37,597
CH_4 excluding CH_4 from LULUCF	43,695	44,290	45,799	41,255	39,731	39,533	38,428	38,259	37,554
N_2O including N_2O from LULUCF	37,459	40,025	39,621	37,782	32,444	31,828	29,764	28,218	27,302
N_2O excluding N_2O from LULUCF	37,368	39,933	39,589	37,751	32,418	31,808	29,750	28,211	27,217
HFCs	351	671	1,986	5,401	6,106	6,855	7,513	8,164	8,755
PFCs	2,487	1,266	1,217	1,715	1,714	1,652	1,501	1,063	1,331
SF_6	333	601	493	465	406	428	436	398	373
Total (including LULUCF)	**484,761**	**483,824**	**508,504**	**521,174**	**509,016**	**520,280**	**489,421**	**435,583**	**444,787**
Total (excluding LULUCF)	**519,246**	**531,913**	**551,570**	**574,749**	**563,989**	**555,761**	**541,589.39**	**491,528**	**501,318**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990 base year	1995	2000	2005	2006	2007	2008	2009	2010
	CO_2 equivalent (Gg)								
1. Energy	417,833	432,460	449,669	471,868	466,811	458,285	449,326	405,511	415,727
2. Industrial Processes	38,390	35,929	36,249	42,592	38,143	38,575	35,642	30,871	31,963
3. Solvent and Other Product Use	2,455	2,235	2,302	2,128	2,122	2,066	1,946	1,815	1,658
4. Agriculture	40,737	40,530	40,134	37,362	36,766	37,379	36,014	34,775	33,741
5. Land Use, Land-Use Change and Forestry	-34,484	-48,089	-43,066	-53,575	-54,973	-35,481	-52,168	-55,946	-56,531
6. Waste	19,831	20,760	23,215	20,800	20,146	19,457	18,661	18,557	18,229
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA

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

The energy sector is the largest contributor to national total GHG emissions with a share, in 2010, of 82.9%. Emissions from this sector decreased by about 0.5% from 1990 to 2010. Substances with decrease rates were CO_2, whose levels reduced by 0.1% from 1990 to 2010 and accounts for 97.2% of the total in the energy sector, and CH_4 which showed a reduction of 26.4% but its share out of the sectoral total is only 1.6%; N_2O, on the other hand, showed an increase of 9.6% from 1990 to 2010 but it is not relevant on total emissions, accounting for 1.2%. Specifically, in terms of total CO_2 equivalent, an increase in emissions was observed in the transport sector, and in the other sectors, about 15.3% and 20.2%, from 1990 to 2010, respectively; in 2010 these sectors, altogether, account for 51.2% of total emissions.

For the industrial processes sector, emissions showed a decrease of 16.7% from the base year to 2010. Specifically, by substance, CO_2 emissions account for 65.1% and showed a decrease by about 26.8%, CH_4 decreased by 51.5%, but it accounts only for 0.2%, while N_2O, whose levels share 2.0% of total industrial emissions, decreased by 90.3%. 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 229.9%), whose level on total sectoral emissions is 32.7%. It should be noted that, except for the motivations explained, the economic recession has had a remarkable influence, in the last two years, on the production levels of most the industries and consequent emissions.

Emissions from the solvent and other product use sector, which refer to CO_2 and N_2O emissions except for pollutants other than greenhouse gases, decreased by 32.5% from 1990 to 2010. The reduction is mainly to be attributed to a decrease by 37.2% in CO_2 emissions, which account for 62.2% of the sector. As regards CO_2, emission levels from paint application sector, which accounts for 45.4% of total CO_2 emissions from this sector, decreased by 44.5%; 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 48.4% of the total, show a decrease of 19.6%. Finally, CO_2 emissions from metal degreasing and dry cleaning activities, decreased by 64.2% but they account for only 6.1% of the total.
The level of N_2O emissions shows a decrease of 22.9%, accounting for 37.8% of total emissions in the sector in 2010.

For agriculture, emissions refer to CH_4 and N_2O levels, which account for 44.1% and 55.9% of the sectoral total, respectively. The decrease observed in the total emissions (-17.2%) was mostly due to the decrease of CH_4 emissions from enteric fermentation (-12.6%), which account for 31.8% of sectoral emissions and to the decrease of N_2O from agricultural soils (-22.2%), which accounts for 44.9% of sectoral emissions.

As regards land use, land-use change and forestry, from 1990 to 2010 total removals in CO_2 equivalent increase by 64.2%; CO_2 accounts for almost the total emissions and removals of the sector.

Finally, emissions from the waste sector decreased by 8.1% from 1990 to 2010, mainly due to a decrease in the emissions from solid waste disposal on land (-15.5%), which account for 70.7% of waste emissions. The most important greenhouse gas in this sector is CH_4 which accounts for 87.3% of the sectoral emissions and shows a decrease of 8.6% from 1990 to 2010. N_2O emission levels increased by 8.8%, whereas CO_2 decreased by 54.6%; these gases account for 11.5% and 1.3%, respectively.

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

Table ES.2. Summary of emission trends by source category and gas in CO2 equivalent (Gg CO2 eq.)

Category	**1990 base year**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
	CO_2 equivalent (Gg)								
1A. Energy: fuel combustion	**407,057**	**422,389**	**440,645**	**464,027**	**459,448**	**451,077**	**441,975**	**398,381**	**408,300**
CO_2: 1. Energy Industries	136,503	139,841	151,894	159,756	161,069	160,870	156,217	131,153	132,634

Category	1990 base year	1995	2000	2005	2006	2007	2008	2009	2010
	CO_2 equivalent (Gg)								
CO_2: 2. Manufacturing Industries and Construction	85,631	85,244	82,452	78,705	77,480	74,199	70,866	54,650	60,016
CO_2: 3. Transport	101,269	111,445	120,101	125,825	127,145	127,209	122,273	117,897	117,384
CO_2: 4. Other Sectors	76,634	76,047	78,596	91,847	85,986	80,962	85,119	87,292	91,038
CO_2: 5. Other	1,046	1,440	806	1,198	982	896	738	844	627
CH_4	1,433	1,580	1,408	1,394	1,418	1,558	1,565	1,566	1,623
N_2O	4,541	6,791	5,388	5,304	5,369	5,383	5,198	4,978	4,979
1B2. Energy: fugitives from oil & gas	**10,776**	**10,072**	**9,024**	**7,841**	**7,363**	**7,208**	**7,351**	**7,130**	**7,426**
CO_2	3,344	3,178	2,588	2,117	2,194	2,181	2,264	2,170	2,322
CH_4	7,420	6,882	6,424	5,710	5,156	5,013	5,073	4,948	5,092
N_2O	12	12	13	14	14	14	13	12	12
2. Industrial processes	**38,390**	**35,929**	**36,249**	**42,592**	**38,143**	**38,575**	**35,642**	**30,871**	**31,963**
CO_2	28,434	26,038	24,571	27,186	27,205	27,684	25,066	20,078	20,804
CH_4	108	113	63	64	66	65	61	38	53
N_2O	6,676	7,239	7,918	7,760	2,647	1,891	1,066	1,130	647
HFCs	351	671	1,986	5,401	6,106	6,855	7,513	8,164	8,755
PFCs	2,487	1,266	1,217	1,715	1,714	1,652	1,501	1,063	1,331
SF_6	333	601	493	465	406	428	436	398	373
3. Solvent and other product use	**2,455**	**2,235**	**2,302**	**2,128**	**2,122**	**2,066**	**1,946**	**1,815**	**1,658**
CO_2	1,643	1,463	1,276	1,304	1,314	1,278	1,219	1,131	1,032
N_2O	812	772	1,027	823	808	788	727	684	626
4. Agriculture	**40,737**	**40,530**	**40,134**	**37,362**	**36,766**	**37,379**	**36,014**	**34,775**	**33,741**
CH_4: Enteric fermentation	12,278	12,348	12,246	10,914	10,699	11,099	10,996	11,007	10,732
CH_4: Manure management	3,462	3,286	3,278	3,149	3,028	3,054	2,961	2,873	2,567
CH_4: Rice Cultivation	1,576	1,671	1,391	1,472	1,475	1,516	1,386	1,565	1,565
CH_4: Field Burning of Agricultural Residues	13	13	12	13	13	13	14	13	12
N_2O: Manure management	3,921	3,782	3,862	3,709	3,601	3,779	3,775	3,812	3,701

Category	1990 base year	1995	2000	2005	2006	2007	2008	2009	2010
	CO_2 equivalent (Gg)								
N_2O: Agriculture soils	19,482	19,426	19,341	18,101	17,947	17,914	16,879	15,502	15,159
N_2O: Field Burning of Agricultural Residues	4	4	4	4	4	4	4	4	4
5A. Land-use change and forestry	**-34,484**	**-48,089**	**-43,066**	**-53,575**	**-54,973**	**-35,481**	**-52,168**	**-55,946**	**-56,531**
CO_2	-34,758	-48,220	-43,204	-53,655	-55,037	-35,748	-52,239	-56,022	-56,659
CH_4	183	39	106	48	38	246	58	69	43
N_2O	91	91	32	32	25	20	13	7	85
6. Waste	**19,831**	**20,760**	**23,215**	**20,800**	**20,146**	**19,457**	**18,661**	**18,557**	**18,229**
CO_2	507	454	202	226	239	207	200	218	230
CH_4	17,405	18,398	20,977	18,539	17,877	17,215	16,373	16,250	15,910
N_2O	1,919	1,908	2,037	2,035	2,030	2,035	2,089	2,089	2,089
TOTAL EMISSIONS (with LULUCF)	**484,761**	**483,824**	**508,504**	**521,174**	**509,016**	**520,280**	**489,421**	**435,583**	**444,787**
TOTAL EMISSIONS (without LULUCF)	**519,246**	**531,913**	**551,570**	**574,749**	**563,989**	**555,761**	**541,589**	**491,528**	**501,318**

ES.4. Other information

In Table ES.3 NO_X, CO, NMVOC and SO_2 emission trends from 1990 to 2010 are summarised.
All gases showed a significant reduction in 2010 as compared to 1990 levels. The highest reduction is observed for SO_2 (-88.3%), while CO and NO_X emissions reduced by about 62.3% and 52% respectively; NMVOC levels showed a decrease by 46.5%.

Table ES.3. Total emissions of indirect greenhouse gases and SO2 (1990-2010) (Gg)

Indirect greenhouse gases and SO_2	1990	1995	2000	2005	2006	2007	2008	2009	2010
	Gg								
NO_X	2,018	1,897	1,427	1,218	1,164	1,133	1,062	979	969
CO	7,325	7,092	4,935	3,505	3,281	3,410	3,035	2,811	2,764
NMVOC	2,024	2,087	1,612	1,318	1,286	1,272	1,196	1,134	1,082
SO_2	1,795	1,320	750	403	381	340	284	233	211

Sommario (Italian)

Nel documento “Italian Greenhouse Gas Inventory 1990-2010. National Inventory Report 2012” 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 un’analisi di sintesi della serie storica dei dati di emissione dal 1990 al 2010, si evidenzia che le emissioni nazionali totali dei sei gas serra, espresse in CO_2 equivalente, sono diminuite del 3.5% nel 2010 rispetto all’anno base (corrispondente al 1990), a fronte di un impegno nazionale di riduzione del 6.5% entro il periodo 2008-2012.

In particolare, le emissioni complessive di CO_2 sono pari all’85% del totale e risultano nel 2010 inferiori del 2.1% rispetto al 1990. Le emissioni di metano e di protossido di azoto sono pari a circa il 7.5 % e 5.4% del totale, rispettivamente, e presentano andamenti in diminuzione sia per il metano (-14.1%) che per il protossido di azoto (-27.2%). Gli altri gas serra, HFC, PFC e SF_6, hanno un peso complessivo sul totale delle emissioni che varia tra lo 0.1% e l’1.7%; le emissioni degli HFC evidenziano una forte crescita, mentre le emissioni di PFC decrescono e quelle di SF_6 mostrano un minore incremento. Sebbene al momento tali variazioni non risultino determinanti ai fini del conseguimento degli obiettivi di riduzione delle emissioni, la significatività del trend degli HFC potrebbe renderli sempre più importanti nei prossimi anni.

PART I: ANNUAL INVENTORY SUBMISSION

1. INTRODUCTION

1.1 Background information on greenhouse gas inventories and climate change

In 1988 the World Meteorological Organisation (WMO) and the United Nations Environment Program (UNEP) established a scientific Intergovernmental Panel on Climate Change (IPCC) in order to evaluate the available scientific information on climate variations, examine the social and economical influence on climate change and formulate suitable strategies for the prevention and the control of climate change.
The first IPCC report in 1990, although considering the high uncertainties in the evaluation of climate change, emphasised the risk of a global warming due to an unbalance in the climate system originated by the increase of anthropogenic emissions of greenhouse gases (GHGs) caused by industrial development and use of fossil fuels. More recently, the scientific knowledge on climate change has firmed up considerably by the IPCC Fourth Assessment Report on global warming which states that "Warming of the climate system is unequivocal (…). There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities (…). Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations". Hence the need of reducing those emissions, particularly for the most industrialised countries.
The first initiative was taken by the European Union (EU) at the end of 1990, when the EU adopted the goal of a stabilisation of carbon dioxide emissions by the year 2000 at the level of 1990 and requested Member States to plan and implement initiatives for environmental protection and energy efficiency. The contents of EU statement were the base for the negotiation of the United Nations Framework Convention on Climate Change (UNFCC) which was approved in New York on 9th May 1992 and signed during the summit of the Earth in Rio the Janeiro in June 1992. Parties to the Convention are committed to develop, publish and regularly update national emission inventories of greenhouse gases (GHGs) as well as formulate and implement programmes addressing anthropogenic GHG emissions. Specifically, Italy ratified the convention through law no.65 of 15/1/1994.
On 11/12/1997, Parties to the Convention adopted the Kyoto Protocol, which establishes emission reduction objectives for Annex B Parties (i.e. industrialised countries and countries with economy in transition) in the period 2008-2012. In particular, the European Union as a whole is committed to an 8% reduction within the period 2008-2012, in comparison with base year levels. For Italy, the EU burden sharing agreement, set out in Annex II to Decision 2002/358/EC and in accordance with Article 4 of the Kyoto Protocol, has established a reduction objective of 6.5% in the commitment period, in comparison with the base 1990 levels.
Italy ratified the Kyoto Protocol on 1st June 2002 through law no.120 of 01/06/2002. The ratification law prescribes also the preparation of a National Action Plan to reduce greenhouse gas emission, which was adopted by the Interministerial Committee for Economic Planning (CIPE) on 19th December 2002 (deliberation n. 123 of 19/12/2002). The Kyoto Protocol finally entered into force on 16th February 2005.
As a Party to the Convention and the Kyoto Protocol, Italy is committed to develop, publish and regularly update national emission inventories as well as formulate and implement programmes to reduce these emissions.
In order to establish compliance with national and international commitments air emission inventories are compiled and communicated annually to the competent institutions.
Specifically, the national GHG emission inventory is communicated through compilation of the Common Reporting Format (CRF), according to the guidelines provided by the United Nations Framework Convention on Climate Change and the European Union's Greenhouse Gas Monitoring Mechanism (IPCC, 1997; IPCC, 2000; IPCC, 2003; IPCC, 2006; EMEP/CORINAIR, 2007; EMEP/EEA, 2009).
The inventory is updated annually in order to reflect revisions and improvements in methodology and availability of new information. Recalculations are applied retrospectively to earlier years, which account for any difference in previously published data.
The submission also provides for detailed information on emission figures and estimation methodologies in the annual National Inventory Report.

As follows, this report is compiled according to the guidelines on reporting as specified in the document FCCC/SBSTA/2002/L.5. It provides an analysis of the 2010 Italian GHG emission inventory, and a revision of the entire time series 1990-2009, communicated in the framework of the annual submission under the Climate Change Convention and the Kyoto Protocol. It is also the annual submission to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism.

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

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

Emission estimates comprise the six direct greenhouse gases under the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride) which contribute directly to climate change owing to their positive radiative forcing effect and four indirect greenhouse gases (nitrogen oxides, carbon monoxide, non-methane volatile organic compounds, sulphur dioxide).
The CRF files, the national inventory reports and other related documents are available at the address http://www.sinanet.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.
Article 5.1 of the Kyoto Protocol established that Annex I Parties should have in place a National System since the end of 2006 for estimating anthropogenic greenhouse gas emissions by sources and removals by sinks and for reporting and archiving inventory information according to the guidelines specified in the UNFCCC Decision 20/COP.7. In addition, the Decision of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions (EC, 2005) required that Member States established a national greenhouse gas inventory system since the end of 2005 at the latest and that the Commission adopts the EC’s inventory system since 30 June 2006.
The ‘National Registry for Carbon sinks’, instituted by a Ministerial Decree on 1st April 2008, is part of the Italian National System and includes information on units of lands subject of activities under Article 3.3 and activities elected under Article 3.4 and related carbon stock changes. In agreement with the Ministerial decree art.4, the Ministry for the Environment, Land and Sea is responsible for the management of the National Registry for Carbon sinks. The Decree also provides that ISPRA and the State Forestry Corps are involved by the Ministry as a technical scientific support for specific activities as defined in the relevant protocol under approval. ISPRA is responsible for the preparation of emission and removals estimates for the LULUCF sector and for KP LULUCF supplementary information under art.7.1 of the Kyoto Protocol.
The National Registry for Carbon sinks is the instrument to estimate, in accordance with the COP/MOP decisions, the IPCC Good Practice Guidance on LULUCF and every relevant IPCC guidelines, the greenhouse gases emissions by sources and removals by sinks in forest land and related land-use changes and to account for the net removals in order to allow the Italian Registry to issue the relevant amount of removal units (RMUs). Detailed information on the Registry is included in Annex 10, whereas additional information on activities under Article 3.3 and Article 3.4 is reported in paragraph 1.2.2.

The Italian National System, currently in place, is fully described in the document 'National Greenhouse Gas Inventory System in Italy' (ISPRA, 2012 [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 document describing the national system which includes all updated information on institutional, legal and procedural arrangements for estimating emissions and removals of greenhouse gases and for reporting and archiving inventory information. The reports are publicly available at http://www.apat.gov.it/site/it-IT/APAT/Pubblicazioni/Altre_Pubblicazioni.html.
A specific unit of the Institute is responsible for the compilation of the Italian Atmospheric Emission Inventory and the Italian Greenhouse Gas Inventory in the framework of the Convention on Climate Change and the Convention on Long Range Transboundary Air Pollution. The whole inventory is compiled by the Institute; scientific and technical institutions and consultants may help in improving information both on activity data and emission factors of some specific activities. All the measures to guarantee and improve the transparency, consistency, comparability, accuracy and completeness of the inventory are undertaken.
ISPRA bears the responsibility for the general administration of the inventory, co-ordinates participation in reviews, publishes and archives the inventory results.
Specifically, ISPRA is responsible for all aspects of national inventory preparation, reporting and quality management. Activities include the collection and processing of data from different data sources, the selection of appropriate emissions factors and estimation methods consistent with the IPCC Guidelines, the IPCC Good Practice Guidance and Uncertainty management and the IPCC Good Practice Guidance for land use, land-use change and forestry, the compilation of the inventory following the QA/QC procedures, the assessment of uncertainty, the preparation of the National Inventory Report and the reporting through the Common Reporting Format, the response to the review process, the updating and data storage.

Different institutions are responsible for statistical basic data and data publication, which are primary to ISPRA for carrying out emission estimates. These institutions are part of the National Statistical System (Sistan), which provides national official statistics, and therefore are required to periodically update statistics; moreover, the National Statistical System ensures the homogeneity of the methods used for official statistics data through a coordination plan, involving the entire public administration at central, regional and local levels.
The National Statistical System is coordinated by the Italian National Institute of Statistics (ISTAT) whereas other bodies, joining the National Statistical System, are the statistical offices of ministries, national agencies, regions and autonomous provinces, provinces, municipalities, research institutes, chambers of commerce, local governmental offices, some private agencies and private subjects who have specific characteristics determined by law.
The Italian statistical system was instituted on 6th September 1989 by the Legislative Decree n. 322/89, which established guiding principles and criteria for reforming public statistics. This decree addresses to all public statistical bodies and agencies which provide official statistics both at local, national and international level in order to assure homogeneity of the methods and comparability of the results. To this end, a national statistical plan which defines surveys, data elaborations and project studies for a three-year period shall be drawn up and updated annually, as established in the Decree n. 322/89. The procedures to be followed with relation to the annual fulfilment as well as the forms to be filled in for census, data elaborations and projects, and how to deal with sensitive information are also defined.

The plan is deliberated by the Committee for addressing and coordinating statistical information (Comstat) and forwarded to the Commission for the assurance of statistical information; the Commission adopts the plan after endorsement of the Guarantor of the privacy of personal data.
Finally, the plan is approved by a Prime Ministerial Decree after consideration of the Interministerial Committee for economic planning (Cipe). The latest Prime Ministerial Decree, which approved the three-year plan for 2011-2013, was issued on 6th August 2008; an update of the plan for 2012-2013 was approved by a Prime Ministerial Decree on 3rd August 2009. Statistical information and results deriving from the completion of the plan are of public domain and the system is responsible for wide circulation.
Ministries, public agencies and other bodies are obliged to provide the data and information specified in the annual statistical plan; the same obligations regard the private entities. All the data are protected by the principles of statistical disclosure control and can be distributed and communicated only at aggregate level even though microdata can circulate among the subjects of the Statistical System.
Sistan activity is supervised by the Commission for Guaranteeing Statistical Information (CGIS) which is an external and independent body. In particular, the Commission supervises: the impartiality and completeness of statistical information, the quality of methodologies, the compliance of surveys with EU and international directives. The Commission, established within the Presidency of the Council of Ministers, is composed of high-profile university professors, directors of statistical or research institutes and managers of public administrations and bodies, which do not participate at Sistan.

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

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

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

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

The 'National Registry for Carbon sinks' has been instituted by a Ministerial Decree on 1st April 2008 and is part of the National Greenhouse Gas Inventory System in Italy (ISPRA, 2012 [a]). In 2009, a technical group, formed by experts from different institutions (ISPRA, Ministry of the Environment, Land and Sea, Ministry of Agriculture, Food and Forest Policies and University of Tuscia), set up the methodological plan of the activities necessary to implement the registry and defined the relative funding. Some of these activities (in particular IUTI, inventory of land use, see Annex 10) have been completed, resulting in land use classification, for all national territory, for the years 1990, 2000 and 2008. A process of validation and verification of IUTI data has been put in place and is expected to supply data useful to update and improve the estimations. For this year submission, emissions and removals from 3.3 and 3.4 activities have been estimated on the basis of data and methodologies used for the inventory under the Convention.
Italy has chosen to elect Forest Management (FM) as an activity under Article 3.4. In accordance with the Annex to Decision 16/CMP.1, credits from Forest Management are capped in the first commitment period. Following the Decision 8/CMP.2, the cap is equal to 2.78 Mt C (10.19 $MtCO_2$) per year, or 13.90 Mt C (50.97 $MtCO_2$) for the whole commitment period.
The description of the main elements of the institutional arrangement under Article 3.3 and activities elected under Article 3.4 is detailed in Annex 10.
Italy has decided to account for Article 3.3 and 3.4 elected activities at the end of the commitment period; information on accounting for activities under art. 3.3 and 3.4 of the Kyoto Protocol, for the year 2008, 2009

and 2010, 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

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 was conceived for the administration of emissions allowances allocated to operators participating to the EU ETS and it was developed according to the UN Data Exchange Standards document. As a consequence, the registry established under Directive 2003/87/CE could also be used as a registry for the administration of Kyoto Protocol units.
Consequently, the Italian registry for the EU ETS could go through an initialization process and a go-live phase with the UNFCCC in order to become part of the Kyoto system of registries. In particular, Italy successfully performed and passed the SSL connectivity testing (Oct. 26th 2007), the VPN connectivity testing (Oct. 15th 2007), the Interoperability test according to Annex H of the UN DES (Nov. the 9th 2007), and submitted all required information through a complete Readiness Questionnaire.
Following this process, the Italian registry fulfilled all of its obligations regarding conformity with the UN Data Exchange Standards and has been deemed fully compliant with the registry requirements defined in decisions 13/CMP.1 and 5/CMP.1.
After successful completion of the go-live process on 16th October 2008, the Italian registry commenced live operations with the International Transaction Log (ITL) and it's been operational ever since, ensuring the precise tracking of holdings, issuances, transfers, cancellations and retirements of allowances and Kyoto units.

The Italian Government modified the previous Legislative Decree 216/2006 which enforced European Directive 87/2003/CE, by the new Legislative Decree 51 of March 7th 2008. Due to this new Decree, ISPRA, as Registry Administrator, is responsible for developing, operating and maintaining the national registry under the Directive; 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.
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 still has to be regulated by a future Decree.

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

- the Registry Administrator (chief of the unit)
- one Registry Manager in charge of Registry functions and operations, resolution of problems, manual intervention, and coordination with the "Competent Authority";
- three persons dedicated to a first level helpdesk and to administrative tasks (e.g. documentation archiving).

Following a European tender, from January 2011 Italy has continuous agreement with Innofactor Ltd. which covers hosting and maintenance of the Registry software. The contract also includes any kind of support and consultancy needed for the registry management.

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).

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

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

SEF tables including all data referring to units holdings and transactions during year 2011 can be found in Annex 8.

1.3 Brief description of the process of inventory preparation

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

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

For the energy and industrial sectors, emission data collected in the framework of the European Emissions Trading Scheme, the National Pollutant Release and Transfer Register (Italian PRTR, former INES) and the Large Combustion Plant (LCP) Directive have yielded considerable developments in the inventory of the relative sectors. In fact, these data are 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 based upon detailed information such as fuel consumption. Other small plants communicate their emissions which are also considered individually.

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

In Figure 1.1 the most important steps to guarantee the continous improvement of the national GHG emission inventory are outlined.

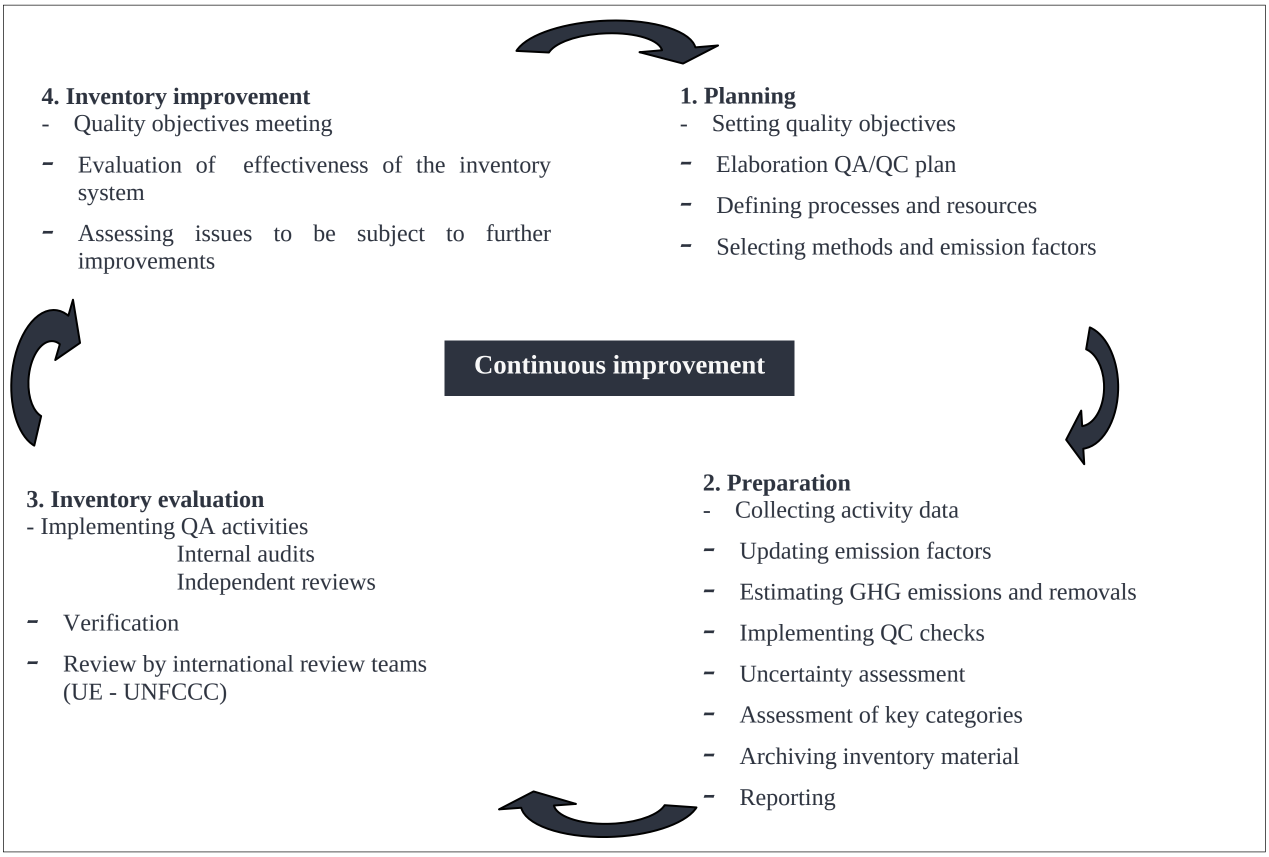

Figure 1.1 National Greenhouse Gas Inventory: annual inventory process

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

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

1.4 Brief general description of methodologies and data sources used

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

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

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

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

In Table 1.2 a summary of the methods and emission factors used in the compilation of the Italian inventory is reported. A more detailed table, describing methods and emission factors for the key categories of the national inventory for 2010, is included in Annex 9.

Table 1.2 Methods and emission factors used in the inventory preparation

SUMMARY 3 SUMMARY REPORT FOR METHODS AND EMISSION FACTORS USED

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

Use the following notation keys to specify the method applied:

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

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

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

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

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

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

In the last years, a lot of information on productions, fuel consumptions, emission factors and emissions in specific energy and industrial sub sectors is obtained from data collected by operators under the European Emissions Trading Scheme (ETS).
To implement the European Directive 2003/87 (EU, 2003), amended by Directive 2009/29/EC (EU, 2009) establishing the EU ETS, Italy according to Legislative Decree n. 216/2006 (Legislative Decree, 2006) and Legislative Decree n. 51/2008 (MATTM, 2008) established the national registry and the national ETS

commitee. The criteria of data reporting are defined by Decision 2007/589/EC (EC, 2007), Monitoring and Reporting Guidelines for GHG emissions under ETS, and adopted at national level by Deliberation of the national ETS Committee n. 14/2010 (MATTM, 2010).
In compliance with the above mentioned legislations independent certification and verification of activity data, emission data and emission factors are required. At national level, data verification has to be carried out by verifiers accredited by the national ETS Committee according to the ministerial decree DEC/RAS/115/2006. The verification of data submissions ensures reliability, credibility, and precision/accuracy of monitoring systems for data and any information relating emissions by plant.
Data from the Italian Emissions Trading Scheme database are incorporated into the national inventory whenever the sectoral coverage is complete; in fact, 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 Release and Transfer Register (INES/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 (reporting period 2002-2006) included in the Italian pollutant emissions register were validated by competent authorities within 30 June and communicated by ISPRA to the Ministry for the Environment, Land and Sea every year and to the European Commission every three years according to EC Decision 2000/479 (two reporting cycles: data related to 2002 and 2004 were reported respectively in 2003 and in 2006). Since 2008 the national pollutant emissions register has been replaced by the national pollutant release and transfer register (the Italian PRTR) to comply with Regulation EC n.166/2006; data have been collected annually at facility level and sent after validation by competent authorities to European Commission within 31 March every year for data referring to the previous year. These data are used for the compilation of the inventory whenever they are complete in terms of sectoral information; in fact, industries communicate figures only if they exceed specific thresholds; furthermore, basic data such as fuel consumption are not supplied and production data are not always split by product but reported as an overall value. Anyway, the Italian PRTR is a good basis for data checks and a way to facilitate contacts with industries which, in many cases, supply, under request, additional information as necessary for carrying out sectoral emission estimates.
In addition, final emissions are checked and verified also taking into account figures reported by industries in their annual environmental reports.
Both for energy and industrial processes, emissions of large industrial point sources are registered individually; communication also takes place in the framework of the European Directive on Large Combustion Plants, based upon detailed information such as fuel consumption. Other small plants communicate their emissions which are also considered individually.
ISPRA collects data from the industrial associations under the ETS and other European directives, Large Combustion Plant and INES/PRTR, and makes use of these data in the preparation of the national inventory ensuring the consistency of time series.

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

1.5 Brief description of key categories

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

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

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

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

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

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

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

Applying the analysis to the 2010 inventory, without the LULUCF sector, 26 key categories were totally individuated, both at level and trend. Results are reported in Table 1.5.

Table 1.5 Key categories (excluding LULUCF) by the IPCC Approach 1 and Approach 2. Year 2010

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

Key categories (excluding the LULUCF sector)	
CO_2 Mobile combustion: Waterborne Navigation	L1
CO_2 Iron and steel production	T1
CO_2 Ammonia production	T1
N_2O Nitric Acid	T1
PFC Aluminium production	T1
CH_4 stationary combustion	T2

If considering emissions and removals from the LULUCF sector, 30 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.

Table 1.6 Key categories (including LULUCF) by the IPCC IPCC Approach 1 and Approach 2. Year 2010

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

Key category analysis for KP-LULUCF was performed according to section 5.4 of the IPCC GPG for LULUCF (IPCC, 2003).
CO_2 emissions and removals from *Afforestation/Reforestation* activities (art. 3.3) and from *Forest management* (art. 3.4) have been assessed as key categories. Their figures have been compared with Table 1.6 Key categories for the latest reported year (2010) based on the level of emissions (including LULUCF). The respective associated UNFCCC subcategories are *Land converting to forest land*, which has been identified as key category with Approach 2, trend assessment, and *Forest land remaining Forest land*, which is a key category at level and trend assessment.

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 are planned for the LULUCF sector. In addition to this evaluation, also categories estimated with higher tiers but affected by a high level of uncertainty are considered in the prioritization plan. For istance, this year, activities are planned for direct N_2O emissions from agricultural soils and indirect N_2O from nitrogen used in agriculture in order to improve the accuracy of the Italian inventory and reduce the overall uncertainty.

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

ISPRA has elaborated an inventory QA/QC plan which describes specific QC procedures to be implemented during the inventory development process, facilitates the overall QA procedures to be conducted, to the extent possible, on the entire inventory and establishes quality objectives.
Particularly, an inventory QA/QC procedures manual (APAT, 2006) has been drawn up which describes QA/QC procedures and verification activities to be followed during the inventory compilation and helps in the inventory improvement. Furthermore, specific QA/QC procedures and different verification activities implemented thoroughly the current inventory compilation, as part of the estimation process, are figured out in the annual QA/QC plan (ISPRA, 2012 [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 include also data and documentation gathering. Specifically, the inventory analyst for a source category maintains a complete and separate project archive for that source category; the archive includes all the materials needed to develop the inventory for that year and is kept in a transparent manner.

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

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

Even though official independent and public reviews prior to the Italian inventory submission are not implemented yet, emission figures are subjected to a process of re-examination once the inventory, the inventory related publications and the national inventory reports are posted on website, specifically www.isprambiente.it, and from the communication of data to different institutions and/or at local level.
In some cases, sectoral major recalculations are presented and shared with the relevant stakeholders prior to the official submission.

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

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

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

In 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). The provincial inventory for the year 2010, and an update of 2005, is also in progress and planned to be completed by the next few months. For the same year, regional inventories will be completed by 2013. Comparisons between top-down and local inventories have been carried out during the last year and will continue in the next years; results are shared among the ‘local inventories’ expert group leading to an improvement in methodologies for both the inventories.

The inventory is also presented to a Technical Committee on Emissions (CTE), coordinated by the Ministry for the Environment, Land and Sea, where all the relevant Ministries and local authorities are represented;

within this 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 review are reported in UNFCCC (2010). The review process of the last year submission is still under finalization and the review report was not available during the actual inventory submission. Notwithstanding some of the issues raised during the process were addressed and implemented.

At European level, reviews of the European inventory are undertaken by experts from different Member States for critical sectoral categories in the context of the European GHG Monitoring Mechanism. Moreover, in the context of the European Effort Sharing Decision (EC, 2009) defining the 2020 emission limit of a Member State in relation to its 2005 emissions, a technical review will be carried out to review and verify emission data of each Member State, for the reference years 2005, 2008 and 2009, prior to determining their annual emission allocations. The review process will take place from June to August this year.

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

The preparation of environmental reports where data are needed at different aggregation levels or refer to different contexts, such as environmental and economic accountings, is also a check for emission trends. At national level, for instance, emission time series are reported in the Environmental Data Yearbooks published by ISPRA. Emission data are also published by the Ministry for the Environment, Land and Sea in the Reports on the State of the Environment and the National Communications as well as in the Demonstrable Progress Report. Moreover, figures are communicated to the National Institute of Statistics to be published in the relevant Environmental Statistics Yearbooks as well as used in the framework of the EUROSTAT NAMEA Project.
At European level, ISPRA also reports on indicators meeting the requirements of Article 3 (1)(j) of Decision N° 280/2004/EC. In particular, Member States shall submit figures on specified priority indicators and should submit information on additional priority and supplementary indicators for the period from 1990 to the last submitted year and forecasts for some specified years. National trends of these indicators are reported in the document ‘Carbon Dioxide Intensity Indicators’ (ISPRA, 2012 [c]).

Comparisons between national activity data and data from international databases are usually carried out in order to find out the main differences and an explanation to them (ENEA/MAP/APAT, 2004). Emission intensity indicators among countries (e.g. emissions per capita, industrial emissions per unit of value added, road transport emissions per passenger car, emissions from power generation per kWh of electricity produced, emissions from dairy cows per tonne of milk produced) can also be useful to provide a preliminary check and verification of the order of magnitude of the emissions. This is carried out at European and international level by considering the annual reports compiled by the EC and the UNFCCC as well as related documentation available from international databases and outcome of relevant workshops.

Additional comparisons between emission estimates from industrial sectors and those published by the industry itself in their Environmental reports are carried out annually in order to assess the quality and the uncertainty of the estimates.
The quality of the inventory has also improved by the organization and participation in sector specific workshops. Follow-up processes are also set up in the framework of the WGI under the EC Monitoring Mechanism, which addresses to the improvement of different inventory sectors. Specifically in the last years, two workshops were held, one related to the management of uncertainty in national inventories and problems on the application of higher methodologies to calculate uncertainty figures, the other on how to use data from the European emissions trading scheme in the national greenhouse gas inventories. Previous workshops addressed methodologies to estimate emissions from the agriculture and LULUCF sectors, involving the Joint Research Centre, from the waste sector, involving the European Topic Center on Resource and Waste Management, as well as from international bunkers, involving the International Energy Agency and EUROCONTROL. Presentations and documentation of the workshops are available on the website at the address: http://air-climate.eionet.europa.eu/meetings/past_html.
A national conference on the Italian emission inventory was organized by ISPRA in October 2006. Methodologies used to carry out national figures and results of time series from 1990 to 2004 were presented detailing explanations for each sector. More than one hundred participants from national and local authorities, Ministries, Industry, Universities and Research organizations attended the meeting.
In 2007, in the context of the national conference on climate change a specific session was dedicated to the national emission inventory. In addition, a specific event was held on the results of the 2005 national GHG inventory. In 2010, the time series of emission figures 1990-2008 were presented in a specific national Kyoto Protocol event.
A specific procedure undertaken for improving the inventory regards the establishment of national expert panels (in particular, in road transport, land use change and forestry and energy sectors) which involve, on a voluntary basis, different institutions, local agencies and industrial associations cooperating for improving activity data and emission factors accuracy. Specifically, for the LULUCF sector, following the election of the 3.3 and 3.4 activities and on account of an in-depth analysis on the information needed to report LULUCF under the Kyoto Protocol, a Scientific Committee, *Comitato di Consultazione Scientifica del Registro dei Serbatoi di Carbonio Forestali*, constituted by the relevant national experts has been established by the Ministry for the Environment, Land and Sea in cooperation with the Ministry of Agriculture, Food and Forest Policies.
In addition to these expert panels, ISPRA participates in technical working groups within the National Statistical System. These groups, named *Circoli di qualità*, coordinated by the National Institute of Statistics, are constituted by both producers and users of statistical information with the aim of improving and monitoring statistical information in specific sectors such as transport, industry, agriculture, forest and fishing. As reported in previous sections, these activities improve the quality and details of basic data, as well as enable a more organized and timely communication.
A summary of all the main QA/QC activities over the past years which ensure the continuous improvement of the inventory is presented in the document ‘Quality Assurance/Quality Control plan for the Italian Emission Inventory. Year 2012’ (ISPRA, 2012 [b]).

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

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

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

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

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

The 2006 IPCC Guidelines (IPCC, 2006) define two approaches to estimating uncertainties in national greenhouse gas inventories: Approach 1, based on the error propagation equations, and Approach 2, corresponding to the application of Monte Carlo analysis.
For the Italian inventory, quantitative estimates of the uncertainties are calculated using Approach 1
which application is described in Annex 1, with or without emissions and removals from the LULUCF sector. Emission categories are disaggregated into a detailed level and uncertainties are therefore estimated for these categories.
For the 2010 total emission figures without LULUCF, an uncertainty of 3.3% in the combined global warming potential (GWP) total emissions is estimated, whereas for the trend between 1990 and 2010 the analysis assesses an uncertainty by 2.6%.
Including the LULUCF sector into national figures, the uncertainty according to Approach 1 is equal to 6.6% for the year 2010, whereas the uncertainty for the trend is estimated to be 5.4%.
The differences in the uncertainty levels, including the LULUCF sector, as compared the 2011 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 5.9% including the LULUCF sector.

Following the recommendations of UNFCCC reviews, Approach 2 was implemented last year to estimate uncertainty of some key categories, for 2009 emission levels. The results show that uncertainty values are lower than those derived from the application of Approach 1. Details on the categories for which the analysis has been already implemented are reported in Annex 1.
For this year submission, Montecarlo analysis has been extended to the other key categories of the agriculture sector. The study will be progressively extended to other inventory categories.

Monte Carlo analysis had also been applied some years ago, following the IPCC Good Practice Guidance (IPCC, 2000), to specific categories of the inventory. Also in that case, the results show that, applying methods higher than the Tier 1 does not make a significant difference in figures if information on uncertainty levels is not sufficiently detailed. Tier 2 was applied to CO_2 emissions from road transport and N_2O emissions from agricultural soils; in the first case measurements were available for emission factors so a low uncertainty was expected, in the other no information on EFs was available and a high uncertainty was supposed. A combination of Montecarlo and Bootstrap simulation was applied to CO_2 emissions, in consideration of the specific data availability assuming a normal distribution for activity data and for the emission factor of natural gas. The overall uncertainty of CO_2 emissions for road transport resulted in 2.06, lower than that resulting from Approach 1 which estimated a figure of 4.2; the reason of the difference is in the lower uncertainty resulting from the application of bootstrap analysis to the emission factor of diesel oil, all the other figures are very similar. For N_2O emissions from agricultural soils, a Montecarlo analysis was applied assuming a normal distribution for activity data and two tests one with a lognormal and the other with a normal for emission factors; the results with the normal distribution calculated an uncertainty figure equal to 32.44, lower than the uncertainty by Approach 1 which was 102; in the case of the lognormal distribution there were problems caused by the formula specified in the IPCC guidelines which is affected by the unit and needs further study before a throughout application. The importance of these results is that in neither of the cases does the uncertainty estimation of the national sectors result in an underestimation.

Results and details of the study, 'Evaluating uncertainty in the Italian GHG inventory', were presented at a EU workshop on Uncertainties in Greenhouse Gas Inventories, held in Finland in September 2005, and they are also available on website at the address http://air-climate.eionet.europa.eu/docs/meetings/050905_EU_GHG_Uncert_WS/meeting050905.html.
A further research on uncertainty, specifically on the comparison of different methodologies to evaluate emissions uncertainty, had also been carried out in the past (Romano et al., 2004).

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

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

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

1.8 General assessment of the completeness

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

Table 1.7 Source and sinks not estimated in the 2010 inventory

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

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

Table 1.8 Source and sinks reported elsewhere in the 2010 inventory

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

2 TRENDS IN GREENHOUSE GAS EMISSIONS

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

Summary data of the Italian greenhouse gas emissions for the years 1990-2010 are reported in Tables A8.1-A8.5 of Annex 8.

The emission figures presented are those sent to the UNFCCC Secretariat and to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism.

Total greenhouse gas emissions, in CO_2 equivalent, excluding emissions and removals from LULUCF, have decreased by 3.5% between 1990 and 2010, varying from 519 to 501 CO_2 equivalent million tons (Mt), whereas the national Kyoto target is a reduction of 6.5%, as compared the base year levels, by the period 2008-2012. It should be noted that the economic recession has had a remarkable influence on the production levels affecting the energy and industrial process sectors, with a consequent notable reduction of total emissions, especially in the last two years.

The most important greenhouse gas, CO_2, which accounts for 85.0% of total emissions in CO_2 equivalent, shows a decrease by 2.1% between 1990 and 2010. In the energy sector, in particular, CO_2 emissions in 2010 are 0.1% lower than in 1990.
CH_4 and N_2O emissions are equal to 7.5% and 5.4% of the total CO_2 equivalent greenhouse gas emissions, respectively. CH_4 emissions have decreased by 14.1% from 1990 to 2010, while N_2O has decreased by 27.2%.
As for other greenhouse gases, HFCs account for 1.7% of total emissions, PFCs and SF_6 are equal to 0.3% and 0.1% of total emissions, respectively. HFC emissions show a strong increase, while PFC emissions show a decrease and SF_6 emissions show a slight increase. Although at present, variations in these gases are not relevant to reaching the emission reduction objectives, the meaningful increasing trend of HFCs will make them even more important in next years.

Figure 2.1 illustrates the national trend of greenhouse gases for 1990-2010, 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.

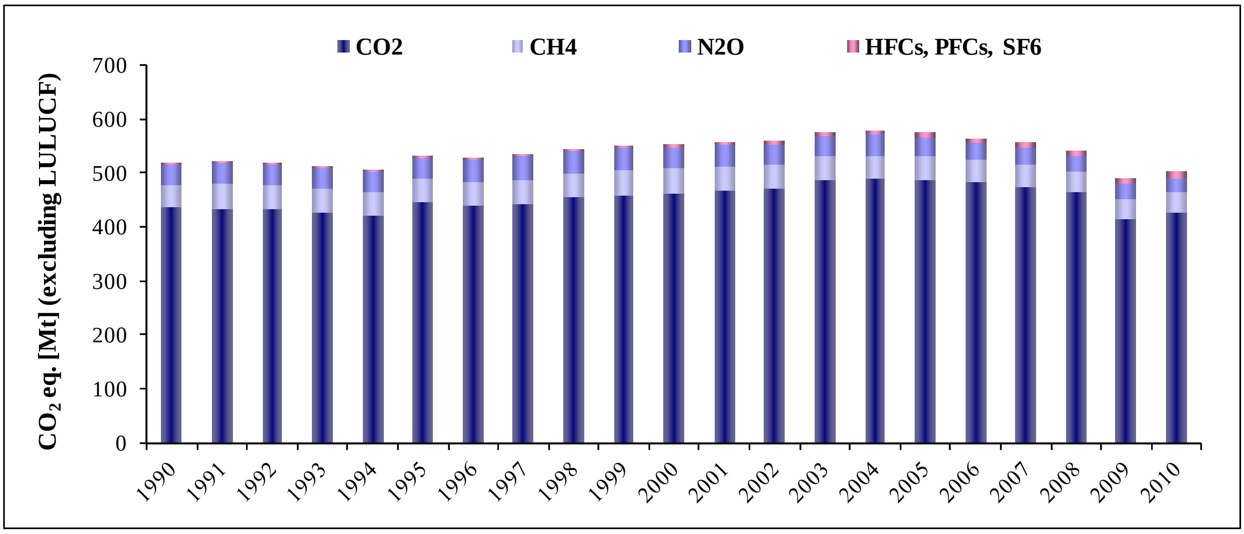

Figure 2.1 National greenhouse gas emissions from 1990 to 2010 (without LULUCF) (Mt CO_2 eq.)

The share of the different sectors, in terms of total emissions, remains nearly unvaried over the period 1990-2010. Specifically for the year 2010, the greatest part of the total greenhouse gas emissions is to be attributed to the energy sector, with a percentage of 82.9%, followed by agriculture and industrial processes,

accounting for 6.7% and 6.4% of total emissions, respectively, waste contributing with 3.6% and use of solvents with 0.3%.
Considering total greenhouse gas emissions with emissions and removals from LULUCF, the energy sector accounts, in 2010, for 74.5% of total emissions and removals, as absolute weight, followed by the LULUCF sector which contributes with 10.1%.

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

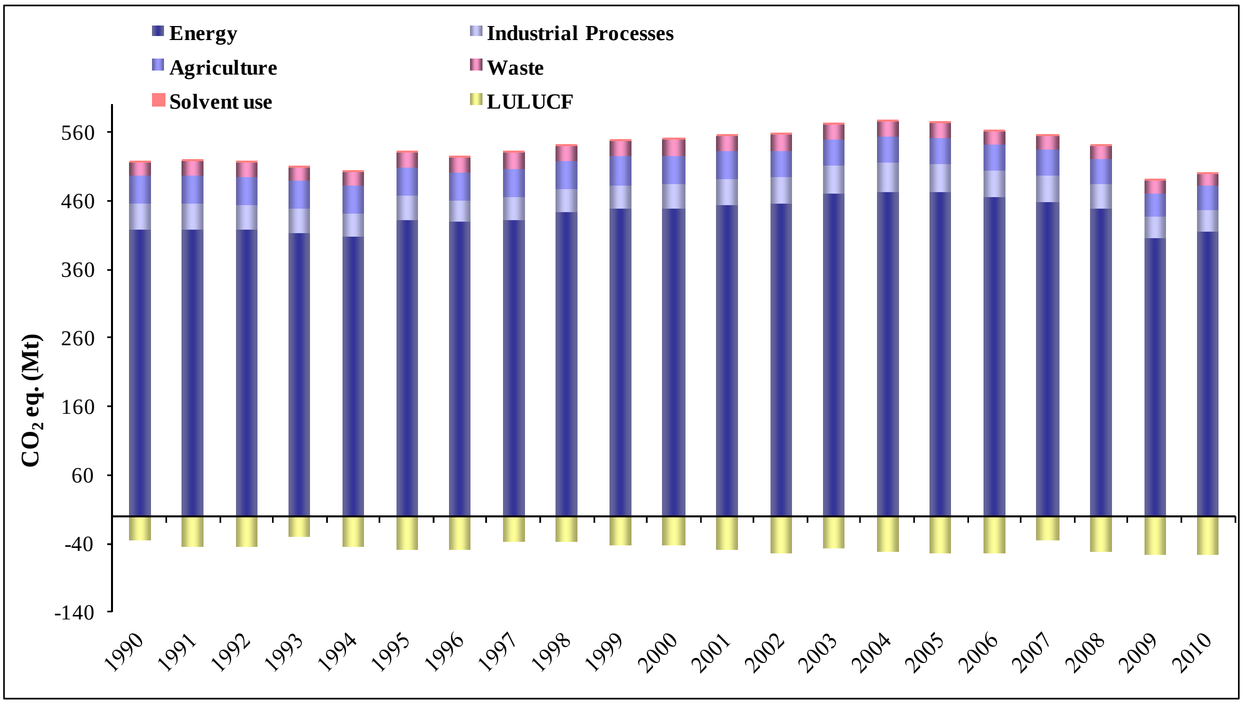

Figure 2.2 Greenhouse gas emissions and removals from 1990 to 2010 by sector (Mt CO_2 eq.)

2.2 Description and interpretation of emission trends by gas

2.2.1 Carbon dioxide emissions

CO_2 emissions, excluding CO_2 emissions and removals from LULUCF, have decreased by 2.1% from 1990 to 2010, ranging from 435 to 426 million tons.
The most relevant emissions derive from the energy industries (31.1%) and transportation (27.5%). Non-industrial combustion accounts for 21.5% and manufacturing and construction industries for 14.1%, while the remaining emissions derive from industrial processes (4.9%) and other sectors (0.8%).

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

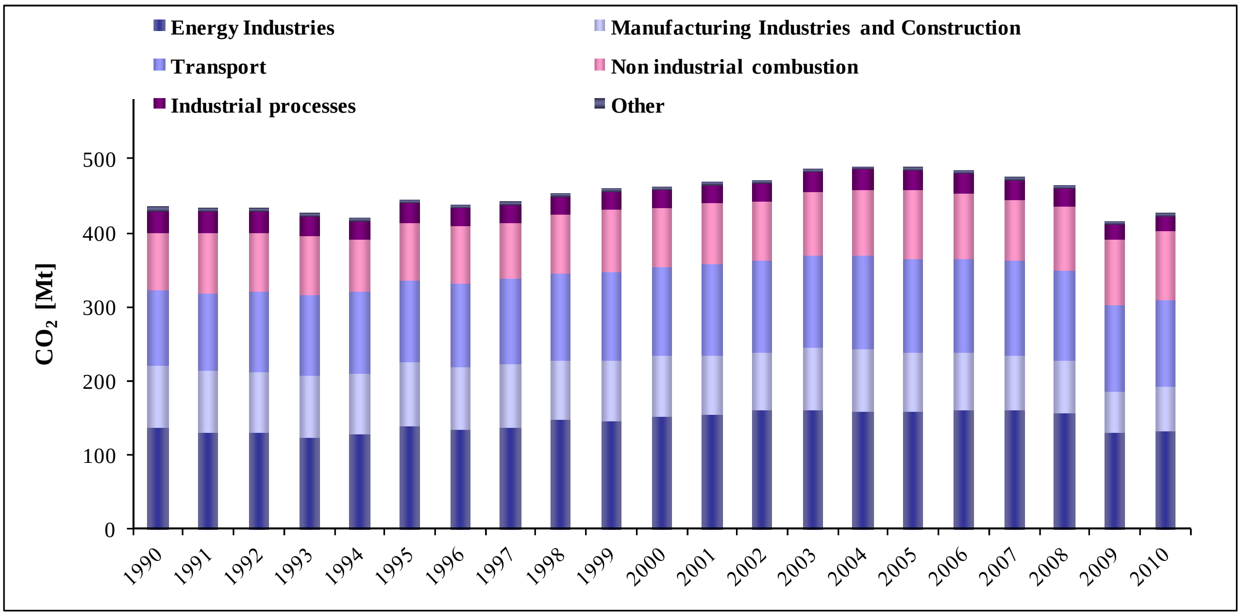

Figure 2.3 National CO_2 emissions by sector from 1990 to 2010 (Mt)

The main sectors responsible for CO_2 emissions are transport and energy industries; in the period 1990-2010, emissions from transport have increased by 15.9% from 1990 to 2010 while those from energy industries decreased by 2.8%. Non industrial combustion emissions have increased by 18.0% and those from industrial processes decreased by 26.8%; emissions from manufacturing industries and construction show a decrease of 29.9%, emissions in the 'Other' sector, mostly fugitive emissions from oil and natural gas and emissions from solvent and other product use, reduced by 34.8%.

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

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

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

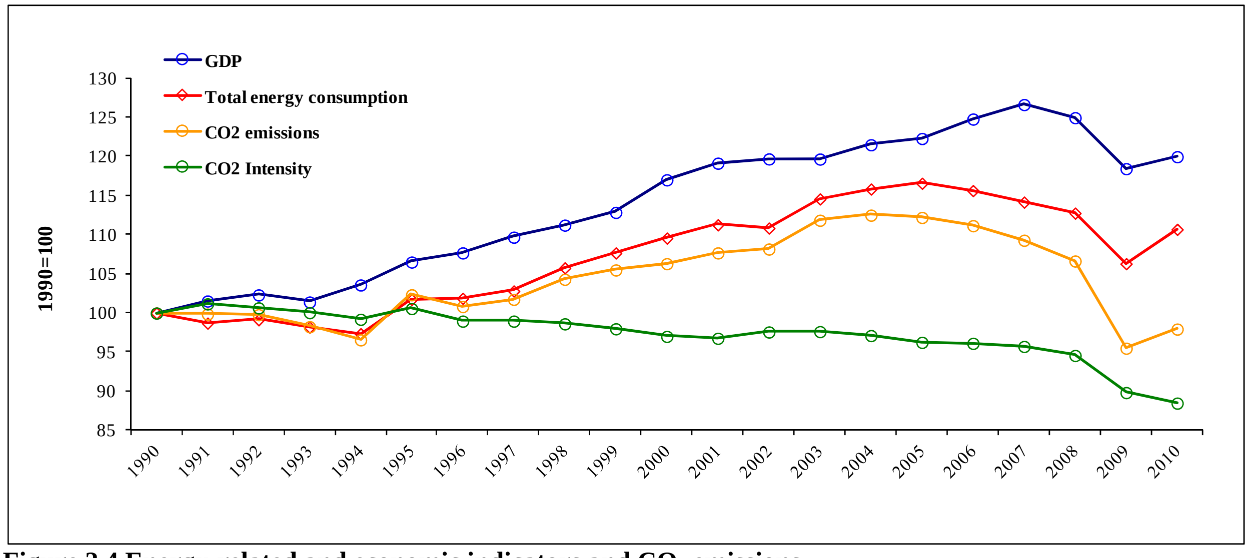

Figure 2.4 Energy-related and economic indicators and CO_2 emissions

2.2.2 *Methane emissions*

Methane emissions (excluding LULUCF) in 2010 represent 7.5% of total greenhouse gases, equal to 37.5 Mt in CO_2 equivalent, and show a decrease of 6.1 Mt (-14.1%) as compared to 1990 levels.

CH_4 emissions, in 2010, are mainly originated from waste sector which accounts for 42.4 % of total methane emissions, as well as from the agriculture (39.6%) and energy (17.9%) sectors.
Activities typically leading to emissions in the waste-management sector are the operation of dumping sites and the treatment of industrial waste-water. The waste sector shows a decrease in emission levels, 8.6% compared to 1990; the solid waste disposal on land, which represents the largest emission sectoral share (81.0%), decreases of 15.5%, while the highest increases concern waste incineration (62.7%) and waste-water handling (38.3%) subcategories.
Emissions in the agricultural sector regard mainly the enteric fermentation (72.1%) and manure management (17.3%) categories. The agriculture sector shows a decrease of emissions equal to 14.2% as compared to 1990.
In terms of CH_4 emissions in the energy sector, the reduction (-24.2%) is the result of two contrasting factors: on the one hand there has been a considerable reduction in emissions deriving from energy industries, manufacturing industries and construction, transport, fugitive emissions from fuels (caused by leakage from the extraction and distribution of fossil fuels, due to the gradual replacement of natural-gas distribution networks), on the other hand a strong increase in the civil sector can be observed, as a result of increased use of methane and biomass in heating systems. Figure 2.5 shows the emission figures by sector.

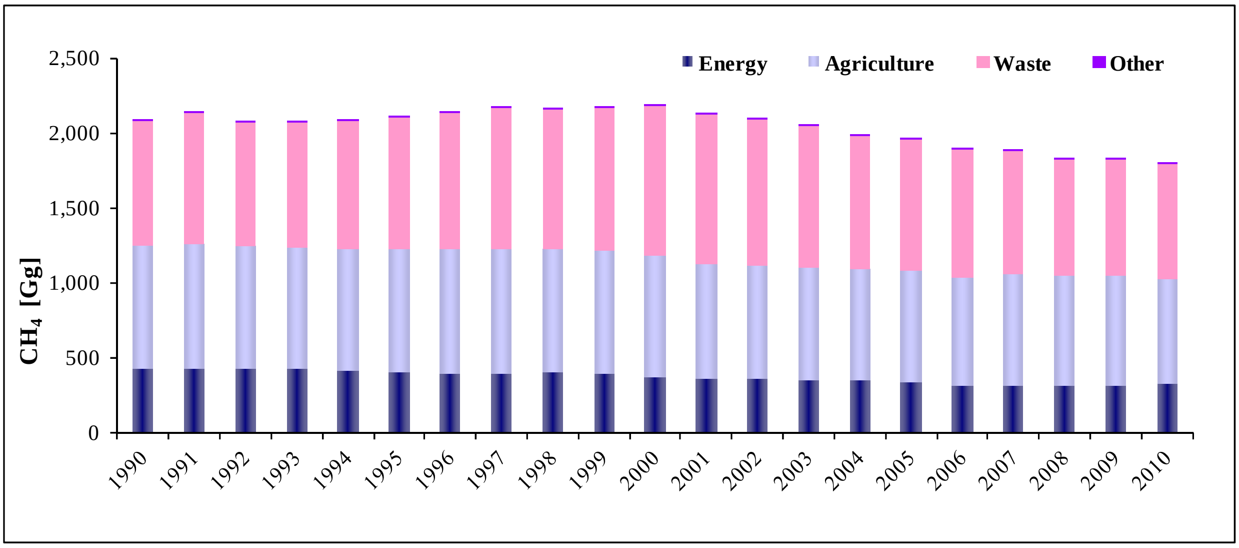

Figure 2.5 National CH_4 emissions by sector from 1990 to 2010 (Gg)

2.2.3 *Nitrous oxide emissions*

In 2010 nitrous oxide emissions (excluding LULUCF) represent 5.4% of total greenhouse gases, with a decrease of 27.2% between 1990 and 2010, from 37.4 to 27.2 Mt CO_2 equivalent.

The major source of N_2O emissions is the agricultural sector (69.3%), 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 19.4% during the period 1990-2010.
Emissions in the energy-use sector (18.3% of the total) show an increase by 9.6% from 1990 to 2010; this growth can be traced primarily to the road transport sector and it is related to the introduction of catalytic converters. However, a high degree of uncertainty still exists with regard to N_2O emission factors of catalysed automobiles.
Emissions from production of nitric acid have decreased of 92.5% from 1990 to 2010 with a notable decrease in the last year due to the introduction of the abatment systems in the main production plant;

emissions from production of adipic acid show an increase from 1990 to 2005 of 32.6% and a decrease from 2005 to 2010 of 91.9% because of the introduction of an abatement technology, showing a global reduction of 89.3%.
Other emissions in the waste sector primarily regard the processing of industrial and domestic waste-water (7.3% of national N_2O emissions).
Figure 2.6 shows national emission figures by sector.

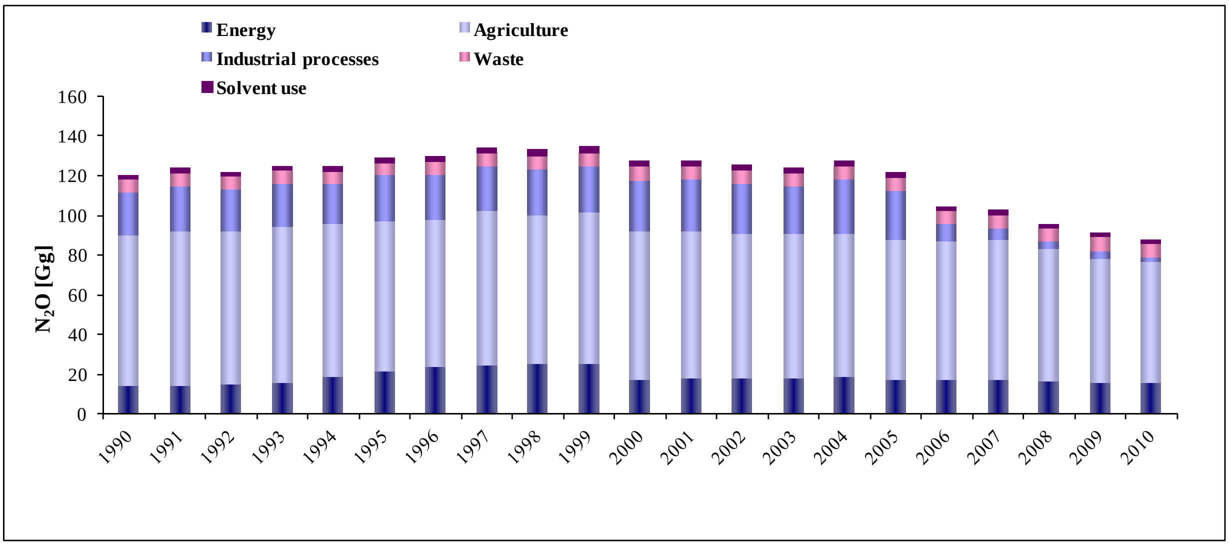

Figure 2.6 National N_2O emissions by sector from 1990 to 2010 (Gg)

2.2.4 Fluorinated gas emissions

Italy has set 1990 as the base year for reduction in the emissions of the fluorinated gases covered by the Kyoto Protocol, HFCs, PFCs and SF_6. Taken altogether, the emissions of fluorinated gases represent 2.1% of total greenhouse gases in CO_2 equivalent in 2010, and they show an increase of 229.9% between 1990 and 2010. This increase is the result of different features for the different gases.

HFCs, for instance, have increased considerably from 1990 to 2010, from 0.4 to 8.8 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 46.5% from 1990 to 2010. The level of PFCs emissions in 2010 is 1.3 Mt in CO_2 equivalent, and it is due to by product emissions in the production of halocarbons (86%), the production of primary aluminium (6.4%) and the use of the gases in the production of semiconductors (7.6%). The production of PFCs is equal to zero in Italy from the year 1999 onwards.
Emissions of SF_6 are equal to 0.37 Mt in CO_2 equivalent in 2010, with an increase of 12.1% as compared to 1990 levels. In 2010, 4.7% of SF_6 emissions derive from the use of gas in aluminium and magnesium foundries, 86.7% from the gas contained in electrical equipments, and 8.6% from the gas use in the semiconductors manufacture. From 2005 to 2006, emissions of SF_6 have fallen by 12.8%, and between 2006 and 2010 a decrease of 8.0%.
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.

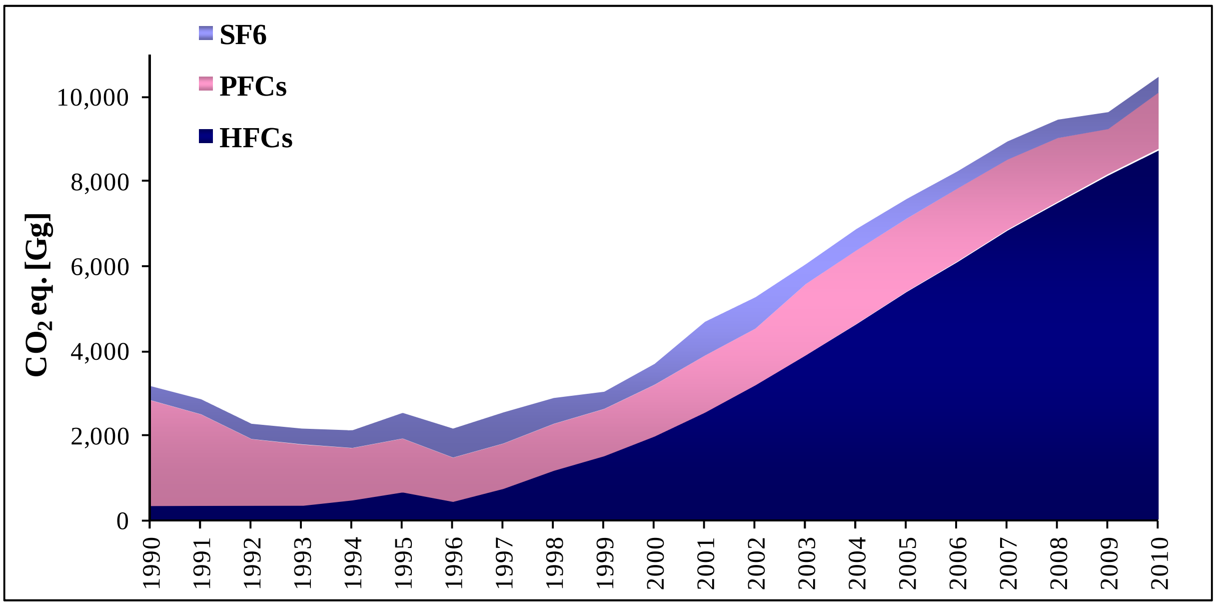

Figure 2.7 National emissions of fluorinated gases by sector from 1990 to 2010 (Gg CO_2 eq.)

2.3 Description and interpretation of emission trends by source

2.3.1 Energy

Emissions from the energy sector account for 82.9% 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.

Table 2.1 Total emissions from the energy sector by source (1990-2010) (Gg CO_2 eq.)

	1990	1995	2000	2005	2006	2007	2008	2009	2010
	Gg CO_2 eq.								
Total emissions	**417,833**	**432,460**	**449,669**	**471,868**	**466,811**	**458,285**	**449,326**	**405,511**	**415,727**
Fuel Combustion (Sectoral Approach)	*407,057*	*422,389*	*440,645*	*464,027*	*459,448*	*451,077*	*441,975*	*398,381*	*408,300*
Energy Industries	137,214	140,541	152,556	160,478	161,783	161,569	156,917	131,781	133,255
Manufacturing Industries and Construction	87,303	86,793	84,017	80,393	79,176	75,880	72,435	55,973	61,375
Transport	103,078	115,607	122,561	127,481	128,855	128,878	123,817	119,377	118,849
Other Sectors	78,343	77,937	80,660	94,384	88,576	83,782	88,005	90,330	94,153
Other	1,120	1,511	851	1,291	1,058	969	801	920	669
Fugitive Emissions from Fuels	*10,776*	*10,072*	*9,024*	*7,841*	*7,363*	*7,208*	*7,351*	*7,130*	*7,426*
Solid Fuels	122	65	73	69	54	84	73	45	65
Oil and Natural Gas	10,654	10,007	8,951	7,772	7,309	7,124	7,278	7,085	7,361

Total greenhouse gas emissions, in CO_2 equivalent, show a decrease of about 0.5% from 1990 to 2010; in particular, an upward trend is noted from 1990 to 2004, with an increase by 13.3%, while between 2004 and 2010 emissions have decreased by 12.2%.
CO_2 emissions, accounting for 97.2% of the total, have decreased by 0.1% from 1990 to 2010; N_2O shows an increase of 9.6% but its share out of the total is only 1.2% whereas CH_4 shows a decrease of 26.4% from 1990 to 2010, accounting for 1.6% of the total emission levels.
It should be noted that from 1990 to 2010 the most significant increase, in terms of total CO_2 equivalent, is observed in transport and in other sectors, about 15.3% and 20.2%, respectively; in 2010 these sectors,

altogether, account for 51.2% of total emissions. In the period 1990-2010, energy industries emissions have decreased by 2.9%, accounting for 32.5% of total emissions.

Details on these figures are described in the specific chapter.

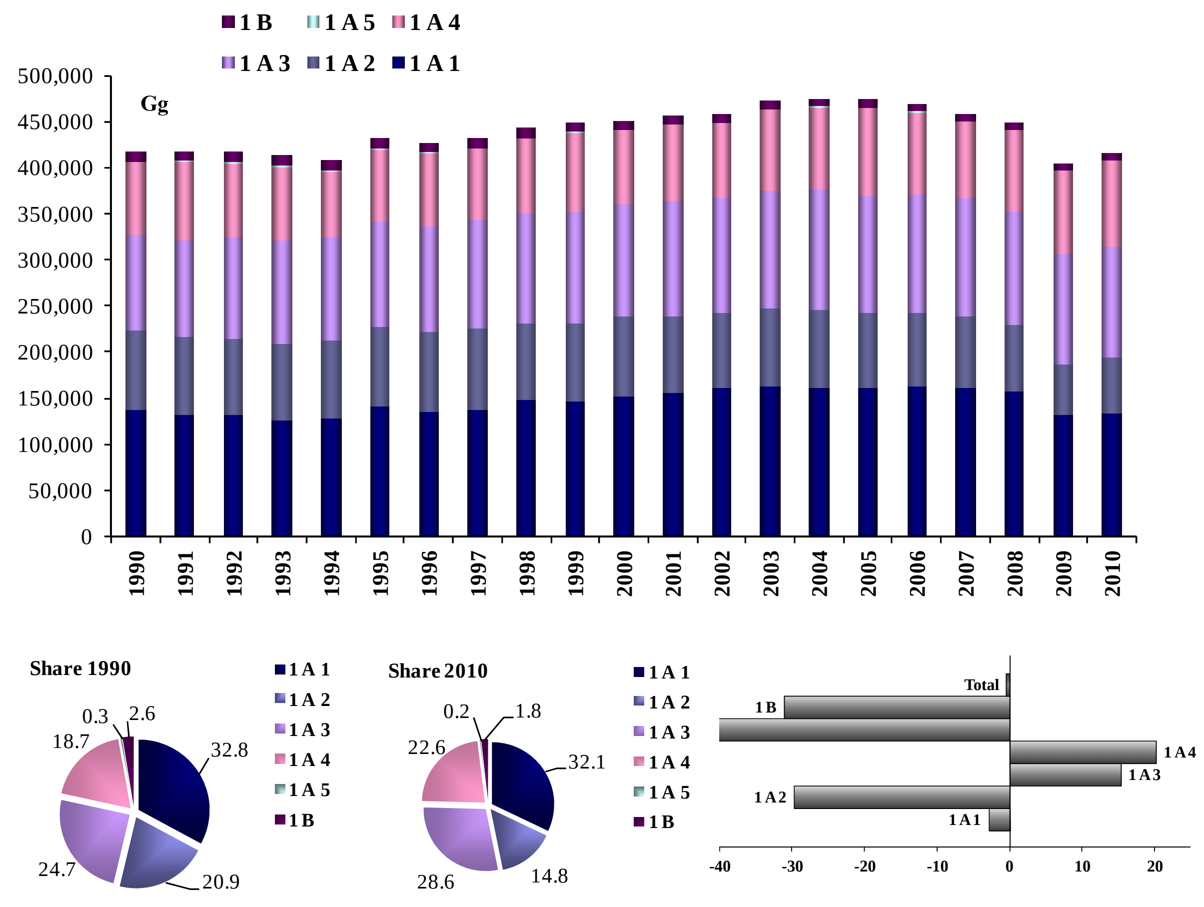

Figure 2.8 Trend of total emissions from the energy sector (1990-2010) (Gg CO_2 eq.)

2.3.2 Industrial processes

Emissions from industrial processes account for 6.4% of total national greenhouse gas emissions, excluding LULUCF.

Emission trends from industrial processes are reported in Table 2.2 and Figure 2.9.
Total emissions, in CO_2 equivalent, show a decrease of 16.7%, from the base year to 2010. Taking into account emissions by substance, CO_2 and N_2O decreased by 26.8% and 90.3%, respectively; these two gases account altogether for about 67.1% of the total emissions from industrial processes (CO_2 for 65.1% and N_2O for 2.0%). CH_4 decreased by 51.5% but it accounts only for 0.2%.
The decrease in emissions is mostly to be attributed to a decrease in chemical industry and metal production emissions. The decrease of GHG emissions in the chemical industry (-76.8%) is due to the decreasing trend of the emissions from nitric acid and adipic acid production (the last production process sharply reduced its emissions, due to a fully operational abatement technology). Emissions from metal production decreased by 61.6% mostly for the different materials used in the pig iron and steel production processes.
On the other hand, a considerable increase is observed in F-gas emissions (229.9%), whose share on total emissions is 32.7%.

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

Table 2.2 Total emissions from the industrial processes sector by gas (1990-2010) (Gg CO_2 eq.)

	1990	1995	2000	2005	2006	2007	2008	2009	2010
	Gg CO_2 eq								
Total	**38,390**	**35,929**	**36,249**	**42,592**	**38,143**	**38,575**	**35,642**	**30,871**	**31,963**
CO_2	28,434	26,038	24,571	27,186	27,205	27,684	25,066	20,078	20,804
CH_4	108	113	63	64	66	65	61	38	53
N_2O	6,676	7,239	7,918	7,760	2,647	1,891	1,066	1,130	647
F-gases	3,171	2,539	3,697	7,581	8,226	8,935	9,449	9,625	10,459
HFCS	*351*	*671*	*1,986*	*5,401*	*6,106*	*6,855*	*7,513*	*8,164*	*8,755*
PFCS	*2,487*	*1,266*	*1,217*	*1,715*	*1,714*	*1,652*	*1,501*	*1,063*	*1,331*
SF_6	*333*	*601*	*493*	*465*	*406*	*428*	*436*	*398*	*373*

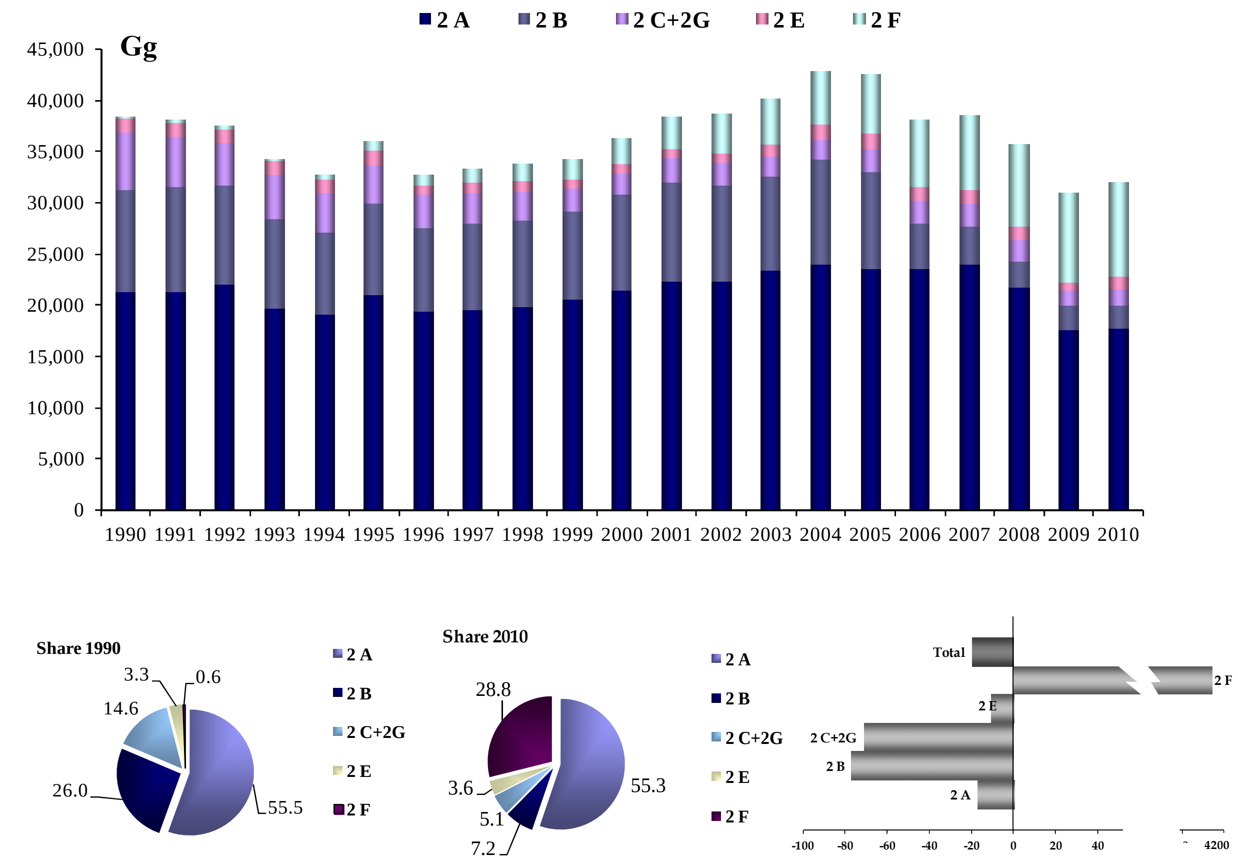

Figure 2.9 Trend of total emissions from the industrial processes sector (1990-2010) (Gg CO_2 eq.)

2.3.3 Solvent and other product use

Emissions from the solvent and other product use sector refer to CO_2 and N_2O, and to other substances that are not greenhouse gases. A considerable amount of emissions from this sector is, in fact, mostly to be attributed to NMVOC.

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

Table 2.3 Total emissions from the solvent and other product use sector by gas (1990-2010) (Gg CO_2 eq.)

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Gg CO_2 eq.									
Total emissions	**2,455**	**2,235**	**2,302**	**2,128**	**2,122**	**2,066**	**1,946**	**1,815**	**1,658**
CO_2	1,643	1,463	1,276	1,304	1,314	1,278	1,219	1,131	1,032
N_2O	812	772	1,027	823	808	788	727	684	626

In 2010, solvent use is responsible for 0.3% of the total CO_2 equivalent emissions (excluding LULUCF).
The share of CO_2 emissions, in this sector, is 62.2% out of the total, while N_2O emissions represent 37.8% of the sectoral total; a decrease by 32.5% is noted from this sector from 1990 to 2010, which is to be attributed to different sources. As regards CO_2, emission levels from paint application sector, which accounts for 45.4% of total CO_2 emissions from this sector, decreased by 44.5%; 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 48.4% of the CO_2 total emissions, show a decrease of 19.6%. Finally, CO_2 emissions from metal degreasing and dry cleaning activities, decreased by 64.2% but they account for only 6.1% of the total.
N_2O emissions from this sector, in 2010, represent 2.3% of the total N_2O national emissions.
The level of N_2O emissions shows a decrease of 22.9%. From 1990 to 1995, a quite stable level of N_2O emissions is observed, afterwards from 1995 to 1998 emissions increased by 36.7%. From 1999 onwards, a reduction in N_2O emissions is observed, due to a decrease in the anaesthetic use of N_2O, which has been replaced by halogen gas.

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

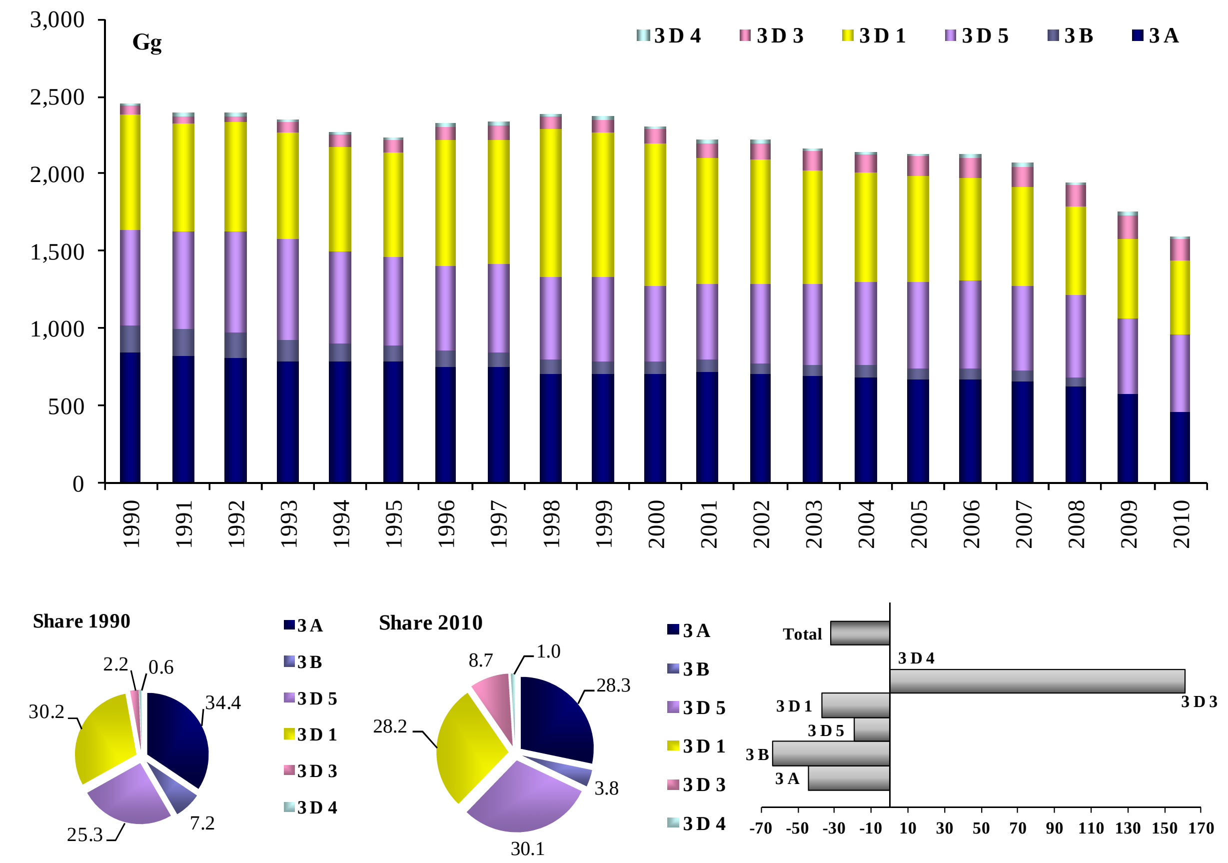

Figure 2.10 Trend of total emissions from the solvent and other product use sector (1990-2010) (Gg CO_2 eq.)

2.3.4 *Agriculture*

Emissions from the agriculture sector account for 6.7% of total national greenhouse gas emissions, excluding LULUCF.

Emissions from the agriculture sector are reported in Table 2.4 and Figure 2.11.

Table 2.4 Total emissions from the agriculture sector by source (1990-2010) (Gg CO_2 eq.)

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Gg CO_2 eq.									
Total emissions	**40,737**	**40,530**	**40,134**	**37,362**	**36,766**	**37,379**	**36,014**	**34,775**	**33,741**
Enteric Fermentation	12,278	12,348	12,246	10,914	10,699	11,099	10,996	11,007	10,732
Manure Management	7,383	7,068	7,140	6,857	6,629	6,833	6,736	6,685	6,268
Rice Cultivation	1,576	1,671	1,391	1,472	1,475	1,516	1,386	1,565	1,565
Agricultural Soils	19,482	19,426	19,341	18,101	17,947	17,914	16,879	15,502	15,159
Field Burning of Agricultural Residues	17	17	16	17	17	17	18	17	16

Emissions refer to CH_4 and N_2O levels, which account for 44.1% and 55.9% of the total emissions of the sector, respectively. The decrease observed in the total emissions (-17.2%) is mostly due to the decrease of CH_4 emissions from enteric fermentation (-12.6%) and to the decrease of N_2O (-22.2%) from agricultural soils, which account for 31.8% and 44.9% of the total sectoral emissions, respectively.

Detailed comments can be found in the specific chapter.

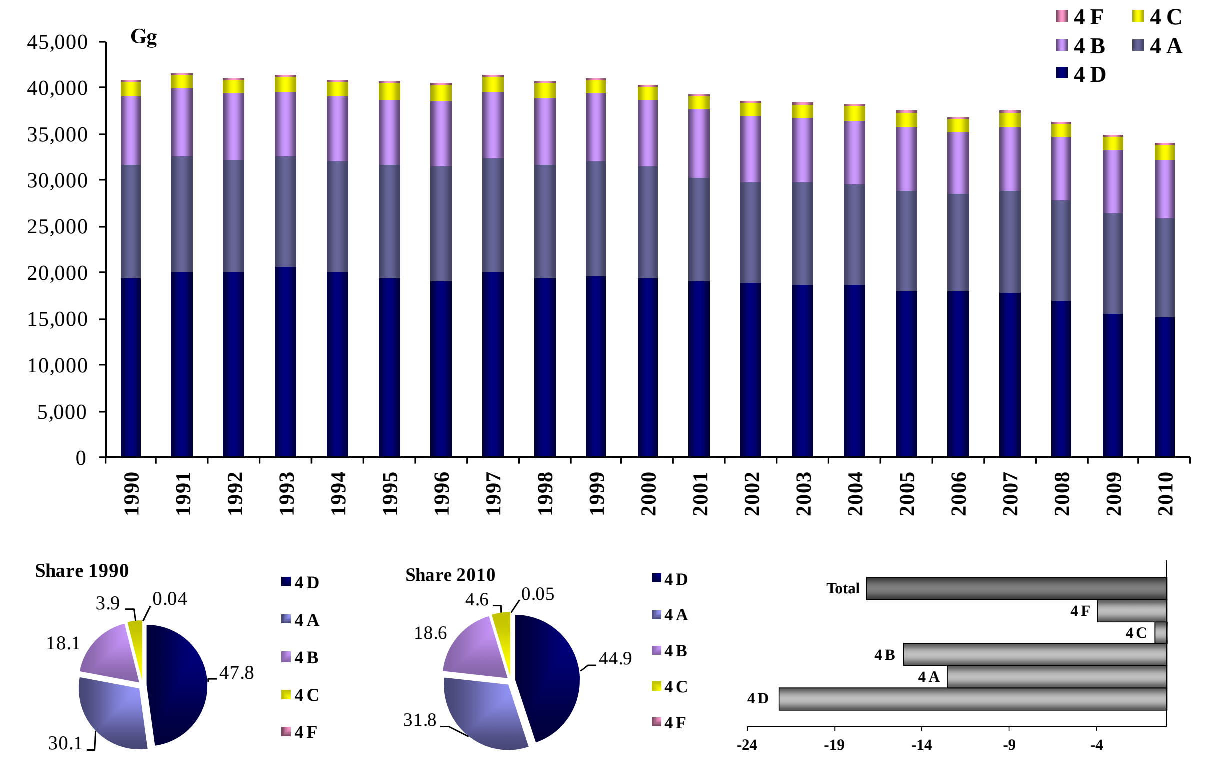

Figure 2.11 Trend of total emissions from the agriculture sector (1990-2010) (Gg CO_2 eq.)

2.3.5 LULUCF

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

Table 2.5 Total emissions from the LULUCF sector by source/sink (1990-2010) (Gg CO_2 eq.)

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Gg CO_2 eq.									
Total emissions	**-34,484**	**-48,089**	**-43,066**	**-53,575**	**-54,973**	**-35,481**	**-52,168**	**-55,946**	**-56,531**
Forest Land	-18,301	-35,363	-29,356	-39,822	-40,263	-22,117	-36,561	-40,138	-39,904
Cropland	-18,231	-12,759	-13,012	-11,501	-11,838	-12,279	-12,128	-12,155	-12,373
Grassland	-480	-2,492	-3,178	-5,614	-6,241	-4,463	-6,880	-7,062	-7,658
Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO
Settlements	2,527	2,525	2,480	3,362	3,370	3,377	3,400	3,409	3,404
Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other	NA	NA	NA	NA	NA	NA	NA	NA	NA

Total removals, in CO_2 equivalent, in the LULUCF sector, show an increase of 64.2% from the base year to 2010.
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.

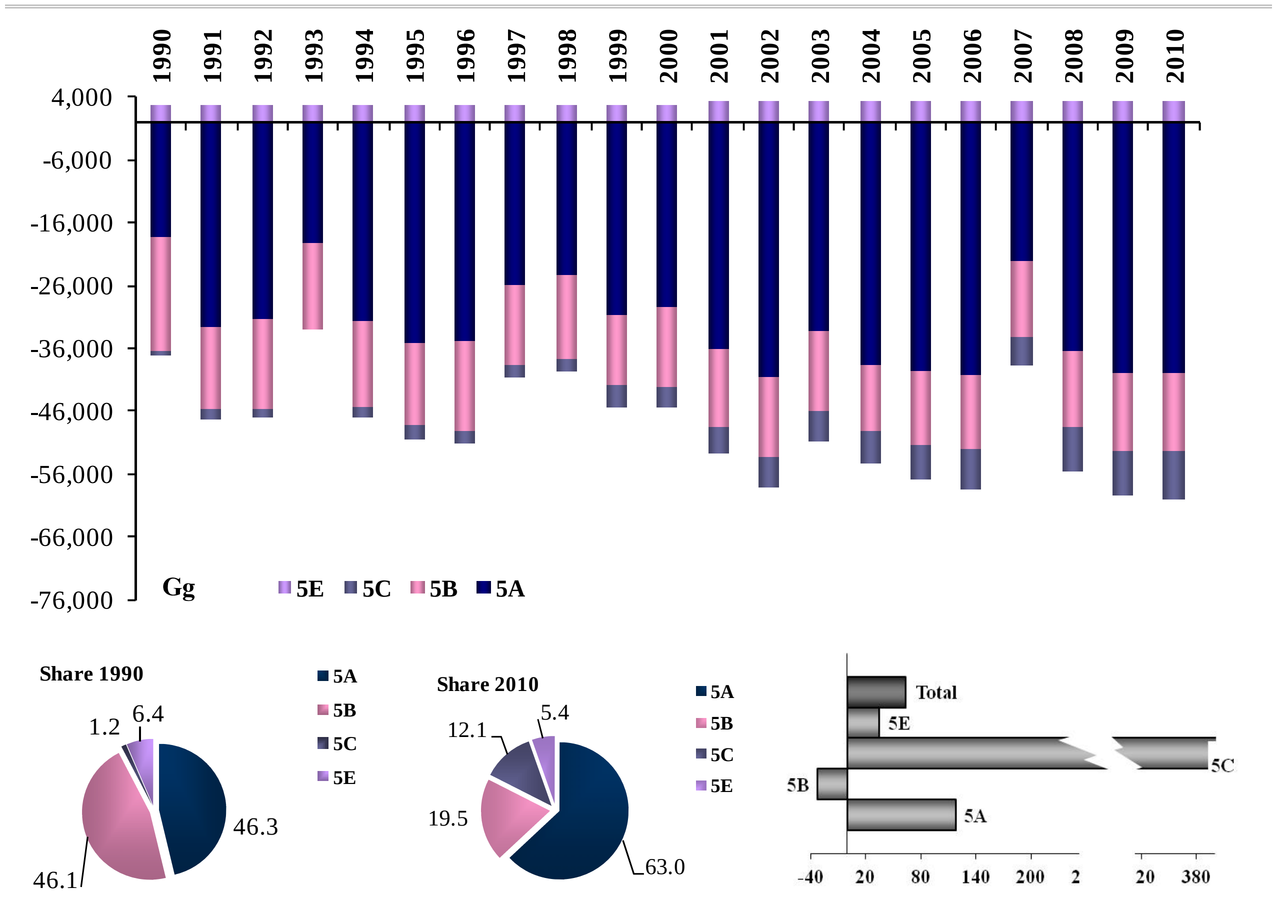

Figure 2.12 Trend of total emissions and removals from the LULUCF sector (1990-2010) (Gg CO_2 eq.)

2.3.6 Waste

Emissions from the waste sector account for 3.6% of total national greenhouse gas emissions, excluding LULUCF.

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

Table 2.6 Total emissions from the waste sector by source (1990-2010) (Gg CO_2 eq.)

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Gg CO_2 eq.									
Total emissions	**19,831**	**20,760**	**23,215**	**20,800**	**20,146**	**19,457**	**18,661**	**18,557**	**18,229**
Solid Waste Disposal on Land	15,254	15,909	18,357	15,514	14,851	14,194	13,364	13,237	12,892
Waste-water Handling	3,822	3,996	4,292	4,629	4,645	4,663	4,689	4,687	4,726
Waste Incineration	755	854	564	652	645	595	604	629	606
Other	0	0	2	4	4	5	4	4	5

Total emissions, in CO_2 equivalent, decreased by 8.1% from 1990 to 2010. The trend is mainly driven by the decrease in emissions from solid waste disposal on land (-15.5%), accounting for 70.7% of the total. Considering emissions by gas, the most important greenhouse gas is CH_4 which accounts for 87.3% of the total and shows a decrease of 8.6% from 1990 to 2010. N_2O levels have increased by 8.8% while CO_2 decreased by 54.6%; these gases account for 11.5% and 1.3%, respectively.
Further details can be found in the specific chapter.

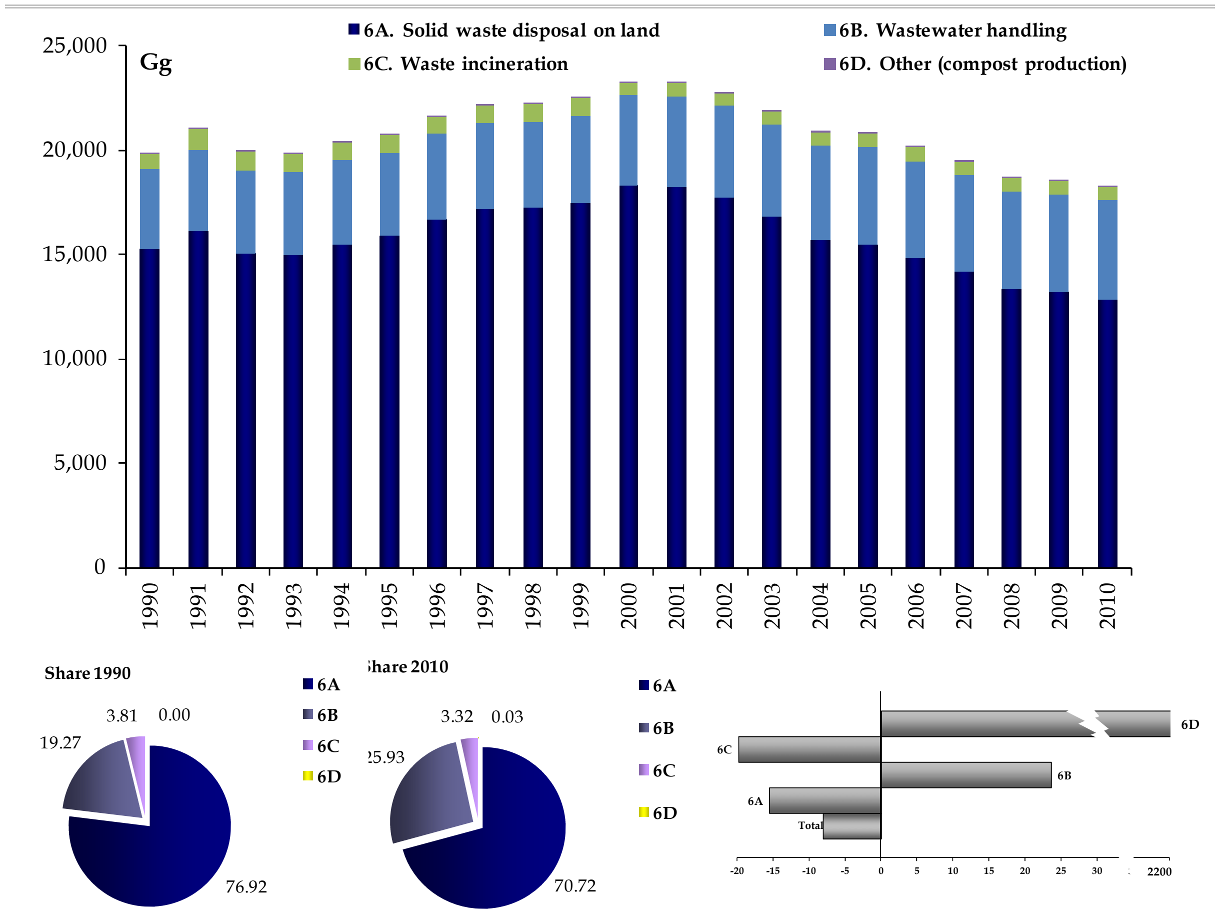

Figure 2.13 Trend of total emissions from the waste sector (1990-2010) (Gg CO_2 eq.)

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

Emission trends of NO_X, CO, NMVOC and SO_2 from 1990 to 2010 are presented in Table 2.7 and Figure 2.14.

Table 2.7 Total emissions for indirect greenhouse gases and SO_2 (1990-2010) (Gg)

Indirect GHG and SO_2	1990	1995	2000	2005	2006	2007	2008	2009	2010
	Gg								
NO_X	2,018	1,897	1,427	1,218	1,164	1,133	1,062	979	969
CO	7,325	7,092	4,935	3,505	3,281	3,410	3,035	2,811	2,764
NMVOC	2,024	2,087	1,612	1,318	1,286	1,272	1,196	1,134	1,082
SO_2	1,795	1,320	750	403	381	340	284	233	211

All gases show a significant reduction in 2010 as compared to 1990 levels. The highest reduction is observed for SO_2 (-88.3%), CO levels have reduced by 62.3%, while NO_X and NMVOC show a decrease by 52.0% and 46.5%, respectively. A detailed description of the trend by gas and sector as well as the main reduction plans can be found in the Italian National Programme for the progressive reduction of the annual national emissions of SO_2, NO_X, NMVOC and NH_3, as requested by the Directive 2001/81/EC.
The most relevant reductions occurred as a consequence of the Directive 75/716/EC, and successive ones related to the transport sector, and of other European Directives which established maximum levels for sulphur content in liquid fuels and introduced emission standards for combustion installations. As a consequence, in the combustion processes, oil with high sulphur content and coal have been substituted with oil with low sulphur content and natural gas.

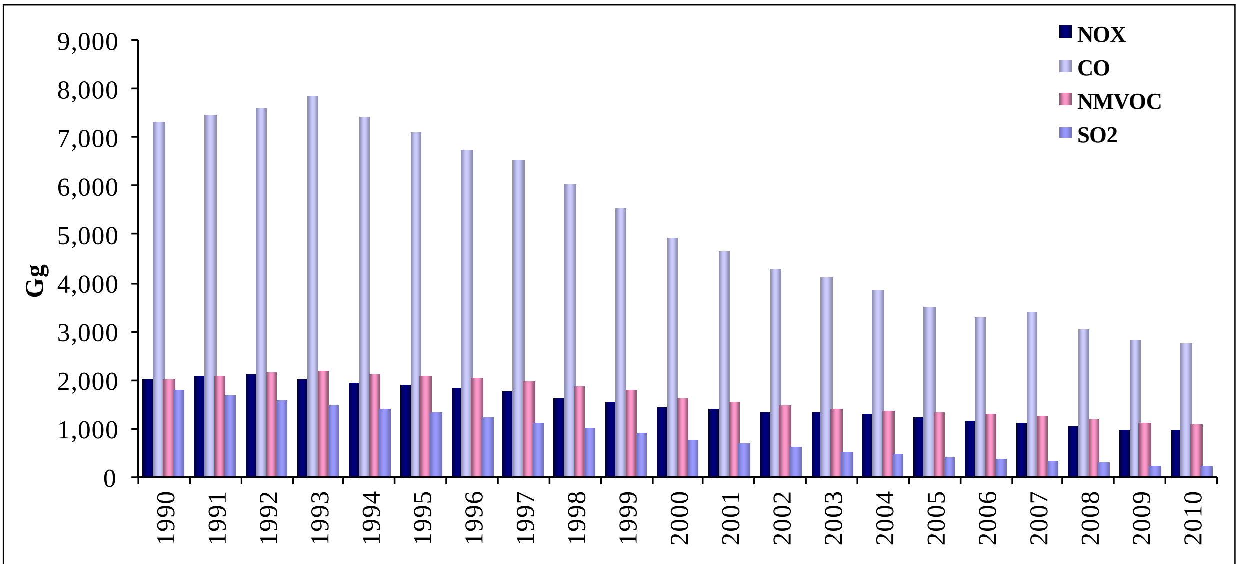

Figure 2.14 Trend of total emissions for indirect greenhouse gases and SO_2 (1990-2010) (Gg)

3 ENERGY [CRF sector 1]

3.1 Sector overview

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

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

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

Total Emission = Emission Factor x Activity Statistic

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

Emission = Σ Point Source Emissions

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

- Other Industry;
- Other Industry Off-road (see paragraph 3.6);
- Iron & Steel (Combustion, Blast Furnaces, Sinter Plant);
- Petrochemical industries (Combustion);

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

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

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

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

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 2010, 97% 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 8.22-8.26. Waste amount is then converted in energy content applying an emission factor equal to 9.2 GJ/t of waste. In 2010, the resulting average emission factor is equal to 116.3 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 2010, the energy sector accounts for 94.8% of CO_2 emissions, 17.9% of CH_4 and 18.3% of N_2O. In terms of CO_2 equivalent, the energy sector shares 84.6% of total national greenhouse gas emissions excluding LULUCF.
Emission trends of greenhouse gases from the energy sector are reported in Table 3.1.

Table 3.1 GHG emission trends in the energy sector 1990-2010 (Mt CO_2 eq.)

	1990	1995	2000	2005	2006	2007	2008	2009	2010
	Mt CO_2 eq.								
Energy	417.8	432.5	449.7	471.9	466.8	458.3	449.3	405.5	415.7
CO_2	404.4	417.2	436.4	459.4	454.9	446.3	437.5	394.0	404.0
CH_4	8.9	8.5	7.8	7.1	6.6	6.6	6.6	6.5	6.7
N_2O	4.6	6.8	5.4	5.3	5.4	5.4	5.2	5.0	5.0

Source: ISPRA elaborations

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

Table 3.2 Production of electricity by sources 1990-2010 (GWh)

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

Source: TERNA

More in general the share of the total energy consumption by primary sources in the period 1990- 2010, reported in Table 3.3, shows an evident change from oil products to natural gas while the consumption of solid fuels and electricity maintain their share constant.

Table 3.3 Total energy consumptions by primary sources 1990-2010 (%)

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

Source: Ministry Economic Development

Recalculations

In 2012 submission, recalculations regarded different sub-sectors.
For the whole energy sector, natural gas CO_2 emission factors have been updated for 2009 because of additional information collected on the chemical composition of natural gas imported.
Refinery gas, petcoke, synthesis gas from heavy residual fuel, coal derived gases CO_2 average emission factors have also been revised from 2005 and residual gas from chemical process CO_2 average emission factors from 1990 based on the analysis of information collected by the plants in the framework of EU ETS.
The whole time series of road transport emissions has been recalculated because of the updated version of the model/software, COPERT 4 version 9.0, used to estimate emissions. Recalculation affected mainly CH_4 and N_2O emissions. Detailed information is reported in paragraph 3.5.3.
Biomass fuel combustion in residential activity data has been revised from 2001 according to the relevant data supplied in the national Energy balance for 2010.
Waste fuel consumption for commercial heating activity data has been updated for the whole time series as a consequence of the reorganization of the waste incinerators database.
Moreover, as requested by the review process, average CH_4 and N_2O emission factors for recreational boats have been updated from 2000 taking in account the percentage of two-stroke engine equipped boats on total

boats. Other minor changes in activity data occurred, including natural gas losses from one operator which have been updated for 2009.

Recalculations affected the whole time series 1990-2009 for all gases. The following table shows the percentage differences between the 2012 and 2011 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 0.17% and 0.30% in 2009 mainly due to the update of residual gas from chemical process CO_2 emission factors from 1990 and the update of CO_2 emission factors for the other fuels in 2009.

Table 3.4 Emission recalculations in the energy sector 1990-2009 (%)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	%																			
Energy	***-0.17***	***-0.09***	***-0.07***	***0.00***	***0.17***	***0.25***	***0.39***	***0.37***	***0.36***	***0.30***	***-0.24***	***-0.23***	***-0.22***	***-0.18***	***-0.19***	***-0.35***	***-0.32***	***-0.05***	***-0.33***	***-0.30***
CO_2	-0.22	-0.14	-0.12	-0.13	-0.15	-0.20	-0.18	-0.23	-0.24	-0.29	-0.28	-0.28	-0.30	-0.26	-0.28	-0.44	-0.41	-0.16	-0.45	-0.45
CH_4	0.65	0.66	0.67	0.70	0.73	0.76	0.89	0.91	0.69	0.83	0.78	1.28	2.50	2.64	3.00	2.83	3.23	4.02	4.04	4.27
N_2O	2.78	3.00	3.26	9.69	26.35	37.03	46.09	48.08	49.30	48.34	1.73	2.11	3.32	3.26	3.25	3.56	3.58	4.79	5.29	6.03

Source: ISPRA elaborations

Key categories

Key category analysis, for the years 1990 and 2010, identified 10 categories at level or trend assessment with Approach 1 and Approach 2 in the energy related emissions.
In the case of the energy sector in Italy, a sector by sector analysis instead of a source by source analysis will better illustrate the accuracy and reliability of the emission data, given the interconnection between the underlying data of most key categories.
In the following box, the relevant key categories are listed, making reference to the section of the text where they are quoted.

Key-categories identification in the energy sector with the IPCC Approach 1 and Approach 2 for 2010

KEY CATEGORIES	**without LULUCF**	**with LULUCF**	**Relevant paragraphs**	**Notes**
1. CO_2 stationary combustion liquid fuels	L,T	L,T	3.3, 3.4 and 3.6	Table 3.8-3.11
2. CO_2 stationary combustion solid fuels	L,T1	L	3.3, 3.4 and 3.6	Table 3.8-3.11
3. CO_2 stationary combustion gaseous fuels	L,T	L,T	3.3, 3.4 and 3.6	Table 3.8-3.11
4. CO_2 mobile combustion: Road Vehicles	L,T	L,T	3.5 and 3.5.3	Tables 3.26, 3.27
5. N_2O stationary combustion	L, T2	L	3.3, 3.4 and 3.6	Table 3.8-3.11
6. CO_2 mobile combustion: Waterborne Navigation	L1	L1	3.5.4	Table 3.28
7. CH_4 fugitive emissions from Oil and Gas Operations	L,T	L1,T1	3.9	Table 3.40
8. CO_2 fugitive emissions from Oil and Gas Operations	L1, T2		3.9	Table 3.40
9. CO_2 stationary combustion other fuels	L1,T1	L1,T1	3.3, 3.4 and 3.6	Table 3.8-3.11
10 CH_4 stationary combustion	T2		3.3, 3.4 and 3.6	Table 3.8-3.11

With reference to the box, six key categories (n. 1, 2, 3, 5, 9 and 10) are linked to stationary combustion and to the same set of energy data: the energy sector CRF Table 1.A.1, the industrial sector, Table 1.A.2 and the civil sector Tables 1.A.4a and 1.A.4b. Four out of six key categories refer to CO_2 emissions. All these sectors refer to the national energy balance (MSE, several years [a]) for the basic energy data and the distribution among various subsectors, even if more accurate data for the electricity production sector can be found in TERNA publications (TERNA, several years). Evolution of energy consumptions/emissions is linked to the activity data of each sector; see paragraph 3.3, 3.4 and 3.6 and Annex 2 for the detailed analysis of those sectors.
Electricity production is the most "dynamic" sector and most of the emissions increase from 1990 to 2010, 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 2010, an increase in use of natural gas instead of fuel oil and gas oil in stationary combustion plants is observed; it results in a decrease of CO_2 emissions from combustion of liquid fuels and an increase of emissions from gaseous fuels.

Table 3.5 Stationary combustion, GHG emissions in 1990 and 2010

	1990	**2010**
CO_2 stationary combustion liquid fuels, Gg	153,467	64,166
CO_2 stationary combustion solid fuels, Gg	59,348	54,967
CO_2 stationary combustion gaseous fuels, Gg	85,066	158,764
CO2 stationary combustion other fuels, Gg	887	5,790
CH4 stationary combustion, Mg	647	1298
N2O stationary combustion, Mg	3444	3797

Source: ISPRA elaborations

Another group of key categories (n. 4, 6) referred to the transport sector, with basic total energy consumption reported in the national energy balance and then subdivided in the different subsectors with activity data taken from various statistical sources; see paragraph 3.5, transport, for an accurate analysis of these key sources. This sector also shows a remarkable increase in emissions, in particular CO_2 from air transport and road transport, as can be seen in Table 3.18 and Table 3.27, respectively. The trend of N_2O and CH_4 emissions is linked to technological changes occurred in the period.

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

Most of the categories described are also key categories for the years 1990 and 2010 taking into account LULUCF emissions and removals.

3.2 Methodology description

Emissions are calculated by the equation:

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

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

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

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

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

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

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

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

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

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

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

The energy balances of fuels used in Italy, published by the Ministry of Economic Development (MSE, several years [a]), compare total supply based on production, exports, imports, stock changes and known losses with the total demand; the difference between total supply and demand is reported as 'statistical difference'. In Annex 5, 2010 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 2010, Primary fuels. From 2001 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 2001, the energy balances prepared by MSE include those quantities in the input while estimating final consumption; this procedure summarizes a complex stock change reporting by operators.

3.3 Energy industries

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

3.3.1 Public Electricity and Heat Production

3.3.1.1 Source category description

This paragraph refers to the main electricity producers that produce electricity for the national grid. From 1998 onwards, the expansion of the industrial cogeneration of electricity and the split of the national monopoly have transformed many industrial producers into "independent producers", regularly supplying the national grid. Those producers account in 2010 for 92.1% of all electricity produced with combustion processes in Italy (TERNA, several years).
No data on consumption / emissions from heat production is reported in this section. In Italy, only limited data do exist about producers working for district heating grids; most of the cogenerated heat is produced and used on the same site by industrial operators. Therefore data on heat production is not reported here but in Table1.A(a)s2 for industry and Table1.A(a)s4 for district heating. In TERNA yearly publication, heat cogenerated while producing electricity is reported separately. Unfortunately, no details are reported on the final use of cogenerated heat, so it can be used in the inventory preparation just to cross check the total fuel amount with other sources as EU ETS or the consumption of fuels in the industry reported in BEN.

3.3.1.2 Methodological issues

The data source on fuel consumption is the annual report "Statistical data on electricity production and power plants in Italy" ("Dati statistici sugli impianti e la produzione di energia elettrica in Italia"), edited from 1999 by the Italian Independent System Operator (TERNA, several years). The reports refer to the total of producers and the estimate of the part belonging to public electricity production is made by the inventory team on the basis of detailed electricity production statistics by industrial operators. Data on total electricity production for the year 2010 are reported in Annex 2. For the time series, see previous NIR reports. The emission factors used are listed in Table 3.12.
Another source of information is the National Energy Balance (MSE, several years [a]), which contains data on the total electricity producing sector. The data of the National Energy Balance (BEN) are also used to address the statistical survey of international organizations, IEA and Eurostat. Both BEN and TERNA publications could be used for the inventory preparation, as they are part of the national statistical system and published regularly.
A detailed analysis of both sources is reported in Annex 2; TERNA data appears to be more suitable for inventory preparation. From year 2005 onwards a valuable source of information is given by the reports prepared for each industrial installation subject to EU ETS scheme. Those reports are prepared by independent qualified verifiers and concern the CO_2 emissions, emission factors and activity data, including fuel used. ISPRA receives copy of the reports from the competent authority (Ministry of Environment) and has been able to extract the information relative to electricity production. The information available is very useful but not fully covering the electricity production sector or the public electricity production. The EU ETS does not include all installations, only those above 20 MWe, it is made on a point source basis so the data include electricity and heat production while the corresponding data from TERNA, concerning only the

fuel used for electricity production, are commercially sensitive, confidential and they are not available to the inventory team. Anyway the comparison of data collected by TERNA with those submitted to the EU ETS allows identifying possible discrepancies in the different datasets and thus providing the Ministry of Economic Development experts with useful suggestions to improve the energy balance.

To estimate CO_2 emissions, and also N_2O and CH_4 emissions, a rather complex calculation sheet is used (APAT, 2003[a]). The data sheet summarizes all plants existing in Italy divided by technology, about 60 typologies, and type of fuel used; the calculation sheet is a model of the national power system. The model is aimed at estimating the emissions of pollutants different from CO_2 that are technology dependent. For each year, a run estimates the fuel consumed by each plant type, the pollutant emissions and GHG emissions. The model has many possible outputs, some of which are built up in order to reproduce the data available from statistical source. 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.

Table 3.6 Public electricity and heat production: Energy data (TJ) and GHG emissions (Mt), 1990-2010

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Fuel consumption (TJ)	1,428,137	1,468,278	1,668,305	1,799,929	1,822,784	1,838,270	1,727,590	1,480,344	1,420,120
GHG (Mt)	107,544	109,875	115,531	119,656	120,784	120,298	113,490	97,266	93,144
CO_2 (Mt)	107,136	109,477	115,159	119,219	120,346	119,875	113,080	96,888	92,797
CH_4 (Mt)	3.9	4.1	3.9	4.4	4.5	4.3	4.2	3.9	3.5
N_2O (Mt)	1.1	1.0	0.9	1.1	1.1	1.1	1.0	1.0	0.9

Source: ISPRA elaborations

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

3.3.2 Refineries

3.3.2.1 Source category description

This subsector covers the energy emissions from the national refineries (16 plants), including the energy used to generate electricity for internal use and exported to the national grid by power plants that directly use off-gases or other residues of the refineries. Those power plants are generally owned by other companies but are located inside the refinery premises or just sideway. In 2009 the power plants included in this source category have generated 4.5% of all electricity produced with combustion processes in Italy.
The energy consumption and emissions are reported in CRF Table 1.A.1.b. Parts of refinery losses, flares, are reported in CRF Table 1.B.2.a and c, using IPCC emission factors.

3.3.2.2 Methodological issues

The consumption data used for refineries come from BEN (MSE, several years [a]); the same data are also reported by Unione Petrolifera, the industrial category association (UP, several years). From 2005 onwards, also the EU ETS “verifier’s reports” cover almost the entire sector, for energy consumptions, combustion emissions and process emissions. Other sources of information are the yearly reporting obligations for the large combustion plants under European Directive (LCP) and the E-PRTR Regulation; both data collections include most of refineries but not all the emission sources.
The available data in BEN specify the quantities of refinery gas, petroleum coke and other liquid fuels. They are reported in Annex 5, Table A5.6.
For the part of the energy and related emissions due to the power plants the source is TERNA and please refers to Annex 2 for further details. The quota of total energy consumption from electricity production included in source category 1.A.1.b is estimated by the electricity production model on the basis of fuels used and plant location.

All the fuel used in boilers and processes, the refinery "losses" and the reported losses of crude oil and other fuels (that are mostly due to statistical discrepancies) are considered to calculate emissions. Fuel lost in the distribution network is accounted for here and not in the individual end use sector. From 2002 particular attention has been paid to avoid double counting of CO_2 emissions checking if the refinery reports of emissions already include losses in their energy balances. IPCC Tier 2 emission factors and national emission factors are used as reported in Table 3.12.
From 2008, TERNA modified the detailed table of fuel consumption and related energy produced introducing a more complete list of fuels. Aim of the change was to revise the consumption values of waste fuels which are very important for estimating the contribution of renewable to electricity production and consequently greenhouse gases.

In Table 3.7, a sample calculation for the year 2010 is reported, with energy and emission data.

Table 3.7 Refineries, CO_2 emission calculation, year 2010

	Consumption, TJ				CO_2 emissions, Gg			
REFINERIES	Petroleum coke	Ref. gas	Liquid fuels	Natural gas	Petroleum coke	Ref. gas	Liquid fuels	Natural gas
energy			113,169	50,871			9,454	2,912
furnaces	37,830	118,766	70,941		3,522	6,809	5,338	
TOTAL				391,577				28,035

Source: ISPRA elaborations

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

3.3.2.3 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions from refineries is estimated to be about 4.2% in annual emissions; a higher uncertainty, equal to 50.1%, is calculated for CH_4 and N_2O emissions because of the uncertainty levels attributed to the related emission factors.
Montecarlo analysis has been carried out to estimate uncertainty of CO_2 emissions from stationary combustion of solid, liquid and gaseous fuels emissions, resulting in 5.1%, 3.3% and 5.8%, respectively. Normal distributions have been assumed for all the parameters. A summary of the results is reported in Annex 1

In Table 3.8 GHG emissions from the sector in the years 1990, 1995, 2000, 2005-2010 are reported.

Table 3.8 Refineries, GHG emission time series

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

Source: ISPRA elaborations

An upward trend in emission levels is observed from 1990 to 2008 explained by the increasing quantities of crude oil processed and the complexity of process used to produce more environmentally friendly transportation fuels. Fuel consumptions have reached a plateau in 2005 and they are now in a downward trend that is expected to continue, due to the reduced quantities of crude oil processed and electricity produced. In 2009 a drop is noted due to the effects of the economic recession that in 2010 has partially recovered.

3.3.2.4 Source-specific QA/QC and verification

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

3.3.2.5 Source-specific recalculations

In 2012 submission, recalculations occurred for this category due to the update of petcoke, gas refinery and synthesis gas CO_2 emission factors from 2005 and natural gas CO_2 emission factor for 2009, and an update of natural gas and fuel oil consumption for 2008 and 2009 from the sector resulting in a decrease of CO_2 emissions equal to 0.2% in 2005 and 0.0002% in 2009 and an increase of 2.1% in 2008. CH_4 and N_2O emissions also increased of about 7% and 5% respectively both in 2008 and 2009 due to the effect of recalculations.

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 2010 the power plants included in this source category have generated about 3% of all electricity produced with combustion processes in Italy.

3.3.3.2 Methodological issues

Fuel consumption data for the sector are reported in the BEN (MSE, several years [a]). Fuels used to produce energy are also reported with more detail as for fuel disaggregation level by TERNA (TERNA, several years). From 2005 onwards, also the EU ETS “verifier’s reports” cover almost the entire sector, for energy consumptions, combustion emissions and process emissions. Other sources of information are the yearly reporting obligations for the large combustion plants under European Directive (LCP) and for facilities under the E-PRTR Regulation; both reporting obligations include most of the iron and steel integrated plants and the only coke producing plant but not all the emission sources. A carbon balance is done, as suggested by the IPCC good practice guidance, to avoid over or under estimation from the sector. In Annex 3 further details on carbon balances of solid fuels and derived gases used are reported.

The high-implied emission factor for solid fuels is due to the large use of derived steel gases and in particular blast furnace gas to produce energy. These gases have been assimilated to the renewable sources and incentives are still provided for their use.

Other fuels are used in co-combustion with coal gases to produce electricity and they are reported by TERNA, see Annex 2. From 2008, natural gas and fuel oil consumptions reported in the CRF for this sector, are those communicated by the operators of the plants included in the sector in the framework of the EU ETS scheme. The consumptions of these fuels, especially for natural gas, are higher than those reported for the previous years. Fuel consumption reported in the sector is subtracted from the total fuel consumption to produce energy, guaranteeing that over and under estimation are avoided.

CH_4 emissions from coke ovens are estimated on the basis of production data to take in account additional volatile emissions due to the specific process.

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 CH4 and N2O emissions on account of the uncertainty levels attributed to the related emission factors.

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

In Table 3.9 GHG emissions from the sector in the years 1990, 1995, 2000, 2005-2010 are reported.

Table 3.9 Manufacture of solid fuels, GHG emission time series

	1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2 emissions, Mt	13.0	11.8	14.4	13.5	14.5	13.8	15.1	9.0	11.8
CH_4 emissions, Gg	4.9	3.8	2.3	1.2	1.0	0.7	0.7	0.6	0.7
N_2O emissions, Gg	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total, Mt CO_2 eq	13.2	11.9	14.5	13.5	14.6	13.9	15.1	9.0	11.8

Source: ISPRA elaborations

An upward trend in emission levels is observed from 1990 to 2008, especially for the last years. That is explained by the increasing quantities of steel production, from 25.5 Mt in 1990 to 30.6 Mt in 2008 and siderurgical products, from 25.0 Mt in 1990 to 35.0 Mt in 2008, and the specialisation of the national industry in high quality steel products, more energy intensive. In 2009 a strong reduction of emissions is observed due to the effects of the economic recession that in 2010 has partially recovered.
The strong reduction of CH_4 emissions in the last years refers to coke production and it is the result of the renewal of the coke production plants in Taranto, started in 2005, and the implementation of best available technologies to reduce volatile organic compounds.

3.3.3.4 Source-specific QA/QC and verification

Basic data to estimate emissions have been reported by national energy balance and the national grid administrator. Data collected under other reporting obligations that include integrated iron and steel plants, such as EU ETS Directive, LCP and E-PRTR databases, have been used to cross-check the energy balance data, fuels used and emission factors. Differences and problems have been analysed in details and solved together with Ministry of Economic Development experts, which are in charge to prepare the National Energy Balance. In particular, in the national PRTR register the integrated plants report every year the CO_2 emitted at each stage of the process, coke production, sinter production and iron and steel production, which result from separate carbon balances calculated in each phase of the production process. Moreover, total CO_2 emissions reported in the E-PRTR by the operators are equal to those reported under the EU ETS scheme.
The detailed analysis and comparison of the different data reported improved the allocation of fuel consumption and CO_2 emissions between 1.A.1.c and 1.A.2.a sectors. From 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 2012 submission, recalculations occurred for this category due to the update of natural gas CO_2 emission factor for 2009 and to the update of coke oven, blast furnace and oxygen converter gases CO_2 emission factors from 2005, resulting in a decrease of CO_2 emission around 2.3%. The decrease of emissions due to the update of coal derived gases emission factors is balanced by an equivalent increase of emissions in the 1.A.2.a category which includes the results of the carbon balance in the iron and steel production sector.

3.3.3.6 Source-specific planned improvements

No specific improvements are planned for the next submission.

3.4 Manufacturing industries and construction

3.4.1 Sector overview

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

In 2010, energy use in industry account for 16.2% of total national CO_2 emissions, 0.3% of CH_4, 4.6% of N_2O. In term of CO_2 equivalent, manufacturing industry share 12.2% of total national greenhouse gas emissions.

Six key categories have been identified for this sector in 2010, as for the energy industries, for level and trend assessment, using both the IPCC Approach 1 and Approach 2:
CO_2 Stationary combustion liquid fuels (L, T);
CO_2 Stationary combustion solid fuels (L, T1);
CO_2 Stationary combustion gaseous fuels (L, T);
CO_2 Stationary combustion other fuels (L1, T1);
N_2O Stationary combustion (L, T2)
CH_4 Stationary combustion (T2).

All these categories, except CH_4 from Stationary combustion, are also key category including the LULUCF estimates in the key category assessment.

In the following Table 3.10, GHG emissions connected to the use of fossil fuels, process emissions excluded, are reported for the years 1990, 1995 and 2000-2010. Industrial emissions show oscillations, related to economic cycles.

Table 3.10 Manufacturing industry, GHG emission time series

	1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2 emissions, Gg	85,631	85,244	82,452	78,705	77,480	74,199	70,866	54,650	60,016
CH_4 emissions, Mg	6.82	7.02	5.72	6.28	6.24	6.53	6.24	4.18	5.51
N_2O emissions, Mg	4.93	4.52	4.66	5.02	5.05	4.98	4.64	3.98	4.01
Industry, total, Gg CO2	87,303	86,793	84,017	80,393	79,176	75,880	72,435	55,973	61,375

Source: ISPRA elaborations

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

Table 3.11 Trend in greenhouse gas emissions from the manufacturing industry sector, 1990-2010

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2 (Gg)									
1.A.2.a Iron and Steel	18,272	18,854	13,535	14,775	14,277	14,462	13,549	8,768	14,092
1.A.2.b Non-Ferrous Metals	738	907	1,252	1,167	1,173	1,142	1,096	1,021	1,130
1.A.2.c Chemicals	19,203	17,280	12,250	10,835	10,553	10,274	9,285	7,384	7,778
1.A.2.d Pulp, Paper and Print	3,076	4,163	4,223	4,563	4,563	5,194	4,289	3,803	4,578
1.A.2.e Food	3,853	5,062	6,238	6,441	5,688	5,429	5,568	4,661	4,398
1.A.2.f Other	40,489	38,978	44,954	40,924	41,225	37,698	37,079	29,015	28,040
CH_4 (Mg)									
1.A.2.a Iron and Steel	3,795	4,226	3,093	3,304	3,275	3,592	3,521	1,892	2,880
1.A.2.b Non-Ferrous Metals	13	16	27	24	25	23	22	20	21
1.A.2.c Chemicals	798	677	318	340	323	301	231	177	198
1.A.2.d Pulp, Paper and Print	77	94	91	104	114	124	115	77	85
1.A.2.e Food	105	127	175	410	390	428	455	464	819
1.A.2.f Other	2,031	1,880	2,019	2,094	2,116	2,057	1,900	1,550	1,505
N_2O (Mg)									
1.A.2.a Iron and Steel	362	370	302	330	326	316	295	191	292
1.A.2.b Non-Ferrous Metals	13	16	25	23	23	22	21	19	21
1.A.2.c Chemicals	346	285	159	152	148	143	125	94	109
1.A.2.d Pulp, Paper and Print	64	82	81	89	90	101	84	70	82
1.A.2.e Food	52	53	76	91	87	81	81	61	57
1.A.2.f Other	4,093	3,712	4,020	4,335	4,375	4,317	4,032	3,547	3,449

Source: ISPRA elaborations

3.4.2 Source category description

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

Iron and steel
The main processes involved in iron and steel production are those related to sinter and blast furnace plants, to basic oxygen and electric furnaces and to rolling mills.
Most of emissions are connected to the integrated steel plants, while for the other plants, the main energy source is electricity (accounted for in 1.A.1.a) and the direct use of fossil fuels is limited to heating – re heating of steel in the intermediate part of the process.
There were four integrated steel plants in 1990 that from 2005 are reduced to two, with another plant that still has a limited production of pig iron. Nevertheless, the steel production has not changed significantly in the 1990-2008 period due to an expansion in capacity of the two operating plants. The maximum production was around 11 Mt/y in 1990, 1995 and in 2005-2008, with lower values in other years and the lowest of 6 Mt in 2009.
It has to be underlined that the integrated steel plants include also the cogeneration of heat and electricity using the recovered "coal gases" from various steps of the process, including steel furnace gas, BOF gas and coke oven gas. All emissions due to the "coal gases" used to produce electricity are included in the electricity grid operator yearly reports and are accounted in the category 1.A.1.c. No detailed info is available for the heat produced, so the emissions are included in source category 1.A.2.a.

Non-Ferrous Metals
In Italy there is a production of primary aluminium (232 Gg in 1990 and 129 Gg in 2010) and of secondary aluminium (350 Gg in 1990 and 601 in 2010). Those productions however use electricity as the primary energy source so the emissions due to the direct use of fossil fuels are limited. At present in Italy, there 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. The bulk of emissions are due to foundries that prepare mechanical pieces for the engineering industry or the market, using all kinds of alloys, including aluminium, steel and iron.

Chemicals

CO_2, CH_4 and N_2O emissions from chemical and petrochemical plants are included in this sector.
In Italy there are petrochemical plants integrated with a nearby refinery and stand alone plants that get the inputs from the market. Main products are Ethylene, Propylene, Styrene.
In particular, ethylene and propylene are produced in petrochemical industry by steam cracking. Ethylene is used to manufacture ethylene oxide, styrene monomer and polyethylene. Propylene is used to manufacture polypropylene but also acetone and phenol. Styrene, also known as vinyl benzene, is produced on industrial scale by catalytic dehydrogenation of ethyl benzene. Styrene is used in the rubber and plastic industry to manufacture through polymerisation processes such products as polystyrene, ABS, SBR rubber, SBR latex. Except for ethylene oxide production, which has stopped since 2002, the other productions of the above mentioned chemicals still occur in Italy. Activity data are stable from 1990 to 2010, 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 2010 the production has been greatly reduced, with less than half of the 1990 production still occurring in 2010.
This source category does include some emissions from the cogeneration of electricity. Due to the transformation of some of those plants in power plants directly connected to the grid (and so reported in category 1.A.1.a) the percentage of the category 1.A.2.c CO_2 emissions due to electricity generation has changed from 22% in 1990 to 19% in 2010.

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 2010. Most of the pulp was imported in 1990, while in 2010 half of the pulp used is produced locally from recycled paper. The paper production is expanding and activity data (total paper produced) was 6.3 Mt in 1990 and 9.0 Mt in 2010. The printing industry represents a minor part of the source category emissions.
This source category includes also the emissions from the cogeneration of electricity. Due to the transformation of some of those plants in power plants directly connected to the grid (and so reported in category 1.A.1.a), the percentage of the category 1.A.2.d CO_2 emissions due to electricity generation has strongly reduced from 1990 to 2010.

Food

Emissions from the food production are included in this source category. In Italy the industrial food production is expanding. A comprehensive activity data for this sector is not available; energy consumption was estimated to be 137 PJ in 1990 and 188 PJ in 2010. Value added in constant money has increased of 0.6% per years from 1990 to 2003 and of 0.1% yearly from 2004 to 2010.
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 reduced from 1990 to 2010.

Other

This sector comprises emissions from many different industrial subsectors, some of which are quite significant in Italy in terms of both value added and export capacity.
In particular, engineering sectors (vehicles and machines manufacturing) is the main industrial sub sector in terms of value added and revenues from export and textiles was the second subsector up to year 2000.
Another sub sector, construction materials, is also included here and it is also quite significant in terms of emissions due to the energy intensity of the processes involved. Construction materials subsector includes the production of cement, lime, bricks, tiles and glass. It comprises thousands of small and medium size enterprises, with only a few large operators, mainly connected to cement production. Some of the production is also exported. The description of the process used to produce cement, lime and glass is reported in chapter 4, industrial processes.

The fabrication of bricks is a rather standard practice in most countries and does not need additional description; fossil source is mainly natural gas. A peculiar national circumstance is the fabrication of tiles, in which are involved many specialised “industrial districts” where many different independent small size enterprises are able to manufacture world level products for both quality and style, exported everywhere. Generally speaking, the processes implemented are efficient with reference to the average European level and use mostly natural gas as the main fossil source since the year 2000.
The remaining “other industries” include furniture and other various “made in Italy” products that produce not negligible amounts of emissions.
The activity data of industries oriented to so different markets are, of course, peculiar to each subsector and it is difficult to identify a common trend. The productions of cement, lime and glass are the most relevant from the emissions point of view.
This short preface is needed to understand the reasons because this subsector is a key sector and accounts, in 2010, for 48.6% of the total source 1.A.2 CO_2 emissions, and for 5.8 % 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 reduced in the last years.

3.4.3 Methodological issues

Energy consumption for this sector is reported in the BEN (see Annex 5, Tables A5.9 and A5.10). The data comprise specification of consumption for 13 sub-sectors and more than 25 fuels. 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).

Table 3.12 Emission Factors for Power, Industry and Civil sector

	t CO_2 / TJ	t CO_2 / t	t CO_2 / toe
Liquid fuels			
Crude oil	72.549	3.035	3.035
Jet gasoline	70.000	3.075	2.929
Jet kerosene	71.500	3.111	2.992
Petroleum Coke, 2010 average	93.104	3.199	3.895
Gasoil	73.274	3.127	3.066
Orimulsion	77.733	2.177	3.252
Synthesis gas from heavy residual, 2010 average	100.911	0.902	4.222
Residual gases from chemical processes	50.209	2.527	2.101
Gaseous fuels, national data			
Natural gas, 2010 average	57.244	1.962 (sm^3)	2.395
Solid fuels			
Steam coal, 2010 average	91.905	2.290	3.845
"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, 2010 average	57.331	2.710	2.406
Coke Gas, 2010 average	41.960	0.734 (sm^3)	1.756
Oxygen converter Gas, 2010 average	196.044	1.217 (sm^3)	8.202
Blast furnace, 2010 average	259.181	0.860 (sm^3)	10.844
Fossil fuels, national data			
Fuel oil, 2010 average	75.660	3.110	3.166
Coking coal	95.702	2.963	4.004
Other fuels			
Municipal solid waste	47.877	0.718	2.003

Source: ISPRA elaborations

Starting from 2005, for petroleum coke, synthesis gas from heavy residual and from 2007 for residual gases from chemical processes the oxidation factors have been modified based on the data reported by operators under the EU ETS scheme. See Annex 6 for further details.
During the revision of the aviation sector, for jet gasoline and jet kerosene, a fraction of carbon oxidised equal to 1 has been applied, as reported in the 2006 IPCC guidelines (IPCC, 2006), for the whole time series, on the basis of expert judgement.

Other sources of information are the yearly survey performed for the E-PRTR, since 2003, and the EU ETS; both surveys include main industrial operators, but not all emission sources. In particular from 2005 onwards the detailed reports by operators subject to EU ETS constitute a valuable source of data, as already said above with reference to oxidation factors and average emission factors.
In general, in the industrial sector 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.
The low implied emission factors and annual variations in the average CO_2 emission factor for solid fuel are due to the fact that both activity data and emissions reported under this category include the results of the carbon balance (see Annex 3 for further details).

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

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

Pulp, Paper and Print
Most of the operators in the paper and pulp sector are included in EU ETS, while only a few of the printing installations are included. The problem for the EU ETS data source for this subsector is that the data are reported on a point source basis, including the production of electricity, but these data are not subject to verification and appear not reliable. On the other hand, the inventory team has no access to the detailed, plant by plant, database of electricity producing plants so the emissions reported in the ETS survey cannot be divided between those belonging to table 1.A.1.a and table 1.A.2.d.
From 2010 submission CH_4 and N_2O emissions from biomass fuel consumption in the sector, have been added to the inventory on the basis of the biomass fuel consumption reported in the annual environmental report by the industrial association (ASSOCARTA, several years). Statistics on biomass fuel consumption appears from 1998; for the years from 1990 to 1997 the use of biomass for energy purposes in the pulp and paper industry has been assumed not occurring.

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

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

3.4.4 Uncertainty and time-series consistency

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

the related emission factors and the difference in emission factors between the industrial subsectors, sources 1.a.2.a-f.
Montecarlo analysis has been carried out to estimate uncertainty of CO_2 emissions from stationary combustion of solid, liquid and gaseous fuels emissions, resulting in 5.1%, 3.3% and 5.8%, respectively. Normal distributions have been assumed for all the parameters. A summary of the results is reported in Annex 1.
Estimates of fuel consumption for industrial use in 2010 are reported in Annex 5, Tables A5.9 and A5.10. Time series of the industrial energy consumption data are contained in the BEN time series and in the CRFs and are reported in the following table.

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

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

Source: ISPRA elaborations

Emission levels observed from 1990 to 2000 are nearly constant with some oscillations, linked to the economic cycles. After year 2000 the general trend is downward, with oscillations due to the economic cycles, see Table 3.11 above. The underlining reason for the reduced emissions is the reduced industrial output, and the increase in 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 (paragraph 3.1). The recalculation refers to the years 1990-2009 for residual gases from chemical processes CO_2 emission factors update, to the years 2005-2009 for CO_2 emission factors updated for pet coke, refinery gas and coal derived gases and to 2009 for natural gas CO_2 emission factor. The reallocation of fuel oil and natural gas fuel consumption between the energy and industrial sectors resulted in recalculation for CH_4 and N_2O emissions from 2008 and 2009.
The recalculation affected the whole time series with differences ranging from -1% in 1990 to -3% in 2009 for CO_2 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 increased in the period from 1990 to 2010, although since 2007 emissions from the sector slightly decreased.

The time series of CO_2, CH_4 and N_2O emissions, in Mt CO_2 equivalent, is reported in Table 3.14; figures comprise all the emissions reported in table 1.A.(a)s3 of the CRF.
Emission estimates are discussed below for each sub sector.

The trend of N_2O emissions is related to the evolution of the technologies in the road transport sector and the distribution between gasoline and diesel fuel consumption.
Methane emission trend is due to the combined effect of technological improvements that limit VOCs from tail pipe and evaporative emissions (for cars) and the expansion of two-wheelers fleet. It has to be underlined that in Italy there is a remarkable fleet of motorbikes and mopeds (about 10.6 million vehicles in 2010) that use gasoline and is increasing every year since 1990. Only a small part of this fleet complies with strict VOC emissions controls.

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

		1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2	Mt	101.3	111.4	120.1	125.8	127.1	127.2	122.3	117.9	117.4
CH_4	Mt	0.78	0.87	0.66	0.44	0.41	0.38	0.36	0.34	0.32
N_2O	Mt	1.03	3.29	1.80	1.22	1.30	1.28	1.19	1.14	1.14
Total, Mt CO_2 eq.	Mt	103.1	115.6	122.6	127.5	128.9	128.9	123.8	119.4	118.8

Source: ISPRA elaborations

CO_2 from road vehicles and CO_2 from waterborne navigation are key categories both in 1990 and in 2010.

3.5.1 Aviation

3.5.1.1 Source category description

The IPCC requires the estimation of emissions for category 1.A.3.a.i International Aviation and 1.A.3.a.ii Domestic Aviation, including figures both for the cruise phase of the flight and the landing and take-off cycles (LTO). Emissions from international aviation are reported as a memo item, and are not included in national totals.
Civil aviation contributes mainly in rising CO_2 emissions. CH_4 and N_2O emissions also occur and are estimated in this category but their contribution is insignificant.
In 2010 total GHG emissions from this source category were about 2.0 per cent of the national total emissions from transport, and about 0.5 per cent of the GHG national total; in terms of CO_2 only, the share is almost the same.
From 1990 to 2010, GHG emissions from the sector increased by 44% 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.
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 reported as a total and not split between domestic and international;
- Data on annual arrivals and departures of domestic and international landing and take-off cycles at Italian airports are reported by different sources: National Institute of Statistics in the statistics yearbooks (ISTAT, several years [a]), Ministry of Transport in the national transport statistics yearbooks (MIT, several years) and the Italian civil aviation in the national aviation statistics yearbooks (ENAC/MIT, several years).

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

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

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

Data on domestic and international aircraft movements from 1990 to 2010 are shown in Table 3.15 where domestic flights are those entirely within Italy. Emission factors are reported in Table 3.16 and Table 3.17. Total fuel consumptions, both domestic and international, are reported by LTO and cruise in Table 3.18.
Emissions from military aircrafts are also estimated and reported under category 1.A.5 Other.
The methodology to estimate military aviation emissions is simpler than the one described for civil aviation since LTO data are not available in this case.
As for activity data, total consumption for military aviation is published in the petrochemical bulletin (MSE, several years [b]) by fuel.

Emission factors are those provided in the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2007). Therefore, emissions are calculated by multiplying military fuel consumption data for the EMEP/CORINAIR default emission factors shown in Table 3.17.

Table 3.15 Aircraft Movement Data (LTO cycles)

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

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

Table 3.16 CO_2 and SO_2 emission factors for Aviation (kg/t) 1990-2010

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

a Emission factor as kg carbon/t.

Table 3.17 Non-CO_2 emission factors for Aviation (2010)

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

a EMEP/CORINAIR, 2007

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

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

Source: ISPRA elaborations

3.5.1.3 Uncertainty and time-series consistency

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

Time series of domestic emissions from the aviation sector is reported in Table 3.19.
An upward trend in emission levels is observed from 1990 to 2010 which is explained by the increasing number of LTO cycles.
Nevertheless, the propagation of more modern aircrafts in the fleet slows down the trend in the most recent years. There has also been a decrease in the number of flights in the last two years.

Table 3.19 GHG emissions from domestic aviation

	1990	1995	2000	2005	2006	2007	2008	2009	2010

CO_2	*Gg*	1,613	1,709	2,649	2,204	2,291	2,428	2,301	2,197	2,319
CH_4	*Mg*	32	33	63	112	98	72	66	66	70
N_2O	*Mg*	45	48	74	62	64	68	64	61	65

Source: ISPRA elaborations

3.5.1.4 Source-specific QA/QC and verification

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

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

3.5.1.5 Source-specific recalculations

No recalculations were performed in this last submission.

3.5.1.6 Source-specific planned improvements

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

3.5.2 Railways

The electricity used by the railways for electric traction is supplied from the public distribution system, so the emissions arising from its generation are reported under category 1.A.1.a Public Electricity.

Emissions from diesel trains are reported under the IPCC category 1.A.3.c Railways. Estimates are based on the gas oil consumption for railways reported in BEN (MSE, several years [a]).

Carbon dioxide, 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.

Table 3.20 Emission factors for railway (Gg/Mt)

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

Source: EMEP/CORINAIR, 2007

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

3.5.3 Road Transport

3.5.3.1 Source category description

The IPCC requires the estimation of emissions for category 1.A.3.b Road transportation.

In 2010, total GHG emissions from this category were about 92.6% of the total national emissions from transport, 26.5% of the energy sector and about 21.9% of the GHG national total.

From 1990 to 2010, GHG emissions from the sector increased by 15.7% due to the increase of vehicle fleet, total mileage and consequently fuel consumptions. In the last years, the trend of fuel consumption and emissions slightly changed. From 2007 GHG emissions from road transport started to decrease and were about 4.1%, 3.5% and 1.1% respectively lower than those of the previous year were.

CO_2 emissions from road transport are a key category in 2010 with Approach 1 and Approach 2 at level and trend assessment, with and without LULUCF. N_2O emissions and CH_4 emissions are not key category.

Emissions from road transport are calculated either from a combination of total fuel consumption data and fuel properties or from a combination of drive related emission factors and road traffic data. Non CO_2 emissions from biomass fuel consumption are included and reported under diesel fuel category. Biomass fuel refers prevalently to the use of biodiesel which is mixed with diesel fuel. Whereas CO_2 emissions are calculated only on the basis of the amount of carbon in the fuel, and they could be easily take off by the total diesel CO_2 emissions, CH_4 and N_2O emissions depend from the technology of vehicles and could not be calculated without more detailed information regarding the type and technology of vehicles and the associated biodiesel consumption.

3.5.3.2 Methodological issues

According to the IPCC Guidelines and Good Practice Guidance (IPCC, 1997; IPCC, 2000; IPCC, 2006) and the EMEP/EEA air pollutant emission inventory guidebook 2009 (EMEP/EEA, 2009), a national methodology has been developed and applied to estimate emissions. In particular, the model COPERT 4 (EMISIA SA, 2011) has been used to estimate emissions for the whole time series. In the 2012 submission, the new version of the model has been used, in particular the version 9.0 which upgrade the methodology, the software and fixed some bugs in the model, determining a recalculation of emission estimates. The annual update of the model is based on the availability of new measurements and studies regarding road transport emissions.

Methodologies are described in the following, distinguishing emissions calculated from fuel consumption and traffic data.

3.5.3.2.1 Fuel-based emissions

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

Emissions of CO_2, expressed as kg carbon per tonne of fuel, are based on the H/C ratio of the fuel; emissions of SO_2 are based on the sulphur content of the fuel. Values of the fuel-based emission factors for CO_2 from consumption of petrol and diesel fuels are shown in Table 3.21. These factors account for the fraction of carbon oxidised for liquid fuels equal to 0.99, as suggested by the 1996 IPCC guidelines (IPCC, 1997). From the nineties, different directives regulating the fuel quality in Europe have been implemented (Directive 93/12/EC, Directive 98/70/EC, Directive 2003/17/EC and Directive 2009/30/EC), in parallel with the evolution of vehicle fleet technologies; this resulted in remarkable differences in the characteristic of the fuels, including the content of carbon, hydrogen and oxygenates, parameters needed to derive the CO_2 emission factors. For this matter a specific survey was conducted to characterize the national fuel used in 2000-2001 and a similar survey is planned for 2012. Regarding 1990-1999, a study has been done to evaluate the use of the default emission factors reported in the IPCC Guidelines 1996 in consideration of the available information on national fuels. Emission factors from the Guidelines have been considered representative for diesel and GPL while for gasoline a country specific emission factor has been calculated taking in account the IPCC default and the specific energy content of the national fuels. For further details see the relevant paragraph in Annex 6.

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

(UP, several years). Directive 2003/17/EC introduced for 2005 new limit for S content in the fuels, both gasoline and diesel, 50% lower than the previous ones.

Table 3.21 Fuel-Based Emission Factors for Road Transport

National emission factors	Mg CO_2 / TJ	Mg CO_2 / Mg
Mtbe	73.121	-
Gasoline, 1990-'99, interpolated emission factor	71.034	3.121
Gasoline, test data, 2000-10[b]	71.145	3.109
Gas oil, 1990-'99, IPCC OECD[a]	73.274	3.127
Gas oil, engines, test data, 2000-10[b]	73.153	3.138
LPG, 1990-'99, IPCC[a] Europe	64.350	3.000
LPG, test data, 2000-10[b]	64.936	2.994
Natural gas (dry) 1990	55.328	-
Natural gas (dry) 2010	57.244	-

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

Emissions of CO_2 and SO_2 can be broken down by vehicle type based on estimated fuel consumption factors and traffic data in a manner similar to the traffic-based emissions described below for other pollutants. The 2010 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 (EMISIA SA, 2011). The updated version 9.0 of the model COPERT 4 has been used for the whole time series of the 2012 submission. As reported more in detail in the following, the updated version of the model considers the increase in fuel consumption due to air conditioning use, it includes additional CO_2 emissions deriving from the consumption of lubricant oil, it estimates the production of CO_2 relating the consumption of urea in vehicles equipped with selective catalytic reduction; the new version revises some functions of the software and fixes some bugs, compared to the version 8.0, used for 2011 submission.

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

Table 3.22 Average fuel consumption and mileage for main vehicle category and road type, year 2010

SNAP CODE	Sub sector	Type of fuel	Mg of fuel consumed	Mileage, km_kVeh
070101	PC Hway	diesel	3,718,557	69,285,138
070101	PC Hway	gasoline	1,904,920	38,739,899
070101	PC Hway	lpg	393,535	5,847,334
070102	PC rur	diesel	5,493,795	118,352,999
070102	PC rur	gasoline	2,868,863	66,315,214
070102	PC rur	lpg	359,204	7,796,445
070103	PC urb	diesel	2,199,637	30,926,960
070103	PC urb	gasoline	3,364,944	41,934,668
070103	PC urb	lpg	464,263	5,847,334
070201	LDV Hway	diesel	1,428,628	13,923,794
070201	LDV Hway	gasoline	42,633	609,364
070202	LDV rur	diesel	2,320,310	38,290,434
070202	LDV rur	gasoline	120,750	1,675,750
070203	LDV urb	diesel	1,908,960	17,404,743
070203	LDV urb	gasoline	126,785	761,705
070301	HDV Hway	diesel	3,599,082	18,919,621

SNAP CODE	Sub sector	Type of fuel	Mg of fuel consumed	Mileage, km_kVeh
070301	HDV Hway	gasoline	697	4,668
070302	HDV rur	diesel	2,463,288	12,737,890
070302	HDV rur	gasoline	2,021	14,005
070303	HDV urb	diesel	1,371,890	4,368,434
070303	HDV urb	gasoline	912	4,668
070400	mopeds	gasoline	356,027	16,607,329
070501	Moto Hway	gasoline	64,635	1,680,578
070502	Moto rur	gasoline	338,145	11,764,047
070503	Moto urb	gasoline	618,561	20,166,938
Total				**543,979,957**

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

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 (MIT, 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 (EMISIA SA, 2011). This source provides emission functions and coefficients relating emission factors (in g/km) to average speed for each vehicle type and Euro emission standard derived by fitting experimental measurements to polynomial functions. These functions were then used to calculate emission factor values for each vehicle type and Euro emission standard at each of the average speeds of the road and area types. In addition N_2O emission factors differ according to the fuel sulphur level (EMEP/EEA, 2009).

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

Emissions are calculated from vehicles of the following types:

- Gasoline passenger cars;
- Diesel passenger cars;
- LPG passenger cars;
- 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.

Greenhouse gas emissions from natural gas fuelled (CNG) passenger cars category have been estimated separately using country specific emission factors; emissions estimated on the basis of the fuel final consumption in road transportation (MSE, several years) have been completely attributed to passenger cars category.

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 (MIT, several years) reports passenger cars mileages time series. Furthermore in 2012 MIT supplied updated information relating articulated heavy duty trucks, in particular as regards the breakdown of the fleet according to the different weight classes (data used for the updating of the whole time series from 1990 to 2010) and data about motorcycles fleet in the detail of subsector and legislation standard of both 2-stroke and 4-stroke categories (this kind of information has been used for the updating of the years 2005 – 2010). The National Institute of Statistics carries out annually a survey on heavy goods vehicles, including annual mileages (ISTAT, several years [b]). The National Association of concessionaries of motorways and tunnels produces monthly statistics on highway mileages by light and heavy vehicles (AISCAT, several years). The National General Confederation of Transport and Logistics (CONFETRA, several years) and the national Central Committee of road transporters (Giordano, 2007) supplied useful information and statistics about heavy goods vehicles fleet composition and mileages.

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

Table 3.23 Passenger Cars and Light Duty Vehicles technological evolution: circulating fleet calculated as stock data multiplied by effective mileage (%)

	1990	1995	2000	2005	2010
PRE ECE, pre-1972	0.05	0.03	0.01	0.01	0.00
ECE 15/00-01, 1972-1977	0.11	0.04	0.01	0.00	0.00
ECE 15/02-03, 1978-1986	0.32	0.15	0.03	0.01	0.01
ECE 15/04, 1987-1992	0.52	0.57	0.28	0.10	0.05
PC Euro 1 - 91/441/EEC, from 1/1/93	0.001	0.23	0.28	0.17	0.06
PC Euro 2 - 94/12/EEC, from 1/1/97	-	-	0.38	0.35	0.23
PC Euro 3 - 98/69/EC Stage2000, from 1/1/2001	-	-	-	0.26	0.21
PC Euro 4 - 98/69/EC Stage2005, from 1/1/2006	-	-	-	0.09	0.41
PC Euro 5 - EC 715/2007, from 1/1/2011	-	-	-	-	0.03
Total	1.00	1.00	1.00	1.00	1.00

a. Gasoline cars technological evolution

	1990	1995	2000	2005	2010
Conventional, pre-1993	1.00	0.92	0.34	0.05	0.01
PC Euro 1 - 91/441/EEC, from 1/1/93	-	0.08	0.10	0.03	0.01
PC Euro 2 - 94/12/EEC, from 1/1/97	-	-	0.56	0.25	0.09
PC Euro 3 - 98/69/EC Stage2000, from 1/1/2001	-	-	-	0.53	0.26
PC Euro 4 - 98/69/EC Stage2005, from 1/1/2006	-	-	-	0.13	0.58
PC Euro 5 - EC 715/2007, from 1/1/2011	-	-	-	-	0.05
Total	1.00	1.00	1.00	1.00	1.00

b. Diesel cars technological evolution

	1990	1995	2000	2005	2010
Conventional, pre-1993	1.00	0.90	0.72	0.47	0.03
PC Euro 1 - 91/441/EEC, from 1/1/93	-	0.10	0.19	0.26	0.03
PC Euro 2 - 94/12/EEC, from 1/1/97	-	-	0.09	0.20	0.10
PC Euro 3 - 98/69/EC Stage2000, from 1/1/2001	-	-	-	0.06	0.09
PC Euro 4 - 98/69/EC Stage2005, from 1/1/2006	-	-	-	0.01	0.73
PC Euro 5 - EC 715/2007, from 1/1/2011	-	-	-	-	0.02
Total	1.00	1.00	1.00	1.00	1.00

c. LPG cars technological evolution

	1990	1995	2000	2005	2010
Conventional, pre 10/1/94	1.00	0.93	0.60	0.38	0.15
LD Euro 1 - 93/59/EEC, from 10/1/94	-	0.07	0.24	0.19	0.12
LD Euro 2 - 96/69/EEC, from 10/1/98	-	-	0.16	0.15	0.26
LD Euro 3 - 98/69/EC Stage2000, from 1/1/2002	-	-	-	0.28	0.24
LD Euro 4 - 98/69/EC Stage2005, from 1/1/2007	-	-	-	0.01	0.23
LD Euro 5 - 2008 Standards 715/2007/EC, from 1/1/2012	-	-	-	-	0.001
Total	1.00	1.00	1.00	1.00	1.00

d. Gasoline Light Duty Vehicles technological evolution

	1990	1995	2000	2005	2010
Conventional, pre 10/1/94	1.00	0.93	0.60	0.26	0.09
LD Euro 1 - 93/59/EEC, from 10/1/94	-	0.07	0.22	0.12	0.07
LD Euro 2 - 96/69/EEC, from 10/1/98	-	-	0.19	0.19	0.21
LD Euro 3 - 98/69/EC Stage2000, from 1/1/2002	-	-	-	0.41	0.33
LD Euro 4 - 98/69/EC Stage2005, from 1/1/2007	-	-	-	0.01	0.29
LD Euro 5 - 2008 Standards 715/2007/EC, from 1/1/2012	-	-	-	-	0.01
Total	1.00	1.00	1.00	1.00	1.00

e. Diesel Light Duty Vehicles technological evolution

Source: ISPRA elaborations on ACI data

Table 3.24 24 Heavy Duty Trucks and Buses technological evolution: circulating fleet calculated as stock data multiplied by effective mileage (%)

	1990	1995	2000	2005	2010
Conventional, pre 10/1/1993	1.00	0.90	0.67	0.39	0.20
HD Euro I - 91/542/EEC Stage I, from 10/1/93	-	0.10	0.10	0.06	0.05
HD Euro II - 91/542/EEC Stage II, from 10/1/96	-	-	0.22	0.27	0.21
HD Euro III - 2000 Standards, 99/96/EC, from 10/1/2001	-	-	-	0.28	0.31
HD Euro IV - 2005 Standards, 99/96/EC, from 10/1/2006	-	-	-	-	0.19
HD Euro V - 2008 Standards, 99/96/EC, from 10/1/2009	-	-	-	-	0.03
Total	1.00	1.00	1.00	1.00	1.00
a. Heavy Duty Trucks technological evolution					

	1990	1995	2000	2005	2010
Conventional, pre 10/1/1993	1.00	0.93	0.65	0.34	0.20
HD Euro I - 91/542/EEC Stage I, from 10/1/93	-	0.07	0.07	0.08	0.07
HD Euro II - 91/542/EEC Stage II, from 10/1/96	-	-	0.28	0.32	0.25
HD Euro III - 2000 Standards, 99/96/EC, from 10/1/2001	-	-	-	0.26	0.45
HD Euro IV - 2005 Standards, 99/96/EC, from 10/1/2006	-	-	-	-	0.01
HD Euro V - 2008 Standards, 99/96/EC, from 10/1/2009	-	-	-	-	0.03
Total	1.00	1.00	1.00	1.00	1.00
b. Buses technological evolution					

Source: ISPRA elaborations on ACI and MIT data

Table 3.25 Mopeds and motorcycles technological evolution: circulating fleet calculated as stock data multiplied by effective mileage (%)

	1990	1995	2000	2005	2010
Conventional, pre 6/17/1999	1.00	1.00	0.86	0.53	0.37
Euro I - 97/24 from 6/17/1999	-	-	0.14	0.27	0.23
Euro II, 2002/51/EC, 2003/77/EC, from 7/1/2004 (for mopeds: 97/24/EC, from 6/17/2002)	-	-	-	0.17	0.23
Euro III, 2002/51/EC, 2003/77/EC, from 1/1/2007 (for mopeds not defined yet)	-	-	-	0.03	0.17
Total	1.00	1.00	1.00	1.00	1.00

Source: ISPRA elaborations on ACI, ANCMA and MIT data

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

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

Table 3.26 Evolution of fleet consistency and mileage

	1990	1995	2000	2005	2006	2007	2008	2009	2010
All passenger vehicles, total mileage (10^9 veh-km/y)	303	361	389	411	418	419	404	397	389
Car fleet (10^6)	27	30	32	34	35	35	36	36	36
Moto, total mileage (10^9 veh-km/y)	31	39	45	48	48	49	47	48	50
Moto fleet (10^6)	7	7	9	10	10	10	10	10	11
Goods transport, total mileage (10^9 veh-km/y)	70	75	89	99	102	105	104	103	105
Truck fleet (10^6), including LDV	2	3	3	4	4	5	5	5	5

Source: ISPRA elaborations

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

3.5.3.3 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions from road transport is estimated to be about 4% in annual emissions; a higher uncertainty is calculated for CH_4 and N_2O emissions because of the uncertainty levels attributed to the related emission factors.
Montecarlo analysis has been carried out by EMISIA[1] on behalf of the Joint Research Centre (Kouridis et al., 2010) in the framework of the study “Uncertainty estimates and guidance for road transport emission calculations” for 2005 emissions; a summary of main results of study are reported in Annex 1. The study shows an uncertainty assessement, at Italian level, for road transport emissions on the basis of 2005 input parameters of the COPERT 4 model (v. 7.0).
The following Table 3.27 summarizes the time series of GHG emissions in CO_2 equivalent from road transport, highlighting the evolution of this growing source. An upward trend in CO_2 emission levels is observed from 1990 to 2007, which is explained by the increasing of the fleet, total mileages, and fuel consumptions.
Nevertheless, the propagation of the number of vehicles, with low fuel consumption per kilometre, slows down the tendency in the last years. In 2010, with respect to 2007, a reduction in total mileages, especially for gasoline passenger cars and light duty vehicles, fuel consumptions and consequently CO_2 emissions has been noted.
CH_4 and N_2O emission trends are consequence of the penetration of new technologies according to the main emission regulations. N_2O emissions strongly reduced in 2005 due to a reduction of the average content of sulphur in national fuel that changed from 0.00553% in 2004 to 0.00247% in 2005 for gasoline and from 0.02263% to 0.0038% for diesel oil.

[1] EMISIA: www.emisia.com

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

		1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2	Gg	93,387	103,552	110,377	117,029	118,263	118,718	113,919	109,906	108,678
CH_4	Gg CO_2 eq	751	835	627	405	379	355	328	309	299
N_2O	Gg CO_2 eq	913	3,179	1,672	1,109	1,181	1,173	1,090	1,053	1,041
Total	**Gg CO_2 eq**	**95,051**	**107,566**	**112,675**	**118,543**	**119,822**	**120,246**	**115,337**	**111,268**	**110,018**

Source: ISPRA elaborations

3.5.3.4 Source-specific QA/QC and verification

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

3.5.3.5 Source-specific recalculations

In 2012 and 2011 submissions, the new versions of COPERT 4 revised both the estimation methodology and the software, but not in such significant way as the transition to COPERT 4. In 2009 in fact, the transition from COPERT III to COPERT 4 was the occasion for a general review of input data, as activity data, model parameters and emission factors.

The most recent update of the software is COPERT 4, version 9.0 (EMISIA SA, 2011). This is a user-friendly version that upgraded the methodology and the software and fixed some bugs, and it has been used to estimate emissions in the 2012 submission determining a recalculation of emission estimates, producing changes mainly regarding, among greenhousegas, methane and nitrous oxide emission estimated values, with respect to the previous submission.
The updating to version COPERT 4 v 9.0 introduces important elements such as the increase in fuel consumption due to air conditioning use, so extra CO_2 emissions in g/km are calculated as a function of temperature and relative humidity; because of CO_2 emissions depend on total statistical fuel consumption, there is not impact on the CO_2 officially reported but instead on other pollutants. Moreover the calculation of additional CO_2 emissions from the consumption of lubricant oil in g/km has been introduced (the same approach for the calculation of fuel-dependent CO_2 has been used). Another significant element is the introduction of the production of CO_2 due to the consumption of urea in vehicles provided with selective catalytic reduction aftertreatment systems, depending on the carbon included in the urea molecule. In addition version 9.0 updates NO_2/NO_X mass ratios, includes ethanol as a fuel, updates biodiesel O:C and H:C ratios, updates the heavy metals emission factors (Gkatzoflias D., Kouridis C., Ntziachristos L., Description of new elements in COPERT 4 v 9.0, November 2011).
CH_4 hot and cold emission factors for Euro 4, Euro 5, Euro 6 diesel passenger cars and light duty vehicles and N_2O hot and cold emission factors parameters for Euro 5 and Euro 6 LPG passenger cars have been updated; in addition for the calculation of N_2O and NH_3 emission factors a maximum value of cumulative mileage has been fixed. Moreover, the calculation algorithm for CH_4, N_2O and NH_3 hot/cold emissions has been revised in particular as regards the calculation of cold urban, hot urban, rural and highway emissions (Gkatzoflias D., Ntziachristos L., COPERT 4 v 8.1, September 2011).

As previously mentioned, another cause explaining differences respect to submission 2011 can be individuated in the updated distribution among weight classes for articulated heavy duty trucks fleet and the additional information about fleet of 2-stroke motorcycles.
Differences between the two last submissions 2011 and 2012 in the total road transport GHG emissions, account for 0.2% in 1990 and 0.1% in 2009. Carbon dioxide values are the same in 1990 and in 2009 show a difference of 0.0001%. As regards methane and nitrous oxide, discrepancies vary respectively from 8.2% in 1990 to 8.3% in 2009 and from 15.7% in 1990 to 7.5% in 2009.

3.5.3.6 Source-specific planned improvements
Improvements for the next submission will be connected to the annual update of the software.

3.5.4 Navigation

3.5.4.1 Source category description
This source category includes all emissions from fuels delivered to water-borne navigation.
Mainly CO_2 emissions derive from this category, whereas CH_4 and N_2O emissions are less important.
Emissions from navigation constituted 4.3% of the total GHG in the transport sector in 2010 and about 1% of the national total. If considering CO_2 only, emissions from navigation are 1.2% out of the national CO_2 emissions. GHG emissions decreased by 6.1% from 1990 to 2010, because of the reduction in fuel consumed in harbour and navigation activities although the increase in the number of movements.
Navigation is a key category with respect to CO_2 emissions in level with Tier1.

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

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

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

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

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

improvements of operational activities in harbour (TECHNE, 2009). On the basis of the results, national average emissions and consumption factors were updated from 2000.
Specifically, for the years referred to in the surveys, the current method estimates emissions from the number of ships movements broken down by ship type at each of the principal Italian ports considering the information of whether the ship movement is international or domestic, the average tonnage and the relevant distance travelled.
For those years, in fact, figures on the number of arrivals, destination, and fleet composition have been provided by the local port authorities and by the National Institute of Statistics (ISTAT, 2009), covering about 90% of the official national statistics on ship movements for the relevant years. Consumption and emission factors are those derived from the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2007) and refer to the 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.

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

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Gasoline for recreational crafts (Gg)	182	210	213	199	199	199	189	179	149
Diesel oil for inland waterways (Gg)	20	23	20	25	24	23	22	22	18
Fuel in domestic cruise navigation (Gg)	778	706	811	740	709	673	670	650	720
Fuel in harbours (dom+int ships) (Gg)	748	693	818	759	727	690	687	667	738
Fuel in international bunkers (Gg)	1,398	1,286	1,333	2,203	2,369	2,468	2,685	2,309	2,230
CO_2 (Gg)	5,420	5,117	5,842	5,403	5,204	4,970	4,914	4,762	5,096
CH_4 (Gg CO_2 eq.)	29	32	32	29	28	27	26	24	22
N_2O (Gg CO_2 eq.)	39	37	43	40	38	36	36	35	38

Source: ISPRA elaborations

3.5.4.4 Source-specific QA/QC and verification

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

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

3.5.4.5 Source-specific recalculations

In 2012 submission, a verification of activity data from different sources was undertaken. In response of the review process the composition of the fleet of gasoline fuelled recreational craft has been updated from 2001 revising the two strokes and four strokes engine distribution considering a change from two strokes to four strokes engines of the national fleet due to the introduction in the market of new models. In 2000, the composition of the fleet was 90% two stroke engine equipped and 10% four stroke while in 2010 the last one is about 30% of the fleet.
The recalculation affected CH_4 and N_2O emissions and accounted for a decrease from 0.003%, in 2001, to 0.04% of GHG emissions in 2009, with respect to the previous submission.

3.5.4.6 Source-specific planned improvements

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

3.6 Other sectors

3.6.1 Sector overview

In this paragraph sectoral emissions are reported, which originate from energy use in the civil sector included in category 1.A.4. Commercial, institutional, residential, agriculture/fisheries, and emissions from military mobile activities which are also included in category 1.A.5. All greenhouse gases as well as CO, NOx, NMVOC and SO_2 emissions are estimated.
In 2010, energy use in other sectors account for 21.5% of CO_2 emissions, 2.9% of CH_4, 7.6% of N_2O emissions. In term of CO_2 equivalent, other sectors share 18.9% of total national greenhouse gas emissions and 22.8% 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 growing use of woody biomass for heating.

Table 3.29 Trend in greenhouse gas emissions from the other sectors, 1990-2010

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2 (Gg)									
1.A.4.a Commercial/ Institutional	16,144	17,197	20,407	26,137	25,508	26,657	27,785	28,598	30,987
1.A.4.b Residential	52,118	50,103	50,159	57,339	52,239	46,456	49,741	51,015	52,790
1.A.4.c Agriculture/ Forestry/ Fisheries	8,372	8,747	8,030	8,371	8,239	7,849	7,593	7,679	7,261
1.A.5 Other (Not elsewhere specified)	1,046	1,440	806	1,198	982	896	738	844	627
CH_4 (Mg)									
1.A.4.a Commercial/ Institutional	1,077	1,306	2,231	3,418	3,606	3,806	4,053	4,160	4,391
1.A.4.b Residential	12,382	15,756	18,129	26,741	28,999	36,196	37,850	41,057	44,410
1.A.4.c Agriculture/ Forestry/ Fisheries	1,269	947	2,449	2,616	2,846	3,515	3,662	3,964	2,530
1.A.5 Other (Not elsewhere specified)	173	223	126	160	127	114	74	73	65
N_2O (Mg)									
1.A.4.a Commercial/ Institutional	424	497	694	981	968	1,060	1,082	1,138	1,256
1.A.4.b Residential	1,570	1,625	1,730	2,210	2,222	2,434	2,549	2,702	2,865
1.A.4.c Agriculture/ Forestry/ Fisheries	2,520	2,756	2,687	2,772	2,761	2,653	2,591	2,630	2,449
1.A.5 Other (Not elsewhere specified)	225	215	135	291	239	227	199	239	131

Source: ISPRA elaborations

Six key categories have been identified for this sector for 2010, as for the energy and manufacturing industries, for level and trend assessment, using both the IPCC Approach 1 and Approach 2:

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

All these categories, except CH_4 from Stationary combustion, are also key category 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 2010, this sector has a share of 6.3% 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 2010, this sector has a share of 10.9% 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 2010, 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 2010, 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 3.6.2 *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, the methodology used to estimate emissions from a range of portable or mobile equipment powered by reciprocating diesel or petrol driven engines is summarized. They include agricultural equipment such as tractors and combined harvesters; construction equipment such as bulldozers and excavators; domestic lawn mowers; aircraft support equipment; and industrial machines such as portable generators and compressors. In the CORINAIR inventory, they are grouped into four main categories (EMEP/CORINAIR, 2007):

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

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

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

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

where

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

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

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

where

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

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

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

Estimates were derived for fuel consumptions for the years 1990-2010 for each of the main categories:

A. Agricultural power units: Data on gas oil consumption were taken from ENEA (ENEA, several years). The consumption of gasoline was estimated using the population method for 1995 without correction. Time series is reconstructed in relation to the fuel used in agriculture.

B. Industrial off-road: The construction component of the gas oil consumption was calculated from the Ministry of Production Activities data (MSE, several years [a]) on buildings and constructions. The industrial component of gas oil was estimated from the population approach for 1995. Time series is reconstructed in relation to the fuel use in industry.

C. Domestic house & garden: gasoline and diesel oil consumption were estimated from the EMEP/CORINAIR population approach for 1995. Time series is reconstructed in relation to the fuel use in agriculture.

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

3.6.4 Uncertainty and time-series consistency

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

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

Estimates of fuel consumption used by other sectors in 2010 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.

Table 3.30 Trend in fuel consumption for the other sector, 1990-2010 (TJ)

	1990	1995	2000	2005	2006	2007	2008	2009	2010
					TJ				
1.A.4a.Commercial/ Institutional	267,685	295,363	357,066	460,177	455,603	469,841	483,563	498,786	539,215
1.A.4b. Residential	861,865	868,489	888,941	1,053,621	970,764	897,246	945,236	977,331	1,022,123
1.A.4c.Agriculture/ Forestry/ Fisheries	114,964	121,138	117,029	123,208	122,082	119,048	115,832	118,109	108,291
1.A.5 Other	14,830	20,800	11,587	16,935	13,887	12,654	10,411	11,898	8,995

Source: ISPRA elaborations

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 2000-2010. Total emissions from the sector are reported in Gg for CO_2, and in Mg for CH_4 and N_2O. An increase in emissions is observed from 1990 to 2000, due to increase in activity data (numbers and size of building with heating); a sharp increase can be observed in 2005 due to exceptionally cold weather conditions. CH_4 and N_2O emissions increase in the period due to the growing use of woody biomass for heating.

Table 3.31 Other sectors, GHG emission time series 1990-2010

	1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2 (Gg)	77,681	77,487	79,402	93,045	86,968	81,859	85,857	88,136	91,665
CH_4 (Mg)	14,901	18,231	22,936	32,936	35,579	43,631	45,639	49,254	51,396
N_2O (Mg)	4,740	5,092	5,247	6,254	6,191	6,374	6,421	6,708	6,701
GHG (Gg CO_2 eq)	79,463	79,449	81,510	95,675	89,634	84,751	88,806	91,250	94,822

Source: ISPRA elaborations

In Table 3.32, other sectors emissions are summarized according to key categories. From 1990 to 2010, an increase in use of natural gas instead of fuel oil and gas oil in stationary combustion plants is observed; it results in a decrease of CO_2 emissions from combustion of liquid fuels and an increase of emissions from gaseous fuels. CH_4 and N_2O emissions increase in the period due to the crescent use of woody biomass for heating.

Table 3.32 Other sectors, GHG emissions in 1990 and 2010

		1990	2010
CO_2 stationary combustion liquid fuels	Gg	39,817	19,109
CO_2 stationary combustion solid fuels	Gg	920	17
CO_2 stationary combustion gaseous fuels	Gg	36,418	67,889
CO_2 stationary combustion other fuels	Gg	526	4,651
CH_4 stationary combustion	Mg	14,901	51,396
N_2O stationary combustion	Mg	4,740	6,701

Source: ISPRA elaborations

3.6.5 Source-specific QA/QC and verification

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

- the overall sum of residential and institutional/service/commercial energy consumption is quite reliable and their uncertainty is the same of the BEN; the quantities of fuels used for those economic sector are routinely reported by main suppliers and the data are well documented.
- the energy consumption for agriculture and fisheries is also routinely reported by energy statistics and the underlying data are quite reliable because the energy use for those sector has special taxation regimes and they are accounted for separately.
- The energy use for military and off roads is instead partly reported and partly estimated with models, as described in paragraph 3.6.2 *others*.

3.6.6 Source-specific recalculations

CO_2 emission factors have been updated for the year 2009 for natural gas. Biomass fuel combustion in residential activity data has been revised from 2001 according to the relevant data supplied in the national energy balance for 2010. Energy recovery from waste reported in the commercial heating has been updated for the whole time series as a consequence of the reorganization of the waste incinerators database; further details are reported in the waste chapter.
The recalculation affected only slightly CO_2 emissions with differences equal to -0.06% in 1990 and 1.4% in 2009, with respect to the previous submission. CH_4 emissions increased of about 30% for the last years while N_2O emissions are 10% higher in the last years with respect to the previous submission.

3.6.7 Source-specific planned improvements

No specific improvements are planned for the next submission.

3.7 International bunkers

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

3.8 Feedstock and non-energy use of fuels

3.8.1 Source category description

In Table 3.33 and 3.34 detailed data on petrochemical and other non-energy use for the year 2010 are given. The tables refer to all products produced starting from fossil fuels, solid, gas or liquid, and used for “non energy” purposes. A national methodology is used for the reporting and estimation of avoided emissions.

3.8.2 Methodological issues

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

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

National energy balances include only the input and output quantities from the petrochemical plants; so 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). Consequently for these fuels also the fraction of carbon stored could have negative values.
The quantities of fuels stored in products, in percentage on net and gross petrochemical input, are estimated with these data, see Table 3.34 for details by product and Table 3.33 for the overall figure. Specifically, the amount of quantity stored in products for each fuel is calculated as the difference between input (petrochemical input) and output (returns to refinery and internal consumption and losses); carbon stored is therefore calculated from the amounts of fuels stored (in tonnes) multiplied by the emission factors (tC/t) reported in Table 3.34. The fuel quantity reported in Table 1.A(d) of the CRF in TJ is the amount of fuels stored and the fractions of carbon stored are consequently equal to 1.
In order to show the actual figures, we report the amount of fuel input of the process and the implied fraction of carbon stored for 2010 in the following box.

Fuel quantity and fraction of carbon stored in 2010

	Fuel quantity (TJ)	Fraction of carbon stored
Virgin nafta	237,946	1.00
Lubricants	44,675	0.95
Bitumen	170,764	1.00
Coal Oils and Tars (from Coking Coal)	4,305	1.00
Natural gas	40,390	0.59
Gasoil	52,216	0.33
LPG	26,501	-0.25
Gasoline	40,284	-0.49
Other	32,006	1.26
Refinery gas	4,268	-9.93
Fuel oil	17,483	-0.15

Non-energy products quantity amount stored from refineries are reported in the BEN and the carbon stored is estimated with emission factors reported in Table 3.35.
As can be seen from the value reported for the year 2010, there is a sizeable difference of the estimated quantities of fuel stored in product if reference is made to "net" or "gross" input. Moreover the estimation of quantities stored in products are quite different from those reported in the Revised 1996 IPCC Guidelines for National GHG Inventories, Reference Manual, ch1, tables 1-5 (IPCC, 1997).

An attempt was made to estimate the quantities stored in products using IPCC percentage values (tables 1-5 of the IPCC Guidelines) and the amount of fuels reported as "petrochemical input" in Table 3.34. The resulting estimate of about 6,279 Gg of products, for the year 2010, is almost 50% bigger than the quantities reported, 4,443 Gg.

Table 3.33 Other non-energy uses, year 2010

Breakdown of total petrochemical flow				
	Petrochemical Input	Returns to refinery/market	Internal consumption / losses	Quantity stored in products
ALL ENERGY CARRIERS, Gg	9,719	3,090	2,186	4,443
% of total input		31.8%	22.5%	45.7%
% of net input			33.0%	67.0%

Source: ISPRA elaborations

Table 3.34 Petrochemical, detailed data from MSE, year 2010 (MSE, detailed petrochemical breakdown)

FUEL TYPE	Petroch. Input	Returns to refinery/ market	Internal consumption / losses	Quantity stored in products	% on gross input	% on net input	Emission factor (IPCC)
	Gg	Gg	Gg	Gg			t C / t
LPG	573	705	12	-144			0.8137
Refinery gas	85	43	886	-844			0.8549
Virgin naphtha	5,465	0	0	5,465			0.8703
Gasoline	917	1,340	22	-445			0.8467
Kerosene	818	655	0	163			0.8485
Gas oil	397	160	0	237			0.8569
Fuel oil	426	126	366	-66			0.8678
Petroleum coke	0	0	0	0			0.955
Others (feedstock)	191	61	53	77			0.8368
Losses			0	0			0.8368
Natural gas	847	0	847	0			0.749
total	9,719	3,090	2,186	4,443	46%	67%	

Source: ISPRA elaborations

Table 3.35 Other non-energy uses, year 2010, MSE several years [a]

NON ENERGY FROM REFINERIES	Quantity stored in products	Energy content IPCC '96	Emission factor	Total energy content, IPCC values
	Gg		t C / t	TJ
Bitumen + tar	4,247	40.19	0.8841	170.7
lubricants	1,222	40.19	0.8038	49.1
recovered lubricant oils	170	40.19	0.8038	6.8
paraffin	90	40.19	0.8368	3.6
others (benzene, others)	835	40.19	0.8368	33.6
Totals	6,564			263.8

Source: ISPRA elaborations

At national level, this methodology seems the most precise according to the available data. The European Project “Non Energy use-CO_2 emissions” ENV4-CT98-0776 has analysed our methodology performing a mass balance between input fuels and output products in a sample year. The results of the project confirm the reliability of the reported data (Patel and Tosato, 1997).
With reference to the data of Table 3.35, 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

In response to the review process recalculations have been performed for the whole time series resolving inconsistencies identified with respect the reporting of international marine fuel oil bunkers and crude oil production data; CO_2 emission factor for natural gas has been updated for 2009.

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 2010, GHG emissions from this source category account for 1.8% out of the total emissions in the energy sector. Trends in fugitive emissions are summarised in Table 3.42.

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

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

Year		IPCC category	without LULUCF	with LULUCF
2010	CH_4	Fugitive emissions from oil and gas operations	L, T	L1,T1
	CO_2	Fugitive emissions from oil and gas operations	L1, T2	-
1990	CH_4	Fugitive emissions from oil and gas operations	L	L
	CO_2	Fugitive emissions from oil and gas operations	L	L1

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

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 one, a surface mine, produces lignite. The underground mine stopped the extraction activities between 1994 and 1999, whereas the surface mine stopped the activity in 2001. CH_4 emissions from solid fuel transformation refer to 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, while N_2O emissions refer to flaring in the production of oil and natural gas and in refineries.
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 the available information is not detailed enough to split emissions between exploration and production; methane emissions are supplied directly by the main companies but as a total. Moreover there is information about the number of permits (about 120 in 2010) for exploration but there is no information on number of drilled wells. N_2O emissions from flaring in oil exploration and refining and storage are reported under oil production flaring. Emissions from transport of oil are reported under refining and storage while emissions from distribution of oil result as not occurring. CO_2 and CH_4 emissions from gas exploration are also included in those from production. According to Tier 1 and default EFs from the GPG 2000, CO2 and CH4 emissions from venting in gas production are included in fugitive emissions from gas production and reported under gas production. CH_4 emissions from other leakage are accounted for in the sectors where they occur.

A summary of the completeness of CO_2, CH_4 and N_2O fugitive emissions is shown in the following Table 3.36.

Table 3.36 Completeness of CO_2, CH_4 and N_2O fugitive emissions

1.B. 2.a. Oil		
i. Exploration	CO_2, CH_4	Included in 1.B.2.a.ii production
i. Exploration	N_2O	Included in 1.B.2.c.ii flaring oil
iii. Transport	CH_4, CO_2	Included in 1.B.2.a.iv refining/storage
iv. Refining/storage	N_2O	Included in 1.B.2.c.ii flaring oil
1.B.2.b. Natural Gas		
i. Exploration	CO_2, CH_4	Included in 1.B.2.b.ii production
v. Other leakage	CH_4	Included in 1.A.1/1.A.2/1.A.4
1.B.2.c. Venting		
ii. Gas	CO_2, CH_4	Included in 1.B.2.b.ii production

3.9.2 Methodological issues

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

Fugitive emissions from oil transport and refining are estimated starting from the total crude oil losses as reported in the National Energy Balance. Emissions have been reported in the Refining/Storage category (1.B.2.a.iv); they occur prevalently from processes in refineries.
Most of the crude oil is imported in Italy by shipment and delivered at the refineries by pipelines as offshore national production of crude oil. Table 3.37 provides the length of pipelines for oil and the amount of oil products transported since 1990.

Table 3.37 Length of pipelines for oil transport (km) and amount of transported oil products (Gg)

	1990	1995	2000	2005	2006	2007	2008	2009	2010*
Length of pipelines (km)	4,140	4,235	4,346	4,328	4,336	4,359	4,360	4,291	4,311
Amount transported (Gg)	94,600	102,274	116,803	133,024	133,869	132,583	134,075	127,371	128,854

Source: MIT

*provisional values

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

In Table 3.38, the time series of crude oil losses published in the BEN and crude oil processed in Italian refineries are shown.

Table 3.38 Refineries activities and losses

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Crude Oil losses (Mg)	1,004	937	757	576	608	603	642	624	664
Crude oil processing (Gg)	93,711	91,014	98,003	106,542	104,388	105,384	99,696	91,105	94,944

Source: MSE, UP

CH_4 emissions from the production of oil and natural gas have been calculated according with activity data published on National Energy Balance (MSE, several years [a]), data by oil and gas industry association (UP, several years), data supplied by operators, and emission factors published on the IPCC Good practice Guidance (IPCC, 2000). CH_4 emission factors for the whole time series have been calculated taking into account this information. For CO_2, the IPCC default emission factor has not been modified, as no specific information is available. N_2O emissions from flaring in oil and gas production have been estimated on the basis of activity production data and emission factors reported in the IPCC GPG (IPCC, 2000). As regards the decline of CH_4 IEF for natural gas production and processing, gas companies stated that along the time there has been an increasing awareness to reduce GHG emissions and new emergency management systems have been implemented periodically in order to reduce emissions from venting. Moreover, with the updating of management systems, more accurate methods to estimate vented gas have been adopted by the main gas company at regular intervals.
In Table 3.39, the time series of national production of oil and gas are reported. Natural gas production should further reduce in the next years.

Table 3.39 National production of oil and natural gas

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Oil (Gg)	4,668	5,236	4,586	6,111	5,781	5,860	5,243	4,573	5,106
Natural gas (Mm^3)	17,296	20,383	16,766	11,963	10,837	9,634	9,071	7,909	7,942

Source: MSE

CH_4 and CO_2 emissions from the transmission in pipelines and distribution of natural gas have been estimated on the basis of activity data published by industry, the national authority, and information collected annually by the Italian gas operators.
Emission estimates take into account the information on: the amount of natural gas distributed (ENI, several years [a]; SNAM, several years); length of pipelines, distinct by low, medium and high pressure and by type, cast iron, grey cast iron, steel or polyethylene pipelines (AEEG, several years); natural gas losses reported in the national energy balance (MSE, several years [a]); methane emissions reported by operators in their environmental reports (ENI, several years [b]; EDISON, several years; SNAM, several years). CO_2 emissions have been calculated considering CO_2 content in the leaked natural gas.
The average natural gas chemical composition has been calculated from the composition of natural gas produced and imported. Main parameters of mixed natural gas, as calorific value, molecular weight, and

density, have been calculated as well. Data on chemical composition and calorific value are supplied by the main national gas providers for domestic natural gas and for each country of origin.

Table 3.40 shows average data for national pipelines natural gas.

Table 3.40 Average composition for pipelines natural gas and main parameters

	1990	1995	2000	2005	2008	2009	2010
HCV (kcal/m$_3$)	9,156	9,193	9,221	9,267	9,280	9,304	9,331
NCV (kcal/m$_3$)	8,255	8,290	8,325	8,360	8,365	8,393	8,418
Molecular weight	17.03	17.19	17.37	17.44	17.46	17.49	17.46
Density (kg/Sm$_3$)	0.72	0.73	0.74	0.74	0.74	0.74	0.74
CH_4 (molar %)	94.30	93.36	92.22	91.93	92.10	92.01	92.03
NMVOC (molar %)	3.45	4.09	4.84	5.35	5.35	5.54	5.74
CO_2 (molar %)	0.22	0.20	0.18	0.49	0.74	0.77	0.75
Other no carbon gas (molar %)	2.03	2.34	2.76	2.24	1.81	1.69	1.48
CH_4 (weight %)	88.83	87.14	85.16	84.53	84.61	84.36	84.52
NMVOC (weight %)	7.33	8.62	10.00	10.73	10.70	11.07	11.28
CO_2 (weight %)	0.57	0.51	0.47	1.23	1.86	1.93	1.89
Other no carbon gas (weight %)	3.27	3.74	4.37	3.51	2.84	2.64	2.30

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

Table 3.41 provides the trend of natural gas distribution network length for each pipeline material and the average CH_4 emission factor.

Table 3.41 Length of low and medium pressure distribution network (km) and network emission factors for CH_4

Material	1990	1995	2000	2005	2008	2009	2010
Steel and cast iron (km)	102,061	131,271	141,848	154,886	191,567	195,918	198.706
Grey cast iron (km)	24,164	23,229	21,314	15,080	4,816	4,776	4.743
Polyethylene (km)	775	7,300	12,550	31,530	45,135	46,908	49.578
Total (km)	127,000	161,800	175,712	201,496	241,518	247,602	253.027
CH_4 Emission Factors (kg/km)	**1,958**	**1,417**	**1,227**	**999**	**725**	**715**	**717**

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

3.9.3 Uncertainty and time-series consistency

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

Montecarlo analysis was applied last year to estimate uncertainty of CH_4 emissions; the resulting figure was 17.2% for 2009. Normal distributions have been assumed for most of the parameters; at the same time, whenever assumptions or constraints on variables were known this information has been appropriately reflected on the choice of type and shape of distributions. A summary of the results is reported in Annex 1. No variation could be conceived on assumptions as concern probability distributions and standard deviations.

Fugitive emissions, in CO_2 equivalent, account for 1.8% out of the total emissions in the energy sector in 2010. Both CH_4 and CO_2 emissions show a reduction from 1990 to 2010 by 31.4% and 30.6%, respectively.
The decrease of CO_2 fugitive emissions is driven by the reduction in crude oil losses in refineries. Fugitive emissions from solid fuels are not significant.
The trend of CH_4 fugitive emissions from solid fuels is related to the extraction of coal and lignite that in Italy is quite low. The decrease of CH_4 fugitive emissions from oil and natural gas is due to the reduction of losses for gas transportation and distribution, because of the gradual replacement of old grey cast iron pipelines with steel and polyethylene pipelines for low and medium pressure network.
As regards the flaring activity from oil and gas production, 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 3.42.

Table 3.42 Fugitive emissions from oil and gas 1990-2010 (Gg CO_2 eq.)

	1990	1995	2000	2005	2006	2007	2008	2009	2010
	Gg CO_2 eq.								
CO_2									
Oil and natural gas	3,344	3,178	2,588	2,117	2,194	2,181	2,264	2,170	2322
CH_4									
Solid fuels	122	65	73	69	54	84	73	45	65
Oil and natural gas	7,298	6,817	6,351	5,641	5,102	4,929	5,001	4,903	5027
N_2O									
Oil and natural gas	12	12	13	14	14	14	13	12	12
Total emissions	10,766	10,072	9,024	7,841	7,363	7,208	7,351	7,130	7,426

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; SNAM, several years), and industrial association for oil and gas (UP, several years).

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

3.9.5 Source-specific recalculations

In the 2012 submission, some recalculations affected emission estimates of the sector.
New information has been provided by an operator as regards fugitive emissions in 2009 and the length of high pressure pipelines for natural gas transport has been updated for 2009.
Recalculations accounted for an increase by 0.04% of CO_2 eq. emissions on total emissions in the same year.

3.9.6 Source-specific planned improvements

No further improvements are planned for the next submission.

4 INDUSTRIAL PROCESSES [CRF sector 2]

4.1 Sector overview

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

In 2010 industrial processes account for 4.9% of CO_2 emissions, 0.1% of CH_4, 2.4% of N_2O, 100% of PFCs, HFCs and SF_6. In terms of CO_2 equivalent, industrial processes share 6.4% 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 2010, while CO_2 emissions from chemical and metal industry reduced sharply in the period.

Table 4.1 Trend in greenhouse gas emissions from the industrial processes sector, 1990-2010 (Gg)

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2 (Gg)									
2A. Mineral Products	21,303	20,976	21,455	23,481	23,536	24,000	21,703	17,594	17,676
2B. Chemical Industry	3,254	1,659	1,362	1,784	1,727	1,759	1,488	1,178	1,663
2C. Metal Production	3,878	3,403	1,754	1,922	1,942	1,925	1,875	1,307	1,465
CH_4 (Gg)									
2B. Chemical Industry	2.45	2.43	2.40	2.28	2.49	2.65	0.60	0.62	0.59
2C. Metal Production	2.71	2.51	2.43	2.59	2.58	2.71	2.39	2.61	2.51
N_2O (Gg)									
2B. Chemical Industry	21.54	22.81	21.11	21.65	20.36	23.35	22.66	22.78	23.06
HFCs (Gg CO_2 eq.)	351	355	359	355	482	671	450	756	1,182
PFCs (Gg CO_2 eq.)	2,487	2,150	1,567	1,444	1,233	1,266	1,038	1,066	1,104
SF_6 (Gg CO_2 eq.)	333	356	358	370	416	601	683	729	605

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

Key-category identification in the industrial processes sector with the IPCC Approach 1 and Approach 2 for 2010

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

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

In addition CO_2 emissions from limestone and dolomite use is a key category in the base year at level assessment with the Approach 1 including and excluding LULUCF.

4.2 Mineral Products (2A)

4.2.1 Source category description

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

Cement
Cement production (2A1) is the main source of CO_2 emissions in this sector. As already mentioned, it is a key source both at level (with both the Approach 1 and Approach 2) and trend assessment (with the Approach 1) and accounts for 3.1% of the total national emissions.

During the last 15 years, in Italy, changes in cement production sector have occurred, leading to a more stable structure. The oldest plants were closed, wet processes were abandoned in favour of dry processes so as to improve the implementation of more modern and efficient technologies. The effects of the global recession period have led at national level only to two plants closedown. In 2010 28 companies (87 plants of which: 58 full cycle and 29 grinding plants) operate in this sector: multinational companies and small and medium size enterprises (operating at national or only at local level) are present in the country. As for the localization of the operating plants: 45% is in northern Italy, 17% is in the central regions of the country and 38% is in the southern regions and in the islands. There are 80 active sintering rotary kilns which belong to the “dry” or of “semidry” types. In 2010 the larger size cement plants (i.e. with cement production capacity > 1 Mt/y) contributed with 16.7% to the national cement production; due to resizing of plants in the previous years, 5 plants keep a cement production capacity >1 Mt/year. In Italy different types of cement are produced; as for 2010 AITEC, the national cement association, has characterised the national production as follows: 72% is CEM II (Portland composite cement); 13.6% is CEM IV (pozzolanic cement); 9.9% is CEM I (ordinary Portland Cement) and 4.5% is CEM III (blastfurnace cement). Clinker production, which has been decreasing since 2007 (about 10% in 2008 compared to 2007; about 19% in 2009 compared to 2008), in 2010 reached practically the same amount as in 2009. As CO_2 emissions and cement/clinker production are strictly related, a decrease in the CO_2 emissions from cement production has been observed in the same way.

Lime
CO_2 emissions occur also from processes where lime is produced and account for 0.46% of the total national emissions. Lime production can also occur, beside lime industry, in different industrial sectors such as iron and steel making, pulp and paper production, soda ash production, sugar production; lime can also be used in a number of processes concerning wastewater treatment, agriculture and the neutralization of acidic emissions in the industrial flue gases. In particular the other relevant lime productions accounted for in Italy are those occurring in the iron and steel making process and in the sugar production process.
Lime is basically produced by calcination of limestone (calcium carbonate) or dolomite (calcium/magnesium carbonate) at 900°C. The process leads to quicklime and CO_2 emissions according to the following reaction:

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

CO_2 is released because of the process reaction itself and also because of combustion to provide energy to the process. CaO and MgO are called quicklime. Quicklime, together with water, give another product of the lime industry which is called calcium hydroxide $Ca(OH)_2$.
CO_2 emissions estimation is related to lime production in mineral industry and it also includes the production of lime in iron and steel making facilities and lime production in sugar mills.

The number of lime producing facilities has been relevantly changing through the years: 85 operating plants in 1990, 46 plants in 2003, 38 plants in 2008 and 35 plants in 2010 (figures for 2008 and 2010 are based on the European emissions trading scheme data). Moreover, 46% of the plants is in the southern regions and in the islands, 39% is in the northern regions and 15% in the central regions. The number of operating kilns has also decreased significantly through the years (about 171 in 1990, 75 in 2003). During the nineties lime industry invested in technology implementation to replace the old kilns with regenerative and high efficiency kilns, rotary kilns are no longer used. Concerning fuel consumptions, 80% of the Italian lime industry uses natural gas, 20% uses coke.

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

CO_2 emissions are also related to the use of limestone and dolomite in different industrial processes, and they account for 0.37% of the total national emissions. Limestone or dolomite can be added in different steps of the production process to obtain the desired product features (i.e. colour, porosity). Sometimes carbonates in limestone and dolomite may have to be calcined ("dead burned") in order to be added to the manufacturing process. Limestone and dolomite are also used in paper production process and in the treatment of power plants flue gases. A decrease in the production processes and the relevant use of limestone in 2009 led to a decrease (-25%) in CO_2 emissions. In 2010 the amount of limestone and dolomite used in the relevant processes was a bit smaller than in 2009.

Glass production

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

With regard to glass chemical composition, the Italian glass production consists of 95% soda-lime glass; 4% borosilicate glass and 1% lead/crystal glass.

The main steps of the production process in glass industry are the following:

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

The formulated batch is generally melted in continuous furnaces, whose size and features are related to the types of glass production. In Italy 80% of the glass industry production is carried out using natural gas as fuel, other fossil fuels consumption is limited to low sulphur content oil. Emissions are basically released by the high temperature melting step and depend on the type of glass product, raw materials and furnaces involved in the production process. Main pollutants are: dust, NO_x, SO_x, CO_2; occasionally and depending on the specific production process, heavy metals, fluorides and chlorides gases could be released. CO_2 emissions are mainly related to the decarbonisation of carbonates used in the process (soda ash, limestone, dolomite) during the melting phase, accounting for 0.16% of the total national emissions.

Soda Ash production and use

In Italy only one facility operates soda ash production via Solvay process. Solvay process allows producing soda ash through the conversion of sodium chloride into sodium carbonate using calcium carbonate and ammonia. CO_2 is released and calcium chloride waste.

Up to the second half of year 2000 in the unit for the production of peroxidates there was one sodium carbonate line and a sodium perborate line which was then converted to sodium carbonate production. Soda ash is also used in glass production processes. CO_2 emissions from soda ash production account for 0.05% of the total national emissions.

4.2.2 Methodological issues

IPCC Guidelines and Good Practice Guidance are used to estimate emissions from this sector (IPCC, 1997; IPCC, 2000; IPCC, 2006).

Activity data are supplied in the national statistical yearbooks (ISTAT, several years) and by industries. Emission factors are those provided by the IPCC Guidelines (IPCC, 1997; IPCC, 2000; IPCC, 2006), by the

EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2007) or by other international Guidebooks (USEPA, 1997).

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

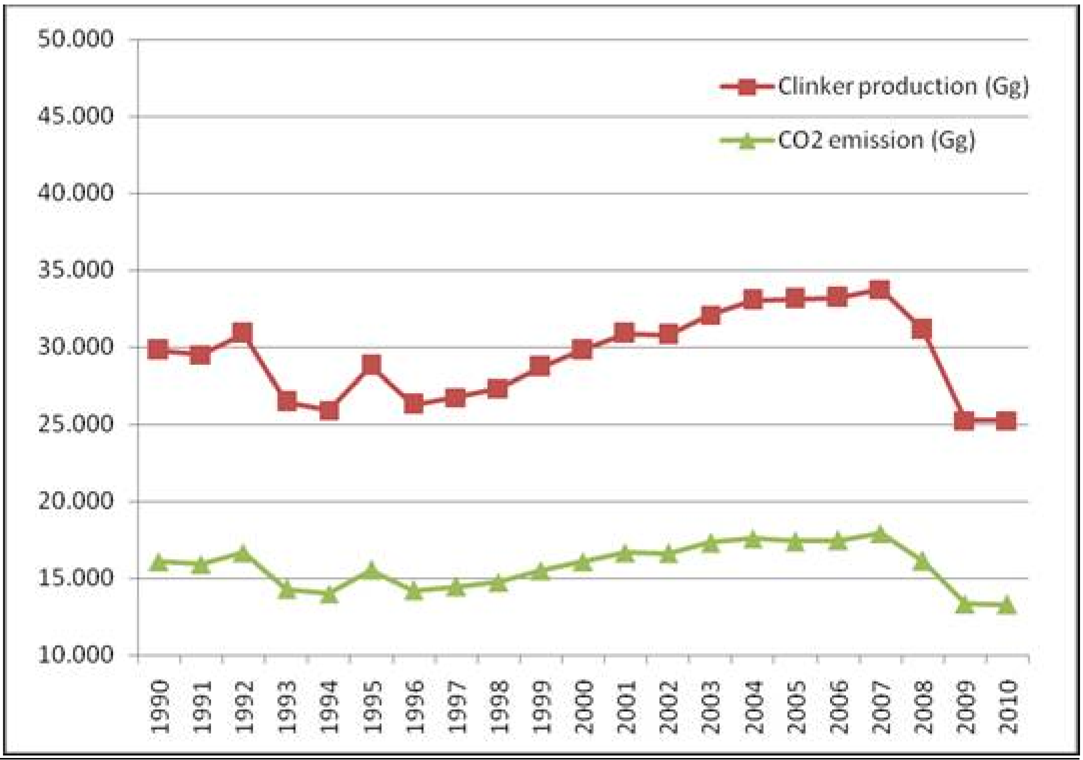

Figure 4.1 Trend of clinker production (Gg) and CO_2 emissions (Gg), 1990-2010.

For the years from 1990 up to 2003 the resulting emission factor for cement production was equal to 540 kg CO_2/t clinker, based on the average CaO content in the clinker and taking into account the contribute of carbonates and additives. In lack of specific data from the plants, this value was suggested to the operators by AITEC (AITEC, 2004) on the basis of a tool provided by the World Business Council for Sustainable Development, available on website at the address http://www.ghgprotocol.org/standard/tools.htm.
From 2004, emission factors are based on the data reported within the frame of the EPER/EPRTR and of the European Emissions Trading scheme. The EF resulted in 518 kg CO_2/t clinker in 2008, in 528 kg CO_2/t clinker in 2009 (EF value for this year has been checked and revised in the present submission) and in 526 kg CO_2/t in 2010 based on the average CaO content in the clinker and taking into account the contribute of carbonates and additives. The average emission factor varies year per year as a consequence of the different types of cement produced and their quality characteristics.

Finally, regarding industry data verification, the available activity data for the cement/clinker production in Italy are consistent to the information supplied by the Italian cement industry association, to the data reported

under the national PRTR and also to the data collected in the frame of the national ETS. Emission data reported under the different obligations are in accordance for all the facilities.
In the framework of the EU-ETS as well as the EPRTR registry, 52 plants out of 58 reported in 2010 their data representing more than 98% of total national clinker production. Under the EU-ETS, cement plants communicate emissions and activity data split between energy and processes phases and specifying the amount of carbonates and additives; both activity data and emissions are independently verified and certified as requested by the EU-ETS directive.

Lime
CO_2 emissions from lime have been estimated on the basis of production activity data supplied by ISTAT (ISTAT, several years up to 2008) and by operators in the frame of the ETS reporting obligations 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). In particular since 2009, information available in the frame of the ETS reporting obligation has allowed us having the lime productions at facility level together with CO2 emissions data (both activity data and CO_2 emissions are certified). The resulting values, in the last years, for the implied emission factor were 706 kg CO_2/t lime production in 2005; 694 kg CO_2/t lime production in 2006; 707 kg CO_2/t lime production in 2007; 710 kg CO_2/t lime production in 2008, 707 kg CO_2/t lime in 2009 and 706 kg CO_2/t lime in 2010.
Under the EU-ETS, lime plants communicate emissions and activity data split between energy and processes phases and specifying the amount of carbonates and additives; both activity data and emissions are independently verified and certified as requested by the EU-ETS directive.

Limestone and dolomite
CO_2 emissions estimates for 2010 from limestone and dolomite use are related to the use of limestone and dolomite in bricks, tiles and ceramic production, paper production and also in the treatment of flue gases from power plants. CO_2 emissions from paper production were accounted for the whole time series in the last submission as requested by the 2010 review report. CO_2 emissions deriving from the treatment of flue gases have been accounted for the whole time series from 2011 submission. In the CRFs the total amount of limestone and dolomite used in these processes is reported, as activity data, and it has been estimated on the basis of the average content of $CaCO_3$ in the different products. Detailed production activity data and emission factors have been supplied in the framework of the European emissions trading scheme and relevant data are annually provided by the Italian bricks and tiles industrial association and by the Italian ceramic industrial associations (ANDIL, 2000; ANDIL, several years; ASSOPIASTRELLE, several years; ASSOPIASTRELLE, 2004). Additional information will be available from 2013, in the context of the EU ETS with the entry of new plants for sectors not previously included, which will be used to verify emission estimates.

Soda ash
CO_2 emissions from soda ash production have been estimated on account of information available about the Solvay process (Solvay, 2003), whereas those from soda ash use are included in glass production. In the present submission activity data for the years since 2007 have been revised based on additional information provided by the operator concerning the productions of soda ash and chlorine which have occurred at the facility since 2007.

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). NMVOC emissions from road paving related to years from 2006 to 2009 have been revised in the present submission because SITEB has supplied to the inventory team more upted production data for the same years (SITEB, 2011, personal communication).

4.2.3 Uncertainty and time-series consistency

The uncertainty in CO_2 emissions from cement, lime, limestone and dolomite use and glass production is estimated to be equal to 10.4% from each activity, resulting from 3% and 10% for activity data and emission factor, respectively. Official statistics of activity data for these categories are quite reliable when compared to the activity data reported by facilities under different data collections, thus leading to the considered uncertainty level for the activity data. The uncertainty level for emission factors is equal to the maximum level reported in the IPCC Good Practice Guidance (IPCC, 2000) for the cement production; this is a conservative estimation because the range of values of the emission factors of the Italian cement plants would lead to a lower uncertainty level.
Montecarlo analysis has been applied to estimate uncertainty of CO_2 emissions from cement for 2009. The resulting figure is equal to 10.0%. Normal distributions have been assumed for the parameters and information deriving from the ETS has been considered in defining the shape of the distributions. A summary of the results is reported in Annex 1.

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

Table 4.2 Production of mineral products, 1990 – 2010 (Gg)

ACTIVITY DATA	1990	1995	2000	2005	2006	2007	2008	2009	2010
					(Gg)				
Cement production (decarbonizing)	29,786	28,778	29,816	33,122	33,210	33,742	31,119	25,259	25,239
Glass (decarbonizing)	3,779	4,259	4,930	5,328	5,327	5,385	5,365	4,736	5,063
Lime (decarbonizing)	2,583	2,873	2,760	3,344	3,496	3,444	3,206	2,390	2,789
Limestone and dolomite use	5,773	5,283	5,132	6,076	6,015	6,035	5,345	3,752	3,540
Soda ash production and use	610	1,070	1,000	915	883	786	752	1,017	1,058

Table 4.3 CO_2 emissions from mineral products, 1990 – 2010 (Gg)

CO_2 EMISSIONS	1990	1995	2000	2005	2006	2007	2008	2009	2010
					(Gg)				
Cement production (decarbonizing)	16,084	15,540	16,101	17,403	17,474	17,914	16,127	13,341	13,276
Glass (decarbonizing)	416	468	549	645	618	663	627	537	559
Lime (decarbonizing)	2,042	2,279	2,185	2,361	2,426	2,434	2,276	1,689	1,969
Limestone and dolomite use	2,540	2,325	2,258	2,674	2,647	2,655	2,352	1,651	1,558
Soda ash production and use	183	321	300	275	247	241	239	302	314

Emission trends are generally related to the production level, which has been decreasing for the last two years; in particular, for 2009, the decrease was mostly affected by the economic recession.

4.2.4 Source-specific QA/QC and verification

CO_2 emissions have been checked with the relevant industrial associations.
Both activity data and average emission factors are also compared every year with data reported in the national EPER/E-PRTR registry and in the European emissions trading scheme.
Under the EU-ETS, operators are requested to report activity data and CO_2 emissions as information verified and certified by auditors who check for consistency to the reporting criteria.
Activity data and emissions reported under EU-ETS and EPER/EPRTR are compared to the information provided by the industrial associations. In particular, comparisons have been carried out for cement, lime, limestone and dolomite, and glass sectors. The general outcome of this verification step shows consistency

among the information collected under different legislative framework and the information provided by the relevant industrial associations.

4.2.5 Source-specific recalculations

Recalculations occurred as, in the current submission, CO_2 emissions in 2009 from clinker production and from lime production have been revised; CO_2 emissions from the soda ash production for the time series from 2007 to 2009 has been revised due to an update of the activity data for the same time period. Consequently, for CO_2 emissions, recalculations for the mineral industry result in -0.11% decrease in 2007, -0.12% decrease in 2008 and +0.12%increase in 2009, mainly due to the update along the time series of the activity data for clinker, lime and soda ash production and use as shown in the following box.
Recalculation also occurred in the current submission for NMVOC emission estimation from road paving because more update activity data were supplied by the sectorial association. Consequently, for NMVOC emissions, recalculations for the mineral industry result in about +10% increase in 2006, +12% increase in 2007, +13% increase in 2008 and +13% increase in 2009, mainly due to the increases along the time series for the activity data of the Road Paving with Asphalt as shown in the following box.

Recalculations (%) in CO_2 emissions time series for the cement production, lime production, soda ash production and use, 1990-2009 and Recalculation (%) in NMVOC emissions time series for the Road Paving with Asphalt, 1990-2009.

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008	2009
CO_2								
2A.1. Cement Production								-0.85%
2A.2. Lime Production								
2A.4. Soda Ash Production and use						- 11,11%	- 11,11%	+42,28%
NMVOC								
2A.6. Road Paving with Asphalt					+9,93%	+12,03%	+13,48%	+12,66%

4.2.6 Source-specific planned improvements

The outcome of further investigations concerning the production of soda ash and chlorine at facility level will be accounted for in the next submission.

4.3 Chemical industry (2B)

4.3.1 Source category description

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

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

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

Adipic acid is then used to produce nylon or is fed to other production processes. Together with adipic acid, N_2O is produced and CO_2 is one of the by-products (Radici Chimica, 1993).
Emissions data from adipic acid production are provided and referenced by one plant, which is the only producer in Italy (Radici Chimica, several years). Specifically for N_2O, adipic acid is a key source at trend assessment, both with Approach 1 and Approach 2. These emissions account for 16% of total N_2O emissions

in 2005, 2.4% in 2008 and 1.8% in 2010; the notable decrease in share is due to the fact that the technology to reduce N_2O emissions has become fully operational at the existing producing facility since 2007.

N_2O emissions have relevantly decreased thanks to the implementation of a catalytic abatement system (pilot scale plant). The use of thermally stable catalysts in the pilot plant has allowed the treatment of highly N_2O concentrated flue gas from the adipic acid production plant, reducing the volume of treated gas and the size of the pilot plant itself. The abatement system is generally run together with the adipic acid production process. In 2004 this system was tested for one month resulting in complete decomposition of N_2O; in 2005 the catalytic process was started only at the end of the year because of technical changes in the system; in 2006 the abatement system had been operating continuously for 9 months (3 months were needed for maintenance and technical changes) leading to the decomposition of 92% (efficiency of the abatement system while in operation) of N_2O emissions. Since 2007 the operating time has been about 11 months (about one month was needed for maintenance operations) and the abatement rate for N_2O emissions has reached an efficiency of the abatement system while in operation exceeding 98% (Radici Chimica, several years).
Also CO_2 emissions are estimated from this source.

Ammonia production
In Italy only one faciltiy had been producing ammonia up to 2010 as a consequence of the resizing of the production at national level after the crisis of the largest fertilizer producer, Enichem Agricoltura, and as a consequence of the international financial crisis in the last years. Two facilities had been producing ammonia in Italy up to 2008, in 2009 one plant stopped the production and the plant reconversion is currently under negotiation. Ammonia is obtained after processing in ammonia converters a “synthesis gas” which contains hydrogen and nitrogen. CO_2 is also contained in the synthesis gas, but it is removed in the decarbonising step within the ammonia production process. Part of CO_2 is recovered as a by-product and part is released to atmosphere. Recovered CO_2 can either be used as input for different production processes (e.g. Urea or Calcium nitrate lines) on site or can be sold to technical gas manufacturers. The results of the investigation concerning the recovered CO_2 were accounted for in the previous submissions: operators provided the information used to revise both the emissions and the EF time series (YARA, several years). CO_2 emissions from ammonia production are also a key source, at trend assessment with the Approach 1.

Nitric acid
In early nineties seven facilities manufactured nitric acid, but since 2003 the production has been carried on only in three plants. In 2008 another plant stopped nitric acid production and the reconversion of the plant is currently under negotiation, so since 2009 nitric acid production has been carried out in only two plants. Nitric acid is produced from ammonia by catalytic oxidation (with air) of NH_3 to NO_2 and subsequent reaction with water. Currently the reactions involved take place in low and medium pressure processes.

N_2O emissions from nitric acid production are key source for trend assessment with Approach 1, although they also show a relevant decrease in emissions from 1990 due to a reduction in production. Moreover, as far as YARA is concerned, the decrease in N_2O emissions is also related to the implementation of catalytic N_2O decomposition in the oxidation reactor (YARA De-N_2O patented technology, based on the use of CeO_2 catalyst) (YARA, several years).

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

Ethylene, Ethylene oxide, Propylene, Styrene
Ethylene, ethylene oxide, propylene and styrene productions belong to the organic chemical processes. In particular, ethylene is produced in petrochemical industry by steam cracking to manufacture ethylene oxide, styrene monomer and polyethylenes. Ethylene oxide is obtained via oxidation of ethylene and it is largely used as precursor of ethylene glycol and in the manufacture of surfactants and detergents. Propylene is

obtained by cracking of oil and it is used to manufacture polypropylene but also acetone and phenol. Styrene, also known as vinyl benzene, is produced on industrial scale by catalytic dehydrogenation of ethyl benzene. Styrene is used in the rubber and plastic industry to manufacture through polymerisation processes such products as polystyrene, ABS, SBR rubber, SBR latex. Except for ethylene oxide production, which has stopped in 2002, the other productions of the above mentioned chemicals still occur in Italy.
As far as ethylene, ethylene oxide and propylene, Syndial Spa (ex Enichem) and Polimeri Europa (Syndial, several years; Polimeri Europa, several years) were the main producers in Italy up to 2006. Since 2007 Polimeri Europa has become the main producer for those products, while it has been the main producer of styrene since 2002.

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

<u>*Caprolactame production*</u>
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.

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

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

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

4.3.2 Methodological issues

<u>*Adipic acid*</u>
Italian production figures and emission estimates for adipic acid have been provided by the process operator (Radici Chimica, several years) for the whole time series. Emissions estimates provided by the operator are based on the IPCC default EF, so the values provided and the estimates in the Italian emissions inventory are, basically, the result of the same methodology. More specifically, N_2O emissions from adipic acid production (category 2B3) have been estimated using the default IPCC emission factor equal to 0.30 kg N_2O/kg adipic acid produced, from 1990 to 2003.

Since 2004 the operator has started to study how to introduce an abatement system; although emission estimates provided by the operator have still been based on the IPCC default emission factor (0.30 kgN_2O/kg adipic acid produced), the operating hours of the abatement system and the abatement rates have also been included in the estimation process. The abatement system is generally run together with the adipic acid production process. In 2004, the N_2O catalytic decomposition abatement technology has been tested so that the value of emission factor has been reduced taking into account the efficiency and the time, one month, that the technology operated. From the end of 2005 the abatement technology is fully operational; the average emission factor in 2006 is equal to 0.05 kg N_2O/kg adipic acid produced and the abatement system had been operating continuously for 9 months; since 2007 the average emission factor has been 0.03 kg N_2O/kg adipic acid produced and the operating time of the abatement system has been 11 months. Improving

the efficiency in operation, the technology system it is expected to reach 95% of abatement rate in the future with respect to the default emission factor 300 kg/t adipic acid produced.
Thus, both for the period 1990-2005 and from 2006 onwards the estimates are provided according to the GPG (default EF has been used when no abatement system was operational; abatement rates have been considered in estimating emission values since 2006). The operator reports also under EPER/E-PRTR both adipic acid production and the N_2O emissions related to this production; adipic production and N_2O emissions have been also reported by the operator to the national competent authoritiy for the ETS (because the facility will join the ETS system in 2013) together with additional information such as abatement rates and operating times. Based on information from the national PRTR EFs are calculated for the plant, the resulting value is checked and verified by the formula included in the following box (based on the IPCC default EFs for adipic acid production, abatement rate and operating time of the abatement technology at the facility). In the formula the average emission factor is calculated subtracting from the default EF (0.300 kgN_2O /kg adipic acid produced) the default EF multiplied by the abatement technology rate and by the operating time factor, parameters and resulting EF values are indicated for the years 2005 to 2010.
The EFs submitted for the adipic acid production in the CRF and the EFs calculated for the plant in the following box are practically the same.

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

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

Values resulting according to the following formula

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

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

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

<u>*Ammonia*</u>
Ammonia production data are published in the international industrial statistical yearbooks (UN, several years), national statistical yearbooks (ISTAT, several years) and from 2002 they have been checked with information reported in the national EPER/E-PRTR registry. Since 2009 only one facility has been producing ammonia in Italy and reporting data to the national PRTR. Recovered CO_2 has been investigated with the cooperation of the operators and the resulting information has been used to revise the whole CO_2 emission time series and the emission factors in the last submission. The analysis has allowed understanding that CO_2 emissions recovered from ammonia production are used to produce urea and technical gases. According to IPCC Guidelines this CO_2 recovered should be accounted for emission and included in the estimate. Differently from the previous submissions the resulting average CO_2 emission factors were found to be higher than the IPCC defaults. In particular, for the years 1990-2001, CO_2 emission factor has been calculated on the basis of information reported by the production plants for 2002 and 2003 in the framework of the national EPER/E-PRTR registry and considering also the amounts of CO_2 recovered since the beginning of the recovery operations. CO_2 reported to the national EPER/E-PRTR registry has been used for the previous years in consideration that, as communicated by the operators, no modifications to the production plants have occurred along the period (YARA, 2007). For the years 2002-2007, the average emission factors result also from data reported by the plants in the national EPER/E-PRTR and they account for the recovered CO_2 data too. As for 2008 the average emission factor is 1.86 t CO_2/t ammonia production, for 2009 the implied emission factor is 1.96 t CO_2/t ammonia production, while in 2010 the implied emission factor is 1.89 t CO_2/t ammonia production. Natural gas is used as feedstock in the ammonia production plants and the amount of fuel used is included in the energy balance under the no energy final consumption sector (see Annex 5), therefore double counting does not occur. The following box shows the time series for the average CO_2 emission factor.

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

	1990-2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
EF ($t\ CO_2$/t ammonia production)	1.90	1.90	1.93	1.94	1.93	1.92	1.90	1.86	1.96	1.89

Nitric acid

With regard to nitric acid production (2B2), production figures at national level are published in the national statistical yearbooks (ISTAT, several years), while at plant level they have been collected from industry (Norsk Hydro, several years; YARA, several years; Radici Chimica, several years). In 1990 there were seven production plants in Italy; three of them closed between 1992 and 1995, and another one closed in 2004, one more closedown in 2008 has left two plants still operating.

The N_2O average emission factors are calculated from 1990 on the basis of the emission factors provided by the existing production plants in the national EPER/E-PRTR registry, applied for the whole time series, and default IPCC emission factors for low and medium pressure plants attributed to the plants, now closed, where it was not possible to collect detailed information. Thus, N_2O emissions are estimated at plant level also considering the operating unit level, if necessary. Activity data have been collected at plant level for the whole time series. Unit specific default IPCC EFs have been used for plants closed in the nineties because it was not possible to collect more detailed information. For the other plants, data supplied in the framework of the EPER/EPRTR registry have been used from 2001 onwards, while for the years 1990-2000 EFs at unit level have been calculated as an average of 2001-2004 data provided by operators in the EPER/EPRTR register. The implied emission factor varies year by year depending on the production levels of the different plants and it was equal to 6.49 and 7.07 kg N_2O/Mg nitric acid production, in 1990 and in 2007 respectively. In 2008, the implementation of catalyst N_2O abatement technology in one of the major production plants, and specifically in one unit of that plant, has led to a significant decrease in total N_2O emissions from nitric acid production, consequently a relevant reduction in the IEF can be observed too (YARA, several years): the implied emission factor for 2008 is in fact 2.29 kg N_2O/Mg nitric acid production (the abatement rate in one plant was 82% so far), the implied emission factor for 2009 is 2.94 kg N_2O/Mg nitric acid production, while for 2010 the implied emission factor is 1.21 kg N_2O/Mg nitric acid production; the relevant decrease is due to the installation of the abatment technology in the other unit of the same producing facility (Radici Chimica, 2011).

Caprolactame

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

Carbon Black

CO_2 and CH_4 emissions from carbon black production process have been estimated on the basis of information supplied by the Italian production plants in the framework of the national EPER/E-PRTR registry and the European emissions trading scheme. In 1996 a change in the production technology in the existing plants caused a reduction of CH_4, NMVOC, NO_x, SO_x and PM_{10} emissions. In 2005, the CO_2 implied emission factor is 2.55 t CO_2/t carbon black production, in 2008 it is equal to 2.59 t CO_2/t carbon black production, in 2009 the IEF is 2.49 t CO_2/t carbon black production, while in 2010 the IEF is 3.06 t CO_2/t carbon black production.

Calcium carbide

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

4.3.3 Uncertainty and time-series consistency

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

In Tables 4.4 and 4.5, the production of chemical industry, including non-key sources, and CO_2, CH_4 and N_2O emission trends are reported.
In general, total emission trends for all the chemical productions have been affected by reductions in productions over the years 2007-2008-2009 (except for adipic acid and titanium dioxide activity data), whenever abatement technologies (e.g. nitric acid since 2008) or closures of plants cannot be regarded to as the specific causes for the decreasing emissions. In 2010 a general increase in productions determines a general increase in emissions estimates compared to 2009 estimates.

Table 4.4 Production of chemical industry, 1990 – 2010 (Gg)

ACTIVITY DATA	1990	1995	2000	2005	2006	2007	2008	2009	2010
				(Gg)					
Adipic acid	49	64	71	75	84	84	76	78	85
Ammonia	1,455	592	414	607	559	578	474	354	505
Calcium carbide	12	7	-	-	-	-	-	-	-
Caprolactame	120	120	111	-	-	-	-	-	-
Carbon black	184	208	221	214	226	234	210	167	206
Ethylene	1,466	1,807	1,771	1,721	1,639	1,797	1,465	1,360	1,551
Ethylene oxide	61	54	13	-	-	-	-	-	-
Nitric acid	1,037	588	556	572	526	505	505	419	417
Propylene	774	693	690	1.037	988	971	870	760	880
Styrene	365	484	613	520	558	549	504	497	524
Titanium dioxide	58	69	72	60	68	72	59	64	70

Table 4.5 CO_2, CH_4 and N_2O emissions from chemical industry, 1990 – 2010 (Gg)

EMISSIONS	1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2 (Gg)									
Ammonia	2,764.50	1,124.80	786.18	1,171.94	1,075.54	1,097.36	881.72	694.83	959.37
Calcium carbide	13.08	7.09	-	-	-	-	-	-	-
Carbon black	422.05	477.48	508.83	548.22	579.21	585.73	544.24	414.96	629.43
Titanium dioxide	52.80	48.11	64.70	62.01	70.57	74.28	60.70	66.27	72.39
Adipic acid	1.33	1.72	1.93	1.50	1.68	1.68	1.52	1.61	1.75
CH_4 (Gg)									
Carbon black	1.84	2.08	0.11	0.10	0.10	0.10	0.10	0.10	0.12
Ethylene	0.12	0.15	0.15	0.15	0.14	0.15	0.12	0.11	0.13
Propylene	0.07	0.06	0.06	0.09	0.08	0.08	0.07	0.06	0.07
Styrene	0.01	NA	NA	NA	NA	NA	NA	NA	NA
Ethylene oxide	0.42	0.37	0.09	-	-	-	-	-	-
N_2O (Gg)									
Nitric acid	6.73	4.22	4.09	5.44	3.95	3.58	1.16	1.23	0.51
Adipic acid	14.77	19.09	21.42	19.59	4.58	2.52	2.28	2.41	1.58
Caprolactame	0.04	0.04	0.03	-	-	-	-	-	-

4.3.4 Source-specific QA/QC and verification

Emissions from adipic acid, nitric acid, ammonia and other chemical industry production have been checked with the relevant process operators and with data reported to the national EPER/E-PRTR registry. Emissions and activity data for adipic acid, nitric acid and ammonia productions have also been checked against the relevant information reported by operator to the national competent authority for the ETS (those chemical processes will join the ETS system in 2013), consistency of both emissions and activity data for those sectors is the outcome of this control.

4.3.5 Source-specific recalculations

Activity data related to 2009 for Ethylene, Polypropilene and Acrilonitrile productions have been updated by the relevant operators. Recalculations for 2009 estimates have occurred as far as CH_4 emission from ethylene production (+0.74%) and NMVOC emission from the Other non specified category (+0.025%) are concerned.

4.3.6 Source-specific planned improvements

Further investigations regarding completeness of CO_2 emissions sources from the activities of this sector are planned.
Further additional checks regarding emissions for 2005-2009 will be carried out on account of information from new entrance installations that will be included in the ETS from 2013.
A detailed balance of the natural gas reported in the Energy Balance, as no energy fuel consumption, and the fuel used for the production processes in the petrochemical sector is planned.

4.4 Metal production (2C)

4.4.1 Source category description

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

The share of CO_2 emissions from metal production accounts, in the year 2010, for 0.34% of the national total CO_2 emissions, and 7.04% of the total CO_2 from industrial processes.
The share of CH_4 emissions is, in 2010, equal to 0.12% of the national total CH_4 emissions while N_2O emissions do not occur.
The share of F-gas emissions from metal production out of the national total F-gas levels was 52.8% in the base-year and has decreased to 1.00% (0.02% of the national total greenhouse gas emissions) in the year 2010.

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

In 1990, there were four integrated iron and steel plants in Italy. In 2010, there are only three of the above mentioned plants, one of which lacks sintering facilities. Oxygen steel production represents about 33% of the total production and the arc furnace steel the remaining 67% (FEDERACCIAI, several years).
Currently, long products represent about 50% of steel production in Italy, flat products about 40% and pipes the remaining 10%. In 2010 long production has been equal to 12.2 Tg with an increase of 9.1% over the previous year but still below 27% compared to 2008; flat production has been equal to 12.6 Tg with an increase of 38.6% on the previous year but still below 9.8% compared to 2008 level. Almost the whole flat production derives from one only integrated iron and steel plant, while in steel plants equipped with electric ovens, almost all located in the northern regions, long products are produced (e.g. carbon steel, stainless steels) and seamless pipes (only one plant) (FEDERACCIAI, several years).
CO_2 emissions from steel production refer to carbonates used in basic oxygen furnaces and crude iron and electrodes in electric arc furnaces. CO_2 emissions from pig iron production refer to carbonates used in sinter and pig iron production. CO_2 emissions from iron and steel production due to the fuel consumption in combustion processes are estimated and reported in the energy sector (1A2a) to avoid double counting.
CH_4 emissions from steel production refer to blast furnace charging, basic oxygen furnace, electric furnaces and rolling mills. CH_4 emissions from coke production are fugitive emissions during solid fuel transformation and have been reported under 1B1b category.

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

Aluminium
From primary aluminium production CO_2 and PFCs (CF_4 and C_2F_6) are emitted.
PFCs are formed during a phenomenon known as the ‘anode effect’, when alumina levels are low.

In 1990 primary aluminium production in Italy was carried out in 5 sites where different technologies were implemented:

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

Since then the implemented technology has been upgraded from Side Work Prebake to Point Fed Prebake; while three old plants stopped the operations in 1991 (Bolzano) and in 1992 (Fusina 2 and Porto Marghera). Since 2000 Alcoa has replaced ENIRISORSE in operating the plants.
At present in Italy two primary aluminium production plants, which use a prebake technology with point feeding, characterised by low emissions, are operating. Primary aluminium production passed from 232 kt in 1990 to 130 kt in 2010.

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 1 Mg. HFC 125 emissions are reported in the category 2G and, in 2010, are equal to 605 kg.

4.4.2 Methodological issues

CO_2 and CH_4 emissions from the sector have been estimated on the basis of activity data published in the national statistical yearbooks (ISTAT, several years), data reported in the framework of the national EPER/E-PRTR registry and the European Emissions Trading Scheme, and supplied by industry (FEDERACCIAI, several years; ALCOA, several years). Emission factors reported in the EMEP/EEA Guidebook (EMEP/EEA, 2009), in sectoral studies (APAT, 2003; CTN/ACE, 2000) or supplied directly by industry (FEDERACCIAI, 2004; ALCOA, 2004; Italghisa, 2011) have been used.

Iron and steel

CO_2 emissions from iron and steel production refer to the carbonates used in sinter plants, in blast furnaces and in steel making plants to remove impurities; they are also related to the steel and pig iron scraps, and graphite electrodes consumed in electric arc furnaces.

Basic information for this sector derives from different sources in the period 1990-2010.

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 2002-2010 data have also been supplied by all the four integrated iron and steel plants in the framework of the European EPER/E-PRTR registry not distinguished for combustion and processes. Qualitative information and documentation available on the plants allowed reconstructing their history including closures or modifications of part of the plants; additional qualitative information regarding the plants collected and checked for other environmental issues or directly asked to the plant permitted to individuate the main driving of the emission trends for pig iron and steel productions.

Time series of carbonates used in basic oxygen furnaces have been reconstructed on the basis of the above mentioned information resulting in no emissions in the last years. Indeed, as regards the largest Italian producer of pig iron and steel, lime production has increased significantly from 2000 to 2008 by about 250,000 over 410,000 tonnes and the amount introduced in basic oxygen furnaces was, in 2004, about 490,000 tonnes (ILVA, 2006). In 2009 lime production, for the same plant, is equal to 216,000 tonnes but also steel production has sharply decreased; in 2010 lime production is 306,930 tonnes. Emissions from lime production in steel making industries are reported in 1A2 Manufacturing Industries and Construction category.

Concerning the electric arc furnaces, additional information on the consumption of scraps, pig iron, graphite and electrodes and their average carbon content has been supplied together with the steel production by industry for a typical plant in 2004 (FEDERACCIAI, 2004) and checked with other sectoral study (APAT, 2003). On the basis of these figures an average emission factor has been calculated.

On account of the amount of carbonates estimated in sinter plants, average emission factor was equal in 1990 to 0.15 t CO_2/t pig iron production, while in 2009 it reduced to 0.06 t CO_2/t pig iron production. The reduction is driven by the increase in the use of lime instead of carbonates in sinter and blast furnaces in the Italian plants. Emissions are reported under pig iron because they are emitted as CO_2 in the blast furnaces producing pig iron.

CO_2 average emission factor in basic oxygen furnaces results in 1990 equal to 0.079 t CO_2/t steel production, while from 2003 is null.

CO_2 average emission factor in electric arc furnaces, equal to 0.035 t CO_2/t steel production, has been calculated on the basis of equation 3.6B of the IPCC Good Practice Guidance (IPCC, 2000) taking into account the pig iron and graphite electrodes used in the furnace and the amount of carbon stored in the final product. The same emission factor has been used for the whole time series.

Implied emission factors for steel production reduced from 0.053 to 0.023 t CO_2/t steel production, from 1990 to 2010, 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.

The amount of carbon stored in steel produced in integrated plants has been considered and subtracted from the carbon balance (see Annex 3). The amount of carbon contained in steel has been estimated on the basis

of EN standard and, from 2005, with emission trading data. Carbon stored is equal to 48,511 tonnes in 1990 and equal to 73,529 tonnes in 2010.
CH_4 emissions from steel production have been estimated on the basis of emission factors derived from the specific IPPC BREF Report (IPPC, 2001 available at http://eippcb.jrc.es), sectoral study (APAT, 2003) and the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2007) and refer to blast furnace, basic oxygen furnace, electric furnaces and rolling mills.

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

Splitting up of ferroalloys national production and IPCC 2006 emission factors

	1990	1995	2000	2005	2006	2007	2008	2009	2010		IPCC 2006 EF
Ferroalloy											kg/t
FeCr	0.30	0.26	-								1,300
FeMn	0.24	0.10	0.28	0.5	0.5	0.3	0.4	0.4	0.4		1,500
FeSi	0.02	-	-								4,800
SiMn	0.32	0.53	0.62	0.5	0.5	0.7	0.6	0.6	0.6		1,400
Si-Metal	0.06	0.05	0.03								5,000
Other	0.07	0.06	0.07								5,000

Implied emission factor for ferroalloys has been reduced from 1.90 to 1.44 t CO_2/t ferroalloys production, from 1990 to 2010 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 53 kt) has resulted in CO_2 emissions decreasing from 395 Gg in 1990 to 77 Gg in 2010.

Aluminium production
PFC emissions from aluminium production have been estimated using both Tier 1 and Tier 2 IPCC methodologies. The Tier 1 has been used to calculate PFC emissions from 1990 to 1999, while Tier 2 has been used since 2000; the use of different methods along the period is due to the lack of detailed data for the years previous to 2000. Although a number of attempts have been tried over the last years by the inventory team to retrieve the 1990-1999 historical operating data, it is not possible to retrieve the information: Alcoa can not provide operating data for the period from 1990 to 1999 as the plants were managed by a different company not operating anymore. Thus the decision to use both tiers, which was supported by previous review processes, confirming the transparency, accuracy and conservativeness of this approach.
PFC emissions, specifically CF_4 and C_2F_6, have been calculated on the basis of information provided by national statistics (ENIRISORSE, several years; ASSOMET, several years) and the national primary aluminium producer (ALCOA, several years), with reference to the documents drawn up by the International Aluminium Institute (IAI, 2003; IAI 2006) and the IPCC Good Practice Guidance (IPCC, 2000).
Tier 1 method has been used to calculate PFC emissions related to the entire period 1990-1999. The emission factors for CF_4 and C_2F_6 were provided by the main national producer (ALCOA, 2004) based on the IAI document (IAI, 2003).
The Tier 1 method used by ALCOA is based on the IAI methodology, which collected anode effect data from 1990 up to 2000, accounting also for reductions in specific emission for all technology categories (specific factors for Point Fed Prebake cells have been considered to estimate emissions).

In 1990 at the five production sites the following technologies were implemented:

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

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

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

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

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

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

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

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

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

Anode Effects (minutes/cell day)

	2000	2005	2006	2007	2008	2009	2010
Primary Aluminium Plant	0.96	0.73	0.65	0.90	0.46	0.74	0.58

CO_2 emissions from aluminium production have been also estimated on the basis of activity data provided by industrial association (ENIRISORSE, several years; ASSOMET, several years) and default emission factor reported by industry (ALCOA, 2004) and by the IPCC Guidelines (IPCC, 1997) which refer to the prebaked anode process.
Emission factor has been assumed equal to 1.55 t CO_2/t primary aluminum production for the years 1990-2001, on the basis of data provided by the producer for 2002; this value is also consistent with the emission factors contained in the IPCC Guidelines and in the Aluminium Sector Greenhouse Gas Protocol. Since 2002 the emission factor has been calculated on account of information from the relevant plant supplied to the

national EPER/EPRTR registry (emissions and productions). Therefore, thanks to the availability of this additional information, CO_2 emission estimations have been carried out by the operator since 2002 according to the criteria defined by the International Aluminium Institute (IAI) and are given by the following three components:

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

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

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

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

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

* site specific value
** default value

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

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

* site specific value
** default value

Magnesium foundries

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

4.4.3 Uncertainty and time-series consistency

The combined uncertainty in PFC emissions from primary aluminium production is estimated to be about 11% in annual emissions, 5% and 10% concerning respectively activity data and emission factors; the uncertainty for SF_6 emissions from magnesium foundries is estimated to be about 7%, 5% for both activity data and emission factors. The uncertainty in CO_2 emissions from the sector is estimated to be 10.4%, for each activity, while for CH_4 emissions about 50%.
In Table 4.11 emission trends of CO_2, CH_4 and F-gases from metal production are reported. The decreasing of CO_2 emissions from iron and steel sector is driven by the use of lime instead of limestone and dolomite to

remove impurities in pig iron and steel while CO_2 emissions from aluminium and ferroalloys are driven by the production levels.
In Table 4.12 the emission trend of F-gases per compound from metal production is given. PFC emissions from aluminium production decreased because of the closure of three old plants in 1991 and 1992 and the update of technology for the two plants still operating. The decreasing of SF_6 consumption in the magnesium foundry from 2003 is due to the abandonment of recycling plant and the optimisation of mixing parameters.

Table 4.11 CO_2, CH_4 and F-gas emissions from metal production, 1990 – 2010 (Gg)

EMISSIONS	1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2 (Gg)									
Iron and steel	3,124	2,897	1,230	1,533	1,562	1,485	1,424	901	1,139
Aluminium production	359	276	295	299	297	354	370	345	250
Ferroalloys	395	230	229	89	83	86	81	61	77
CH_4 (Gg)									
Pig iron	2.13	2.10	2.02	2.06	2.07	2.00	1.88	1.02	1.54
Steel	0.58	0.60	0.60	0.67	0.74	0.75	0.73	0.52	0.63
PFC (Gg CO_2 eq.)									
Aluminium production	1,673	298	198	182	156	199	111	146	85
SF_6 (Gg)									
Magnesium foundries	-	-	0.0072	0.0035	0.0026	0.0023	0.0004	0.0004	0.0007
HFC125 - 2G Other (Gg)									
Magnesium foundries	-	-	-	-	-	0.0003	0.0023	0.0006	0.0006

Table 4.12 Actual F-gas emissions per compound from metal production in Gg CO_2 equivalent, 1990 – 2010

COMPOUND	1990	1995	2000	2005	2006	2007	2008	2009	2010
Gg CO_2 eq.									
CF_4 (PFC-14)	1,289.2	235.8	169.2	155.5	133.0	170.3	94.6	124.3	72.7
C_2F_6 (PFC-16)	384.1	61.7	29.0	26.6	22.8	29.1	16.2	21.3	12.4
Total PFC emissions from aluminium production	*1,673.4*	*297.5*	*198.2*	*182.1*	*155.7*	*199.4*	*110.8*	*145.6*	*85.2*
Total SF_6 emissions from magnesium foundries	*0.0*	*0.0*	*172.1*	*84.7*	*61.2*	*53.9*	*10.5*	*9.2*	*17.5*
HFC-125 in Magnesium foundries	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.9*	*6.5*	*1.6*	*1.7*
Total F-gas emissions from metal production	1,673.4	297.5	370.3	266.8	217.0	254.3	127.9	156.4	104.3

In response to the last review process (UNFCCC, 2010) a more robust Tier 1 comparison has been evaluated in order to strengthen the conservativeness of combined Tier 1 and Tier 2 approaches.
In particular, as suggested by previous review processes, several comparisons were analyzed, using Tier 1 and Tier 2 approach, and under Tier 1 approach using different emission factors available from the following references (IAI, 2003; IAI, 2006; IPCC 2000):

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

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

Table 4.13 Default CF_4 and C_2F_6 Emission Factors

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

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

Table 4.14 Default CF_4 and C_2F_6 Slope Coefficients

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

Worthy of remark is that, lacking specific plant data, IAI 2003 is the only document including emission factors for Point Fed Prebake technology, which is the technology implemented at the two remaining production sites since 1990. Moreover, as reported in this document, IAI proposed lowest accuracy default method departs from the IPCC default method. In the IPCC default method a single specific emission value is specified for each of four reduction technology categories: Center Work Prebake, Side Work Prebake, Vertical Stud Søderberg and Horizontal Stud Søderberg. The IPCC expert working panel mostly based these default factors on 1990 average IAI anode effect data and the average technology specific slope factors. IAI survey data collected since the publication of the original IPCC default values shows substantial reductions over the period 1990 to 2000 in specific emissions in all technology categories. In addition it has been shown that among the overall category of Center Work Prebake cells, the more modern Point Fed Prebake cells have made progress at a faster rate than for the older bar broken Center Work Prebake cells. Thus the original category has been broken into two separate types.
This is one of the most important reasons that convinced Italy to use IAI 2003 default emission factors over the period 1990-1999, as indicated also by ALCOA, instead of IPCC Good Practice Guidance default emission factors. As reported in a recent publication supplied by ECOFYS (ECOFYS, 2009), currently all new aluminium plants are designed according to Point Fed Prebake technology and the first improvement in the primary aluminium industry advancement is to replace current technologies with PFPB. Other technologies, Vertical Stud Søderberg, Center Work Prebake and Side Work Prebake are expected to be gradually replaced by PFPB. Only 20% of the existing plants had not yet been upgraded to PFPB in EU27. Moreover, the mean implied emission factor value for CF_4 over the period 2000-2009 is 0.12 (kg/t), comprised between 0.3 and 0.1 kg/t indicated in IAI 2003 for PFPB technology (see Table 4.6).

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

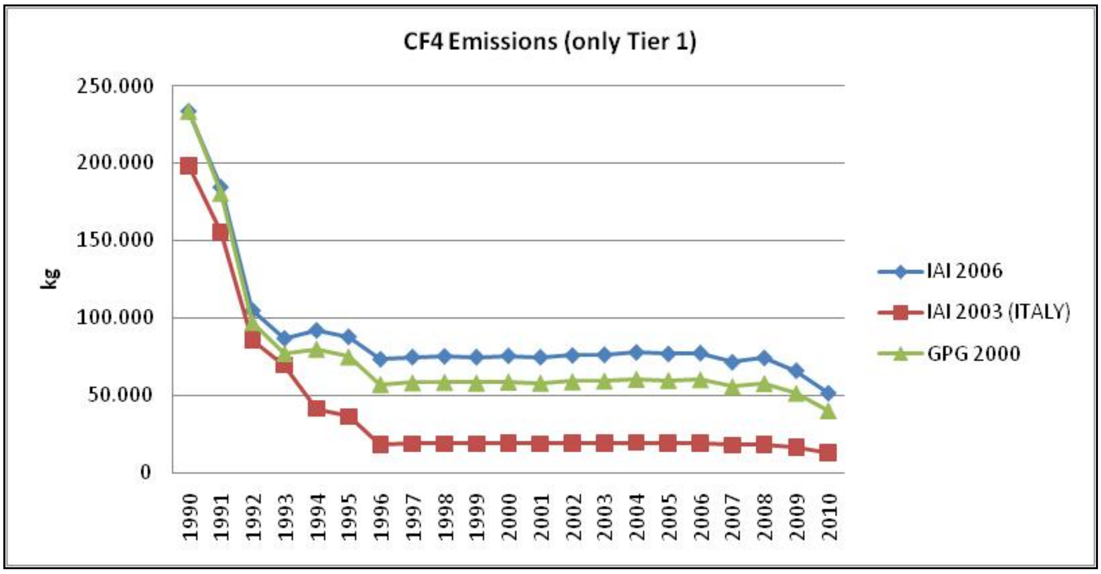

Figure 4.2 CF_4 emissions (only Tier 1)

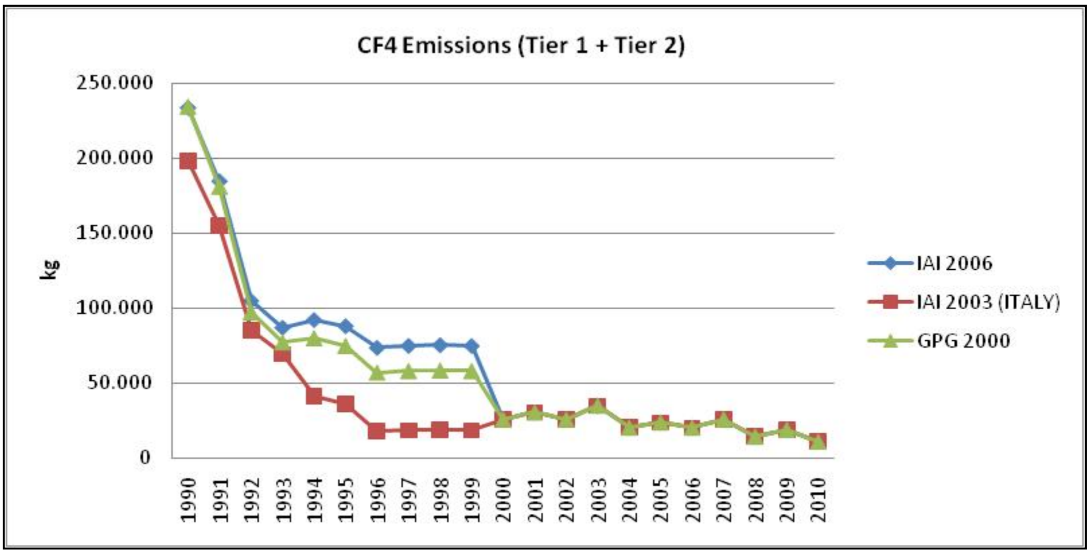

Figure 4.3 CF_4 emissions (Tier 1+Tier 2)

As for consistency, the Tier 1 + Tier 2 approach in estimating emissions is more reliable in producing the time series because it allows to use site specific data provided by the operator from 2000 onwards (and the use of the best available data is a good practice). Moreover, emission factor values reported in the IPCC Good Practice Guidance or in the 2006 IAI document (mean implied emission factor is 0.12 kg/t) lead to higher values for the emissions time series than those calculated out of emission factor values in 2003 IAI document (0.08 kg/t supplied by ALCOA and used by the Party), which means that national estimates can be considered conservative for the period. So for 1990 the use of EFs from IAI 2003, red line, results in CF_4 emission levels lower than those estimated by using the other EF references. This comparison was already done during the compilation of the 2006 submission and the Initial Report, which resulted in the establishment of the assigned amount.
Tier1 (1990-1999) and Tier 2 (2000-2009) time series are also better linked using IAI 2003 EFs (see Figure 4.3) because of the minor gap from 1999 to 2000 since the mean implied emission factor value for CF_4 over the period 2000-2009 is 0.12 (kg/t), comprised between 0.3 and 0.1 kg/t indicated in IAI 2003 for PFPB technology (see Table 4.6).
For this reason, the use of the combined Tier1+Tier2 approach, in this case, is conservative.

4.4.4 Source-specific QA/QC and verification

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

4.4.5 Source-specific recalculations

Minor recalculations in the sector have been done because iron and steel activity data for 2009 have been updated.

4.4.6 Source-specific planned improvements

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

4.5 Other production (2D)

4.5.1 Source category description

Only indirect gases and SO_2 emissions occur from these sources.
In this sector, non-energy emissions from pulp and paper as well as food and drink production, especially wine and bread, are reported. CO_2 from food and drink production (e.g. CO_2 added to water or beverages) can be of biogenic or non-biogenic origin but only information on CO_2 emissions of non-biogenic origin should be reported in the CRF.
According to the information provided by industrial associations, CO_2 emissions do not occur, but only NMVOC emissions originate from these activities.
CO_2 emissions from food and beverages do not occur since they originated from sources of carbon that are part of a closed cycle.
As regards the pulp and paper production, NO_X and NMVOC emissions as well as SO_2 are estimated. NOx and SOx emissions have been referred to the paper and pulp production from acid sulphite and neutral sulphite semichemical processes up to 2009, activity data and emissions were provided by the two Italian production plants: in 2008 the bleached sulphite pulp production has stopped while in 2009 the neutral sulphite semi-chemical pulp process has closed (reconversion of the plant is currently under negotiation). NMVOC emissions are related to chipboard production and have been estimated and reported also for 2010.

4.6 Production of halocarbons and SF_6 (2E)

4.6.1 Source category description

The sub-sector production of halocarbons and SF_6 consists of two sources, “By-product emissions” and “Fugitive emissions”, identified as non-key sources. The production of halocarbons and SF_6 took place in two facilities in Italy up to 2008 (Spinetta Marengo and Porto Marghera). Since the very beginning of 2005 the plant in Spinetta Marengo has not been producing SF_6 any longer. In the first quarter of 2008 the production plant at Porto Marghera has stopped its activity, since then there is only one facility in Italy where halocarbons productions have been carried out.
Within by-product emissions, HFC23 emissions are released from HCFC22 manufacture, CF_4 emissions are released from SF_6 and HCFC22/TFM productions, whereas C_2F_6 and HFC 143a emissions are released from the production of C_3F_6 (and also CFC 115) and HFC 134a, respectively. Production of CFC115 was carried

out only in one facility and stopped in 1998. Since the very beginning of 2005 the plant in Spinetta Marengo has not been producing SF_6 any longer.
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.
A focus on by-product emissions from this sector has led to revise emission estimates for the whole emissions time series. The share of F-gas emissions from the production of halocarbons and SF_6 in the national total of F-gases was 40.5% in the base-year (1990), was 13.8% in 2008 and 10.94% in 2010. The share in the national total greenhouse gas emissions was 0.25% in the base-year, 0.24% in 2008 and 0.23% in 2010.

4.6.2 *Methodological issues*

For both source categories ”By-product emissions” and “Fugitive emissions”, the IPCC Tier 2 method is used, based on plant-level data. The communication is supplied annually by the only national producer, and includes productions, emissions, import and export data for each gas (Solvay, several years). In particular, the operator of the only producing facility has been reporting CF_4 emissions to the national PRTR register for four years since 2007; but in the guidelines and guidebook CF_4 emissions as by product emissions are not mentioned for this kind of production process. CF_4 emissions represent additional by product emissions together with HFC23 emissions (those being well referenced instead). The operator supplied all the relevant information for a better understanding of the activities taking place at the site of Spinetta Marengo and to help the inventory team to allocate CF_4 emissions from HCFC22 production properly. In particular the operator explained that HCFC22 production has been carried out in Spinetta Marengo since ‘50s and up to 1990 part of HCFC22 was probably also sold as a marketable product. Since 1990 practically all the HCFC22 produced has been the input for the TFM (tetrafluoroethylene monomer) production process (by pyrolisis of HCFC22 at 600 °C), the TFM has been then used to produce TFE (tetrafluoroethylene, C_2F_4) and PTFE (polytetrafluoroethylene), HFP (hexafluoropropylene) and the other different fluoropolymers and fluoroelastomers. All the fluorinated flue gases from the different production lines are collected and treated in a centralized abatement unit (thermal oxidation system). The abatement unit is run continuously and allows reducing F-gas emissions not depending on the operating level of the main production process. In the treated flue gases CF_4 is still present (65% of CF_4 released to air pass through the abatement system untreated for thermodynamic reasons; 35% of CF_4 released to air is formed during the reactions occurring in the abatement unit). Estimations of CF_4 emissions released to air have been then reported to the national PRTR since 2007. The operator has provided the time series for the activity data from 2002 to 2010 (HCFC22 and TFM), since the activity data for the period before year 2002 are not retrievable (the property of the facility has changed over the years before 2002 and the administrative systems and softwares have also been changed a number of times) to complete the activity data time series for the period 1990-2001 a linear increasing production level was assumed from 1990 up to the 2002 production level for the present submission. The ratio relating TFM production to HCFC22 production in 2002 has been taken also over the years 2001 back to 1990 to estimate the TFM productions. CF_4 emission factor for 2007 was set constant in order to estimate the CF_4 time series over the years from 1990 to 2006. CF_4 emissions time series have been then included in the estimates of the present submission under the CRF category 2E1 (By -product emissions).
HFC23 is a by product of the HCFC22 production process, the HFC23/HCFC22 rate is about 3%. The abatement system, as previously mentioned, allows for treating all the fluorinated flue gases, vented gases originated in the processes at the facilty before being released to air. Since 1989 the abatement system has allowed to reduce HFC23 released to air, up to 1996 HFC23 emissions had been about 30 t/y. In 1996 the abatement system was improved with a second operating unit, since 1996 the abatement rate has been 99.99% thus reducing drastically HFC23 emissions to zero. HFC23 emissions are included in the estimates under CRF category 2E1 (By -product emissions) (Solvay Solexis, 2011).

4.6.3 *Uncertainty and time-series consistency*

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

HFC 23 emissions from HCFC 22 had been drastically reduced since 1996 due to the installation of a second thermal oxidation system in the facility located in Spinetta Marengo (the only facility currently producing HCFC22 in Italy). Productions and emissions from 1990 to 1995 are constant as supplied by industry; from 1996, untreated leaks have been collected and sent to the thermal oxidation system, thus allowing reduction of emissions to zero. CF_4 by-product emissions in HCFC22 production process have been fully investigated, information supplied by the operator has allowed estimating emissions for the whole time series.
This information about productions and emissions is yearly directly updated by the producer, and it is also reported in the framework of the national PRTR register, confirming that the technology is fully operating.
PFC (C_2F_6) by-product emissions and SF_6 fugitive emissions were constant from 1990 to 1995 (4 t/y for C_2F_6 emissions; 5 t/y for SF_6 emissions) and from 1996 to 1998 (1 t/y for C_2F_6 emissions; 2 t/y for SF_6 emissions) and have eventually reduced to zero since 1999 due to the stop of the CFC 115 production in one facility and the upgrade of the thermal oxidation system mentioned above in the other facility. Besides SF_6 production has stopped since the 1st of January 2005.
Regarding fugitive emissions, emissions of 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. The relavant productions in Italy which originate these fugitive emissions stopped in the first quarter of 2008.
In Table 4.15 an overview of the emissions from production of halocarbons and SF_6 is given for the 1990-2010 period, per compound.

Table 4.15 Actual emissions of F-gases per compound from production of halocarbons and SF_6 in Gg CO_2 equivalent, 1990 – 2010

COMPOUND	1990	1995	2000	2005	2006	2007	2008	2009	2010
					Gg CO_2 eq.				
HFC 23	351.0	351.0	-	-	-	-	-	-	-
HFC 143a	-	22.8	3.8	4.2	4.6	4.6	-	-	-
CF_4	776.6	873.1	872.1	1,361.1	1,429.9	1,365.0	1,300.0	845.0	1,144.0
PFC C2÷C3 (C_2F_6)	36.8	36.8	-	-	-	-	-	-	-
Total F-gas by product emissions	*1,164*	*1,284*	*876*	*1,365*	*1,434*	*1,370*	*1,300*	*845*	*1,144*
HFC 125	-	28.0	2.8	3.4	3.9	5.0	0.01	-	-
HFC 134a	-	39.0	15.6	12.6	12.4	8.8	-	-	-
HFC 227ea	-	-	-	-	-	-	-	-	-
SF_6	119.5	119.5	-	-	-	-	-	-	-
Total F-gas fugitive emissions	*119.5*	*186.5*	*18.4*	*16.0*	*16.3*	*13.9*	*0.01*	-	-
Total F-gas emissions from production of halocarbons and SF_6	1,284	1,470	894	1,381	1,451	1,383	1,300	845	1,144

4.6.4 Source-specific QA/QC and verification

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

4.6.5 Source-specific recalculations

Recalculation of the whole Total F-gas emissions time series for category 2E has occurred, because CF_4 emissions as a by product of HCFC22 production process have been accounted and included in the present submission resulting in a range from +53% in 1990 and around +100% in the last years.

4.6.6 Source-specific planned improvements

No further improvements are planned.

4.7 Consumption of halocarbons and SF_6 (2F)

4.7.1 Source category description

The sub-sector consumption of halocarbons and SF_6 consists of three sources, “HFC, PFC emissions from ODS substitutes”, key category at level and trend assessment, both Tier 1 and 2 approaches, “PFC, HFC, SF_6 emissions from semiconductor manufacturing”, “SF_6 emissions from electrical equipment”, that are non-key categories.
Potential emissions are also reported in this section.
The share of F-gas emissions from the consumption of halocarbons and SF_6 in the national total of F-gases was 6.73% in the base-year 1990, 89.6% in 2009 and 88.08% in 2010; the share in the national total greenhouse gas emissions was 0.04% in the base-year, 1.75% in 2009 and 1.84% in 2010.

4.7.2 Methodological issues

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

Sub-sources of F-gas emissions and calculation methods

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

Basic data have been supplied by industry: specifically, for the mobile air conditioning equipment the national motor company and the agent’s union of foreign motor-cars vehicles have provided the yearly consumptions (FIAT, several years; IVECO, several years; UNRAE, several years; CNH, several years); for the other air conditioning equipment the producers supply detailed table of consumption data by gas (Solvay, several years); pharmaceutical industry has provided aerosols/metered dose inhaler data (Sanofi Aventis, several years; Boehringer Ingelheim, several years; Chiesi Farmaceutici, several years; GSK, several years; Lusofarmaco, several years; Menarini, several years); the semiconductor manufacturing industry has supplied consumption data for four national plants (ST Microelectronics, several years; MICRON, several years; Numonyx, several years); finally, for the sub-source fire extinguishers, the European Association for Responsible Use of HFCs in Fire Fighting was contacted (ASSURE, 2005).
Losses rates have been checked with industry and they are distinguished by domestic equipment, small and large commercial equipment, industrial chillers, mobile air conditioning equipment, foaming, aerosols and fire extinguishers.
Refrigeration activities, such as commercial, transport, industrial and other stationary, are all reported under domestic refrigeration because no detailed information is available to split consumptions and emissions in the different sectors. Anyway, appropriate losses rates have been applied for each gas, taking into account the equipment where refrigerants are generally used. Therefore implied product life factors, especially for

HFC 134a, result from the weighted average of different losses rates, from 0.7% for domestic refrigeration to 10% for large chillers.
In general, concerning the air-conditioning and refrigeration sector, the emissions from equipment disposal have been included into the emissions during the product's life for the whole time series.

SF_6 emissions from electrical equipment have been estimated according to the IPCC Tier 2a approach from 1990 to 1994 because facility level specific data are not available, IPCC Tier 3c has been used since 1995 (for both medium and high voltage electrical equipment) because facility level specific data have become available, unfortunately it is not possible to extend Tier 3c approach back over the whole time series. Tier 3b is applied for the part of emissions from the energy production plant during services. SF_6 leaks from installed equipment have been estimated on the basis of the total amount of sulphur hexafluoride accumulated and average leakage rates; leakage data published in environmental reports have also been used for major electricity producers (ANIE, several years). Additional data on SF_6 used in high voltage gas-insulated transmission lines have been supplied by the main energy distribution companies checked with data reported under the national PRTR register (ACEA, several years; A2A, several years; AEM, several years; EDIPOWER, several years; EDISON, several years; ENDESA, 2004; ENDESA, several years [a] and [b]; ENEL, several years; TERNA, several years).

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

4.7.3 Uncertainty and time-series consistency

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

In Table 4.16 an overview of the emissions from consumption of halocarbons and SF_6 is given for the 1990-2010 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.

Table 4.16 Actual F-gas emissions per compound from the consumption of halocarbons and SF_6 in Gg CO_2 equivalent. 1990-2010

COMPOUND	1990	1995	2000	2005	2006	2007	2008	2009	2010
					Gg CO_2 eq.				
HFC 23	0.0	1.6	7.1	17.0	19.2	20.8	22.7	24.6	26.0
HFC 32	0.0	0.0	52.6	235.3	276.5	316.7	355.1	391.8	428.2
HFC 125	0.0	1.8	371.5	1,643.2	1,932.3	2,215.3	2,488.5	2,752.8	3,014.2
HFC 134a	0.0	224.3	1,128.6	1,888.8	2,056.4	2,209.0	2,329.8	2,432.8	2,539.1
HFC 143a	0.0	2.7	206.3	901.5	1,062.0	1,220.7	1,377.9	1,533.7	1,688.4
Total HFC emissions from refrigeration and air conditioning equipment	*0.0*	*230.5*	*1,766.1*	*4,685.7*	*5,346.4*	*5,982.6*	*6,574.1*	*7,144.2*	*7,695.9*
HFC 134a emissions from foam blowing	0.0	0.0	64.2	234.1	247.4	259.0	268.9	277.2	278.0
HFC 245fa emissions from foam blowing	0.0	0.0	0.0	133.5	150.0	166.6	183.4	200.4	217.7
HFC 227ea emissions from fire extinguishers	0.0	0.0	19.6	79.9	97.7	114.6	130.6	145.8	160.3
HFC 134a emissions from aerosols/metered dose inhalers	0.0	0.0	108.4	240.2	237.3	307.7	341.1	397.7	393.4
Total HFC emissions from ODS substitutes	*0.0*	*0.0*	*192.2*	*687.7*	*732.4*	*847.9*	*923.9*	*1,021.1*	*1,049.3*
HFC 23	0.0	0.0	5.1	7.0	6.5	5.4	8.4	5.6	8.5
HFC 134a	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
CF_4	0.0	24.4	64.8	96.8	87.0	71.5	59.4	42.6	58.5
C_2F_6	0.0	34.6	82.0	62.8	30.8	11.4	12.9	11.3	20.7
C_3F_8	0.0	0.0	0.0	3.5	3.5	0.1	0.1	0.0	0.0
C_4F_8	0.0	0.0	0.4	8.7	6.6	4.6	17.4	18.3	22.4
SF_6	0.0	0.0	20.9	61.5	46.5	36.3	31.4	21.8	32.1
Total PFC. HFC. SF_6 *emissions from semiconductor manufacturing*	*0.0*	*59.0*	*173.2*	*240.4*	*181.0*	*129.4*	*129.6*	*99.6*	*142.2*
SF_6 emissions from electrical equipment	*213.4*	*482.0*	*300.4*	*319.1*	*298.1*	*337.4*	*393.7*	*367.0*	*323.8*
Total F-gas emissions from consumption of halocarbons and SF_6	**213.4**	**771.4**	**2,432.0**	**5,932.9**	**6,557.9**	**7,297.2**	**8,021.2**	**8,631.9**	**9,211.1**

In Table 4.17 an overview of the potential emissions is given for the 1990-2010 period, per compound. In some years import data for HFC compounds are equal to zero while exports are greater than production data because of stocks availability thus leading to negative values for HFC compounds: in fact, the formula suggested by the UNFCCC guidelines to calculate potential emissions does not consider stock variations.

Table 4.17 Potential F-gas emissions per compound from the consumption of halocarbons and SF_6 in Gg CO_2 equivalent. 1990 – 2010

COMPOUND	1990	1995	2000	2005	2006	2007	2008	2009	2010
					Gg CO_2 eq.				
HFC 32	0.0	0.0	10.4	31.9	129.4	115.4	174.9	98.7	224.3
HFC 125	0.0	148.4	268.8	1,131.2	1,456.0	4268.7	-1,610.4	1,661.6	1,462.3
HFC 134a	0.0	1,739.4	2,107.3	5,575.7	6,026.8	6,004.4	1,735.1	2,293.4	1,237.7
HFC 143a	0.0	11.4	68.4	801.8	1,691.0	905.9	2,177.4	1,586.4	1,428.9
HFC 152a	0.0	0.0	0.0	0.0	0.0	163.0	237.0	131.4	141.2
HFC 227ea	0.0	0.0	72.5	0.0	0.0	34,486.8	58.0	88.0	-1,119.9
HFC 245fa	0.0	0.0	0.0	760.0	790.4	822.0	854.9	889.1	924.7
Total HFC potential emissions	*0.0*	*1,899.2*	*2,527.4*	*8,300.6*	*10,093.6*	*46,766.2*	*3,626.8*	*6,748.5*	*4,299.2*
CF_4	0.0	0.0	55.8	148.9	159.9	141.3	112.3	83.3	123.9
C_2F_6	0.0	0.0	65.5	111.4	67.8	54.9	67.0	65.7	103.1
C_3F_8	0.0	0.0	0.0	17.9	17.9	1.5	1.5	0.6	0.6
C_4F_8	0.0	0.0	0.5	29.0	28.8	53.5	59.2	58.7	69.6
Total PFC potential emissions	*0.0*	*0.0*	*121.8*	*307.2*	*274.4*	*251.2*	*239.9*	*208.3*	*297.2*
SF_6	*3,752.3*	*3,675.8*	*3,919.6*	*1,541.8*	*2,182.9*	*1,985.9*	*1,881.6*	*2,160.1*	*2,666.8*
Total F-gas potential emissions	**3,752.3**	**5,575.0**	**6,568.8**	**10,149.6**	**12,550.9**	**49,003.2**	**5,748.2**	**9,116.8**	**7,263.1**

4.7.4 Source-specific QA/QC and verification

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

4.7.5 Source-specific recalculations

Minor recalculations occurred for 2009 HFC 134a emission estimation from refrigeration and air conditioning equipment (-0.4%).
Recalculations have occurred in Potential emissions time series since 2007 resulting in the changes reported in the following Table 4.18, per compound: available data (reported by operators under the fluorinated gas European Regulation) related to import, export and blends have been considered.

Table 4.18 Recalculations in potential F-gas emissions per compound in percentage since 2007

COMPOUND	2007	2008	2009
HFC 32	-17.07%	-4.94%	0.57%
HFC 125	-9.25%	3.82%	17.20%
HFC 134a	5.86%	49,332.59%	189.03%
HFC 143a	-36.09%	-1.04%	15.32%
HFC 152a	-3,891.95%	1,514.21%	1,557.40%
HFC 227ea	100%	100%	172.35%
CF_4	-	-11.61%	-
C_2F_6	-	-0.48%	-
C_3F_8	-	-	-
C_4F_8	-	-20.00%	-
SF_6	-	-	-

4.7.6 Source-specific planned improvements

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

5 SOLVENT AND OTHER PRODUCT USE [CRF sector 3]

5.1 Sector overview

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

In 2010, solvent use is responsible for about 0.2% of the total CO_2 emissions (excluding LULUCF) and 37.8% of total NMVOC emissions, and represents the main source of anthropogenic NMVOC national emissions. N_2O emissions, in 2010, share 2.3% of the total N_2O national emissions.
The sector is responsible, in 2010, for about 0.3% of the total CO_2 equivalent emissions (excluding LULUCF).

Table 5.1 Trend in NMVOC, CO_2 and N_2O emissions from the solvent use sector, 1990 – 2010 (Gg)

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008	2009	2010
NMVOC (Gg)									
3A. Paint application	270.79	252.60	226.07	215.59	217.54	211.84	199.79	186.63	150.36
3B. Degreasing and dry cleaning	56.66	34.12	26.40	23.10	22.50	21.92	21.36	20.81	20.28
3C. Chemical products	77.21	88.25	103.64	72.70	78.08	79.35	75.01	73.45	77.19
3D. Other	199.59	182.76	156.88	179.67	181.53	176.19	169.81	155.42	160.38
CO_2 (Gg)									
3A. Paint application	844.07	787.35	704.65	672.00	678.06	660.30	622.74	581.72	468.68
3B. Degreasing and dry cleaning	176.62	106.34	82.27	72.01	70.14	68.33	66.56	64.86	63.20
3D. Other	622.12	569.66	489.00	560.04	565.84	549.20	529.31	484.43	499.90
N_2O (Gg)									
3D. Other (use of N_2O for anaesthesia, aerosol cans and explosives)	2.62	2.49	3.31	2.66	2.61	2.54	2.35	2.21	2.02

CO_2 emissions from the sector are a key category, in 2010, for trend assessment calculated with Approach 2, because of the high level of uncertainty in the estimates and a reduction of emissions in the years. This source is not a key category if including the LULUCF sector in the uncertainty analysis. Results are reported in the following box. As for the base year, these emissions were a key category for the level assessment, according to Approach 2, even when considering the LULUCF sector.

Key-source identification in the solvent and other product use sector with the IPCC Approach1 and Approach 2 approaches (without LULUCF) for 2010

3	CO_2	Solvent and other product use	Key (T2)

5.2 Source category description

In accordance with the indications of the IPCC Guidelines (IPCC, 1997), the carbon contained in oil-based solvents, or released from these products, is considered both as NMVOC and CO_2 emissions as final oxidation of NMVOC. Emissions from the following sub-sectors are estimated: solvent use in paint application (3A), degreasing and dry cleaning (3B), manufacture and processing of chemical products (3C), other solvent use, such as printing industry, glues application, use of domestic products (3D).
CO_2 emissions are estimated and included in this sector, as they are not already accounted for in the energy and industrial processes sectors.
N_2O emissions from the use of N_2O for anaesthesia, aerosol cans and explosives (3D) are also estimated. Emissions of N_2O from fire extinguishers do not occur.

5.3 Methodological issues

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

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

Emissions of N_2O have been estimated taking into account information available by industrial associations. Specifically, the manufacturers and distributors association of N_2O products has supplied data on the use of N_2O for anaesthesia from 1994 to 2009 (Assogastecnici, several years). For previous years, data have been estimated by the number of surgical beds published by national statistics (ISTAT, several years [a]).
Moreover, the Italian Association of Aerosol Producers (AIA, several years [a] and [b]) has provided data on the annual production of aerosol cans. It is assumed that all N_2O used will eventually be released to the atmosphere, therefore the emission factor for anaesthesia is equal to 1 Mg N_2O/Mg product use, while the emission factor used for aerosol cans is 0.025 Mg N_2O/Mg product use, because the N_2O content in aerosol cans is assumed to be 2.5% on average (Co.Da.P., 2005).
For the estimation of N_2O emissions from explosives, data on the annual consumption of explosives have been obtained by a specific study on the sector (Folchi and Zordan, 2004); as stated in the document, this figure is believed to be constant for all the time series with a variation within a range of 30%. As for the emission factor, the estimated N_2O emissions represent the theoretically maximum emittable amount; in fact, no figures are available on the amount of N_2O emissions actually emitted upon detonations and the value of 3,400 Mg N_2O/Mg explosive use is provided by a German reference (Benndford, 1999) which corresponds to the assumption of 68 g N_2O per kg ammonium nitrate.

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

5.4 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions from solvent use is estimated equal to 58% due to an uncertainty by 30% and 50% in activity data and emission factors, respectively. For N_2O emissions, the uncertainty is estimated equal to 51% due to an uncertainty in activity data of N_2O use of 50% and 10% in the emission factor.
The European Directives (EC, 1999; EC, 2004) regarding NMVOC emission reduction in this sector entered into force in Italy, in January 2004 and in March 2006 respectively, establishing a reduction of the solvent content in products. Figure 5.1 shows NMVOC emission trend from 1991 to 2010, by sub-sector, with respect to 1990.
The decrease in NMVOC emission levels from 1990 to 2010 is about 32%, mainly to be attributed to the reduction of emissions in paint application, degreasing and dry cleaning and application of glue and adhesives; in 2010, specifically, the reduction of emissions from paint application for domestic use, which drop by 67% from the previous year, is due to the implementation of Italian Legislative Decree 161/2006.

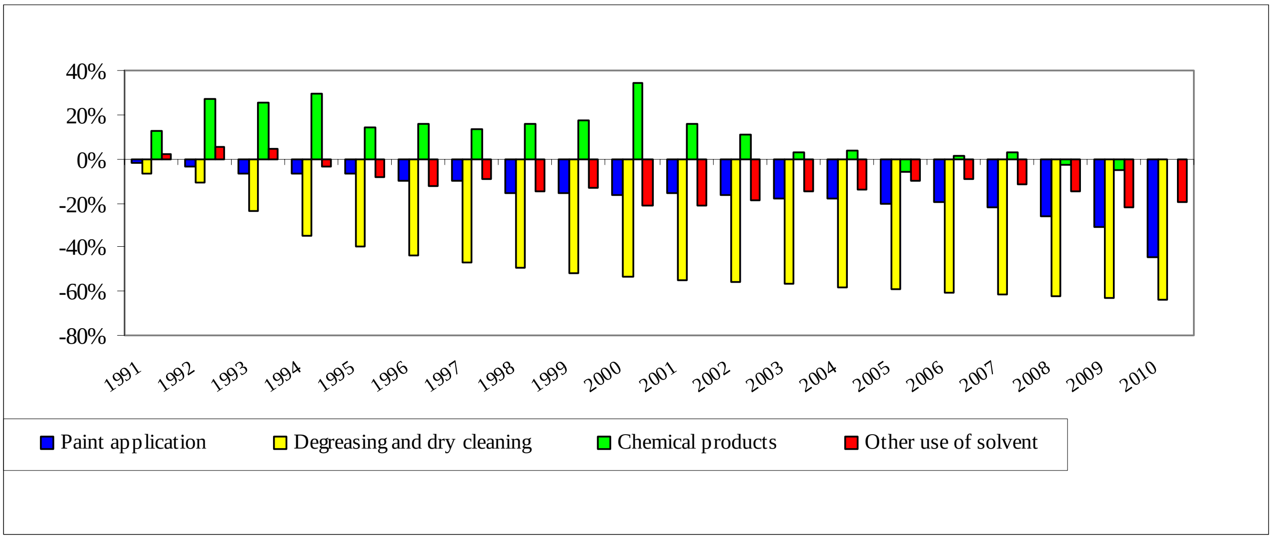

Figure 5.1 Trend of NMVOC emissions from 1991 to 2010 as compared to 1990

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

5.5 Source-specific QA/QC and verification

Data production and consumption time series for some activities (paint application in constructions and buildings, polyester processing, polyurethane processing, pharmaceutical products, paints manufacturing, glues manufacturing, textile finishing, leather tanning, fat edible and non edible oil extraction, application of glues and adhesives) are checked with data acquired by the National Statistics Institute (ISTAT, several years [a], [b] and [c]), the Sectoral Association of the Italian Federation of the Chemical Industry (AVISA, several years) and the Food and Agriculture Organization of the United Nations (FAO, several years). For specific categories, emission factors and emissions are also shared with the relevant industrial associations; this is particularly the case of paint application for wood, some chemical processes and anaesthesia and aerosol cans.
In the framework of the MeditAIRaneo project, ISPRA commissioned to Techne Consulting S.r.l. a survey to collect national information on emission factors in the solvent sector. The results, published in the report "*Rassegna dei fattori di emissione nazionali ed internazionali relativamente al settore solventi*" (TECHNE,

2004), have been used to verify and validate the emission estimates. At the end of 2008, ISPRA commissioned to Techne Consulting S.r.l. another survey to compare emission factors with the last update published in the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2008). The results are reported in "*Fattori di emissione per l'utilizzo di solventi*" (TECHNE, 2008) and have been used to update emission factors for polyurethane and polystyrene foam processing activities.
In addition, for paint application, data communicated from the industries in the framework of the EU Directive 2004/42, implemented by the Italian Legislative Decree 161/2006, on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products have been used as a verification of emission estimates. These data refer to the composition of the total amount of paints and varnishes (water and solvent contents) in different subcategories for interior and exterior use and the total amount of products used for vehicle refinishing and they are available from the year 2007.

5.6 Source-specific recalculations

In Table 5.2 the comparison of CO_2, NMVOC and N_2O emissions between the actual and last year submission is reported only for those years where recalculations actually occurred.
The main modifications involved category 3A with respect to CO_2 and NMVOC emissions, due to the update, from 2005, of emission factors for paint application in boat building, wood and other industrial paint application and, from 2007, to the change of emission factors for car repairing on account of information communicated within the Legislative Decree 161/2006. Recalculations are also observed, for the year 2009, in category 3C, for NMVOC emissions, due to the update of activity data in rubber processing. In addition, in 2009, all the emissions show a change in category 3D, considering an updating of the apparent consumption of cosmetics in domestic solvent use, which affected CO_2 and NMVOC, and new information on the use of N_2O in aerosol cans, provided by the relevant industry, which influenced N_2O emissions.

Table 5.2 Differences in CO_2 and NMVOC emissions between the updated time series and the 2011 submission

	CO_2	CO_2	NMVOC	NMVOC	NMVOC	N_2O
	3A. Paint application	3D. Other	3A. Paint application	3C. Chemical products	3D. Other	3D. Other (use of N_2O for anaesthesia, aerosol cans and explosives)
2005	-1.66%		-1.66%			
2006	-2.66%		-2.66%			
2007	-5.50%		-5.50%			
2008	-7.74%		-7.74%			
2009	-9.05%	-0.34%	-9.05%	-0.12%	-0.34%	1.87%

5.7 Source-specific planned improvements

No further improvements are planned.

6 AGRICULTURE [CRF sector 4]

6.1 Sector overview

In this chapter information on the estimation of greenhouse gas (GHG) emissions from the Agriculture sector, as reported under the IPCC Category 4 in the Common Reporting Format (CRF), is given. Emissions from enteric fermentation (4A), manure management (4B), rice cultivation (4C), agriculture soils (4D) and field burning of agriculture residues (4F) are included in this sector. Methane (CH_4) and nitrous oxide (N_2O) emissions are estimated and reported. Savannas areas (4E) are not present in Italy. Emissions from other sources (4G) have not been estimated. CO_2 and F-gas emissions do not occur.
To provide update information on the characteristics of the agriculture sector in Italy, figures from the Farm Structure Survey 2007 (FSS 2007) are reported. In Italy, there are 1.7 millions of agricultural holdings with a Utilized Agricultural Area (UAA) of 12.7 million hectares, +0.3% more than FSS 2005. Between 2000 (Agricultural Census) and 2007, agricultural holdings have decreased by 22% (474,000 units). At national level, the average size of the agricultural holdings varied from 7.4 hectares in 2005 to 7.6 hectares in 2007. With respect to 2000 Agricultural Census, holdings have gained 1.5 hectares of UAA. The distribution of agricultural holdings by type confirms a typical family conduction system, which characterized the Italian agriculture. Direct conduction of holdings by farmers is around 1.6 million (93.9% of total agricultural holdings with UAA) which hold 10 million hectares of UAA (78.8% of total) (EUROSTAT, 2007[a], [b]; ISTAT, 2008[a]). Updated figures of the agriculture sector such as added value, employment, productivity are available (INEA, 2010).

6.1.1 Emission trends

Emission trends per gas
In 2010, 6.7% of the Italian GHG emissions, excluding emissions and removals from LULUCF, (7.8% in 1990) originated from the agriculture sector, which is the second source of emissions, after the energy sector which accounts for 82.9%. For the agriculture sector, the trend of GHGs from 1990 to 2010 shows a decrease of 17.2% 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 14.2% and 19.4%, respectively (see Table 6.1). In 2010, the agriculture sector has been the second source for CH_4, after the waste sector, sharing 40% of national CH_4 levels. As for N_2O, agriculture is the dominant source, accounting for 69% of national N_2O emissions.

Table 6.1 GHG emissions and trend from 1990 to 2010 for the agriculture sector (Gg CO_2 eq.)

	1990	1995	2000	2005	2006	2007	2008	2009	2010
					Gg CO_2 eq.				
CH_4	17,330	17,317	16,928	15,548	15,215	15,681	15,356	15,457	14,877
N_2O	23,407	23,212	23,207	21,814	21,551	21,697	20,658	19,319	18,864
Total	**40,737**	**40,530**	**40,134**	**37,362**	**36,766**	**37,379**	**36,014**	**34,775**	**33,741**

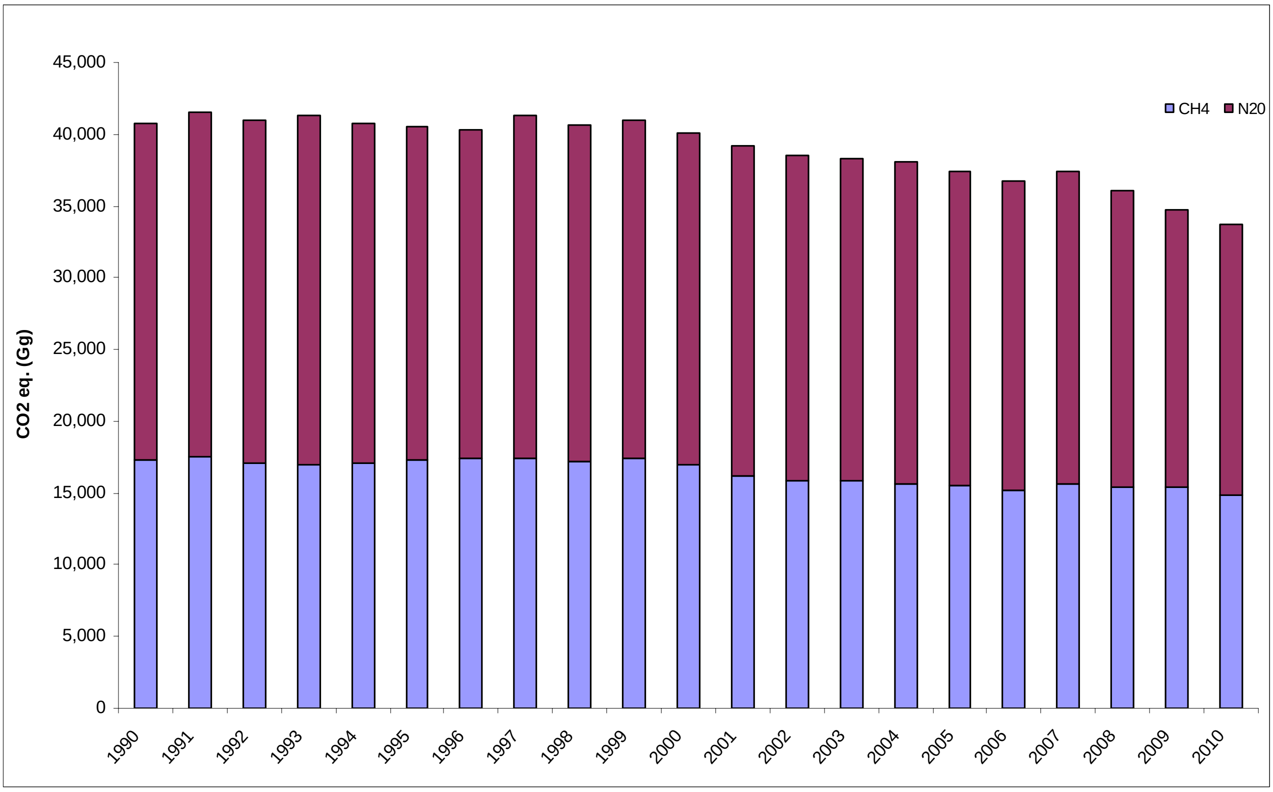

Figure 6.1 Trend of GHG emissions for the agriculture sector from 1990 to 2010 (Gg CO_2 eq.)

Emission trends per sector
Total GHG emissions and trends by sub category from 1990 to 2010 are presented in Table 6.2 (expressed in Gg. CO_2 eq.). CH_4 emissions from enteric fermentation (4A) and N_2O emissions from direct agriculture soils (4D) are the most relevant categories. In 2010, their individual share in national GHG emissions excluding LULUCF was 2.1% and 3.0 %, respectively.

Table 6.2 Total GHG emissions from 1990 to 2010 for the agriculture sector (Gg CO_2 eq.)

Year	GHG emissions (Gg CO_2 eq.) by sub category					
	4A	4B	4C	4D	4F	TOTAL
1990	12,278	7,383	1,576	19,482	17	**40,737**
1995	12,348	7,068	1,671	19,426	17	**40,530**
2000	12,246	7,140	1,391	19,341	16	**40,134**
2001	11,423	7,344	1,390	19,029	15	**39,201**
2002	11,107	7,115	1,439	18,822	17	**38,500**
2003	11,134	7,075	1,470	18,645	15	**38,339**
2004	10,908	6,868	1,534	18,705	18	**38,033**
2005	10,914	6,857	1,472	18,101	17	**37,362**
2006	10,699	6,629	1,475	17,947	17	**36,766**
2007	11,099	6,833	1,516	17,914	17	**37,379**
2008	10,996	6,736	1,386	16,879	18	**36,014**
2009	11,007	6,685	1,565	15,502	17	**34,775**
2010	10,732	6,268	1,565	15,159	16	**33,741**

6.1.2 Key categories

In 2010, N_2O from agricultural soils, both direct and indirect emissions, CH_4 from enteric fermentation, N_2O from manure management were ranked among the top-10 level key sources with the Approach 2, including the uncertainty (L2). CH_4 enteric fermentation and N_2O from agricultural soils, both direct and indirect emissions are ranked among the top-10 trend key sources with Approach 2, including the uncertainty (T2). In the following box, key and non-key categories from the agriculture sector are shown, with a level and/or trend assessment (*IPCC Approach 1 and Approach 2*), excluding and including the LULUCF sector in the analysis.

Key-source identification in the agriculture sector with the IPCC Approach 1 and Approach 2 for 2010

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

6.1.3 Activities

Emission factors used for the preparation of the national inventory reflect the characteristics of the Italian agriculture sector. Information from national research studies is considered. Activity data are mainly collected from the National Institute of Statistics (ISTAT, *Istituto Nazionale di Statistica*). Every year, national and international references, and personal communications used for the preparation of the agriculture inventory are kept in the *National References Database.*
Improvements for the Agriculture sector are described in the Italian Quality Assurance/Quality Control plan (ISPRA, 2012). Moreover, an internal report describes the procedure for preparing the agriculture UNFCCC/CLRTAP national emission inventory, and projections (Cóndor, 2012).
In the last years, results from different research projects have improved the quality of the agriculture national inventory (MeditAIRaneo project and Convention signed between ISPRA and the Ministry for the Environment, Land and Sea; CRPA, 2006[a], CRPA, 2006[b]). Furthermore, suggestions from the inventory review processes have been considered (UNFCCC, 2009; UNFCCC, 2010[a]; UNFCCC, 2010[b]; ISPRA, 2012). Methodologies for the preparation of agriculture national inventory under the Convention on Long-Range Transboundary Air Pollution (CLRTAP) and the United Nations Framework Convention on Climate Change (UNFCCC) are consistent. Synergies among international conventions and European directives while preparing the agriculture inventory are implemented (Cóndor, 2006; Cóndor and De Lauretis, 2007; Cóndor *et al.*, 2007[b]; Cóndor *et al.*, 2008[b]; Cóndor and De Lauretis, 2009; Cóndor and Vitullo, 2010, 2011; Cóndor, 2011).
The national agriculture UNFCCC/CLRTAP emission inventory is used, every 5 years, to prepare a more disaggregated inventory by region and province as requested by CLRTAP (Cóndor *et al.*, 2008[c]). A database with the time series for all sectors and pollutants is available (ISPRA, 2008[a], [b]; ISPRA, 2009). Methodologies used for the inventory, emission scenarios and projections are similar (MATTM, 2007; MATTM, 2009).

6.1.4 Agricultural statistics

The Italian National Statistical System (SISTAN[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);

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

- 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 quality reports of the FSS 2005 and FSS 2007 (ISTAT, 2008[b]; ISTAT, 2007[e]). The main agricultural statistics used for the agriculture emission inventory are available on-line and a new database was launched in April 2009. Detailed information is provided in the following box:

Main activity data sources used for the Agriculture emission inventory

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

Differences in the some animal populations are found between FAOSTAT and national statistics. FAO publishes figures of the *x-1* year on 1st January of the *x* year. Each year ISPRA verifies the official statistics directly contacting the experts responsible for each agricultural survey (number of animals, agricultural surface/production, fertilizers, etc). Agricultural statistics reported by ISTAT are also those published in the European statistics database[6] (EUROSTAT). Whenever outliers are identified, ISTAT and category associations are contacted. The verification of statistics is part of the QA/QC procedures implemented.

6.2 Enteric fermentation (4A)

6.2.1 Source category description

Methane is produced as a by-product of enteric fermentation, which is a digestive process where carbohydrates are degraded by microorganisms into simple molecules.
Methane emissions from enteric fermentation are a major key category, both in terms of level and trend, for approach 2. All livestock categories have been estimated except camels and llamas, which are not present in Italy. Methane emissions from poultry do not occur, and emissions from rabbits are estimated and included in “Other” as suggested by the IPCC guidelines.
In 2010, CH_4 emissions from this category were 511.05 Gg which represents 72.1% of CH_4 emissions for the agriculture sector (70.9% in 1990) and 28.6% for national CH_4 emissions (28.1% in 1990). Methane emissions from this source consist mainly of cattle emissions: dairy cattle (209.29 Gg) and non-dairy cattle (187.46 Gg). These two sub-categories represented 41.0% (42.7% in 1990) and 36.7% (39.9% in 1990), respectively, of total enteric fermentation emissions.

6.2.2 Methodological issues

Methane emissions from enteric fermentation are estimated by defining an emission factor for each livestock category, which is multiplied by the population of the same category. Data for each livestock category are collected from ISTAT (several years [a], [b], [c], [f]; ISTAT, 1991; 2007[a], [b]; 2012[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

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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 http://epp.eurostat.ec.europa.eu/portal/page/portal/agriculture/data/database

was necessary to reconstruct the number of animals for some categories. The reconstruction used information available from other official sources such as FAO and UNA (FAO, 2011; UNA, 2011).

Activity data for the different livestock categories

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

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

Dairy cattle

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

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

Parameters	Value	Reference
Average weight (kg)	602.7	CRPA, 2006[a]
Coefficient NE_m (dairy cattle)	0.335	NRC, 2001; IPCC, 2000
Pasture (%)	5	CRPA, 2006[a]; ISTAT, 2003
Weight gain (kg day^{-1})	0.051	CRPA, 2006[a]; CRPA, 2004[b]
Milk fat content (%)	3.59-3.72	ISTAT, several years [a], [b], [d], [e]; ISTAT, 2012[b]
Hours of work per day	0	CRPA, 2006[a]
Portion of cows giving birth	0.90-0.97	AIA, 2010
Milk production (kg $head^{-1}$ day^{-1})	11.5-17.7	CRPA, 2006[a]; ISTAT, 2012[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, 2012[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 2010, the CH_4 dairy cattle EF was 119.9 kg CH_4 $head^{-1}$ $year^{-1}$ with an average milk production of 6,823 kg $head^{-1}$ $year^{-1}$ (18.7 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).

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

Year	Dairy cattle (head)	Fat content in milk (%)	Portion of cows giving birth	Milk production yield (kg $head^{-1}$ d^{-1})

1990	2,641,755	3.59	0.97	11.5
1995	2,079,783	3.64	0.95	14.8
2000	2,065,000	3.65	0.93	15.1
2001	2,077,618	3.65	0.91	14.9
2002	1,910,948	3.67	0.91	16.2
2003	1,913,424	3.67	0.91	16.2
2004	1,838,330	3.71	0.90	16.8
2005	1,842,004	3.71	0.91	17.2
2006	1,821,370	3.69	0.90	17.4
2007	1,838,783	3.71	0.90	17.3
2008	1,830,711	3.72	0.90	17.7
2009	1,878,421	3.67	0.90	17.4
2010	1,746,140	3.72	0.90	18.7

Non-dairy cattle

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

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

Year	<1 year		1-2 years Males		1-2 years Females		>2 years Males	>2 years Females			TOTAL
	for slaughter	others	breeding	for slaughter	breeding	for slaughter	all	breeding	for slaughter	others	
						(heads)					
1990	300,000	2,127,959	72,461	708,329	749,111	186,060	128,958	467,216	57,654	312,649	**5,110,397**
1995	458,936	1,796,034	27,871	783,300	684,881	154,548	155,116	430,564	40,198	657,856	**5,189,304**
2000	408,000	1,783,000	27,521	641,479	736,000	160,000	93,000	500,000	51,000	588,000	**4,988,000**
2001	496,264	1,498,068	25,528	595,029	709,941	181,550	75,365	591,000	46,000	442,525	**4,661,270**
2002	409,970	1,617,127	26,194	610,550	647,656	176,481	65,948	541,233	59,582	444,408	**4,599,149**
2003	412,682	1,594,994	27,598	643,277	673,246	158,094	78,890	520,237	48,873	433,388	**4,591,279**
2004	445,231	1,509,387	28,458	663,316	648,308	149,053	71,762	460,765	38,385	451,606	**4,466,271**
2005	500,049	1,418,545	26,424	615,921	588,660	181,971	102,081	466,566	37,971	471,733	**4,409,921**
2006	540,223	1,407,401	26,091	608,152	584,680	182,719	78,328	395,066	54,022	419,083	**4,295,765**
2007	519,034	1,410,357	26,852	625,902	593,369	189,704	79,936	498,091	59,961	440,845	**4,444,051**
2008	502,391	1,401,501	26,908	627,186	630,194	196,936	74,059	469,074	48,075	372,051	**4,348,375**
2009	494,463	1,313,146	25,191	587,167	617,494	183,420	83,087	478,782	67,781	373,865	**4,224,396**
2010	507,452	1,228,696	23,913	557,386	597,733	212,983	70,284	445,370	70,411	372,089	**4,086,317**

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

	<1 year	1-2 years Males		1-2 years Females		>2 years Males	>2 years Females		
Parameters	Others (*)	breeding	for slaughter	breeding	for slaughter	all	breeding	for slaughter	Others
Average weight (kg)	236	557	557	405	444	700	540	540	557
Percentage weight ingested	2.1	1.9	2.1	2.1	2.1	2.4	2.1	2.1	1.9
Dry matter intake (kg $head^{-1}$ day^{-1})	4.8	10.7	11.6	8.5	9.3	17.1	11.5	11.5	10.6
Gross Energy (MJ $head^{-1}day^{-1}$)	89.4	197.3	214.8	156.9	171.2	315.5	212.2	212.2	195.3
CH_4 conversion (%)	4	4.5	4	6	4	6	6	6	6

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

National characteristics of Italian breeding are reflected in EFs, and they are also related to the age classification of animals and dry matter intake. In Table 6.6, Implied Emission Factors (IEF) for non-dairy cattle are shown. In 2010, the non dairy-cattle EF was 45.88 kg CH_4 $head^{-1}$ $year^{-1}$ while IPCC default EF is 48 kg CH_4 $head^{-1}$ $year^{-1}$ (IPCC, 1997). The inter-annual decrease 2005/2006 of the IEF for non-dairy cattle is related to the reduction in the number of animals for some categories and an increase in the number of the '*less than 1 year for the slaughter*' category (no emissions) (see Table 6.4).

Buffalo

Data collected in the framework of the MeditAIRaneo project allowed for the implementation of the Tier2 approach for the buffalo category (IPCC, 2000). Two different country-specific CH_4 EFs, for cow buffalo and other buffaloes, were developed. Detailed description of the methodology is reported in Cóndor *et al.* (Cóndor *et al.*, 2008[a]). In 2010, the cow buffalo CH_4 EF was 68.97 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 (64.69 kg CH_4 $head^{-1}$ $year^{-1}$). Parameters used for the Tier 2 approach are shown in the following boxes.

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

Parameters	Value	Reference
Average body weight (kg)	630	Infascelli, 2003; Consorzio per la tutela del formaggio mozzarella di bufala campana, 2002
Coefficient NE_m, cattle/buffalo (lactating)	0.335	IPCC, 2000
Pasture (%)	2.90	ISTAT, 2003; Zicarelli, 2001; expert judgement
Weight gain (kg day^{-1})	0.055	Estimations
Milk fat content (%)	7.73-7.92	ISTAT, several years [a], [b], [d], [e]; ISTAT, 2012[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})	1.9-2.4	ISTAT, 2012[b]; OSSLATTE/ISMEA, 2003; ;OSSLATTE, 2001; ISTAT, several years [a], [b], [c] [d], [e], [f]
Digestibility of feed (%)	65	Infascelli, 2003; Masucci *et al.*, 1997, 1999;
Methane conversion rate (%)	6	CRPA, 2006[a]
MJ/kg methane	55.65	IPCC, 2000

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

Parameter	Calves (3 months-1 year)	Sub-adult buffaloes (1-3 years)
Average body weight (kg)	130	405
Dry matter intake (% of body weight $head^{-1}$ day^{-1})	3.0	2.5
Dry matter intake (kg $head^{-1}$ day^{-1})	3.9	10.1
Gross Energy (MJ $head^{-1}$ day^{-1})	71.68	186.58
CH4 conversion (%)	6	6
CH_4 emission factor (kg $head^{-1}$ $year^{-1}$)	21.16 (*)	73.42

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

Rabbits

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

Other livestock categories

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

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

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sheep	Goats	Horses	Mules and asses	Sows	Other swine	Rabbits
	average CH_4 EF (kg CH_4 $head^{-1}$ $year^{-1}$)									
1990	94.5	45.6	62.9	8.0	5.0	18.0	10.0	1.5	1.5	0.08
1995	106.0	47.4	64.4	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2000	107.0	47.0	66.8	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2001	106.3	46.7	69.7	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2002	110.8	46.5	68.0	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2003	110.8	46.6	67.6	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2004	113.2	46.3	69.7	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2005	114.7	46.4	72.3	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2006	115.0	44.7	70.9	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2007	114.9	46.1	68.3	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2008	116.5	45.5	66.8	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2009	114.8	46.3	65.0	8.0	5.0	18.0	10.0	1.5	1.5	0.08
2010	119.9	45.9	64.7	8.0	5.0	18.0	10.0	1.5	1.5	0.08

Table 6.7 Time series of number of animals from 1990 to 2010 (heads)

Year	Buffalo	Sheep	Goats	Horses	Mules and asses	Sows	Other swine	Rabbits	Poultry
	(heads)								
1990	94,500	8,739,253	1,258,962	287,847	83,853	650,919	7,755,602	14,893,771	173,341,562
1995	148,404	10,667,971	1,372,937	314,778	37,844	689,846	7,370,830	17,110,587	184,202,416
2000	192,000	11,089,000	1,375,000	280,000	33,000	708,000	7,599,000	17,873,993	176,722,211
2001	193,774	8,311,383	1,024,769	285,000	33,000	697,491	8,068,771	18,494,839	209,187,654
2002	185,438	8,138,309	987,844	277,819	28,913	751,159	8,415,099	18,852,530	205,566,136
2003	222,268	7,950,981	960,994	282,936	28,507	736,637	8,420,087	18,866,643	196,511,409
2004	210,195	8,106,043	977,984	277,767	28,932	724,891	8,247,181	19,654,694	191,315,963
2005	205,093	7,954,167	945,895	278,471	30,254	721,843	8,478,427	20,504,282	188,595,022
2006	230,633	8,227,185	955,316	287,123	31,013	771,751	8,509,352	20,238,089	177,274,561
2007	293,947	8,236,668	920,085	315,725	34,557	753,721	8,519,214	20,964,928	188,871,886
2008	307,149	8,175,196	957,248	332,496	36,239	756,345	8,496,102	19,515,455	197,298,265
2009	344,007	8,012,651	960,950	343,519	40,608	745,508	8,411,572	17,689,669	199,924,644
2010	365,086	7,900,016	982,918	373,324	46,475	717,366	8,603,753	17,957,421	198,346,719

6.2.3 Uncertainty and time-series consistency

Uncertainty related to CH_4 emissions from enteric fermentation was 28% for annual emissions, resulting from the combination of 20% of uncertainty for both activity data and emission factors.

In the last year submission, Montecarlo analysis was also applied to estimate uncertainty of this category for 2009; an asymetrical probability density distribution resulted from the analysis, showing uncertainties values equal to -21.8% and 31.7%. Different distributions have been assumed for the parameters; assumptions or constraints on variables have been appropriately reflected on the choice of type and shape of distributions. A summary of the results is reported in Annex 1.

In 2010, livestock CH_4 emissions from enteric fermentation were 12.6% (511.05 Gg) lower than in 1990 (584.69 Gg). Between 1990 and 2010 cattle livestock has decreased by 24.8% (from 7,752,152 to 5,832,457 heads). Dairy cattle and non-dairy cattle have decreased by 33.9% (from 2,641,755 to 1,746,140) and 20.0% (from 5,110,397 to 4,086,317), 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 2010, cattle contribute with 77.6% 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 2012, are represented by 'other swine' and 'sow' (13.99 Gg).

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

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sheep	Goats	Horses	Mules and asses	Sows	Other swine	Rabbits	TOTAL
						(Gg)					
1990	249.75	233.00	5.95	69.91	6.29	5.18	0.84	0.98	11.63	1.16	**584.69**
1995	220.53	246.22	9.55	85.34	6.86	5.67	0.38	1.03	11.06	1.33	**587.98**
2000	221.03	234.48	12.83	88.71	6.88	5.04	0.33	1.06	11.40	1.39	**583.14**
2001	220.87	217.91	13.51	66.49	5.12	5.13	0.33	1.05	12.10	1.44	**543.96**
2002	211.81	213.95	12.61	65.11	4.94	5.00	0.29	1.13	12.62	1.46	**528.92**
2003	212.01	214.17	15.02	63.61	4.80	5.09	0.29	1.10	12.63	1.47	**530.19**
2004	208.15	206.60	14.64	64.85	4.89	5.00	0.29	1.09	12.37	1.53	**519.41**
2005	211.19	204.65	14.82	63.63	4.73	5.01	0.30	1.08	12.72	1.59	**519.73**
2006	209.46	192.10	16.36	65.82	4.78	5.17	0.31	1.16	12.76	1.57	**509.48**
2007	211.36	205.03	20.06	65.89	4.60	5.68	0.35	1.13	12.78	1.63	**528.51**
2008	213.21	197.94	20.52	65.40	4.79	5.98	0.36	1.13	12.74	1.52	**523.60**
2009	215.64	195.53	22.37	64.10	4.80	6.18	0.41	1.12	12.62	1.37	**524.14**
2010	209.29	187.46	23.62	63.20	4.91	6.72	0.46	1.08	12.91	1.39	**511.05**

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.

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

Sub category	Parameter	Year of submission 2012	Year of submission 2013	Activities
Dairy cattle	Fat content	√		Data from 2010 fat parameter has been collected (ISTAT new database on-line)
Dairy cattle	Portion cow giving birth	√		Data from 2010 has been collected (AIA, 2011)
Dairy cattle/buffalo	Milk production	√		Data from 2010 on milk production has been collected (ISTAT new database on-line)

6.2.5 Source-specific recalculations

Recalculations affected the whole time series on account of the update of the net energy growth parameter for dairy cattle and buffalo.

An update of the number of animals for a single category of non-dairy cattle between 1-2 year lead to a change of EF (mean average) and emission for non-dairy cattle in 2009. The number of rabbits has been updated for the year 2009 according to ISTAT data.
Recalculations accounted for an increase of emissions in the category equal to 0.8% and 2.1% in 1990 and 2009, respectively. In Table 6.10, previous and current dairy cattle and buffalo EFs are shown.

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

Year	Dairy cattle		Buffalo	
	EF 2011 submission	EF 2012 submission	EF 2011 submission	EF 2012 submission
	(kg head^{-1} year^{-1})			
1990	92.8	94.5	61.7	62.9
1991	97.7	99.5	62.9	64.1
1992	100.9	102.6	62.4	63.6
1993	100.6	102.4	65.5	66.7
1994	103.4	105.1	65.6	66.7
1995	104.3	106.0	63.2	64.4
1996	105.8	108.1	62.4	63.6
1997	106.7	108.5	62.9	64.0
1998	106.4	108.2	62.0	63.1
1999	106.3	108.0	64.9	66.1
2000	105.3	107.0	65.7	66.8
2001	104.6	106.3	68.2	69.7
2002	109.1	110.8	66.4	68.0
2003	109.0	110.8	66.2	67.6
2004	111.5	113.2	68.3	69.7
2005	112.9	114.7	71.0	72.3
2006	113.2	115.0	69.7	70.9
2007	113.2	114.9	67.1	68.3
2008	114.7	116.5	65.7	66.8
2009	113.0	114.8	63.8	65.0
2010	-	119.9	-	64.7

6.2.6 Source-specific planned improvements

In the framework of the collaboration between ISPRA and ISTAT (Agriculture Service) we expect to continuously update and improve activity data. Every year agricultural statistics from other sources are also updated (UNA, 2011; AIA, 2010).

6.3 Manure management (4B)

6.3.1 Source category description

In 2010, CH_4 emissions from manure management were 122.25 Gg, which represents 17.3% of CH_4 emissions for the agriculture sector (20.0% in 1990) and 6.8% of national CH_4 emissions (7.9% in 1990). CH_4 emissions from swine were 54.82 Gg and from cattle were 43.24 Gg. These two sub-categories represented 45% and 35%, respectively, of total CH_4 manure management emissions.

In 2010, N_2O emissions from manure management were 11.94 Gg, which represents 19.6% of total N_2O emissions for the agriculture sector (16.8% in 1990) and 13.6% of national N_2O emissions (10.5% in 1990). In 2010, N_2O emissions from this source mainly consist of the solid storage source (10.48 Gg), accounting for 87.8% 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 Approach 1 and Approach 2, and trend (Approach 2).

6.3.2 Methodological issues

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

Methane emissions (cattle and buffalo)

Method 1: Regional basis
Methane emission estimations for manure management are drawn up on a regional basis and depend on specific manure management practices and environmental conditions (Safley *et al*., 1992; Steed and Hashimoto, 1995; Husted, 1994). The following factors are used: average regional monthly temperatures (UCEA, 2011), amount of slurry and solid manure produced per livestock category (CRPA, 2006[a]; Regione Emilia Romagna, 2004) and management techniques for the application of slurry and solid manure for agricultural purposes in Italy (CRPA, 1993).
For cattle and buffalo, the estimation of the EF starts with the calculation of the *methane emission rate* (g CH_4 m^{-3} day^{-1}), which is obtained from an equation for slurry (Husted, 1994) and solid manure (Husted, 1993). Then, the *methane emission rate* is transformed to g m^{-3} $month^{-1}$.
Equations are presented below (CRPA, 2006[a]; CRPA, 1997[a]).

For slurry:

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

For solid manure:

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

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. Final data from the census will be available on April 2012. 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 = 4.80 gCH_4/Kg VS • VS production slurry (kg VS head^{-1} day-^{1}) • 365 days *Eq. 6.4*

Table 6.11 Methane manure management EFs for cattle and buffalo in 2010 (kg CH_4 head^{-1} yr^{-1})

Livestock category	Slurry (kg CH_4 head^{-1} yr^{-1})	Solid manure (kg CH4 head-1 yr-1)	CH_4 manure management EF (kg CH_4 head^{-1} yr^{-1})
Calf	6.22	0.00	**6.22**
Cattle	5.22	3.59	**8.81**
Female cattle	2.90	4.14	**7.04**
Other dairy cattle	4.01	6.65	**10.66**
Dairy cattle	5.64	9.41	**15.04**
Cow buffalo	4.93	10.32	**15.25**
Other buffaloes	3.12	3.17	**6.30**

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

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

Year	Calf	Cattle	Female cattle	Other dairy cattle	Dairy cattle	Cow buffalo	Other buffaloes
	(kg CH_4 head^{-1} yr^{-1})						
1990	6.22	8.11	6.71	10.66	15.04	15.25	6.34
1995	6.22	8.56	6.71	10.66	15.04	15.25	6.33
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

Year	Calf	Cattle	Female cattle	Other dairy cattle	Dairy cattle	Cow buffalo	Other buffaloes
	(kg CH_4 head^{-1} yr^{-1})						
2004	6.22	8.34	6.98	10.66	15.04	15.25	6.30
2005	6.22	8.61	6.95	10.66	15.04	15.25	6.30
2006	6.22	8.52	6.87	10.66	15.04	15.25	6.29
2007	6.22	8.56	7.05	10.66	15.04	15.25	6.29
2008	6.22	8.58	6.99	10.66	15.04	15.25	6.29
2009	6.22	8.75	7.03	10.66	15.04	15.25	6.29
2010	6.22	8.81	7.04	10.66	15.04	15.25	6.30

Since 2006 submission, a reduction of CH_4 emissions has been introduced in the manure management category (4B) in order to consider the biogas production. A national census on biogas production/technology can be found in CRPA and CRPA/AIEL (CRPA, 2008; CRPA/AIEL 2008). Biogas production data are collected every year by the National Electric Network (TERNA, 2011). For further information on biogas activity data see Annex 7.2.

Reductions of CH_4 emissions related to biogas recovery are assumed for cattle and swine livestock categories, and distributed according to the contribution of emissions from each category. This reduction is evident in the IEF reported in the CRF. In 2010, the CRF IEFs, for dairy cattle and non-dairy cattle, were 11.23 kg CH_4 head^{-1} year^{-1}, and 5.78 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	11.23
Non-dairy cattle	7.75	5.78
Buffalo	12.30	12.30

(*) IEF as reported in the CRF submission 2012

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	2.84	2.68	0.13	0.17
Buffalo	5.32	2.68	0.13	0.10
Swine	0.32	0.50	0.46	0.46

(*) IEF as reported in the CRF submission 2012

Methane emissions (swine)

For the estimation of CH_4 emissions for swine, a country-specific *methane emission rate* was experimentally determined by the Research Centre on Animal Production (CRPA, 1996). The estimation of the EF considers: the structure of the storage for slurry (tank and lagoons), type of breeding and seasonal production of biogas.
Different parameters were considered, such as the livestock population, average weight for fattening swine and sows, and *methane emission rate*. Methane emission rates used are 41 normal litre CH_4/100 kg live weight/day for fattening swine, and 47 normal litre CH_4/100 kg live weight/day for sows including piglets (CRPA, 1997[a]). Then, a reduction of emissions of 8% for covered storage structures is applied to the *methane emission rate*. Characteristics of swine breeding and EFs are shown in Table 6.13. In the 2006 submission, parameters such as: average weight of sows, production of slurry (t $year^{-1}$ per t live weight) and volatile solid content in the slurry (g SV/kg slurry w.b.) were updated. The slurry production considered the different swine categories (classified by weight and housing characteristics). Volatile solid content were determined experimentally from 598 measurements carried out by CRPA (CRPA, 2006[a]).
In 2010, the EF from sow was 22.34 kg CH_4 $head^{-1}year^{-1}$, and for the other swine category was 8.36 kg CH_4 $head^{-1}$ $year^{-1}$ (average swine EF is 7.88 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 5.88 kg CH_4 $head^{-1}$ $year^{-1}$. The difference between the EF and the IEF is due to the reduction in CH_4 because of biogas recovery. For reporting purposes, the VS daily excretion and Bo is estimated and is useful to verify the EF accuracy. The VS daily excretion was estimated for each sub-category with the following parameters: animal number, production of slurry (t/a/t live weight) and the volatile solids content in the slurry (g VS/kg slurry w.b.). Methane producing potential (Bo) used Equation 4.17 from the IPCC (IPCC, 2000).

Table 6.13 Methane manure management parameters and emission factors for swine in 2010

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**	**578,152**	**13,768**	**8.36**
20-50 kg	35	65,555	13,768	3.48
50-80 kg	65	96,142	13,768	6.46
80-110 kg	95	142,612	13,768	9.44
110 kg and more	135	269,499	13,768	13.41
Boar	200	4,344	13,768	19.86
Sow	**172**	**140,783**	**15,783**	**22.34**
Piglets	10	17,325	*15,783*	*1.14*
Sow	172.1	123,459	*15,783*	*19.60*
			TOTAL	**7.88**

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

Other livestock categories
Methane EFs used for calculating the other livestock categories are those proposed by the IPCC 1996 Guidelines. Since the yearly average temperature in Italy is 13 °C, EFs are characteristic of the "cold" climatic region (IPCC, 1997). A study carried out at national level by CRPA (CRPA, 1997[a]) assessed the specific IPCC default EFs to estimate emissions from this category, and an average figure was calculated for

each animal category considering that the manure of some animals occur in Italian provinces where average temperatures are higher than 15° C (temperate).

In Table 6.14, 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}

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

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sows	Other swine
	(kg CH_4 head^{-1} year^{-1})				
1990	15.04	7.47	12.17	22.14	8.54
1995	15.04	7.82	11.95	21.96	8.52
2000	15.04	7.67	11.71	21.97	8.43
2001	15.04	7.72	13.74	22.20	8.55
2002	15.04	7.66	14.07	22.27	8.21
2003	15.04	7.69	12.98	22.19	8.20
2004	15.04	7.73	12.87	22.22	8.27
2005	15.04	7.78	12.29	22.30	8.35
2006	15.04	7.67	11.96	22.16	8.35
2007	15.04	7.77	11.97	22.21	8.33
2008	15.04	7.70	11.75	22.14	8.32
2009	15.04	7.75	12.03	22.17	8.40
2010	15.04	7.75	12.30	22.34	8.36

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

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

When estimating emissions from manure management, the amount related to manure excreted while grazing is subtracted and reported in ‘Agricultural soils’ under soil emissions - animal production (see Table 6.15). 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 11.65 kg head^{-1} yr^{-1}. This last parameter is a weighted average: sow (28.36 kg head^{-1} yr^{-1}) and other swine (12.85 kg head^{-1} yr^{-1}).

Table 6.15 Average weight and nitrogen excretion rates in 2010

Livestock category	Average weight (kg)	N excreted Housing (kg head^{-1} yr^{-1})	N excreted Grazing (kg head^{-1} yr^{-1})	TOTAL Nitrogen excreted (kg head^{-1} yr^{-1})
Non-dairy cattle	381	48.54	1.29	**49.83**
Dairy cattle	603	110.20	5.80	**116.00**
Buffalo	525	92.20	2.75	**94.96**
Other swine	84	12.85	-	**12.85**
Sow	172	28.36	-	**28.36**
Sheep	48	1.62	14.58	**16.20**
Goat	48	1.62	14.58	**16.20**
Horses	550	20.00	30.00	**50.00**
Mules and asses	300	20.00	30.00	**50.00**
Poultry	1.7	0.53	-	**0.53**
Rabbit	1.6	1.02	-	**1.02**

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[7] and net nitrogen arriving to the field[8] were obtained. In order to get reliable information on feed consumption and characteristics, and composition of the feed ratio, the project considered territorial and dimensional representativeness of Italian breeding. Final annual nitrogen excretion rates used for the UNFCCC/CLRTAP agriculture national inventory are reported in a report from CRPA (CRPA, 2006[a]).
In Table 6.16, nitrogen excretion rates for the main livestock categories are shown for the whole time series. For the other livestock categories nitrogen excretion is the same for the whole time series, as shown below:

- sheep, 16.2 kg head^{-1} year^{-1}
- goats, 16.2 kg head^{-1} year^{-1}
- horses, 50.0 kg head^{-1} year^{-1}
- mules and asses, 50.0 kg head^{-1} year^{-1}
- hen, 0.66 kg head^{-1} year^{-1}
- broilers, 0.36 kg head^{-1} year^{-1}
- other poultry, 0.825 kg head^{-1} year^{-1}
- rabbits, 1.02 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.

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

Year	Dairy cattle	Non-dairy cattle	Buffalo	Other swine	Sows
	(kg N head^{-1} yr^{-1})				
1990	116.0	50.00	93.94	13.13	28.10
1995	116.0	49.86	92.42	13.10	27.86
2000	116.0	50.08	90.76	12.96	27.87
2001	116.0	50.69	105.23	13.14	28.17
2002	116.0	50.39	107.58	12.61	28.27

[7] Nitrogen excretion = N consumed – N retained
[8] 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})				
2003	116.0	50.53	99.82	12.60	28.16
2004	116.0	50.04	99.01	12.72	28.20
2005	116.0	49.76	94.91	12.84	28.30
2006	116.0	48.52	92.59	12.84	28.12
2007	116.0	49.84	92.61	12.81	28.18
2008	116.0	49.76	91.05	12.79	28.09
2009	116.0	50.19	93.04	12.92	28.13
2010	116.0	49.83	94.96	12.85	28.36

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

6.3.3 Uncertainty and time-series consistency

Uncertainty of CH_4 and N_2O emissions from manure management has been estimated equal to 102%, as a combination of 20% and 100% for activity data and emission factors, respectively.
In this year submission, Montecarlo analysis was also applied to estimate uncertainty of these two categories. The resulting figures were 22.96% and 10.19% for CH_4 and N_2O emissions from manure management, respectively. Normal and lognormal distributions have been assumed for the parameters; at the same time, whenever assumptions or constraints on variables were known this information has been appropriately reflected on the range of distribution values. A summary of the results is reported in Annex 1.

In 2010, livestock CH_4 emissions from manure management were 26% (122.25 Gg CH_4) lower than in 1990 (164.86 Gg CH_4). From 1990 to 2010, dairy and non-dairy cattle livestock population decreased by 34% and 20%, respectively, whereas swine increased by 9%. The reduction of manure management emissions has mainly driven down by the number of cattle and, in the last years, the increasing amount of biogas recovered for energy production. Cattle CH_4 emissions contribute with 35% (in 1990 with 47%) to total CH_4 manure management emissions and swine with 45% (41% in 1990).
In Table 6.17, CH_4 emission trends from manure management are shown. These emissions considered the reduction of CH_4 because of biogas recovery.

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

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sows	Other swine	Sheep	Goats	Horses	Mules and asses	Poultry	Rabbits	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**
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**
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**

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sows	Other swine	Sheep	Goats	Horses	Mules and asses	Poultry	Rabbits	TOTAL
	(Gg)											
2002	28.17	34.54	2.61	16.40	53.46	1.77	0.14	0.41	0.02	16.39	1.50	**155.42**
2003	28.11	34.47	2.89	15.96	53.97	1.73	0.14	0.42	0.02	15.68	1.50	**154.89**
2004	26.73	33.38	2.70	15.57	52.58	1.76	0.14	0.41	0.02	15.27	1.57	**150.14**
2005	26.44	32.74	2.52	15.36	53.87	1.73	0.14	0.41	0.03	15.05	1.63	**149.93**
2006	25.21	30.31	2.76	15.73	52.04	1.79	0.14	0.42	0.03	14.15	1.61	**144.20**
2007	25.05	31.28	3.52	15.16	51.26	1.79	0.13	0.47	0.03	15.07	1.67	**145.43**
2008	24.11	29.32	3.61	14.66	49.56	1.78	0.14	0.49	0.03	15.74	1.56	**140.99**
2009	23.79	27.57	4.14	13.91	47.60	1.74	0.14	0.51	0.03	15.95	1.41	**136.79**
2010	19.61	23.63	4.49	11.96	42.86	1.72	0.14	0.55	0.04	15.82	1.43	**122.25**

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

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

Year	Liquid system	Solid storage	Other	TOTAL
	(Gg)			
1990	0.62	12.03	-	**12.65**
1995	0.57	11.54	0.09	**12.20**
2000	0.54	11.36	0.56	**12.46**
2001	0.54	11.59	0.78	**12.91**
2002	0.52	11.05	0.84	**12.42**
2003	0.52	10.92	0.89	**12.33**
2004	0.51	10.59	0.89	**11.98**
2005	0.51	10.49	0.97	**11.96**
2006	0.50	10.16	0.95	**11.61**
2007	0.51	10.73	0.94	**12.19**
2008	0.51	10.71	0.96	**12.18**
2009	0.51	10.81	0.98	**12.30**
2010	0.49	10.48	0.97	**11.94**

In 2010, N_2O emissions from manure management were 6% (11.94 Gg N_2O) lower than in 1990 (12.65 Gg N_2O). The major contribution is given by the ‘solid storage system’ with 88% (in 1990 with 95%).

6.3.4 Source-specific QA/QC and verification

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

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

Category/sub category	Parameter	Year of submission 2012	2013	Activities
Dairy cattle	N excretion		√	Still further efforts on theoretical assessment of N excretion data will be done based on N balance methodology (Gruber and Poesch, 2006).
Livestock categories	Type of housing		√	A query on the type of housing of different livestock categories has been introduced in the Farm and structure survey 2005. Results have been analysed. According to experts from CRPA, information collected from SPA 2005 (housing data) needs to be validated with information from the Agricultural Census (CRPA, 2010) (final data is expected by April 2012).
Livestock categories	Slurry and solid manure storage facilities		√	We are analysing and verifying information coming from the Farm and Structure Survey 2007, where a query related to storage facilities for slurry and solid manure was incorporated. Validation will be executed with data coming from the 2010 Agricultural census (final data is expected by April 2012).
Livestock categories	Production methods		√	Different queries have been incorporated in an specific section of the 2010 Agricultural Census. Grazing, housing, storage systems and land spreading information will be collected.
Livestock categories	Biogas	√		Data on biogas from 2010 has been collected (web site TERNA)

6.3.5 Source-specific recalculations

Recalculations only affected the year 2009 with a decrease of CH_4 emissions by 0.45% and an increase of N_2O emissions by 1.34%. The update of non dairy female 1-2 years liquid and solid MMS data led to a recalculation in N_2O emissions. Moreover, CH_4 emissions changed for the update of rabbits and the update of the distribution of biogas recovered between swine and cattle.
Parameters used for this submission are shown in Table 6.20.

6.3.6 Source-specific planned improvements

Future agricultural surveys will contribute to the improvement of the national agriculture emission inventory (Cóndor *et al.*, 2005; Cóndor and De Lauretis, 2009). Information from the FSS 2005 and FSS 2007 on housing and storage systems, respectively, was analysed. Information obtained from these surveys will be validated with information from the Agricultural Census (CRPA, 2010). Furthermore, we expect that in the 2010 Italian Agricultural Census, detailed information on production systems will be obtained with an *ad hoc* survey. Results will be available in April 2012. Finally, a specific research on land spreading practices finished at the end of 2009. Results need to be analysed before incorporating them for future submissions (CRPA, 2009).
For the dairy cattle category, the suggestions by the review process (UNFCCC, 2009) have been taken into consideration. Nitrogen excretion in Italy has been evaluated through a Nitrogen Balance Inter-regional Project (nitrogen balance in animal farms), funded by the Regional Governments of the most livestock-intensive Italian Regions. The N-balance methodology has been applied in real case farms, monitoring their normal feeding practice, without specific diet adaptation. In the project, the most relevant dairy cattle production systems in Italy have been considered. Contrary to what is normally found in European milk production systems, poor correlation between the N excretion and milk production has been found. Probably there are two reasons for explaining the absence of correlation: a) extreme heterogeneity in the protein content of the forage and in the use of the feed; b) the non optimisation of the protein diet of less productive cattle (De Roest and Speroni, 2005; CRPA, 2010). Still further efforts on theoretical assessment of nitrogen excretion data will be done based on nitrogen balance methodology (Gruber and Pötsch, 2006). An ad-hoc agro-environmental indicator group coordinated by the Ministry of Agriculture is working to determine gross nitrogen balances, therefore N coefficients will be revised.

Table 6.20 Parameters used for the different livestock categories in 2012 submission

Livestock category			Average weight (kg) Submission 2012	N excretion (kg N head^{-1} yr^{-1}) Submission 2012
DAIRY CATTLE			603	116
NON- DAIRY CATTLE				
Less than 1 year (*)			207(**)	24.3 (**)
From 1 year - less than 2 years				
	Male	for reproduction	557	66.8
		for slaughter	557	66.8
	Female	for breeding	405	67.6
		for slaughter	444	53.3
From 2 years and more				
	Male	for reproduction	700	84.0
		for slaughter and work	700	84.0
	Female	Breeding heifer	540	90.2
		Slaughter heifer	540	64.8
		Other dairy cattle	557	54.1
BUFFALO	Cow buffalo		630	116
	Other buffaloes		313	52.2
OTHER SWINE	Weight less than 20 kg		10	
	From 20 kg weight and under 50 kg		35	5.3
	From 50 kg and more			
		Boar	200	30.5
		For slaughter		
		from 50 to 80 kg	65	9.9
		from 80 to 110 kg	95	14.5
		from 110 kg and more	135	20.6
SOW			172.1	28.4 (**)
SHEEP	Sheep		51	16.2
	Other sheep		21	16.2
GOAT	Goat		54	16.2
	Other goat		15	16.2
EQUINE	Horses		550	50.0
	Mules and asses		300	50.0
POULTRY	Broilers		1.2	0.36
	Hen		1.8	0.66
	Other poultry		3.3	0.83
RABBIT	Female rabbits		4	2.5
	Other rabbit		1.3	0.8

(*) Categories included in less than 1 year are: calf, fattening male cattle, fattening heifer and heifer for replacement;
(**) values are variable for the time series.

6.4 Rice cultivation (4C)

6.4.1 Source category description

For the rice cultivation category, only CH_4 emissions are estimated, other GHGs do not occur; N_2O from fertilisation during cultivation was estimated and reported in "Agricultural soils" under direct soil emissions - synthetic fertilizers. In 2010, CH_4 emissions from rice cultivation were 74.54 Gg, which represent 10.5 % of CH_4 emissions for the agriculture sector (9.1% in 1990) and 4.2% for national CH_4 emissions (3.6% in 1990).
In Italy, CH_4 emissions from rice cultivation are estimated only for an irrigated regime, other categories suggested by IPCC (rainfed, deep water and "other") are not present. Methane emissions, reported in the CRF, represent two water regimes: single aeration (15.69 Gg) and multiple aeration (58.84 Gg).
In response to UNFCCC review processes from 2004 and 2005 (UNFCCC, 2005; UNFCCC, 2004) and in consultation with an expert in CH_4 emissions and rice cultivation (Wassmann, 2005), a detailed methodology was developed. New activity data and parameters are used for the estimation of CH_4 emissions (Cóndor *et al*., 2007[a]). For this purpose, an expert group on rice cultivation together with the C.R.A. – Experimental Institute of Cereal Research – Rice Research Section of Vercelli was established. Different national experts from the rice cultivation sector were also contacted[9].
The quality of the Italian rice emission inventory was verified with the Denitrification Decomposition model (DNDC) model. Initial results have found a high correspondence between the EFs used for the Italian inventory and those simulated with DNDC model (Leip and Bocchi, 2007).

6.4.2 Methodological issues

For the estimation of CH_4 emissions from rice cultivation a detailed methodology was implemented following the IPCC guidelines (IPCC, 2006). We have considered country-specific circumstances. Parameters such as an adjusted integrated emission factor (kg CH_4 $m^{-2}day^{-1}$), cultivation period of rice (days) and annual harvested area (ha) cultivated under specific conditions are considered. Information of the cultivated surface is collected 100% from rice farmers. Every year, data are collected on time by the National Rice Institute (ENR, 2011[b]). Activity data information is shown in the following box.

Parameters used for the calculation of CH_4 emissions from rice cultivation

Parameters	Reference
Cultivated surface with "dry-seeded" technique (%)	ENR, 2011[a]
Cultivated surface – national (ha)	ISTAT, 2012[d],[e]; ISTAT, several years [a],[b]; ENR, 2011[b]
Cultivated surface by rice varieties (ha)	ENR, 2011[b]
Cultivation period of rice varieties (days)	ENR, 2011[b]
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, 2012[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

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

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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).

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

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

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

In general, rice seeds are mechanically broadcasted in flooded fields. However, in Italy for the last 15 years, seeds are also drilled to dry soil in rows. The rice which has been planted in dry soil is generally managed as a dry crop until it reaches the 3-4 leaf stage. After this period, the rice is flooded and grows in continuous submersion, as in the conventional system (Ferrero and Nguyen, 2004; Russo, 1994).
During the cultivation period, water is commonly kept at a depth of 4-8 cm, and drained away 2-3 times during the season to improve crop rooting, to reduce algae growth and to allow application of herbicides. Rice fields are drained at the end of August to allow harvesting, once in a year (Ferrero and Nguyen, 2004; Baldoni and Giardini, 1989; Tinarelli, 1973; 1986).
Nitrogen is generally the most limiting plant nutrient in rice production and is subject to losses because of the reduction processes (denitrification) and leaching. Sufficient nitrogen should be applied pre-plant or pre-flood to assure that rice plant needs no additional nitrogen until panicle initiation or panicle differentiation

stage. When additional nitrogen is required, it should be top-dressed at either of these plant stages or whenever nitrogen deficiency symptoms appear. The above-mentioned applications are usually used in two or three periods; the first period is always before sowing, that is on dry soil, while the others occur during the growing season (Russo, 2001; Russo, 1993; Russo *et al*., 1990; Baldoni and Giardini, 1989).
In Italy, another type of fertilization practise is the incorporation of straw. The incorporation period can vary according to weather conditions, but probably mainly incorporated approximately one month before flooding (Russo, 1988; Russo 1976). Rice straw are often burned in the field, otherwise incorporated into the soil or buried. For other agronomic practice, a national publication has been considered for understanding fertilizer and crop residues management (Zavattaro *et al*., 2004).

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

The estimation of CH_4 emissions for the rice cultivation category considers an irrigated regime, which includes intermittently flooded with single aeration and multiple aeration regimes. The CH_4 emission factor is adjusted with the following parameters: daily integrated emission factor for continuously flooded fields without organic fertilizers, scaling factor to account for the differences in water regime in the rice growing season (*SFw*), scaling factor to account for the differences in water regime in the preseason status (*SFp*) and scaling factor which varies for both types and amount of amendment applied (*SFo*). Scaling factor parameters have been updated according to literature (Yan *et al*., 2005) and the IPCC 2006 Guidelines (IPCC, 2006).
Assumptions of agronomic practices, and parameters used for CH_4 emission estimations are shown in Table 6.21 and Table 6.22, respectively.
Total CH_4 emissions for rice cultivation in 2010 were 74.54 Gg.

Table 6.22 Parameters used for estimating CH_4 emissions from rice cultivation in 2010

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)	65,323	82,048	100,282
Daily EF (g CH_4 m^{-2} d^{-1})	0.20	0.28	0.28
SF_w	0.60	0.52	0.52
SF_p	0.68	0.68	0.68
SF_o	2.1	2.1	2.1
Adjusted daily EF (g CH_4 m^{-2} d^{-1})	0.17	0.21	0.21
Days of cultivation (days)	138	155	155
Seasonal EF (g CH_4 m^{-2} yr^{-1})	24.02	32.27	32.27
Methane emissions (Gg)	**15.69**	**26.48**	**32.36**

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 2010, CH_4 emissions from rice cultivation were 0.7% (74.54 Gg CH_4) lower than in 1990 (75.06 Gg CH_4). In Italy, the driving force of CH_4 emissions from rice cultivation is the harvest area and the percentage of single aerated surface (lower CH_4 emission factor). From 1990-2010, the harvest area has increased by 15%, from 215,442 ha $year^{-1}$ (1990) to 247,653 ha $year^{-1}$ (2010). The percentage of single aerated surface has increased from 1% (1990) to 26.4% (2010). Water regime trends were estimated together with expert judgement expertise (Tinarelli, 2005; Lupotto *et al*., 2005) and national available statistics (ENR, 2011[b]). 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.

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

Category/sub category	**Parameter**	**Year of submission** 2012	2013	**Activities**
Activity data	Days of cultivation and cultivars	√		Data from 2010 and provisional data from 2011 has been uploaded. Cultivation dates for rice varieties have been updated from 1990-2009.
Rice	Emission factor	√	√	We have contacted DG Joint Research Centre Institute for Environment and Sustainability - Climate Change Unit, in charge of measuring rice paddy fields in Italy. New measurements have been done since 2007. Data is not available yet. We expect to obtain updated information on EFs for future submissions.

6.4.5 Source-specific recalculations

There has been a recalculation of CH_4 emissions for the whole time series on account of an update of cultivation period for some rice varieties.
In Table 6.24, CH_4 emissions for the 2011 and actual submissions are shown.

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

Year	Harvested area ($10^{9} m^2 yr^{-1}$)	CH_4 emissions (Gg) 2011 submission	CH_4 emissions (Gg) 2012 submission
1990	2.15	74.4	75.06
1991	2.06	71.1	71.64
1992	2.16	73.9	74.39
1993	2.32	77.5	78.00
1994	2.36	79.2	79.98
1995	2.39	78.9	79.56
1996	2.38	77.3	78.37
1997	2.33	76.9	77.82
1998	2.23	73.0	73.50
1999	2.21	71.3	72.00
2000	2.20	65.8	66.26
2001	2.18	65.8	66.19
2002	2.19	67.6	68.52
2003	2.20	69.7	70.00
2004	2.30	73.0	73.04
2005	2.24	70.1	70.11
2006	2.29	70.3	70.23
2007	2.33	72.5	72.18
2008	2.24	66.5	65.99
2009	2.38	75.2	74.51
2010	2.48	-	74.54

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 2010 they represented 93% (ENR, 2011[b]; Confalonieri and Bocchi, 2005).

6.5 Agriculture soils (4D)

6.5.1 Source category description

In 2010, N_2O emissions from agricultural soils were 48.90 Gg, representing 80.4% of N_2O emissions for the agriculture sector (83.2% in 1990) and 55.7% for national N_2O emissions (52.1% in 1990). N_2O emissions from this source consist of direct soil (23.34 Gg), animal production (4.98 Gg) and indirect soil (20.58 Gg) emissions.
Direct and indirect N_2O emissions from agricultural soils are key sources at level and trend assessment, both with Approach 1 and Approach 2. Animal Production is a key source at level and trend assessment with Approach 2, taking into account the uncertainty.
In Italy, agricultural soil emissions are estimated for direct and indirect soils and animal production. For direct soil emissions the following sources are estimated: synthetic fertilizers, animal waste applied to soil, N-fixing crops 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 is in charge of collecting, elaborating and reporting the UNFCCC/CLRTAP agriculture national emission inventory (APAT, 2005), thus, consistency among methodologies and parameters is verified. Since 2006 submission, the UNFCCC/CLRTAP inventory has updated country-specific nitrogen excretion rates and EFs. The nitrogen balance coming from the CLRTAP emission inventory feeds the UNFCCC inventory, specifically for the estimation of $FRAC_{GASM}$ and $FRAC_{GASF}$ parameters, used for calculating F_{AM} and F_{SN}. Following recommendations from the UNFCCC ERT, direct and indirect N_2O emissions from the use of sewage sludge in agricultural soils have been estimated (UNFCCC, 2010[b]).

6.5.2 *Methodological issues*

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

Data used for estimating agricultural soil emissions

Data	Reference
Fertilizer distributed (t/yr)	ISTAT, 2012[c]; ISTAT, several years [a], [b]
Nitrogen content (%)	ISTAT, 2012[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, 2012[d],[e]; ISTAT, several years [a], [b]
Annual crop production (t yr^{-1})	ISTAT, 2012[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, 2012[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 submission, a specification for “Other nitrogenous fertilizers” was introduced (ENEA, 2006). This improvement was introduced since 1998, because activity data is available from that year.
The time series of nitrogen content of fertilizers is shown in Table 6.30. In 2010, the total use of synthetic fertilizers was 496,637 t N, while F_{SN} parameter was 449,972 t N (see Table 6.27).

Table 6.25 Total use of synthetic fertilizer in 2010 (t N yr^{-1})

Type of fertilizers	Fertilizers distributed (t yr^{-1})	Nitrogen content (%)	Nitrogen content of synthetic fertilizers (t N yr^{-1})
Ammonium sulphate	154,932	21.0%	32,568
Calcium cyanamide	29,585	16.8%	4,958
Nitrate (*)	270,630	26.9%	72,833
Urea	456,951	45.9%	209,829
Other nitric nitrogen	109,439	28.4%	3,332
Other ammoniacal nitrogen	-	-	12,412
Other amidic nitrogenous	-	-	15,366
Phosphate nitrogen	254,252	18.0%	45,837
Potassium nitrogen	90,471	17.6%	15,955
NPK nitrogen	511,238	12.6%	64,462
Organic mineral	227,116	8.4%	19,085
TOTAL	**2,104,613**		**496,637**

(*) includes ammonim nitrate < 27% and ammonium nitrate > 27% and calcium nitrate

Animal waste applied to soil (F_{AM})
The manure nitrogen corrected for NH_3 and NO_x emissions, excluding manure produced during grazing (kg N yr^{-1}), is calculated with the IPCC methodology (IPCC, 1997). It uses country-specific nitrogen excretion rates (CRPA, 2006[a]; GU, 2006; Xiccato *et al*., 2005). A country-specific $FRAC_{GASM}$ parameter is estimated and used for the calculation of the animal waste applied to soil. The $FRAC_{GASM}$(direct) and $FRAC_{GASM}$(indirect) parameters are reported in Table 6.27. The estimation has followed the IPCC definition; therefore, NH_3 and NOx emissions from animal manure are divided by the total nitrogen excreted. The F_{AM} (t yr^{-1}) value is estimated by summing the F_{AM} for each livestock category; then emissions are calculated with emission factor 0.0125 kg N-N_2O/kgN (IPCC, 1997). In 2010, F_{AM} parameter was 435,289 t N.

N-fixing crops (F_{BN})
Nitrogen input from N-fixing crops (F_{BN}, kg N yr^{-1}) is calculated with a country-specific methodology. Peculiarities that are present in Italy were considered: N-fixing crops and legumes forage. F_{BN} is calculated with two parameters: cultivated surface and nitrogen fixed per hectare (Erdamn 1959 in Giardini, 1983). Emissions are calculated using the default emission factor 0.0125 kg N-N_2O/kgN (IPCC, 1997). In Table 6.26, cultivated surface from N-fixing species (ha yr^{-1}) and N fixed by each species (kg N ha^{-1} yr^{-1}) are shown. In 2010 F_{BN} parameter was 170,659 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 2010, F_{CR} parameter was 116,426 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.

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

	N fixed	1990	1995	2000	2008	2009	2010
	(kg N ha^{-1} yr^{-1})	(ha)					
Bean, fresh seed	40	29,096	23,943	23,448	20,736	20,108	20,567
Bean, dry seed	40	23,002	14,462	11,046	5,972	6,290	7,001
Broad bean, fresh seed	40	16,564	14,180	11,998	9,547	8,563	8,950
Broad bean, dry seed	40	104,045	63,257	47,841	54,310	49,784	52,108
Pea, fresh seed	50	28,192	21,582	11,403	12,854	15,295	15,967
Pea, dry seed	72	10,127	6,625	4,498	10,378	10,751	11,692
Chickpea	40	4,624	3,023	3,996	5,265	5,929	6,813
Lentil	40	1,048	1,038	1,016	1,821	1,868	2,458
Tare	80	5,768	6,532	6,500	6,500	6,500	6,500
Lupin	40	3,303	3,070	3,000	3,000	3,000	3,000
Soya bean	58	521,169	195,191	256,647	107,795	134,704	159,511
Alfalfa	194	987,000	823,834	810,866	712,674	720,382	745,244
Clover grass	103	224,087	125,009	114,844	98,301	100,484	103,241
TOTAL		**1,958,025**	**1,301,746**	**1,307,102**	**1,049,153**	**1,083,659**	**1,143,052**

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

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

Year	F_{SN} (t N)	F_{AM} (t N)	F_{BN} (t N)	F_{CR} (t N)	F_{SEWAGE} (t N)	$FRAC_{GASF}$	$FRAC_{GASM}$ (direct)	$FRAC_{GASM}$ (indirect) (*)
1990	691,723	473,906	254,654	147,541	4,875	0.087	0.319	0.328
1995	726,343	453,464	191,018	142,216	7,823	0.089	0.298	0.308
2000	715,366	457,680	189,545	144,372	10,954	0.089	0.286	0.296
2001	737,063	467,387	182,928	137,779	16,076	0.089	0.299	0.307
2002	745,286	453,326	177,529	142,457	15,339	0.090	0.297	0.305
2003	750,296	452,991	175,154	119,184	14,648	0.090	0.296	0.304
2004	765,064	440,086	172,532	143,172	8,055	0.091	0.293	0.302
2005	710,888	439,859	176,624	145,247	8,874	0.088	0.292	0.301
2006	713,369	430,569	175,243	128,431	7,778	0.092	0.290	0.299
2007	694,048	446,908	160,575	125,878	8,305	0.093	0.292	0.301
2008	595,641	445,673	160,572	126,173	8,841	0.097	0.291	0.300
2009	469,086	448,092	163,797	113,568	11,365	0.096	0.292	0.301
2010	449,972	435,289	170,659	116,426	12,689	0.094	0.290	0.300

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

Sewage sludge applied to soils (F_{SEWAGE})
Direct and indirect N_2O emissions from the application of sewage sludge to agricultural soils were calculated using the tier 1 methodology described in the IPCC GPG (IPCC, 2000). Direct emissions were estimated by applying the relevant default IPCC equations, EFs and parameters (see Annex A7.3). From 1995 to 2009 activity data (amount of sewage sludge) and parameters (N content) were collected from the Ministry for the Environment, Land and Sea, which is in charge of collecting and reporting data under the EU Sewage Sludge Directive 86/278/EEC (MATTM, 2010). From 1990 to 1994 AD and parameters were reconstructed, description is available in the Waste Chapter. The amount of sewage N applied was calculated using the amount of sewage sludge (expressed in t dry matter) and the N content of sludge. Emission factor used was 0.0125 kg N-N_2O/kg N and the volatilization factor was 20% for N-NH_3+NOx emissions (IPCC, 1997).

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

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

- Atmospheric deposition
- Nitrogen leaching and run-off

For estimating of N_2O emissions due to atmospheric deposition of NH_3 and NO_x the IPCC approach was followed (IPCC, 1997). Parameters which are used are the: total use of synthetic fertilizer, t N yr^{-1}, $FRAC_{GASF}$ emission factor, total N excreted by livestock (kg head^{-1}yr^{-1}), $FRAC_{GASM}$ emission factor (see Table 6.27) and emission factor 0.01 kg N_2O-N per kg NH_3-N + NO_x-N emitted (IPCC, 2000; IPCC, 1997). The estimation of N_2O emissions due to nitrogen leaching and run-off has followed the IPCC approach (IPCC, 1997). Parameters which are used are the: total use of synthetic fertilizer, t N yr^{-1} (see Table 6.25), total N excreted by livestock (kg head^{-1} yr^{-1}), $FRAC_{LEACH}$ emission factor 0.3 N/kg nitrogen of fertilizer or manure and the emission factor 0.025 Kg N_2O-N per kg nitrogen leaching/run-off (IPCC, 2000; IPCC, 1997). As mentioned before, the $FRAC_{LEACH}$ IPCC default value was compared with the country-specific

$FRAC_{LEACH}$ parameter (ADBPO, 2001; ADBPO, 1994). Indirect emissions from sewage sludge applied to soils are included in the atmospheric deposition and N leaching estimations.

6.5.3 Uncertainty and time-series consistency

Uncertainty for N_2O emissions from agricultural soils (direct soil emissions, indirect soil emissions and animal production) has been estimated to be 102%, as combination of 20% and 100% for activity data and emission factor, respectively.
In this year submission, Montecarlo analysis was also applied to estimate uncertainty of the two key categories *Direct N_2O emissions from agricultural soils* and *Indirect N_2O emissions from nitrogen used in agriculture*. The resulting figures were 21.34% and 21.67% for *Direct and Indirect* N_2O emissions, respectively. Normal and lognormal distributions have been assumed for the parameters; at the same time, whenever assumptions or constraints on variables were known this information has been appropriately reflected on the range of distribution values. A summary of the results is reported in Annex 1.

In Table 6.28, time series of N_2O emissions are reported.

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

Year	Direct Soil Emissions	Animal Production	Indirect Soil emissions	TOTAL
	(Gg)			
1990	30.99	5.60	26.26	62.84
1995	30.00	6.44	26.23	62.67
2000	29.89	6.60	25.90	62.39
2001	30.32	5.18	25.88	61.38
2002	30.18	5.03	25.51	60.72
2003	29.76	4.93	25.45	60.15
2004	30.11	4.98	25.24	60.34
2005	29.18	4.90	24.32	58.39
2006	28.67	5.02	24.20	57.89
2007	28.28	5.06	24.44	57.79
2008	26.34	5.06	23.05	54.45
2009	23.76	5.02	21.23	50.01
2010	23.34	4.98	20.58	48.90

In 2010, N_2O emissions from agricultural soils were 22.2% (48.90 Gg N_2O) lower than in 1990 (62.84 Gg N_2O). Major contributions were given by direct soil (23.34 Gg) and indirect soil emissions (20.58 Gg). Indirect N_2O emissions from nitrogen leaching and run-off sub-category have the highest individual contribution with respect to total 4D N_2O emissions, equal to 32.4% (15.87 Gg N_2O). N_2O emissions from leaching and run-off are related to the nitrogen content in fertilizers and animal wastes, therefore, emissions are mainly linked to the use of N fertilizers and the animal number trends. In 2010, the second individual source with respect to total N_2O emissions was the direct emissions of synthetic fertilizers with 8.84 Gg (18.1%), followed by animal wastes applied to soils, with 8.55 Gg (17.5%). The time series of N_2O emissions from 4D is shown in Table 6.29. Between 1996 and 1997 there was a high increase in the use of nitrogen fertilizers in Italy, thus, emissions could be identified as outlier (see Table 6.29). Between 2007/2008 (-17%) and 2008/2009 (-25%) N fertiliser distribution has decreased. In 2010 the same trend was observed. According to the Italian Fertilizer Association (AIF) the use of fertilisers is determined by their cost and particularly by the price of agricultural products. In the last years, prices have decreased and, as a result, farmers need to save costs, consequently, less fertilisers is being used (Perelli, 2007; De Corso 2008).

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

Year	Direct N_2O emissions						Animal Production	Indirect N_2O emissions	
	Synthetic fertilizer	Animal Wastes	N-fixing Crops	Crop Residue	Histosols	Sewage sludge		Atmospheric Deposition	Nitrogen Leaching and Run-off
	Gg						Gg	Gg	
1990	13.59	9.31	5.00	2.90	0.11	0.08	5.60	5.99	20.27
1995	14.27	8.91	3.75	2.79	0.11	0.16	6.44	5.69	20.55
2000	14.05	8.99	3.72	2.84	0.11	0.17	6.60	5.49	20.41
2001	14.48	9.18	3.59	2.71	0.11	0.25	5.18	5.54	20.35
2002	14.64	8.90	3.49	2.80	0.11	0.24	5.03	5.39	20.11
2003	14.74	8.90	3.44	2.34	0.11	0.23	4.93	5.35	20.10
2004	15.03	8.64	3.39	2.81	0.11	0.13	4.98	5.25	20.00
2005	13.96	8.64	3.47	2.85	0.11	0.14	4.90	5.10	19.22
2006	14.01	8.46	3.44	2.52	0.11	0.12	5.02	5.06	19.14
2007	13.63	8.78	3.15	2.47	0.11	0.13	5.06	5.20	19.24
2008	11.70	8.75	3.15	2.48	0.11	0.14	5.06	5.08	17.97
2009	9.21	8.80	3.22	2.23	0.11	0.18	5.02	4.87	16.36
2010	8.84	8.55	3.35	2.29	0.11	0.20	4.98	4.71	15.87

6.5.4 Source-specific QA/QC and verification

Synthetic fertilizers and nitrogen content are compared with the international FAO agriculture database statistics (FAO, 2011). In Table 6.30, national and FAO time series of total nitrogen applied are reported. Differences between national data and FAO database are related to the difference in data elaboration (ISTAT, 2004) and could be attributed to different factors. First, national data are more disaggregated by substance than FAO data and the national nitrogen content is considered for each substance, while FAO utilises default values. Besides, differences could also derive from different products classification. In Table 6.31, activity data used for N_2O estimations have been provided. In Table 6.32, the QA/QC plan for this category is presented. From a meeting held in July 2011 with the FAO officer in charge of the fertiliser database, ISPRA verified that there are two FAO databases for fertilisers. In Table 6.30 an archive and a new database are presented. Differences between FAO and national statistics will be overcome as soon as the same classification is used.

Table 6.30 Total annual N content in fertilizer applied from 1990 to 2010

Year	National data (t N)	FAO database (Nitrous fertilizer consumption, Mt)	FAO new database (Nitrous fertilizer consumption, Mt)
1990	757,509	878,960	-
1991	837,402	906,720	-
1992	884,121	910,000	-
1993	945,290	917,900	-
1994	875,536	879,200	-
1995	797,500	875,000	-
1996	756,057	876,000	-
1997	856,945	855,000	-
1998	772,227	845,000	-
1999	788,243	868,000	-
2000	785,593	828,000	-
2001	808,964	773,161	-
2002	819,352	785,314	845,003
2003	824,649	Not available	846,812

Year	National data (t N)	FAO database (Nitrous fertilizer consumption, Mt)	FAO new database (Nitrous fertilizer consumption, Mt)
2004	841,363	Not available	866,469
2005	779,846	Not available	800,697
2006	785,265	Not available	798,807
2007	765,490	Not available	812,460
2008	659,922	Not available	702,472
2009	518,778	Not available	609,800
2010	496,637	Not available	Not available

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

Year	Cultivated surface (ha)	Crop production (t)	Total residue production (dry matter)
1990	2,128,674	82,247,958	20,719,032
1995	1,484,453	81,343,949	20,466,710
2000	1,491,315	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	69,147,007	18,845,035
2008	1,220,887	68,508,147	19,419,500
2009	1,258,535	62,564,634	16,914,244
2010	1,319,242	63,502,191	17,368,537

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

Category/sub category	Parameter	Year of submission		Activities
		2012	2013	
Activity data	Fertilizer	√		Results obtained from the research study on land spreading have been compared with those obtained with the inventory process (CRPA, 2009).

6.5.5 Source-specific recalculations

N_2O emissions have been recalculated for the whole time series due to the update of fraction of livestock N excretion that volatilizes and, in 2009, also to the update of fraction of livestock N excreted by female non dairy cattle of 1-2 years, leading to an increase of emissions equal to 0.29% in 2009.

6.5.6 Source-specific planned improvements

Information that allows compare national and FAO statistics was collected (see Table 6.30). No further improvements are planned.

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 2010, CH_4 emissions from this source were 0.59 Gg, representing 0.08% of emissions for the agriculture sector. N_2O emissions were 0.013 Gg, representing 0.02% of emissions for the agriculture sector.

6.6.2 Methodological issues

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

Data used for estimating field burning of agriculture residues emission

Data	Reference
Annual crop production	ISTAT, 2012[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, burnt on open fields, are reported in this category (4F) while emissions from removable residues burnt off-site, are reported under the waste sector (waste incineration- 6C category).

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

Year	Agricultural production						
	Wheat	Barley	Maize	Oats	Rye	Rice	Sorghum
	(t)						
1990	8,108,500	1,702,500	5,863,900	298,400	20,800	1,290,700	114,200
1995	7,946,081	1,387,069	8,454,164	301,322	19,780	1,320,851	214,802
2000	7,427,660	1,261,560	10,139,639	317,926	10,292	1,245,555	215,200
2001	6,413,329	1,125,720	10,556,185	310,087	8,588	1,272,952	213,992
2002	7,547,763	1,190,326	10,554,423	328,759	9,631	1,378,796	215,072
2003	6,229,454	1,020,838	8,702,289	306,425	6,941	1,448,212	158,217
2004	8,638,721	1,156,620	11,368,007	337,694	7,851	1,525,509	215,394
2005	7,717,129	1,214,054	10,427,930	429,153	7,876	1,444,818	184,915
2006	7,181,720	1,297,395	9,626,373	394,866	8,590	1,449,973	221,392
2007	7,170,181	1,225,282	9,809,265	361,148	8,954	1,540,097	193,243
2008	8,859,410	1,236,711	9,722,910	356,094	10,756	1,332,974	224,557
2009	6,534,748	1,049,200	8,142,974	314,421	12,204	1,644,135	243,398
2010	6,849,725	944,257	8,495,946	288,880	13,926	1,564,377	275,564

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

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

In 2010, final CH_4 emissions from on field burning of agriculture residues (0.59 Gg CH_4) have been estimated multiplying the C-CH_4 value (0.446 Gg C-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.

Table 6.34 Parameters used for the estimation of CH_4 emissions from agriculture residues in 2010

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	6,850	1,182	1,008	88	43	214
Rye	14	2	2	0	0	0
Barley	944	189	162	15	5	27
Oats	289	51	43	4	2	8
Rice	1,564	262	197	88	37	183
Maize	8,496	850	354	0	0	0
Sorghum	276	96	80	7	3	13
TOTAL	**18,433**	**2,631**	**1,846**	**203**	**89**	**446**

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

a) Amount of nitrogen from stubble burning release in air (t N), calculated with the amount of "fixed" dry residue oxidized and the fraction of nitrogen from the dry matter of residues. The fraction of nitrogen has been calculated considering raw protein content from residues (dry matter fraction) divided by 6.25.
b) N-N_2O from stubble burning (t N-N_2O), calculated with the amount of nitrogen from stubble burning release in air and the default emissions rate for N- N_2O, equal to 0.007 (IPCC, 1997).

In 2010, final N_2O emissions from on field burning of agriculture residues (0.013 Gg N_2O) are estimated by multiplying the N-N_2O value (0.008 Gg N) with the coefficient 44/28.
Table 6.35 shows the parameters for the estimation of CH_4 emissions from field burning of agriculture residues.

Table 6.35 Parameters used for the estimation of nitrous oxide from agriculture residues in 2010

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	88.3	0.030	0.005	0.424	3.0
Rye	0.2	0.036	0.006	0.001	0.01
Barley	14.6	0.037	0.006	0.086	0.6
Oats	3.9	0.040	0.006	0.025	0.2
Rice	88.4	0.041	0.007	0.580	4.1
Maize	0		0.007	0.000	0
Sorghum	7.2	0.037	0.006	0.043	0.3
TOTAL	**202.6**			**1.159**	**8.1**

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 2010, CH_4 emissions from field burning of agriculture residues were 0.59 Gg emissions of CH_4 and 0.013 Gg emissions of N_2O emissions (see Table 6.36). Variation in emissions trend is related to cereal production trends.

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

Year	CH_4 (Gg)	N_2O (Gg)
1990	0.6232	0.0130
1995	0.6157	0.0129
2000	0.5779	0.0121
2001	0.5343	0.0114
2002	0.6013	0.0126
2003	0.5462	0.0117
2004	0.6687	0.0140
2005	0.6212	0.0131
2006	0.6040	0.0129
2007	0.6119	0.0131
2008	0.6523	0.0134
2009	0.5966	0.0129
2010	0.5945	0.0127

6.6.4 Source-specific QA/QC and verification

In response to the review process (UNFCCC, 2007) and in order to verify the national assumption, which considered that 10% of the cultivated surface (cereals) is burned in Italy, a specific elaboration of data 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

No recalculations were done for this emission source.

6.6.6 Source-specific planned improvements

No specific improvements are planned.

7 Land Use, Land Use Change and Forestry [CRF sector 5]

7.1 Sector overview

CO_2 emissions and removals occur as a result of changes in land-use and from forestry. The sector is responsible for 56.6 Mt of CO_2 removals from the atmosphere in 2010.
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 2010 are shown in Figure 7.1.

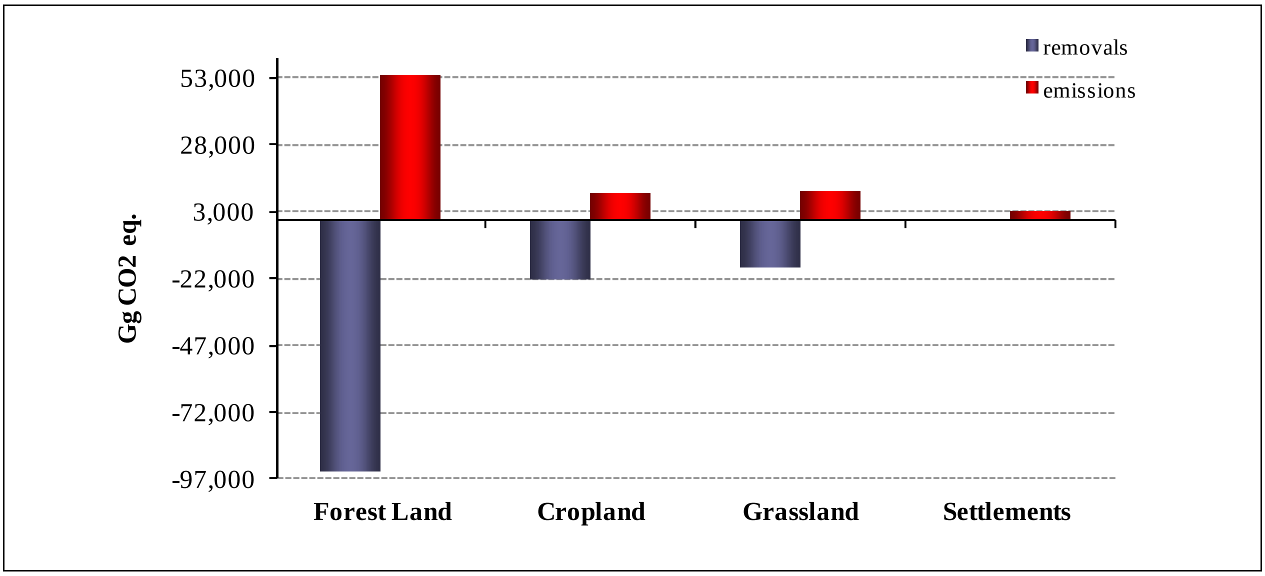

Figure 7.1 Greenhouse gas removals and emissions in LULUCF sector in 2010 [Gg CO_2 eq.]

In Table 7.1 emissions and removals time series is reported.

Table 7.1 Trend in greenhouse gas emissions from the LULUCF sector in the period 1990-2010

GHG Gas Source and Sink Categories	1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2	**-34,758**	**-48,220**	**-43,204**	**-53,655**	**-55,037**	**-35,748**	**-52,239**	**-56,022**	**-56,659**
A. Forest Land	-18,484	-35,403	-29,462	-39,871	-40,302	-22,364	-36,619	-40,207	-39,947
B. Cropland	-18,320	-12,850	-13,044	-11,532	-11,864	-12,298	-12,141	-12,162	-12,458
C. Grassland	-480	-2,492	-3,178	-5,614	-6,241	-4,463	-6,880	-7,062	-7,658
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	2,527	2,525	2,480	3,362	3,370	3,377	3,400	3,409	3,404
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
CH_4	**8.70**	**1.87**	**5.03**	**2.29**	**1.82**	**11.71**	**2.75**	**3.27**	**2.06**
A. Forest Land	8.70	1.87	5.03	2.29	1.82	11.71	2.75	3.27	2.06
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
N_2O	**0.29**	**0.29**	**0.10**	**0.10**	**0.08**	**0.07**	**0.04**	**0.02**	**0.27**
A. Forest Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Cropland	0.29	0.29	0.10	0.10	0.08	0.06	0.04	0.02	0.27
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
LULUCF (*Gg CO_2 equivalent*)	**-34,484**	**-48,089**	**-43,066**	**-53,575**	**-54,973**	**-35,481**	**-52,168**	**-55,946**	**-56,531**

CO_2 emissions and removals in LULUCF sector, in the period 1990-2010, are shown in Figure 7.2.

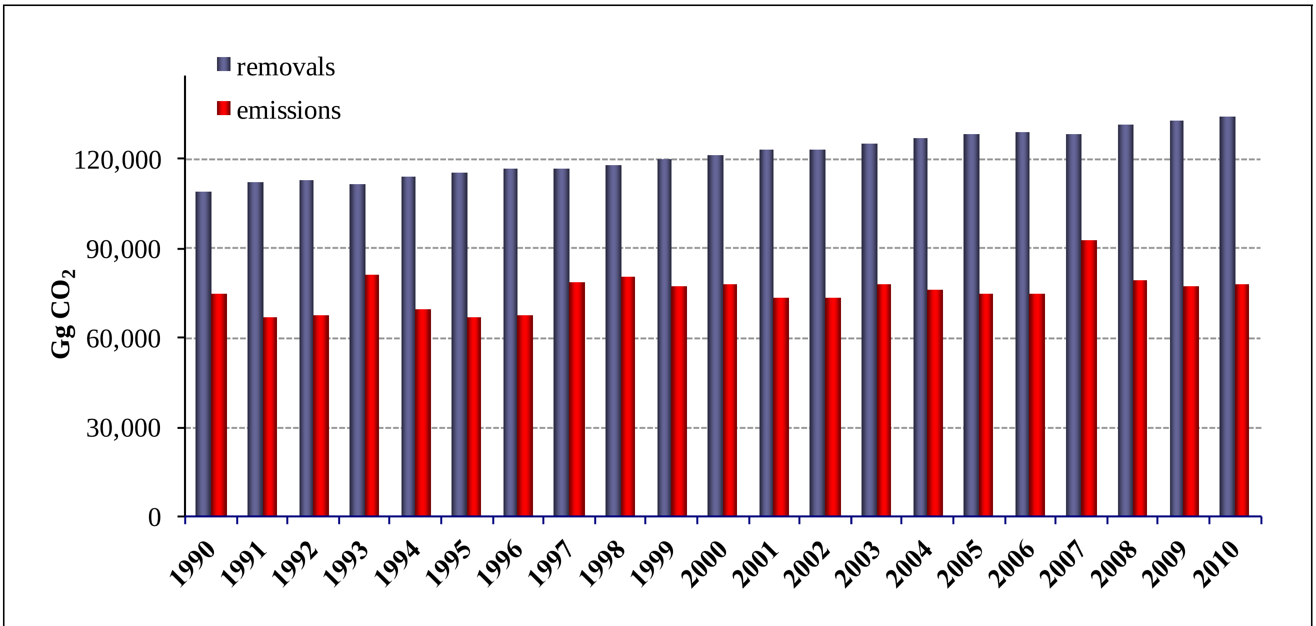

Figure 7.2 CO_2 removals and emissions in LULUCF sector in the period 1990-2010 [Gg CO_2]

The outcome of the key category analysis for 2010, according to level and/or trend assessment (*IPCC Approach 1 and Approach 2*), is listed in Table 7.2. CO_2 emissions and removals from forest land remaining forest land, cropland remaining cropland and grassland remaining grassland, land converted to grassland and land converted to settlements have been identified as key categories, both in level and in trend assessment. CO_2 emissions and removals from land converted to forest land and from land converted to cropland have resulted key categories with Approach 2 concerning trend assessment. Concerning CH_4 or N_2O emissions, no categories have resulted as a key source.

Table 7.2 Key categories identification in the LULUCF sector

	gas	*categories*	2010
5.A.1	CO_2	Forest land remaining forest land	key (L, T)
5.A.2	CO_2	Land converted to forest land	key (T2)
5.B.1	CO_2	Cropland remaining cropland	key (L, T)
5.B.2	CO_2	Land converted to cropland	key (T2)
5.C.1	CO_2	Grassland remaining Grassland	key (L, T)
5.C.2	CO_2	Land converted to Grassland	key (L, T)
5.E	CO_2	Land converted to Settlements	key (L, T2)
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

For the land use conversion, land use change matrices have been used; the matrices have allowed pointing out the average areas of transition land, separately for each initial and final land use (i.e. forest land, grassland, etc.). Annual figures for areas in transition between different land uses have been derived by a hierarchy of basic assumptions (informed by expert judgement) of known patterns of land-use changes in Italy as well as the need for the total national area to remain constant. A task force has been established among national experts and, in this context, an expert judgment has been made on the basis of known patterns of land-use changes in Italy, also considering local studies and researches on land uses transitions.
LUC matrices for each year of the period 1990–2010 have been assembled based on time series of national land use statistics for forest lands, croplands, grasslands, wetlands and settlement areas. More in details the following assumptions have been used: growth in forest land area as detected by the National Forest Inventories is used as the basis. The rule then assumes that new forest land area can only come from grassland; 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. These rules have been set up also on the basis of the relevant normative (i.e. concerning deforestation activities, in Italy land use changes from forest to other land use categories are allowed in very limited circumstances (railways, highways constructions or other public utility projects), as stated in art. 4.2 of the Law Decree n. 227 of 2001; land use changes due to wildfires are not allowed by national legislation (Law Decree 21 November 2000, n. 353, art.10.1)).
Concerning settlements, initial land use may be cropland (annual and perennial), forest land or grassland (see Tables 7.32, 7.34 and 7.35 of NIR2011); in addition a conservative approach was applied, hypothesising that the total deforested area is converted into settlements.
Regarding wetlands category, there is no occurrence of land transition to and from wetlands, considering that most of them are nature reserves.
Activities planned in the framework of the 'National Registry for Carbon sinks' are expected to be useful to detect the different land uses and land uses changes between 1990 and 2012. Some of these activities (in particular IUTI, inventory of land use) have been completed, resulting in land use classification, for all national territory, for the years 1990, 2000 and 2008. A process of validation and verification of IUTI data has been put in place and is expected to supply data useful to update and improve the estimations.
In response to ERT recommendation, Italy has decided to use the IPCC default land use transition period of 20 years, in the estimation process of carbon stock changes in mineral soils related to land use changes. In

particular the 20-years transition period has been applied to estimate carbon stock changes from the following land use changes:

LULUCF

- Land converted to Forest land
  Grassland to Forest land
- Land converted to Cropland
  Grassland to Cropland
- Land converted to Grassland
  Cropland to Grassland

KP-LULUCF

- Art. 3.3 - Afforestation/Reforestation

The relevant equations of IPCC GPG for LULUCF (i.e. eq. 3.2.32, eq. 3.3.3, eq. 3.4.8) have been applied; once a land has converted to a land use category, the annual changes in carbon stocks in mineral soils have been reported for 20 years subsequent the conversion. For the remaining land use change (Land converted to Settlements and Art. 3.3 - Deforestation) Italy has decided to use a land use transition period equal to 1 year, taking into account the nature of final land use category (Settlements) and assuming that soils organic matter content of previous land use category is lost in the conversion year. Soil Organic Content (SOC) reference value, for Settlements category, has been assumed to be zero.
In the following Table 7.3, the land use matrices for each year of the period 1990–2010 are reported.

Table 7.3 Land use change matrices for the years 1990-2010

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

		2005						
		Forest	**Grassland**	**Cropland**	**Wetlands**	**Settlements**	**Other Land**	*Initial sum*
	2006	8,605	9,085	10,012	57	1,488	887	*30,134*
2006	**Forest**	**8,605**				0.7		*8,605*
	Grassland	79	**9,085**	0		0		*9,085*
	Cropland		90	**10,012**		11		*10,012*
	Wetland				**57**			*57*
	Settlements					**1,488**		*1,488*
	Other Land						**887**	*887*
	Final sum	*8,683*	*9,096*	*9,911*	*57*	*1,499*	*887*	30,134

		2006						
		Forest	**Grassland**	**Cropland**	**Wetlands**	**Settlements**	**Other Land**	*Initial sum*
	2007	8,683	9,096	9,911	57	1,499	887	*30,134*
2007	**Forest**	**8,683**				0.7		*8,683*
	Grassland	79	**9,096**	0		0		*9,096*
	Cropland		90	**9,911**		11		*9,911*
	Wetland				**57**			*57*
	Settlements					**1,499**		*1,499*
	Other Land						**887**	*887*
	Final sum	*8,761*	*9,107*	*9,810*	*57*	*1,510*	*887*	30,134

		2007						
		Forest	**Grassland**	**Cropland**	**Wetlands**	**Settlements**	**Other Land**	*Initial sum*
	2008	8,761	9,107	9,810	57	1,510	887	30,134
2008	**Forest**	**8,761**				0.7		*8,761*
2008	**Grassland**	79	**9,107**	0		0		*9,107*
2008	**Cropland**		90	**9,810**		11		*9,810*
2008	**Wetland**				**57**			*57*
2008	**Settlements**					**1,510**		*1,510*
2008	**Other Land**						**887**	*887*
2008	*Final sum*	*8,839*	*9,119*	*9,710*	*57*	*1,522*	*887*	30,134

		2008						
		Forest	**Grassland**	**Cropland**	**Wetlands**	**Settlements**	**Other Land**	*Initial sum*
	2009	8,839	9,119	9,710	57	1,522	887	30,134
2009	**Forest**	**8,839**				0.7		*8,839*
2009	**Grassland**	79	**9,119**	0		0		*9,119*
2009	**Cropland**		90	**9,710**		11		*9,710*
2009	**Wetland**				**57**			*57*
2009	**Settlements**					**1,522**		*1,522*
2009	**Other Land**						**887**	*887*
2009	*Final sum*	*8,917*	*9,130*	*9,609*	*57*	*1,533*	*887*	30,134

		2009						
		Forest	**Grassland**	**Cropland**	**Wetlands**	**Settlements**	**Other Land**	*Initial sum*
	2010	8,917	9,130	9,609	57	1,533	887	30,134
2010	**Forest**	**8,917**				0.7		*8,917*
2010	**Grassland**	79	**9,130**	0		0		*9,130*
2010	**Cropland**		90	**9,609**		11		*9,609*
2010	**Wetland**				**57**			*57*
2010	**Settlements**					**1,533**		*1,533*
2010	**Other Land**						**887**	*887*
2010	*Final sum*	*8,995*	*9,142*	*9,508*	*57*	*1,544*	*887*	30,134

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, in 2010, 62.9% of total CO_2 LULUCF emissions and removals; in particular, the living biomass removals represent 84.7%, while the removals from dead organic matter and soils stand for 13.2% and 2.1% of total 2010 forest land CO_2 removals, respectively, also taking into account that, for forest land remaining forest land soils pool has been not reported, providing in the relevant paragraph information to demonstrate that the pool is not a source.
CO_2 removals from forest land remaining forest land have identified as key category (sinks) in level and in trend assessment either with Approach 1 and Approach 2. CO_2 emissions and removals from land converted to forest land have resulted key categories at Approach 2 concerning trend assessment. Concerning CH_4 or N_2O emissions, neither forest land nor land converting to forest land have resulted as a key source.

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

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 fulfil national forest definition, have been reported into cropland category (plantations) and in grassland category (shrublands).
For the land use conversion, land use change matrices have been used; as abovementioned, LUC matrices for each year of the period 1990–2010 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 (Tabacchi et al., 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 2006-2010.
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. ISTAT data on forest were, instead, administrative data underestimating the total forest extension as a consequence of the sample and definition used. Anyway ISTAT data have been used to verify the linear trend assumption of forest areas increase.

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

In the current submission, forest definition adopted by Italy in the Framework of Kyoto Protocol has been adopted; the forest definition adopted by Italy agrees with the Food and Agriculture Organization of the United Nations definitions, therefore the threshold values for tree crown cover, land area and tree height are applied:

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

7.2.4 Methodological issues

Forest Land remaining Forest Land
All the data concerning the growing stock and the related carbon are assessed by a model (Federici et al., 2008), estimating the evolution in time of the Italian forest carbon pools, according to the GPG classification and definition: living biomass, both aboveground and belowground, dead organic matter, including dead wood and litter, and soils as soil organic matter.
The model has been applied at regional scale (NUTS2) because of availability of forest-related statistical data: the First Italian National Forest Inventory (IFN) data and the Inventory of Forests and Carbon pools (INFC) were input data for the forest area, per region and inventory typologies.
The inventory typologies, classified in 4 main categories, are:

Stands*: norway spruce, silver fir, larches, mountain pines, mediterranean pines, other conifers, European beech, turkey oak, other oaks, other broadleaves*.

Coppices: *European beech, sweet chestnut, hornbeams, other oaks, turkey oak, evergreen oaks, other broadleaves, conifers*.

Plantations: *eucalyptuses coppices, other broadleaves coppices, poplar stands, other broadleaves stands, conifers stands, others*.

Protective Forests: *rupicolous forest, riparian forests, shrublands*

To estimate the growing stock of Italian forest, from 1990 to 2010, 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[10], for each forest typology by the Italian yield tables collection;
3. starting from 1986, for each year the growing stock per hectare [m^3 ha^{-1}] is computed, from the previous year growing stock volume, with the addition of the calculated increment ("y" value of the derivative Richards) for the current year and subtraction of the losses due to harvest, mortality and fire for the current year. Mortality and rate of drain and grazing are applied, as percentage, directly to the growing stock amount of the previous year.

The relationship can be summarized as follows:

$$v_i = \frac{V_{i-1} + I_i - H_i - F_i - M_i - D_i}{A_i}$$

where:

$$I_i = f(v_{i-1}) \cdot A_{i-1}$$

in which the current increment is estimated year by year applying the derivative Richards function and

v_i is the volume per hectare of growing stock for the current year

V_{i-1} is the total previous year growing stock volume

I_i is the total current increment of growing stock for the current year

H_i is the total amount of harvested growing stock for the current year

F_i is the total amount of burned growing stock for the current year

Mi is the annual rate of mortality

D is the annual rate of drain and grazing for the protective forest

A_i is the total area referred to a specific forest typology for the current year

v_{i-1} is the previous year growing stock volume per hectare

A_{i-1} is the total area referred to a specific forest typology for the previous year

f is the Richards function reported above

The average rate of mortality, the fraction of standing biomass per year, used for the calculation was 0.0116, concerning the evergreen forest, and 0.0117, for deciduous forest, according to the GPG (IPCC, 2003).

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[10] In the followed approach the Richards function is fitted through the data of growing stock [m^3] and increment [m^3 y^{-1}] obtained by the data of the national forestry inventory and yield tables collection.

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

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

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

where the general constrain for the parameters are the following:

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

The constant y_0 is derived from the data of age and volume reported in the yield tables: more precisely y_0 has the value of the volume for the age 1. After choosing the function, it is fitted to the measurements by non-linear regression. The minimization of the deviation is performed by the least squares method. The model performances were evaluated against the data by validation statistics according to Jabssen and Heuberger (1995).

The rate of draining and grazing, applied to protective forest, has been set as 3% following an expert judgement (Federici et al., 2008) because of total absence of referable data.
Total commercial harvested wood, for construction and energy purposes, has been obtained from national statistics (ISTAT, several years [a]); several sources have considered data on biomass removed in commercial harvest published by ISTAT (disaggregated at NUTS2 level, in sectoral statistics (ISTAT, several years [a]) or at NUTS1 level for coppices and high forests in national statistics (ISTAT, several years [c])) underestimated, particularly concerning fuelwood consumption (APAT - ARPA Lombardia, 2007, UNECE – FAO, Timber Committee, 2008, Corona et al., 2007). In particular a specific survey conducted in the framework of the Inventory of Forests and Carbon pools (INFC) has done a regional assessment of the harvested biomass; these data were used to infer a correction factor[11], on regional basis, that was applied to the entire time series of commercial harvested wood. The computed figures have been subtracted, as losses, from growing stock volume, as mentioned above.
Carbon amount released by forest fires has been included in the overall assessment of carbon stocks change. Not having data on the fraction of growing stock oxidised as consequence of fires, the most conservative hypothesis has been adopted: all growing stock of burned forest areas has been assumed to be completely oxidised and so released. Moreover, not having data on forest typologies of burned areas, the total value of burned forest area coming from national statistics has been subdivided and assigned to forest typologies based on their respective weight on total national forest area. Finally, the amount of burned growing stock has been calculated multiplying average growing stock per hectare of forest typology for the assigned burned area. Assessed value has been subtracted to total growing stock of respective typology, as aforesaid.
In Figure 7.3, losses of carbon due to harvest and forest fires, referred to forest land category and reported as percentage on total aboveground carbon, are shown.

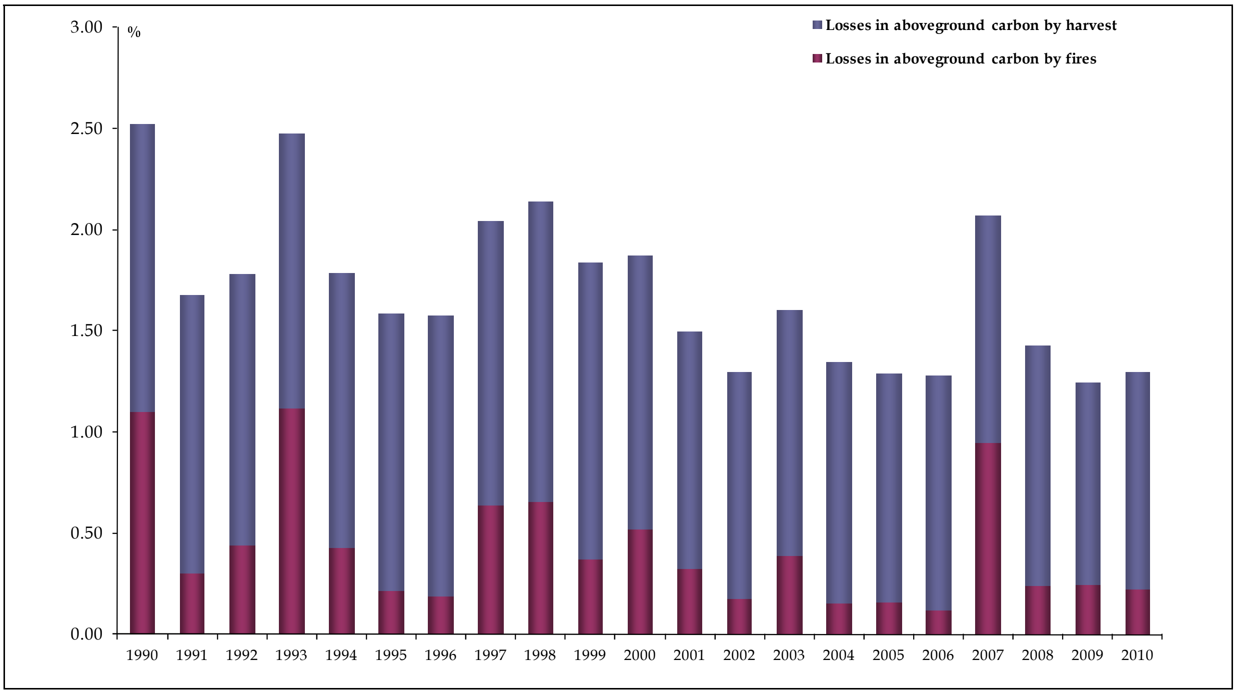

Figure 7.3 Losses by harvest and fires in relation to aboveground carbon

In the following Table 7.4, values of burned growing stocks, reported in cubic meter, and respective CO_2 released, for different categories (stands, coppices, plantations, protective forests) are shown.

[11] A correction factor for each Italian region (21) has been pointed out. The mean value is 1.57, obtained as ratio of data from official statistics and INFC survey data The variance is equal to 0.82.

Table 7.4 Burned growing stocks and CO_2 released for the years 1990-2010

Year	**burned growing stock** *m^3*				**CO_2 released** *Gg*			
	stands	*coppice*	*protective*	*total*	*stands*	*coppice*	*protective*	*total*
1990	3,618,589	5,046,365	1,355,460	10,020,414	4,507	7,319	2,049	13,875
1991	982,055	1,265,329	437,679	2,685,063	1,225	1,832	661	3,718
1992	1,367,665	2,030,880	673,779	4,072,324	1,709	2,935	1,017	5,661
1993	3,767,099	4,081,014	1,748,270	9,596,382	4,707	5,888	2,637	13,232
1994	1,446,621	1,077,384	844,906	3,368,911	1,810	1,552	1,274	4,635
1995	696,663	1,229,256	270,598	2,196,517	873	1,768	408	3,049
1996	875,227	765,714	271,883	1,912,824	1,098	1,100	410	2,608
1997	2,463,651	3,355,828	825,884	6,645,363	3,096	4,814	1,243	9,154
1998	2,823,942	2,360,107	1,197,022	6,381,071	3,552	3,381	1,801	8,734
1999	1,231,989	1,761,625	586,933	3,580,547	1,552	2,521	883	4,956
2000	2,276,964	2,128,870	899,157	5,304,990	2,870	3,044	1,352	7,266
2001	1,353,129	1,478,632	578,592	3,410,353	1,708	2,112	870	4,689
2002	628,838	1,027,555	355,343	2,011,737	795	1,466	534	2,795
2003	1,440,027	1,977,277	708,596	4,125,899	1,822	2,818	1,064	5,704
2004	620,278	840,094	373,250	1,833,622	786	1,196	560	2,542
2005	586,834	973,486	369,150	1,929,470	744	1,385	554	2,683
2006	452,836	747,667	280,483	1,480,985	575	1,062	421	2,058
2007	4,917,990	4,307,507	1,738,644	10,964,140	6,245	6,114	2,607	14,966
2008	1,352,759	1,081,588	488,496	2,922,843	1,720	1,534	732	3,986
2009	1,164,190	822,684	657,423	2,644,297	1,482	1,166	985	3,633
2010	1,303,389	1,014,817	501,366	2,819,571	1,661	1,437	751	3,849

Non CO_2 emissions from fires have been estimated and reported in CRF table 5(V); details on the methodology used to estimate emissions are reported in the paragraph 7.12.2.
Once the growing stock is estimated, the amount of aboveground tree biomass (dry matter), belowground biomass (dry matter) and dead mass (dry matter), can be assessed, from 1990 to 2010. 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 (MAF/ISAFA, 1988) [m^3 ha^{-1}]
BEF = Biomass Expansion Factors which expands growing stock volume to volume of aboveground woody biomass (ISAFA, 2004)
WBD = Wood Basic Density for conversions from fresh volume to dry weight (d.m) [t m^{-3}] (Giordano, 1980)
A = forest area occupied by specific typology [ha] (MAF/ISAFA, 1988)

The BEF were derived for each forest typology and wood basic density (WBD) values were different for the main tree species:

2. starting from 1985, for each year, current increment per hectare [m^3 ha^{-1} y^{-1}] is computed with the derivative Richards function, for every specific forest typology by the Italian yield tables collection;

3. starting from 1986, for each year growing stock per hectare [m^3 ha^{-1}] is computed, from the previous year growing stock volume, adding the calculated increment ("y" value of the derivative Richards) for the current year and subtracting losses due to harvest, mortality and fire for the current year, as described above.
   Re-applying the relation:

$$\text{Aboveground tree biomass} = GS \cdot BEF \cdot WBD \cdot A$$

   it is possible to obtain the aboveground woody tree biomass (d.m.) [t] for each forest typology, for each year, starting from the 1986.

In Table 7.5 biomass expansion factors for the conversions of volume to aboveground tree biomass and wood basic densities are reported.

Table 7.5 Biomass Expansion Factors and Wood Basic Densities

	Inventory typology	BEF *aboveground biomass / growing stock*	WBD *Dry weigth t/ fresh volume*
stands	norway spruce	1.29	0.38
	silver fir	1.34	0.38
	larches	1.22	0.56
	mountain pines	1.33	0.47
	mediterranean pines	1.53	0.53
	other conifers	1.37	0.43
	european beech	1.36	0.61
	turkey oak	1.45	0.69
	other oaks	1.42	0.67
	other broadleaves	1.47	0.53
coppices	european beech	1.36	0.61
	sweet chestnut	1.33	0.49
	hornbeams	1.28	0.66
	other oaks	1.39	0.65
	turkey oak	1.23	0.69
	evergreen oaks	1.45	0.72
	other broadleaves	1.53	0.53
	conifers	1.38	0.43
protective	rupicolous forest	1.44	0.52
	riparian forest	1.39	0.41

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

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

where:

GS = volume of growing stock [m^3 ha^{-1}]
R = Root/Shoot ratio which converts growing stock biomass in belowground biomass
BEF = Biomass Expansion Factors which expands growing stock volume to volume of aboveground woody biomass (ISAFA, 2004)

WBD = Wood Basic Density [t d.m. m^{-3}]
A = forest area occupied by specific typology [ha]
Also in this case, the Root/shoot ratios and WBDs were derived for each forest typology. In Table 7.6 root/shoot ratio and wood basic densities are reported

Table 7.6 Root/Shoot ratio and Wood Basic Densities

	Inventory typology	R *Root/shoot ratio*	WBD *Dry weigth t/ fresh volume*
stands	norway spruce	0.29	0.38
	silver fir	0.28	0.38
	Larches	0.29	0.56
	mountain pines	0.36	0.47
	mediterranean pines	0.33	0.53
	other conifers	0.29	0.43
	european beech	0.20	0.61
	turkey oak	0.24	0.69
	other oaks	0.20	0.67
	other broadleaves	0.24	0.53
coppices	european beech	0.20	0.61
	sweet chestnut	0.28	0.49
	Hornbeams	0.26	0.66
	other oaks	0.20	0.65
	turkey oak	0.24	0.69
	evergreen oaks	1.00	0.72
	other broadleaves	0.24	0.53
	Conifers	0.29	0.43
protective	rupicolous forest	0.42	0.52
	riparian forest	0.23	0.41

The net carbon stock change of living biomass has been calculated according to the GPG for LULUCF (IPCC, 2003), from the aboveground tree biomass and belowground biomass:

$$\Delta C_{\text{Living biomass}} = \Delta C_{\text{Aboveground biomass}} + \Delta C_{\text{Belowground biomass}}$$

where the total amount of carbon has been obtained from the biomass (d.m.), multiplying by the conversion factor carbon content/dry matter.

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

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

where:
GS = volume of growing stock [m^3 ha^{-1}]
BEF = Biomass Expansion Factors which expands growing stock volume to volume of aboveground woody biomass
WBD = Wood Basic Density [t d.m. m^{-3}]
DCF = Dead mass Conversion Factor which converts aboveground woody biomass in dead mass
A = forest area occupied by specific typology [ha]

The amount of carbon in litter is estimated from the aboveground carbon amount with linear relations, [$C_{Litter} = f(C_{Aboveground})$] calculated on data collected within the European project Biosoil[12] (for litter) and a Life+ project FutMon[13] (*Further Development and Implementation of an EU-level Forest Monitoring System*), for the aboveground biomass. BioSoil (2005-2007) was a Demonstration project funded under Regulation (EC) n. 2152/2003 on forest monitoring and environment interactions in the Community (Forest Focus), part of the programme of the International Cooperative Programme on the Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests[14]). It was composed of a soil module and a biodiversity module. The soil module aimed at assessing soil chemistry and carbon stocks in European forests using the sampling design of ICP level I network with a common field and analytical protocol. In Italy, the BioSoil project was coordinated by the CONECOFOR division of the National Forest Service (CFS), who contracted research institution and university departments (BioSoil, 2011) for the technical work and elaboration. In total 239 forest plots have been surveyed belonging to a national grid of 15 by 18 km. The sites were a subset of the 1985 National Forest Inventory. Soil sampling and laboratory analysis were done in 2006 and 2007. The measurements and analyses performed by the FutMon project were carried out on the same 239 forest plots monitored by Biosoil.
Litter amount was assessed on the basis of weight of the OL horizon. OL horizon is characterised by an accumulation of mainly leaves/needles, twigs and woody materials (including bark), fruits etc. There may be some fragmentation, but most of the original biomass structures are easily discernible. Leaves and/or needles may be discoloured and slightly fragmented. Organic fine substance (in which the original organs are not recognisable with naked eye) amounts to less than 10% by volume. The total litter carbon amount has been estimated from aboveground carbon amount with linear relations differentiated per forestry use: stands (resinous, broadleaves, mixed stands) and coppices. In Table 7.7 the different relations used to obtain litter carbon amount per ha [t C ha^{-1}] from the aboveground carbon amount per ha [t C ha^{-1}] have been reported.

Table 7.7 Relations litter - aboveground carbon per ha

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

[12] BioSoil project – http://biosoil.jrc.ec.europa.eu/; http://forest.jrc.ec.europa.eu/contracts/biosoil
[13] FutMon: Life+ project for the "Further Development and Implementation of an EU-level Forest Monitoring System"; http://www.futmon.org/;
http://www3.corpoforestale.it/flex/cm/pages/ServeAttachment.php/L/IT/D/D.e54313ecaf7ae893e249/P/BLOB%3AID%3D397
[14] International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests operating under the UNECE Convention on Long-range Transboundary Air Pollution – http://www.icp-forests.org/

riparian forest	y = 0.0197x + 2.4517	0.2037	1.83

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.
In response to ERT recommendation regarding soils pool, Italy has decided to apply the IPCC Tier1, assuming that, for forest land remaining forest land, the carbon stock in soil organic matter does not change, regardless of changes in forest management, types, and disturbance regimes; in other words it has to be assumed that the carbon stock in mineral soil remains constant so long as the land remains forest. Therefore carbon stock changes in soils pool, for forest land remaining forest land, have been not reported.

Land converted in Forest Land
The area of land converted to forest land is always coming from grassland. There is no occurrence for other conversion. Carbon stocks change due to grassland converting to forest land has been estimated and reported. The carbon stock change of living biomass has been calculated taking into account the increase and the decrease of carbon stock related to the areas in transition to forest land, using the same For-est model already used in *the forest land remaining forest land* sub-category: a description of the methodology used in the estimation process is provided in par. 7.2.4.
Net carbon stock change in dead organic matter and soil has been calculated as well. In response to ERT recommendation, Italy has decided to use the IPCC default land use transition period of 20 years, to estimate carbon stock changes in mineral soils related to land converted in Forest Land. The relevant equations of IPCC GPG for LULUCF (i.e. eq. 3.2.32, eq. 3.3.3, eq. 3.4.8) have been applied; once a land has converted to a land use category, the annual changes in carbon stocks in mineral soils have been reported for 20 years subsequent the conversion. SOC reference value for grassland has been revised and set to 78.9 t C ha^{-1}, after a review of the latest papers reporting data on soil carbon in mountain meadows, pastures, set-aside lands as well as soil not disturbed since the agricultural abandonment, in Italy (Viaroli and Gardi 2004, CRPA 2009, IPLA 2007, ERSAF 2008, Del Gardo *et al* 2003, LaMantia *et al* 2007, Benedetti *et al* 2004, Masciandaro and Ceccanti 1999, Xiloyannis 2007). Concerning forest soils pool, in current submission, following the 2011 review finding, Italy has decided to apply the IPCC Tier1 for carbon stock changes; therefore a detailed description of the methodology used in the estimation process of abovementioned pool is provided in par. 10.3.1.2, related to the KP-LULUCF.
The total amount of carbon for dead organic matter has been obtained from the dead organic matter (d.m.), multiplying by the conversion factor carbon content/dry matter.
In Table 7.8 carbon stock changes due to conversion to forest land, for the living biomass, dead organic matter and soil pools, have been reported.

Table 7.8 Carbon stock changes in land converting to forest land

	Conversion Area		**Carbon stock change in living biomass**			**Net C stock change in dead organic matter**	**Net C stock change in mineral soils**
	annual change	*20 years change*	***Increase***	***Decrease***	***Net change***		
year	*kha*		*Gg C*				
1990	77.65	635	197.6	-156.5	41.1	7.1	69.8
1991	77.74	682	198.3	-123.0	75.3	12.0	75.7
1992	77.74	728	198.8	-127.8	71.0	11.4	81.5
1993	77.74	775	199.1	-157.9	41.1	7.7	87.4
1994	77.74	821	199.4	-129.5	69.9	11.6	93.2
1995	77.74	867	199.7	-121.5	78.2	12.3	100.5
1996	77.74	933	200.0	-123.6	76.4	12.0	109.7
1997	77.74	998	200.2	-144.4	55.8	9.0	118.9
1998	77.74	1,063	200.1	-148.6	51.5	8.6	128.1

	Conversion Area		Carbon stock change in living biomass			Net C stock change in dead organic matter	Net C stock change in mineral soils
	annual change	*20 years change*	***Increase***	***Decrease***	***Net change***		
year	*kha*		*Gg C*				
1999	77.74	1,128	200.2	-135.6	64.6	10.6	137.2
2000	77.74	1,193	200.4	-139.5	60.9	10.0	148.0
2001	77.74	1,266	200.7	-125.3	75.4	11.9	159.6
2002	77.74	1,338	200.8	-116.7	84.1	13.1	171.1
2003	77.74	1,410	201.0	-133.0	68.0	10.9	182.6
2004	77.74	1,482	201.1	-122.6	78.5	12.3	194.1
2005	77.74	1,554	201.2	-121.0	80.3	12.4	207.3
2006	78.63	1,555	201.3	-120.9	80.4	12.5	212.3
2007	78.63	1,556	203.8	-161.4	42.4	7.5	217.4
2008	78.63	1,557	203.7	-130.9	72.9	11.2	222.4
2009	78.63	1,558	204.7	-125.2	79.5	12.5	227.4
2010	78.63	1,559	205.4	-126.8	78.6	12.2	233.6

CO_2 emissions due to wildfires in forest land remaining forest land are included in CRF Table 5.A.1, carbon stocks change in living biomass - decrease.
Values of burned growing stocks and respective CO_2 released, for different categories (stands, coppices, protective forests), are reported in the previous Table 7.4.

7.2.5 Uncertainty and time series consistency

Estimates of removals by forest land are based on application of the above-described model. To assess the overall uncertainty related to the years 1990–2010, Approach 1 of 2006 IPCC Guidelines (IPCC, 2006) has been followed. In Table 7.9, the values of carbon stocks in the five pools, for the 1985, and the abovementioned uncertainties are reported.

Table 7.9 Carbon stocks and uncertainties for year 1985 and current increment related uncertainty

Carbon stocks $t\ CO_2\ eq.\ ha^{-1}$	*Aboveground biomass*	V_{AG}	137.8
	Belowground biomass	V_{BG}	31.5
	Dead mass	V_D	20.8
	Litter	V_L	11.9
	Soil	V_S	293.1
Uncertainty	*Growing stock*	E_{NFI}	3.2%
	Current increment (Richards)[15]	E_{NFI}	51.6%
	Harvest[16]	E_H	30%
	Fire[17]	E_F	30%
	Drain and grazing	E_D	30%
	Mortality	E_M	30%
	BEF	E_{BEF1}	30%
	R	E_R	30%
	DCF	E_{DEF}	30%
	Litter (stock + regression)	E_L	102%
	Soil (stock + regression)	E_S	113%
	Basic Density	E_{BD}	30%
	C Conversion Factor	E_{CF}	2%

The uncertainties related to the carbon pools and the overall uncertainty for 1985 has been computed and shown in Table 7.10.

Table 7.10 Uncertainties for the year 1985

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

The overall uncertainty related to 1985 (the year of the first National Forest Inventory) has been propagated through the years, till 2010, following Approach 1.
The uncertainties related to the carbon pools and the overall uncertainty for 2010 are shown in Table 7.11.

[15] 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
[16] Good Practice Guidance default value (IPCC, 2003)
[17] Good Practice Guidance default value (IPCC, 2003)

Table 7.11 Uncertainties for the year 2010

Aboveground biomass	E_{AG}	78.02%
Belowground biomass	E_{BG}	78.02%
Dead mass	E_D	83.59%
Litter	E_L	101.62%
Soil	E_S	113.00%
Overall uncertainty	$\mathbf{E_{2010}}$	**68.08%**

Following Approach 1 and the abovementioned methodology, the overall uncertainty in the estimates produced by the described model has been quantified; in Table 7.12 the uncertainties of the 1985-2010 period are reported.

Table 7.12 Overall uncertainties 1985 - 2010

1985	1990	1995	2000	2005	2006	2007	2008	2009	2010
68.1%	70.4%	70.0%	69.5%	68.7%	68.5%	68.5%	68.4%	68.2%	68.1%

The overall uncertainty in the model estimates between 1990 and 2010 has been assessed with the following relation:

$$E_{1990-2010} = \frac{\sqrt{(E_{1990} \cdot V_{1990})^2 + (E_{2010} \cdot V_{2010})^2}}{|V_{1990} + V_{2010}|}$$

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 1990–2010 is equal to 49.98%.
A Montecarlo analysis has been carried out to assess uncertainty for Forest Land category (considering both Forest Land remaining Forest Land and Land converted to Forest Land), considering the different reporting pools (*aboveground, belowground, litter, deadwood and soils*), and the subcategories stands, coppices and rupicolous and riparian forests for the reporting year 2009, resulting equal to 49%. As for Land converted to Forest Land, an asymetricall probability density distribution resulted from the analysis, showing uncertainties values equal to -147.6% and 192.3%. Normal distributions have been assumed for most of the parameters. A more detailed description of the results is reported in Annex 1.
The table reporting the uncertainties referring to all the categories (Forest Land, Cropland, Grassland, Wetlands, Settlements, Other Land) is shown in Annex 1.
A comparison between carbon in the aboveground biomass pool, estimated with the described methodology, and INFC data about 2006 aboveground carbon stock of the whole Italian forest results in 11% difference (Table 7.13).

Table 7.13 Comparison between estimated and INFC 2006 aboveground carbon stock

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

A comparison of the model results versus data measured in the framework of Italian National Forest Inventory (INFC) may be carried out on the basis of the outcomes of the soil survey of INFC. In the following Table 7.14 estimated carbon stocks for Soil Organic Matter (SOM) and litter, for 2008, are provided.

Table 7.14 Comparison between estimated and INFC 2008 carbon stocks for SOM and litter

2008	INFC	For-est model	*differences*	
	t C= Mg	*t C= Mg*	*t C= Mg*	*%*
SOM	703,524,894	730,243,364	26,718,469	**-3.80**
litter	28,170,660	30,016,553	1,845,893	**-6.55**

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[18], ISTAT data[19]) has been made. Data entries have been checked several times during the compilation of the inventory; particular attention has been focussed on the categories showing significant changes between two years in succession. Land use matrices have been accurately checked and cross-checked to ensure that data were properly reported. An independent verification of reported data was done in the framework of the National Forestry Inventory, resulting in comparison of the model results versus data measured, relating to the year 2005 (Tabacchi et al., 2010). In Figure 7.4 outcome of the comparison is shown.

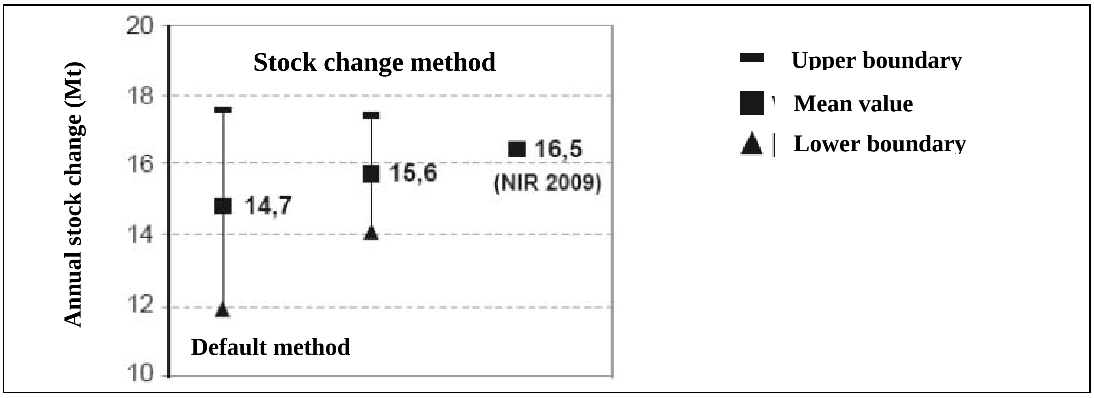

Figure 7.4 Comparison between carbon stock changes, for living biomass pool, by the National Inventory (NIR, 2009) and estimated data on the basis of INFC measurements (modified from Tabacchi et al., 2010)

The INFC classification system, and consequent categories list, has changed respect to the system (and inventory categories) used in the first forest inventory. A transition matrix, between the INFC and first forest inventory classification systems, has been planned, and included in the national registry for forest carbon sinks activities, to be elaborated in order to use all information acquired with INFC. In the meanwhile a comparison among INFC current increment data and For-est model current increment data is possible only for a not exhaustive number of inventory typologies. In the following Figure 7.5 the comparison has been reported.

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

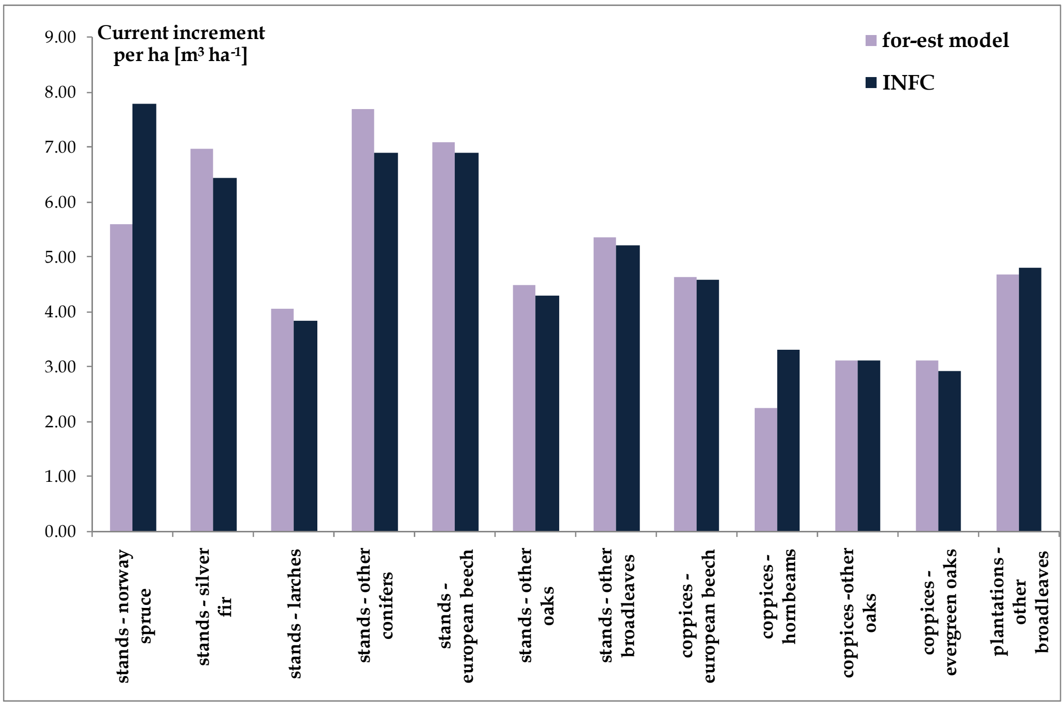

Figure 7.5 Comparison among INFC current increment data and For-est model current increment data

Regarding both soil and litter, a validation of the applied methodology has been done in Piemonte region, comparing results of a regional soil inventory with data obtained with the abovementioned methodology (Petrella and Piazzi, 2006). Results show a good agreement between the two dataset either in litter and soil. An interregional project, named INEMAR[20], developed to carry out atmospheric emission inventories at local scale, has added a module to estimate forest land emission and removals, following the abovementioned methodology. The module has been applied, at local scale with local data, in Lombardia region, for the different pools and for the year 1990, 2000, 2005, 2008. In Figure 7.6 carbon stocks, in the different pools, estimated by the National Inventory (ISPRA) and the correspondent values obtained in the INEMAR framework for the Lombardia region, have showed (ARPA Lombardia - Regione Lombardia, 2011 [a, b]).

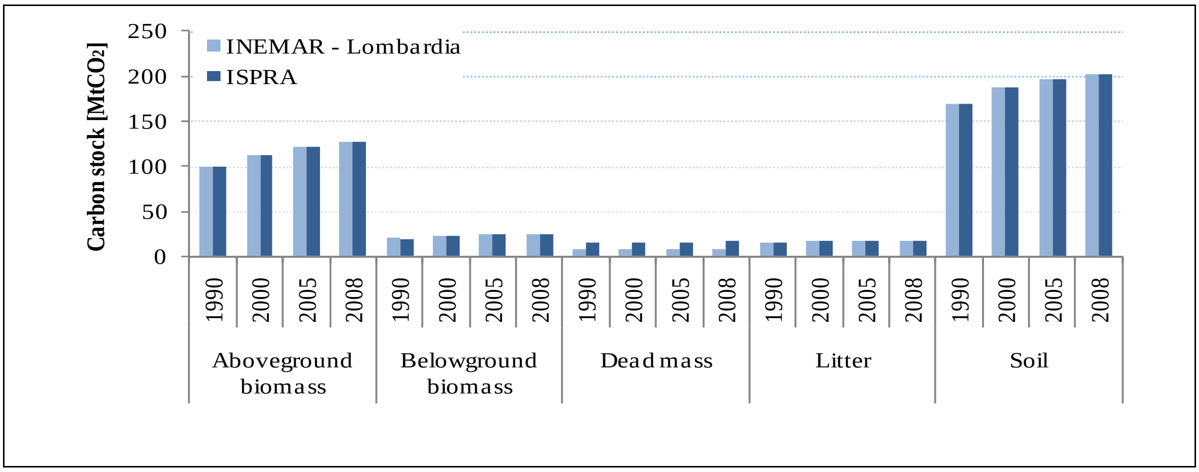

Figure 7.6 Carbon stocks estimates by the National Inventory (ISPRA) and the INEMAR project for Lombardia

In Table 7.15 carbon stocks, in the different pools, estimated by the National Inventory (ISPRA) and the correspondent values obtained in the INEMAR framework for the Lombardia region, have showed.

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

Table 7.15 Carbon stocks estimates by the National Inventory (ISPRA) and the INEMAR project for Lombardia

	INEMAR - Lombardia	ISPRA	Differences
	Gg CO_2	*Gg CO_2*	*%*
1990	311,370	319,203	-2.45
2000	345,886	353,326	-2.11
2005	367,537	375,275	-2.06
2008	379,742	387,673	-2.05

The same module, applied in Lombardia region, will be applied, at local scale with local data, in seven of the 20 Italian regions and the results will constitute a good validation of the used methodology.
Further identification of critical issues and uncertainties in the estimations derived from the participation at workshops and pilot projects (MATT, 2002). Specifically, the European pilot project to harmonise the estimation and reporting of EU Member States, in 2003, led to a comparison among national approaches and problems related to the estimation methodology and basic data needed (JRC, 2004). The estimate methodology has been presented and discussed during several national workshops; findings and comments collected have been used in the refining estimation process.

7.2.7 Category-specific recalculations

Recalculations of emissions and removals have been carried out on the basis of the IPCC Good Practice Guidance for LULUCF (IPCC, 2003).
Deviations from the previous sectoral estimates are equal to an average decrease of 82.7%, concerning the whole forest land category; as well regards the different carbon pools, a slight decrease of 0.08% in living biomass pool and of 0.04% in dead organic matter pool. A remarkable decrease in soils carbon pool estimates, have to be noticed. Concerning soils pool, Italy has decided to apply two main findings of 2011 review process: in the subcatecategory forest land remaining forest land, soils carbon stock has been assumed to remain constant, and therefore soils carbon pool has been not reported, while in the subcatecategory land converting to forest land the IPCC default land use transition period of 20 years has been used in the estimation process, resulting in major deviation respect previous sectoral estimates.

7.2.8 Category-specific planned improvements

The INFC data related to the soils survey will definitely constitute a robust database, allowing for refined estimates and lower related uncertainty. The 'National Registry for Carbon sinks', instituted by a Ministerial Decree on 1st April 2008, is part of National Greenhouse Gas Inventory System in Italy (ISPRA, 2011 [a]) and includes information on units of lands subject of activities under Article 3.3 and activities elected under Article 3.4 and related carbon stock changes. The National Registry for Carbon sinks is the instrument to estimate, in accordance with the COP/MOP decisions, the IPCC Good Practice Guidance on LULUCF and every relevant IPCC guidelines, the greenhouse gases emissions by sources and removals by sinks in forest land and related land-use changes and to account for the net removals in order to allow the Italian Registry to issue the relevant amount of RMUs. In 2009, a technical group, formed by experts from different institutions (ISPRA; Ministry of the Environment, Land and Sea; Ministry of Agriculture, Food and Forest Policies and University of Tuscia), set up the methodological plan of the activities necessary to implement the registry and defined the relative funding. Some of these activities (in particular IUTI, inventory of land use) has been completed, resulting in land use classification, for all national territory, for the years 1990, 2000 and 2008. A process of validation and verification of IUTI data has been put in place and is expected to supply data useful to update and improve the estimations. Activities planned in the framework of the National Registry for Forest Carbon Sinks should also provide data to improve estimate of carbon sequestration due to Afforestation/reforestation activities (with a special focus on soil organic content), and should allow to refine the estimate of forest land category. Specifically, for the LULUCF sector, following the election of 3.4 activities and on account of an in-depth analysis on the information needed to report LULUCF under the Kyoto Protocol, a Scientific Committee, *Comitato di Consultazione Scientifica del Registro dei Serbatoi di*

Carbonio Forestali, constituted by the relevant national experts has been established by the Ministry for the Environment, Land and Sea in cooperation with the Ministry of Agriculture, Food and Forest Policies.

An expert panel on forest fires has been set up, in order to obtain geographically referenced data on burned area; the overlapping of land use map and georeferenced data should assure the estimates of burned areas in the different land uses. The fraction of CO_2 emissions due to forest fires, now included in the estimate of the forest land remaining forest land, will be pointed out.
In addition to these expert panels, ISPRA participates in technical working groups, denominated *Circoli di qualità*, within the National Statistical System (Sistan). Concerning LULUCF sector, this group, coordinated by the National Institute of Statistics, is constituted by both producers and users of statistical information with the aim of improving and monitoring statistical information for forest sector. These activities should improve the quality and details of basic data, as well as enable a more organized and timely communication.
The upgrade of the used model has been postponed, in order to implement INFC data related to the soils survey and the IUTI results, to achieve the above cited improvements and to obtain more accurate estimates of the carbon stored in the dead wood, litter and soil pools, using the outcomes of research projects on carbon stocks inventories, with a special focus on the Italian territory. The upgrading of the model will also allow the use of the INFC biomass data, actually not utilized, as classification system, and consequent categories list, has changed from the first forest inventory to INFC. A transition matrix, between the INFC and first forest inventory classification systems, has been planned to be elaborated in order to use all information acquired with INFC.

7.3 Cropland (5B)

7.3.1 Description

Under this category, CO_2 emissions from living biomass, dead organic matter and soils, from cropland remaining cropland and from land converted in cropland have been reported.
Cropland removals share 19.6% of total CO_2 2010 LULUCF emissions and removals, in particular the living biomass removals represent 97.2%, while the emissions and removals from soils stand for 2.6% of total cropland CO_2 emissions and removals. The remaining 0.2% is due to dead organic matter pool.
Removals are almost entirely due to cropland remaining cropland, while only land converting to cropland category is responsible for emissions.
CO_2 emissions and removals from cropland remaining cropland have been identified as key category in level and in trend assessment either by Approach 1 and Approach 2. CO_2 emissions and removals from land converting to cropland have been identified as key category in trend assessment (Approach 2). Concerning N_2O emissions, the category land converting to cropland has not resulted as a key source.

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

Coherently with forest definition adopted by Italy in the framework of application of elected 3.4 activities, under Kyoto Protocol, plantations have been reported into cropland category, as they do not fulfil national forest definition which excludes agroforestry systems, predominantly used for agricultural practice. Plantations (*eucalyptuses coppices, other broadleaves coppices, poplar stands, other broadleaves stands,* and *conifers stands*) in Italy have to be considered an agroforestry system, characterized by short rotation coppice system. Poplar stands, representing 83% of the total plantation areas in Italy, are typically grown in a short rotation coppice system for two to five years. Once harvested, these crops are usually substituted by annual crops like maize or wheat. For the land use conversion, land use change matrices have been used; as abovementioned, LUC matrices for each year of the period 1990–2010 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 recommendation, Italy has decided to use the IPCC default land use transition period of 20 years, in the estimation process of carbon stock changes

in mineral soils related to land converting to cropland; once a land has converted to a land use category, the annual changes in carbon stocks in mineral soils have been reported for 20 years subsequent the conversion.
Furthermore land use changes have been derived, by the way of land use change matrices, smoothing the amount of changes over a 5 year period, harmonizing the whole time series, resulting in a constant amount of C stock change in the 5 year period, following a previous review remark.

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

Cropland areas have been determinated on the basis of national statistics (ISTAT, [b], [c]) related to annual crops and perennial woody crops. The subcategory "plantations" has been added; plantation areas have been derived from national forest inventories (IFN, IFNC), through a linear interpolation between the 1985 and 2005 data, extrapolating data for period 2006-2010. National statistics on cropland areas have been used, in order to derive the land in conversion from grassland to cropland, by the way of land use change matrices, following the assumption that transition into cropland category occurs only from grassland category.

7.3.4 Methodological issues

Cropland remaining Cropland
Cropland includes all annual and perennial crops; the change in biomass has been estimated only for perennial crops, since, for annual crops, the increase in biomass stocks in a single year is assumed equal to biomass losses from harvest and mortality in that same year. Activity data for cropland remaining cropland have been subdivided into annual and perennial crops. The perennial crops have been further subdivided into woody crops and plantations. Carbon stock changes due to annual conversion from one cropland subcategory to another (i.e. annual crops to perennial woody crops) have not been assessed, coherently with the IPCC GPG for LULUCF.

Perennial – woody crops
Concerning woody crops, estimates of carbon stocks changes are applied to aboveground biomass only, according to the GPG (IPCC, 2003), 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 3.222 Tg C for 2010, 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 1990-2010 under investigation; therefore, as no management changes can be documented, resulting change in carbon stock has been reported as zero.

Perennial – plantations
Regarding plantations, growing stock and the related carbon are assessed by a model (Federici et al., 2008), estimating the evolution in time of the different pools and applied at regional scale (NUTS2). A detailed description of the model is reported in the paragraph 7.2.4. Total harvested wood for construction and energy

purposes has been obtained from national statistics (ISTAT, several years [a]); these figures have been subtracted, as losses, from growing stock volume, as mentioned above.

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

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

where:
GS = volume of growing stock (MAF/ISAFA, 1988) [m^3 ha^{-1}]
BEF = Biomass Expansion Factors which expands growing stock volume to volume of aboveground woody biomass (ISAFA, 2004)
WBD = Wood Basic Density for conversions from fresh volume to dry weight (d.m) [t m^{-3}] (Giordano, 1980)
A = area occupied by specific typology [ha] (MAF/ISAFA, 1988)

In Table 7.16 the biomass expansion factors for the conversions of volume to aboveground tree biomass and wood basic densities are reported.

Table 7.16 Biomass Expansion Factors and Wood Basic Densities for plantations

	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

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

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

where:
GS = volume of growing stock [m^3 ha^{-1}]
BEF = Biomass Expansion Factors which expands growing stock volume to volume of aboveground woody biomass (ISAFA, 2004)
R = Root/Shoot ratio which converts growing stock biomass in belowground biomass
WBD = Wood Basic Density [t d.m. m^{-3}]
A = area occupied by specific typology [ha]

In Table 7.17 Root/shoot ratio for the conversion of growing stock biomass in belowground biomass and wood basic densities for plantations typologies are reported.

Table 7.17 Root/shoot ratio and Wood Basic Densities for plantations

	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

Concerning Dead Organic Matter pool, only carbon amount contained in litter pool has been estimated, through linear relation established with aboveground carbon, on the basis of the outcomes of European project Biosoil[21] (for litter) and a Life+ project FutMon[22], for the aboveground biomass. In Table 7.18 the different relations used to obtain litter carbon amount per ha [t C ha^{-1}] from the aboveground carbon amount per ha [t C ha^{-1}] have been reported.

Table 7.18 Relations litter – aboveground carbon per ha for plantations

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

Regarding soils pool, following the ERT recommendation, Italy has decided to apply the IPCC Tier1, assuming that, the carbon stock in soil organic matter, for plantation, does not change. Therefore carbon stock changes in soils pool, for cropland remaining cropland, have been not reported.
In Table 7.19, plantations areas and net changes in carbon stock, for the different required pools, are reported, for the period 1990-2010.

Table 7.19 Change in carbon stock in living biomass, dead organic matter and soil organic matter in plantations

	Area	Living biomass			Dead organic matter	Soil organic matter
		Increase	Decrease	Net Change		
	kha	*Gg C*				
1990	142	888	-305	583	14.0	0
1991	144	874	-326	547	13.4	0
1992	146	866	-353	513	12.9	0
1993	147	867	-364	503	12.5	0
1994	149	862	-396	467	12.0	0
1995	151	860	-421	439	11.6	0
1996	152	861	-359	502	12.7	0
1997	154	849	-381	469	12.1	0
1998	156	839	-413	426	11.4	0
1999	157	845	-466	379	10.6	0
2000	159	841	-408	433	11.5	0
2001	161	821	-323	499	12.7	0
2002	162	808	-326	482	12.4	0
2003	164	792	-323	469	12.2	0
2004	166	776	-324	452	12.0	0
2005	167	756	-311	445	11.8	0
2006	169	741	-349	392	11.0	0
2007	170	713	-371	342	10.0	0
2008	172	691	-313	379	10.8	0

[21] BioSoil project – http://biosoil.jrc.ec.europa.eu/; http://forest.jrc.ec.europa.eu/contracts/biosoil
[22] FutMon: Life+ project for the "Further Development and Implementation of an EU-level Forest Monitoring System"; http://www.futmon.org/; http://www3.corpoforestale.it/flex/cm/pages/ServeAttachment.php/L/IT/D/D.e54313ecaf7ae893e249/P/BLOB%3AID%3D397

2009	174	666	-268	398	11.0	0
2010	175	668	-405	263	8.8	0

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 7.20; it has to be noticed that CRF Reporter doesn't allow reporting such a contribution to overall emissions, and therefore these emissions are not included in the current submission.

Table 7.20 CO_2 emissions from urea application

	amount of urea	**EF**	**C emissions**	**CO_2 emissions**
	Mg	*t C^{-1}*	*Gg C*	*Gg C*
1990	633,873	0.20	127	465
1991	708,148	0.20	142	519
1992	731,357	0.20	146	536
1993	848,043	0.20	170	622
1994	802,345	0.20	160	588
1995	698,251	0.20	140	512
1996	598,943	0.20	120	439
1997	716,463	0.20	143	525
1998	717,711	0.20	144	526
1999	751,223	0.20	150	551
2000	716,412	0.20	143	525
2001	799,064	0.20	160	586
2002	863,113	0.20	173	633
2003	770,412	0.20	154	565
2004	785,515	0.20	157	576
2005	691,255	0.20	138	507
2006	735,487	0.20	147	539
2007	732,213	0.20	146	537
2008	679,390	0.20	136	498
2009	506,694	0.20	101	372
2010	456,951	0.20	91	335

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, following the ERT recommendation, Italy has decided to use the IPCC default land use transition period of 20 years, to estimate carbon stock changes in mineral soils related to land converted to cropland; once a land has converted to cropland, the annual changes in carbon stocks in mineral soils have been reported for 20 years subsequent the conversion.
N_2O emissions arising from the conversion of land to cropland have been also estimated, and reported in Table 5(III) - N_2O emissions from disturbance associated with land-use conversion to cropland.
The carbon stocks change, for land converted to cropland, is equal to the carbon stocks change due to the removal of biomass from the initial land use plus the carbon stocks from one year of growth in cropland 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 2010, has been estimated through the construction of the land use change matrices, one for each year. The GPG equation 3.3.8 (IPCC, 2003) has been used to estimate the change in carbon stocks resulting from the land use change. The carbon stocks change per area for land converted to cropland is assumed, following the Tier1, equal to loss in carbon stocks in biomass immediately before conversion to cropland.
For the Italian territory, only conversion from grassland to cropland has occurred; therefore the default estimates for standing biomass grassland, as dry matter, reported in Table 3.4.2 of GPG (IPCC, 2003) for warm temperate – dry have been used, equal to 1.6 t d.m. ha^{-1}. Changes in carbon stocks from one year of cropland growth have been obtained by the default biomass carbon stocks reported in Table 3.3.8, for temperate region. In accordance to national expert judgement, it has been assumed that the final crop type, for the areas of transition land, is annual cropland; this assumption has been made on the basis of known patterns of land-use changes in Italy, also considering that most common woody crops are, in Italy, olive groves, orchards or vineyards and that biomass clearing is unusual.
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- 2010. C emissions [Gg C] due to change in carbon stocks in living biomass in land converted to cropland are reported in Table 7.21.

Table 7.21 Change in carbon stock in living biomass in land converted to cropland

	Conversion Area		**$\Delta C_{converted\ land}$**
	annual change	*20 years change*	
year	*kha*	*kha*	*Gg C*
1990	14.0	207	18.14
1991	0.48	208	0.63
1992	0.48	208	0.63
1993	0.48	208	0.63
1994	0.48	209	0.63
1995	0.48	209	0.63
1996	0	182	0
1997	0	155	0
1998	0	127	0
1999	0	100	0
2000	0	72	0
2001	0	72	0
2002	0	72	0
2003	0	72	0
2004	0	72	0
2005	0	72	0
2006	0	58	0
2007	0	44	0
2008	0	30	0
2009	0	16	0
2010	0	2	0

Changes in carbon stocks in mineral soils in land converted to cropland have been estimated following land use changes, resulting in a change of the total soil carbon content, with a land use transition period of 20 years. Initial land use soil carbon stock [$SOC_{(0-T)}$] and soil carbon stock in the inventory year [SOC_0] for the cropland area have been estimated from the reference carbon stocks.
SOC reference value for cropland has been set to 56.7 tC/ha on the basis of reviewed references. This value has been drawn up by analysing a collection of the latest papers reporting data on soil carbon under the most

common agricultural practices in Italy, including woody cropland cultivations such as vineyards and olive orchards (Triberti *et al* 2008, Ceccanti *et al* 2008, Monaco *et al* 2008, Martiniello 2007, Lugato and Berti 2008, Francaviglia et al., 2006, IPLA 2007, ERSAF 2008, Del Gardo *et al* 2003, Puglisi *et al*, 2008, Lagomarsino *et al* 2009, Perucci *et al* 2008).
Whenever the soil carbon stock was not reported in the papers, it has been calculated at the default depth of 30 cm from the soil carbon content, the bulk density, and the stoniness according to the following formula (Batjes 1996):

$$T_d = \sum_{i=1}^{K} \rho_i \cdot P_i \cdot D_i \cdot (1 - S_i)$$

where
T_d is the overall soil carbon stock (gcm^{-2}) and, for each K layer of the soil profile, ρ_i is the soil bulk density (gcm^{-3}), P_i is the soil carbon content (gCg^{-1}), D_i is the layer thickness (cm), S_i is the fraction of gravel > 2mm.

If not available in the papers, soil bulk density has been calculated on the basis of the soil organic matter and texture (Adam 1973):

$$\rho = \frac{100}{\left(\frac{X}{\rho_0}\right) + \left(\frac{100 - X}{\rho_m}\right)}$$

where
ρ, soil bulk density (gcm^{-3}); *X*, percent by weight of organic matter; ρ_0, average bulk density of organic matter (0.224 gcm^{-3}) and ρ_m, bulk density of the mineral matter usually estimated at 1.33 gcm^{-3} or determined on the “mineral bulk density chart” (Rawls and Brakensiek, 1985).

Since soil carbon stocks are derived from experimental measurements under some representative cropland management systems, the effect of the practices is intended to be included into the values and consequently no stock change factors (F_{LU}, F_{MG}, F_I) have been applied on the soil carbon stock. Each soil carbon stock was assigned to the geographical area where the relative soil carbon content has been measured and the overall values have been averaged by means of weights resulting from the proportional relevance of the investigated area (ha) over the entire Italian territory.
The annual change in carbon stocks in mineral soils has been, at last, assessed as described in the equation 3.3.3 of the GPG (IPCC, 2003). C emissions [Gg C] due to change in carbon stocks in soils in land converted to cropland are reported in Table 7.22.

Table 7.22 Change in carbon stock in soil in land converted to cropland

	Conversion Area		Carbon stock
	annual change	*20 years change*	
year	*kha*	*kha*	*Gg C*
1990	14.0	207	-221.47
1991	0.48	208	-221.98
1992	0.48	208	-222.50
1993	0.48	208	-223.01
1994	0.48	209	-223.53
1995	0.48	209	-224.04
1996	0	182	-194.67
1997	0	155	-165.31
1998	0	127	-135.94
1999	0	100	-106.57
2000	0	72	-77.20
2001	0	72	-77.20
2002	0	72	-77.20
2003	0	72	-77.20
2004	0	72	-77.20
2005	0	72	-77.20
2006	0	58	-62.28
2007	0	44	-47.35
2008	0	30	-32.43
2009	0	16	-17.50
2010	0	2	-2.57

7.3.5 Uncertainty and time series consistency

Uncertainty estimates for the period 1990–2010 have been assessed following Approach 1 of 2006 IPCC Guidelines (IPCC, 2006). The table reporting the uncertainties referring to the category cropland is shown in Annex 1. Input uncertainties deal with activity data and emission factors have been assessed on the basis of the information provided in the IPCC Good Practice Guidance for LULUCF (IPCC, 2003).
A Montecarlo analysis has been carried out to assess uncertainty for Cropland category (considering both Cropland remaining Cropland and Land converted to Cropland). For Cropland remaining Cropland, an asymetricall probability density distribution resulted from the analysis, showing uncertainties values equal to -108.5% and 210.2%, taking into account all the carbon pools estimated. As for Land converted to Cropland, an asymetricall probability density distribution resulted from the analysis, showing uncertainties values equal to -408.2% and 178.5%. Normal distributions have been assumed for most of the parameters. A more detailed description of the results is reported in Annex 1.

7.3.6 Category-specific QA/QC and verification

Systematic quality control activities have been carried out in order to ensure completeness and consistency in time series and correctness in the sum of sub-categories; where possible, activity data comparison among different sources (FAO database[23], ISTAT data[24]) has been made. Data entries have been checked several times during the compilation of the inventory; particular attention has been focussed on the categories

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

showing significant changes between two years in succession. Land use matrices have been accurately checked and cross-checked to ensure that data were properly reported. Several QA activities are carried out in the different phases of the inventory process. In particular the applied methodologies have been presented and discussed during several national workshop and expert meeting, collecting findings and comments to be incorporated in the estimation process. All the LULUCF categories have been embedded in the overall QA/QC-system of the Italian GHG inventory.

7.3.7 Category-specific recalculations

Recalculations of emissions and removals have been carried out on the basis of LULUCF Good Practice Guidance (IPCC, 2003). The comparison with the previous sectoral estimates results in mean decrease of 9.49% in cropland category, in the period 1990-2009. In particular cropland remaining cropland subcategory decreases by 5.74%, while an increase of 22.4% is noted for land converting to cropland, in comparison with the previous submission. Notable deviations from the previous sectoral estimates occurred in soils pool (increase of 159.98%), due to adoption of the default inventory time period (20 years) to estimate soil carbon stock changes for land converting to cropland.

7.3.8 Category-specific planned improvements

Additional researches will be made to collect more country-specific data on woody crops. Improvements will concern the implementation of the estimate of carbon change in cropland biomass at a higher disaggregated level, with the subdivision of the activity data in the main categories of woody cropland (orchards, citrus trees, vineyards, olive groves) and the application of different biomass accumulation rates and harvest/maturity cycles for the various categories.
Further investigation will be made to obtain ancillary information about the final crop types, concerning the areas in transition to cropland, in order to obtain a more precise estimate of the carbon stocks change. Activities planned in the framework of the National Registry for Forest Carbon Sinks should also provide data to improve estimate of carbon sequestration due to Afforestation/reforestation activities (with a special focus on soil organic content), and should allow to refine the estimate of soil organic content in cropland category.

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 7,658 Gg of CO_2 removals in 2010, with 1,300 Gg of CO_2 removals due to living biomass pool, 32 Gg CO_2 removals due to dead organic matter pool and 5,965 Gg of CO_2 removals due the soils pool. In 2010, grassland emissions share 12.1% of absolute CO_2 LULUCF emissions and removals, in particular the living biomass emissions represent 17.0%, while the removals from dead organic matter pool share for 5.1% and removals from soils stand for 77.9% of absolute total grassland CO_2 emissions and removals.
CO_2 emissions and removals from grassland remaining grassland have resulted as key category, concerning trend analysis, either by Approach 1 and Approach 2, and concerning level analysis only by Approach 2. CO_2 emissions and removals from land converting to grassland have been identified as key category in level and in trend assessment, either by Approach 1 and Approach 2. Concerning N_2O emissions, the category land converting to cropland has not resulted as a key source.

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

Coherently with forest definition adopted by Italy in the framework of application of elected 3.4 activities, under Kyoto Protocol, shrublands have been reported into grassland category, as they don't fulfil national forest definition. For the land use conversion, land use change matrices have been used; as abovementioned, LUC matrices for each year of the period 1990–2010 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 recommendation, Italy has decided to use the IPCC default land use transition period of 20 years, in the estimation process of carbon stock changes in mineral soils related to land converting to grassland; once a land has converted to a land use category, the annual changes in carbon stocks in mineral soils have been reported for 20 years subsequent the conversion.
Furthermore land use changes have been derived, by the way of land use change matrices, smoothing the amount of changes over a 5 year period, harmonizing the whole time series, resulting in a constant amount of C stock change in the 5 year period, following a previous review remark.

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

Grassland areas have been determinate on the basis of national statistics (ISTAT, [b], [c]) related to grazing lands, forage crops, permanent pastures, and lands once used for agriculture purposes, but in fact set-aside since 1970. The subcategory "shrublands" has been added; shrublands areas have been derived from national forest inventories (IFN, IFNC), through a linear interpolation between the 1985 and 2005 data, extrapolating data for period 2006-2010. National statistics on cropland areas have been used, in order to derive the land in conversion from cropland to grassland, by the way of LUC matrix, following the assumption that transition into cropland category occurs only from grassland category.

7.4.4 Methodological issues

Grassland remaining Grassland
Grassland includes all grazing land and other wood land that do not fulfil 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 1990-2010 under investigation; therefore, as no management changes can be documented, resulting change in carbon stock has been reported as zero.
No CO_2 emissions from organic soils or from application of carbonate containing lime have occurred.

Other wooded land
Regarding shrublands, growing stock and the related carbon are assessed by a model (Federici et al., 2008), estimating the evolution in time of the different pools and applied at regional scale (NUTS2). A detailed description of the model is reported in the paragraph 7.2.4.
The aboveground biomass was calculated, for shrublands, through the relation:

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

where:
GS = volume of growing stock (MAF/ISAFA, 1988) [m^3 ha-^{1}]
BEF = Biomass Expansion Factors which expands growing stock volume to volume of aboveground woody biomass (ISAFA, 2004)
WBD = Wood Basic Density for conversions from fresh volume to dry weight (d.m.) [t m^{-3}] (Giordano, 1980)
A = area occupied by specific typology [ha] (MAF/ISAFA, 1988)

In Table 7.23 biomass expansion factors for the conversions of volume to aboveground tree biomass and wood basic densities are reported.

Table 7.23 Biomass Expansion Factors and Wood Basic Densities for shrublands

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

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

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

where:
GS = volume of growing stock [m^3 ha^{-1}]
BEF = Biomass Expansion Factors which expands growing stock volume to volume of aboveground woody biomass (ISAFA, 2004)
R = Root/Shoot ratio which converts growing stock biomass in belowground biomass
WBD = Wood Basic Density [t d.m. m^{-3}]
A = area occupied by specific typology [ha]

In Table 7.24 Root/shoot ratio for the conversion of growing stock biomass in belowground biomass and wood basic density for shrubland are reported.

Table 7.24 Root/Shoot ratio and Wood Basic Densities for shrubland

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

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 (ISAFA, 2004)
WBD = Wood Basic Density [t d.m. m^{-3}]
DCF = Dead mass Conversion Factor which converts aboveground woody biomass in dead mass
A = area occupied by specific typology [ha]

Carbon amount contained in litter pool has been estimated, through linear relation established with aboveground carbon, on the basis of the outcomes of European project Biosoil[25] (for litter) and a Life+ project FutMon[26], for the aboveground biomass. In Table 7.25 the relation used to obtain litter carbon amount per ha [t C ha^{-1}] from the aboveground carbon amount per ha [t C ha^{-1}] has been reported.

Table 7.25 Relations litter - aboveground carbon per ha for shrubland

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

As for soils pool, following the ERT recommendation, Italy has decided to apply the IPCC Tier1, assuming that, the carbon stock in soil organic matter, for shrubland, does not change. Therefore carbon stock changes in soils pool, for grassland remaining grassland, have been not reported.
In Table 7.26, other wooded land areas and net changes in carbon stock, for the different required pools, are reported, for the period 1990-2010.

Table 7.26 Change in carbon stock in living biomass, dead organic matter and soil organic matter in other wooded land

	Area	**Living biomass**			**Dead organic matter**	**Soil organic matter**
		Increase	Decrease	Net Change		
	kha			*Gg C*		
1990	1,561	2,477	-2,584	-106.47	32.07	0
1991	1,578	2,517	-2,356	161.38	63.26	0
1992	1,595	2,560	-2,487	73.01	52.97	0
1993	1,612	2,612	-2,852	-239.95	16.52	0
1994	1,629	2,652	-2,508	144.28	61.27	0
1995	1,646	2,685	-2,300	385.10	89.31	0
1996	1,663	2,718	-2,333	385.30	89.33	0
1997	1,680	2,755	-2,518	236.87	72.05	0
1998	1,697	2,796	-2,692	104.60	56.65	0
1999	1,714	2,829	-2,461	368.44	87.37	0
2000	1,731	2,866	-2,629	237.89	72.17	0
2001	1,748	2,899	-2,514	384.68	89.26	0
2002	1,766	2,930	-2,473	456.94	97.68	0
2003	1,783	2,962	-2,570	391.75	90.09	0
2004	1,800	2,992	-2,521	470.55	99.26	0
2005	1,817	3,021	-2,522	499.25	102.60	0
2006	1,834	3,050	-2,519	530.09	106.20	0
2007	1,851	3,093	-3,084	8.96	45.98	0
2008	1,868	3,122	-2,609	513.05	104.69	0
2009	1,886	3,153	-2,682	471.08	100.03	0
2010	1,903	3,181	-2,651	530.19	107.10	0

Land converted to Grassland

[25] BioSoil project – http://biosoil.jrc.ec.europa.eu/; http://forest.jrc.ec.europa.eu/contracts/biosoil
[26] FutMon: Life+ project for the "Further Development and Implementation of an EU-level Forest Monitoring System"; http://www.futmon.org/;
http://www3.corpoforestale.it/flex/cm/pages/ServeAttachment.php/L/IT/D/D.e54313ecaf7ae893e249/P/BLOB%3AID%3D397

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, following the ERT recommendation, Italy has decided to use the IPCC default land use transition period of 20 years, to estimate carbon stock changes in mineral soils related to land converted to grassland; once a land has converted to grassland, the annual changes in carbon stocks in mineral soils have been reported for 20 years subsequent the conversion. As a result of conversion to grassland, it is assumed that the dominant vegetation is removed entirely, after which some type of grass is planted or otherwise established; alternatively grassland can result from the abandonment of the preceding land use, and the area is taken over by grassland. The Tier 1 has been followed, assuming that carbon stocks in biomass immediately after the conversion are equal to 0 t C ha^{-1}.
The annual area of land undergoing a transition from non grassland, only cropland as far as Italy is concerned, to grassland during each year has been pointed out, from 1990 to 2010, for each initial and final land use, through the use of the land use change matrices, one for each year. The GPG equation 3.4.13 (IPCC, 2003) has been used to estimate the change in carbon stocks, resulting from the land use change. Concerning Italian territory, only conversion from cropland to grassland has occurred; therefore the default biomass carbon stocks present on land converted to grassland, as dry matter, as supplied by Table 3.4.9 of the GPG for warm temperate – dry, have been used, equal to 6.1 t d.m. ha^{-1}. Since, according to national expert judgement, it has been assumed that lands in conversion to grassland are mostly annual crops, carbon stocks in biomass immediately before conversion have been obtained by the default values reported in Table 3.3.8 of the GPG, for annual cropland.
As pointed out above in the land use matrices (see Table 7.3), the conversion of lands into grassland has taken place only in a few years during the period 1990-2010. C emissions [Gg C] due to change in carbon stocks in living biomass in land converted to grassland, are reported in Table 7.27.

Table 7.27 Change in carbon stock in living biomass in land converted to grassland

	Conversion Area		**C_{before}**	**ΔC_{growth}**	**ΔC**
	annual change	*20 years change*			
year	*kha*	*kha*	*t C ha^{-1}*	*t C ha^{-1}*	*Gg C*
1990	0	192	5	3.05	0
1991	0	192	5	3.05	0
1992	0	192	5	3.05	0
1993	0	192	5	3.05	0
1994	0	192	5	3.05	0
1995	0	192	5	3.05	0
1996	103	295	5	3.05	-202
1997	103	399	5	3.05	-202
1998	103	502	5	3.05	-202
1999	103	605	5	3.05	-202
2000	103	709	5	3.05	-202
2001	111	819	5	3.05	-216
2002	111	882	5	3.05	-216
2003	111	945	5	3.05	-216
2004	111	1,008	5	3.05	-216
2005	111	1,071	5	3.05	-216
2006	90	1,161	5	3.05	-176
2007	90	1,251	5	3.05	-176
2008	90	1,341	5	3.05	-176
2009	90	1,431	5	3.05	-176

2010	90	1,521	5	3.05	-176

Changes in carbon stocks in mineral soils in land converted to grassland have been estimated following land use changes, resulting in a change of the total soil carbon content, with a land use transition period of 20 years. Initial land use soil carbon stock [$SOC_{(0-T)}$] and soil carbon stock in the inventory year [SOC_0] for the grassland have been estimated from the reference carbon stocks.

SOC reference value for grassland has been revised and set to 78.9 tC/ha on the basis of reviewed references. It makes the current estimate consistent with the SOC stocks reported for grassland in temperate regions, 60-150 tC/ha (Gardi et al., 2007). This value has been drawn up by analysing a collection of the latest papers reporting data on soil carbon in mountain meadows, pastures, set-aside lands as well as soil not disturbed since the agricultural abandonment in Italy (Viaroli and Gardi 2004, CRPA 2009, IPLA 2007, ERSAF 2008, Del Gardo *et al* 2003, LaMantia *et al* 2007, Benedetti *et al* 2004, Masciandaro and Ceccanti 1999, Xiloyannis 2007).

Whenever the soil carbon stock was not reported in the papers, it has been calculated at the default depth of 30 cm from the soil carbon content, the bulk density, and the stoniness according to the following formula (Batjes 1996):

$$T_d = \sum_{i=1}^{K} \rho_i \cdot P_i \cdot D_i \cdot (1 - S_i)$$

where T_d is the overall soil carbon stock (gcm^{-2}) and, for each K layer of the soil profile, ρ_i is the soil bulk density (gcm^{-3}), P_i is the soil carbon content (gCg^{-1}), D_i is the layer thickness (cm), S_i is the fraction of gravel > 2mm. If not available in the papers, soil bulk density has been calculated on the basis of the soil organic matter and texture (Adam 1973):

$$\rho = \frac{100}{\left(\frac{X}{\rho_0}\right) + \left(\frac{100 - X}{\rho_m}\right)}$$

where ρ, soil bulk density (gcm^{-3}); *X*, percent by weight of organic matter; ρ_0, average bulk density of organic matter (0.224 gcm^{-3}) and ρ_m, bulk density of the mineral matter usually estimated at 1.33 gcm^{-3} or determined on the "mineral bulk density chart" (Rawls and Brakensiek, 1985).

Since soil carbon stocks are derived from experimental measurements under some representative cropland 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. C emissions [Gg C] due to change in carbon stocks in soils in land converted to grassland, are reported in Table 7.28.

Table 7.28 Change in carbon stock in soils

	Conversion Area		Carbon stock
year	*annual change*	*20 years change*	
	kha	*kha*	*Gg C*
1990	0	192	205
1991	0	192	205
1992	0	192	205
1993	0	192	205
1994	0	192	205
1995	0	192	205
1996	103	295	316
1997	103	399	426
1998	103	502	537
1999	103	605	648
2000	103	709	758
2001	111	819	877
2002	111	882	944
2003	111	945	1,011
2004	111	1,008	1,078
2005	111	1,071	1,145
2006	90	1,161	1,241
2007	90	1,251	1,338
2008	90	1,341	1,434
2009	90	1,431	1,530
2010	90	1,521	1,627

7.4.5 Uncertainty and time series consistency

Uncertainty estimates for the period 1990–2010 have been assessed following Approach 1 of 2006 IPCC Guidelines (IPCC, 2006). The table reporting the uncertainties referring to the category grassland is shown in Annex 1. Input uncertainties deal with activity data and emission factors have been assessed on the basis of the information provided in the IPCC Good Practice Guidance for LULUCF (IPCC, 2003).
A Montecarlo analysis has been carried out to assess uncertainty for Grassland category (considering both Grassland remaining Grassland and Land converted to Grassland). For Grassland remaining Grassland, an asymetricall probability density distribution resulted from the analysis, showing uncertainties values equal to -67.7% and 75.0%. An asymetrical probability density distribution resulted from the analysis also for the subcategory Land converted to Grassland, showing uncertainties values equal to -119.3% and 194.5%. Normal distributions have been assumed for most of the parameters; whenever assumptions or constraints on variables were known this information has been appropriately reflected on the choice of type and shape of distributions. A more detailed description of the results is reported in Annex 1.

7.4.6 Category-specific QA/QC and verification

Systematic quality control activities have been carried out in order to ensure completeness and consistency in time series and correctness in the sum of sub-categories; where possible, activity data comparison among different sources (FAO database[27], ISTAT data[28]) has been made. Data entries have been checked several

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

times during the compilation of the inventory; particular attention has been focussed on the categories showing significant changes between two years in succession. Land use matrices have been accurately checked and cross-checked to ensure that data were properly reported. Several QA activities are carried out in the different phases of the inventory process. In particular the applied methodologies have been presented and discussed during several national workshop and expert meeting, collecting findings and comments to be incorporated in the estimation process. All the LULUCF categories have been embedded in the overall QA/QC-system of the Italian GHG inventory.

7.4.7 Category-specific recalculations

Recalculations of emissions and removals have been carried out on the basis of LULUCF Good Practice Guidance (IPCC, 2003). The comparison with the previous sectoral estimates results in mean decrease of 37.61% in grassland category, in the period 1990-2009. In particular grassland remaining grassland subcategory decreases by 312.29%, while a decrease of 262.40% has to be noted for land converting to grassland, in comparison with the previous submission. Notable deviations from the previous sectoral estimates occurred in soils pool (decrease of 415.66%), due to adoption of the default inventory time period (20 years) to estimate soil carbon stock changes for land converting to grassland.

7.4.8 Category-specific planned improvements

Concerning land in transition to grassland, further investigation will be made to obtain additional information about different types of management activities on grassland, and the crop types of land converting to grassland, to obtain a more accurate estimate of the carbon stocks change.
Activities planned in the framework of the National Registry for Forest Carbon Sinks should also provide data to improve estimate of carbon sequestration due to Afforestation/reforestation activities (with a special focus on soil organic content), and should allow to refine the estimate of soil organic content in grassland category.

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 1990–2010 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 1990-2010, 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[29] have been included in this category (MAMB, 1992). No data were available on flooded lands, therefore reservoirs or water bodies regulated by human activities have not been considered.

7.5.4 Methodological issues

No estimates related to emissions of CO_2, CH_4 and N_2O from flooded lands have been supplied, as very few information on this source is available. Concerning land converted to wetland, no land in transition to wetlands has occurred in 1990-2010.

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 2010, settlements emissions share 5.4% of absolute CO_2 LULUCF emissions and removals.
CO_2 emissions and removals from land converting to settlements have resulted as key category, concerning level analysis, either by Approach 1 and Approach 2, and concerning trend analysis only by Approach 2.

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

For the land use conversion, land use change matrices have been used; as abovementioned, LUC matrices for each year of the period 1990–2010 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[30] 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 2007-2010. The average area of land undergoing a transition from non-settlements to settlements during each year, from 1990 to 2010, has been estimated with the land use change matrices that have also permitted to specify the initial and final land use.
In response to ERT remark in the 2009 review, land use changes have been derived, by the way of LUC matrices, smoothing the amount of changes over a 5 year period, harmonizing the whole time series, resulting in a constant amount of C stock change in the 5 year period.

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

All artificial surfaces, transportation infrastructures (urban and rural), power lines and human settlements of any size, comprising also parks, have been included in this category.

[29] Ramsar Convention on Wetlands: http://www.ramsar.org/ (Ramsar, 2005)
[30] 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, conversions from forest land, grassland and cropland to settlements have occurred in the 1990-2010 period. Carbon stock changes related to forest land converted to settlements have been estimated, for each year and for each pool (living biomass, dead organic matter and soils), on the basis of forest land carbon stocks deduced from the model described in paragraph 7.2.4 and 10.3.1.2, concerning soils pool. SOC reference value, for settlements category, has been assumed, using a conservative approach, to be zero.

In Table 7.29 C stocks [Gg C] related to change in carbon stocks in living biomass, dead organic matter and soils in forest land converted to settlements are reported.

Table 7.29 Change in carbon stocks in forest land converted to settlements

	Forest land to settlements				
Year	*Conversion Area*	*Living biomass*	*Dead organic matter*	*Soils*	***Total Carbon stock***
	kha	*Gg C*	*Gg C*	*Gg C*	*Gg C*
1990	0.72	-34.03	-6.49	-58.07	-98.59
1991	0.72	-34.34	-6.52	-58.07	-98.93
1992	0.72	-34.59	-6.55	-58.07	-99.22
1993	0.72	-34.60	-6.55	-58.07	-99.22
1994	0.72	-34.86	-6.58	-58.07	-99.51
1995	0.72	-35.19	-6.62	-58.34	-100.16
1996	0.72	-35.52	-6.66	-58.34	-100.52
1997	0.72	-35.67	-6.67	-58.34	-100.68
1998	0.72	-35.77	-6.68	-58.34	-100.79
1999	0.72	-35.99	-6.71	-58.34	-101.04
2000	0.72	-36.18	-6.73	-58.64	-101.56
2001	0.72	-36.50	-6.77	-58.64	-101.91
2002	0.72	-36.89	-6.82	-58.64	-102.35
2003	0.72	-37.15	-6.85	-58.64	-102.63
2004	0.72	-37.49	-6.89	-58.64	-103.02
2005	0.72	-37.84	-6.93	-58.98	-103.75
2006	0.72	-38.20	-6.98	-58.98	-104.15
2007	0.72	-38.21	-6.98	-58.98	-104.16
2008	0.72	-38.49	-7.01	-58.98	-104.48
2009	0.72	-38.82	-7.05	-58.98	-104.84
2010	0.72	-39.13	-7.09	-59.19	-105.41

Concerning grassland converted to settlements, change in carbon stocks has been computed only for soil pool, as, in Tier 1 approach, no change in carbon stocks in the grassland living biomass pool has been assumed. For what concerns cropland in transition to settlements, carbon stocks, for each year and for crops type (annual or perennial), have been estimated, using as default coefficients the factors shown in the following Table 7.30.

Table 7.30 Stock change factors for cropland

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

In Table 7.31 C stocks [Gg C] related to change in carbon stocks in living biomass in cropland (annual and perennial) converted to settlements are reported.

Table 7.31 Change in carbon stocks in living biomass in cropland converted to settlements

	annual crops to settlements		**perennial crops to settlements**		***Total Carbon stock***
Year	*Conversion Area* *kha*	*Carbon stock* *Gg C*	*Conversion Area* *kha*	*Carbon stock* *Gg C*	*Gg C*
1990	0	0	0	0	0
1991	0	0	0	0	0
1992	0	0	0	0	0
1993	0	0	0	0	0
1994	0	0	0	0	0
1995	0	0	0	0	0
1996	5.66	-28.30	1.88	-118.23	-146.53
1997	5.66	-28.28	1.88	-118.48	-146.76
1998	5.65	-28.26	1.88	-118.74	-147.00
1999	5.65	-28.24	1.89	-119.00	-147.24
2000	5.64	-28.22	1.89	-119.27	-147.49
2001	7.88	-39.41	2.68	-168.71	-208.11
2002	7.85	-39.27	2.70	-170.37	-209.64
2003	7.83	-39.14	2.73	-172.07	-211.20
2004	7.80	-39.00	2.76	-173.81	-212.81
2005	7.77	-38.86	2.79	-175.59	-214.45
2006	7.74	-38.70	2.82	-177.65	-216.35
2007	7.71	-38.53	2.85	-179.76	-218.29
2008	7.67	-38.36	2.89	-181.91	-220.27
2009	7.64	-38.18	2.92	-184.11	-222.29
2010	7.60	-38.00	2.96	-186.35	-224.36

Changes in soil carbon stocks from land converting to settlements have been also estimated. In Table 7.32 soil C stocks [Gg C] of cropland (annual and perennial) and grassland converted to settlements are reported.

Table 7.32 Change in carbon stocks in soil in cropland and grassland converted to settlements

	annual crops to settlements		perennial crops to settlements		grassland to settlements	
Year	***Conversion Area***	***Carbon stock***	***Conversion Area***	***Carbon stock***	***Conversion Area***	***Carbon stock***
	kha	*Gg C*	*kha*	*Gg C*	*kha*	*Gg C*
1990	0	0	0	0	7.56	-590.55
1991	0	0	0	0	7.54	-588.60
1992	0	0	0	0	7.54	-588.60
1993	0	0	0	0	7.54	-588.60
1994	0	0	0	0	7.54	-588.60
1995	0	0	0	0	7.54	-588.60
1996	5.66	-320.95	1.88	-106.40	0	0
1997	5.66	-320.72	1.88	-106.63	0	0
1998	5.65	-320.49	1.88	-106.86	0	0
1999	5.65	-320.25	1.89	-107.10	0	0
2000	5.64	-320.01	1.89	-107.34	0	0
2001	7.88	-446.84	2.68	-151.83	0	0
2002	7.85	-445.35	2.70	-153.32	0	0
2003	7.83	-443.82	2.73	-154.85	0	0
2004	7.80	-442.25	2.76	-156.42	0	0
2005	7.77	-440.64	2.79	-158.03	0	0
2006	7.74	-438.79	2.82	-159.88	0	0
2007	7.71	-436.89	2.85	-161.78	0	0
2008	7.67	-438.79	2.89	-163.71	0	0
2009	7.64	-436.89	2.92	-165.69	0	0
2010	7.60	-430.96	2.96	-167.71	0	0

7.6.5 Uncertainty and time series consistency

Uncertainty estimates for the period 1990–2010 have been assessed following Approach 1 of 2006 IPCC Guidelines (IPCC, 2006). The table reporting the uncertainties referring to the category settlements is shown in Annex 1. Input uncertainties deal with activity data and emission factors have been assessed on the basis of the information provided in the IPCC Good Practice Guidance for LULUCF (IPCC, 2003).
A Montecarlo analysis has been carried out to assess uncertainty for Settlements category, resulting in an asymetricall probability density distribution, with uncertainties values equal to -100.3% and 49.2%. Normal distributions have been assumed for most of the parameters; whenever assumptions or constraints on variables were known this information has been appropriately reflected on the choice of type and shape of distributions. A more detailed description of the results is reported in Annex 1.

7.6.6 Category-specific QA/QC and verification

Systematic quality control activities have been carried out in order to ensure completeness and consistency in time series and correctness in the sum of sub-categories; where possible, activity data comparison among different sources (FAO database[31], ISTAT data[32]) has been made. Data entries have been checked several times during the compilation of the inventory; particular attention has been focussed on the categories showing significant changes between two years in succession. Land use matrices have been accurately checked and cross-checked to ensure that data were properly reported. Several QA activities are carried out in the different phases of the inventory process. In particular the applied methodologies have been presented and discussed during several national workshop and expert meeting, collecting findings and comments to be incorporated in the estimation process. All the LULUCF categories have been embedded in the overall QA/QC-system of the Italian GHG inventory.

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

7.6.7 Category-specific recalculations

Estimates of soil carbon stock changes resulting from transition of forest land, cropland and grassland to settlements have been provided. Moderate deviations from the previous sectoral estimates occurred, essentially due to the refining of procedure followed in building the land use matrices, with the smoothing of the sum of a 5 years changes over a 5-year period, harmonizing the cropland and grassland time series. The comparison with previous submission results in mean decrease of emissions equal to 0.7% in settlements category, in the period 1990-2009.

7.6.8 Category -specific planned improvements

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

7.7 Other Land (5F)

Under this category, CO_2 emissions, from living biomass, dead organic matter and soils, from land converted in other land should be accounted for; no data is reported since the conversion to other land is not occurring.

7.8 Direct N_2O emissions from N fertilization (5(I))

N_2O emissions from N fertilization of cropland and grassland are reported in the agriculture sector; therefore only forest land should be included in this table; no data have been reported, since no fertilizers are applied to forest land.

7.9 N_2O emissions from drainage of soils (5(II))

As regards N_2O emissions from N drainage of forest or wetlands soils no data have been reported, since no drainage is applied to forest or wetlands soils.

7.10 N_2O emissions from disturbance associated with land-use conversion to Cropland (5(III))

7.10.1 Description

Under this category, N_2O emissions from disturbance of soils associated with land-use conversion to cropland are reported, according to the GPG (IPCC, 2003). N_2O emissions from cropland remaining cropland are included in the agriculture sector of the good practice guidance. The good practice guidance provides methodologies only for mineral soils.

7.10.2 Methodological issues

N_2O emissions from land use conversions are derived from mineralization of soil organic matter resulting from conversion of land to cropland. The average area of land undergoing a transition from non-cropland to cropland during each year, from 1990 to 2010, 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 7.33 N_2O emissions resulting from the disturbance associated with land-use conversion to cropland are reported.

Table 7.33 N_2O emissions from land-use conversion to cropland

	Conversion Area		**Carbon stock**	**$N_{net\text{-}min}$**	**N_2O $_{net\text{-}min}$ -N**	**N_2O emissions**
	annual change	*annual change*				
year	*kha*	*kha*	*Gg C*	*kt N*	*kt N_2O-N*	*Gg N_20*
1990	13.95	207	221	14.8	0.185	0.290
1991	0.48	208	222	14.8	0.185	0.291
1992	0.48	208	222	14.8	0.185	0.291
1993	0.48	208	223	14.9	0.186	0.292
1994	0.48	209	224	14.9	0.186	0.293
1995	0.48	209	224	14.9	0.187	0.293
1996	0	182	195	13.0	0.162	0.255
1997	0	155	165	11.0	0.138	0.216
1998	0	127	136	9.1	0.113	0.178
1999	0	100	107	7.1	0.089	0.140
2000	0	72	77	5.1	0.064	0.101
2001	0	72	77	5.1	0.064	0.101
2002	0	72	77	5.1	0.064	0.101
2003	0	72	77	5.1	0.064	0.101
2004	0	72	77	5.1	0.064	0.101
2005	0	72	77	5.1	0.064	0.101
2006	0	58	62	4.2	0.052	0.082
2007	0	44	47	3.2	0.039	0.062
2008	0	30	32	2.2	0.027	0.042
2009	0	16	17	1.2	0.015	0.023
2010	0	2	3	0.2	0.174	0.273

7.10.3 Category-specific recalculations

Notable deviations from the previous sectoral estimates occurred, due to due to adoption of the default inventory time period (20 years) to estimate soil carbon stock changes for land converting to cropland. This results in a mean increase of emissions equal to 92%, in the period 1990-2009.

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 1998-2010, since data on agricultural lime application have been made available only for that period; moreover CO_2 emissions from agricultural dolomite application have been included in CO_2 emissions from limestone application, as national statistics on amount of lime applied don't allow to disaggregate the two components (limestone and dolomite). CO_2 emissions from agricultural lime application are reported in the Table5(IV) - CO_2 emissions from agricultural lime application.

7.11.2 Methodological issues

Tier 1 approach, hypothesising that total amount of carbonate containing lime is applied annually to cropland soil, has been followed; an overall emission factor of 0.12 t C (t limestone or dolomite)$^{-1}$ has been used to estimate CO_2 emissions, without differentiating between variable compositions of lime material. The GPG equation 3.3.6 has been used to estimate CO_2 emissions, without disaggregation between calcic limestone and dolomite, as national statistics report an aggregate annual amount of lime.

7.11.3 Category-specific planned improvements

Improvements will concern the acquirement of data about annual amount of lime applied in the period 1990-1997; consideration will be focussed onto the acquisition of disaggregated data on calcic limestone and dolomite agricultural application.

7.12 Biomass Burning (5(V))

7.12.1 Description

Under this source category, CH_4 and N_2O emissions from forest fires are estimated, in accordance with the IPCC method.
National statistics on areas affected by fire per region and forestry use, high forest (resinous, broadleaves, resinous and associated broadleaves) and coppice (simple, compound and degraded), were used (ISTAT, several years [a]). No fires have occurred in plantations, included in subcategory cropland remaining cropland; due to the economic business related to plantations, additional measures are usually undertaken by owners to prevent and avoid fires events.
CO_2 emissions due to forest fires in forest land remaining forest land are included in Table 5.A.1 of the CRF, under carbon stock change in living biomass - decrease. Non CO_2 emissions from fires have been estimated and reported in CRF Table 5(V), while NO_x, CO and NMVOC emissions from forest fires have been reported in CRF Table 5. SO_2 emissions from forest fires are reported in 5G (Other - SO_2 from forest fires)

7.12.2 Methodological issues

In Italy, in consideration of national legislation[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 7.2.4.
CH_4, N_2O, CO and NO_x have been estimated following GPG approach (eq. 3.2.19), multiplying the amount of C released from 1990 to 2010, calculated on the basis of regional parameters (Bovio, 1996), by the emission ratios from EMEP/EEA 2009 (table 3.3, chapt. 11.B).

In Table 7.34 CH_4 and N_2O emissions resulting from biomass burning are reported.

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[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

Table 7.34 CH_4 and N_2O emissions from biomass burning

	CH_4 emissions	N_2O emissions
year	*Gg*	*Gg*
1990	8.705	0.003
1991	2.664	0.001
1992	3.947	0.001
1993	10.009	0.003
1994	4.159	0.001
1995	1.875	0.001
1996	1.788	0.001
1997	5.555	0.002
1998	6.380	0.002
1999	3.535	0.001
2000	5.030	0.002
2001	3.301	0.001
2002	1.841	0.001
2003	3.855	0.001
2004	2.278	0.001
2005	2.293	0.001
2006	1.822	0.001
2007	11.711	0.004
2008	2.749	0.001
2009	3.268	0.001
2010	2.062	0.001

7.12.3 Category-specific planned improvements

An expert panel on forest fires has been set up, in order to obtain geographically referenced data on burned area; the overlapping of land use map and georeferenced data should assure the estimates of burned areas in the different land uses, with a particular focus on grassland fires in order to provide estimates of CO_2 emissions. Activities planned in the framework of the National Registry for Forest Carbon Sinks should also provide data to improve estimate of emissions by biomass burning.

7.12.4 Uncertainty and time series consistency

Uncertainty estimates for the period 1990–2010 have been assessed following Approach 1 of 2006 IPCC Guidelines (IPCC, 2006). Input uncertainties deal with activity data and emission factors have been assessed on the basis of the information provided in the IPCC Good Practice Guidance for LULUCF (IPCC, 2003).

7.12.5 Category-specific QA/QC and verification

Systematic quality control activities have been carried out in order to ensure completeness and consistency in time series and correctness. Data entries have been checked several times during the compilation of the inventory. Several QA activities are carried out in the different phases of the inventory process. In particular the applied methodologies have been presented and discussed during several national workshop and expert meeting, collecting findings and comments to be incorporated in the estimation process. All the LULUCF categories have been embedded in the overall QA/QC-system of the Italian GHG inventory.

7.12.6 Category-specific recalculations

Time series of emissions from forest fires are changed, between current and previous submission, in consequence of the update of emission factors used in the estimation process. Methane emissions have increased by 20%, respect the previous submission (the emission factor changed from 12g $kg^{-1}C$ to 15g kg^{-1}), while N_2O emissions have sensibly decreased (the emission factor changed from 7g $kg^{-1}C$ to 0.4g kg^{-1}).

8 WASTE [CRF sector 6]

8.1 Sector overview

The waste sector comprises four source categories:

1. solid waste disposal on land (6A);
2. wastewater handling (6B);
3. waste incineration (6C);
4. other waste (6D).

The waste sector share of GHG emissions in the national greenhouse total is presently 3.64% (and was 3.82% in the base year 1990).

The trend in greenhouse gas emissions from the waste sector is summarised in Table 8.1. It clearly shows that methane emissions from solid waste disposal sites (landfills) are by far the largest source category within this sector.

Emissions from waste incineration facilities without energy recovery are reported under category 6C, whereas emissions from waste incineration facilities, which produce electricity or heat for energetic purposes, are reported under category 1A4a (according to the IPCC reporting guidelines).

Under 6D, CH_4 and NMVOC emissions from compost production and NO_x emissions from sludge spreading are reported.

Emissions from methane recovered, used for energy purposes, in landfills and wastewater treatment plants are estimated and reported under category 1A4a.

Table 8.1 Trend in greenhouse gas emissions from the waste sector 1990 – 2010 (Gg)

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2 (Gg)									
6C. Waste incineration	507.18	453.89	201.57	225.56	238.76	206.76	200.03	218.37	230.11
CH_4 (Gg)									
6A. Solid waste disposal on land	726.38	757.56	874.15	738.78	707.20	675.89	636.40	630.32	613.89
6B. Wastewater handling	94.76	105.62	112.73	129.67	130.40	130.77	129.62	129.66	131.04
6C. Waste incineration	7.65	12.91	11.94	14.14	13.46	12.89	13.43	13.59	12.44
6D. Other (compost production)	0.01	0.02	0.10	0.20	0.21	0.22	0.21	0.21	0.25
N_2O (Gg)									
6B. Wastewater handling	5.91	5.74	6.21	6.15	6.15	6.18	6.34	6.34	6.37
6C. Waste incineration	0.28	0.42	0.36	0.42	0.40	0.38	0.39	0.40	0.37

In the following box, key and non-key sources of the waste sector are presented based on level, trend or both. Methane emissions from landfills result as a key category at level and trend assessment calculated with Approach 1 and Approach 2; methane emission from wastewater handling is a key source at level assessment with Approach 1 and Approach 2, and at trend assessment taking into account uncertainty. When including the LULUCF sector in the key source analysis, methane emissions from landfills result as a key source at level assessment calculated with Approach 1 and Approach 2 and at trend assessment only with Approach 1, whereas methane emission from wastewater handling is a key category at level assessment with Approach 1 and Approach 2, and at trend assessment taking into account uncertainty.

Key-source identification in the waste sector with the IPCC Approach 1 and Approach 2 (without LULUCF) for 2010

6A	CH_4	Emissions from solid waste disposal sites	Key (L, T)
6B	CH_4	Emissions from wastewater handling	Key (L, T2)
6B	N_2O	Emissions from wastewater handling	Non-key
6C	CO_2	Emissions from waste incineration	Non-key
6C	CH_4	Emissions from waste incineration	Non-key
6C	N_2O	Emissions from waste incineration	Non-key
6D	CH_4	Emissions from other waste (compost production)	Non-key

8.2 Solid waste disposal on land (6A)

8.2.1 Source category description

The source category Solid waste disposal on land is a key category for CH_4, both in terms of level and trend. The share of CH_4 emissions in the total national methane is presently 41.6% (and was about 40% in the base year 1990).
For this source category, also NMVOC emissions are estimated; it has been assumed that non-methane volatile organic compounds are 1.3 weight per cent of methane (Gaudioso et al., 1993): this assumption refers to US EPA data (US EPA, 1990).
Methane is emitted from the degradation of waste disposed of in municipal landfills, both managed and unmanaged.
The main parameters that influence the estimation of emissions from landfills are, apart from the amount of waste disposed into managed landfills, the waste composition, the fraction of methane in the landfill gas and the amount of landfill gas collected and treated. These parameters are strictly dependent on the waste management policies throughout the waste streams which start from waste generation, flow through collection and transportation, separation for resource recovery, treatment for volume reduction, stabilisation, recycling and energy recovery and terminate at landfill sites.
Waste disposal in landfill sites is still the main disposal practice: the percentage of waste disposed in landfills dropped from 91.1% in 1990 to 46.5% in 2010. This trend is strictly dependent on policies that have been taken in the last 20 years in waste management. In fact, at the same time, waste incineration as well as composting and mechanical and biological treatment have shown a remarkable rise due to the enforcement of legislation. Also recyclable waste collection, which at the beginning of nineties was a scarce practice and waste were mainly disposed in bulk in landfills or incineration plants, has been increasing: in 2010, the percentage of municipal solid waste separate collection is near 34%, but still far from legislative targets (fixed 50% in 2009).
In particular, in Italy the first legal provision concerning waste management was issued in 1982 (Decree of President of the Republic 10 September 1982, n.915), as a consequence of the transposition of some European Directives on waste (EC, 1975; EC, 1976; EC, 1978). In this decree, uncontrolled waste dumping as well as unmanaged landfills are forbidden, but the enforcement of these measures has been concluded only in 2000. Thus, from 2000 municipal solid wastes are disposed only into managed landfills.
For the year 2010, the non hazardous landfills in Italy disposed 16,187 kt of MSW and 3,343 kt of industrial wastes, as well as 370 kt of sludge from urban wastewater treatment plants.
Since 1999, the number of MSW landfills has decreased by more than 500 plants, despite the decrease of the amount of wastes disposed of is less pronounced. This because both uncontrolled landfills and small controlled landfills have been progressively closed, especially in the south of the country, where the use of modern and larger plants was opted in order to serve large territorial areas.
Concerning the composition of waste which is disposed in municipal landfills, this has been changed over the years, because of the modification of waste production due to changes in the life-style and not to a forceful policy on waste management.
The Landfill European Directive (EC, 1999) has been transposed into national decree only in 2003 by the Legislative Decree 13 January 2003, n. 36 and applied to the Italian landfills since July 2005, but the effectiveness of the policies will be significant in the future. Moreover, a following law decree (Law Decree 30 December 2008, n.208) moved to December 2009 the end of the temporary condition regarding waste acceptance criteria, thus the composition of waste accepted in landfills is expected to change hardly.
Finally, methane emissions are expected especially from non hazardous waste landfills due to biodegradability rate of the wastes disposed of; in the past, provisions by law forced only non hazardous waste landfills to have a collecting gas system. Investigation has been carried out on C&D waste landfills to prove that inert waste does not generate methane emissions. Investigation on industrial sludge disposed into landfills for hazardous waste is planned for the future.

8.2.2 Methodological issues

Emission estimates from solid waste disposal on land have been carried out using the IPCC Tier 2 methodology, through the application of the First Order Decay Model (FOD).
Parameter values used in the landfill emissions model are:

1) total amount of waste disposed;
2) fraction of Degradable Organic Carbon (DOC);
3) fraction of DOC dissimilated (DOC_F);
4) fraction of methane in landfill gas (F);
5) oxidation factor (O_X);
6) methane correction factor (MCF);
7) methane generation rate constant (k);
8) landfill gas recovered (R).

It has been assumed that all the landfills, both managed and unmanaged, started operations in the same year, and have the same parameters, although characteristics of individual landfill sites can vary substantially.
Moreover, the share of waste disposed of into uncontrolled landfills has gradually decreased, as specified previously, and in the year 2000 it has been assumed equal to 0; nevertheless, emissions still have been occurring due to the waste disposed in the past years. The unmanaged sites have been considered “shallow” according to the IPCC classification.

Municipal solid waste

Basic data on waste production and landfills system are those provided by the national Waste Cadastre. The Waste Cadastre is formed by a national branch, hosted by ISPRA, and by regional and provincial branches. The basic information for the Cadastre is mainly represented by the data reported through the Uniform Statement Format (MUD), complemented by information provided by regional permits, provincial communications and by registrations in the national register of companies involved in waste management activities.
These figures have been elaborated and published by ISPRA yearly since 1999: the yearbooks report waste production data, as well as data concerning landfilling, incineration, composting and generally waste life-cycle data (ANPA-ONR, several years; ISPRA, several years).
For inventory purposes, a database of waste production, waste disposal in managed and unmanaged landfills and sludge disposal in landfills was created and it has been assumed that in Italy waste landfilling started in 1950.
The complete database from 1975 of waste production, waste disposal in managed and unmanaged landfills and sludge disposal in landfills is reconstructed on the basis of different sources (MATTM, several years; FEDERAMBIENTE, 1992; AUSITRA-Assoambiente, 1995; ANPA-ONR, 1999 [a], [b]; APAT, 2002; APAT-ONR, several years; ISPRA, several years), national legislation (Legislative Decree 5 February 1997, n.22), and regression models based on population (Colombari et al, 1998).
Since waste production data are not available before 1975, they have been reconstructed on the basis of proxy variables. Gross Domestic Product data have been collected from 1950 (ISTAT, several years [a]) and a correlation function between GDP and waste production has been derived from 1975; thus, the exponential equation has been applied from 1975 back to 1950.
Consequently the amount of waste disposed into landfills has been estimated, assuming that from 1975 backwards the percentage of waste landfilled is constant and equal to 80%; this percentage has been derived from the analysis of available data. As reported in the Figure 8.1, in the period 1973 – 1991 data are available for specific years (available data are reported in dark blue, whereas estimated data are reported in light blue). From 1973 to 1991 waste disposal has increased, because the most common practice in waste management; from early nineties, thanks to a change in national policies, waste disposal in landfill has started to decrease, in favour of other waste treatments.

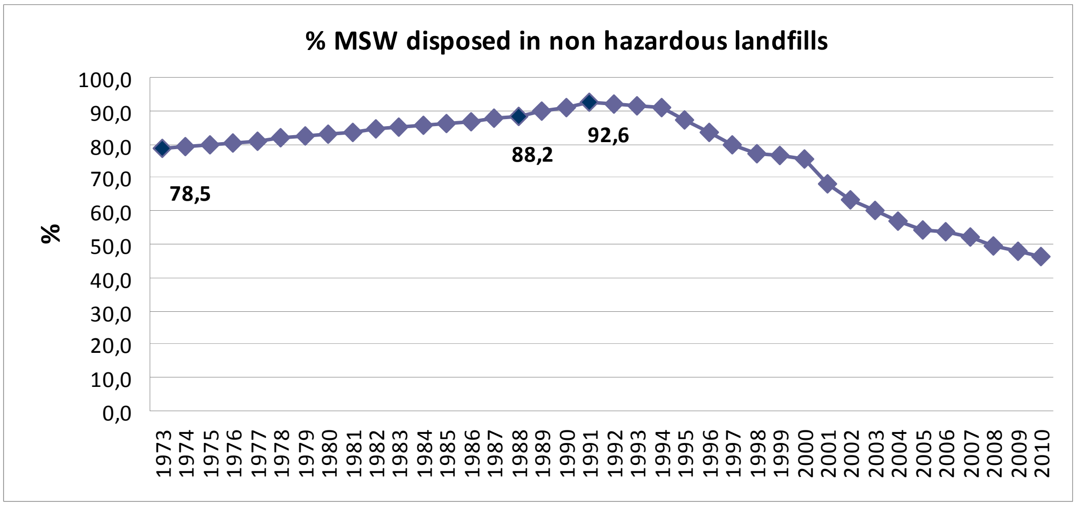

Figure 8.1 Percentage of MSW disposal on land (%)

In the following Table 8.2, the time series of MSW production and MSW disposed of into non hazardous landfills from 1990 is reported. The amount of waste disposed in managed landfills is yearly provided by the national Waste Cadastre since 1995. The time series has been reconstructed backwards on the basis of several studies reporting data available for 1973, 1988, 1991, 1994 (Tecneco, 1972; MATTM, several years). The amount of waste disposed in unmanaged landfills has been estimated as a function of the waste disposed in managed landfills. Different studies provided information about the percentage of waste in unmanaged sites for 1973, 1979, 1991 (Tecneco, 1972; ISTAT, 1984, MATTM, several years). Since 2000 the percentage of waste in unmanaged landfills is equal to 0% because of legal enforcement described in 8.2.1.

Industrial waste

Industrial wastes assimilated to municipal solid waste (AMSW) could be disposed of in non hazardous landfills. Composition of AMSW must be comparable to municipal solid waste composition.

From 2001, data on industrial waste disposed in municipal landfills are available from Waste Cadastre.

For previous years, assimilated municipal solid waste production has been reconstructed, and the same percentage of MSW disposed in landfill has been applied also to AMSW.

The complete database of AMSW production from 1975 to 2000 has been reconstructed starting from data available for the years 1988 (ISTAT, 1991) and 1991 (MATTM, several years) with a linear interpolation, and with a regression model based on Gross Domestic Product (Colombari et al, 1998). From 1975 back to 1950 AMSW production has been derived as a percentage of MSW production; this percentage has been set equal to 15%, which is approximately the value obtained from the only data available (MSW and AMSW production for the years 1988 and 1991).

In Table 8.2, the time series of AMSW and domestic sludge disposed of into non hazardous landfills from 1990 is reported.

Table 8.2 Trend of MSW production and MSW, AMSW and domestic sludge disposed in landfills, 1990 – 2010

ACTIVITY DATA	1990	1995	2000	2005	2006	2007	2008	2009	2010
MSW production (Gg)	22,231	25,780	28,959	31,664	32,511	32,542	32,467	32,110	34,793
MSW disposed in landfills for non hazardous waste (Gg)	17,432	22,459	21,917	17,226	17,526	16,912	16,069	15,418	16,187
Assimilated MSW disposed in landfills for non hazardous waste (Gg)	2,828	2,978	2,825	2,914	2,481	2,777	3,703	3,181	3,343
Sludge disposed in managed landfills for non hazardous waste (Gg)	2,454	1,531	1,326	544	525	407	364	335	370
Total Waste to managed landfills for non hazardous waste (Gg)	16,363	21,897	26,069	20,684	20,532	20,095	20,136	18,934	19,900
Total Waste to unmanaged landfills for non hazardous waste (Gg)	6,351	5,071	0	0	0	0	0	0	0
Total Waste to landfills for non hazardous waste (Gg)	22,714	26,968	26,069	20,684	20,532	20,095	20,136	18,934	19,900

Sludge from urban wastewater plants

Sludge from urban wastewater treatment plants has also been considered, because it can be disposed of at the same landfills as municipal solid waste and assimilated, once it meets specific requirements. The fraction of sludge disposed in landfill sites has been estimated to be 75% in 1990, decreasing to 10% in 2010.

On the basis of their characteristics, sludge from urban wastewater treatment plants is also used in agriculture, sludge spreading on land, and in compost production, or treated in incineration plants.

The percentage of each treatment (landfilling, soil spreading, composting, incinerating and stocking) has been reconstructed within the years starting from 1990: for that year, percentages have been set based on data on tonnes of sludge treated in a given way available from a survey conducted by the National Institute of Statistics on urban wastewater plants for the year 1993 (ISTAT, 1998 [a] and [b]; De Stefanis P. et al., 1998). From 1990 onwards each percentage has been varied on the basis of data available for specific years: in particular, data on sludge use in agriculture have been communicated by the Ministry for the Environment, Land and Sea concerning the reference time period from 1995 (MATTM, 2005; MATTM 2010); data on sludge used in compost production are published from 1999, while data on sludge disposed into landfills are published from 2001 (APAT-ONR, several years; ISPRA, several years).

The total production of sludge from urban wastewater plants is communicated by the Ministry for the Environment, Land and Sea from 1995 (MATTM, 2005; MATTM 2010) in the framework of the reporting commitments established by the European Sewage Sludge Directive (EC, 1986) transposed into the national Legislative Decree 27 January 1992, n. 99.

Moreover, sewage sludge production is available from different sources also for the years 1987, 1991 (MATTM, several years) and 1993 (ISTAT, 1998 [a] and [b]). Thus, for the missing years data have been extrapolated.

As for the waste production, also sludge production time series has been reconstructed from 1950. Starting from the number of wastewater treatment plants in Italy in 1950, 1960, 1970 and 1980 (ISTAT, 1987), the equivalent inhabitants have been derived.

To summarize, from 1987 both data on equivalent inhabitants and sludge production are available (published or estimated), thus it is possible to calculate a *per capita* sludge production: the parameter results equal on average to 80 kg inhab.$^{-1}$ yr^{-1}. Consequently, this value has been multiplied to equivalent inhabitants from 1987 back to 1950.

In Table 8.3, time series of sewage sludge production and landfilling is reported.

Table 8.3 Trend of total sewage sludge production and landfilling, 1990 – 2010

ACTIVITY DATA	1990	1995	2000	2005	2006	2007	2008	2009	2010
Total sewage sludge production (Gg)	3,272	2,437	3,402	4,299	4,280	3,510	3,041	3,736	3,696
Sewage sludge landfilled (Gg)	2,454	1,531	1,326	544	525	407	364	335	370
Percentage (%)	75.0	62.8	39.0	12.7	12.3	11.6	12.0	9.0	10.0

Waste composition

One of the most important parameter that influences the estimation of emissions from landfills is the waste composition.

An in-depth survey has been carried out, in order to diversify waste composition over the years.

On the basis of data available on waste composition (Tecneco, 1972; CNR, 1980; Ferrari, 1996), three slots (1950-1970; 1971-1990; 1991- 2005) have been individuated to which different waste composition has been assigned. Waste composition used from 2005 back to 1971 (CNR, 1980; Ferrari, 1996) has been better specified, on the basis of data available from those publications. In particular, screened waste (< 20mm) has been included in emissions estimation, because the 50% of it has been assumed as organic and thus rapidly biodegradable. This assumption has been strengthened by expert judgments and sectoral studies (Regione Piemonte, 2007; Regione Umbria, 2007).

Moreover, a fourth slot (2006-2009) has been individuated on the basis of the analysis of several regional waste composition and the analysis of waste disposed of into non hazardous landfills specified by the European Waste Catalogue (EWC) code for the year 2007, available from Waste Cadastre database (ISPRA, 2010). Data on waste composition refer to recent years and they are representative of the national territory, deriving from the North of Italy (Regione Piemonte, 2007; Regione Veneto, 2006; Regione Emilia Romagna, 2009), the Centre (Regione Umbria, 2007; Provincia di Roma, 2008) and the South (Regione Calabria, 2002; Regione Sicilia 2004). The new waste composition, adopted from 2006, includes compost residues which are disposed into landfills because their parameters are not in compliance with those set by the law: compost residues are reported under garden and park waste component, as they are considered moderately biodegradable. The moisture content and the organic carbon content are from national studies (Andreottola and Cossu, 1988; Muntoni and Polettini, 2002).

In Tables 8.4, 8.5, 8.6 and 8.7 waste composition of each national survey mentioned above and waste composition derived from the analysis of EWC code is reported, together with moisture content, organic carbon content and consequently degradable organic carbon both in waste type *i* and in bulk waste, DOC calculation is described in following paragraphs.

Waste types containing most of the DOC and thus involved in methane emissions are highlighted in bold type.

Since sludge is not included in waste composition, because it usually refers to waste production and not to waste landfilled, it has been added to each waste composition, recalculating the percentage of waste type.

Table 8.4 Waste composition and Degradable Organic Carbon calculation, 1950 - 1970

WASTE COMPONENT	Composition by weight (wet waste)	Moisture content	Organic carbon content (dry matter)	DOC_i (kgC/tMSW)
Organic	**32.7%**	**60%**	**48%**	**62.72**
Garden and park	**3.6%**	**50%**	**48%**	**8.71**
Paper, paperboard	**29.7%**	**9%**	**50%**	**135.09**
Plastic	2.9%	2%	70%	
Inert	26.9%			
Sludge	**4.2%**	**75%**	**48%**	**5.07**
DOC				**211.59**

Table 8.5 Waste composition and Degradable Organic Carbon calculation, 1971 – 1990

WASTE COMPONENT	Composition by weight (wet waste)	Moisture content	Organic carbon content (dry matter)	DOC_i (kgC/tMSW)
Organic	**33.3%**	**60%**	**48%**	**64.00**
Garden and park	**3.7%**	**50%**	**48%**	**8.89**
Paper, paperboard, textile and wood	**19.6%**	**9%**	**50%**	**89.26**
Plastic	6.3%	2%	70%	
Inert	6.2%			
Metal	2.6%			
Screened waste (< 2 cm)				
- organic	8.0%	**60%**	**48%**	**15.45**
- non organic	8.0%			
Sludge	**12.0%**	**75%**	**48%**	**14.44**
DOC				**192.04**

Table 8.6 Waste composition and Degradable Organic Carbon calculation, 1991 - 2005

WASTE COMPONENT	Composition by weight (wet waste)	Moisture content	Organic carbon content (dry matter)	DOC_i (kgC/tMSW)
Organic	**24.7%**	**60%**	**48%**	**47.37**
Garden and park	**4.2%**	**50%**	**48%**	**10.09**
Paper, paperboard	**25.5%**	**8%**	**44%**	**103.38**
Nappies	**2.7%**	**8%**	**44%**	**10.98**
Textiles	**4.8%**	**10%**	**55%**	**23.98**
Leather and rubbers	2.1%	2%	70%	
Light plastics	8.9%	2%	70%	
Rigid plastics	3.0%	2%	70%	
Inert and glasses	5.9%			
Metal	2.9%			
Bulky waste	0.5%			
Various	1.5%			
Screened waste (< 2 cm)				
- organic	**3.4%**	**60%**	**48%**	**6.60**
- non organic	3.4%			
Sludge	**6.3%**	**75%**	**48%**	**7.53**
DOC				**209.93**

Table 8.7 Waste composition and Degradable Organic Carbon calculation, 2006 – 2010

WASTE COMPONENT	Composition by weight (wet waste)	Moisture content	Organic carbon content (dry matter)	DOC_i (kgC/tMSW)
Organic	**21.9%**	**60%**	**48%**	**42.07**
Garden and park	**5.6%**	**50%**	**48%**	**13.53**
Wood	**1.6%**	**20%**	**50%**	**6.47**
Paper, paperboard, nappies	**23.9%**	**8%**	**44%**	**96.72**
Textiles and leather	**3.0%**	**10%**	**55%**	**14.86**
Plastics	11.8%	2%	70%	
Metals and Aluminium	2.3%			
Inert and glasses	6.4%			
Bulky waste	2.2%			
Various	6.5%			
Screened waste (< 2 cm)				
- organic	**5.4%**	**60%**	**48%**	**10.43**
- non organic	5.4%			
Sludge	**3.9%**	**75%**	**48%**	**4.68**
DOC				**188.76**

On the basis of the waste composition, waste stream have been categorized in three main types: rapidly biodegradable waste, moderately biodegradable waste and slowly biodegradable waste, as reported in Table 8.8. Methane emissions have been estimated separately for each mentioned biodegradability class and the results have been consequently added up.

Table 8.8 Waste biodegradability

Waste biodegradability	Rapidly biodegradable	Moderately biodegradable	Slowly biodegradable
Food	X		
Sewage sludge	X		
Screened waste (organic)	X		
Garden and park		X	
Paper, paperboard			X
Nappies			X
Textiles, leather			X
Wood			X

Degradable organic carbon (DOC) and Methane generation potential (L_0)

Degradable organic carbon (DOC) is the organic carbon in waste that is accessible to biochemical decomposition, and should be expressed as Gg C per Gg waste. The DOC in waste bulk is estimated based on the composition of waste and can be calculated from a weighted average of the degradable carbon content of various components of the waste stream. The following equation estimates DOC using default carbon content values.

$$DOC = \Sigma_i (DOC_i * W_i)$$

Where:

DOC = fraction of degradable organic carbon in bulk waste, kg C/kg of wet waste

DOC_i = fraction of degradable organic carbon in waste type *i*,

W_i = fraction of waste type *i* by waste category

Degradable organic carbon in waste type *i* can be calculated as following:

$$DOC_i = C_i * (1-u_i) * W_i$$

Where:
C_i = organic carbon content in dry waste type *i*, kg C/ kg of waste type *i*
u_i= moisture content in waste type *i*
W_i = fraction of waste type *i* by waste category

Once known the degradable organic carbon, the methane generation potential value (L_0) is calculated as following:

$$L_0 = MCF * DOC * DOC_F * F * 16/12$$

Where:
MCF = methane correction factor
DOC_F = fraction of DOC dissimilated
F = fraction of methane in landfill gas

Fraction of degradable organic carbon (DOC_F) is an estimate of the fraction of carbon that is ultimately degraded and released from landfill, and reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the landfill.
DOC_F value is dependent on many factors like temperature, moisture, pH, composition of waste: the default value 0.5 has been used.
The methane correction factor (MCF) accounts for that unmanaged SWDS (solid waste disposal 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 unmanaged SWDS. The MCF should be also interpreted as the 'waste management correction factor' because it reflects the management aspects.
The MCF value used for unmanaged landfill is the default IPCC value reported for uncategorised landfills: in fact, in Italy, before 2000 the existing unmanaged landfills were mostly shallow, because they resulted in uncontrolled waste dumping instead of real deep unmanaged landfills. To be conservative, the default IPCC value reported for uncategorised landfills has been used. It is assumed that landfill gas composition is 50% carbon dioxide and 50% methane. The following Table 8.9 summarize the methane generation potential values (L_0) generated, distinguished for managed and unmanaged landfills.

Table 8.9 Methane generation potential values by waste composition and landfill typology

L_0 ($m^3 CH_4$ $tMSW^{-1}$)	**1950 - 1970**	**1971 - 1990**	**1991 - 2005**	**2006 - 2010**
Rapidly biodegradable				
- Managed landfill	90.5	86.6	88.1	90.2
- Unmanaged landfill	54.3	52.0	52.9	54.1
Moderately biodegradable				
- Managed landfill	118.2	118.2	118.2	118.2
- Unmanaged landfill	70.9	70.9	70.9	70.9
Slowly biodegradable				
- Managed landfill	224.1	224.1	205.9	204.0
- Unmanaged landfill	134.5	134.5	123.5	122.4

Finally, oxidation factors have been assumed equal to 0.1 for managed landfills and 0 for unmanaged according to the IPCC Good Practice Guidance where 0.1 is suggested for well managed landfills.

Methane generation rate constant (k)
The methane generation rate constant *k* in the FOD method is related to the time necessary for DOC in waste to decay to half its initial mass (the 'half life' or t½).

The maximum value of *k* applicable to any single SWDS is determined by a large number of factors associated with the composition of the waste and the conditions at the site. The most rapid rates are associated with high moisture conditions and rapidly degradable material such as food waste. The slowest decay rates are associated with dry site conditions and slowly degradable waste such as wood or paper. Thus, for each rapidly, moderately and slowly biodegradable fraction, a different maximum methane generation rate constant has been assigned, as reported in Table 8.10.
The methane generation rate constant *k* values derive from a foreign study (Ham, 1979) and they are not based on Italian data, but Italian national experts reported (Andreottola and Cossu, 1988) that these figures can be considered representatives of average biogas production conditions with respect to the characteristics of national landfills and waste composition especially in terms of moisture.
Different *k* values for rapidly, moderately and slowly biodegradable waste are applied to the different parts of the model.

Table 8.10 Half-life values and related methane generation rate constant

WASTE TYPE	Half life	Methane generation rate constant
Rapidly biodegradable	1 year	0.69
Moderately biodegradable	5 years	0.14
Slowly biodegradable	15 years	0.05

Landfill gas recovered (R)
Landfill gas recovered data have been reconstructed on the basis of information on extraction plants (De Poli and Pasqualini, 1991; Acaia et al., 2004; Asja, 2003) and electricity production (TERNA, several years).
Only managed landfills have a gas collection system, and the methane extracted can be used for energy production or can be flared.
The amount of methane recovery in landfills has increased as a result of the implementation of the European Directive on the landfill of waste (99/31/EC); the amounts of methane recovered and flared have been estimated taking into account the amount of energy produced, the energy efficiency of the methane recovered, the captation efficiency and the efficiency in recovering methane for energy purposes assuming that the rest of methane captured is flared.
The total CH_4 recovered is the sum of methane flared and methane used for energy purposes (see figure 8.2).
The methane used for energy production is estimated starting from the electricity produced annually (E=GWh*3.6=TJ) by landfills (TERNA, several years) assuming an energy conversion efficiency equal to 0.3, typical efficiency value for engines that produce electricity from biogas (Colombo, 2001), and a LCV (Lower Calorific Value) equal to 50.038 TJ/Gg:

$$((E/0.3)/50.038)*1000 = CH_4 \text{ Mg/year}$$

The LCV used for biogas derives from national experts and it has been verified with energy and quantitative data about biogas production from waste supplied by TERNA (National Independent System Operator). For the years 1987, 1988, 1989 and 1990, the methane flared is supplied by the plants (De Poli and Pasqualini, 1991); from 1991 to 1997 the methane flared has been extrapolated from the previous years; finally, for the following years the methane flared has been estimated on the basis of information supplied by the main operators (Asja, 2003 and Acaia, 2004) regarding the efficiency in recovering methane for energy purposes with respect to the total methane collected.This value increased from 60% of the total, in 1998, to 70% since 2002.

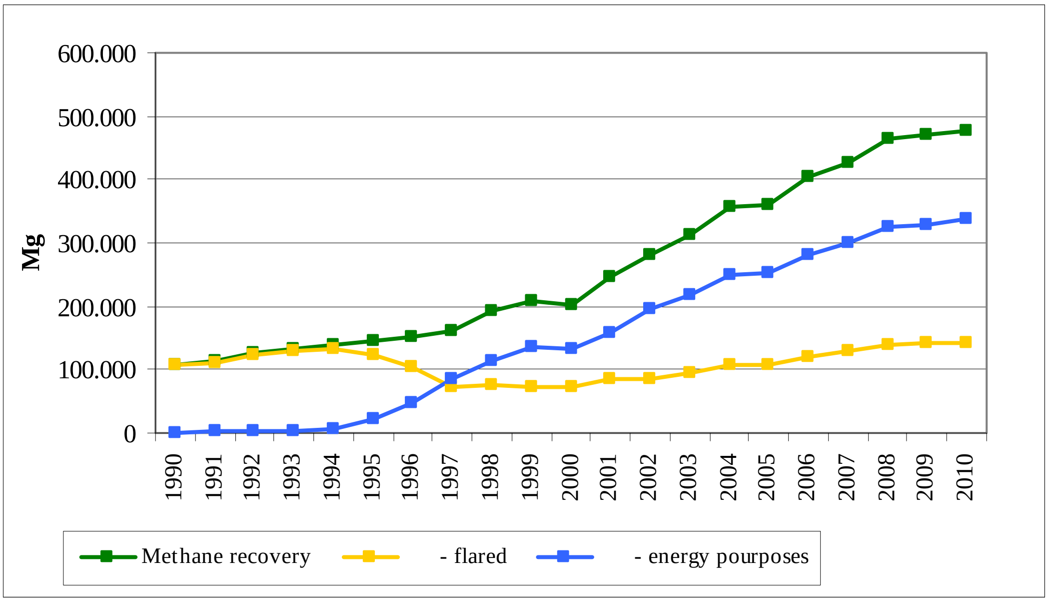

Figure 8.2 Methane recovery distinguished in flared amount and energy purposes (Mg)

CH_4 and NMVOC emission time series

The time series of CH_4 emissions is reported in Table 8.11; emissions from the amount used for energy purposes are estimated and reported under category 1A4a.

Whereas waste production continuously increases, from 2001 solid waste disposal on land has decreased as a consequence of waste management policies, although fluctuations in the amounts of industrial waste and sludge could influence this trend as for the year 2010 (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.

Table 8.11 Methane produced, recovered and CH_4 and NMVOC net emissions, 1990 – 2010 (Gg)

EMISSIONS	1990	1995	2000	2005	2006	2007	2008	2009	2010
Managed Landfills									
Methane produced (Gg)	648.1	755.0	1,028.3	1,084.6	1,097.3	1,091.3	1,088.5	1,092.2	1,084.2
Methane recovered (Gg)	108.9	144.1	203.4	360.5	403.2	427.3	464.3	470.4	476.6
Methane recovered (%)	16.8	19.1	19.8	33.2	36.7	39.2	42.7	43.1	44.0
CH_4 net emissions (Gg)	479.0	542.6	732.8	643.2	616.6	589.8	554.5	552.4	539.7
NMVOC net emissions (Gg)	6.3	7.1	9.7	8.5	8.1	7.8	7.3	7.3	7.1
Unmanaged Landfills									
Methane produced (Gg)	250.6	217.7	143.2	96.8	91.8	87.2	83.0	79.0	75.2
Methane recovered (Gg)	0	0	0	0	0	0	0	0	0
CH_4 net emissions (Gg)	247.3	214.9	141.4	95.6	90.6	86.1	81.9	77.9	74.2
NMVOC net emissions (Gg)	3.3	2.8	1.9	1.3	1.2	1.1	1.1	1.0	1.0

8.2.3 Uncertainty and time-series consistency

The uncertainty in CH_4 emissions from solid waste disposal sites has been estimated both by Approach 1 and Approach 2 of the IPCC guidelines.

Following Approach 1, the combined uncertainty is estimated to be 36.1%, 20% and 30% for activity data and emission factors, respectively, as suggested by the IPCC Good Practice Guidance (IPCC, 2000).

Applying Montecarlo analysis, the resulting uncertainty is estimated equal to 12.6% in 2009. Normal distributions have been assumed for most of the parameters; whenever assumptions or constraints on variables were known this information has been appropriately reflected on the choice of type and shape of distributions. A summary of the results is reported in Annex 1.

Emissions from landfills (Table 8.11) are influenced, apart from the amount of waste landfilled, also from waste composition, as for each biodegradability class different parameters are used in the model. The total amount of waste disposed into managed landfills increased until 2000 (in 2000 the landfilling of waste in unmanaged landfills has stopped too), then it decreased from 2000 to 2003, while from 2003 it is quite stable. We enhance that the total amount of waste disposed of is the sum of municipal solid wastes (which have decreased due to the enforcement of the legislation), sludge and industrial waste, which are subjected to fluctuation. As previously reported, four waste compositions have been used, changing from 1950 to 2010 as well as the percentage of rapidly, moderately and slowly biodegradable fraction. The combination of the amount of waste landfilled and the waste composition has led to an increase of methane production from 1990 to 2002 and stabilization from 2003 to 2010. At the same time, biogas recovery has increased from 1990 to 2010, but from 2000 the recovery rate is higher: in 2010 the methane recovered is half of the methane produced.

8.2.4 Source-specific QA/QC and verification

The National Waste cadastre is managed by ISPRA and is formed by a national branch hosted by ISPRA and regional and provincial branches hosted respectively by the Regional Agencies for the Protection of the Environment. So the system requires continuous and systematic knowledge exchange and QA/QC checks in order to ensure homogeneity of information concerning waste production and management throughout the entire Italian territory. At central level, ISPRA provides assessment criteria and procedures for data validation, through the definition of uniform standard procedures for all regional branches. The national branch, moreover, ensures spreading of the procedures and training of technicians in each regional branch. Data are validated by ISPRA detecting potential errors and data gaps, comparing among different data sources and asking for further explanation to the regional branches whenever needed. Moreover, ISPRA has started a number of sectoral studies with a view to define specific waste production coefficients related to each production process. So through the definition of such ‘production factors’ and the knowledge of statistical information on production, it is possible to estimate the amount of waste originated from each sector for the selected territorial grid cell and compare the results to the statistical data on waste production.
Moreover, ISPRA is involved in an in depth environmental study of Malagrotta area, the biggest non hazardous waste landfill in the European Union. The study has been assigned to the Institute by the Minister of the Environment, Land and Sea, in order to verify the real status of the environment. The results of this study will be compared with national estimates and could be used as quality control and verification procedure.
For general QC checks on emission estimates and related parameters, each inventory expert fills in, during the inventory compilation process, a format with a list of questions to be answered which helps the compiler avoid potential errors and is also useful to prove the appropriateness of the methodological choices.
Moreover, an in depth analysis of EWC codes of waste disposed of in landfills has been done for the year 2007, thanks to the complete database of Waste Cadastre kindly supplied by ISPRA Waste Office. This accurate analysis has permitted to verify the correctness of waste typology assumptions used for the estimations.

8.2.5 Source-specific recalculations

Recalculations in the sector have been done because methane recovered has been updated in 2009 (TERNA, several years). Furthermore, the quantity of waste disposed in landfill has been updated since 2008 (ISPRA, several years) producing a recalculation for 2009.
In Table 8.12, municipal and industrial (assimilated to MSW) wastes disposed into non hazardous landfills are reported also for Submission 2011, with differences in percentage.

Table 8.12 MSW disposed into landfills time series, 1990 – 2010 (t), AMSW disposed into landfills time series, 1990 – 2010 (t), and differences in percentage between Submission 2012 and Submission 2011.

Year	Submission 2012			Submission 2011					
	MSW to landfill (t)	AMSW to landfill (t)	Total waste (except sludge) to landfill (t)	MSW to landfill (t)	AMSW to landfill (t)	Total waste (except sludge) to landfill (t)	Δ% MSW	Δ% AMSW	Δ% Total
1990	17,431,760	2,827,867	20,259,627	17,431,760	2,827,867	20,259,627	-	-	-
1995	22,458,880	2,977,672	25,436,552	22,458,880	2,977,672	25,436,552	-	-	-
2000	21,917,417	2,825,340	24,742,757	21,917,417	2,825,340	24,742,757	-	-	-
2005	17,225,728	2,913,697	20,139,425	17,225,728	2,913,697	20,139,425	-	-	-
2006	17,525,881	2,480,830	20,006,711	17,525,881	2,480,830	20,006,711	-	-	-
2007	16,911,545	2,776,637	19,688,182	16,911,545	2,776,637	19,688,182	-	-	-
2008	16,068,760	3,703,220	19,771,980	15,981,406	3,703,220	19,684,626	0.55%	-	0.44%
2009	15,418,152	3,180,904	18,599,056	16,158,457	3,216,432	19,374,888	-4.58%	-1.10%	-4.00%
2010	16.187.282	3.342.705	19.529.988						

The amount of methane recovered has also been updated as reported in Table 8.13.
These updates have influenced methane and NMVOC emissions. In Table 8.13 differences in percentage between emissions from landfills reported in the updated time series and 2011 submission are presented.

Table 8.13 Differences in percentage between emissions from landfills reported in the updated time series and 2011 submission

EMISSIONS	1990	1995	2000	2005	2006	2007	2008	2009
Managed Landfills								
Methane produced (Gg)	-	-	-	-	-	-	-	0.10%
Methane recovered (Gg)	-	-	-	-	-	-	-	-5.15%
CH_4 net emissions (Gg)	-	-	-	-	-	-	-	4.46%
NMVOC net emissions (Gg)	-	-	-	-	-	-	-	4.46%
Unmanaged Landfills								
Methane produced (Gg)	-	-	-	-	-	-	-	-
Methane recovered (Gg)	-	-	-	-	-	-	-	-
CH_4 net emissions (Gg)	-	-	-	-	-	-	-	-
NMVOC net emissions (Gg)	-	-	-	-	-	-	-	-

8.2.6 Source-specific planned improvements

Currently, more recent data on fraction of CH_4 in landfill gas and on the amount of landfill gas collected and treated are not available. Furthermore investigation on industrial sludge disposed into landfills is planned for the future.
Regarding the energy conversion efficiency of biogas engine, currently assumed equal to 0.3, further investigations are planned as the technological evolution is probably leading to increase efficiency to around 40%.

8.3 Wastewater handling (6B)

8.3.1 Source category description

Under source category 6B, CH_4 and N_2O are estimated both from domestic and commercial wastewater as well as from industrial wastewaters.
In Table 8.14 an emission reporting scheme is shown.

Table 8.14 Emissions reporting scheme

6.B.1 Industrial wastewater	
Wastewater	
Sludge	Emissions from sludge are reported in 6.B.1 Industrial wastewater/wastewater
6.B.2 Domestic and commercial wastewater	
6.B.2.1 Domestic and commercial wastewater	
Wastewater	N_2O emissions are reported in 6.B.2.2 Human sewage
Sludge	N_2O emissions are reported in 6.B.2.2 Human sewage
6.B.2.2 Human sewage	

The principal by-product of the anaerobic decomposition of the organic matter in wastewater is methane gas. Normally, CH_4 emissions are not encountered in untreated wastewater because even small amounts of oxygen tend to be toxic to the organisms responsible for the production of methane. Occasionally, however, as a result of anaerobic decay in accumulated bottom deposits, methane can be produced. Again, wastewater collected in closed underground sewers is not believed to be a significant source of CH_4 (IPCC, 2006). In 2005, about 84% of population is served by sewer systems, whereas 74.8% of population is served by wastewater treatment plants (COVIRI, 2005). In the framework of the Urban WasteWater Treatment Directive (UWWTD,2011) data regarding agglomerations ≥ 2,000 p.e. (population equivalent) and referred to reporting year 2007, Italy reported: 3,246 agglomerations ≥ 2,000 p.e. and 97.8% of all agglomerations have a collecting system in place, 2,942 of these agglomerations (or 90.6% of the total generated load) have installations for secondary treatment in place, while 2,584 agglomerations (or 79.6% of the total generated load) have more stringent treatment installations in place. In unsewered areas, onsite systems, such as Imhoff tanks, are usually used.
On the contrary, in treatment plants, methane is produced from the anaerobic treatment process used to stabilised wastewater sludge.
The plant typology is usually distinguished in ‘primary’ (only physical-chemical unit operations such as sedimentation), ‘secondary’ (biological unit process) or ‘advanced’ treatments, defined as those additional treatments needed to remove suspended and dissolved substances remaining after conventional secondary treatment.
In Italy wastewater handling is managed mainly using a secondary treatment, with aerobic biological units: a WWTP standard design consists of bar racks, grit chamber, primary sedimentation, aeration tanks (with return sludge), settling tank, chlorine contact chamber. The stabilization of sludge occurs in aerobic or anaerobic reactors; where anaerobic digestion is used, the reactors are covered and provided of gas recovery.
As a consequence of these considerations, it is assumed that domestic and commercial wastewaters are treated 95% aerobically and 5% anaerobically. The bad management of aerobic process is assumed equal to 5% as a conservative estimation.
For high strength organic waste, such as some industrial wastewater, anaerobic process is recommended also for wastewater besides sludge treatment.
It is assumed that industrial wastewaters are treated 85% aerobically and 15% anaerobically (IRSA-CNR, 1998).
Emissions from methane recovered, used for energy purposes, in wastewater treatment plants are estimated and reported under category 1A4a.
A percentage of 1.8% of domestic and commercial wastewater is currently treated in Imhoff tanks, where the digestion of sludge occurs anaerobically without gas recovery. Therefore, very few emissions from sludge disposal do occur.

8.3.2 Methodological issues

Regarding N_2O emissions from human sewage, the default approach suggested by the IPCC Guidelines (IPCC, 1997), and updated in the Good Practice Guidance (IPCC, 2000), based on population and *per capita* intake protein has been followed. Fraction of nitrogen protein ($Frac_{NPR}$) 0.16 kg N kg^{-1} protein and emission factor (EF_6) 0.01 kg N-N_2O kg^{-1} N produced have been used, whereas the time series of the protein intake is from the yearly FAO Food Balance (FAO, several years).
N_2O emissions from industrial wastewater have been estimated on the basis of the emission factors equal to 0.25 g N_2O/m^3 of wastewater production (EMEP/CORINAIR, 2007). The waste water production is resulting from the model for the estimation of methane emissions from industrial waste water.
The methane estimation concerning industrial wastewaters makes use of the IPCC method based on wastewater output and the respective degradable organic carbon for each major industrial wastewater source. No country specific emission factors of methane per Chemical Oxygen Demand (COD) are available so the default value of 0.25 kg CH_4 kg^{-1} COD, suggested in the IPCC Good Practice Guidance (IPCC, 2000), has been used for the whole time series.
As recommended by the IPCC Good Practice Guidance (IPCC, 2000) for key source categories, data have been collected for several industrial sectors (iron and steel, refineries, organic chemicals, food and beverage, paper and pulp, textiles and leather industry). The total amount of organic material, for each industry selected, has been calculated multiplying the annual production (t $year^{-1}$) by the amount of wastewater consumption per unit of product (m^3 t^{-1}) and by the degradable organic component (kg COD $(m^3)^{-1}$). Moreover, the fraction of industrial degradable organic component removed as sludge has been assumed equal to zero. The yearly industrial productions are reported in the national statistics (ISTAT, several years [a], [b] and [c]), whereas the wastewater consumption factors and the degradable organic component are either from Good Practice Guidance (IPCC, 2000) or from national references. National data have been used in the calculation of the total amount of both COD produced and wastewater output specified as follows: refineries (UP, several years), organic chemicals (FEDERCHIMICA, several years), beer (Assobirra, several years), wine, milk and sugar sectors (ANPA-ONR, 2001), pulp and paper sector (ANPA-FLORYS, 2001; Assocarta, several years), and leather sector (ANPA-FLORYS, 2000; UNIC, several years).

In Table 8.15 detailed references for 2010 are reported: for these national data, slightly differences within the years can occur.

Table 8.15 Wastewater generation and COD values, 2010.

	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	4.71	UNIC, several years

CH_4 emissions from sludge generated by domestic and commercial wastewater treatment have been calculated using the IPCC default method on the basis of national information on anaerobic sludge treatment system (IPCC, 1997; IPCC 2000). All the anaerobic digestion systems are equipped with systems to collect the methane produced. The methane collected is partly flared and partly used for energy purposes. The total methane recovered is estimated on the basis of the methane production and the efficiency of captation. Where anaerobic digestion of sludge is used, the reactors are covered and provided of gas recovery and the efficiency of captation is equal to 100%; so the methane recovered and reported in the CRFs is equal to the methane production.
A recent survey by the National Institute of Statistics (ISTAT, 2004) has provided information on urban wastewater treatment plants in Italy for the year 1999: an investigation on previous references has been done and data on primary treatment plants using Imhoff tanks are also available for 1987 (ISTAT, 1991; ISTAT, 1993) and 1993 (ISTAT, 1998 [a] and [b]).
CH_4 emissions have been calculated on the basis of the equivalent inhabitants treated in Imhoff tanks, the organic load in biochemical oxygen demand per person equal to 60 g BOD_5 $capita^{-1}$ d^{-1}, as defined by national legislation and expert estimations (Legislative Decree 11 May 1999, no.152; Masotti, 1996; Metcalf and Eddy, 1991), the fraction of BOD_5 that readily settles equal to 0.3 (ANPA, 2001; Masotti, 1996), and the IPCC emission factor default value of 0.6 g CH_4 g^{-1} BOD_5.
CH_4 emissions from wastewater have been estimated assuming that 5% of domestic and commercial wastewater is treated anaerobically. This assumption may correspond to the Italian situation where wastewater is treated in aerobic biological units with the possibility of bad management cases. Both in the case of the sludge and in the case of wastewater Equation 5.5 reported in the IPCC Good Practice Guidance (IPCC, 2000) has been used. The emission factor has been calculated using the Equation 5.7 (IPCC, 2000), whereas MCF has been assumed equal to 1 (0 – 1) and the default value B_0 = 0.6 $kgCH_4$/kg BOD.
In the case of sludge, most of the CH_4 produced (254,436 Mg in 2010) is recovered and not emitted because of the anaerobic digestion of sludge takes place in reactors are covered and provided with gas recovery

system and the efficiency of captation is equal to 100%. Only CH_4 produced in Imhoff tanks (7,002 Mg in 2010) is emitted.
In the case of wastewater, the lack of information has led to use the most conservative estimate considering MCF=1 again. Further investigations are planned.

8.3.3 Uncertainty and time-series consistency

The combined uncertainty in CH_4 emissions from wastewater handling is estimated to be about 104% in annual emissions 100% and 30% for activity data and emission factor respectively, as derived by the IPCC Good Practice Guidance (IPCC, 2000). The uncertainty in N_2O emissions is 30% both for activity data and emission factor as suggested in the GPG (IPCC, 2000).

The amount of total industrial wastewater production is reported, for each sector, in Table 8.16; as previously noted only the 15% of industrial flows are treated anaerobically (IRSA-CNR, 1998).
CH_4 emission trend for industrial wastewater handling for different sectors is shown in Table 8.17, whereas the emission trend for N_2O emissions both from industrial wastewater handling and human sewage is shown in Table 8.18.
Concerning CH_4 emissions from industrial wastewater, neither wastewater flow nor average COD value change much over time, therefore emissions are stable and mainly related to the production data.
The CH_4 emission trend from wastewater and sludge generated by domestic and commercial wastewater treatment is reported in Table 8.19.

Table 8.16 Total industrial wastewater production by sector, 1990 – 2010 (1000 m^3)

Wastewater production (1000 m^3)	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Iron and steel	9,534	7,778	6,756	6,861	7,032	7,091	6,728	4,133	6,165
Oil refinery	NA	NA	NA	NA	NA	NA	NA	NA	NA
Organic chemicals	210,936	212,317	215,049	214,735	214,972	215,265	214,747	214,056	214,192
Food and beverage	179,120	177,383	182,736	185,657	182,693	180,401	180,106	184,727	191,547
Pulp and paper	377,167	402,952	387,285	366,025	365,649	368,979	346,504	304,619	328,679
Textile industry	108,460	103,047	101,572	75,492	78,272	79,796	68,768	56,443	64,389
Leather industry	23,623	25,002	27,216	19,229	19,254	18,366	16,804	14,944	14,246
Total	908,840	928,479	920,614	868,000	867,872	869,898	833,656	778,920	819,218

Table 8.17 CH_4 emissions from anaerobic industrial wastewater treatment, 1990 – 2010 (Gg)

CH_4 Emissions (Gg)	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Iron and steel	0.036	0.029	0.025	0.026	0.026	0.027	0.025	0.015	0.023
Oil refinery	5.850	5.625	4.250	4.750	4.750	4.750	4.750	4.750	4.750
Organic chemicals	23.794	23.911	24.173	24.177	24.227	24.274	24.180	24.046	24.082
Food and beverage	22.946	22.112	22.871	23.197	23.220	23.085	22.757	23.506	24.005
Pulp and paper	0.923	0.986	1.055	0.997	0.996	1.005	0.944	0.829	0.895
Textile industry	4.067	3.864	3.809	2.831	2.935	2.992	2.579	2.117	2.415
Leather industry	3.192	3.378	3.677	2.901	3.122	3.100	2.632	2.319	2.517
Total	60.81	59.91	59.86	58.88	59.28	59.23	57.87	57.58	58.69

Table 8.18 N_2O emissions from industrial wastewater handling and human sewage, 1990 – 2010 (Gg)

N_2O Emissions (Gg)	1990	1995	2000	2005	2006	2007	2008	2009	2010
Industrial Wastewater	0.227	0.232	0.230	0.217	0.217	0.217	0.208	0.195	0.205
Human Sewage	5.682	5.505	5.979	5.933	5.932	5.967	6.136	6.141	6.165
Total	5.91	5.74	6.21	6.15	6.15	6.18	6.34	6.34	6.37

Table 8.19 CH_4 emissions from sludge generated by domestic and commercial wastewater treatment, 1990 – 2010 (Gg)

Domestic and Commercial Wastewater	1990	1995	2000	2005	2006	2007	2008	2009	2010
Wastewater (5% treated anaerobically)									
Organic loading in wastewater (t year^{-1})	49.80	63.75	74.03	105.63	106.25	107.04	107.53	108.25	108.92
CH_4 emissions (Gg)	29.88	38.25	44.42	63.38	63.75	64.23	64.52	64.95	65.35
Sludge (generated by Imhoff tanks)									
Eq. inhabitants treated in Imhoff tanks (10^3 millions)	1,033	1,893	2,144	1,880	1,870	1,855	1,834	1,808	1,776
Organic loading in sludge (t year^{-1})	6.79	12.43	14.09	12.35	12.29	12.19	12.05	11.88	11.67
CH_4 emissions (Gg)	4.07	7.46	8.45	7.41	7.37	7.31	7.23	7.13	7.00

8.3.4 Source-specific QA/QC and verification

Where information is available, wastewater flows and COD concentrations are checked with those reported yearly by the industrial sectoral reports or technical documentation developed in the framework of the Integrated Pollution and Prevention Control (IPPC) Directive of the European Union (http://eippcb.jrc.es).
Moreover, in the framework of EPER/E-PRTR registry the methodology used to estimate emissions from wastewater handling can be used by the operators of wastewater treatment plants to check if their emission data exceed the reporting threshold values.
Finally, a Ph.D. thesis on GHG emissions from wastewater handling has been carried out at Environmental, Hydraulic, Infrastructures and Surveying Engineering Department (DIIAR) of Politecnico di Milano (Solini, 2010), where national methodology has been compared with that reported in 2006 IPCC Guidelines (IPCC, 2006) and with a methodology developed in the framework of a previous thesis Ph.D. for the estimation of emissions from wastewater treatment plants located in Regione Lombardia.

8.3.5 Source-specific recalculations

Recalculations in the sector have been done because the activity data regarding equivalent inhabitants have been updated in 2009 (ISTAT, several years [c]). Methane emissions from domestic and commercial wastewater showed changes reported in Table 8.20.

Table 8.20 Differences in percentages between time series reported in the updated time series and 2010 submission

Domestic and Commercial Wastewater	1990	1995	2000	2005	2006	2007	2008	2009
Wastewater (5% treated anaerobically)								
Organic loading in wastewater (t year^{-1})	-	-	-	-	-	-	-	-0.002%
CH_4 emissions (Gg)	-	-	-	-	-	-	-	-0.002%

Moreover, N_2O emissions from industrial wastewater have been recalculated in 2009 because of some updated data regarding pulp and paper and leather industry. In Table 8.21, differences in percentage between new time series and 2010 submission are reported.

Table 8.21 Differences in percentages between time series reported in the updated time series and 2010 submission

N_2O Emissions (Gg)	1990	1995	2000	2005	2006	2007	2008	2009
Industrial Wastewater	-	-	-	-	-	-	-	-0.345%
Human Sewage	-	-	-	-	-	-	-	-

8.3.6 Source-specific planned improvements

Methane conversion factor from domestic and commercial wastewater will be investigated in the future. Moreover the served population equivalent figures supplied by the National Institute of Statistics will be verified with the results of the next national survey.

8.4 Waste incineration (6C)

8.4.1 Source category description

Existing incinerators in Italy are used for the disposal of municipal waste, together with some industrial waste, sanitary waste and sewage sludge for which the incineration plant has been authorized by the competent authority. Other incineration plants are used exclusively for industrial and sanitary waste, both hazardous and not, and for the combustion of waste oils, whereas there are few plants where treat residual waste from waste treatments, as well as sewage sludge, are treated.
Emissions from incineration of human bodies in crematoria have been estimated too.
As mentioned above, emissions from waste incineration facilities with energy recovery are reported under category 1A4a (Combustion activity, commercial/institutional sector), whereas emissions from other types of waste incineration facilities are reported under category 6C (Waste incineration). For 2010, more than 95% of the total amount of waste incinerated is treated in plants with energy recovery system.
A complete database of the incineration plants is now available, updated with the information reported in the yearly report on waste production and management published by ISPRA (APAT-ONR, several years; ISPRA, several years).
Emissions from removable residues from agricultural production are included in the IPCC category 6C: the total residues amount and carbon content have been estimated by both IPCC and national factors. The detailed methodology is reported in Chapter 6 (6.6.2).
CH_4 emissions from biogenic, plastic and other non-biogenic wastes have been calculated.

8.4.2 Methodological issues

Regarding GHG emissions from incinerators and crematoria, the methodology reported in the IPCC Good Practice Guidance (IPCC, 2000) has been applied, combined with that reported in the CORINAIR Guidebook (EMEP/CORINAIR, 2007; EMEP/EEA, 2009). A single emission factor for each pollutant has been used combined with plant specific waste activity data.
As regard incineration plants, emissions have been calculated for each type of waste: municipal, industrial, hospital, sewage sludge and waste oils.
A complete database of these plants has been built, on the basis of various sources available for the period of the entire time series, extrapolating data for the years for which no information was available (MATTM, several years; ANPA-ONR, 1999 [a] and [b]; APAT, 2002; APAT-ONR, several years; AUSITRA-Assoambiente, 1995; Morselli, 1998; FEDERAMBIENTE, 1998; FEDERAMBIENTE, 2001; AMA-Comune di Roma, 1996; ENI S.p.A., 2001; COOU, several years).
For each plant a lot of information is reported, among which the year of the construction and possible upgrade, the typology of combustion chamber and gas treatment section, if it is provided with energy recovery (thermal or electric), and the type and amount of waste incinerated (municipal, industrial, etc.).

Different procedures were used to estimate emission factors, according to the data available for each type of waste, except CH_4 emission factor that is derived from EMEP Corinair (EMEP/CORINAIR, 2007).

Specifically:

1 for municipal waste, emission data from a large sample of Italian incinerators were used (FEDERAMBIENTE, 1998);
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.

Table 8.22 Waste incineration emission factors

POLLUTANT/WASTE TYPOLOGY	NMVOC (kg/t)	CO (kg/t)	CO_2 fossil (kg/t)	N_2O (kg/t)	NO_x (kg/t)	SO_2 (kg/t)	CH_4 (kg/t)
Municipal waste	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

Here below (Tables 8.23, 8.24, 8.25, 8.26), details about data and calculation of specific emission factors are reported. Emission factors have been estimated on the basis of a study conducted by ENEA (De Stefanis, 1999), based on emission data from a large sample of Italian incinerators (FEDERAMBIENTE, 1998; AMA-Comune di Roma, 1996), legal thresholds (Ministerial Decree 19 November 1997, n. 503 of the Ministry of Environment; Ministerial Decree 12 July 1990) and expert judgements.
In details, CO_2 emission factor for municipal waste has been calculated considering a carbon content equal to 23%; moreover, on the basis of the IPCC Guidelines (IPCC, 1997) and referring to the average content analysis on a national scale (FEDERAMBIENTE, 1992), a distinction was made between CO_2 from fossil fuels (generally plastics) and CO_2 from renewable organic sources (paper, wood, other organic materials). Only emissions from fossil fuels, which are equivalent to 35% of the total, were included in the inventory. This fraction is not expected to change significantly because of the energy characteristics required for the waste incinerated.
CO_2 emission factor for industrial, oils and hospital waste has been derived as the average of values of investigated industrial plants. On the other hand, CO_2 emissions from the incineration of sewage sludge were not included at all, while all emissions relating to the incineration of hospital and industrial waste were considered.

In Table 8.27 activity data are reported by type of waste.

Table 8.23 Municipal waste emission factors

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 8.24 Industrial waste and oils emission factors

INDUSTRIAL AND OIL WASTE	Average concentration values (mg/Nm^3)	Standard specific flue gas volume (Nm^3/KgMSW)	E.F. (g/t)
SO_2	160.00	8	1,280
NO_x	250.00		2,000
CO	70.00		560
N_2O			100
CH_4			59.80
NMVOC			7,400
CO_2			1,200 (kg/t)

Table 8.25 Hospital waste emission factors

HOSPITAL WASTE	Average concentration values (mg/Nm^3)	Standard specific flue gas volume (Nm^3/KgMSW)	E.F. (g/t)
SO_2	3.24	8	26
NO_x	75.45		604
CO	9.43		75
N_2O			100
CH_4			59.80
NMVOC			7,400
CO_2			1,200 (kg/t)

Table 8.26 Sewage sludge emission factors

SEWAGE SLUDGE	Average concentration values (mg/Nm^3)	Standard specific flue gas volume (Nm^3/KgMSW)	E.F. (g/t)
SO_2	300	6	1,800
NO_x	500		3,000
CO	100		600
N_2O			100
CH_4			59.80
NMVOC			7,400
CO_2			700 (kg/t)

Table 8.27 Amount of waste incinerated by type, 1990 – 2010 (Gg)

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Total Waste incinerated	1,656	2,149	3,062	4,964	5,066	6,014	6,067	6,536	7,387
- with energy recovery	911	1,558	2,752	4,721	4,824	5,794	5,858	6,306	7,160
- without energy recovery	745	591	310	243	242	220	209	229	227
MSW incinerated	1,026	1,437	2,325	3,220	3,269	3,307	3,381	3,842	4,321
- with energy recovery	626	1,185	2,161	3,168	3,247	3,279	3,357	3,811	4,302
- without energy recovery	399	251	164	52	23	28	24	31	19
Industrial Waste incinerated									
Other waste	473	536	604	1,602	1,625	2,548	2,522	2,534	2,900
- with energy recovery	258	330	510	1,447	1,458	2,410	2,394	2,393	2,743
- without energy recovery	215	206	94	155	167	137	127	141	156
Hospital waste	134	152	110	126	145	132	140	136	145
- with energy recovery	25	41	77	106	119	104	106	102	114
- without energy recovery	109	111	34	21	26	28	34	34	31
Sludge	20.72	23.18	21.50	15.60	25.98	26.06	24.00	24.00	20.87
- with energy recovery	0.00	0.00	3.40	0.00	0.00	0.00	0.00	0.00	0.00
- without energy recovery	20.72	23.18	18.11	15.60	25.98	26.06	24.00	24.00	20.87
Waste oil	2.66	1.41	0.82	0.67	0.43	0.75	0.29	0.19	0.18
- with energy recovery	1.77	0.94	0.55	0.54	0.35	0.62	0.29	0.19	0.18
- without energy recovery	0.89	0.47	0.27	0.12	0.08	0.14	0.00	0.00	0.00

CH_4 and N_2O emissions from agriculture residues removed, collected and burnt ‘off-site’, as a way to reduce the amount of waste residues, are reported in the waste incineration sub-sector.

Removable residues from agriculture production are estimated for each crop type (cereal, green crop, permanent cultivation) taking into account the amount of crop produced, the ratio of removable residue in the crop, the dry matter content of removable residue, the ratio of removable residue burned, the fraction of residues oxidised in burning, the carbon and nitrogen content of the residues. Most of these wastes refer especially to the prunes of olives and wine, because of the typical national cultivation. Emissions due to stubble burning, which are emissions only from the agriculture residues burned on field, are reported in the agriculture sector, under 4.F. Under the waste sector the burning of removable agriculture residues that are collected and could be managed in different ways (disposed in landfills, used to produce compost or used to produce energy) is reported. Different percentages of the removable agriculture residue burnt for different residues are assumed, varying from 10% to 90%, according to national and international literature. Moreover, these removable wastes are assumed to be all burned in open air (e.g. on field) or in fireplaces without abatement technology control, taking in consideration the higher available CO, NMVOC, PM, PAH and dioxins emission factors. The amount of these wastes treated differently is not supplied, but they are included in the respective sectors (landfill, composting, etc.).

The methodology is the same used to calculate emissions from residues burned on fields, in the category 4F, described in details in Chapter 6.

On the basis of carbon and nitrogen content of the residues, CH_4 and N_2O emissions have been calculated, both accounting nearly for 100% of the whole emissions from waste incineration. CO_2 emissions have been calculated but not included in the inventory as biomass. All these parameters refer both to the IPCC Guidelines (IPCC, 1997) and country-specific values (CESTAAT, 1988; Borgioli, 1981).
As regard incineration of corpses in crematoria, activity data have been supplied by a specific branch of Federutility, which is the federation of energy and water companies (SEFIT, 2010). Emission factors are from EMEP/EEA Air Pollutant Emission Inventory Guidebook (EMEP/EEA, 2009).

In Table 8.28 time series of cremation as well as annual deaths and crematoria in Italy are reported.

Table 8.28 Cremation time series (activity data), 1990 – 2010

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Cremations (no. of corpses)	5,809	15,436	30,167	48,196	53,013	58,554	63611	71,898	76,868
Deaths (no. of corpses)	543,700	555,203	560,241	567,304	557,892	570,801	585126	591,663	587,488
Mortal remains (no.)	1,000	1,750	1,779	9,880	10,101	12,824	15,165	15,819	18,899
Cremation percentage	1.07	2.78	5.38	8.50	9.50	10.26	10.87	12.15	13.08
Crematoria (no.)	NA	31	35	43	44	45	46	51	54

The major emissions from crematoria are nitrogen oxides, carbon monoxide, sulphur dioxide, particulate matter, mercury, hydrogen fluoride (HF), hydrogen chloride (HCl), NMVOCs, other heavy metals, and some POPs. Here below emission factors used for GHG emissions estimate; all emission factors are from EMEP/EEA, 2009 except for CH_4 and N_2O, assumed equal to MSW emission factor because not available from 2009 Guidebook. CO_2 emissions have been not calculated for the inventory as human body is ‘biomass’.

In Table 8.29 emission factors for cremation are reported.

Table 8.29 Cremation emission factors

POLLUTANT/WASTE TYPOLOGY	NMVOC (kg/body)	CO (kg/body)	N_2O (kg/t)	NO_x (kg/body)	SO_2 (kg/body)	CH_4 (kg/t)
Cremation	0.013	0.141	0.1	0.309	0.544	0.06

8.4.3 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions from waste incineration is estimated to be about 25.5%, 5% and 25% for activity data and emission factors respectively. For N_2O and CH_4 emissions, the combined uncertainty is estimated to be about 100% and 20.6%.

The time series of activity data, distinguished in Municipal Solid Waste and other (including cremation), is shown in Table 8.30; CO_2 emission trends for each type of waste category are reported in Table 8.31, both for plants without energy recovery, reported under 6C, and plants with energy recovery, reported under 1A4a. In Table 8.32 N_2O and CH_4 emissions are summarized, including those from open burning and cremation.

In the period 1990-2010, total CO_2 emissions have increased by 372%, but whereas emissions from plants with energy recovery have increased by nearly 784%, emissions from plants without energy recovery decreased by 55% (Table 8.31). While CO_2 emission trend reported in 6C is influenced by the amount of waste incinerated in plant without energy recovery, CH_4 and N_2O emission trend are related to the open burning, as already reported above.

Table 8.30 Waste incineration activity data, 1990 – 2010 (Gg)

Activity Data	1990	1995	2000	2005	2006	2007	2008	2009	2010
MSW Production (Gg)	22,231	25,780	28,959	31,664	32,511	32,542	32,467	32,110	34,793
MSW Incinerated (%)	4.6%	5.6%	8.0%	10.2%	10.1%	10.2%	10.4%	12.0%	12.4%
- in energy recovery plants	2.8%	4.6%	7.5%	10.0%	10.0%	10.1%	10.3%	11.9%	12.4%
MSW to incineration (Gg)	1,026	1,437	2,325	3,220	3,269	3,307	3,381	3,842	4,321
Industrial, Sanitary, Sewage Sludge and Waste Oil to incineration (Gg)	631	712	737	1,744	1,797	2,706	2,686	2,694	3,066
Cremation (no. of corpses)	5,809	15,436	30,167	48,196	53,013	58,554	63,611	71,898	76,868
Total Waste to incineration, excluding cremation (6C and 1A4a) (Gg)	**1,656**	**2,149**	**3,062**	**4,964**	**5,066**	**6,014**	**6,067**	**6,536**	**7,387**

Table 8.31 CO_2 emissions from waste incineration (without and with energy recovery), 1990 – 2010 (Gg)

CO_2 Emissions	1990	1995	2000	2005	2006	2007	2008	2009	2010
Incineration of domestic or municipal wastes (Gg)	115.47	72.64	47.30	15.02	6.61	8.19	7.04	8.93	5.64
Incineration of industrial wastes (except flaring) (Gg)	257.99	247.11	113.09	185.57	200.30	164.81	152.68	169.13	187.44
Incineration of hospital wastes (Gg)	131.07	132.73	40.36	24.61	31.62	33.34	40.31	40.31	37.04
Incineration of waste oil (Gg)	2.66	1.41	0.82	0.36	0.24	0.41	0.00	0.00	0.00
Incineration of corpses	NO	NO	NO	NO	NO	NO	NO	NO	NO
Waste incineration (6C) (Gg)	507	454	202	226	239	207	200	218	230
Waste incineration reported under 1A4a (Gg)	526	791	1,331	2,781	2,833	3,968	3,972	4,097	4,651
Total waste incineration (Gg)	1,033	1,245	1,532	3,007	3,072	4,174	4,172	4,315	4,881

Table 8.32 N_2O and CH_4 emissions from waste incineration (cremation and open burning included), 1990 – 2010 (Gg)

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008	2009	2010
N_2O (Gg)									
Waste incineration (6C)	0.32	0.45	0.40	0.46	0.44	0.42	0.43	0.44	0.40
MSW incineration reported under 1A4a	0.05	0.08	0.13	0.27	0.27	0.37	0.37	0.38	0.43
CH_4 (Gg)									
Waste incineration (6C)	7.65	12.91	11.94	14.14	13.46	12.89	13.43	13.59	12.44
MSW incineration reported under 1A4a	0.03	0.05	0.08	0.16	0.16	0.22	0.22	0.23	0.26

8.4.4 Source-specific QA/QC and verification

Several verification were carried out which led to some recalculationsas described in the following paragraph 8.4.5.

8.4.5 Source-specific recalculations

As planned in the previous submission a rearrangement of incinerators database has been made. During this process an in depth analysis about all incineration plants has been carried out with the target to eliminate double counting and to add eventual no counted plants.
Moreover, mortal remains have been added to cremation of corpses.

Table 8.33 Differences in percentages between time series reported in the updated time series and 2010 submission

GAS/SUBSOURCE	1990	1995	2000	2005	2006	2007	2008	2009
CO_2 (Gg)								
Waste incineration (6C)	-5.53%	-6.03%	0.0005%	-7.82%	-10.74%	-13.92%	-19.95%	-12.61%
MSW incineration reported under 1A4a	-7.47%	-5.17%	-0.001%	0.61%	1.02%	36.84%	32.02%	40.99%
N_2O (Gg)								
Waste incineration (6C)	-0.87%	-0.58%	0.005%	-0.36%	-0.58%	-0.70%	-1.13%	-0.62%
MSW incineration reported under 1A4a	-6.56%	-4.37%	-0.001%	0.53%	0.89%	32.15%	28.07%	37.55%
CH_4 (Gg)								
Waste incineration (6C)	-0.02%	-0.01%	0.0001%	-0.01%	-0.02%	-0.02%	-0.03%	-0.02%
MSW incineration reported under 1A4a	-6.56%	-4.37%	-0.001%	0.53%	0.89%	32.15%	28.07%	37.55%

The analysis regarding incineration plants has been conducted through verifications and comparisons with data reported in E-PRTR registry, Emissions Trading Scheme and updated data of waste amount (ISPRA, several years). These investigations have shown that some plants have been erroneously reported as incinerators whilst boilers and cement kiln facility already considered in the energy sector. Other plants were erroneously classified without energy recovery system whereas they were already equipped. On the other hand, since 2007 co-incinerators have been identified and considered during the estimation process in 1A4a because modern plants with energy recovery.
Once the list of plants was updated, a new and unique database has been developed to manage activity data, emissions of greenhouse gases and other pollutants, and spatial disaggregation, supporting QA / QC processes.
Recalculations regarding mortal remains are negligible.

8.4.6 Source-specific planned improvements

No further improvements are planned.

8.5 Other waste (6D)

8.5.1 Source category description

Under this source category CH_4 emissions from compost production have been reported. The amount of waste treated in composting plants has shown a great increase from 1990 to 2010 (from 363,319 tons to 8,395,700 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: plants that treat a selected waste (food, market, garden waste, sewage sludge and other organic waste, mainly from the agro-food industry); and mechanical-biological treatment plants, where the unselected waste is treated to produce compost, refuse derived fuel (RDF), and a waste with selected characteristics suitable for landfilling or incinerating systems.
It is assumed that 100% of the input waste to the composting plants from selected waste is treated as compost, while in mechanical-biological treatment plants 30% of the input waste is treated as compost on the basis of national studies and references (Favoino and Cortellini, 2001; Favoino and Girò, 2001).
For these emissions, literature data (Hogg, 2001) have been used for the emission factor, 0.029 g CH_4 kg^{-1} treated waste, which is the same as the compost production emission factor.
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 8.34, activity data, CH_4 and NMVOC emissions are reported. Moreover, NO_x emissions from sludge spreading are reported.

Table 8.34 CH_4 and NMVOC emissions from compost production, 1990 – 2010 (Gg)

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Waste treated in composting plants (t)									
CH_4 (Gg)									
Compost production (6D)	0.011	0.023	0.097	0.200	0.213	0.220	0.210	0.209	0.246
NMVOC (Gg)									
Compost production (6D)	0.018	0.040	0.168	0.346	0.369	0.380	0.364	0.363	0.427
NO_x (Gg)									
Sludge spreading (6D)	0.641	1.028	1.440	1.166	1.022	1.092	1.162	1.494	1.668

8.5.3 Uncertainty and time-series consistency

The uncertainty in CH_4 emissions from compost production is estimated to be about 100% in annual emissions, 10% and 100% concerning activity data and emission factors respectively.

8.5.4 Source-specific QA/QC and verification

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

8.5.5 Source-specific recalculations

Negligible recalculations due to the 2009 compost activity data update.

8.5.6 Source-specific planned improvements

No specific activities are planned.

9 RECALCULATIONS AND IMPROVEMENTS

9.1 Explanations and justifications for recalculations

To meet the requirements of transparency, consistency, comparability, completeness and accuracy of the inventory, the entire time series from 1990 onwards is checked and revised every year during the annual compilation of the inventory. Measures to guarantee and improve these qualifications are undertaken and recalculations should be considered as a contribution to the overall improvement of the inventory.

Recalculations are elaborated on account of changes in the methodologies used to carry out emission estimates, changes due to different allocation of emissions as compared to previous submissions, changes due to error corrections and in consideration of new available information.

The complete revised CRFs from 1990 to 2009 have been submitted as well as the CRF for the year 2010 and recalculation tables of the CRF have been filled in. Explanatory information on the major recalculations between the 2011 and 2012 submissions for the year 2009 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 2011 submission and the actual one (2012 submission) are summarised in Table 9.2 by gas; differences in emission levels due to recalculations are also reported.

Improvements in the calculation of emission estimates have led to a recalculation of the entire time series of the national inventory. Considering total GHG emissions without LULUCF, estimates show a decrease in comparison with the last year submission, equal to -0.20% for the base year and -0.43% for 2009. Considering the national total with the LULUCF sector, the base year has increased by 7.07% and the 2008 emission levels decreased by 11.45%.

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 fugitive emissions on account of the addition of N_2O emissions from flaring in refineries and CO_2 emissions from transmission and distribution of natural gas. In the industrial sector, revisions occurred considering the addition of CO_2 emissions from the use of limestone and dolomite in pulp and paper industries and in Power plants. The LULUCF sector was also affected by an update in methodology to derive Land use changes by the way of LU matrices and the availability of new information on forest fires areas and harvesting.

For 2009, changes regarded the energy sector, due to the update of emission factors for different fuel on account of information derive from operators under the European emissions trading scheme, in particular pet coke, synthesis gases, derived gases and natural gas. The amount of fuel oil and natural gas consumptions has been reallocated between energy production and manufacturing industries. In the industrial sector, revisions are due to the update of CO_2 emission factors for cement and glass production and to the addition of PFC emissions from the production of Tetrafluoroethylene polymers. In the agriculture sector, there has been a recalculation on account of the amount of biogas recovered and the update of different activity data and parameters; there has also been a modification in the cultivation period for some rice varieties. The LULUCF sector was also affected by the same revisions, as for 1990. In the waste sector, the main revision regarded the update of waste incineration emissions on the basis of data collected at plant level.

Table 9.1 Explanations of the main recalculations in the 2012 submission

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
Total (Net Emissions)	√	√	**update of CO2 emission factors for pet coke, refinery gas, synthesis gases, residual gas from chemical processes and coal derived gases; PFCs emissions from the production of TFEM; CH4 emissions from enteric fermentation of dairy cows and buffaloes; CO2 from LULUCF: Tier 1 approach has been appplied for FL remaining FL, soils pool; Default 20 years period has been applied for land in conversion to other land use.**
1. Energy	√	√	**update of CO2 emission factors for pet coke, refinery gas, synthesis gases, residual gas from chemical processes and coal derived gases: update of CO2 natural gas emission factor; update of COPERT version (COPERT 4.9) for road transport emissions; update of average recreational boats CH4 and N2O emission factors; update of biomass fuel consumption activity data.**
A. Fuel Combustion (Sectoral Approach)	√	√	**update of CO2 emission factors for pet coke, refinery gas, synthesis gases, residual gas from chemical processes and coal derived gases: update of CO2 natural gas emission factor; update of COPERT version (COPERT 4.9) for road transport emissions; update of average recreational boats CH4 and N2O emission factors; update of biomass fuel consumption activity data.**
1. Energy Industries		√	**update of CO2 emission factors for pet coke, synthesis gases and derived gases: update of CO2 natural gas emission factor; CO2, CH4, N2O reallocation of fuel oil and natural gas consumptions between energy production and manufacturing industries** CO2, CH4, N2O - 1.AA.1.A Public Electricity and Heat Production \ Liquid Fuels and Gaseous Fuels; 1.AA.1.B Petroleum Refining \ Liquid Fuels and Gaseous Fuels: reallocation of fuel oil and natural gas consumptions between energy production and manufacturing industries - §NIR par.3.3.1.2 CO2 - 1.AA.1.A Public Electricity and Heat Production \ Gaseous Fuels: - update of CO2 natural gas emission factor - §NIR par.3.3.1.2 CO2 - 1.AA.1.B Petroleum Refining \ Liquid Fuels: update of CO2 emission factors for refinery gas, petcoke and synthesis gas from heavy residuals - §NIR par.3.3.2.2 CO2 - 1.AA.1.B Petroleum Refining \ Gaseous Fuels: update of CO2 natural gas emission factor - §NIR par. 3.3.2.2 CO2 - 1.AA.1.C Manufacture of Solid Fuels and Other Energy Industries \ Solid Fuels: update of CO2 emission factors for coke gas, blast furnaces gas and oxygen converter gas - §NIR par. 3.3.3.2 CO2 - 1.AA.1.C Manufacture of Solid Fuels and Other Energy Industries \ Gaseous Fuels: update of CO2 natural gas emission factor - §NIR par.3.3.3.2
2. Manufacturing Industries and Construction		√	**update of CO2 emission factor for residual gas from chemical processes; update of CO2 natural gas emission factor; update of CO2 emission factors for petcoke, refinery gas and derived solid gases; CO2, CH4, N2O reallocation of fuel oil and natural gas consumptions between energy production and manufacturing industries**.

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
			CO2 - 1.AA.2.A Iron and Steel \ Liquid Fuels: update of CO2 pet coke emission factor - §NIR par. 3.4.3 CO2 - 1.AA.2.A Iron and Steel \ Solid Fuels: update of CO2 emission factors for coke gas, blast furnaces gas - §NIR par. 3.4.3 CH4 - 1.AA.2.A Iron and Steel \ Solid Fuels: update of blast furnace activity data - §NIR par. 3.4.3 CO2 - 1.AA.2.A Iron and Steel \ Gaseous Fuels: update of CO2 natural gas emission factor - §NIR par. 3.4.3 CO2 - 1.AA.2.B Non-Ferrous Metals \ Gaseous Fuels: update of CO2 natural gas emission factor - §NIR par. 3.4.3 CO2 - 1.AA.2.C Chemicals \ Liquid Fuels: update of CO2 emission factor for refinery gas and petcoke - §NIR par. 3.4.3 CO2 - 1.AA.2.C Chemicals \ Gaseous Fuels: update of CO2 natural gas emission factor - §NIR par. 3.4.3 CO2 - 1.AA.2.C Chemicals \ Other Fuels: update of CO2 emission factor for residual gas from chemical processes - §NIR par. 3.4.3 CO2 - 1.AA.2.D Pulp, Paper and Print \ Gaseous Fuels; 1.AA.2.E Food Processing, Beverages and Tobacco \ Gaseous Fuels: update of CO2 natural gas emission factor - §NIR par. 3.4.3 CO2 - 1.AA.2.F Other (please specify) \ Other non-specified \ Liquid Fuels: update of CO2 petcoke emission factor; reallocation of fuel oil consumptions between energy production and manufacturing industries - §NIR par. 3.4.3 CH4 - 1.AA.2.F Other (please specify) \ Other non-specified \ Liquid Fuels: glass production data; reallocation of fuel oil consumptions between energy production and manufacturing industries - §NIR par. 3.4.3 CO2 - 1.AA.2.F Other (please specify) \ Other non-specified \ Gaseous Fuels: update of CO2 natural gas emission factor; reallocation of natural gas consumptions between energy production and manufacturing industries - §NIR par. 3.4.3 CH4, N2O - 1.AA.2.F Other (please specify) \ Other non-specified \ Gaseous Fuels: reallocation of natural gas consumptions between energy production and manufacturing industries - §NIR par. 3.4.3
3. Transport	√	√	**CO2: update of CO2 natural gas emission factor; update of lenght of high pressure distribution network - CH4: update of COPERT version (COPERT 4.9); update of average recreational boats emission factor - N2O: update of COPERT version (COPERT 4.9); update of average recreational boats emission factor** CH4, N2O- 1.AA.3.B Road Transportation \ Liquid Fuels: update of COPERT version (COPERT 4.9) - §NIR par.3.5.3.2 CO2- 1.AA.3.B Road Transportation \ Gaseous Fuels \ update of CO2 natural gas emission factor - §NIR par.3.5.3.2 CH4, N2O- 1.AA.3.B Road Transportation \ Gaseous Fuels: update of COPERT version (COPERT 4.9) - §NIR par.3.5.3.2 CH4, N2O- 1.AA.3.B Road Transportation \ Liquid Fuels\Gasoline: update of average recreational boats

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
			emission factor - §NIR par.3.5.3.2 CO2, CH4, N2O - 1.AA.3.E Other Transportation (please specify) \ Pipeline compressors \ Gaseous Fuels: update of lenght of high pressure distribution network; update of CO2 natural gas emission factor - - §NIR par. 3.5.3
4. Other Sectors		√	**CO2, CH4, N2O: update of waste fuel consumption for commercial heating; update of CO2 natural gas emission factor** CO2 - 1.AA.4.A Commercial/Institutional \ Gaseous Fuels: update of CO2 natural gas emission factor; update of natural gas fuel consumption - §NIR par.3.6.3 CO2, CH4, N2O - 1.AA.4.A Commercial/Institutional \ Gaseous Fuels: update of natural gas fuel consumption - §NIR par.3.6.3 CO2, CH4, N2O - 1.AA.4.A Commercial/Institutional \ Biomass: update of biomass fuel consumption - §NIR par.3.6.3 CO2, CH4, N2O - 1.AA.4.A Commercial/Institutional \ Other Fuels: update of waste fuel consumption - §NIR par.3.6.3 CO2 - 1.AA.4.B Residential \ Gaseous Fuels: update of CO2 natural gas emission factor - §NIR par.3.6.3 CO2, CH4, N2O - 1.AA.4.B Residential \ Biomass: update of biomass fuel consumption - §NIR par. 3.6.3 CH4, N2O - 1.AA.4.C Agriculture/Forestry/Fisheries \ Liquid Fuels: update of emission factor for gasoline used in national fishing - - §NIR par.3.6.3 CO2 - 1.AA.4.C Agriculture/Forestry/Fisheries \ Liquid Fuels: update of CO2 natural gas emission factor - - §NIR par.3.6.3
5. Other			
B. Fugitive Emissions from Fuels		√	**CO2, CH4: reallocation of CO2 emissions between flaring and production processes; update of losses by one operator - §NIR par.3.9.2**
1. Solid Fuels			
2. Oil and Natural Gas		√	CO2, CH4: update of losses by one operator- §NIR par.3.9.2 CO2 - 1.B.2.A.4 Refining / Storage: reallocation of CO2 emissions between flaring and production processes - §NIR par.3.9.2 CO2, CH4 - 1.B.2.B.3 Transmission: update of losses by one operator - §NIR par.3.9.2 CO2, CH4 - 1.B.2.B.4 Distribution - 1.B.2.D Other (please specify) \ Flaring in Refineries: reallocation of CO2 emissions between flaring and production processes - §NIR par.3.9.2 CO2 - 1.C3 CO2 Emissions from Biomass: update of biomass fuel consumption in the commercial and residential sectors - §NIR par.3.9.2
2. Industrial Processes	√	√	**CO2: update of EF for cement production and update of CO2 average emission factor for glass production on the basis of ETS figures; update of soda ash production - §NIR par.4.2.2 CH4: update of pig iron production data and rolling mills activity data. update of Ethylene production - §NIR par.4.2.2 PFCs, CF4 - PFC emissions from the production of polymers of Tetrafluoroethylene have been added HFCs:update of activity data from operators of mobile air conditioning; update of import export data**

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**
			reported by operators; update of activity data from operators of mobile air conditioning (HFC-134a) - §NIR par.4.2.2 **SF6: update of import export data reported by operators - §NIR par.4.2.2**
A. Mineral Products		√	**update of CO2 EF for cement;update of CO2 average emission factor for glass production on the basis of ETS figures; update of soda ash production** CO2 - 2.A.1 Cement Production: update of EF for clinker production - §NIR par.4.2.2 CO2 - 2.A.4.1 Soda Ash Production: update of activity data - §NIR par.4.2.2 CO2 - 2.A.4.1 Glass Production: update of CO2 average emission factor for glasso production on the basis of ETS figures- §NIR par.4.2.2
B. Chemical Industry		√	**CH4 - update of Ethylene production (2.B.5.2) - §NIR par.4.3.2**
C. Metal Production		√	**CH4 - update of pig iron and rolling mills activity data** CH4 - 2.C.1.1 Steel: update of pig iron and rolling mills activity data - §NIR par.4.4.2 CH4 - 2.C.1.2 Pig Iron: update of pig iron activity data - §NIR par.4.4.2
D. Other Production			
E. Production of Halocarbons and SF6	√	√	**PFCs, CF4 - PFC emissions from the production of polymers of Tetrafluoroethylene have been added** CF4 - 2.E.1.2 Other (please specify) \ Production of C2F4: PFC emissions from the production of polymers of Tetrafluoroethylene have been added - §NIR par.4.6.2
F. Consumption of Halocarbons and SF6		√	**HFCs - update of import export data reported by operators** HFC-32, HFC-125: update of import export data reported by operators - §NIR par.4.7.2 HFC-134a: update of activity data from operators of mobile air conditioning; update of import export data reported by operators - §NIR par.4.7.2 HFC-143a, HFC-227ea, SF6: update of import export data reported by operators - §NIR par.4.7.2 HFC-134a - 2.IIA.F.1.6 Mobile Air-Conditioning \ HFC-134a: update of import export data reported by operators - §NIR par.4.7.2 HFC-125, HFC-134a, HFC-143a, SF6 - 2.F.P2.1 In bulk: update of import export data reported by operators - §NIR par.4.7.2 HFC-32, HFC-134a, HFC-125, HFC-152a, HFC-143a, HFC-227ea - 2.F.P3.1 In bulk: update of import export data reported by operators - §NIR par.4.7.2
G. Other			
3. Solvent and Other Product Use		√	**CO2 - update of NMVOC EFs for paint application of boat building, wood and other industrial paints; update of activity data for house cleaning products and fat edible and non edible oil extraction** **N2O - update of aerosol cans production** CO2: 3.A Paint application: update of NMVOC EFs for paint application of boat building, wood and other industrial paints - §NIR par.5.3 N2O: 3.D.3 N2O from Aerosol Cans: update of aerosol cans production - §NIR par.5.3 CO2: 3.D.5 Other (please specify) \ Domestic solvent use: update of activity data for house cleaning products - §NIR par.5.3

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
			CO2: 3.D.5 Other (please specify) \ Fat edible and non-edible oil extraction: update of activity data - §NIR par.5.3
4. Agriculture		√	**CH4 - update of NE growth figures for dairy cattle and buffalo enteric fermentation; Update of cultivation period for some rice varieties in rice cultivation** **N2O - update of non dairy female 1-2 years liquid and solid MMS data; update of fraction of livestock N excretion volatilized**
A. Enteric Fermentation		√	**CH4 - update of NE growth figures for dairy cattle and buffaloupdate of NE growth figures for dairy cattle and buffalo; update of rabbits population** CH4 - 4.A Enteric Fermentation \ Cattle \ Option A \ Dairy Cattle: update of NE growth figures for dairy cattle - §NIR par.6.2.2 CH4 - 4.A Enteric Fermentation \ Cattle \ Option A \ Non Dairy Cattle: update of EF for female 1-2 years - §NIR par.6.2.2 CH4 - 4.A Enteric Fermentation \ Buffalo: update of NE growth figures for buffalo- §NIR par.6.2.2
B. Manure Management		√	**CH4 - update of rabbits population; update of biogas recovered distribution between swine and cattle** **N2O - update of non dairy female 1-2 years liquid and solid MMS data** CH4 - 4.B Manure Management \ Cattle \ Option A \ Dairy Cattle; 4.B Manure Management \ Cattle \ Option A \ Non-Dairy Cattle, 4.B Manure Management\ Swine : update of biogas recovered - §NIR par.6.3.2 CH4 - 4.B Manure Management \ Other livestock (please specify) \ Rabbits: Update of activity data (population) - §NIR par.6.3.2 N2O - 4.B Manure Management \ Liquid system: update of activity data (population) - §NIR par.xxxx N2O - 4.B Manure Management \ Solid storage and dry lot: update of activity data (population) - §NIR par.6.3.2
C. Rice Cultivation		√	CH4 - 4.C Rice Cultivation: Update of cultivation period for some rice varieties (4.c.1.2.1 Single Aeration, 4.c.1.2.2 Multiple Aeration) - §NIR par.6.4.2
D. Agricultural Soils		√	**update of N excretion of female non dairy cattle 1-2 years; update of fraction of livestock N excretion volatilized** N2O - 4.D Agricultural Soils: update of N excretion of female non dairy cattle 1-2 years; update of fraction of livestock N excretion volatilized - §NIR par.6.5.2 N2O - 4.D.1.2 Animal Manure Applied to Soils: update of fraction of livestock N excretion volatilized - §NIR par.6.5.2 N2O - 4.D.2 Pasture, Range and Paddock Manure, 4.D.3.1 Atmospheric Deposition, 4.D.3.2 Nitrogen Leaching and Run-off: update of N excretion of female non dairy cattle 1-2 years - §NIR par.6.5.2 N2O - 4.D.3.1 Atmospheric Deposition: update of fraction of livestock N excretion volatilized - §NIR par.6.5.2
E. Prescribed Burning of Savannas			
F. Field Burning of Agricultural Residues			
G. Other			
5. Land Use, Land-Use Change and Forestry	√	√	**CO2: Tier 1 approach has been appplied for FL remaining FL, soils pool; Default 20 years period has**

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
			been applied for land in conversion to other land use; CH4, N2O: Update of EF on the basis of EMEP/EEA Guidebook 2009 for wildfires
A. Forest Land	√	√	**CO2: Default inventory period (20 years) has been used for categories in conversion to other LU; Tier 1 approach has been appplied for FL remaining FL, soils pool; CH4, N2O: Update of EF on the basis of EMEP/EEA Guidebook 2009 for wildfires** 5.A.1 Forest Land remaining Forest Land \ Carbon stock change (living biomass, dead organic matter): Growth curves parameters have been refined - §NIR par.7.2.4 5.A.1 Forest Land remaining Forest Land \ Carbon stock change (mineral soils): Tier 1 approach has been used - §NIR par.7.2.4 5.A.1 Forest Land remaining Forest Land \ 5(V) Biomass Burning \ Wildfires: Update of EF on the basis of EMEP/EEA Guidebook 2009 - §NIR par.7.12.2 5.A.2.2 Grassland converted to Forest Land \ Total: Carbon stock change (living biomass, dead organic matter: The smoothing process applied to LU time series has been refined on the basis of 2010 available data - §NIR par.7.2.4 5.A.2.2 Grassland converted to Forest Land \ Total\Net carbon stock change in soils/Carbon/Mineral Soils: Default inventory period (20 years) has been used - §NIR par.7.2.4
B. Cropland	√	√	**CO2: Default inventory period (20 years) has been used for land converting to CL; Tier 1 approach has been applied for CL remaining CL (plantation), soils pool. N2O: Default inventory period (20 years) has been used for land converting to CL** CO2: 5.B.1 Cropland remaining Cropland \ Carbon stock change \ perennial - woody crops\Carbon stock change (living biomass, dead organic matter): The smoothing process applied to LU time series has been refined on the basis of 2010 available data; Growth curves parameters have been refined - §NIR par.7.3.4 CO2: 5.B.2.2 Grassland converted to Cropland\Net carbon stock change in soils/Carbon/Mineral Soils: Default inventory period (20 years) has been used - §NIR par.7.3.4 N2O: 5.B.2.2 Grassland converted to Cropland: Default inventory period (20 years) has been used - §NIR par.7.3.4 ; 7.10.2
C. Grassland	√	√	**CO2: Default inventory period (20 years) has been used for land converting to GL; Tier 1 approach has been applied for GL remaining GL (other wooded land), soils pool** 5.C.1 Grassland remaining Grassland \ Carbon stock change \ other wooded lands\ Net carbon stock change in soils/Carbon/Mineral Soils: Tier 1 approach has been used - §NIR par.x7.4.4 5.C.2.2 Cropland converted to Grassland\Carbon stock change (living biomass): The smoothing process applied to LU time series has been refined on the basis of 2010 available data - §NIR par.7.4.4 5.C.2.2 Cropland converted to Grassland\Carbon stock change\Net carbon stock change in soils/Carbon/Mineral Soils: Default inventory period (20 years) has been used - §NIR par.7.4.4

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**
D. Wetlands			
E. Settlements	√	√	**CO2: The smoothing process applied to LU time series has been refined on the basis of 2010 available data - §NIR par.7.6.4**
F. Other Land			
G. Other			
6. Waste		√	**CO2: update on the basis of a comparison at plant level of data from different surveys (update of data about plants with or without energy recovery, construction of a new DB)** **CH4, N2O: update of methane recovered in 2009 and waste landfilled in 2008; update of equivalent inhabitants activity data for domestic wastewater and leather and pulp and paper industrial waste water production activity data; update on the basis of a comparison at plant level of data from different surveys (update of data about plants with or without energy recovery, construction of a new DB)**
A. Solid Waste Disposal on Land		√	CH4: 6.A Solid Waste Disposal on Land: update of methane recovered in 2009 and waste landfilled in 2008 - §NIR par.8.1.2 CH4: 6.A.1 Managed Waste Disposal on Land: update of data about solid waste disposal on land for 2008 - §NIR par.8.1.2 Recovery/CH4: 6.A.1 A Managed Waste Disposal on Land: update of activity data - §NIR par.8.1.2
B. Waste-water Handling		√	CH4,N2O: update of equivalent inhabitants activity data for domestic wastewater and leather and pulp and paper industrial waste water production activity data - §NIR par.8.2.2 CH4, N2O: 6.B.1 Industrial Wastewater \ Wastewater: update of activity data - §NIR par.8.2.2 CH4: 6.B.2.1 Domestic and Commercial (w/o human sewage) \ Wastewater: update of equivalent inhabitants activity data - §NIR par.8.2.2 Recovery/CH4: 6.B.2.1 Domestic and Commercial (w/o human sewage) \ Sludge: update of equivalent inhabitants activity data - §NIR par.8.2.2
C. Waste Incineration		√	**CO2, CH4, N2O: update on the basis of a comparison at plant level of data from different surveys (update of data about plants with or without energy recovery, construction of a new DB) - §NIR par.8.3.2** CO2, CH4, N2O: 6.C.1 Biogenic: update on the basis of a comparison at plant level of data from different surveys (update of data about plants with or without energy recovery, construction of a new DB) - §NIR par.8.3.2 CO2, CH4, N2O:: 6.C.2 Other (non-biogenic - please specify) \ plastics and other non-biogenic waste: update on the basis of a comparison at plant level of data from different surveys (update of data about plants with or without energy recovery, construction of a new DB - §NIR par.8.3.2
D. Other		√	**CH4: update of compost activity data** CH4: 6.D Other (please specify) \ Compost production: update of activity data- §NIR par.8.4.2
7. Other (as specified in Summary 1.A)			
Memo Items:			
International Bunkers			

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**
Aviation			
Marine			
Multilateral Operations			
CO2 Emissions from Biomass		√	CO2: update on the basis of a comparison at plant level of data from different surveys (update of data about plants with or without energy recovery, construction of a new DB) - §NIR par.8.3.2
NIR Chapter	**DESCRIPTION**		**REFERENCE**
	Please tick where the latest NIR includes major changes in descriptions compared to the previous year NIR		**If ticked please provide some more detailed information for example reference to pages in the NIR**
Chapter 1.2 Institutional arrangements			
Chapter 1.6 QA/QC plan			

Table 9.2 Differences in time series between the 2012 and 2011 submissions due to recalculations

	subm	1990	1995	2000	2005	2006	2007	2008	2009
Net CO_2 emissions/removals (Gg CO_2-eq.)	2011	373,817	365,997	384,685	399,534	388,430	402,699	373,126	322,481
	2012	400,254	396,931	419,281	434,508	428,577	439,738	411,723	359,413
Differences		*7.07%*	*8.45%*	*8.99%*	*8.75%*	*10.34%*	*9.20%*	*10.34%*	*11.45%*
CO_2 emissions (without LULUCF) (Gg CO_2-eq.)	2011	435,895	445,959	463,670	490,119	485,428	476,226	466,004	417,212
	2012	435,012	445,151	462,485	488,163	483,614	475,486	463,962	415,434
Differences		*-0.20%*	*-0.18%*	*-0.26%*	*-0.40%*	*-0.37%*	*-0.16%*	*-0.44%*	*-0.43%*
CH_4 emissions (Gg CO_2-eq.)	2011	43,671	44,164	45,733	41,024	39,485	39,408	38,152	37,352
	2012	43,878	44,330	45,905	41,303	39,769	39,779	38,485	38,327
Differences		*0.47%*	*0.38%*	*0.38%*	*0.68%*	*0.72%*	*0.94%*	*0.87%*	*2.61%*
CH_4 emissions (without LULUCF) (Gg CO_2-eq.)	2011	43,524	44,132	45,649	40,986	39,454	39,211	38,105	37,297
	2012	43,695	44,290	45,799	41,255	39,731	39,533	38,428	38,259
Differences		*0.39%*	*0.36%*	*0.33%*	*0.66%*	*0.70%*	*0.82%*	*0.85%*	*2.58%*
N_2O emissions (Gg CO_2-eq.)	2011	37,382	38,103	39,506	37,572	32,236	31,582	29,495	27,827
	2012	37,459	40,025	39,621	37,782	32,444	31,828	29,764	28,218
Differences		*0.21%*	*5.04%*	*0.29%*	*0.56%*	*0.64%*	*0.78%*	*0.91%*	*1.40%*
N_2O emissions (without LULUCF) (Gg CO_2-eq.)	2011	37,246	38,096	39,497	37,568	32,233	31,562	29,490	27,822
	2012	37,368	39,933	39,589	37,751	32,418	31,808	29,750	28,211
Differences		*0.33%*	*4.82%*	*0.23%*	*0.49%*	*0.57%*	*0.78%*	*0.88%*	*1.40%*
HFCs (Gg CO_2-eq.)	2011	351	671	1,986	5,401	6,106	6,855	7,513	8,173
	2012	351	671	1,986	5,401	6,106	6,855	7,513	8,164
Differences		*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*-0.10%*
PFCs (Gg CO_2-eq.)	2011	1,808	491	345	354	284	287	201	218
	2012	2,487	1,266	1,217	1,715	1,714	1,652	1,501	1,063
Differences		*37.57%*	*158.02%*	*252.50%*	*384.54%*	*504.10%*	*475.45%*	*648.09%*	*387.95%*
SF_6 (Gg CO_2-eq.)	2011	333	601	493	465	406	428	436	398
	2012	333	601	493	465	406	428	436	398
Differences		*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*
Total (with LULUCF) (Gg CO_2-eq.)	2011	457,362	450,027	472,749	484,351	466,947	481,259	448,921	396,449
	2012	484,761	483,824	508,504	521,174	509,016	520,280	489,421	435,583
Differences		*5.99%*	*7.51%*	*7.56%*	*7.60%*	*9.01%*	*8.11%*	*9.02%*	*9.87%*
Total (without LULUCF) (Gg CO_2-eq.)	2011	519,157	529,951	551,640	574,893	563,911	554,569	541,749	491,120
	2012	519,246	531,913	551,570	574,749	563,989	555,761	541,589	491,528
Differences		*0.02%*	*0.37%*	*-0.01%*	*-0.03%*	*0.01%*	*0.22%*	*-0.03%*	*0.08%*

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 2011, emission levels of the base year, as total emissions in CO_2 equivalent without LULUCF, slightly changed (-0.20%) due to a revision in different sectors as previously described.

If considering emission levels with LULUCF, an increase by 1.12% is observed between the 2011 and 2012 total figures in CO_2 equivalent.
The trend 'base year- year 2009' does not show a significant change from the previous to this year submission.

Figure 9.1 shows the time series of the range of total national GHG emissions due to recalculations in the last years (submissions 2001-2011) and the 2012 emission estimates. Values of the coefficient of variation are also illustrated which show that the first years of the time series were mostly affected by recalculation in terms of variability whereas lower values are observed for the last years. Moreover, it can be noted that recalculations usually result in higher figures as compared previous sumissions. In total, the graph shows that improvements in methodologies guarantee accurate estimates and minor changes from one year to another for the entire time series.

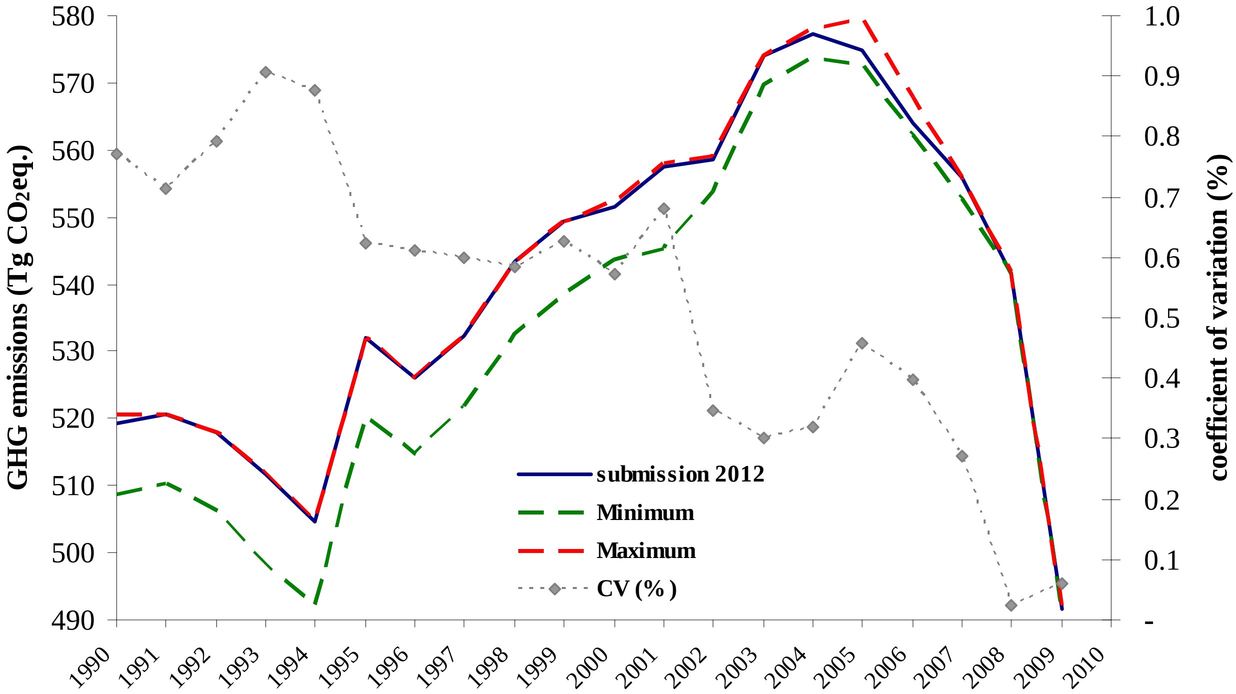

Figure 9.1 Range of national GHG emissions (Tg CO_2 eq.) in the 2001-2012 submissions and coefficient of variation (%)

9.4 Recalculations, response to the review process and planned improvements

This chapter summarises the recalculations and improvements made to the Italian GHG inventory since the 2010 submission.
In addition to a new year, the inventory is updated annually by a revision of the existing activity data and emission factors in order to include new information available; the update could also reflect the revision of methodologies. Revisions always apply to the whole time series.
The inventory may also be expanded by including categories not previously estimated if sufficient information on activity data and suitable emission factors have been identified and collected.

9.4.1 Recalculations

The key differences in emission estimates occurred since the last year submission are reported in Table 9.1 and Table 9.2.

Besides the usual updating of activity data, recalculations may be distinguished in methodological changes, source allocation and error corrections.
All sectors were involved in methodological changes. Specifically:
Energy. CO_2 emission factors have been updated for residual gases from chemical processes affecting relevantly the whole time series. CO_2 emission factors have been updated for pet coke, refinery gas, synthesis and coal derived gases, and natural gas in the last years. There has been a reallocation of fuel oil and natural gas consumptions between energy production and manufacturing industries for 2008 and 2009. A revision in the road transport sector affected CH_4 and N_2O for the use of the new version of COPERT 4; and there has also been an update in the maritime sector of CH_4 and N_2O emission factors for recreational boats in the last years. Moreover, there has been an update of waste fuel consumption and biomass for commercial heating.

Industrial sector. Recalculations affected CO_2 emission factors for cement for 2009 and glass production from 2000 on account of information available from ETS data. In addition, there has been a revision of CH_4 emissions for the update of pig iron and rolling mills production. Activity data for F-gases have been updated and PFCs emissions from the production of polymers of tetrafluoroethylene have been added.

Solvent and other product use sector. A minor update of activity data occurred in this sector.

Agriculture. Besides the update of basic data, CH_4 emissions have been revised for the whole time series considering the update of net energy growth figures for dairy cattle and buffalo enteric fermentation and the change in cultivation period for some rice varieties in rice cultivation. N_2O emissions have also been recalculated for the update of liquid and solid MMS figures related to non dairy female of 1-2 years and update of fraction of livestock N excretion volatilized.

LULUCF. Recalculations affected CO_2 emissions because of the application of Tier 1 approach to FL remaining FL soils pool. Furthermore, default 20 years period has been applied for land in conversion to other land use. CH_4 and N_2O have also been recalculated due to the update of the relevant emission factors provided by EMEP/EEA Guidebook 2009 for wildfires.

Waste. A revision concerned CO_2 emissions on the basis of the update of data on plants with or without energy recovery and a construction of a new database. CH_4 and N_2O emissions have been updated on the basis of a change in the quantities of methane recovered and waste landfilled in the last two years.

9.4.2 Response to the UNFCCC review process

In 2011, the Italian GHG inventory was subject to the centralised review of the 2011 inventory submission. The process is still under finalization and the review report was not available during the compilation of the 2012 submission.
Notwithstanding, the main critical issues raised during the review process were addressed in the current inventory compilation, and different improvements have been carried out. A complete list of improvements following the UNFCCC review process is reported in Annex 12.

Improvements regarded the completeness and transparency of the information reported in the NIR.
Additional explanations for the trend of emission factors or emissions have been included for different sectors. Some inconsistencies and differences between CRF and NIR, and with international statistics, have been resolved.
More information on the methodology used to verify and certify the ETS data used to estimate emissions in the energy and industrial sectors has been added and the description of country specific methods and the rationale behind the choice of emission factors, activity data and other related parameters for different sector has been better detailed.
The main improvement for LULUCF sector was the use the IPCC default land use transition period of 20 years, in the estimation process of carbon stock changes in mineral soils related to land use changes. In particular the 20-years transition period has been applied to estimate carbon stock changes from the following land use changes: Land converted to Forest land, Land converted to Cropland, Land converted to Grassland and for Art. 3.3 activities (Afforestation/Reforestation).

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. Some of activities planned in this framework (in particular IUTI, inventory of land use) have been completed, resulting in land use classification, for all national territory, for the years 1990, 2000 and 2008. A process of validation and verification of IUTI data has been put in place and is expected to supply data useful to update and improve the estimations.
Specific improvements are identified in the relevant chapters and specified in the 2012 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 annually updated. The database has helped highlighting the main discrepancies in information and detecting potential errors leading to a better use of these data in the national inventory.
For the agriculture and waste sectors, improvements will be related to the availability of new information on emission factors, activity data as well as parameters necessary to carry out the estimates; specifically, improvements are expected for the review of nitrous oxide emission factors in the agricultural soil emissions and availability of information on waste composition and other parameters following the entering into force of the European landfill directive.

For the LULUCF; activities planned in the framework of the National Registry for Forest Carbon Sinks should provide data to improve estimate of emissions by biomass burning and the final results of the INFC data related to the soils survey will definitely constitute a robust database for forest fires, allowing refined estimates and lower related uncertainty.
Additional studies will regard the comparison between local inventories and national inventory and exchange of information with the ‘local inventories’ national expert group.

Further analyses will concern the collection of statistical data and information to estimate uncertainty in specific sectors by implementing Approach 2 of the IPCC guidelines.

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

10 **KP-LULUCF**

10.1 General information

Under Article 3, paragraph 3, of the Kyoto Protocol (KP), Italy reports emissions and removals from afforestation (A), reforestation (R) and deforestation, and under Article 3, paragraph 4 emissions and removals from forest management (FM). The estimates for emissions and removals under Articles 3.3 and 3.4 are consistent with the IPCC GPG LULUCF 2003 and Decisions 15/CMP.1 and 16/CMP.1 of the KP.

10.1.1 Definition of forest and any other criteria

Forest is defined by Italy under the Kyoto Protocol reporting using the same definition applied by the Food and Agriculture Organization of the United Nations for its Global Forest Resource assessment (FAO FRA 2000). This definition is consistent with definition given in Decision 16/CMP.1. Forest is a land with following threshold values for tree crown cover, land area and tree height:

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

Forest roads, cleared tracts, firebreaks and other open areas within the forest as well as protected forest areas are included in forest

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. The total Italian forest area is eligible under *forest management* activity, since the entire Italian forest area has to be considered managed forest lands.

Concerning *deforestation* activities, in Italy land use changes from forest to other land use categories are allowed in very limited circumstances, as stated in art. 4.2 of the Law Decree n. 227 of 2001.

10.1.4 Description of precedence conditions and/or hierarchy among Article 3.4 activities, and how they have been consistently applied in determining how land was classified

As Italy has elected only *forest management* under Article 3.4 activities, there is no need to build up a hierarchy between *forest management* and other Article 3.4 activities.

10.2 Land-related information

Italy implements the Reporting Method 1 for lands subject to Article 3.3 and Article 3.4 activities. The reporting area boundaries have been identified with the administrative boundaries of Italian regions (NUTS2 level). These areas include multiple units of land subject to *afforestation/reforestation* and *deforestation* and land areas subject to *forest management*. In the reporting, the same geographical boundaries were used for Article 3.3 and Article 3.4 activities. Approach 2 has been used for representing land areas.
Data for land use and land-use changes were obtained by the National Forest Inventories ((IFN1985 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 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 1990–2010 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).

Table 10.1 Land transition matrices - Areas and changes in areas between the previous and the current inventory years (2008 – 2009 - 2010) [kha]

2008

	kha	Art 3.3 Aff. / Ref.	Deforestation	Art. 3.4 FM	Other	*total (beginning of 2008)*
Art 3.3	**Aff. / Ref.**	**1,401**				*1,401*
	Deforestation		**12**			*13*
Art. 3.4	**FM**		0.72	**7,450**		*7,451*
	Other	*79*			**21,191**	*21,269*
	Total (end of 2008)	*1,480*	*13*	*7,450*	*21,191*	*30,134*

2009

	kha	Art 3.3 Aff. / Ref.	Deforestation	Art. 3.4 FM	Other	*total (beginning of 2009)*
Art 3.3	**Aff. / Ref.**	**1,480**				*1,480*
	Deforestation		**13**			*13*
Art. 3.4	**FM**		0.72	**7,449**		*7,450*
	Other	*79*			**21,112**	*21,191*
	Total (end of 2009)	*1,558*	*14*	*7,449*	*21,112*	*30,134*

2010

	kha	Art 3.3 Aff. / Ref.	Deforestation	Art. 3.4 FM	Other	*total (beginning of 2010)*
Art 3.3	**Aff. / Ref.**	**1,558**				*1,558*
	Deforestation		**14**			*14*
Art. 3.4	**FM**		0.72	**7,448**		*7,449*
	Other	*79*			**21,034**	*21,112*
	Total (end of 2010)	*1,637*	*14*	*7,448*	*21,034*	*30,134*

10.2.3 Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

The Italian regions have been used as the geographical units for reporting (Figure 10.1); boundaries of reporting areas have been identified with the administrative boundaries of Italian regions (NUTS2 level). ID-codes have been assigned following the denomination of the different regions.

Figure 10.1 Geographical locations of the reporting regions and their identification codes

10.3 Activity-specific information

10.3.1 Methods for carbon stock change and GHG emission and removal estimates

10.3.1.1 Description of the methodologies and the underlying assumptions used

Methods for estimating carbon stock changes in forests (for Article 3.3 *afforestation/reforestation* and Article 3.4 *forest management*) are the same as those used for the UNFCCC greenhouse gas inventory: details are given in par. 7.2.4. A growth model, For-est[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).

Following the ERT recommendation regarding soils pool, Italy has decided to apply the IPCC Tier1, assuming that, for land under Forest Management activities, the carbon stock in soil organic matter does not change, regardless of changes in forest management, types, and disturbance regimes; in other words it has to be assumed that the carbon stock in mineral soil remains constant so long as the land remains forest. Therefore carbon stock changes in soils pool, for land subject to Forest Management, have been not reported, and transparent and verifiable information that the pool is not a net source for Italy is provided in the par. 10.3.1.2.

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[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/

Furthermore, following the ERT finding in the 2011 review process, Italy has decided to use the IPCC default land use transition period of 20 years, to estimate carbon stock changes in soils pools for afforestation/reforestation activities under art. 3.3 of the Kyoto Protocol.
In the KP CRF tables changes in carbon stock are reported in terms of gains and losses, for aboveground and belowground biomass, and net carbon stock change for the remaining pools (dead wood, litter, soils).
Concerning carbon stock changes resulting from *deforestation* activities, for the current submission no detailed information was available on the land use of the deforested area, since the activities planned in the framework of the registry for carbon sinks are still in progress; consequently, a conservative approach was applied, hypothesising that the total deforested area is converted into settlements. Carbon stock changes related to the forest land areas, before deforestation activities, have been estimated, for each year and for each pool (living biomass, dead organic matter and soils), on the basis of forest land carbon stocks deduced from the model described in par. 7.2.4.In addition, it should be noted that land use changes due to wildfires are not allowed by national legislation (Law Decree 21 November 2000, n. 353, art.10, comma 1).
The loss, in terms of carbon, due to deforested area is computed assuming that the total amount of carbon, existing in the different pools before deforestation, is lost.
GHG emissions from biomass burning were estimated with the same method as described in par. 7.12.2. CO_2 emissions due to forest fires in areas subject to art. 3.3 and art 3.4 activities have been included in corresponding tables: in particular, CO_2 emissions from biomass burning in land subject to art 3.3 activities are included in Table 5(KP-I)A.1.1, Losses (Aboveground and belowground pools), while CO_2 emissions from burnt areas under *forest management* are included in Table 5(KP-I)B.1, Forest Management, Losses (Aboveground and belowground pools).

10.3.1.2 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

Following the main finding of 2011 review process, Italy has decided to not account for the soil carbon stock changes from activities under Article 3.4, providing transparent and verifiable information to demonstrate that soils pool is not a source in Italy, as required by par. 21 of the annex to decision 16/CMP.1).

Art. 3.4 – Forest Management: demonstration that soils pool is not a source

Carbon stock changes in minerals soils, for *Forest land remaining Forest land* and for land under art. 3.4 (*Forest Management*) activities, have been estimated from the aboveground carbon amount with linear relations (SOC = f ($C_{Aboveground}$)), per forestry use – stands (resinous, broadleaves, mixed stands) and coppices, calculated on data collected within the European project Biosoil[35] (for soils) and a Life+ project FutMon[36] (*Further Development and Implementation of an EU-level Forest Monitoring System*), for the aboveground biomass. Soil carbon stocks of mineral soils were assessed down to 40 cm with layer-based sampling (0-10, 10-20, 20-40 cm) on 227 forest plots on a 15x18 km grid. Data have been calculated layer by layer by using measured data of layer depth and soil carbon concentration (704 values), bulk density (543 measured data, 163 estimated data in the field or using pedofunctions) and volume of coarse fragment (704 values estimated in the field). BioSoil assessed also OF and OH layer in which organic material is in various states of decomposition (down to humus). Those layers were included in the estimation of carbon stocks in mineral soils.
In Table 10.2 the different relations used to obtain soil carbon amount per ha [t C ha^{-1}] from the aboveground carbon amount per ha [t C ha^{-1}] have been reported.

[35] BioSoil project – http://biosoil.jrc.ec.europa.eu/; http://forest.jrc.ec.europa.eu/contracts/biosoil
[36] FutMon: Life+ project for the "Further Development and Implementation of an EU-level Forest Monitoring System"; http://www.futmon.org/;
http://www3.corpoforestale.it/flex/cm/pages/ServeAttachment.php/L/IT/D/D.e54313ecaf7ae893e249/P/BLOB%3AID%3D397

Table 10.2 Relations soil - aboveground carbon per ha

	Inventory typology	Relation soil – aboveground C per ha	R^2	Standard error
stands	norway spruce	y = 0.2218x + 73.005	0.0713	40.14
	silver fir	y = 0.2218x + 73.005	0.0713	40.14
	larches	y = 0.2218x + 73.005	0.0713	40.14
	mountain pines	y = 0.2218x + 73.005	0.0713	40.14
	mediterranean pines	y = 0.2218x + 73.005	0.0713	40.14
	other conifers	y = 0.2218x + 73.005	0.0713	40.14
	european beech	y = 0.2502x + 79.115	0.0925	44.10
	turkey oak	y = 0.2502x + 79.115	0.0925	44.10
	other oaks	y = 0.2502x + 79.115	0.0925	44.10
	other broadleaves	y = 0.2502x + 79.115	0.0925	44.10
coppices	european beech	y = 0.2683x + 70.208	0.073	33.39
	sweet chestnut	y = 0.2683x + 70.208	0.073	33.39
	hornbeams	y = 0.2683x + 70.208	0.073	33.39
	other oaks	y = 0.2683x + 70.208	0.073	33.39
	turkey oak	y = 0.2683x + 70.208	0.073	33.39
	evergreen oaks	y = 0.2683x + 70.208	0.073	33.39
	other broadleaves	y = 0.2683x + 70.208	0.073	33.39
	conifers	y = 0.2218x + 73.005	0.0713	40.14
protective	rupicolous forest	y = 0.3262x + 68.648	0.1338	38.96
	riparian forest	y = 0.3262x + 68.648	0.1338	38.96

Linear relationships resulted in different trends for the different forest inventory typologies. In the following table 10.3 the Soil Organic Content (SOC) per hectare, inferred by the use of the linear relationships, are shown for the different inventory typologies and different years.

Table 10.3 Soil Organic Content (SOC) per hectare, for the different inventory typologies

	Inventory typology	1990	1995	2000	2005	2010
		t C ha^{-1}	*t C ha^{-1}*	*t C ha^{-1}*	*t C ha^{-1}*	*t C ha^{-1}*
stands	norway spruce	86.19	85.57	84.99	84.62	84.20
	silver fir	88.02	86.99	86.02	85.71	85.45
	larches	84.42	83.72	83.09	82.90	82.73
	mountain pines	84.47	85.34	86.06	87.13	87.98
	mediterranean pines	83.87	85.62	87.08	88.77	89.90
	other conifers	80.48	81.25	81.88	82.75	83.51
	european beech	99.94	99.68	99.54	99.84	99.91
	turkey oak	95.74	96.02	96.28	96.92	97.22
	other oaks	89.83	90.17	90.52	91.29	91.70
	other broadleaves	90.54	90.62	90.62	91.18	91.53
coppices	european beech	84.02	83.54	83.14	83.10	83.20
	sweet chestnut	84.94	88.08	90.65	93.38	95.96
	hornbeams	76.78	76.42	76.15	76.05	76.03
	other oaks	75.85	76.29	76.54	76.78	76.96
	turkey oak	79.74	79.19	78.74	78.49	78.37
	evergreen oaks	80.19	79.99	79.81	79.81	79.81
	other broadleaves	79.11	80.80	82.15	83.48	84.52
	conifers	80.42	80.85	81.25	81.86	82.45
protec tive	rupicolous forest	77.30	77.82	78.33	78.97	79.48
	riparian forest	84.53	83.93	83.47	83.19	83.00

Table 10.4 Carbon stock changes in mineral soils (Soil Organic Matter (SOM) pool)

Inventory typology	1990	1995	2000	2005	2010
	Gg C	*Gg C*	*Gg C*	*Gg C*	*Gg C*
stands	2,075	2,476	2,296	2,624	2,552
coppices	3,632	4,003	3,832	3,977	4,122
rupicolous and riparian forests	608	690	665	696	700
Total	**6,314**	**7,170**	**6,793**	**7,297**	**7,375**

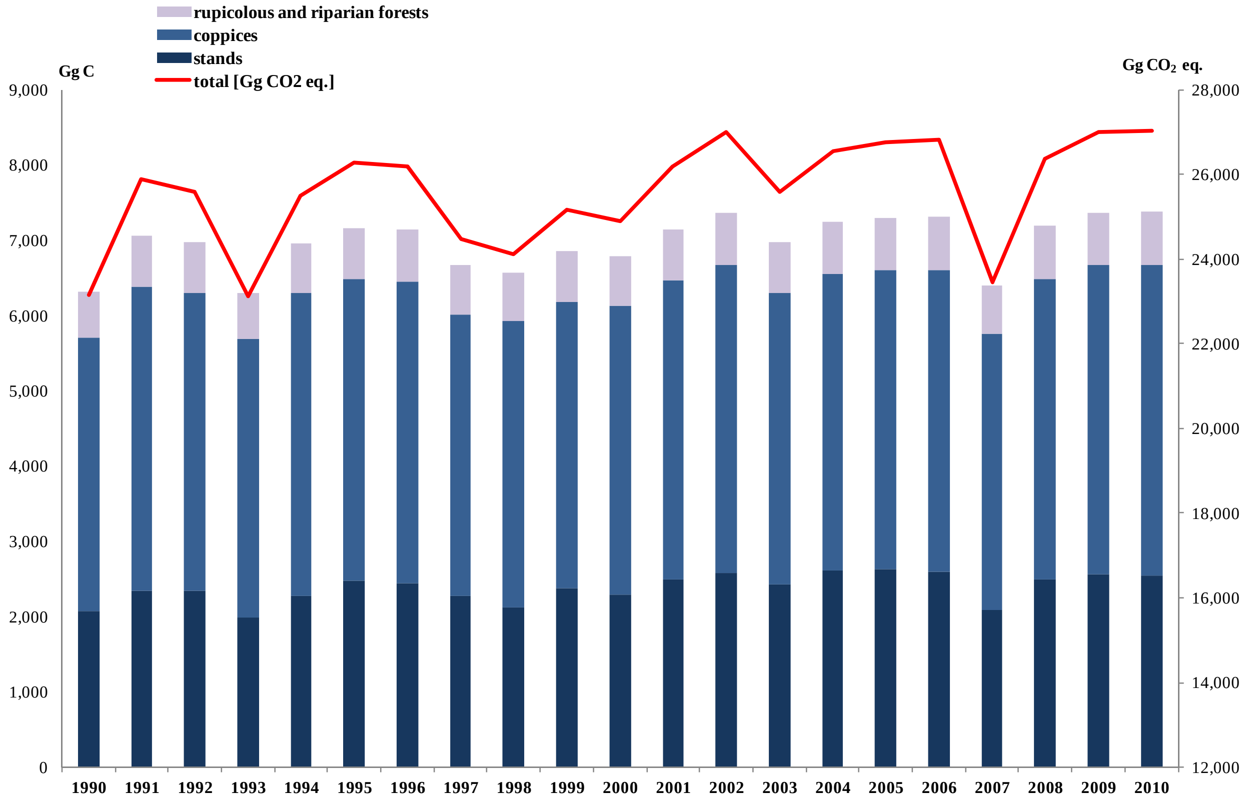

Figure 10.2 Carbon stock changes in mineral soils in the period 1990-2010 (SOM pool)

A comparison of the model results versus data measured in the framework of Italian National Forest Inventory (INFC) may be carried out on the basis of the outcomes of the soil survey of INFC. In the following table 10.5 estimated carbon stocks for SOM and litter, for 2008, are provided:

Table 10.5 Comparison between estimated and INFC 2008 carbon stocks for SOM and litter

2008	INFC	For-est model	*differences*	
	t C= Mg	*t C= Mg*	*t C= Mg*	*%*
SOM	703,524,894	730,243,364	26,718,469	**-3.80**
litter	28,170,660	30,016,553	1,845,893	**-6.55**

In 2011 submission, Montecarlo analysis has been carried out for the CO_2 emissions and removals from Forest Land remaining Forest Land, considering the different reporting pools (aboveground, belowground, litter, deadwood and soils), and the subcategories stands, coppices and rupicolous and riparian forests for the reporting year 2009, resulting equal to 49%. In the following table 10.6, the results of the uncertainty assessment for soils pool are reported:

Table 10.6 Montecarlo uncertainty assessment for soils pool

Uncertainties for the different subcategories, year 2010	
	soils
stands	44.65
coppices	67.35
rupicolous and riparian forests	58.52
total	**49.33**

Table 5(KP-I)A.1.3 Article 3.3 activities: Afforestation and Reforestation. Units of land otherwise subject to elected activities under Article 3.4 (information item)
According to the fact that all Italian forests are managed, the whole area subject to *afforestation/reforestation* should be reported here since otherwise subject to *forest management.*

Table 5(KP-I)A.2.1 Article 3.3 activities: Deforestation. Units of land otherwise subject to elected activities under Article 3.4 (information item)
Only *forest management* has been elected under Article 3.4. As *Deforestation* is a permanent loss of forest cover, any unit of land that has been deforested under Article 3.3 cannot also be subject to *forest management* under Article 3.4.

Table 5(KP-II)1. Direct N_2O emissions from N fertilization
No N fertilization is applied to Italian forests, so emissions are reported as not occurring.

Table 5(KP-II)2. N_2O emissions from drainage of soils
Reporting of these emissions is not mandatory so no estimates are made. There is no activity data on the extent of drainage under *forest management* areas but this is currently under investigation.

Table 5(KP-II)3. N_2O emissions from disturbance associated with land use conversion to cropland.
Deforestation to Cropland has been supposed as not occurring in Italy, as total deforested area was assumed in transition into settlements. New data will become available in 2012, from the activities planned in the framework of the registry for carbon sinks; this will enable this assumption to be re-examined and new estimates to be produced if necessary.

Table 5(KP-II)4. Carbon emissions from lime application
No lime is applied to Italian forests, so emissions are reported as not occurring. This is consistent with UNFCCC reporting, where all liming is assumed to occur in Cropland remaining Cropland.

10.3.1.3 Information on whether or not indirect and natural GHG emissions and removals have been factored out

Italy has not factored out removals from elevated carbon dioxide concentrations, indirect nitrogen deposition or the dynamic effects of age structure resulting from activities prior to 1 January 1990, considering also that GPG do not give methods for factoring out. For the first commitment period, the effect of indirect and natural removals will be considered through the cap under Article 3.4 credits from *forest management*. For Italy the cap is 2.78 Mt C per year.

10.3.1.4 Changes in data and methods since the previous submission (recalculations)

Recalculations of emissions and removals have been carried out on the basis of the IPCC Good Practice Guidance for LULUCF (IPCC, 2003).
Several differences from previous KP-LULUCF submission affect each pool, as a consequence of the application of the main findings of 2011 review process related to soils pool. Actually notable variations from previous submissions are due to the adoption of Italy of the IPCC Tier 1 approach to estimate soil carbon stock changes for land subject to Forest Management activities, as requested by 2011 review process. Furthermore, following the ERT recommendation, Italy has decided to use the IPCC default land use transition period of 20 years, to estimate carbon stock changes in soils pools for afforestation/reforestation activities under art. 3.3 of the Kyoto Protocol. Concerning afforestation/reforestation activities, the 2012 submission results in an average increase of 2.1% in net carbon stock changes for aboveground, an average decrease of 1.2% for belowground pool, an average increase of 0.5% for litter pool as for deadwood pool (increased by 0.9%). A remarkable decrease of 29.7% for soils pool, respect the previous submission, emerges in 2011 submission, resulting from the adoption of the IPCC default land use transition period of 20 years in the estimation process.
Concerning deforestation activities, slight deviation are noticeable respect the previous submission for all pools (average decrease of 0.4% for aboveground, 0.3% for belowground, 0.1% for litter, 0.4% for deadwood and 0.1% for soils), resulting from the detection and correction of computation errors.

With reference to forest management, the 2012 submission results in an average decrease of 39.7% respect the previous submission, mainly due to the adoption of Italy of the IPCC Tier 1 approach to estimate soil carbon stock changes for land subject to Forest Management activities. The differences, respect previous submission, affecting the remaining pools are the results of the correction of computation errors occurred in the previous submission.

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 2010, in the table 10.2.

Table 10.2 Uncertainties for the year 2010

Aboveground biomass	E_{AG}	78.02%
Belowground biomass	E_{BG}	78.02%
Dead mass	E_D	83.59%
Litter	E_L	101.62%
Soil	E_S	113.00%
Overall uncertainty	E_{2010}	68.08%

The uncertainties for Article 3.3 activities estimates are expected to be higher. It can be assumed that the given uncertainty analysis in table 10.2 cover the uncertainty of all gains and all losses in living tree biomass under FM and ARD. The Montecarlo analysis has been implemented for LULUCF sector with particular focus on Forest land category. Detailed description can be found in Annex 1.

10.3.1.6 Information on other methodological issues

Italy has decided to account for the emissions and removals under Article 3 paragraphs 3 and 4 at the end of the commitment period. Activities planned in the framework of the registry for carbon sinks are still in progress, therefore methodologies for area changes detection and the related uncertainties will be further developed. The inventory of land use (IUTI, see Annex 10) has been completed, resulting in land use classification, for all national territory, for the years 1990, 2000 and 2008. A process of validation and verification of IUTI data has been put in place and is expected to supply data useful to update and improve the estimations. Moreover data on the last phase of national forest inventory, covering litter and soils pools, at NUT2 level, will be released in 2012, 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 2010 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

For ARD activities (Art. 3.3) Italy reports all the area subject to these activities since 1990 (that has to be considered the starting year of ARD activities). Furthermore, for each reporting year of the committment period, the area that annually is added to each of art. 3.3 activities has been reported in table NIR-2, for the relevant year.
Concerning Forest Management (Art. 3.4) Italy considers the entire national territory as managed, i.e. subject to human activities, consequently the entire national forest area is subject to human activities that, by-law, are aimed at sustainably manage the forest. Therefore, as described in par. 10.1.3, the whole set of human activities, implemented in forest, are part of the *forest management* activities under art. 3.4 and those activities were already in place before the starting of first commitment period of the Kyoto Protocol.

10.4 Article 3.3

Italy reports all emissions by sources and removals by sinks from 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[37]. 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[38], 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.

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[37] In particular: Law Decree n. 227/2001; Law n. 353/2000; Law 1497/1939; Law Decree n. 3267/1923; 985, Law n. 431

[38] "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.

Table 10.3 Area estimates for 1990, 2008, 2009 2010 and cumulative for 1990-2008, 1990-2009 and 1990-2010 (kha) under Article 3.3 activities Afforestation/Reforestation.

Afforestation/Reforestation	1990	2008	2009	2010	1990-2008	1990-2009	1990-2010
					kha		
Abruzzo	4.8	4.8	4.8	4.7	91	95	100
Basilicata	2.5	2.5	2.4	2.4	47	49	52
Calabria	1.5	1.5	1.9	2.1	29	31	33
Campania	2.8	3.7	3.7	3.6	55	58	62
Emilia-Romagna	7.2	7.2	7.2	7.2	137	144	151
Friuli-Venezia Giulia	3.5	3.5	3.5	3.5	67	71	74
Lazio	6.2	6.2	6.2	6.1	118	124	130
Liguria	0.0	0.0	0.0	0.0	1	1	1
Lombardia	4.0	4.0	4.0	4.0	77	81	85
Marche	4.0	4.0	3.9	3.9	75	79	83
Molise	0.8	0.8	0.8	0.8	16	17	17
Piemonte	9.9	9.9	9.9	9.9	189	199	208
Puglia	1.2	1.2	1.2	1.2	24	25	26
Sardegna	5.3	5.3	5.3	5.3	101	106	111
Sicilia	3.0	3.0	2.9	2.9	56	59	62
Toscana	7.8	7.9	7.8	7.8	149	157	165
Trentino	5.0	5.0	5.0	5.0	96	101	106
Bolzano-Bozen	*2.7*	*2.7*	*2.7*	*2.7*	52	55	58
Trento	*2.3*	*2.3*	*2.3*	*2.3*	44	46	48
Umbria	2.6	2.6	2.6	2.6	50	52	55
Valle d'Aosta	1.0	1.0	1.0	1.0	20	21	22
Veneto	4.4	4.4	4.4	4.4	84	88	92
Italia	**77.7**	**78.6**	**78.6**	**78.6**	1,480	1,558	1,637

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 Article 3.4

Key category analysis for KP-LULUCF was performed according to section 5.4 of the IPCC GPG for LULUCF (IPCC, 2003).
CO_2 emissions and removals from *forest management* (art. 3.4) and from *Afforestation/Reforestation* activities (art. 3.3) have been assessed as key category, in accordance with the IPCC good practice guidance for LULUCF section 5.4.4. The figures have been compared with Table 1.6 Key categories for the latest reported year (2010) based on level of emissions (including LULUCF).

Article 3.3 Afforestation and reforestation (CO_2): CO_2 emissions and removals from the associated UNFCCC subcategory *land converting to forest land* have been identified as key category with approach 2, in trend assessment. Therefore AR is stated to be a key category.

Article 3.4 Forest management (CO_2): The associated UNFCCC subcategory *Forest land remaining Forest land* is a key category in level and in trend assessment (Approach 1). The *forest management* category contribution is also greater than other categories in the UNFCCC key category.

10.7 Information relating to Article 6

Italy is not participating in any project under Article 6 (Joint Implementation).

11 **Information on accounting of Kyoto units**

11.1 Background information

The Standard Electronic Format report for 2011, containing the information required in paragraph 11 of the annex to decision 15/CMP.1 and adhering to the SEF guidelines, has been submitted to the UNFCCC Secretariat electronically (SEF_IT_2012_1_11-5-0 13-1-2012.xls).
The report contains information on unit holdings in the Italian registry at the beginning and at the end of the reporting year as well as on transfers of units in 2011 to and from other Parties of the Kyoto Protocol. The contents of the report (Report R1) can also be found in Annex 8 of this document.

11.2 Summary of information reported in the SEF tables

At the beginning of 2011 the holdings in the Italian registry per unit type were as follow:

- a total of 2,416,336,803 AAUs: 2,185,496,062 in the party holding accounts and 203,840,741 in the entity holding accounts;
- a total of 290,006 ERUs: 287,848 in the party holding accounts and 2,158 in the entity holding accounts;
- a total of 34,874,612 CERs: 15,698,709 in the party holding accounts and 19,175,903 in the entity holding accounts.

At the end of 2011 the holdings in the Italian registry per unit type were as follow:

- a total of 2,383,241,381 AAUs: 1,602,189,698 in the party holding accounts, 213,293,289 in the entity holding accounts and 567,758,394 in the retirement account;
- a total of 2,857,200 ERUs: 2,105,194 in the entity holding accounts and 752,006 in the retirement account;
- a total of 52,430,414 CERs: 23,852,661 in the entity holding accounts and 28,577,753 in the retirement account.

During 2011 the Italian registry received in all 97,610,518 units: 40,163,828 AAUs, 3,357,194 ERUs and 54,089,496 CERs.
Conversely, 110,582,944 units were externally transferred to other national registries: 73,259,250 AAUs, 790,000 ERUs and 36,533,694 CERs.
There were no transactions of any kind involving RMUs, tCERs or lCERs.

At the end of 2011 no RMUs, t-CERs or l-CERs were held in the Italian registry and the total amount of units corresponded to 2,438,528,995 tonnes CO_2 eq. while Italy's assigned amount is 2,416,277,898 tonnes CO_2 eq.

Full details are available in the SEF tables reported in Annex 8.

11.3 Discrepancies and notifications

The list of discrepant transactions for the year 2011, pursuant to 15/CMP.1 annex I.E paragraph 12, has been submitted to the UNFCCC Secretariat electronically (SIAR Reports 2012-IT v1.0.xls - Worksheet R2) along with this document.
From this list the only discrepant transactions with an applicable DES response code are reported in the table below (although code 4003 and 4010 are not assessed as a discrepancy according to the reporting requirements).

DES Response	Average number of occurrences per		Transaction Number	Proposal Date Time	Transaction Type	Final State	Explanation	Units Involved Abbreviated		
	Reported Year	Prior to the Reported Year						Serial Number	Unit Type	Quantity
4003	0,04	0,35								
			IT-26831	2011-04-12 14.02.27	ExternalTransfer	Terminated				
								GR-412852469-	AAU	1500
			IT-26834	2011-04-12 14.08.54	ExternalTransfer	Terminated				
								GR-412852469-	AAU	1500
4010	0,04	0,36								
			IT-26831	2011-04-12 14.02.27	ExternalTransfer	Terminated				
								GR-412852469-	AAU	1500
			IT-26834	2011-04-12 14.08.54	ExternalTransfer	Terminated				
								GR-412852469-	AAU	1500

As for the actions and changes implemented to address discrepancies, two software upgrades resulted in enhanced robustness and reliability of the system.

- the update from Greta version 4.3 to version 5.1 improved performance and reliability by changing the processing of reconciliation messages from a synchronous to an asynchronous process. This ensured that the Registry responds to ITL messages within an appropriate time period, thus eliminating time-out errors. A windows service is used to process the reconciliation messages, improving reliability and making the process more robust by enabling processing failures to be retried. In addition, the reconciliation function was streamlined thus becoming more efficient. Additionally, improvements have been made to the handling of transaction messaging: due to the complexity of the previous implementation and the conceptual simplicity of the requirements, it was decided to completely replace it with a new brand new implementation utilising the new SAM service. Together these changes have resulted in increased reliability of the registry when operating under a higher work load. This effectively increases the capacity of the registry.

- In Greta version 5.2 (integrated in Greta 5.3) a new message flow was introduced. In Q3 2009, the UNFCCC raised a change request to alter the message flow for external transfers. The new message flow introduces an additional step that marks the transaction and unit blocks as proposed in the acquiring registry until the acquiring registry has confirmed acceptance of the unit blocks and the ITL has completed the transaction. The purpose of the additional step is to ensure that a registry cannot transfer units received by external transfer until the ITL have completed the transaction. The new message flow helps reducing the number of discrepant transactions in production.

During the reported period (1st January 2011 - 31st December 2011) no CDM notifications and no non-replacements occurred.
No invalid units exist as at 31 December 2011.

11.4 Publicly accessible information

Non-confidential information required by Decision 13/CMP.1 annex II.E paragraphs 44-48, is publicly accessible through the registry website at http://www.greta.sinanet.isprambiente.it/.

All required information is provided with the following exceptions:
- paragraph 45(e): representative name and contact information is deemed as confidential according to Annex XVI of the EU Registry Regulation No 916/2007/EC;
- paragraph 46: no Article 6 (Joint Implementation) project is reported as conversion to an ERU under an Article 6 project did not occur in the specified period;
- paragraph 47(a)(d)(f): holding and transaction information is provided on an account type level, due to more detailed information being declared confidential by article 75 of EC Regulation 920/2010 as emended by EC Regulation 1193/2011.

11.5 Calculation of the commitment period reserve (CPR)

The commitment period reserve for Italy is 2,174,650,108 tonnes of CO_2 equivalent (or assigned amount units). The CPR is based on the assigned amount and has not changed from the previous submission.

11.6 KP-LULUCF accounting

Italy has decided to account for Article 3.3 and 3.4 LULUCF activities at the end of the commitment period, therefore no information on KP-LULUCF accounting is included in the SEF tables.
In Table 11, information on accounting for the KP-LULUCF activities based on the reporting for the year 2008, 2009 and 2010 are given.

Table 11.1 Information table on accounting for activities under art. 3.3 and 3.4 of the Kyoto Protocol, for 2008, 2009 and 2010

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Net emissions/removals(1)				Accounting Parameters(7)	Accounting Quantity (8)
	2008	2009	2010	Total(6)		
A. Article 3.3 activities						
A.1. Afforestation and Reforestation						-19455
A.1.1. Units of land not harvested since the beginning of the commitment period(2)	-6080	-6668	-6706	-19455		-19455
A.1.2. Units of land harvested since the beginning of the commitment period(2)						
A.2. Deforestation	388	390	392	1170		1170
B. Article 3.4 activities						
B.1. Forest Management (if elected)	-36805	-34448	-36215	-107468		-50967
3.3 offset(3)					0	0
FM cap(4)					50967	-50967

(1) All values are reported in table 5(KP) of the CRF for the relevant inventory year as reported in the current submission and are automatically entered in this table.
(2) In accordance with paragraph 4 of the annex to decision 16/CMP.1, debits resulting from harvesting during the first commitment period following Afforestation and Reforestation since 1990 shall not be greater than credits accounted for on that unit of land.
(3) In accordance with paragraph 10 of the annex to decision 16/CMP.1, for the first commitment period, a Party included in Annex I that incurs a net source of emissions under the provisions of Article 3.3 may account for anthropogenic greenhouse gas emissions by sources and removals by sinks in areas under Forest Management under Article 3.4, up to a level that is equal to the net source of emissions under the provisions of Article 3.3, but not greater than 9.0 megatonnes of carbon times five, if the total anthropogenic greenhouse gas emissions by sources and removals by sinks in the managed forest since 1990 is equal to, or larger than, the net source of emissions incurred under Article 3.3.
(4) In accordance with paragraph 11 of the annex to decision 16/CMP.1, for the first commitment period only, additions to and subtractions from the assigned amount of a Party resulting from Forest Management under Article 3.4, after the application of paragraph 10 of the annex to decision 16/CMP.1 and resulting from Forest Management project activities undertaken under Article 6, shall not exceed the value inscribed in the appendix of the annex to decision 16/CMP.1, times five.
(5) Net emissions and removals in the Party's base year, as established by decision 9/CP.2.
(6) Cumulative net emissions and removals for all years of the commitment period reported in the current submission.
(7) The values in the cells "3.3 offset" and "FM cap" are absolute values.
(8) The accounting quantity is the total quantity of units to be added to or subtracted from a Party's assigned amount for a particular activity in accordance with the provisions of Article 7.4 of the Kyoto Protocol.

12 Information on changes in national system

No changes with respect to last year submission occurred in the Italian National System.

13 **Information on changes in national registry**

13.1 Previous Review Recommendations

The SIAR Report from last year reported the following recommendations:

P2.4.2.2: The party should only report such transactions that are actually considered as discrepancies in the sense of the reporting guidelines.
P2.4.2.4: When providing information respective to changes in the national registry in its next annual report, the Party is encouraged to state clearly whether or not a change occurred for each germane reporting item.

Both recommendations have been addressed in the current submission in the following way:

P2.4.2.2 → According to the SIAR Reporting Requirements and Guidance for Registries report R-2 has been submitted along with this document but only discrepant transactions with an applicable DES response code are reported in the table in paragraph 11.3 (although code 4003 and 4010 are not assessed as a discrepancy according to the reporting requirements).
P2.4.2.4 → A clear statement is provided for each reporting item (either a change has occurred or not) in the following paragraph.

13.2 Changes to National Registry

According to decision 15/CMP.1 Annex II.E, each Party included in Annex I with a commitment inscribed in Annex B shall include in its national inventory report information on any changes that have occurred in its national registry, compared with information reported in its last submission.

In January 2011 ISPRA, as registry administrator, drew up a contract with Innofactor Ltd for the hosting of the production servers (network connectivity and VPN devices) and the provision of data communication services to the production environment.
The changes occurred in the Italian registry during the reporting year are mainly a consequence of the new hosting arrangements and can be identified as follows:

(a) name and contact information of the registry administrator designated by the Party to maintain the national registry
No change in the name or contact information of the registry administrator occurred during the reported period.
(b) names of the other Parties with which the Party cooperates by maintaining their national registries in a consolidated system
No change of cooperation arrangement occurred during the reported period.
(c) database structure and capacity of the national registry
The changes are due to major change of the registry hardware infrastructure and to upgrades to new versions of the software. For a description of the changes please refer to point (c) in Annex 11. Relevant updated readiness documentation (Database and Application Backup plan, Disaster Recovery plan, Test Plan, Test Report) has been submitted along with the NIR.
(d) national registry conformance to the technical standards for data exchange between registry systems
No change in the registry's conformance to technical standards occurred for the reported period.
(e) procedures employed in the national registry to minimize discrepancies and steps taken to terminate transactions and to correct problems
The change is a consequence of the upgrade to new software versions. For a description of the changes please refer to point (e) in Annex 11. Relevant updated readiness documentation (Test Plan, Test Report) has been submitted along with the NIR.
(f) security measures employed in the national registry to prevent unauthorized manipulations and to prevent operator error
The change is a consequence of the modifications in security procedures. For a description of the change please refer to point (f) in Annex 11. Relevant updated readiness documentation (Security Plan, Operational Plan) has been submitted along with the NIR
(g) information publicly accessible by means of the user interface to the national registry
No change to the list of publicly available information occurred during the reporting period.
(h) Internet address of the interface to its national registry
No change of the registry Internet address occurred during the reporting period.
(i) measures taken to safeguard, maintain and recover data in order to ensure the integrity of data storage and the recovery of registry services in the event of a disaster
The change is a consequence of the location of a new disaster recovery site and the revision of the disaster recovery plan and backup procedures. For a description of the change please refer to point (i) in Annex 11. Relevant updated readiness documentation (Application Logging documentation, Disaster Recovery Plan, Test Plan, Test Report) has been submitted along with the NIR.
(j) results of any test procedures
Test results and release notes for version 5.1, 5.2 and 5.3 of the Greta registry software have been submitted along with the NIR.

14 **Information on minimization of adverse impacts in accordance with Article 3, paragraph 14**

14.1 Overview

In the framework of the EU Burden Sharing Agreement, Italy has committed to reduce its GHG emissions by 6.5% below base-year levels (1990) over the first commitment period, 2008-2012. After the review of the initial report of Italy under the Kyoto Protocol (KP), the Kyoto objective was fixed in 483.255 MtCO_2 per year for each year of the "commitment period" (UNFCCC, 2007; MATTM, 2009).

In this section Italy provides an overview of its commitments under Article 3.1, and specifically how it is striving to implement individually its commitment under Article 3 paragraph 14 of the KP. Under Article 3.14 of the KP:
"Each Party included in Annex I shall strive to implement the commitments mentioned in paragraph 1[39] 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[40], of the Convention. In line with relevant decisions of the Conference of the Parties on the implementation of those paragraphs, the Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, consider what actions are necessary to minimize the adverse effects of climate change and/or the impacts of response measures on Parties referred to in those paragraphs. Among the issues to be considered shall be the establishment of funding, insurance and transfer of technology.

For the preparation of this chapter ISPRA has collected information through the revision of peer review international articles on sustainable development (SD) of ex-ante/ex-post assessments related to activities on climate change mitigation, and through personal communication with people/institutions involved in project/programs/policy implementation of climate change activities. Moreover, experts from the Ministry for the Environment, Land and Sea (*Ministero dell'Ambiente e della Tutela del Territorio e del Mare*, MATTM) and the Directorate General for Development Co-operation (DGCS) from the Ministry of Foreign Affairs (*Ministero degli Affari Esteri,* MAE) were contacted. This chapter has been updated with new information according to the on-going activities at national and international level.

As the reporting obligation related to Article 3, paragraph 14 does not include an obligation to report on each specific mitigation policy. Italy briefly describes how EU is striving to minimize adverse impacts, because Italy is member of the European Union, thus incorporated into its European legal system to implement directives/policies; and individually how is striving to implement Article 3.14 with specific examples.
Two main parts are requested under Article 3.14 for reporting purposes: commitments to minimize adverse effects (section 14.2, 14.3) and priority actions (section 14.4, 14.5). Future improvements/research activities are expected for next submissions (section 14.6).

14.2 European Commitment under Art 3.14 of the Kyoto Protocol

The EU is well aware of the need to assess impacts, and has built up thorough procedures in line with obligations. This includes bilateral dialogues and different platforms that allow interacting with third

[39] **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."

[40] **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."

countries, explain new policy initiatives and receive comments from third countries. Impacts on third countries are mostly indirect and can frequently neither be directly attributed to a specific EU policy, nor directly measured by the EU in developing countries. A wide-ranging impact assessment (IA) system accompanying all new policy initiatives has been established. This approach ensures that potential adverse social, environmental and economic impacts on various stakeholders are identified and minimized within the legislative process (European Commission, 2010[b]).

At European level, IA is required for most important Commission initiatives, policy and programs and those which will have the most far-reaching impacts. In 2009, IA was adopted, replacing the previous Guidelines 2005 and also the 2006 update. In general, the IA evidence advantages and disadvantages of possible policy options by assessing their potential impacts. Among different issues, it should be assessed which are the likely social, environmental and economic impacts of those options (European Commission, 2009[a]). Since 2003 all IA of EU policies are listed and published online by subject (European Commission, 2010[a]). Key questions on economic, social and environmental impacts in relation to third countries are listed in Table 14.1.

Table 14.1 Questions in relation to impacts on Third countries

Economic	Social	Environmental
• How does the policy initiative affect trade or investment flows between the EU and third countries? How does it affect EU trade policy and its international obligations, including in the WTO? • Does the option affect specific groups (foreign and domestic businesses and consumers) and if so in what way? • Does the policy initiative concern an area in which international standards, common regulatory approaches or international regulatory dialogues exist? • Does it affect EU foreign policy and EU development policy? • What are the impacts on third countries with which the EU has preferential trade arrangements? • Does it affect developing countries at different stages of development (least developed and other low-income and middle income countries) in a different manner? • Does the option impose adjustment costs on developing countries? • Does the option affect goods or services that are produced or consumed by developing countries?	• Does the option have a social impact on third countries that would be relevant for overarching EU policies, such as development policy? • Does it affect international obligations and commitments of the EU arising from e.g. the ACP-EU Partnership Agreement or the Millennium Development Goals? • Does it increase poverty in developing countries or have an impact on income of the poorest populations?	• Does the option affect the emission of greenhouse gases (e.g. carbon dioxide, methane etc) into the atmosphere? • Does the option affect the emission of ozone-depleting substances (CFCs, HCFCs etc)? • Does the option affect our ability to adapt to climate change? • Does the option have an impact on the environment in third countries that would be relevant for overarching EU policies, such as development policy?

Source: European Commission, 2010[b]

A review of European response measures for two EU policies were chosen for further description because the IA identified potential impacts on thirds countries. These measures are the Directive 2009/28/EC on the promotion of the use of renewable energy, and the EU emission trading scheme for the inclusion of the aviation (see European Commission, 2009[b]; European Commission, 2010[b]).

Directive on the promotion of the use of renewable energy

EU will reach a 20% share of energy from renewable sources in the overall energy consumption by 2020 (with individual targets for each Member State) and a 10% share of renewable energy specifically in the transport sector, which includes biofuels, biogas, hydrogen and electricity from renewables. IAs related to enhanced use in the EU showed that the cultivation of energy crops have positive (growing of EU demand for bioenergy generates new export revenues and employment opportunities for developing countries and boosts rural economies), and negative (biodiversity, soil and water resources and have positive/ negative effects on air pollutants) impacts. For this reason, Article 17 of the EU's Directive has created "sustainability criteria", applicable to all biofuels (biomass used in the transport sector) and bioliquids, which consider to establish a threshold for GHG emission reductions that have to be achieved from the use of biofuels; to exclude the use of biofuels from land with high biodiversity value (primary forest and wooded land, protected areas or highly biodiverse grasslands), and to exclude the use of biofuels from land with high C stocks, such as wetlands, peatlands or continuously forested areas. In this context, developing country representatives as well as other stakeholder were extensively consulted during the development of the sustainability criteria and preparation of the directive and the extensive consultation process has been documented. The Commission will also report on biofuels' potential indirect land use change effect and the positive and negative impact on social sustainability in the Union and in third countries, including the availability of foodstuffs at affordable prices, in particular for people living in developing countries, and wider development issues. The first reports will be submitted in 2012 (European Commission, 2010[b]).

Inclusion of aviation in the EU emission trading scheme
In 2005 the Commission adopted a Communication entitled "Reducing the Climate Change Impact of Aviation", which evaluated the policy options available to this end and was accompanied by an IA. The assessment concluded that, in view of the likely strong future growth in air traffic emissions, further measures are urgently needed. Aircraft operators from developing countries will be affected to the extent they operate on routes covered by the scheme. As operators from third countries generally represent a limited share of emissions covered, the impact is also modest. On the other hand, to the extent that aviation's inclusion in the EU ETS creates additional demand for credits from JI and CDM projects, there will also be indirect positive effects as such projects imply additional investments in clean technologies in developing countries (European Commission, 2010[b]).

Common Agricultural Policy
Furthermore, many developing countries and least developed countries (LDC) are based on the agricultural production, therefore, it will be important to understand how the *EU Common Agricultural Policy (CAP) Health Check*, together with the new targets on climate change and renewable energies will potentially influence developing countries. Some information on cereal intervention options on third parties have been identified (European Commission, 2008). Some studies on the impact of agricultural policies on developing countries are also available (Schmidhuber, 2009; Hallam, 2010). Brooks et al (2010) has recently presented DEVPEM[41] a companion to the OECD-country PEM[42] as a tool for policy evaluation in developing countries. Preliminary results for Malawi indicate that agricultural policies may have fundamentally different impacts on incomes in low income countries to those obtained in developed OECD countries.

14.3 Italian commitment under Art 3.14 of the Kyoto Protocol

Article 3, paragraph 14 of the KP is related to Annex I Parties' way of implementing commitments under Article 3.1 of the KP. Therefore, it addresses the implementation of the quantified emission limitation and reduction objectives (QELROs) under Article 3.1, the implementation of LULUCF activities under Article 3 paragraphs 3 and 4, the use of Emission Reduction Units (ERUs) and Certified Emission Reductions (CERs) under Article 3 paragraphs 10, 11, and 12.
Italy is aware of the potential direct and indirect impact of measures/policies and tries to ensure that the implementation of national mitigation policies under the KP does not impact other parties. Minimizing adverse effects of policies/measures are described in Chapter 4.6 in the Fifth National Communication (MATTM, 2009). Information of activities under Article 3 paragraphs 3 and 4 of the KP is described in 'Chapter 10' KP-LULUCF' of this report.

National and sectoral Italian policies are expected to have no direct impacts in developing countries. Policies and measures in the Italian energy sector aim to increase energy efficiency and develop a low-carbon energy system but in the context of a global energy scenarios that do not foresee a decline in income for fossil fuel exporting countries (IEA, World Energy Outlook 2008).

Efforts to tackle adverse social, economic, and environmental impacts of mitigation actions are directly expected in the framework of the Kyoto Mechanisms. Hence, this chapter has concentrated efforts to analyze the Clean Development Mechanism and Joint Implementation in order to provide response to reporting requirements under Article 3.14 of KP.

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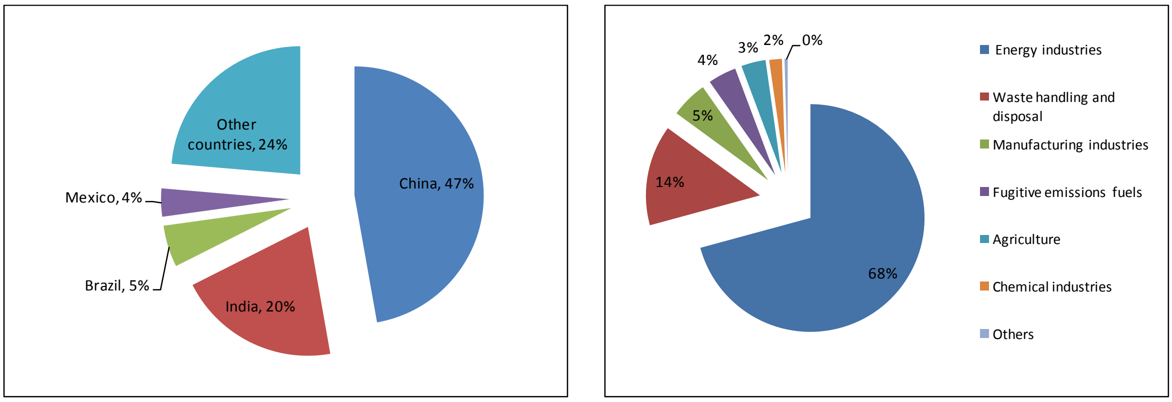
[41] DEVPEM, Development Policy Evaluation Model
[42] PEM, Policy Evaluation Model examine the effects of agricultural policies in member countries

Procedure for assessing sustainability at local and national level for CDM and JI

The Clean Development Mechanism (CDM), defined in Article 12 of the KP, allows a country with an emission-limitation commitment (Annex B Party) to implement an emission-reduction project in developing countries.

For this section, information was collected from the UNFCCC CDM Project Search Database (UNFCCC, 2011[a]). Direct contact with experts involved in the CDM project cycle and peer review article were revised. By the time CDM database was consulted world-wide 82.5% of CDM projects were registered in Asia and the Pacific Region, 15.0% in Latin America and Caribbean, 2.1% in Africa, and 0.4% Eastern Europe. The distribution of registered projects by scope activity was mainly: energy industries (68.2%), waste handling and disposal (13.7%) and manufacturing industries (5%). Registered projects by Host Party were mainly in China (47.2%), India (20.4%), Brazil (5.2%) and Mexico (3.5%). The distribution of CDM projects by Host country and scope is presented in Figure 14.1.

Italy as investor Party, contributes with 1.7% of world-wide CDM project portfolio. Italy is involved in more than 100 CDM projects at different stage, and is involved directly, as government, in 27 registered CDM (MATTM, 2011[a]). Up to day Italy is involved in 77 CDM registered projects (UNFCCC, 2012[a]), which means 33% more projects respect to the beginning of 2011. Projects by dimension are 53.2% large scale and 46.8% small-scale. Italy is the only proposer for 44.2% of the CDM projects. In Annex A8.2.4 a complete list of CDM projects is available.



Source: UNFCCC (2012[a])

Figure 14.1 Italian CDM projects by Host country and scope (as for 15/02/2012)

Parties should follow a project cycle to propose CDM projects (first designing phase and realization phase). During the first phase, among other activities, Parties participating in the CDM shall designate a national authority (DNA). Each Host Party has implemented a procedure for assessing CDM projects. The DNA evaluates project documentation against a set of pre-defined criteria, which tend to encompass social, environmental and economic aspects. For instance, India has SD criteria such as the social, economic, environmental and technological 'well-being'. Instead, China discriminated projects by priority area and by gas based-approach (Olsen and Fenhann, 2008; Boyd et al., 2009).

Most of the CDM projects (if large-scale) are subject to ex-ante assessments. For instance, environmental impact assessments (EIA) are required. In other cases, because of the size of the project, EIA are not necessary. Still some CDM projects have performed voluntary EIA. This is the case for the *Santa Rosa* Hydroelectric CDM project in Peru (Endesa Carbono, 2010). After, a second evaluation is performed by the DNA as described previously. For example, in the Peruvian DNA, the process follows the: submission of the project to the Ministry of competence on the activities, a site visit of the project done by the Ministry of Environment, and the conformation of an *ad hoc* committee that evaluate projects considering legal, social, environmental and economic criteria (MINAM, 2010). Thus, possible impacts of the CDM projects are mainly subject to local and national verification.

In some cases, an ex-post assessment could be also performed by the Designated Operational Entities (DOE), which validated CDM projects and certifies as appropriate and requests the Board to issue CERs. For some CDM projects, for instance, *Poechos I* Hydroelectric project (Peru), CERs are approve only if the project complies also with social and environmental conditions (Endesa Carbono, 2010). In addition, Italy agreed to accept in principle common guidelines for approval of large hydropower project activities. EU Member

States have arrived at uniform guidelines on the application of Article 11b(6) of the Directive 2004/101/EC to ensure compliance (of such projects) with the international criteria and guidelines, including those contained in the World Commission on Dams 2000 Report. It aims to ensure that hydro projects are developed along the SD and the not damaging to the environment (exploring possible alternatives) and addressing such issues as gaining public acceptance, and fair and equitable treatment of stakeholders, including local and indigenous people (MATTM, 2010[a]).
Another feedback for participating to CDM project with SD characteristics comes from the carbon funds. For instance, Italy participates to the *BioCarbon Fund* (BCF), the *Community Development Carbon Fund* (CDCF) and the *Italian Carbon Fund* (ICF). The first two funds aim to finance projects with strong **social** impact at local level, that combine community development attributed with emission reductions and will significantly improve the life of the poor and their local environment (MATTM, 2010[a]). Italian CDM projects which are under the CDCF initiative are listed in Annex A8.2.4.

The Joint implementation (JI) is defined in Article 6 of the KP allowing a country with a limitation commitment (Annex B) to earn emission reduction units (ERUs) from an emission-reduction or emission removal project in another Annex B Party. Two procedures could be followed. 'Track 1' procedures apply when the Host Party and investors meets all of the eligibility requirements to transfer and/or acquire ERUs, and the project is additional to any that would otherwise occur. 'Track 2' applies when the Host Party fulfils with a limited set of eligibility requirements or there is not an institutional authority able to follow up the project cycle. In this case the project should go through the verification procedure under the Joint Implementation Supervisory Committee (JISC). The development of the project is divided in a design and implementation phases (see MATTM 2011[b]). Parties involved in JI activities should designated focal point for approving projects, and prepared Guidelines and Procedures for approving Art.6 Projects, including the consideration of stakeholders' (MATTM, 2010[b]). By the time the JI database was consulted no JI projects were found for Italy (UNFCCC, 2012[b]). However, in the Italian Carbon Fund the 'Russian Federation: Rosneft Associated Gas Recovery Project for the Komsomolskoye Oil Field' project is under a validation phase (Carbon Finance, 2012).
Voluntary validation of sustainable development is taking place at international level for CDM and JI projects. The UNEP Risoe Centre database[43] highlights the Gold Standard (GS) and the Climate, Community and Biodiversity Alliance (CCB) for assessing SD on CDM project, and only GS for JI projects. The GS operates a certification scheme for premium quality carbon credits and promotes sustainable development (GS label). Indicators include air/water quality, soil condition, biodiversity, quality of employment, livelihood of the poor, access to affordable and clean energy services, etc (Gold Standard, 2011). After labelling, these projects are tracked in the UNFCCC/CDM Registry. The CCBA is a voluntary standard, which support the design and identification of land management activities that simultaneously minimize climate change, support sustainable development, and conserve biodiversity. Project design standards include: climate, community, and biodiversity indicators (CCBA, 2011). By the 1 February 2012, the UNEP Risoe database reports 552 JI projects (track1+track2) from which 314 projects are registered (88,2% track 1+11,8% track 2). By the 1 February 2012, from all registered CDM 14 projects (2 projects for submission 2011) were validated with CCB, and 149 projects with GS (79 projects for submission 2011).

Assessment of social, environmental, and economic effects of CDM and JI projects
The assessment of adverse social, environmental, and economic impacts contribution of CDM projects has been concentrated in the energy sector (or non-forestry CDM projects). Results from most relevant peer-review literature are available in this section.
Most common used methodologies for assessing sustainability are checklists and multicriteria assessments (Olsen 2007). For instance, Sirohi (2007) has qualitatively analyzed and discussed the Project Design Document (PDD) of 65 CDM projects covering all the types of CDM project activity in India. Results from this paper show that the benefits of the projects focusing on improving energy efficiency in industries, fossil fuel switching in industrial units and destruction of HFC-23 would remain largely "firm-specific" and are unlikely to have an impact on rural poverty. Boyd et al. (2009) have chosen randomly 10 CDM projects that capture diversity of project types and regions. Environment and development benefits (environment, economic, technology transfer, health, employment, education and other social) were assessed qualitatively. This review shows divergences and no causal relationship between project types and SD outcomes. Sutter

[43] http://uneprisoe.org/

and Parreño (2007) assessed CDM projects in terms of their contribution to employment generation, equal distribution of CDM returns, and improvement of local air quality. The multi-attribute assessment methodology (MATA-CDM) for non-forestry CDM projects was used for assessing 16 CDM projects registered at UNFCCC as of August 30, 2005. Results indicated that projects might contribute to one of the two CDM objectives (GHG emission reductions and SD in the Host country), but neither contributes strongly to both objectives. Uruguay's DNA has adopted this tool for approval of CDM projects. Nussbaumer (2009) has presented a SD assessment of 39 CDM projects. Label CDM projects ('Gold Standard' label and CDCF focuses) were compared to similar non-labelled CDM projects. Results show that labelled CDM activities tend to slightly outperform comparable projects, although not unequivocally. Nussbaumer selected criteria based on those from Sutter (2003) including social (stakeholder participation, improved service availability, equal distribution, capacity development), environmental (fossil energy resources, air quality, water quality, land resource) and economic (regional economy, microeconomic efficiency, employment generation, sustainable technology transfer) issues.
Some studies have also addressed the assessment of forestry CDM projects. Olsen and Fenhann (2008) have developed a taxonomy for sustainability assessment based on PDD text analysis. These authors concluded that the taxonomy can be supportive of DNAs to decide what the consequences should be, if a CDM project at the verification stage does not show signs of realizing its potential SD benefits. Palm et al (2009) developed a ranking process to assess sustainability of forest plantation projects in India. They concluded that successful implementation of forest-based project activities will require local participation and are likely to involve multiple forest products and environmental services demanded by the local community. For the first time an study has addressed the choice of an appropriate method for measuring strong sustainability. In a decision-aiding process, 10 UNFCCC/CDM afforestation/reforestation projects were evaluated through criteria that reflect global and local interests using a non-compensatory multicriteria method. Criteria for assessing SD included: social (land tenure, equitably share natural, skill development, ensure local participation), economic (employment, financial resource to local entities, financial forestry incentives) and environmental (use of native species, conservation and maintenance of soil/water resources, biodiversity conservation) issues. The multicriteria assessment allows sorting forestry projects in three ordered categories: synergistic, reasonably synergistic, and not synergistic. This means that those projects, which are synergistic comply with a higher number of criteria (Cóndor et al., 2010).
A recent report from the UNFCCC concluded that most studies of hydrofluorocarbon and nitrous oxide related projects yield the fewest SD benefits, but the studies differ in their assessment of other project types. It also reports that other studies suggest a trade-off between the goals of the CDM in favour of producing low-cost emission reductions at the expense of achieving SD benefits (UNFCCC, 2011[b]).

For this section we have accessed project databases (UNFCCC, Carbon Finance, UNEP Risoe Centre) and peer-reviewed articles. Nineteen out from seventy-seven registered CDM projects (24.7%), in which Italy is involved, has participated to an international SD assessment (see Annex A8.2.4 for detailed information on CDM research studies). For non-forestry CDM projects, Nussbaumer (2009) have published results of SD assessment from Honduras and Peru (Hydroelectric), Nepal (Biogas), Argentina (landfill), Moldova (Biomas), India (small hydroelectric and wind) and China (hydropower), and Sirohi (2007) for projects in India (biomass, F-gas, hydroelectric). For forestry CDM projects, Cóndor et al. (2010) has assessed 3 out from 13 CDM projects in which Italy is involved. 'The Moldova Soil Conservation' project was classified as a 'synergistic' project, while the 'Assisted Natural Regeneration of Degraded Lands' project in Albania and the 'Facilitating Reforestation for Guangxi Watershed Management' project in China were classified as 'reasonably synergistic'. The higher the assignment of the project, the better the performance respect to social, economic and environmental criteria including climate change, biodiversity and desertification issues.

Most articles found for JI are related with institutional arrangements (Evans et al., 2000; Streimikiene and Mikalauskiene, 2007; Firsova and Taplin, 2008) or the integration of JI with other mechanisms such as the white certificates (Oikonomou and van der Gaast, 2008). On peer-review article, no much information was found regarding JI and SD assessment. However, Cha et al. (2008) developed Environmental-Efficiency and Economic-Productivity indicators to choose an environmentally and economically-efficient CDM and JI project.

14.4 Funding, strengthening capacity and transfer of technology

According to Art 3.14 of the KP information on funding and transfer of technology need to be described, thus, brief information is provided in this section.

The flow of financial resources to developing countries and multilateral organisations from Italy is shown in Table 14.2 (OECD, 2011). Between 2006 and 2008 the Ministry of Foreign Affairs has contributed with around 30 million EUR in bilateral and multilateral cooperation with developing countries for climate change related activities. In order to contribute to the implementation of the commitment foreseen in the “Bonn Declaration”, since 2002 the Ministry for the Environment, Land and Sea, has been authorized to finance bilateral and multilateral activities in developing countries for 55.1 million EUR/year as of 2008 (MATTM, 2009). A recent peer review report of the Development Assistance Committee (DAC) describes bilateral and multilateral cooperation funding activities in Italy. The Directorate General for Development Co-operation (DGCS) from the Ministry of Foreign Affairs in collaboration with other players in Italian Co-operation is in charge of implementing recommendations (OECD, 2009). The most important institutional actor is the Ministry for the Environment, Land and Sea, because of its contribution to implementing the Kyoto Protocol and other Rio conventions in developing countries.
The Ministry of Foreign Affairs defined the Programming Guidelines and Directions of Italian Development Co-operation 2011-2013, where priority areas are identified (MAE, 2010[c]): i) agriculture/food security; ii) human development, particularly referred to health and education/training; iii) governance and civil society; iv) support for endogenous development, inclusive and sustainable, the private sector, and v) environment, land and natural resources management, particularly referred to water and mitigation/adaptation to climate change. The aid effectiveness is a top priority for the Italian cooperation as described in the ‘Aid Effectiveness Action Plan’ (DGCS, 2009). The Ministry of Foreign Affairs has a database of environmental projects available online (DGCS, 2011). The ecosystem approach management is a strategy adopted by Italian cooperation. In the environment field, projects that have been monitored by the Central Technical Unit/DGCS - Ministry of Foreign Affairs, are subject to field visit and ex-post assessments in order to verify compliance in the framework of climate change activities (MAE, 2010[a]).

Table 14.2 Financial resources to developing countries and multilateral organisations from Italy

	Italy				
	1998-99	**2006**	**2007**	**2008**	**2009**
NET DISBURSEMENTS			**USD million**		
I. Official Development Assistance (ODA) (A + B)	2 042	3 641	3 971	4 861	3 297
ODA as % of GNI	**0.17**	**0.20**	**0.19**	**0.22**	**0.16**
A. Bilateral Official Development Assistance (1 + 2)	574	2 001	1 270	1 838	875
1. Grants and grant-like contributions	588	2 147	1 252	1 919	871
of which: Technical co-operation	47	171	141	153	90
Developmental food aid	41	6	15	54	40
Humanitarian aid	54	74	83	119	114
Contributions to NGOs	19	10	-	0	0
Administrative costs	26	56	49	67	59
2. Development lending and capital	- 13	- 146	19	- 81	4
of which: New development lending	- 73	- 155	36	- 71	0
B. Contributions to Multilateral Institutions	1 468	1 640	2 700	3 022	2 423
Grants and capital subscriptions, Total	1 468	1 640	2 700	3 022	2 423
of which: EU	693	1 316	1 494	1 713	1 862
IDA	394	30	35	556	214
Regional Development Banks	165	16	10	351	24
II. Other Official Flows (OOF) net (C + D)	- 95	- 957	- 261	408	- 72
C. Bilateral Other Official Flows (1 + 2)	- 95	- 957	- 261	408	- 72
1. Official export credits (a)	13	38	81	34	- 28
2. Equities and other bilateral assets	- 108	- 995	- 342	374	- 44
D. Multilateral Institutions	-	-	-	-	-
III. Grants by Private Voluntary Agencies	34	123	63	105	162
IV. Private Flows at Market Terms (long-term) (1 to 4)	10 273	2 705	649	207	2 181
1. Direct investment	1 734	1 151	1 353	1 544	129
2. Private export credits	455	2 602	2 843	2	463
3. Securities of multilateral agencies	-	-	-	-	-
4. Bilateral portfolio investment	8 083	-1 049	-3 547	-1 339	1 590
V. Total Resource Flows (long-term) (I to IV)	**12 254**	**5 512**	**4 422**	**5 581**	**5 569**
Total Resource Flows as a % of GNI	**1.05**	**0.30**	**0.21**	**0.25**	**0.27**

Source: OECD (2011) http://www.oecd.org/document/9/0,3746,en_2649_34447_1893129_1_1_1_1,00.html

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 (MATTM, 2007; 2009).

The DGCS of the Ministry of Foreign Affairs is contributing with bilateral projects in the energy sector, for example, in Albania, Bangladesh, Sierra Leone and Palestinian territories (improvement of electric system or

[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).

hydroelectric power generation) (DGCS, 2011). An example is the hydroelectric project in Ethiopia that has been supported by the Ministry of Foreign Affairs. Next step of this project will be an ex-post assessment of adverse effects through the use of the OECD-DAC guidelines (MAE, 2010[b]). These guidelines include the assessment of the relevance, effectiveness, efficiency, impact (positive/negative) and sustainability of the activities (OECD, 2008). In June 2010 the guidelines for on-going and ex- post evaluation of official development assistance implemented by the DGCS-Ministry of Foreign Affairs were published (MAE, 2010[d]).

Evidence of technology transfer activities were found in the context of the Kyoto Mechanisms. An study analyzed comprehensively technology transfer in the CDM: 3296 registered and proposed projects (Seres et al., 2009). Results address that roughly 36% of the projects accounting for 59% of the annual emission reductions claim to involve technology transfer. These authors concluded that as the number of projects increases, technology transfer occurs beyond the individual projects. This is observed for several of the most common project types in China and Brazil with the result that the rate of technology transfer for new projects in those countries has fallen significantly.

14.5 Priority actions in implementing commitments under Article 3 paragraph 14

For the purposes of completeness in reporting, and according to the reporting guidelines for supplementary information (UNFCCC, 2002), a summary of how Italy gives priority to the actions specified in Decision 15/CMP.1, paragraph 24 is given below. More detailed information is found in the Fifth National Communication under the UNFCCC, Chapter 5 Projections and effects of policies and measures and Chapter 7 Financial resources and transfer of technology (MATTM, 2009). The preparation of this paragraph was discussed with energy experts from ISPRA (ISPRA, 2011[a], [b]).

Paragraph 24 (a)
The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities.

EU emissions trading scheme, promotion of biomass and biofuel, Common Agricultural Policy can potentially have impacts in developing countries (European Commission, 2009[b]; 2010[b]). Italy is subject to the European legal system and it will implement the EU legislation. At national level, it is not planned to further increase biomass – biofuel objectives already established (ISPRA, 2011[a]).

Paragraph 24 (b)
Removing subsidies associated with the use of environmentally unsound and unsafe technologies.

Council regulation EC No 1407/2002 rules for granting state aid to contribute to restructure coal industry (European Commission, 2010[b]). Anyway, Italy has a negligible domestic coal production.

Paragraph 24 (c)
Cooperating in the technological development of non-energy uses of fossil fuels, and supporting developing country Parties to this end.

At European level and national level, ‘non-energy uses of fossil fuels’ is not a current research priority (European Commission, 2010[b]).

Paragraph 24 (d)
Cooperating in the development, diffusion, and transfer of less greenhouse gas emitting advanced fossil-fuel technologies, and/or technologies relating to fossil fuels that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other non-Annex I Parties in this effort.

The ongoing activities on multilateral and bilateral Italian cooperation are coordinated through the Ministry of Foreign Affairs and the Ministry for the Environment, Land and Sea, see MATTM (2009).
For example, Italy has signed with India a Memorandum of Understanding (MoU) on “Co-operation in the Area of Climate Change and Development and Implementation of Projects under the CDM/ Kyoto Protocol”. In this framework, the MATTM supported a project on Carbon Sequestration Potential Assessment.
The Italian Government has already funded research on carbon capture and storage (CCS) technologies carried out by several organizations and institutions: total value 10-15 million euro for the period 2009-2011. A draft decree transposing EU directive 2009/31/CE in the Italian legislation has been presented to the Parliament by the MATTM and the Ministry for Economic Development. ENEL and ENI, the two major energy utilities in the country, have signed a general agreement for CCS development and will apply for EU funds to set up a pilot unit in Brindisi and a demonstration unit in Porto Tolle. At the international level, Enel is developing a project to build a CO_2 capture system in China and has signed agreements for the development of CCS with other countries like South Korea (ISPRA, 2011[b]).

Paragraph 24 (e)
Strengthening the capacity of developing country Parties identified in Article 4, paragraphs 8 and 9, of the Convention for improving efficiency in upstream and downstream activities relating to fossil fuels, taking into consideration the need to improve the environmental efficiency of these activities.

The ongoing activities on multilateral and bilateral Italian cooperation are coordinated through the Ministry of Foreign Affairs and the Ministry for the Environment, Land and Sea, see MATTM (2009).
For example, in Central Eastern Europe Italy has multilateral activities within the Regional Environmental Center for Central and Eastern Europe (REC CEE). More than 100 projects have been implemented for the region, specifically, to climate change and energy issues, several programs were carried out on training and capacity building, energy efficiency in small and medium-sized enterprises, public access to information and participation in climate decision-making processes, promotion of climate change mitigation and adaptation policies, development of solar passive and active systems and development of national GHG emission registries.

Paragraph 24 (f)
Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies.

The ongoing activities on multilateral and bilateral Italian cooperation are coordinated through the Ministry of Foreign Affairs and the Ministry for the Environment, Land and Sea, see MATTM (2009). For example, within the framework of the Mediterranean Renewable Energy Programme (MEDREP) Initiative, the MATTM has signed a MoU with UNEP-DTIE in order to carry out projects helping the establishment of a regional RET market in the Mediterranean region (Tunisia, Egypt, Montenegro and Albania). After, the Mediterranean Investment Facility was launched aiming to the development (2007–2011) of several projects having an important impact on CO_2 emissions by diversifying the use of small scale renewable energy and energy efficiency technologies by targeting different niche markets.
In 2007, the MATTM supported the “Observatory for Renewable Energy in Latin America and the Caribbean” through the signature of a Trust Fund Agreement with UNIDO. Activities are focused on biomass utilization in Uruguay and Brazil in order to reduce the methane emissions and the GHGs’ climate change effects, promoting the utilization of bio-digester plants for the electricity production into the livestock farms, based on a local energy management distributed generation system.

14.6 Additional information and future activities related to the commitment of Article 3.14 of the Kyoto Protocol

Italy is aware of its commitments under Article 3.14 of KP, and it is also well aware of the need to assess social, environmental and economic impacts. Different national and international mechanisms and guidelines are guiding the prevention of adverse effects while implementing projects in developing countries. Different activities have been identified for future commitments under Art 3.14. For instance, priority actions need to be further classified into positive and negative, direct and indirect features.

Italian private companies are participating to flexible mechanisms. For instance, ENI an Italian world-wide energy company, projects to reduce gas flaring associated with oil production, with the goal of reducing by 70% emissions from gas flaring, compared to 2007. For some of these projects, ENI promotes the recognition flexible mechanisms within the CDM (ENI, 2010). ENEL is the Italian largest power company that is one of the main worldwide operators applying the CDM. Most of these initiatives were developed bilaterally between Enel-Endesa and the Host country. The group portfolio includes 105 direct participation projects, mostly located in China (79 projects) and other located in India, Africa and Latin America. As for the JI mechanism, the Group's portfolio includes 7 projects in Uzbekistan and Ukraine and 32 indirect-participation projects in the European Union, Russia, Moldova and Ukraine (ENEL, 2011).
Finally, projects from decentralized development cooperation are to be considered (OICS, 2011). Principles, actors, priority areas and instruments relating to programs conducted by DGCS with the regions and local authorities (provinces and municipalities) are defined in specific guidelines for decentralized cooperation (MAE, 2010[e]).

14.7 Review process of Article 3.14 of the Kyoto Protocol

In 2011 an in-country review process for the Fifth National Communication took place. During this process also the minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol was reviewed. Additional information reported for submission 2010 and 2011 related with this theme was also provided. According to the UNFCCC review report, the Expert review team (ERT) considers the reported information to be transparent and complete. The ERT also commends Italy for its comprehensive, transparent and well-documented information on the minimization of adverse impacts and encourages it to continue exploring and reporting on the adverse impacts of the response measures (UNFCCC, 2011[a]).

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15.1 INTRODUCTION

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ANNEX 1: KEY CATEGORIES AND UNCERTAINTY

A1.1 Introduction

The 2006 IPCC Guidelines (IPCC, 2006) recommends as good practice the identification of *key categories* in national GHG inventories. A *key category* is defined as an emission source that has a significant influence on a country's GHG inventory in terms either of the absolute/relative level of emissions or the trend in emissions, or both. The concept of key sources was originally derived for emissions excluding the LULUCF sector and expanded, referring to categories, in the IPCC Good Practice Guidance for LULUCF (IPCC, 2003) to cover also LULUCF emissions by sources and removals by sinks. In this document whenever the term *category* is used, it includes both sources and sinks. The 2006 Guidelines provide a harmonized method to deal with both sources and removals and correct some inconsistencies between the previous versions. For these reasons, the updated IPCC guidelines have been followed to implement the key category and uncertainty analyses in the Italian inventory.

Two different approaches are reported in the guidelines according to whether or not a country has performed an uncertainty analysis of the inventory: Approach 1 and Approach 2.

When using Approach 1, key categories are identified by means of a pre-determined cumulative emissions threshold, usually fixed at 95% of the total. If an uncertainty analysis is carried out at category level for the inventory, Approach 2 can be used to identify key categories. Approach 2 is a more detailed analysis that builds on Approach 1; in fact, the results of Approach 1 are multiplied by the relative uncertainty of each source/sink category. Key categories are those that represent 90% of the uncertainty contribution.

So the factors which make a source or a sink a key category have a high contribution to the total, a high contribution to the trend and a high uncertainty.

If both the approaches are applied it is good practice to use the results of the Approach 2 analysis.

For the Italian inventory, a key category analysis has been carried out according to both the methods, excluding and including the LULUCF sector. National emissions have been disaggregated, as far as possible, into the categories proposed in the IPCC guidelines; other categories have been added to reflect specific national circumstances. Both level and trend analysis have been applied. For the base year, the level assessment has been carried out.

Summary of the results of the key category analysis, for the base year and 2010, is reported in Tables 1.3–1.6 of chapter 1. The tables indicate whether a key category derives from the level assessment or the trend assessment, according to Approach 1, Approach 2 or both.

For the base year, 20 sources were individuated according to Approach 1, whereas 17 sources were carried out by Approach 2. Including the LULUCF sector in the analysis, 26 categories were selected jointly by the Approach 1 and Approach 2.

For the year 2010, 18 sources were individuated by the Approach 1 accounting for 95% of the total emissions, without LULUCF; for the trend 16 key sources were selected. Jointly for the Approach 1, both level and trend, 23 key categories were totally individuated.

Repeating the *key category* analysis for the full inventory including the LULUCF sector, 22 categories were individuated accounting for 95% of the total emissions and removals in 2010, and 19 key categories in trend assessment. Jointly for the Approach 1, both level and trend, 27 key categories were totally individuated.

The application of the Approach 2 to the 2010 emission levels gives as a result 16 key categories accounting for the 90% of the total levels with uncertainty; when applying the trend analysis the key categories are equal to 17 with differences with respect to the previous list.

The application of the Approach 2 including the LULUCF categories results in 19 key categories, for the year 2010, accounting for the 90% of the total levels with uncertainty; for the trend analysis including LULUCF categories, the results were 15 key categories. Jointly for both the level and trend, 21 key categories were totally individuated.

A1.2 Approach 1 key category assessment

As described in the 2006 IPCC Guidelines (IPCC, 2006), and previously in the IPCC Good Practice Guidance (IPCC, 2000; IPCC, 2003), the Approach 1 for identifying key categories assesses the impact of

various categories on the level and on the trend of the national emission inventory. Both level and trend assessments should be applied to an emission GHG inventory.
As regards the level assessment, the contribution of each source or sink category to the total national inventory level is calculated as follows:

$$\text{Category Level Assessment} = \frac{|\text{Source or Sink Category Estimate}|}{\text{Total Contribution}}$$

$$L_{x,t} = \frac{|E_{x,t}|}{\sum_y |E_{y,t}|}$$

where

$L_{x,t}$ = level assessment for source or sink x in year t;

$|E_{x,t}|$ = absolute value of emission and removal estimate of source or sink category x in year t;

$\sum_y |E_{y,t}|$ = total contribution, which is the sum of the absolute values of emissions and removals in year t.

The contribution of all categories (including the LULUCF sector) is entered as absolute values.

Therefore, key categories are those which, when summed in descending order of magnitude, add up to over 95% of the total emissions.

As far as the trend assessment is concerned, the contribution of each source and sink category's trend can be assessed by the following equation:

$$\text{Category Trend Assessment} = (\text{Source or Sink Category Level Assessment}) \cdot |\text{Source or Sink Category Trend - Total Trend}|$$

$$T_{x,t} = |E_{x,0}| \Big/ \sum_y |E_{y,0}| \cdot \left| \left[(E_{x,t} - E_{x,0}) \Big/ |E_{x,0}| \right] - \left[(E_t - E_0) \Big/ \sum_y |E_{y,0}| \right] \right|$$

where

$T_{x,t}$ = trend assessment, which is the contribution of the source or sink category trend to the overall inventory trend;

$|E_{x,0}|$ = absolute value of emission and removal estimate of source or sink category x in the base year (year 0);

$\sum_y |E_{y,0}|$ = total contribution, which is the sum of the absolute values of emissions and removals in year 0;

$E_{x,t}$ *and* $E_{x,0}$ = real values of estimates of source or sink category x in years t and 0, respectively;

E_t *and* $E_0 = \sum_y E_{y,t}$ *and* $\sum_y E_{y,0}$ = total inventory estimates in years t and 0, respectively.

The source or sink category trend is the change in the category emissions over time, computed by subtracting the base year estimate for a generic category from the latest inventory year estimate and dividing by the absolute value of the latest inventory year estimate; the total trend is the change in the total inventory emissions over time, computed by subtracting the base year estimate for the total inventory from the current year estimate and dividing by the current year estimate.

In circumstances where the base year emissions for a given category are zero, the expression is reformulated to avoid zero in the denominator:

$$T_{x,t} = \left| E_{x,t} \middle/ \left| E_{x,0} \right| \right|$$

As differences in trend are more significant to the overall inventory level for larger categories, the results of the trend difference is multiplied by the results of the level assessment to provide appropriate weighting.
Thus, key categories will be those for which the category trend diverges significantly from the total trend, weighted by the emission level of the category.
Both level and trend assessments have been carried out for the Italian GHG inventory. For the base year, a level assessment is computed.
In this section, detailed results are reported for the 2010 inventory.
The results of Approach 1 are shown in Table A1.1 and Table A1.2, level and trend assessments without LULUCF categories. Results of the key category analysis with the LULUCF are reported in Table A1.3 and Table A1.4.

Table A1.1 Results of the key category analysis without LULUCF. Approach 1 Level assessment, year 2010

CATEGORIES	2010 CO_2 eq.	Level assessment	Cumulative Percentage
CO2 stationary combustion gaseous fuels	158,764	0.317	0.32
CO2 Mobile combustion: Road Vehicles	108,678	0.217	0.53
CO2 stationary combustion liquid fuels	64,166	0.128	0.66
CO2 stationary combustion solid fuels	54,967	0.110	0.77
CO2 Cement production	13,276	0.026	0.80
CH4 from Solid waste Disposal Sites	12,892	0.026	0.82
CH4 Enteric Fermentation in Domestic Livestock	10,732	0.021	0.84
HFC, PFC substitutes for ODS	8,745	0.017	0.86
Direct N2O Agricultural Soils	7,236	0.014	0.88
Indirect N2O from Nitrogen used in agriculture	6,379	0.013	0.89
CO2 stationary combustion other fuels	5,790	0.012	0.90
CO2 Mobile combustion: Waterborne Navigation	5,096	0.010	0.91
CH4 Fugitive emissions from Oil and Gas Operations	5,027	0.010	0.92
N2O stationary combustion	3,797	0.008	0.93
N2O Manure Management	3,701	0.007	0.94
CH4 Emissions from Wastewater Handling	2,752	0.005	0.94
CH4 Manure Management	2,567	0.005	0.95
CO2 Fugitive emissions from Oil and Gas Operations	2,322	0.005	0.95
CO2 Mobile combustion: Aircraft	2,319	0.005	0.96
N2O Emissions from Wastewater Handling	1,975	0.004	0.96
CO2 Lime production	1,969	0.004	0.96
CO2 Mobile combustion: Other	1,917	0.004	0.97
CO2 Other industrial processes	1,903	0.004	0.97
CH4 from Rice production	1,565	0.003	0.97
CO2 Limestone and Dolomite Use	1,558	0.003	0.98
N2O from animal production	1,544	0.003	0.98
CH4 stationary combustion	1,298	0.003	0.98
PFC from the production of halocarbons and SF6	1,144	0.002	0.99
CO2 Iron and Steel production	1,139	0.002	0.99
N2O Mobile combustion: Road Vehicles	1,041	0.002	0.99
CO2 Emissions from solvent use	1,032	0.002	0.99
CO2 Ammonia production	959	0.002	0.99
N2O Emissions from solvent use	626	0.001	1.00
N2O Adipic Acid	490	0.001	1.00
SF6 Electrical Equipment	324	0.001	1.00
CH4 Mobile combustion: Road Vehicles	299	0.001	1.00
CH4 Emissions from Waste Incineration	261	0.001	1.00
CO2 Emissions from Waste Incineration	230	0.000	1.00
N2O Nitric Acid	157	0.000	1.00
PFC, HFC, SF6 Semiconductor manufacturing	142	0.000	1.00
N2O Emissions from Waste Incineration	114	0.000	1.00
PFC Aluminium production	85	0.000	1.00
N2O Mobile combustion: Other	83	0.000	1.00
CH4 Fugitive emissions from Coal Mining and Handling	65	0.000	1.00
CH4 Industrial Processes	53	0.000	1.00
N2O Mobile combustion: Waterborne Navigation	38	0.000	1.00
CH4 Mobile combustion: Waterborne Navigation	22	0.000	1.00
N2O Mobile combustion: Aircraft	20	0.000	1.00
SF6, HFC Magnesium production	19	0.000	1.00
CH4 Agricultural Residue Burning	12	0.000	1.00
N2O Fugitive emissions from Oil and Gas Operations	12	0.000	1.00
CH4 Emissions from Other Waste	5.2	0.000	1.00
N2O Agricultural Residue Burning	4.0	0.000	1.00
CH4 Mobile combustion: Other	2.6	0.000	1.00

Table A1.2 Results of the key category analysis without LULUCF. Approach 1 Trend assessment, 1990- 2010

CATEGORIES	Contribution to trend (%)	Cumulative Percentage
CO2 stationary combustion liquid fuels	0.372	0.37
CO2 stationary combustion gaseous fuels	0.339	0.71
CO2 Mobile combustion: Road Vehicles	0.082	0.79
HFC, PFC substitutes for ODS	0.039	0.83
CO2 stationary combustion other fuels	0.022	0.85
N2O Adipic Acid	0.017	0.87
CO2 stationary combustion solid fuels	0.010	0.88
CO2 Cement production	0.010	0.89
Direct N2O Agricultural Soils	0.009	0.90
CH4 Fugitive emissions from Oil and Gas Operations	0.009	0.91
CO2 Iron and Steel production	0.008	0.92
N2O Nitric Acid	0.008	0.93
CH4 from Solid waste Disposal Sites	0.008	0.93
CO2 Ammonia production	0.008	0.94
PFC Aluminium production	0.007	0.95
Indirect N2O from Nitrogen used in agriculture	0.007	0.95
CH4 Enteric Fermentation in Domestic Livestock	0.005	0.96
CO2 Fugitive emissions from Oil and Gas Operations	0.004	0.96
CO2 Limestone and Dolomite Use	0.004	0.97
CH4 Emissions from Wastewater Handling	0.004	0.97
CH4 Manure Management	0.003	0.97
CO2 Mobile combustion: Aircraft	0.003	0.98
CH4 stationary combustion	0.003	0.98
CO2 Emissions from solvent use	0.002	0.98
N2O stationary combustion	0.002	0.99
CH4 Mobile combustion: Road Vehicles	0.002	0.99
PFC from the production of halocarbons and SF6	0.002	0.99
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.002	0.99
CO2 Emissions from Waste Incineration	0.001	0.99
N2O Emissions from Wastewater Handling	0.001	0.99
N2O Mobile combustion: Road Vehicles	0.001	0.99
N2O Emissions from solvent use	0.001	0.99
PFC, HFC, SF6 Semiconductor manufacturing	0.001	0.99
CO2 Mobile combustion: Waterborne Navigation	0.001	1.00
N2O from animal production	0.001	1.00
SF6 Electrical Equipment	0.001	1.00
SF6 Production of SF6	0.001	1.00
CH4 Emissions from Waste Incineration	0.000	1.00
CO2 Other industrial processes	0.000	1.00
CO2 Mobile combustion: Other	0.000	1.00
N2O Manure Management	0.000	1.00
CH4 Fugitive emissions from Coal Mining and Handling	0.000	1.00
CH4 Industrial Processes	0.000	1.00
N2O Mobile combustion: Other	0.000	1.00
CH4 from Rice production	0.000	1.00
N2O Emissions from Waste Incineration	0.000	1.00
SF6, HFC Magnesium production	0.000	1.00
N2O Other industrial processes	0.000	1.00
N2O Mobile combustion: Aircraft	0.000	1.00
CH4 Mobile combustion: Waterborne Navigation	0.000	1.00
CH4 Emissions from Other Waste	0.000	1.00
CO2 Lime production	0.000	1.00
CH4 Mobile combustion: Other	0.000	1.00
CH4 Mobile combustion: Aircraft	0.000	1.00

Table A1.3 Results of the key category analysis with LULUCF. Approach 1 Level assessment, year 2010

CATEGORIES	2010 CO_2 eq.	Level assessment	Cumulative Percentage
CO2 stationary combustion gaseous fuels	158,764	0.281	0.28
CO2 Mobile combustion: Road Vehicles	108,678	0.192	0.47
CO2 stationary combustion liquid fuels	64,166	0.114	0.59
CO2 stationary combustion solid fuels	54,967	0.097	0.68
CO2 Forest land remaining Forest Land	-38,758	0.069	0.75
CO2 Cement production	13,276	0.024	0.78
CH4 from Solid waste Disposal Sites	12,892	0.023	0.80
CO2 Cropland remaining Cropland	-12,467	0.022	0.82
CH4 Enteric Fermentation in Domestic Livestock	10,732	0.019	0.84
HFC, PFC substitutes for ODS	8,745	0.015	0.86
Direct N2O Agricultural Soils	7,236	0.013	0.87
Indirect N2O from Nitrogen used in agriculture	6,379	0.011	0.88
CO2 stationary combustion other fuels	5,790	0.010	0.89
CO2 Land converted to Grassland	-5,321	0.009	0.90
CO2 Mobile combustion: Waterborne Navigation	5,096	0.009	0.91
CH4 Fugitive emissions from Oil and Gas Operations	5,027	0.009	0.92
N2O stationary combustion	3,797	0.007	0.92
N2O Manure Management	3,701	0.007	0.93
CO2 Land converted to Settlements	3,404	0.006	0.94
CH4 Emissions from Wastewater Handling	2,752	0.005	0.94
CH4 Manure Management	2,567	0.005	0.95
CO2 Grassland remaining Grassland	-2,337	0.004	0.95
CO2 Fugitive emissions from Oil and Gas Operations	2,322	0.004	0.95
CO2 Mobile combustion: Aircraft	2,319	0.004	0.96
N2O Emissions from Wastewater Handling	1,975	0.003	0.96
CO2 Lime production	1,969	0.003	0.97
CO2 Mobile combustion: Other	1,917	0.003	0.97
CO2 Other industrial processes	1,903	0.003	0.97
CH4 from Rice production	1,565	0.003	0.98
CO2 Limestone and Dolomite Use	1,558	0.003	0.98
N2O from animal production	1,544	0.003	0.98
CH4 stationary combustion	1,298	0.002	0.98
CO2 Land converted to Forest Land	-1,190	0.002	0.98
PFC from the production of halocarbons and SF6	1,144	0.002	0.99
CO2 Iron and Steel production	1,139	0.002	0.99
N2O Mobile combustion: Road Vehicles	1,041	0.002	0.99
CO2 Emissions from solvent use	1,032	0.002	0.99
CO2 Ammonia production	959	0.002	0.99
N2O Emissions from solvent use	626	0.001	1.00
N2O Adipic Acid	490	0.001	1.00
SF6 Electrical Equipment	324	0.001	1.00
CH4 Mobile combustion: Road Vehicles	299	0.001	1.00
CH4 Emissions from Waste Incineration	261	0.000	1.00
CO2 Emissions from Waste Incineration	230	0.000	1.00
N2O Nitric Acid	157	0.000	1.00
PFC, HFC, SF6 Semiconductor manufacturing	142	0.000	1.00
N2O Emissions from Waste Incineration	114	0.000	1.00
PFC Aluminium production	85	0.000	1.00
N2O Land converted to Cropland	85	0.000	1.00
N2O Mobile combustion: Other	83	0.000	1.00
CH4 Fugitive emissions from Coal Mining and Handling	65	0.000	1.00
CH4 Industrial Processes	53	0.000	1.00
CH4 Forest land remaining Forest Land	43	0.000	1.00
N2O Mobile combustion: Waterborne Navigation	38	0.000	1.00

Table A1.4 Results of the key category analysis with LULUCF. Approach 1 Trend assessment, 1990-2010

CATEGORIES	Contribution to trend (%)	Cumulative Percentage
CO2 stationary combustion gaseous fuels	0.311	0.31
CO2 stationary combustion liquid fuels	0.295	0.61
CO2 Mobile combustion: Road Vehicles	0.089	0.70
CO2 Forest land remaining Forest Land	0.074	0.77
HFC, PFC substitutes for ODS	0.034	0.80
CO2 Cropland remaining Cropland	0.032	0.83
CO2 Land converted to Grassland	0.021	0.86
CO2 stationary combustion other fuels	0.019	0.87
N2O Adipic Acid	0.014	0.89
CO2 Grassland remaining Grassland	0.010	0.90
N2O Nitric Acid	0.007	0.91
CO2 Iron and Steel production	0.007	0.91
CH4 Fugitive emissions from Oil and Gas Operations	0.006	0.92
Direct N2O Agricultural Soils	0.006	0.92
CO2 Ammonia production	0.006	0.93
CO2 Cement production	0.006	0.94
PFC Aluminium production	0.006	0.94
CH4 from Solid waste Disposal Sites	0.004	0.95
Indirect N2O from Nitrogen used in agriculture	0.004	0.95
CO2 Land converted to Settlements	0.004	0.95
CH4 Emissions from Wastewater Handling	0.004	0.96
CO2 Mobile combustion: Aircraft	0.003	0.96
CO2 Limestone and Dolomite Use	0.003	0.96
CO2 Fugitive emissions from Oil and Gas Operations	0.003	0.97
CO2 Land converted to Forest Land	0.003	0.97
CH4 stationary combustion	0.003	0.97
CO2 Land converted to Cropland	0.003	0.98
N2O stationary combustion	0.002	0.98
CH4 Manure Management	0.002	0.98
CH4 Enteric Fermentation in Domestic Livestock	0.002	0.98
CO2 stationary combustion solid fuels	0.002	0.98
CO2 Emissions from solvent use	0.002	0.99
PFC from the production of halocarbons and SF6	0.002	0.99
CH4 Mobile combustion: Road Vehicles	0.002	0.99
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.001	0.99
N2O Emissions from Wastewater Handling	0.001	0.99
CO2 Emissions from Waste Incineration	0.001	0.99
N2O Mobile combustion: Road Vehicles	0.001	0.99
CO2 Mobile combustion: Other	0.001	0.99
CO2 Other industrial processes	0.001	0.99
PFC, HFC, SF6 Semiconductor manufacturing	0.001	0.99
SF6 Electrical Equipment	0.000	1.00
CH4 Forest land remaining Forest Land	0.000	1.00
CO2 Mobile combustion: Waterborne Navigation	0.000	1.00
CH4 from Rice production	0.000	1.00
N2O Emissions from solvent use	0.000	1.00
CH4 Emissions from Waste Incineration	0.000	1.00
SF6 Production of SF6	0.000	1.00
N2O Manure Management	0.000	1.00
CO2 Lime production	0.000	1.00
N2O from animal production	0.000	1.00
CH4 Industrial Processes	0.000	1.00
CH4 Fugitive emissions from Coal Mining and Handling	0.000	1.00
N2O Mobile combustion: Other	0.000	1.00

The application of Approach 1, excluding LULUCF categories, gives as a result 18 key categories accounting for the 95% of the total levels; when applying the trend analysis, excluding LULUCF categories, the key categories decreased to 16 with some differences with respect to the previous list (Tables A1.1, A1.2).
The Approach 1 *key category* level assessment, repeated for the full inventory including the LULUCF, results in 22 key categories (sources and sinks), whereas 19 key categories outcome from the trend analysis, with some differences as respect to the list resulting from level assessment (Tables A1.3, A1.4).

A1.3 Uncertainty assessment (IPCC Approach 1)

Approach 2 for the identification of key categories implies the assessment of the uncertainty analysis to an emission inventory.
As already mentioned, the IPCC Approach 1 has been applied to the Italian GHG inventory to estimate uncertainties for the base year and the last submitted year. In this section, detailed results are reported for the 2010 inventory.
The uncertainty analysis has also been implemented both excluding and including the LULUCF sector in the national totals.
Results are reported in Table A1.5, for the year 2010, excluding the LULUCF sector.
Details on the method used for LULUCF are described in the relevant chapter, chapter 7. In Table A1.6, results by category, concerning only CO_2 emissions and removals, are reported whereas in Table A1.7, results include CO_2, CH_4, N_2O emissions and removals. Finally, in Table A1.8 figures of inventory total uncertainty, including the LULUCF sector, are shown.

Table A1.5 Results of the uncertainty analysis excluding LULUCF (Approach 1). Year 2010 (continued)

		Emissions		Uncertainty				Sensitivity		Uncertainty in trend		
IPCC category	**Gas**	**1990**	**2010**	**AD**	**EF**	**Combined**	**Contribution to variance**	**Type A**	**Type B**	**introduced by EF uncertainty**	**introduced by AD uncertainty**	**in total national emissions**
		Gg CO_2 eq.										
CO2 stationary combustion liquid fuels	CO2	153,467	64,166	3%	3%	0.042	0.000	0.161	0.124	0.005	0.005	0.000
CO2 stationary combustion solid fuels	CO2	59,348	54,967	3%	3%	0.042	0.000	0.004	0.106	0.000	0.004	0.000
CO2 stationary combustion gaseous fuels	CO2	85,066	158,764	3%	3%	0.042	0.000	0.147	0.306	0.004	0.013	0.000
CO2 stationary combustion other fuels	CO2	887	5,790	3%	3%	0.042	0.000	0.010	0.011	0.000	0.000	0.000
CH4 stationary combustion	CH4	647	1,298	3%	50%	0.501	0.000	0.001	0.002	0.001	0.000	0.000
N2O stationary combustion	N2O	3,444	3,797	3%	50%	0.501	0.000	0.001	0.007	0.000	0.000	0.000
CO2 Mobile combustion: Road Vehicles	CO2	93,387	108,678	3%	3%	0.042	0.000	0.036	0.209	0.001	0.009	0.000
CH4 Mobile combustion: Road Vehicles	CH4	751	299	3%	40%	0.401	0.000	0.001	0.001	0.000	0.000	0.000
N2O Mobile combustion: Road Vehicles	N2O	913	1,041	3%	50%	0.501	0.000	0.000	0.002	0.000	0.000	0.000
CO2 Mobile combustion: Waterborne Navigation	CO2	5,420	5,096	3%	3%	0.042	0.000	0.000	0.010	0.000	0.000	0.000
CH4 Mobile combustion: Waterborne Navigation	CH4	29	22	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Waterborne Navigation	N2O	39	38	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion: Aircraft	CO2	1,613	2,319	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	1,917	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	83	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	65	3%	200%	2.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Fugitive emissions from Oil and Gas Operations	CO2	3,344	2,322	3%	25%	0.252	0.000	0.002	0.004	0.000	0.000	0.000
CH4 Fugitive emissions from Oil and Gas Operations	CH4	7,298	5,027	3%	25%	0.252	0.000	0.004	0.010	0.001	0.000	0.000
N2O Fugitive emissions from Oil and Gas Operations	N2O	12	12	3%	25%	0.252	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Cement production	CO2	16,084	13,276	3%	10%	0.104	0.000	0.004	0.026	0.000	0.001	0.000
CO2 Lime production	CO2	2,042	1,969	3%	10%	0.104	0.000	0.000	0.004	0.000	0.000	0.000
CO2 Limestone and Dolomite Use	CO2	2,540	1,558	3%	10%	0.104	0.000	0.002	0.003	0.000	0.000	0.000
CO2 Iron and Steel production	CO2	3,124	1,139	3%	10%	0.104	0.000	0.004	0.002	0.000	0.000	0.000
CO2 Ammonia production	CO2	2,765	959	3%	10%	0.104	0.000	0.003	0.002	0.000	0.000	0.000
CO2 Other industrial processes	CO2	1,880	1,903	3%	10%	0.104	0.000	0.000	0.004	0.000	0.000	0.000
N2O Adipic Acid	N2O	4,579	490	3%	10%	0.104	0.000	0.008	0.001	0.001	0.000	0.000
N2O Nitric Acid	N2O	2,086	157	3%	10%	0.104	0.000	0.004	0.000	0.000	0.000	0.000
N2O Other industrial processes	N2O	11	0	3%	10%	0.104	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Industrial Processes	CH4	108	53	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000

Table A1.5 Results of the uncertainty analysis excluding LULUCF (Approach 1). Year 2010

IPCC category	Gas	Emissions 1990	Emissions 2010	Uncertainty AD	Uncertainty EF	Uncertainty Combined	Uncertainty Contribution to variance	Sensitivity Type A	Sensitivity Type B	Uncertainty in trend introduced by EF uncertainty	Uncertainty in trend introduced by AD uncertainty	Uncertainty in trend in total national emissions
		Gg CO_2 eq.										
PFC Aluminium production	PFC	1,673	85	5%	10%	0.112	0.000	0.003	0.000	0.000	0.000	0.000
SF6, HFC Magnesium production	SF6-H	0	19	5%	5%	0.071	0.000	0.000	0.000	0.000	0.000	0.000
SF6 Electrical Equipment	SF6	213	324	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	142	30%	50%	0.583	0.000	0.000	0.000	0.000	0.000	0.000
HFC, PFC substitutes for ODS	HFC	0	8,745	30%	50%	0.583	0.000	0.017	0.017	0.008	0.007	0.000
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	HFC	351	0	5%	10%	0.112	0.000	0.001	0.000	0.000	0.000	0.000
PFC from the production of halocarbons and SF6	PFC	813	1,144	5%	10%	0.112	0.000	0.001	0.002	0.000	0.000	0.000
CH4 Enteric Fermentation in Domestic Livestock	CH4	12,278	10,732	20%	20%	0.283	0.000	0.002	0.021	0.000	0.006	0.000
CH4 Manure Management	CH4	3,462	2,567	20%	100%	1.020	0.000	0.001	0.005	0.001	0.001	0.000
N2O Manure Management	N2O	3,921	3,701	20%	100%	1.020	0.000	0.000	0.007	0.000	0.002	0.000
CH4 Agricultural Residue Burning	CH4	13	12	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	9,606	7,236	20%	100%	1.020	0.000	0.004	0.014	0.004	0.004	0.000
Indirect N2O from Nitrogen used in agriculture	N2O	8,140	6,379	20%	100%	1.020	0.000	0.003	0.012	0.003	0.003	0.000
CH4 from Rice production	CH4	1,576	1,565	3%	20%	0.202	0.000	0.000	0.003	0.000	0.000	0.000
N2O from animal production	N2O	1,736	1,544	20%	100%	1.020	0.000	0.000	0.003	0.000	0.001	0.000
CH4 from Solid waste Disposal Sites	CH4	15,254	12,892	20%	30%	0.361	0.000	0.004	0.025	0.001	0.007	0.000
CH4 Emissions from Wastewater Handling	CH4	1,990	2,752	100%	30%	1.044	0.000	0.002	0.005	0.000	0.007	0.000
N2O Emissions from Wastewater Handling	N2O	1,832	1,975	30%	30%	0.424	0.000	0.000	0.004	0.000	0.002	0.000
CO2 Emissions from Waste Incineration	CO2	507	230	5%	25%	0.255	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Emissions from Waste Incineration	CH4	161	261	5%	20%	0.206	0.000	0.000	0.001	0.000	0.000	0.000
N2O Emissions from Waste Incineration	N2O	87	114	5%	100%	1.001	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Emissions from Other Waste	CH4	0	5	10%	100%	1.005	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Emissions from solvent use	CO2	1,643	1,032	30%	50%	0.583	0.000	0.001	0.002	0.001	0.001	0.000
N2O Emissions from solvent	N2O	812	626	50%	10%	0.510	0.000	0.000	0.001	0.000	0.001	0.000
TOTAL		**519,246**	**501,318**				**0.001**					**0.001**
						Percertage uncertainty in total inventory	**3.3%**			**Trend uncertainty**		**2.6%**

Table A1.6 Results of the uncertainty analysis for the LULUCF sector – CO_2 (Approach 1)

IPCC Category	Gas	Emissions 1990	Emissions 2010	Uncertainty AD	Uncertainty EF	Combined uncertainty	Contribution to variance 2010	Sensitivity Type A	Sensitivity Type B	Trend uncertainty in LULUCF emissions introduced by EF	Trend uncertainty in LULUCF emissions introduced by AD uncertainty	Trend uncertainty in total LULUCF emissions
		Gg CO_2 eq										
A. Forest Land	CO_2	-18,484	-39,947	*23%*	*43%*	49%	12%	28%	115%	12%	38%	16%
B. Cropland	CO_2	-18,320	-12,458	*75%*	*75%*	106%	5%	50%	36%	37%	38%	28%
C. Grassland	CO_2	-480	-7,658	*75%*	*75%*	106%	2%	20%	22%	15%	23%	8%
D. Wetlands	CO_2	0	0			0%	0%	0%	0%	0%	0%	0%
E. Settlements	CO_2	2,527	3,404	*75%*	*75%*	106%	0%	2%	10%	2%	10%	1%
F. Other Land	CO_2	0	0			0%	0%	0%	0%	0%	0%	0%
G. Other	CO_2	0	0			0%	0%	0%	0%	0%	0%	0%
TOTAL		**-34,758**	**-56,659**				**20%**					**53%**
						Percertage uncertainty	**45%**				**Trend uncertainty**	**73%**

[a] the combined uncertainty has been calculated as explained in Chapter 7, 7.2.3 Uncertainty and time series consistency; in order to provide estimate of uncertainties in trend in national emissions introduced by emission factor and activity data, values for the uncertainty related to activity data and emission factor have been assigned by expert judgment, taking into account the final combined uncertainty

Table A1.7 Results of the uncertainty analysis for the LULUCF sector – CO_2, CH_4, N_2O (Approach 1)

IPCC Category	Gas	Emissions 1990	Emissions 2010	Uncertainty AD	Uncertainty EF	Combined uncertainty	Contribution to variance 2009	Sensitivity Type A	Sensitivity Type B	Trend uncertainty in LULUCF emissions introduced by EF uncertainty	Trend uncertainty in LULUCF emissions introduced by AD uncertainty	Trend uncertainty in total LULUCF emissions
		Gg CO_2 eq										
A. Forest Land	CO_2 eq	-18,323	-39,909	*23%*	*43%*	49%	12%	29%	116%	12%	38%	16%
B. Cropland	CO_2 eq	-18,231	-12,373	*75%*	*75%*	106%	5%	50%	36%	38%	38%	29%
C. Grassland	CO_2 eq	-480	-7,658	*75%*	*75%*	106%	2%	20%	22%	15%	24%	8%
D. Wetlands	CO_2 eq	0	0			0%	0%	0%	0%	0%	0%	0%
E. Settlements	CO_2 eq	2,527	3,404	*75%*	*75%*	106%	0%	2%	10%	2%	10%	1%
F. Other Land	CO_2 eq	0	0			0%	0%	0%	0%	0%	0%	0%
G. Other	CO_2 eq	0	0			0%	0%	0%	0%	0%	0%	0%
TOTAL		**-34,507**	**-56,536**				**20%**					**54%**
						Percertage uncertainty	**45%**				**Trend uncertainty**	**73%**

Table A1.8 Results of the uncertainty analysis including LULUCF (Approach 1). Year 2010 (continued)

		Emissions		Uncertainty				Sensitivity		Uncertainty in trend		
IPCC category	Gas	1990	2010	AD	EF	Combined	Contribution to variance	Type A	Type B	introduced by EF uncertainty	introduced by AD uncertainty	in total national emissions
		Gg	Gg									
CO2 stationary combustion liquid fuels	CO2	153,467	64,166	3%	3%	0.042	0.000	0.158	0.132	0.005	0.006	0.000
CO2 stationary combustion solid fuels	CO2	59,348	54,967	3%	3%	0.042	0.000	0.001	0.113	0.000	0.005	0.000
CO2 stationary combustion gaseous fuels	CO2	85,066	158,764	3%	3%	0.042	0.000	0.166	0.328	0.005	0.014	0.000
CO2 stationary combustion other fuels	CO2	887	5,790	3%	3%	0.042	0.000	0.010	0.012	0.000	0.001	0.000
CH4 stationary combustion	CH4	647	1,298	3%	50%	0.501	0.000	0.001	0.003	0.001	0.000	0.000
N2O stationary combustion	N2O	3,444	3,797	3%	50%	0.501	0.000	0.001	0.008	0.001	0.000	0.000
CO2 Mobile combustion: Road Vehicles	CO2	93,387	108,678	3%	3%	0.042	0.000	0.047	0.224	0.001	0.010	0.000
CH4 Mobile combustion: Road Vehicles	CH4	751	299	3%	40%	0.401	0.000	0.001	0.001	0.000	0.000	0.000
N2O Mobile combustion: Road Vehicles	N2O	913	1,041	3%	50%	0.501	0.000	0.000	0.002	0.000	0.000	0.000
CO2 Mobile combustion: Waterborne Navigation	CO2	5,420	5,096	3%	3%	0.042	0.000	0.000	0.011	0.000	0.000	0.000
CH4 Mobile combustion: Waterborne Navigation	CH4	29	22	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion: Waterborne Navigation	N2O	39	38	3%	100%	1.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion: Aircraft	CO2	1,613	2,319	3%	3%	0.042	0.000	0.002	0.005	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	1,917	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	83	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	65	3%	200%	2.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Fugitive emissions from Oil and Gas Operations	CO2	3,344	2,322	3%	25%	0.252	0.000	0.002	0.005	0.000	0.000	0.000
CH4 Fugitive emissions from Oil and Gas Operations	CH4	7,298	5,027	3%	25%	0.252	0.000	0.003	0.010	0.001	0.000	0.000
N2O Fugitive emissions from Oil and Gas Operations	N2O	12	12	3%	25%	0.252	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Cement production	CO2	16,084	13,276	3%	10%	0.104	0.000	0.003	0.027	0.000	0.001	0.000
CO2 Lime production	CO2	2,042	1,969	3%	10%	0.104	0.000	0.000	0.004	0.000	0.000	0.000
CO2 Limestone and Dolomite Use	CO2	2,540	1,558	3%	10%	0.104	0.000	0.002	0.003	0.000	0.000	0.000
CO2 Iron and Steel production	CO2	3,124	1,139	3%	10%	0.104	0.000	0.004	0.002	0.000	0.000	0.000
CO2 Ammonia production	CO2	2,765	959	3%	10%	0.104	0.000	0.003	0.002	0.000	0.000	0.000
CO2 Other industrial processes	CO2	1,880	1,903	3%	10%	0.104	0.000	0.000	0.004	0.000	0.000	0.000
N2O Adipic Acid	N2O	4,579	490	3%	10%	0.104	0.000	0.008	0.001	0.001	0.000	0.000
N2O Nitric Acid	N2O	2,086	157	3%	10%	0.104	0.000	0.004	0.000	0.000	0.000	0.000
N2O Other industrial processes	N2O	11	0	3%	10%	0.104	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Industrial Processes	CH4	108	53	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000

Table A1.8 Results of the uncertainty analysis including LULUCF (Approach 1). Year 2010

		Emissions		Uncertainty				Sensitivity		Uncertainty in trend		
IPCC category	Gas	1990	2010	AD	EF	Combined	Contribution to variance	Type A	Type B	introduced by EF uncertainty	introduced by AD uncertainty	in total national emissions
		Gg	Gg									

PFC Aluminium production	PFC	1,673	85	5%	10%	0.112	0.000	0.003	0.000	0.000	0.000	0.000
SF6, HFC Magnesium production	SF6-H	0	19	5%	5%	0.071	0.000	0.000	0.000	0.000	0.000	0.000
SF6 Electrical Equipment	SF6	213	324	5%	10%	0.112	0.000	0.000	0.001	0.000	0.000	0.000
SF6 Production of SF6	SF6	120	0	5%	10%	0.112	0.000	0.000	0.000	0.000	0.000	0.000
PFC, HFC, SF6 Semiconductor manufacturing	PFC-I	0	142	30%	50%	0.583	0.000	0.000	0.000	0.000	0.000	0.000
HFC, PFC substitutes for ODS	HFC	0	8,745	30%	50%	0.583	0.000	0.018	0.018	0.009	0.008	0.000
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	HFC	351	0	5%	10%	0.112	0.000	0.001	0.000	0.000	0.000	0.000
PFC from the production of halocarbons and SF6	PFC	813	1,144	5%	10%	0.112	0.000	0.001	0.002	0.000	0.000	0.000
CH4 Enteric Fermentation in Domestic Livestock	CH4	12,278	10,732	20%	20%	0.283	0.000	0.001	0.022	0.000	0.006	0.000
CH4 Manure Management	CH4	3,462	2,567	20%	100%	1.020	0.000	0.001	0.005	0.001	0.001	0.000
N2O Manure Management	N2O	3,921	3,701	20%	100%	1.020	0.000	0.000	0.008	0.000	0.002	0.000
CH4 Agricultural Residue Burning	CH4	13	12	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	9,606	7,236	20%	100%	1.020	0.000	0.003	0.015	0.003	0.004	0.000
Indirect N2O from Nitrogen used in agriculture	N2O	8,140	6,379	20%	100%	1.020	0.000	0.002	0.013	0.002	0.004	0.000
CH4 from Rice production	CH4	1,576	1,565	3%	20%	0.202	0.000	0.000	0.003	0.000	0.000	0.000
N2O from animal production	N2O	1,736	1,544	20%	100%	1.020	0.000	0.000	0.003	0.000	0.001	0.000
CH4 from Solid waste Disposal Sites	CH4	15,254	12,892	20%	30%	0.361	0.000	0.002	0.027	0.001	0.008	0.000
CH4 Emissions from Wastewater Handling	CH4	1,990	2,752	100%	30%	1.044	0.000	0.002	0.006	0.001	0.008	0.000
N2O Emissions from Wastewater Handling	N2O	1,832	1,975	30%	30%	0.424	0.000	0.001	0.004	0.000	0.002	0.000
CO2 Emissions from Waste Incineration	CO2	507	230	5%	25%	0.255	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Emissions from Waste Incineration	CH4	161	261	5%	20%	0.206	0.000	0.000	0.001	0.000	0.000	0.000
N2O Emissions from Waste Incineration	N2O	87	114	5%	100%	1.001	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Emissions from Other Waste	CH4	0	5	10%	100%	1.005	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Emissions from solvent use	CO2	1,643	1,032	30%	50%	0.583	0.000	0.001	0.002	0.000	0.001	0.000
N2O Emissions from solvent use	N2O	812	626	50%	10%	0.510	0.000	0.000	0.001	0.000	0.001	0.000
CO2 Forest land remaining Forest Land	CO2	-18,051	-38,758	23%	43%	0.490	0.002	0.046	0.080	0.020	0.026	0.001
CH4 Forest land remaining Forest Land	CH4	183	43	23%	43%	0.490	0.000	0.000	0.000	0.000	0.000	0.000
N2O Forest land remaining Forest Land	N2O	1	0	23%	43%	0.490	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Cropland remaining Cropland	CO2	-19,066	-12,467	75%	75%	1.061	0.001	0.010	0.026	0.008	0.027	0.001
CO2 Land converted to Forest Land	CO2	-433	-1,190	75%	75%	1.061	0.000	0.002	0.002	0.001	0.003	0.000
CO2 Land converted to Cropland	CO2	746	9	75%	75%	1.061	0.000	0.001	0.000	0.001	0.000	0.000
CO2 Grassland remaining Grassland	CO2	273	-2,337	75%	75%	1.061	0.000	0.005	0.005	0.004	0.005	0.000
CO2 Land converted to Grassland	CO2	-753	-5,321	75%	75%	1.061	0.000	0.010	0.011	0.007	0.012	0.000
N2O Land converted to Cropland	N2O	90	85	75%	75%	1.061	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Land converted to Settlements	CO2	2,527	3,404	0.75	0.75	1.061	0.000	0.002	0.007	0.002	0.007	0.000
TOTAL		**484,761**	**444,787**				**0.004**					**0.003**
						Percertage uncertainty in total inventory	**6.6%**				**Trend uncertainty**	**5.4%**

Emission sources of the Italian inventory are disaggregated into a detailed level, 57 sources, according to the IPCC list in the guidelines and taking into account national circumstances and importance. Considering also the LULUCF sector, sources and sinks of the Italian inventory are disaggregated into 67 categories. Uncertainties are therefore estimated for these categories. To estimate uncertainty for both activity data and emission factors, information provided in the IPCC Good Practice Guidance and Guidelines, as well as expert judgement have been used; standard deviations have also been considered whenever measurements were available.
The assumptions on which uncertainty estimations are based on are documented for each category. Figures to draw up uncertainty are checked with the relevant analyst experts and literature references and they are consistent with the IPCC Good Practice Guidance and the 2006 IPCC Guidelines (IPCC, 2000; IPCC, 2006).
The general approach followed for quantifying a level of uncertainty to activity data and emission factors is to set values within a range low, medium and high according to the confidence the expert relies on the value. For instance, a low value (e.g. 3-5%) has been attributed to activity data derived from the energy balance and statistical yearbooks, medium-high values within a range of 20-50% for all the data which are not directly or only partially derived from census or sample surveys or data which are simple estimations. For emission factors, the uncertainties set are usually higher than those for activity data; figures suggested by the IPCC good practice guidance and guidelines (IPCC, 2000; IPCC, 2006) are used when the emission factor is a default value or when appropriate, low values are attributed to measured data whereas the uncertainty values are high in all other cases.
For the base year, the uncertainty estimated by Approach 1 is equal to 3.5%; if considering the LULUCF sector the overall uncertainty increases to 5.9%.
In 2010, the results of Approach 1 suggest an uncertainty of 3.3% in the combined GWP total emissions. The analysis also estimates an uncertainty of 2.6 % in the trend between 1990 and 2010.
For the LULUCF sector, the uncertainty value resulting from Approach 1 is 45% in the combined GWP total emissions for the year 2010, whereas the uncertainty in the trend is 73%. The same figures results from the analysis applied to CO_2 emissions only. Details of the figures are shown in Tables A1.6 and A1.7.
Including the LULUCF sector in the total uncertainty assessment, Approach 1 shows an uncertainty of 6.6% in the combined GWP total emissions for the year 2010, whereas the uncertainty in the trend between 1990 and 2010 is equal to 5.5%. Results are shown in Table A1.8.

Further investigation is needed to better quantify the uncertainty values for some specific source, nevertheless it should be noted that a conservative approach has been followed.

A1.4 Approach 2 key category assessment

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

Level Assessment, with Uncertainty = Approach 1 Level Assessment · Relative Category Uncertainty

Trend Assessment, with Uncertainty = Approach 1 Trend Assessment · Relative Category Uncertainty

Approach 2 has been applied both to the base and the current year submission. In this section, detailed results are reported for the 2010 inventory, whereas for the base year results of the analysis excluding and including LULUCF categories are reported in Table A1.13 and Table A1.14.
The results of the Approach 2 key category analysis, without LULUCF categories, are provided in Table A1.9, for 2010, while in Table A1.10 results, including LULUCF categories, are shown.
The application of Approach 2 to the base year gives as a result 17 key categories accounting for the 90% of the total levels uncertainty. Including the LULUCF categories, 19 key categories result accounting for 90% of the total uncertainty levels.

For the year 2010, 16 key categories accounting for the 90% of the total levels uncertainty were identified; when applying the trend analysis the key categories increased to 17 with differences with respect to the previous list.

The application of Approach 2 to the inventory, including the LULUCF categories, results in 19 key categories which account for the 90% of the total levels uncertainty; for the trend analysis, with LULUCF, the number of key categories decreases to 15 with differences with respect to the previous list.

Table A1.9 Results of the key category analysis without LULUCF. Approach 2 Level assessment, year 2010

CATEGORIES	Share	Uncertainty	L*U	Level assessment with uncertainty	Cumulative Percentage
Direct N2O Agricultural Soils	0.01	1.0198	0.0147	0.1140	0.11
CO2 stationary combustion gaseous fuels	0.32	0.0424	0.0134	0.1040	0.22
Indirect N2O from Nitrogen used in agriculture	0.01	1.0198	0.0130	0.1005	0.32
HFC, PFC substitutes for ODS	0.02	0.5831	0.0102	0.0788	0.40
CH4 from Solid waste Disposal Sites	0.03	0.3606	0.0093	0.0718	0.47
CO2 Mobile combustion: Road Vehicles	0.22	0.0424	0.0092	0.0712	0.54
N2O Manure Management	0.01	1.0198	0.0075	0.0583	0.60
CH4 Enteric Fermentation in Domestic Livestock	0.02	0.2828	0.0061	0.0469	0.65
CH4 Emissions from Wastewater Handling	0.01	1.0440	0.0057	0.0444	0.69
CO2 stationary combustion liquid fuels	0.13	0.0424	0.0054	0.0420	0.73
CH4 Manure Management	0.01	1.0198	0.0052	0.0404	0.77
CO2 stationary combustion solid fuels	0.11	0.0424	0.0047	0.0360	0.81
N2O stationary combustion	0.01	0.5009	0.0038	0.0294	0.84
N2O from animal production	0.00	1.0198	0.0031	0.0243	0.86
CO2 Cement production	0.03	0.1044	0.0028	0.0214	0.88
CH4 Fugitive emissions from Oil and Gas Operations	0.01	0.2518	0.0025	0.0195	0.90
N2O Emissions from Wastewater Handling	0.00	0.4243	0.0017	0.0129	0.92
CH4 stationary combustion	0.00	0.5009	0.0013	0.0100	0.93
CO2 Emissions from solvent use	0.00	0.5831	0.0012	0.0093	0.94
CO2 Fugitive emissions from Oil and Gas Operations	0.00	0.2518	0.0012	0.0090	0.94
N2O Mobile combustion: Road Vehicles	0.00	0.5009	0.0010	0.0081	0.95
N2O Emissions from solvent use	0.00	0.5099	0.0006	0.0049	0.96
CH4 from Rice production	0.00	0.2022	0.0006	0.0049	0.96
CO2 stationary combustion other fuels	0.01	0.0424	0.0005	0.0038	0.97
CO2 Mobile combustion: Waterborne Navigation	0.01	0.0424	0.0004	0.0033	0.97
CO2 Lime production	0.00	0.1044	0.0004	0.0032	0.97
CO2 Other industrial processes	0.00	0.1044	0.0004	0.0031	0.98
CO2 Limestone and Dolomite Use	0.00	0.1044	0.0003	0.0025	0.98
CH4 Fugitive emissions from Coal Mining and Handling	0.00	2.0002	0.0003	0.0020	0.98
PFC from the production of halocarbons and SF6	0.00	0.1118	0.0003	0.0020	0.98
CH4 Mobile combustion: Road Vehicles	0.00	0.4011	0.0002	0.0019	0.98
CO2 Iron and Steel production	0.00	0.1044	0.0002	0.0018	0.99
N2O Emissions from Waste Incineration	0.00	1.0012	0.0002	0.0018	0.99
CO2 Mobile combustion: Other	0.00	0.0583	0.0002	0.0017	0.99
CO2 Ammonia production	0.00	0.1044	0.0002	0.0015	0.99
CO2 Mobile combustion: Aircraft	0.00	0.0424	0.0002	0.0015	0.99
PFC, HFC, SF6 Semiconductor manufacturing	0.00	0.5831	0.0002	0.0013	0.99
N2O Mobile combustion: Other	0.00	1.0004	0.0002	0.0013	0.99
CO2 Emissions from Waste Incineration	0.00	0.2550	0.0001	0.0009	1.00
CH4 Emissions from Waste Incineration	0.00	0.2062	0.0001	0.0008	1.00
N2O Adipic Acid	0.00	0.1044	0.0001	0.0008	1.00
N2O Mobile combustion: Waterborne Navigation	0.00	1.0004	0.0001	0.0006	1.00
SF6 Electrical Equipment	0.00	0.1118	0.0001	0.0006	1.00
CH4 Industrial Processes	0.00	0.5009	0.0001	0.0004	1.00
N2O Mobile combustion: Aircraft	0.00	1.0004	0.0000	0.0003	1.00
N2O Nitric Acid	0.00	0.1044	0.0000	0.0003	1.00
CH4 Mobile combustion: Waterborne Navigation	0.00	0.5009	0.0000	0.0002	1.00
PFC Aluminium production	0.00	0.1118	0.0000	0.0001	1.00
CH4 Agricultural Residue Burning	0.00	0.5385	0.0000	0.0001	1.00
CH4 Emissions from Other Waste	0.00	1.0050	0.0000	0.0001	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.00	0.2518	0.0000	0.0000	1.00
N2O Agricultural Residue Burning	0.00	0.5385	0.0000	0.0000	1.00
SF6, HFC Magnesium production	0.00	0.0707	0.0000	0.0000	1.00
CH4 Mobile combustion: Other	0.00	0.5009	0.0000	0.0000	1.00
CH4 Mobile combustion: Aircraft	0.00	0.5009	0.0000	0.0000	1.00
N2O Other industrial processes	0.00	0.1044	0.0000	0.0000	1.00
SF6 Production of SF6	0.00	0.1118	0.0000	0.0000	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.00	0.1118	0.0000	0.0000	1.00

Table A1.10 Results of the key category analysis without LULUCF. Approach 2 Trend assessment, 1990- 2010

CATEGORIES	Trend assessment	Uncertainty	T*U	Relative trend assessment with uncertainty	Cumulative Percentage
HFC, PFC substitutes for ODS	0.0168	0.5831	0.0098	0.217	0.22
CO2 stationary combustion liquid fuels	0.1618	0.0424	0.0069	0.151	0.37
CO2 stationary combustion gaseous fuels	0.1476	0.0424	0.0063	0.138	0.51
Direct N2O Agricultural Soils	0.0039	1.0198	0.0040	0.088	0.59
Indirect N2O from Nitrogen used in agriculture	0.0028	1.0198	0.0029	0.064	0.66
CH4 Emissions from Wastewater Handling	0.0016	1.0440	0.0017	0.037	0.70
CH4 Manure Management	0.0015	1.0198	0.0015	0.034	0.73
CO2 Mobile combustion: Road Vehicles	0.0357	0.0424	0.0015	0.033	0.76
CH4 from Solid waste Disposal Sites	0.0035	0.3606	0.0013	0.028	0.79
CH4 Fugitive emissions from Oil and Gas Operations	0.0039	0.2518	0.0010	0.022	0.81
N2O Adipic Acid	0.0076	0.1044	0.0008	0.017	0.83
CH4 stationary combustion	0.0013	0.5009	0.0006	0.014	0.84
CO2 Emissions from solvent use	0.0011	0.5831	0.0006	0.014	0.86
CH4 Enteric Fermentation in Domestic Livestock	0.0022	0.2828	0.0006	0.013	0.87
N2O stationary combustion	0.0009	0.5009	0.0005	0.010	0.88
CO2 Cement production	0.0043	0.1044	0.0005	0.010	0.89
CO2 Fugitive emissions from Oil and Gas Operations	0.0017	0.2518	0.0004	0.010	0.90
CO2 stationary combustion other fuels	0.0095	0.0424	0.0004	0.009	0.91
CO2 Iron and Steel production	0.0036	0.1044	0.0004	0.008	0.92
N2O Nitric Acid	0.0036	0.1044	0.0004	0.008	0.93
CO2 Ammonia production	0.0033	0.1044	0.0003	0.008	0.93
PFC Aluminium production	0.0029	0.1118	0.0003	0.007	0.94
CH4 Mobile combustion: Road Vehicles	0.0008	0.4011	0.0003	0.007	0.95
N2O from animal production	0.0003	1.0198	0.0003	0.006	0.95
CH4 Fugitive emissions from Coal Mining and Handling	0.0001	2.0002	0.0002	0.004	0.96
CO2 stationary combustion solid fuels	0.0045	0.0424	0.0002	0.004	0.96
CO2 Limestone and Dolomite Use	0.0017	0.1044	0.0002	0.004	0.97
N2O Emissions from Wastewater Handling	0.0004	0.4243	0.0002	0.004	0.97
N2O Manure Management	0.0002	1.0198	0.0002	0.004	0.97
PFC, HFC, SF6 Semiconductor manufacturing	0.0003	0.5831	0.0002	0.004	0.98
N2O Emissions from solvent use	0.0003	0.5099	0.0002	0.003	0.98
N2O Mobile combustion: Road Vehicles	0.0003	0.5009	0.0002	0.003	0.98
CO2 Emissions from Waste Incineration	0.0005	0.2550	0.0001	0.003	0.99
N2O Mobile combustion: Other	0.0001	1.0004	0.0001	0.002	0.99
PFC from the production of halocarbons and SF6	0.0007	0.1118	0.0001	0.002	0.99
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.0007	0.1118	0.0001	0.002	0.99
CO2 Mobile combustion: Aircraft	0.0015	0.0424	0.0001	0.001	0.99
N2O Emissions from Waste Incineration	0.0001	1.0012	0.0001	0.001	0.99
CH4 Industrial Processes	0.0001	0.5009	0.0001	0.001	1.00
CH4 Emissions from Waste Incineration	0.0002	0.2062	0.0000	0.001	1.00
SF6 Electrical Equipment	0.0002	0.1118	0.0000	0.001	1.00
SF6 Production of SF6	0.0002	0.1118	0.0000	0.001	1.00
CO2 Other industrial processes	0.0002	0.1044	0.0000	0.000	1.00
CH4 from Rice production	0.0001	0.2022	0.0000	0.000	1.00
N2O Mobile combustion: Aircraft	0.0000	1.0004	0.0000	0.000	1.00
CO2 Mobile combustion: Waterborne Navigation	0.0003	0.0424	0.0000	0.000	1.00
CO2 Mobile combustion: Other	0.0002	0.0583	0.0000	0.000	1.00
CH4 Emissions from Other Waste	0.0000	1.0050	0.0000	0.000	1.00
CH4 Mobile combustion: Waterborne Navigation	0.0000	0.5009	0.0000	0.000	1.00
SF6, HFC Magnesium production	0.0000	0.0707	0.0000	0.000	1.00
N2O Other industrial processes	0.0000	0.1044	0.0000	0.000	1.00
CH4 Mobile combustion: Other	0.0000	0.5009	0.0000	0.000	1.00
CH4 Mobile combustion: Aircraft	0.0000	0.5009	0.0000	0.000	1.00
CO2 Lime production	0.0000	0.1044	0.0000	0.000	1.00
N2O Mobile combustion: Waterborne Navigation	0.0000	1.0004	0.0000	0.000	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.0000	0.2518	0.0000	0.000	1.00
CH4 Agricultural Residue Burning	0.0000	0.5385	0.0000	0.000	1.00
N2O Agricultural Residue Burning	0.0000	0.5385	0.0000	0.000	1.00

Table A1.11 Results of the key category analysis with LULUCF. Approach 2 Level assessment, year 2010

CATEGORIES	Share	Uncertainty	L*U	Level assessment with uncertainty	Cumulative Percentage
CO2 Forest land remaining Forest Land	0.07	0.4904	0.0336	0.1726	0.17
CO2 Cropland remaining Cropland	0.02	1.0607	0.0234	0.1201	0.29
Direct N2O Agricultural Soils	0.01	1.0198	0.0131	0.0670	0.36
CO2 stationary combustion gaseous fuels	0.28	0.0424	0.0119	0.0612	0.42
Indirect N2O from Nitrogen used in agriculture	0.01	1.0198	0.0115	0.0591	0.48
CO2 Land converted to Grassland	0.01	1.0607	0.0100	0.0513	0.53
HFC, PFC substitutes for ODS	0.02	0.5831	0.0090	0.0463	0.58
CH4 from Solid waste Disposal Sites	0.02	0.3606	0.0082	0.0422	0.62
CO2 Mobile combustion: Road Vehicles	0.19	0.0424	0.0082	0.0419	0.66
N2O Manure Management	0.01	1.0198	0.0067	0.0343	0.70
CO2 Land converted to Settlements	0.01	1.0607	0.0064	0.0328	0.73
CH4 Enteric Fermentation in Domestic Livestock	0.02	0.2828	0.0054	0.0276	0.76
CH4 Emissions from Wastewater Handling	0.00	1.0440	0.0051	0.0261	0.78
CO2 stationary combustion liquid fuels	0.11	0.0424	0.0048	0.0247	0.81
CH4 Manure Management	0.00	1.0198	0.0046	0.0238	0.83
CO2 Grassland remaining Grassland	0.00	1.0607	0.0044	0.0225	0.85
CO2 stationary combustion solid fuels	0.10	0.0424	0.0041	0.0212	0.87
N2O stationary combustion	0.01	0.5009	0.0034	0.0173	0.89
N2O from animal production	0.00	1.0198	0.0028	0.0143	0.91
CO2 Cement production	0.02	0.1044	0.0025	0.0126	0.92
CH4 Fugitive emissions from Oil and Gas Operations	0.01	0.2518	0.0022	0.0115	0.93
CO2 Land converted to Forest Land	0.00	1.0607	0.0022	0.0115	0.94
N2O Emissions from Wastewater Handling	0.00	0.4243	0.0015	0.0076	0.95
CH4 stationary combustion	0.00	0.5009	0.0012	0.0059	0.96
CO2 Emissions from solvent use	0.00	0.5831	0.0011	0.0055	0.96
CO2 Fugitive emissions from Oil and Gas Operations	0.00	0.2518	0.0010	0.0053	0.97
N2O Mobile combustion: Road Vehicles	0.00	0.5009	0.0009	0.0047	0.97
N2O Emissions from solvent use	0.00	0.5099	0.0006	0.0029	0.97
CH4 from Rice production	0.00	0.2022	0.0006	0.0029	0.98
CO2 stationary combustion other fuels	0.01	0.0424	0.0004	0.0022	0.98
CO2 Mobile combustion: Waterborne Navigation	0.01	0.0424	0.0004	0.0020	0.98
CO2 Lime production	0.00	0.1044	0.0004	0.0019	0.98
CO2 Other industrial processes	0.00	0.1044	0.0004	0.0018	0.98
CO2 Limestone and Dolomite Use	0.00	0.1044	0.0003	0.0015	0.99
CH4 Fugitive emissions from Coal Mining and Handling	0.00	2.0002	0.0002	0.0012	0.99
PFC from the production of halocarbons and SF6	0.00	0.1118	0.0002	0.0012	0.99
CH4 Mobile combustion: Road Vehicles	0.00	0.4011	0.0002	0.0011	0.99
CO2 Iron and Steel production	0.00	0.1044	0.0002	0.0011	0.99
N2O Emissions from Waste Incineration	0.00	1.0012	0.0002	0.0010	0.99
CO2 Mobile combustion: Other	0.00	0.0583	0.0002	0.0010	0.99
CO2 Ammonia production	0.00	0.1044	0.0002	0.0009	0.99
CO2 Mobile combustion: Aircraft	0.00	0.0424	0.0002	0.0009	0.99
N2O Land converted to Cropland	0.00	1.0607	0.0002	0.0008	1.00
PFC, HFC, SF6 Semiconductor manufacturing	0.00	0.5831	0.0001	0.0008	1.00
N2O Mobile combustion: Other	0.00	1.0004	0.0001	0.0007	1.00
CO2 Emissions from Waste Incineration	0.00	0.2550	0.0001	0.0005	1.00
CH4 Emissions from Waste Incineration	0.00	0.2062	0.0001	0.0005	1.00
N2O Adipic Acid	0.00	0.1044	0.0001	0.0005	1.00
N2O Mobile combustion: Waterborne Navigation	0.00	1.0004	0.0001	0.0003	1.00
SF6 Electrical Equipment	0.00	0.1118	0.0001	0.0003	1.00
CH4 Industrial Processes	0.00	0.5009	0.0000	0.0002	1.00
CH4 Forest land remaining Forest Land	0.00	0.4904	0.0000	0.0002	1.00
N2O Mobile combustion: Aircraft	0.00	1.0004	0.0000	0.0002	1.00
N2O Nitric Acid	0.00	0.1044	0.0000	0.0001	1.00
CH4 Mobile combustion: Waterborne Navigation	0.00	0.5009	0.0000	0.0001	1.00
CO2 Land converted to Cropland	0.00	1.0607	0.0000	0.0001	1.00
PFC Aluminium production	0.00	0.1118	0.0000	0.0001	1.00
CH4 Agricultural Residue Burning	0.00	0.5385	0.0000	0.0001	1.00
CH4 Emissions from Other Waste	0.00	1.0050	0.0000	0.0000	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.00	0.2518	0.0000	0.0000	1.00
N2O Agricultural Residue Burning	0.00	0.5385	0.0000	0.0000	1.00
SF6, HFC Magnesium production	0.00	0.0707	0.0000	0.0000	1.00
CH4 Mobile combustion: Other	0.00	0.5009	0.0000	0.0000	1.00
CH4 Mobile combustion: Aircraft	0.00	0.5009	0.0000	0.0000	1.00
N2O Forest land remaining Forest Land	0.00	0.4904	0.0000	0.0000	1.00
N2O Other industrial processes	0.00	0.1044	0.0000	0.0000	1.00
SF6 Production of SF6	0.00	0.1118	0.0000	0.0000	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.00	0.1118	0.0000	0.0000	1.00

Table A1.12 Results of the key category analysis with LULUCF. Approach 2 Trend assessment, 1990- 2010

CATEGORIES	Trend assessment	Uncertainty	T*U	Relative trend assessment with uncertainty	Cumulative Percentage
CO2 Forest land remaining Forest Land	0.0342	0.4904	0.0168	0.18	0.18
CO2 Cropland remaining Cropland	0.0146	1.0607	0.0154	0.17	0.35
CO2 Land converted to Grassland	0.0095	1.0607	0.0101	0.11	0.46
HFC, PFC substitutes for ODS	0.0156	0.5831	0.0091	0.10	0.56
CO2 stationary combustion gaseous fuels	0.1438	0.0424	0.0061	0.07	0.63
CO2 stationary combustion liquid fuels	0.1365	0.0424	0.0058	0.06	0.70
CO2 Grassland remaining Grassland	0.0046	1.0607	0.0049	0.05	0.75
Direct N2O Agricultural Soils	0.0028	1.0198	0.0029	0.03	0.78
CO2 Land converted to Settlements	0.0019	1.0607	0.0021	0.02	0.80
Indirect N2O from Nitrogen used in agriculture	0.0019	1.0198	0.0020	0.02	0.82
CO2 Mobile combustion: Road Vehicles	0.0410	0.0424	0.0017	0.02	0.84
CH4 Emissions from Wastewater Handling	0.0016	1.0440	0.0017	0.02	0.86
CO2 Land converted to Forest Land	0.0013	1.0607	0.0014	0.01	0.88
CO2 Land converted to Cropland	0.0012	1.0607	0.0013	0.01	0.89
CH4 Manure Management	0.0011	1.0198	0.0011	0.01	0.90
CH4 Fugitive emissions from Oil and Gas Operations	0.0030	0.2518	0.0007	0.01	0.91
CH4 from Solid waste Disposal Sites	0.0020	0.3606	0.0007	0.01	0.92
N2O Adipic Acid	0.0066	0.1044	0.0007	0.01	0.93
CH4 stationary combustion	0.0013	0.5009	0.0006	0.01	0.93
N2O stationary combustion	0.0011	0.5009	0.0006	0.01	0.94
CO2 Emissions from solvent use	0.0008	0.5831	0.0005	0.01	0.95
CO2 stationary combustion other fuels	0.0089	0.0424	0.0004	0.00	0.95
CO2 Fugitive emissions from Oil and Gas Operations	0.0013	0.2518	0.0003	0.00	0.95
N2O Nitric Acid	0.0031	0.1044	0.0003	0.00	0.96
CO2 Iron and Steel production	0.0031	0.1044	0.0003	0.00	0.96
CO2 Ammonia production	0.0028	0.1044	0.0003	0.00	0.96
PFC Aluminium production	0.0026	0.1118	0.0003	0.00	0.97
CH4 Mobile combustion: Road Vehicles	0.0007	0.4011	0.0003	0.00	0.97
CO2 Cement production	0.0026	0.1044	0.0003	0.00	0.97
CH4 Enteric Fermentation in Domestic Livestock	0.0010	0.2828	0.0003	0.00	0.98
N2O Emissions from Wastewater Handling	0.0005	0.4243	0.0002	0.00	0.98
N2O Manure Management	0.0002	1.0198	0.0002	0.00	0.98
N2O Mobile combustion: Road Vehicles	0.0004	0.5009	0.0002	0.00	0.98
CH4 Fugitive emissions from Coal Mining and Handling	0.0001	2.0002	0.0002	0.00	0.98
PFC, HFC, SF6 Semiconductor manufacturing	0.0003	0.5831	0.0001	0.00	0.99
CO2 Limestone and Dolomite Use	0.0014	0.1044	0.0001	0.00	0.99
CH4 Forest land remaining Forest Land	0.0002	0.4904	0.0001	0.00	0.99
N2O Emissions from solvent use	0.0002	0.5099	0.0001	0.00	0.99
CO2 Emissions from Waste Incineration	0.0004	0.2550	0.0001	0.00	0.99
N2O from animal production	0.0001	1.0198	0.0001	0.00	0.99
PFC from the production of halocarbons and SF6	0.0007	0.1118	0.0001	0.00	0.99
N2O Mobile combustion: Other	0.0001	1.0004	0.0001	0.00	0.99
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.0006	0.1118	0.0001	0.00	0.99
CO2 Mobile combustion: Aircraft	0.0015	0.0424	0.0001	0.00	1.00
N2O Emissions from Waste Incineration	0.0001	1.0012	0.0001	0.00	1.00
CH4 from Rice production	0.0002	0.2022	0.0000	0.00	1.00
CH4 Emissions from Waste Incineration	0.0002	0.2062	0.0000	0.00	1.00
CH4 Industrial Processes	0.0001	0.5009	0.0000	0.00	1.00
CO2 stationary combustion solid fuels	0.0009	0.0424	0.0000	0.00	1.00
CO2 Other industrial processes	0.0003	0.1044	0.0000	0.00	1.00
SF6 Electrical Equipment	0.0002	0.1118	0.0000	0.00	1.00
SF6 Production of SF6	0.0002	0.1118	0.0000	0.00	1.00

Table A1.13 Results of the key category analysis without LULUCF. Approach 2 Level assessment, year 1990

CATEGORIES	Share	Uncertainty	L*U	Level assessment with uncertainty	Cumulative Percentage
Direct N2O Agricultural Soils	0.02	1.0198	0.0189	0.1436	0.14
Indirect N2O from Nitrogen used in agriculture	0.02	1.0198	0.0160	0.1217	0.27
CO2 stationary combustion liquid fuels	0.30	0.0424	0.0125	0.0954	0.36
CH4 from Solid waste Disposal Sites	0.03	0.3606	0.0106	0.0806	0.44
N2O Manure Management	0.01	1.0198	0.0077	0.0586	0.50
CO2 Mobile combustion: Road Vehicles	0.18	0.0424	0.0076	0.0581	0.56
CO2 stationary combustion gaseous fuels	0.16	0.0424	0.0070	0.0529	0.61
CH4 Manure Management	0.01	1.0198	0.0068	0.0517	0.66
CH4 Enteric Fermentation in Domestic Livestock	0.02	0.2828	0.0067	0.0509	0.71
CO2 stationary combustion solid fuels	0.11	0.0424	0.0048	0.0369	0.75
CH4 Emissions from Wastewater Handling	0.00	1.0440	0.0040	0.0304	0.78
CH4 Fugitive emissions from Oil and Gas Operations	0.01	0.2518	0.0035	0.0269	0.81
N2O from animal production	0.00	1.0198	0.0034	0.0259	0.83
N2O stationary combustion	0.01	0.5009	0.0033	0.0253	0.86
CO2 Cement production	0.03	0.1044	0.0032	0.0246	0.88
CO2 Emissions from solvent use	0.00	0.5831	0.0018	0.0140	0.90
CO2 Fugitive emissions from Oil and Gas Operations	0.01	0.2518	0.0016	0.0123	0.91
N2O Emissions from Wastewater Handling	0.00	0.4243	0.0015	0.0114	0.92
N2O Adipic Acid	0.01	0.1044	0.0009	0.0070	0.93
N2O Mobile combustion: Road Vehicles	0.00	0.5009	0.0009	0.0067	0.94
N2O Emissions from solvent use	0.00	0.5099	0.0008	0.0061	0.94
CO2 Iron and Steel production	0.01	0.1044	0.0006	0.0048	0.95
CH4 stationary combustion	0.00	0.5009	0.0006	0.0048	0.95
CH4 from Rice production	0.00	0.2022	0.0006	0.0047	0.96
CH4 Mobile combustion: Road Vehicles	0.00	0.4011	0.0006	0.0044	0.96
CO2 Ammonia production	0.01	0.1044	0.0006	0.0042	0.96
CO2 Limestone and Dolomite Use	0.00	0.1044	0.0005	0.0039	0.97
CH4 Fugitive emissions from Coal Mining and Handling	0.00	2.0002	0.0005	0.0036	0.97
CO2 Mobile combustion: Waterborne Navigation	0.01	0.0424	0.0004	0.0034	0.97
N2O Nitric Acid	0.00	0.1044	0.0004	0.0032	0.98
CO2 Lime production	0.00	0.1044	0.0004	0.0031	0.98
CO2 Other industrial processes	0.00	0.1044	0.0004	0.0029	0.98
PFC Aluminium production	0.00	0.1118	0.0004	0.0027	0.99
N2O Mobile combustion: Other	0.00	1.0004	0.0003	0.0019	0.99
CO2 Emissions from Waste Incineration	0.00	0.2550	0.0002	0.0019	0.99
CO2 Mobile combustion: Other	0.00	0.0583	0.0002	0.0016	0.99
PFC from the production of halocarbons and SF6	0.00	0.1118	0.0002	0.0013	0.99
N2O Emissions from Waste Incineration	0.00	1.0012	0.0002	0.0013	0.99
CO2 Mobile combustion: Aircraft	0.00	0.0424	0.0001	0.0010	1.00
CH4 Industrial Processes	0.00	0.5009	0.0001	0.0008	1.00
N2O Mobile combustion: Waterborne Navigation	0.00	1.0004	0.0001	0.0006	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.00	0.1118	0.0001	0.0006	1.00
CO2 stationary combustion other fuels	0.00	0.0424	0.0001	0.0006	1.00
CH4 Emissions from Waste Incineration	0.00	0.2062	0.0001	0.0005	1.00
SF6 Electrical Equipment	0.00	0.1118	0.0000	0.0003	1.00
CH4 Mobile combustion: Waterborne Navigation	0.00	0.5009	0.0000	0.0002	1.00
N2O Mobile combustion: Aircraft	0.00	1.0004	0.0000	0.0002	1.00
SF6 Production of SF6	0.00	0.1118	0.0000	0.0002	1.00
CH4 Agricultural Residue Burning	0.00	0.5385	0.0000	0.0001	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.00	0.2518	0.0000	0.0000	1.00
CH4 Mobile combustion: Other	0.00	0.5009	0.0000	0.0000	1.00
N2O Agricultural Residue Burning	0.00	0.5385	0.0000	0.0000	1.00
N2O Other industrial processes	0.00	0.1044	0.0000	0.0000	1.00
CH4 Mobile combustion: Aircraft	0.00	0.5009	0.0000	0.0000	1.00
CH4 Emissions from Other Waste	0.00	1.0050	0.0000	0.0000	1.00
SF6, HFC Magnesium production	0.00	0.0707	0.0000	0.0000	1.00
PFC, HFC, SF6 Semiconductor manufacturing	0.00	0.5831	0.0000	0.0000	1.00
HFC, PFC substitutes for ODS	0.00	0.5831	0.0000	0.0000	1.00

Table A1.14 Results of the key category analysis with LULUCF. Approach 2 Level assessment, year 1990

CATEGORIES	Share	Uncertainty	L*U	Level assessment with uncertainty	Cumulative Percentage
CO2 Cropland remaining Cropland	0.03	1.0607	0.0360	0.1973	0.20
Direct N2O Agricultural Soils	0.02	1.0198	0.0175	0.0956	0.29
CO2 Forest land remaining Forest Land	0.03	0.4904	0.0158	0.0864	0.38
Indirect N2O from Nitrogen used in agriculture	0.01	1.0198	0.0148	0.0810	0.46
CO2 stationary combustion liquid fuels	0.27	0.0424	0.0116	0.0635	0.52
CH4 from Solid waste Disposal Sites	0.03	0.3606	0.0098	0.0537	0.58
N2O Manure Management	0.01	1.0198	0.0071	0.0390	0.62
CO2 Mobile combustion: Road Vehicles	0.17	0.0424	0.0071	0.0387	0.66
CO2 stationary combustion gaseous fuels	0.15	0.0424	0.0064	0.0352	0.69
CH4 Manure Management	0.01	1.0198	0.0063	0.0344	0.72
CH4 Enteric Fermentation in Domestic Livestock	0.02	0.2828	0.0062	0.0339	0.76
CO2 Land converted to Settlements	0.00	1.0607	0.0048	0.0261	0.78
CO2 stationary combustion solid fuels	0.11	0.0424	0.0045	0.0246	0.81
CH4 Emissions from Wastewater Handling	0.00	1.0440	0.0037	0.0203	0.83
CH4 Fugitive emissions from Oil and Gas Operations	0.01	0.2518	0.0033	0.0179	0.85
N2O from animal production	0.00	1.0198	0.0032	0.0173	0.86
N2O stationary combustion	0.01	0.5009	0.0031	0.0168	0.88
CO2 Cement production	0.03	0.1044	0.0030	0.0164	0.90
CO2 Emissions from solvent use	0.00	0.5831	0.0017	0.0093	0.91
CO2 Fugitive emissions from Oil and Gas Operations	0.01	0.2518	0.0015	0.0082	0.92
CO2 Land converted to Grassland	0.00	1.0607	0.0014	0.0078	0.92
CO2 Land converted to Cropland	0.00	1.0607	0.0014	0.0077	0.93
N2O Emissions from Wastewater Handling	0.00	0.4243	0.0014	0.0076	0.94
N2O Adipic Acid	0.01	0.1044	0.0009	0.0047	0.94
CO2 Land converted to Forest Land	0.00	1.0607	0.0008	0.0045	0.95
N2O Mobile combustion: Road Vehicles	0.00	0.5009	0.0008	0.0045	0.95
N2O Emissions from solvent use	0.00	0.5099	0.0007	0.0040	0.96
CO2 Iron and Steel production	0.01	0.1044	0.0006	0.0032	0.96
CH4 stationary combustion	0.00	0.5009	0.0006	0.0032	0.96
CH4 from Rice production	0.00	0.2022	0.0006	0.0031	0.97
CH4 Mobile combustion: Road Vehicles	0.00	0.4011	0.0005	0.0029	0.97
CO2 Grassland remaining Grassland	0.00	1.0607	0.0005	0.0028	0.97
CO2 Ammonia production	0.00	0.1044	0.0005	0.0028	0.97
CO2 Limestone and Dolomite Use	0.00	0.1044	0.0005	0.0026	0.98
CH4 Fugitive emissions from Coal Mining and Handling	0.00	2.0002	0.0004	0.0024	0.98
CO2 Mobile combustion: Waterborne Navigation	0.01	0.0424	0.0004	0.0022	0.98
N2O Nitric Acid	0.00	0.1044	0.0004	0.0021	0.98
CO2 Lime production	0.00	0.1044	0.0004	0.0021	0.99
CO2 Other industrial processes	0.00	0.1044	0.0003	0.0019	0.99
PFC Aluminium production	0.00	0.1118	0.0003	0.0018	0.99
N2O Mobile combustion: Other	0.00	1.0004	0.0002	0.0013	0.99
CO2 Emissions from Waste Incineration	0.00	0.2550	0.0002	0.0013	0.99
CO2 Mobile combustion: Other	0.00	0.0583	0.0002	0.0011	0.99
N2O Land converted to Cropland	0.00	1.0607	0.0002	0.0009	0.99
PFC from the production of halocarbons and SF6	0.00	0.1118	0.0002	0.0009	0.99
CH4 Forest land remaining Forest Land	0.00	0.4904	0.0002	0.0009	1.00
N2O Emissions from Waste Incineration	0.00	1.0012	0.0002	0.0009	1.00
CO2 Mobile combustion: Aircraft	0.00	0.0424	0.0001	0.0007	1.00
CH4 Industrial Processes	0.00	0.5009	0.0001	0.0005	1.00
N2O Mobile combustion: Waterborne Navigation	0.00	1.0004	0.0001	0.0004	1.00
HFC-23 from HCFC-22 Manufacture and HFCs fugitive	0.00	0.1118	0.0001	0.0004	1.00
CO2 stationary combustion other fuels	0.00	0.0424	0.0001	0.0004	1.00
CH4 Emissions from Waste Incineration	0.00	0.2062	0.0001	0.0003	1.00
SF6 Electrical Equipment	0.00	0.1118	0.0000	0.0002	1.00
CH4 Mobile combustion: Waterborne Navigation	0.00	0.5009	0.0000	0.0001	1.00
N2O Mobile combustion: Aircraft	0.00	1.0004	0.0000	0.0001	1.00
SF6 Production of SF6	0.00	0.1118	0.0000	0.0001	1.00
CH4 Agricultural Residue Burning	0.00	0.5385	0.0000	0.0001	1.00
N2O Fugitive emissions from Oil and Gas Operations	0.00	0.2518	0.0000	0.0000	1.00
CH4 Mobile combustion: Other	0.00	0.5009	0.0000	0.0000	1.00
N2O Agricultural Residue Burning	0.00	0.5385	0.0000	0.0000	1.00
N2O Other industrial processes	0.00	0.1044	0.0000	0.0000	1.00
N2O Forest land remaining Forest Land	0.00	0.4904	0.0000	0.0000	1.00
CH4 Mobile combustion: Aircraft	0.00	0.5009	0.0000	0.0000	1.00
CH4 Emissions from Other Waste	0.00	1.0050	0.0000	0.0000	1.00
SF6, HFC Magnesium production	0.00	0.0707	0.0000	0.0000	1.00

A1.5 Uncertainty assessment (IPCC Approach 2)

Montecarlo analysis was applied last year to estimate uncertainty of some of the key categories of the Italian inventory. In this current submission, the analysis has been carried out for the remaining key categories of the agriculture sector as reported in Table A1.15. Most of the results prove that both approaches (Approach 1 and 2) produce comparable results.

In Table A.1.15 the outcomes of the Approach 1 (error propagation) and Approach 2 (Montecarlo analysis) are shown.

Table A1.15 Comparison between uncertainty assessment by Approach 1 and Approach 2

Sector	*Categories*	*Key*	Approach 1 %	Approach 2 (Montecarlo) %
Energy	CO_2 stationary combustion liquid fuels	L, T	4.2	3.3
Energy	CO_2 stationary combustion solid fuels	L, T1	4.2	5.1
Energy	CO_2 stationary combustion gaseous fuels	L, T	4.2	5.8
Energy	CO_2 Mobile combustion: Road Vehicles	L, T	4.2	7.4
Energy	CH_4 Mobile combustion: Road Vehicles	-	40.1	77.8
Energy	N_2O Mobile combustion: Road Vehicles	-	50.1	19.4
Energy	CH_4 Fugitive emissions from Oil and Gas Operations	L1, T1	25.2	17.4
Industrial Processes	CO_2 Cement production	L1	10.4	10.0
Agriculture	CH_4 Enteric Fermentation in Domestic Livestock	L	28.3	-21.8; +31.7
Agriculture*	Direct N_2O Agriculture soils	L, T	101.9	21.34
Agriculture*	Indirect N_2O from Nitrogen used in agriculture	L, T	101.9	21.67
Agriculture*	N_2O Manure management	L	101.9	10.19
Agriculture*	CH_4 Manure management	L, T2	101.9	22.96
Waste	CH_4 from Solid waste Disposal Sites	L, T1	36.1	12.6
LULUCF	CO_2 Forest land remaining Forest land	L, T	49.0	42.9
LULUCF	CO_2 Land converted to Forest land	-	106.1	-147.6; 192.3
LULUCF	CO_2 Cropland remaining Cropland	L, T	106.1	-108.5; 210.2
LULUCF	CO_2 Land converted to Cropland	T2	106.1	-408.2; 178.5
LULUCF	CO_2 Grassland remaining Grassland	L, T	106.1	-67.7; 75.0
LULUCF	CO_2 Land converted to Grassland	L, T	106.1	-119.3; 194.5
LULUCF	CO_2 Land converted to Settlements	L, T	106.1	-100.3; 49.2

* These categories have been processes in 2012 submission

A summary of the results is described in the following by category.

Energy: CO_2 from stationary combustion liquid fuels

Montecarlo analysis has been carried out for CO_2 emissions from stationary combustion of liquid fuels, for the reporting year 2009. In Table A1.16 a description of the main statistics resulting from the Montecarlo analysis is shown.

Table A1.16 Statistics of the Montecarlo analysis for CO_2 emissions from stationary combustion of liquid fuels, year 2009

	Value
Trials	5000
Mean	72,096,300
Median	72,096,998
Standard Deviation	1,181,053
Range Minimum	68,046,555
Range Maximum	77,401,681
Uncertainty (%)	**3.28**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.1.

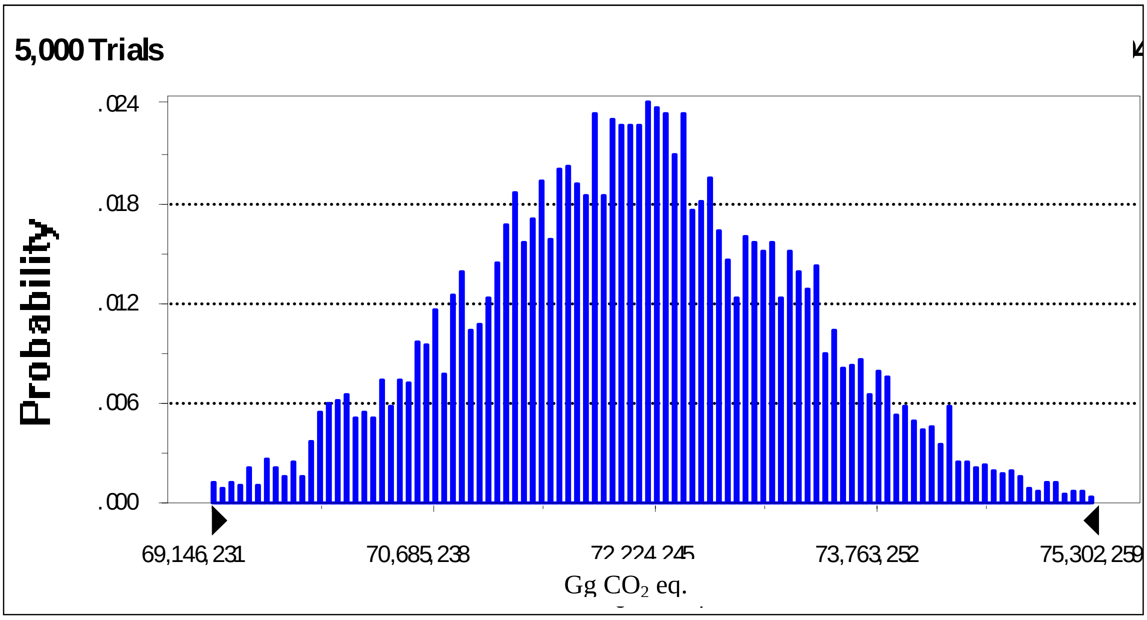


Figure A1.1 Probability density function resulting from Montecarlo analysis for CO_2 emissions from stationary combustion of liquid fuels, year 2009

Energy: CO_2 from stationary combustion solid fuels

Montecarlo analysis has been carried out for the CO_2 emissions from stationary combustion of solid fuels, for the reporting year 2009. In Table A1.17 a description of the main statistics resulting from the Montecarlo analysis is shown.

Table A1.17 Statistics of the Montecarlo analysis for CO_2 emissions from stationary combustion of solid fuels, year 2009

	Value
Trials	5000
Mean	49,289,917
Median	49,285,332
Standard Deviation	1,253,323
Range Minimum	44,384,889
Range Maximum	53,681,603
Uncertainty (%)	**5.08**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.2.

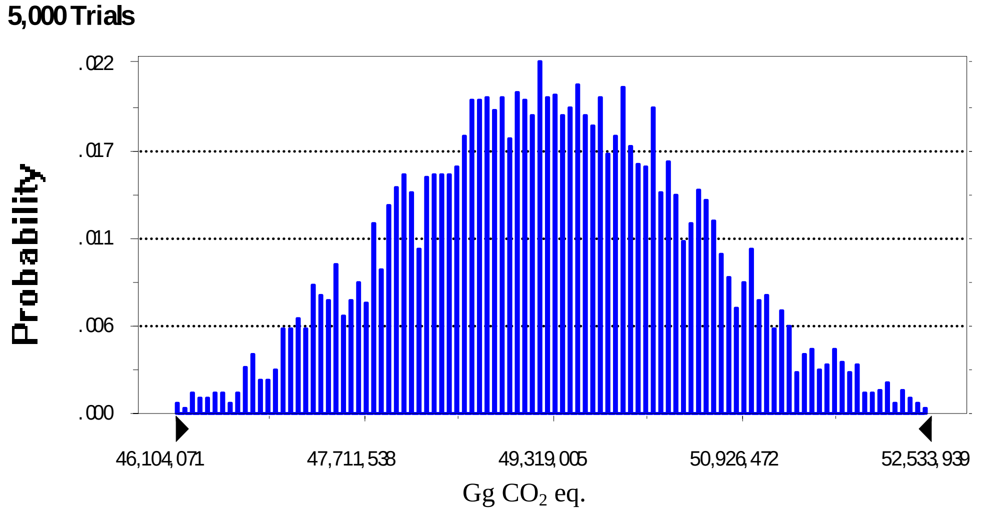


Figure A1.2 Probability density function resulting from Montecarlo analysis for CO_2 emissions from stationary combustion of solid fuels, year 2009

Energy: CO_2 from stationary combustion gaseous fuels

Montecarlo analysis has been carried out for the CO_2 emissions from stationary combustion of gaseous fuels, for the reporting year 2009. In Table A1.18 a description of the main statistics resulting from the Montecarlo analysis is shown.

Table A1.18 Statistics of the Montecarlo analysis for CO_2 emissions from stationary combustion of gaseous fuels, year 2009

	Value
Trials	5000
Mean	149,122,449
Median	149,184,196
Standard Deviation	4,355,657
Range Minimum	133,814,642
Range Maximum	165,672,245
Uncertainty (%)	**5.84**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.3.

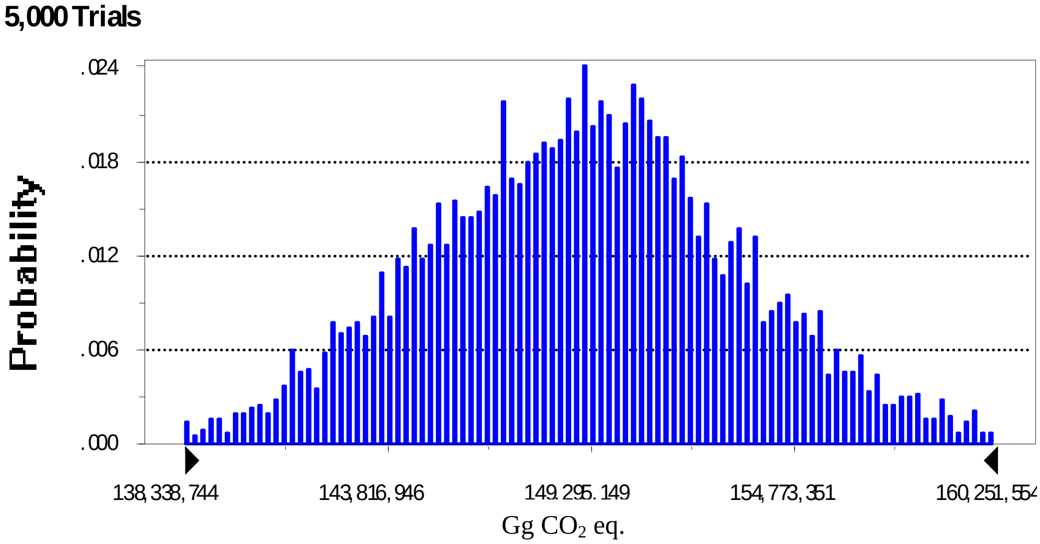


Figure A1.3 Probability density function resulting from Montecarlo analysis for CO_2 emissions from stationary combustion of gaseous fuels, year 2009

Energy: CO_2, CH_4 and N_2O Mobile combustion: Road Vehicles

Uncertainty of road transport emissions, at national level, has been assessed in the framework of study[46] "Uncertainty estimates and guidance for road transport emission calculations" performed by EMISIA[47] on behalf of the Joint Research Centre. The uncertainty has been assessed on the basis of 2005 input parameters of the COPERT 4 model (v. 7.0). In Table A1.19 a description of the statistics resulting for Mobile combustion: Road Vehicles is shown.

Table A1.19 Statistics of the Montecarlo analysis for GHG emissions from Mobile combustion: Road Vehicles, year 2005

	CO_2	CH_4	N_2O
Mean	110,735	19	614
Median	110,622	18	608
Standard Deviation	4,079	7	59
Variation (%)	4	34	10
Uncertainty (%)	**7.37**	**77.78**	**19.41**

The probability density functions, for CO_2, CH_4 and N_2O emissions from mobile combustion, resulting from the Montecarlo assessment is shown in Figure A1.4.

[46] Kouridis C., Gkatzoflias D., Kioutsioukis I., Ntziachristos L., Pastorello P., Dilara P., 2010 .Uncertainty Estimates and Guidance for Road Transport Emission Calculations, Joint Research Centre 2010; URL: http://www.emisia.com/docs/COPERT%20uncertainty.pdf

[47] EMISIA: www.emisia.com

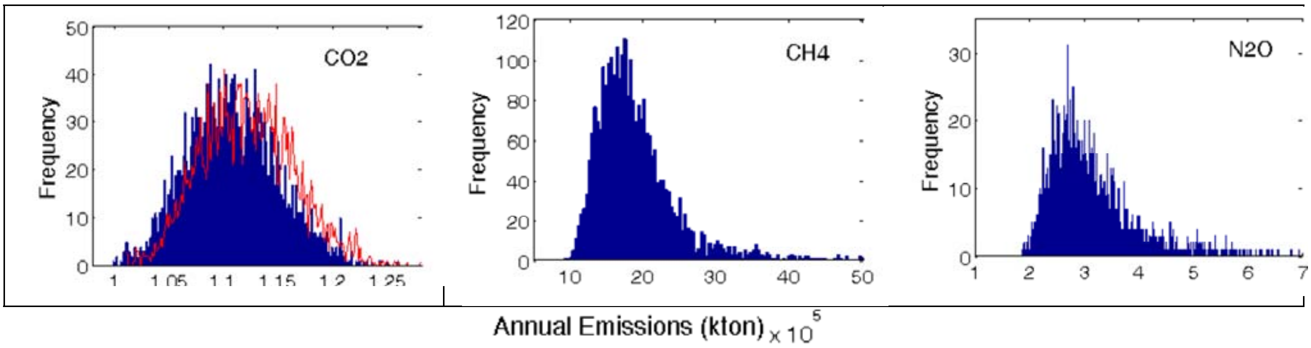


Figure A1.4 Probability density function resulting from Montecarlo analysis for CO_2, CH_4 and N_2O emissions from Mobile combustion: Road Vehicles, year 2005 (Kouridis et al., 2010)

Industrial Processes: CO_2 from Cement production

Montecarlo analysis has been carried out for the CO_2 emissions from cement production, for the reporting year 2009. In Table A1.20 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.20 Statistics of the Montecarlo analysis for CO_2 emissions from cement production, year 2009

	Value
Trials	5000
Mean	13,447,765
Median	13,452,009
Standard Deviation	670,995
Range Minimum	11,167,723
Range Maximum	16,119,133
Uncertainty (%)	**9.98**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.5.

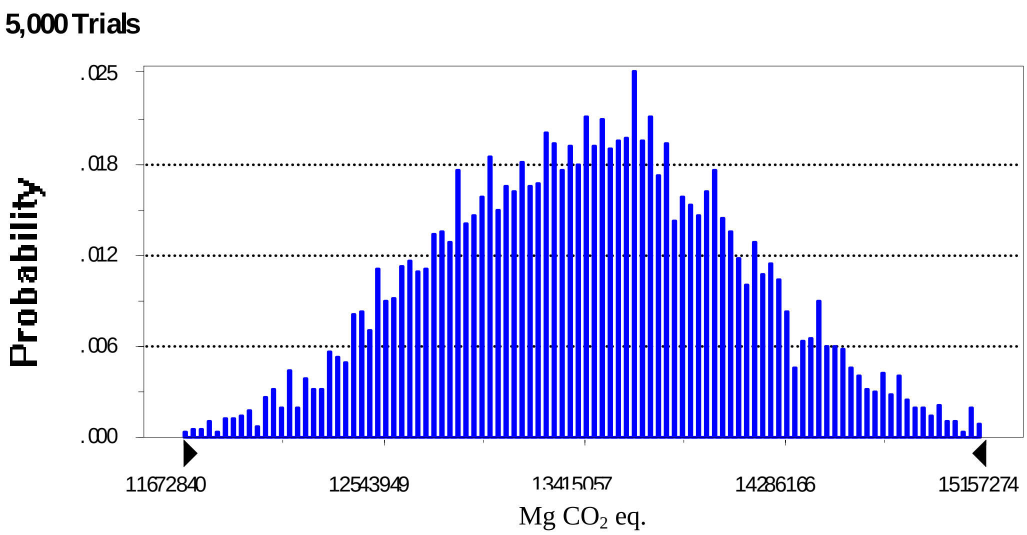


Figure A1.5 Probability density function resulting from Montecarlo analysis for CO_2 emissions from cement production, year 2009

Energy: CH_4 Fugitive emissions from Oil and Gas Operations

Montecarlo analysis has been carried out for CH_4 fugitive emissions from oil and gas operations, for the reporting year 2009. In Table A1.21 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.21 Statistics of the Montecarlo analysis for CH_4 from fugitive emissions, year 2009

	Value
Trials	5000
Mean	4904
Median	4903
Standard Deviation	427
Range Minimum	3027
Range Maximum	6532
Uncertainty (%)	**17.40**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.6.

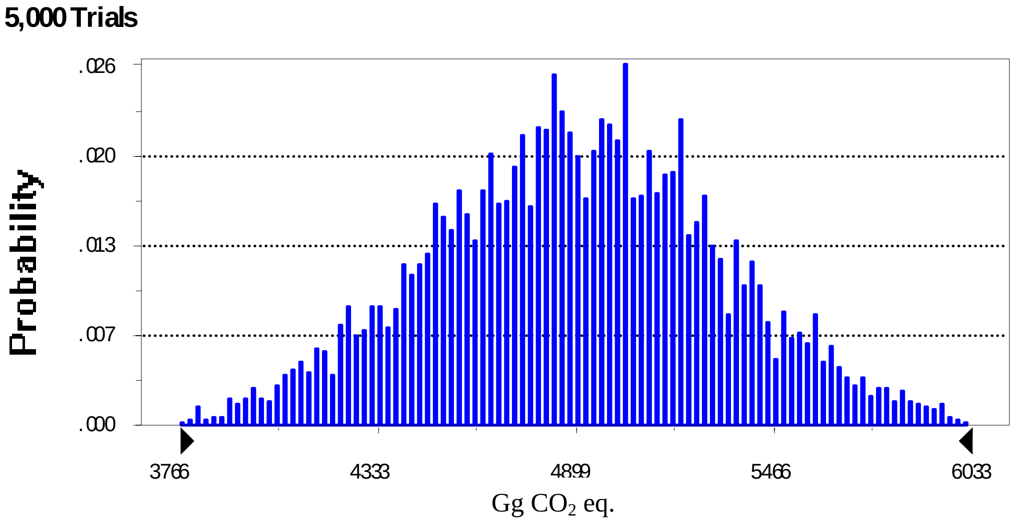


Figure A1.6 Probability density function resulting from Montecarlo analysis for CH_4 from fugitive emissions, year 2009

Agriculture: CH_4 Enteric Fermentation in Domestic Livestock

Montecarlo analysis has been carried out for the CH_4 emissions from enteric fermentation in domestic livestock, for the reporting year 2009. In Table A1.22 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.22 Statistics of the Montecarlo analysis for CH_4 emissions from enteric fermentation, year 2009

	Value
Trials	5000
Mean	519,226
Median	512,480
Standard Deviation	71,264
Range Minimum	340,639
Range Maximum	869,092
Uncertainty (%)	**-21.8; +31.7**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.7.

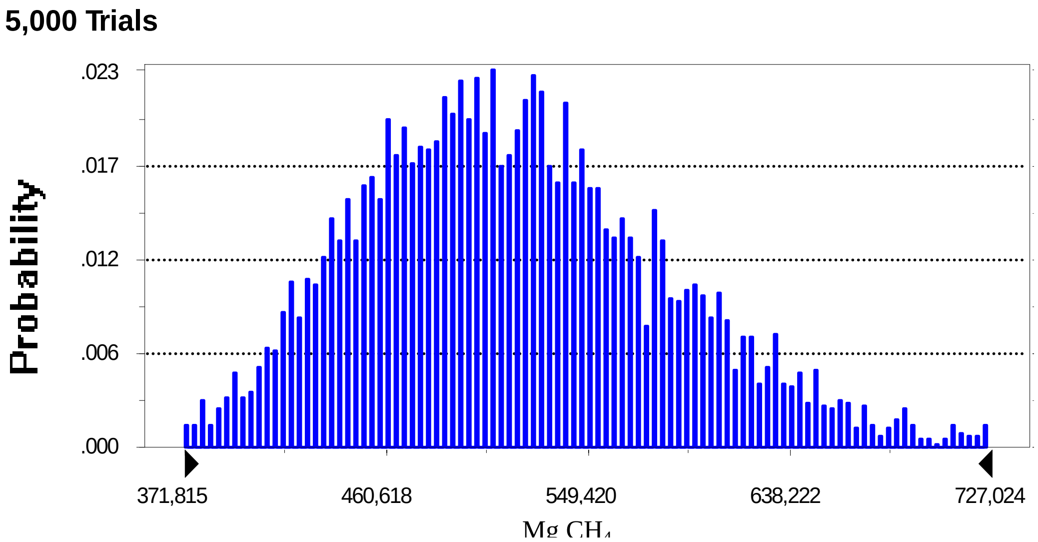


Figure A1.7 Probability density function resulting from Montecarlo analysis for CH_4 emissions from enteric fermentation, year 2009

Agriculture: Direct N_2O Agriculture soils

Montecarlo analysis has been carried out for the Direct N_2O emissions from Agriculture soils, for the reporting year 2010. In Table A1.23 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.23 Statistics of the Montecarlo analysis for Direct N_2O Agriculture soils emissions, year 2010

	Value
Trials	10000
Mean	23.24
Median	23.08
Standard Deviation	2.48
Range Minimum	16.85
Range Maximum	33.43
Uncertainty (%)	**21.34**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.8.

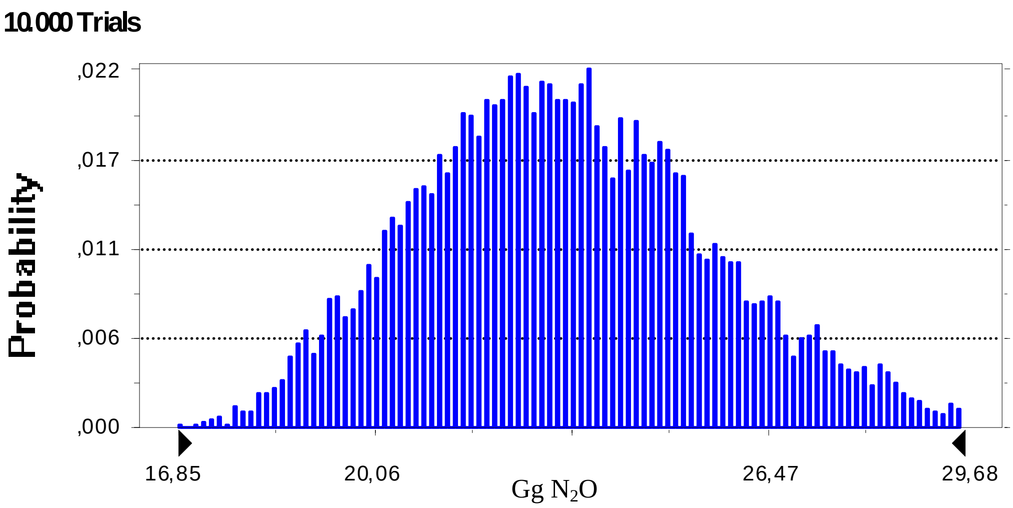


Figure A1.8 Probability density function resulting from Montecarlo analysis for Direct N_2O Agriculture soils **emissions, year 2010**

Agriculture: Indirect N_2O from Nitrogen used in agriculture
Montecarlo analysis has been carried out for the indirect N_2O emission from nitrogen used in agriculture, for the reporting year 2010. In Table A1.24 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.24 Statistics of the Montecarlo analysis for indirect N_2O emissions from nitrogen used in agriculture, year 2010

	Value
Trials	10000
Mean	20.58
Median	20.47
Standard Deviation	2.23
Range Minimum	13.53
Range Maximum	29.42
Uncertainty (%)	**21.67**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.9.

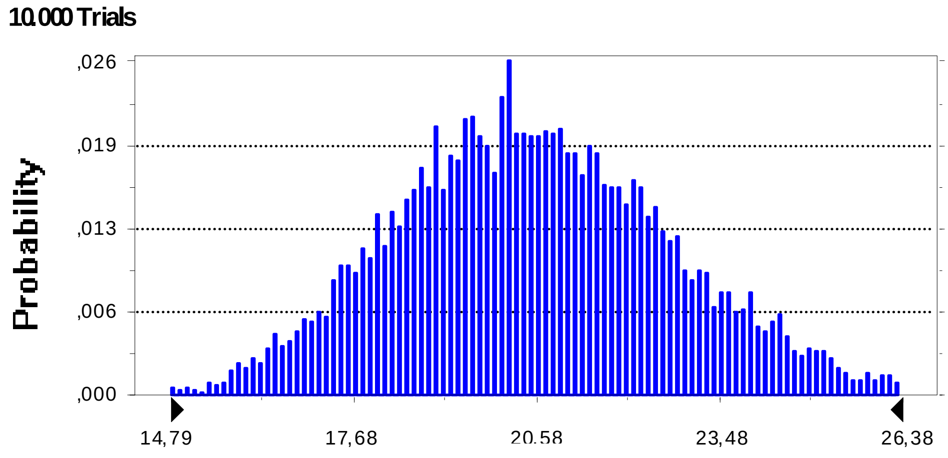


Figure A1.9 Probability density function resulting from Montecarlo analysis for indirect N_2O emissions from nitrogen used in agriculture, year 2010

Agriculture: N_2O manure management
Montecarlo analysis has been carried out for N_2O emissions from manure management, for the reporting year 2010. In Table A1.25 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.25 Statistics of the Montecarlo analysis for N_2O emissions from Manure management, year 2010

	Value
Trials	10000
Mean	11.9438
Median	11.9284
Standard Deviation	0.6087
Range Minimum	9.5877
Range Maximum	14.6361
Uncertainty (%)	**10.19**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.10.

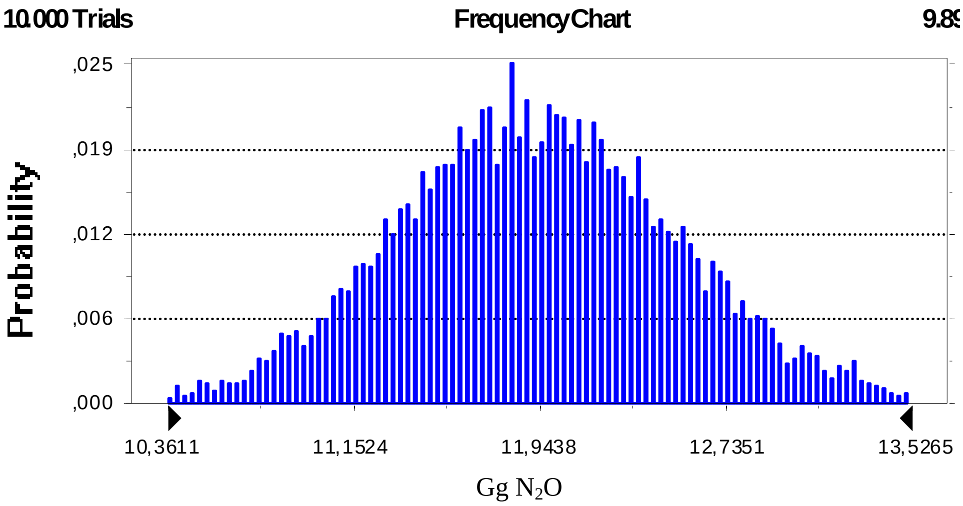


Figure A1.10 Probability density function resulting from Montecarlo analysis for N_2O emissions from Manure management, year 2010

Agriculture: CH_4 manure management

Montecarlo analysis has been carried out for the CH4 emissions from manure management, for the reporting year 2010. In Table A1.26 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.26 Statistics of the Montecarlo analysis for CH_4 emissions from enteric fermentation, year 2010

	Value
Trials	10000
Mean	121.44
Median	120.93
Standard Deviation	13.94
Range Minimum	78.05
Range Maximum	180.80
Uncertainty (%)	**22.96**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.11.

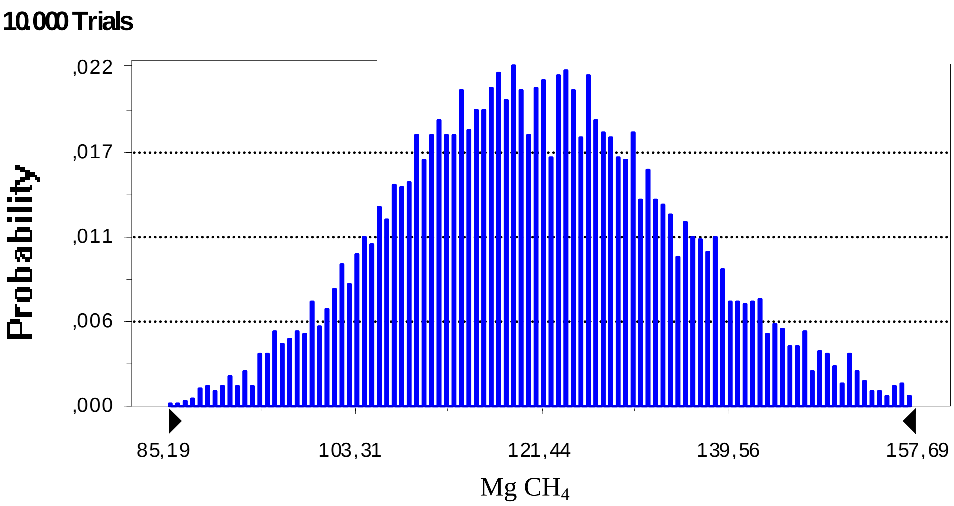


Figure A1.11 Probability density function resulting from Montecarlo analysis for CH_4 emissions from enteric fermentation, year 2010

LULUCF: CO_2 Forest Land remaining Forest Land

Montecarlo analysis has been carried out for the CO_2 emissions and removals from *Forest Land remaining Forest Land*, considering the different reporting pools (*aboveground, belowground, litter, deadwood and soils*), and the subcategories stands, coppices and rupicolous and riparian forests for the reporting year 2009. In Table A1.27 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.27 Statistics of the Montecarlo analysis for CO_2 emissions and removals from Forest Land remaining Forest Land, year 2009

				Value		
	aboveground	*belowground*	*litter*	*deadwood*	*soils*	**total**
Trials	10000	10000	10000	10000	10000	10000
Mean	433	75	31	64	493	1,097
Median	431	75	31	64	494	1,098
Standard Deviation	82	14	12	12	122	236
Range Minimum	152	24	-16	24	2	197
Range Maximum	822	129	79	117	947	2,063
Uncertainty (%)	**37.86**	**37.18**	**79.40**	**36.87**	**49.33**	**42.93**

In Table A1.28 the results of the uncertainty assessment for the different subcategories are reported, related to the year 2009.

Table A1.28 Uncertainties assessed for the different subcategories, year 2009

	aboveground	*belowground*	*litter*	*deadwood*	*soils*	*total*
stands	40.78	39.93	88.16	39.32	44.65	**41.91**
coppices	53.81	54.99	74.81	53.47	67.35	**59.51**
rupicolous and riparian forests	56.53	61.49	79.66	56.91	58.52	**55.03**
total	**37.86**	**37.18**	**79.40**	**36.87**	**49.33**	**42.93**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.12.

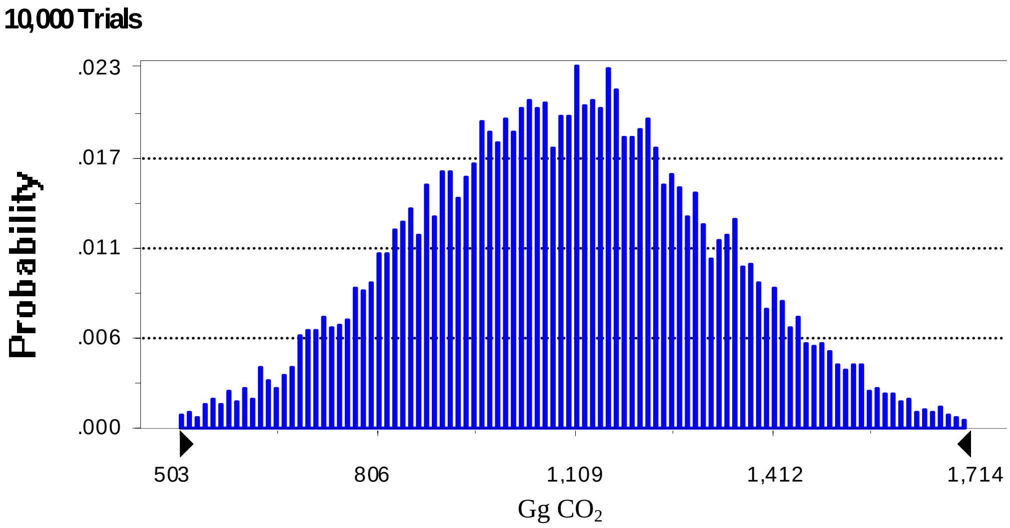


Figure A1.12 Probability density function resulting from Montecarlo analysis for the CO_2 emissions and removals from Forest Land remaining Forest Land category, year 2009

In Table A.1.29 the outcomes of the Approach 1 (error propagation) and Approach 2 (Montecarlo analysis) are shown, for the reporting pools. A general reduction in the uncertainty estimates has to be noted by comparing Montecarlo analysis results with the Approach 1 outcomes.

Table A1.29 Comparison between uncertainty assessment with Approach 1 and Approach 2

Uncertainty	Approach 1 %	Approach 2 (Montecarlo analysis) %
aboveground	42.68	37.86
belowground	42.68	37.18
litter	52.17	79.40
deadwood	101.62	36.80
soils	113.00	49.33
total	**67.98**	**42.93**

LULUCF: CO_2 Land converting to Forest Land

For *Land converting to Forest Land* category, Approach 2 has been carried out taking into account the different reporting pools (aboveground, belowground, litter, deadwood and soils), for the year 2009. In Table A1.30 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.30 Statistics of the Montecarlo analysis for Land converting to Forest Land, year 2009

	Value					
	aboveground	*belowground*	*litter*	*deadwood*	*soils*	**total**
Trials	10000	10000	10000	10000	10000	10000
Mean	6	1	0.43	0.83	13.64	22
Median	6	1	0.40	0.82	12.25	20
Standard Deviation	2	0	0.25	0.34	18.63	18
Range Minimum	-1	0	-0.01	-0.18	-48.94	-37
Range Maximum	15	2	1.74	2.21	108.58	108
Uncertainty (%)	**-72.6; 85.8**	**-72.5; 86.2**	**-91.3; 153.1**	**-72.5; 84.8**	**-257.2; 342.8**	**-147.6; 192.3**

The probability function resulting from the Montecarlo assessment is shown in Figure A1.13.

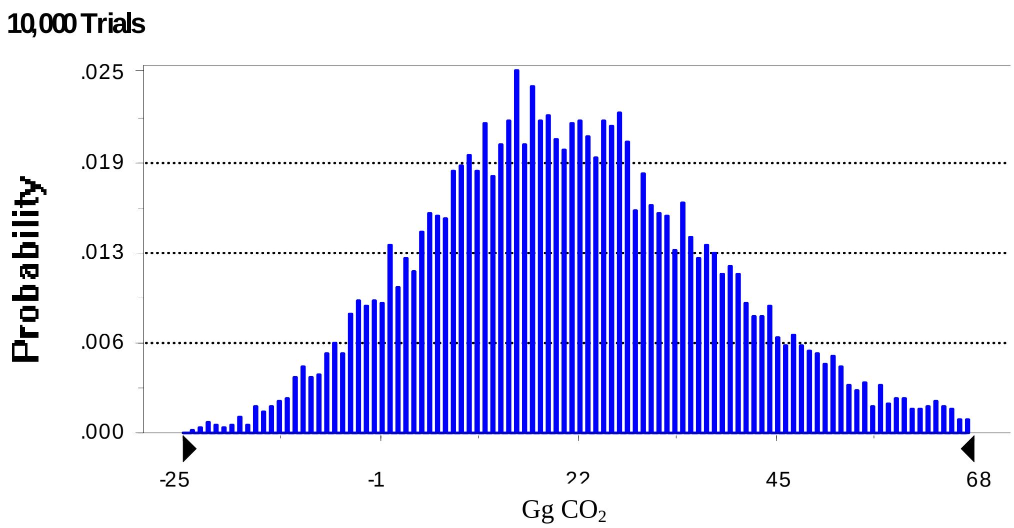


Figure A1.13 Probability density function resulting from Montecarlo analysis for the Land converting to Forest Land, year 2009

LULUCF: CO_2 Cropland remaining Cropland

For CO_2 emissions and removals from Cropland remaining Cropland, Approach 2 has been carried out taking into account the reporting subcategories (*woody crops, plantations, CO_2 emissions from organic soils, CO_2 emissions from lime application*), for the year 2009. In Table A1.31 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.31 Statistics of the Montecarlo analysis for CO_2 emissions and removals from Cropland remaining Cropland, year 2009

	Value				
	woody crops	*plantations*	*CO_2 emissions from organic soils*	*CO_2 emissions from lime application*	**total**
Trials	10000	10000	10000	10000	10000
Mean	3,017	-3.58	-90.26	-4.58	2,919
Median	2,662	-35.06	-81.65	-4.50	2,568
Standard Deviation	2,090	369.65	41.40	1.20	2,124
Range Minimum	-1,403	-1,595	-427.49	-10.59	-1913
Range Maximum	18,326	1739	409.17	-0.97	18,865
Uncertainty (%)	**-100.2; 199.4**	**-2173; 2454**	**-136.4; 57.3**	**-58.5; 46.4**	**-108.5; 210.2**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.14.

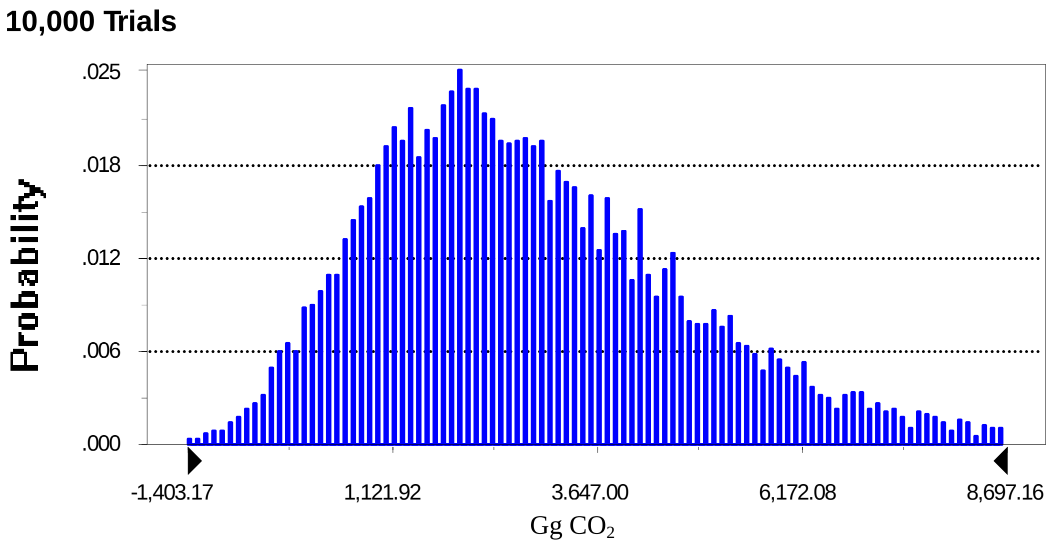


Figure A1.14 Probability density function resulting from Montecarlo analysis for the CO_2 emissions and removals from Cropland remaining Cropland, year 2009

LULUCF: CO_2 Land converting to Cropland

For CO_2 emissions and removals from Land converting to Cropland, Approach 2 has been carried out taking into account the *living biomass* and *soils* carbon pools, for the year 2009. In Table A1.32 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.32 Statistics of the Montecarlo analysis for CO_2 emissions and removals from *Land converting to Cropland*, year 2009

	Value		
	Living biomass	*Soils*	**total**
Trials	5000	5000	5000
Mean	7	-112	-105
Median	4	-85	-79
Standard Deviation	11	119	118
Range Minimum	-7	-1,169	-1,097
Range Maximum	149	414	410
Uncertainty (%)	**-150.7; 821.7**	**-384.1; 160.3**	**-408.2; 178.5**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.15.

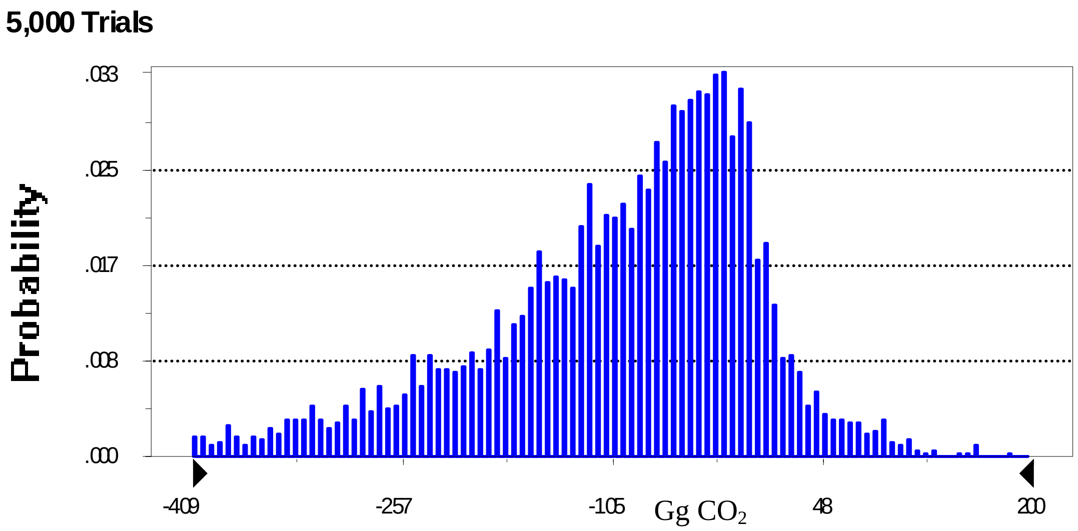


Figure A1.15 Probability density function resulting from Montecarlo analysis for CO_2 emissions and removals from Land converting to Cropland, year 2009

LULUCF: CO_2 Grassland remaining Grassland

For CO_2 emissions and removals from Grassland remaining grassland, Approach 2 has been carried out taking into account the different carbon pools, for the year 2009. In Table A1.33 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.33 Statistics of the Montecarlo analysis for CO_2 emissions and removals from Grassland remaining Grassland, year 2009

	Value					
	aboveground	*belowground*	*litter*	*deadwood*	*soils*	**total**
Trials	10000	10000	10000	10000	10000	10000
Mean	26.59	11.05	9.66	3.63	82.86	133.79
Median	25.72	10.61	9.65	3.52	82.25	132.04
Standard Deviation	10.63	5.34	3.45	1.47	30.48	48.08
Range Minimum	-4.54	-3.88	-3.19	-0.69	-8.88	-9.27
Range Maximum	81.63	37.31	23.31	11.27	204.58	354.91
Uncertainty (%)	**-68.6; 94.6**	**-82.6; 114.5**	**-70.4; 70.5**	**-69.9; 95.4**	**-70.6; 74.3**	**-67.7; 75.0**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.16.

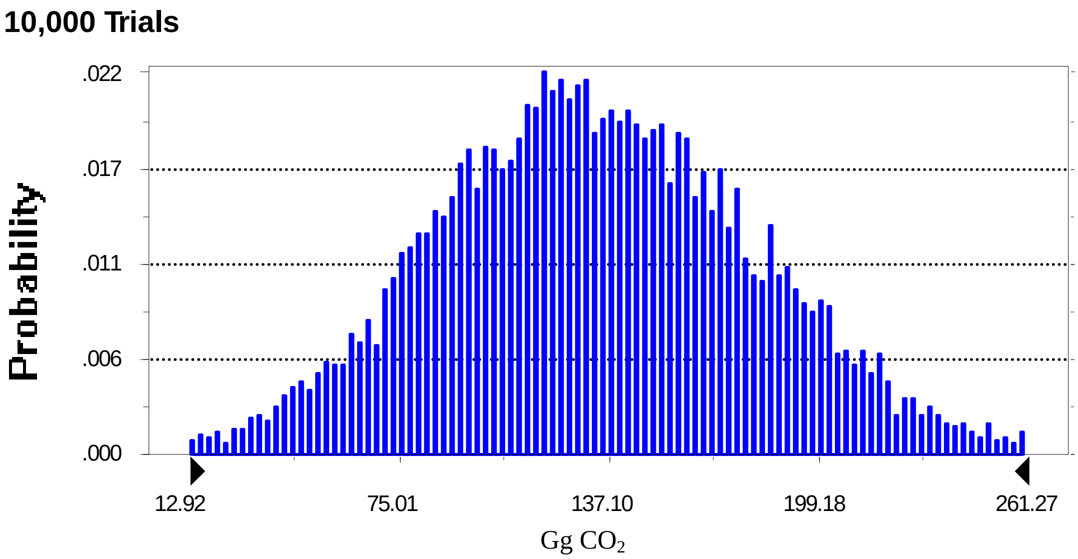


Figure A1.16 Probability density function resulting from Montecarlo analysis for CO_2 emissions and removals from Grassland remaining Grassland, year 2009

LULUCF: CO_2 Land converting to Grassland

For CO_2 emissions and removals from Land converting to Grassland, Approach 2 has been carried out taking into account the *living biomass* and *soils* carbon pools, for the year 2009. In Table A1.34 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.34 Statistics of the Montecarlo analysis for CO_2 emissions and removals from Land converting to Grassland, year 2009

	Value		
	Living biomass	*Soils*	**total**
Trials	5000	5000	5000
Mean	-371.6	4,006	3,635
Median	-304.7	3,650	3,283
Standard Deviation	462.0	2,654	2,623
Range Minimum	-5,426	4,813	-6,794
Range Maximum	1,640	20,503	19,126
Uncertainty (%)	**-383.8; 222.9**	**-106.1; 179.8**	**-119.3; 194.5**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.17.

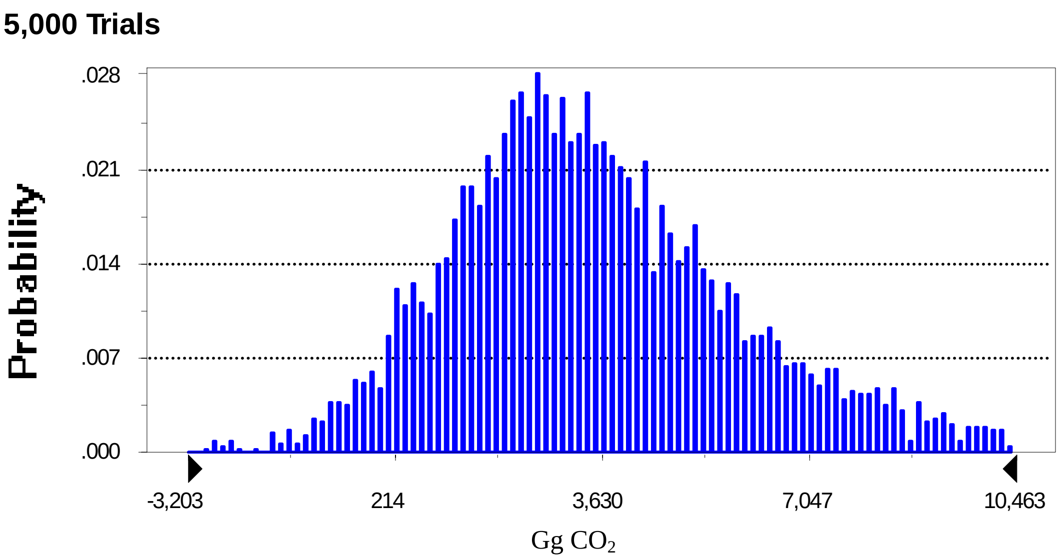


Figure A1.17 Probability density function resulting from Montecarlo analysis for the CO_2 emissions and removals from Land converting to Grassland, year 2009

LULUCF: CO_2 Land converting to Settlements

For CO_2 emissions from Land converting to Settlements, Approach 2 has been carried out taking into account the reporting subcategories (*annual crops converting to Settlements, woody crops converting to Settlements*, *Grassland converting to Settlement*, *Forest land converting to Settlements*), for the year 2009. In Table A1.35 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.35 Statistics of the Montecarlo analysis for CO_2 emissions from Land converting to Settlements, year 2009

	Value				
	Annual crops to SL	*woody crops to SL*	*Grassland to SL*	*Forest land to SL*	**total**
Trials	10000	10000	10000	10000	10000
Mean	-450.9	-377.7	-274.7	-100.4	-4,428.4
Median	-362.8	-312.3	-240.7	-100.7	-4,116.9
Standard Deviation	323.9	262.3	175.8	23.68	1,693.4
Range Minimum	-3,739.5	-4,229.4	-2,423.8	-283.7	-18,736.0
Range Maximum	-22.0	-29.5	-2.3	-40.3	-1.073.8
Uncertainty (%)	**-262.1; 72.0**	**-238.1; 70.8**	**-193.5; 82.9**	**-56.0; 35.1**	**-100.3; 49.2**

In Table A1.36 the results of the uncertainty assessment for the different subcategories are reported, related to the year 2009.

Table A1.36 Uncertainties assessed for the different subcategories, year 2009

Uncertainty	**living biomass %**	**dead organic matter %**	**Soils %**	**Total %**
annual crops to SL	*-300.9; 75.5*	-	*-267.1; 72.0*	*-262.1;72.0*
woody crops to SL	*-288.8; 74.3*	-	*-235.5; 70.5*	*-238.1; 70.8*
Cropland to SL	-288.8; 67.0	-	-187.0; 62.5	**-193.5; 82.9**
Grassland to SL	-	-	-193.5; 82.9	**-193.5; 82.9**
Forest land to SL	-115.9; 54.3	-56.9; 51.3	68.2; 40.0	**-56.0; 35.1**
Land to SL	-	-	-	**-100.3; 49.2**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.18.

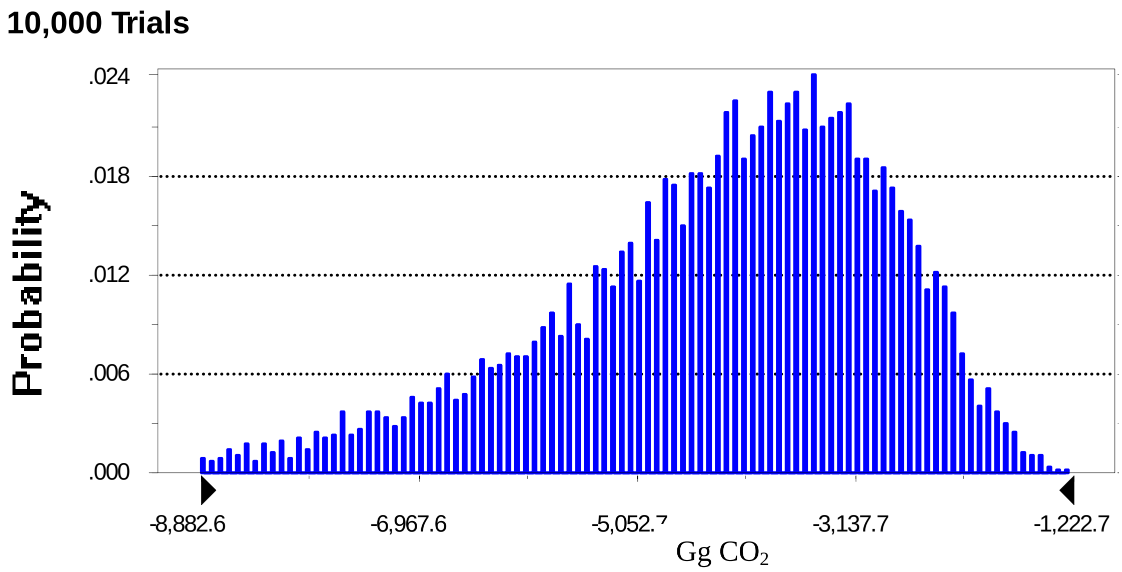


Figure A1.18 Probability density function resulting from Montecarlo analysis for the CO_2 emissions from Land converting to Settlements, year 2009

Waste*: *CH_4 from Solid waste Disposal Sites

Montecarlo analysis has been carried out for the CH_4 emissions from Solid waste disposal sites, for the reporting year 2009. In Table A1.37 a description of the statistics resulting from the Montecarlo analysis is shown.

Table A1.37 Statistics of the Montecarlo analysis for Solis waste disposal on land category, year 2009

	Value
Trials	5000
Mean	595,157
Median	595,893
Standard Deviation	37,423
Range Minimum	469,077
Range Maximum	728,751
Uncertainty (%)	**12.58**

The probability density function resulting from the Montecarlo assessment is shown in Figure A1.19.

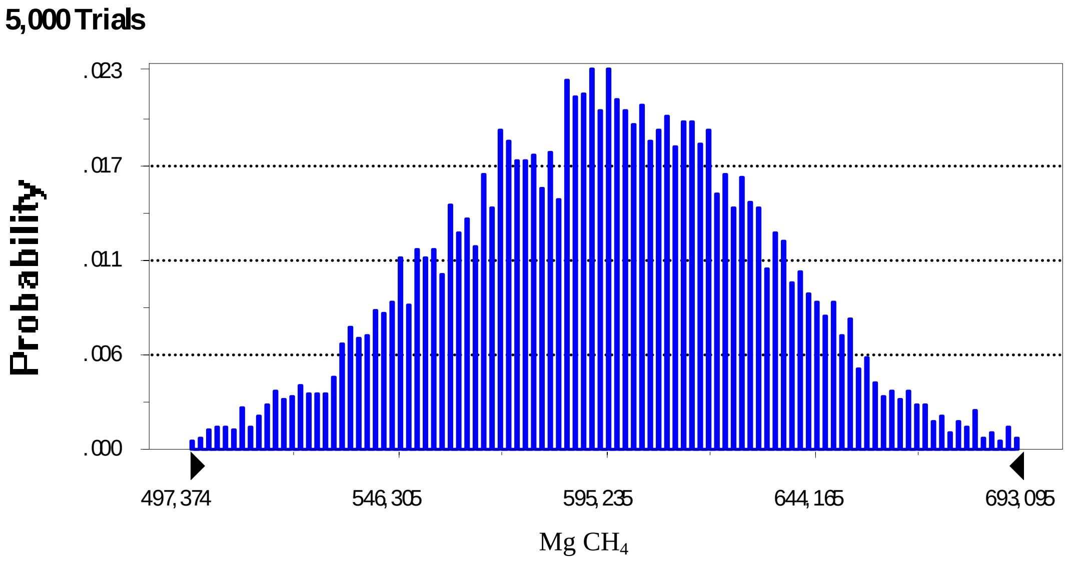


Figure A1.19 Probability density function resulting from Montecarlo analysis for the Solis waste disposal on land category, year 2009

ANNEX 2: ENERGY CONSUMPTION FOR POWER GENERATION

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.

Detailed data are collected at plant level, on monthly basis. They include electricity production and estimation of physical quantities of fuels and the related energy content; for the largest installations, the energy content is based on laboratory tests. Up to 1999, the fuel consumption was reported at a very detailed level, 17 different fuels, allowing a quite precise estimation of the carbon content. From 2000 onward, the published data aggregate all fuels in five groups that do not allow for a precise evaluation of the carbon content. In Table A2.1, the time series of fuel consumptions for power sector production is reported.

Table A2.1 Time series of power sector production by fuel, Gg or Mm^3

	1990	1995	2000	2005	2006	2007	2008	2009	2010
national coal	58	-	Solids	Solids	Solids	Solids	Solids	Solids	Solids
imported coal	10,724	8,216	9,633	16,253	16,587	16,886	16,878	15,218	14,998
lignite	1,501	380							
Natural gas, m^3	9,731	11,277	22,334	30,544	31,381	33,957	33,706	28,634	29,630
BOF(steel converter) gas, m^3	509	633	Coal	Coal	Coal	Coal	Coal	Coal	Coal
Blast furnace gas, m^3	6,804	6,428	gases	gases	gases	gases	gases	gases	gases
Coke gas, m^3	693	540	8,690	12,104	13,131	11,353	10,648	6,661	8,822
Light distillate	5	6	oil	oil	oil	oil	oil	oil	oil
Diesel oil	303	184	products	products	products	products	products	products	products
Heavy fuel oil	21,798	25,355	19,352	7,941	7,629	5,292	4,366	3,715	2,152
Refinery gas	211	378							
Petroleum coke	186	189							
Orimulsion	-	-							
Gases from chemical processes	444	803	Others	Others	Others	Others	Others	Others	Others
Tar	2	-		Mm^3=978	Mm^3=1,321	Mm^3=1,423	Mm^3=1,414	Mm^3=1,289	Mm^3=1,501
Heat recovered from Pyrite	146	3		Gg=15,460	Gg=16,253	Gg=17,490	Gg=16,520	Gg=14,789	Gg=18,160
Other fuels	344	697	5,153						

Source: TERNA, several years

Figures reported in the table show that natural gas has substituted oil products, from 1990 to 2010, becoming the main fuel for electricity production while coal consumption has slightly increased in the last years as compared to 1990.
For the purpose of calculating GHG emissions, a detailed list of 25 fuels was delivered to ISPRA by TERNA for the years from 2000 to 2007. From 2008 the list of the fuels used to estimate emissions was expanded by TERNA, up to 34 different types. The list includes different variety of renewable sources according to their composition and origin, useful to estimate the percentage of renewable sources for electricity generation and to comply with national regulations of waste derived fuels. A list of different quantities of fuel oils used according to the sulphur content was also added. Energy data of previous years have not been changed (see previous reports).
The detailed information is confidential and only the output of the simulation model applied to calculate emissions for the year 2010, at an aggregated level, is reported in Table A2.2. The consumption of municipal solid waste (MSW) / industrial wastes is separated from the biomass consumption, since the use of this fuel for electricity generation is expanding and EFs are different.
It has to be underlined that fuels used to cogenerate heat and electricity in some power plants are not included in TERNA data, where only the fuel used for electricity production is reported.
At national level, other statistics on the fuel used for electricity production exist, the most remarkable being the National Energy Balance (BEN), published annually (MSE, several years) and those published by Unione Petrolifera, the Oil companies association (UP, several years). In the past, also the association of the industrial electricity producers (UNAPACE, several years) up to the year 1998, and ENI, the former national oil company up to the year 2000, published production data with the associated fuel consumptions (ENI, several years).

A2.2 Methodological issues

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

- BEN data are prepared on the basis of TERNA reports to IEA, so both data sets come from the same source;
- before being published in the BEN, TERNA data are revised to be adapted to the reporting methodology: balance is done on the energy content of fuels and the physical quantities of fuels are converted to energy using standard conversion factors; so the total energy content of the fuels is the “right” information extracted from the TERNA reports and the physical quantities are changed to avoid discrepancies; the resulting information cannot be cross checked with detailed plant data (point source evaluation) based on the physical quantities;
- the used fuel types are much more detailed in TERNA database, 34 fuels as above mentioned, whereas in BEN all fuels are added up (using energy content) and reported together in 12 categories: emission factors for certain fuels (coal gases or refinery by-products) are quite different and essential information is lost with this process;
- finally, the two data sets usually differ, even considering the total energy values of fuels or the produced electricity, there are always small differences, less than 1%, that increase the already sizable discrepancy between the reference approach and the detailed approach; the BEN adjust the physical quantities according to fixed low heating values and this process combined with the reduction of fuel types from 17 to 12 adds rounding errors and this may cause the small difference between the production of electricity of the two sources, 0.4% in 2010. The difference in the energy consumption value is equal to 0.5%.

Table A2.2 reports the differences between the national energy balance and TERNA data for 2010. For the other years, differences are explained in previous NIR reports. In Table A2.2, annual data from different sources are reported: detailed data reported by TERNA are compared with data available in the national energy balance.
For each source, three types of data are presented: electricity production, physical quantities of fuel consumptions and amount of energy used.

Table A2.2 Energy consumption for electricity production, year 2010

Fuels	TERNA			BEN		
	GWe, gross	Gg / Mm^3	Pj	GWe, gross	Gg/ Mm^3	Pj
Coal	39,734.0	14,998	376.8	39,734.8	14,181	376.8
Coke oven gas	1,573.9	759	14.2	1,541.9	782	13.9
Blast furnace gas	2,919.4	7,698	26.2	2,920.9	6,969	26.2
Oxi converter gas	237.9	366	2.4	238.0		2.4
total derived gases	4,731.3	8,823	42.8	4,700.8	7,751	42.5
Coal	**44,465.3**		**419.6**	**44,435.6**		**419.3**
Light distillates	3.3	1	0.04	96.5	12	0.5
Light fuel oil	657.6	152	6.4	557.0	138	5.9
Fuel oil - high sulfur content	6,503.6	1,543	63.4	12,534.9	2,399	98.4
Fuel oil - low sulfur content	0.0		0.0	4,900.0	1,076	44.1
Refinery gas	2,112.3	314	15.2	2,037.2	294	14.8
Petroleum coke	631.0	143	4.9	627.9	143	5.0
Oriemulsion	0.0	0	0.0			
total fuel oil	*9,908.0*		*90.0*	*20,753.5*	*1,568*	*168.6*
Gas from chemical proc.	796.9	1,352	17.2	1,815.5	2,494	27.5
Heavy residuals/ tar	10,867.9	8,174	78.6			
Others	108.3		0.7			
total residual	*11,773.1*		*96.4*	*1,815.5*		*27.5*
Oil+residuals	**21,681.1**		**186.5**	**22,569.0**		**196.2**
Natural gas	**152,736.9**	29,630	**1,030.0**	**152,736.9**	30,059	**1,030.0**
Biofuels	3,078.4	295	21.3			0.0
Biogas	2,054.1	1,263	20.7			0.0
Biomass	2,259.6	3,043	29.3	7,372.7	7,070	73.9
Municipal waste	4,095.8	4,449	62.5	4,113.4	5,674	59.3
Grand total	**230,371**		**1,769.7**	**231,227**		**1,778.8**
TERNA /BEN differences				-0.4%		-0.5%

Source: ISPRA elaborations

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

To estimate CO_2 emissions, and also N_2O and CH_4 emissions, a rather complex calculation sheet is used (APAT, 2003). The data sheet summarizes all plants existing in Italy divided by technology, about 60 typologies, and type of fuel used; the calculation sheet can be considered a model of the national power system. The main scope of the model is to estimate the emissions of pollutants different from CO_2 that are technology dependent. For each year, a run estimates the fuel consumed by each plant type, the pollutant emissions and GHG emissions.

The model has many possible outputs; same of which are built up in such a way to reproduce the data available from statistical source. The model is revised every year to mirror the changes occurred in the power plants. Moreover, the model is also able to estimate the energy/emissions data related to the electricity produced and used on site by the main industrial producers. Those data are reported in the other energy industries, Tables 1.A.1.b and 1.A.1.c of the CRF, and in the industrial sector section, Table 1.A.2 of the CRF.

The following Table A2.3 shows an intermediate step of the process, with all energy and emissions summarized by fuel and split in two main categories of producers: public services and industrial producers for the year 2010. Since 1998, expansion of industrial cogeneration of electricity and split of national monopoly has transformed many industrial producers into “independent producers”, regularly supplying the national grid. So part of the energy/emissions of the industrial producers are added to Table 1.A.1.a of the CRF, according to the best information available.

Table A2.3 Power sector, Energy/CO_2 emissions in CRF format, year 2010

	TJ	**C, Gg**	**CO_2, Gg**
For Table 1.A.1, a. Public Electricity and Heat Production			
Liquid fuels	131,091	2,954	10,823
Solid fuels	376,732	9,449	34,624
Natural gas	929,803	14,140	51,808
Refinery gases	11,948	188	689
Coal gases	25,014	1,254	4,594
Biomass	102,124	2,941	10,776
Other fuels (incl.waste)	44,746	1,001	3,669
Total	**1,621,457**	**28,986**	**106,208**
Industrial producers (Table 1.A.1, a-b-c) and auto-producers,			
to table "1.A.2 Manufacturing Industries "			
Liquid fuels	5,889	127	464
Solid fuels	5	0	0
Natural gas	100,167	1,523	5,581
Refinery gases	3,282	52	189
Other refinery products	17,073	416	1,526
Coal gases	17,780	891	3,266
Biomass			
Other fuels (incl.waste)	3,711	51	186
Total	**147,907**	**3,060**	**11,213**
General total	**1,769,364**	**32,046**	**117,421**

Source: ISPRA elaborations

In conclusion, the main question of the accuracy of the underlying energy data of key sources is connected to the discrepancies between BEN and TERNA in the estimates of electricity produced and of the energy content of the used fuels. The difference is small but it should not occur because both data sets derive from the same source. On the basis of this consideration, we decided to base the inventory on TERNA data that are expected to be more reliable. In particular because the emission factors used are based on the energy content of the fuel we have made an effort to reproduce with the model the TERNA energy consumption figure and ignored discrepancies in the electricity production or in the physical quantities of fuel used.

A2.3 Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions from electricity production is estimated to be about 4.2% in annual emissions; a higher uncertainty, equal to 50.1%, is calculated for CH_4 and N_2O emissions on account of the uncertainty levels attributed to the related emission factors.
For the year 2009, Montecarlo analysis has been carried out to estimate uncertainty of CO_2 emissions from stationary combustion of solid, liquid and gaseous fuels emissions, resulting in 5.1%, 3.3% and 5.8%, respectively. Normal distributions have been assumed for all the parameters. A summary of the results is reported in Annex 1.
Estimates of fuel consumption for electricity generation in 2010 are reported in Table A2.3.
In Table A2.4, the time series of the total CO_2 emissions from electricity generation activities is reported, including total electricity produced and specific indicators of CO_2 emissions for the total energy production and for the thermoelectric production respectively, expressed in grams of CO_2 per kWh. The emission factors are reported excluding the electricity produced from pumped storage units using water that has previously been pumped uphill, as requested by Directive 2009/28/EC of the European Parliament and of the Council promoting the electricity renewable sources.

The time series clearly shows that although the specific carbon content of the kWh generated in Italy has constantly improved over the years, total emissions have raised till 2006 due to the even bigger increase of electricity production. The decreasing trend of 2007 and 2008 results from an increase in energy production from renewable sources, combined with a further reduction in the use of oil products for electricity production. In 2009 and 2010 the decrease is even more accentuated because of the economic recession.

Table A2.4 Time series of CO_2 emissions from electricity production

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Total electricity produced (gross), TWh	216.9	241.5	276.6	303.7	314.1	313.9	319.1	292.6	302.1
Total CO_2 emitted, Mt	126.4	135.4	142.6	143.2	146.4	144.6	139.0	118.1	118.4
g CO_2 / kwh of gross thermo-electric production	708	692	649	568	561	546	534	523	514
g CO_2 / kwh of total gross* production	592	571	528	482	476	469	443	410	396

* excluding electricity production from pumped storage units using water that has previously been pumped uphill
Source: ISPRA elaborations

The trend of CO_2 emissions for thermoelectric production is the result of an increase of natural gas share due to the entry into service of more efficient combined cycle plants. The downward trend takes also into account the general increase in efficiency of the power plants.

A2.4 Source-specific QA/QC and verification

Basic activity data to estimate emissions from all operators are annually collected and reported by the national grid administrator (TERNA, several years). Other data are collected directly from operators for plants bigger than 20 MWh, with a yearly survey since 2005 and communicated at international level in the framework of the EU ETS scheme. Activity data and other parameters, as net calorific values, are compared every year at an aggregate level, by fuel; differences and problems have been identified, analysed in detail and solved with sectoral experts.
In addition, time series resulting from the recalculation have been presented to the national experts in the framework of an *ad hoc* working group on air emissions inventories. The group is chaired by ISPRA and includes participants from the local authorities responsible for the preparation of local inventories, sectoral experts, the Ministry of Environment, Land and Sea, and air quality model experts. Top-down and bottom-up approaches have been compared with the aim to identify the potential problems and future improvements to be addressed.

A2.5 Source-specific recalculations

Recalculations of the sector refer to CO_2 emission factors for the years 2005-2009 for refinery gas, petcoke and synthesis gas from heavy residuals and 2009 for natural gas and to the reallocation of fuel oil consumptions between energy production and manufacturing industries for 2008 and 2009. Refinery gas, petcoke and synthesis gas from heavy residuals CO_2 emission factor has been updated taking into account the information supplied by the plants in the framework of the EU ETS scheme. Natural gas CO_2 emission factor has been updated for change of imported gas parameters. The recalculations affected only slightly the time series from 2005 to 2009 with differences ranging from -0.2% to -0.9%, for CO_2, and 1.3% for N_2O, with respect to earlier submission.
Specifically, referring to Public electricity and heat production sub sector, recalculations occur only in 2008 and 2009 on account of the reallocation of natural gas and fuel oil consumptions between energy and industrial sectors and the update of CO_2 emission factor of natural gas in 2009; recalculations result in a reduction by about 1% in terms of CO_2 equivalent.

A2.6 Source-specific planned improvements

No specific improvements are planned for the next submission.

ANNEX 3: ESTIMATION OF CARBON CONTENT OF COALS USED IN INDUSTRY

The preliminary use of the CRF software in 2001 underlined an unbalance of emissions in the solid fuel rows above 20%. A detailed verification pointed out to an already known fact for Italy: the combined use of standard IPCC emission factors for coals, national emission factors for coal gases and CORINAIR methodology emission factors for steel works processes produces double counting of emissions.
The main reason for this is the specific national circumstance of extensive recovery of coal gases from blast furnaces, coke ovens and oxygen converters for electricity generation. The emissions from those gases are separately accounted for and reported in the electricity generation section.
Another specific national circumstance is the concentration of steel works, since the year 2005, in two sites, with integrated steel plants, coke ovens and electricity self-production. Limited quantities of pig iron are produced also in one additional location. This has allowed for careful check of the processes involved and the emissions estimates at site level and, with reference to other countries, may or may not have exacerbated the unbalances in carbon emissions due to the use of standard emission factor developed for other industrial sites.

To avoid the double counting a specific methodology has been developed: it balances energy and carbon content of coking coals used by steelworks, industry, for non energy purposes and coal gasses used for electricity generation.
A balance is made between the coal used for coke production and the quantities of derived fuels used in various sectors. The iron and steel sector gets the resulting quantities of energy and carbon after subtraction of what is used for electricity generation, non energy purposes and other industrial sectors. The use of reductants is also included in this balance. The carbon balance methodology does not imply to separate off input between the energy and industrial sectors but ensures no double counting occurs.
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 2010, 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 used 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.

Table A3.1 Energy balance, 2010, Tcal

coke	coke gas	blast furnace gas	NOTES
5.652			For blast furnace
0	3.324	6.272	For electricity production
22.738	0	104	For steel industries
145	0	0	For other industries use
0	0		For domestic use
28.535	3.324	6.377	Total consumption
385	168	8	Consumption for production of secondary fuels
-1	0	0	Losses of transformation
28.919	3.493	6.385	Total consumption + losses and prod.
Energy balance, coke ovens		**Energy balance, blast furnace gas**	
-308		128.8	Difference in energy consumption
-0.9%		2.0%	Unbalance in %
33.966			Coke oven output
2.420			Transformation losses, coke ovens
1.302			non energy use
37.688			sub total
37.688			Coking coal input to coke ovens
11.773			Blast furnace coal input
-1.246			import + stock change

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.

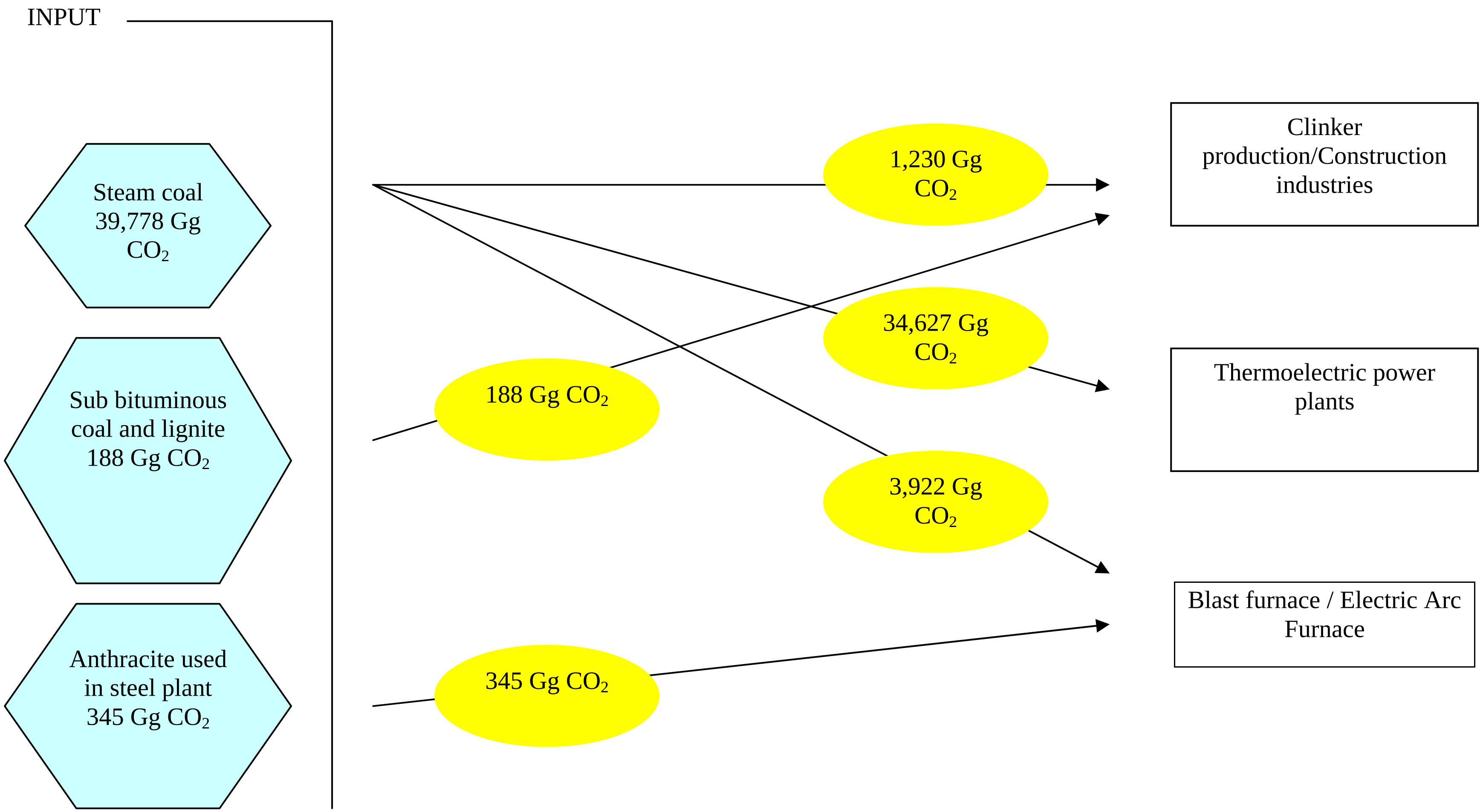
Additional information from the operators on fuel consumptions and average emission factors is submitted in the framework of the EU ETS scheme and it is used to verify our calculation and CO_2 emissions at plant level and to calculate average CO_2 emission factors for coal and derived gases from 2005.

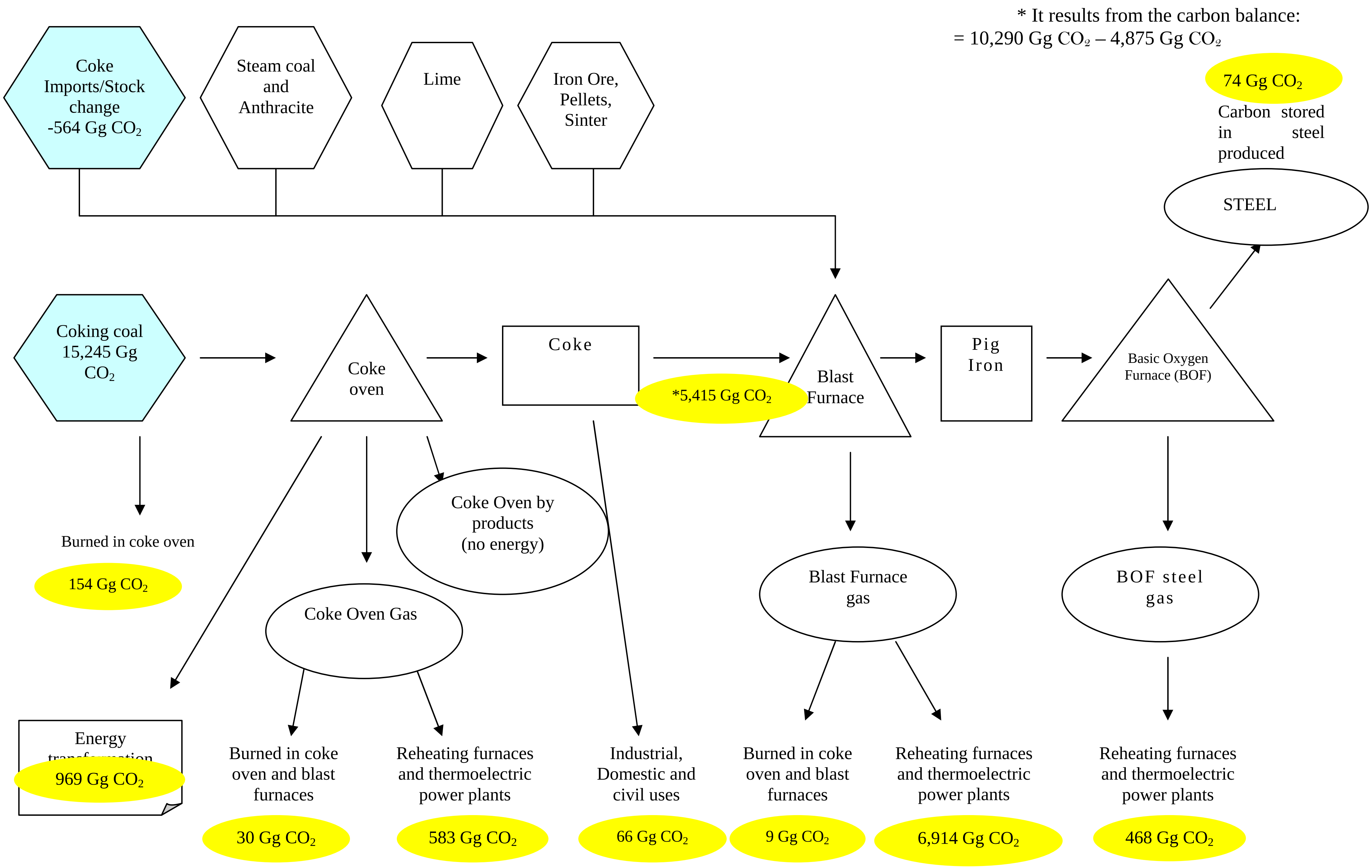
Table A3.2 Carbon balance, 2010, Mt CO_2

coke	coke gas	Blast furnace gas + oxi gas	NOTES	Total according to BEN	Total used for CRF
2.50			From blast furnace (no direct emissions, transformed in coal gasses)	2.12	
0.00	0.65	6.84	From electricity prod.	7.49	8.75
10.08	0.00	0.12	From steel industries	10.19	9.94
0.06	0.00	0.00	From other industries use	0.06	0.06
0.00	0.00		From domestic use	0.00	
12.65	0.65	6.96	Total emissions, final uses	20.26	18.75
0.15	0.03	0.01	Consumption for production of secondary fuels	0.19	
0.00	0.00	0.00	Losses of transformation	0.00	
12.80	0.69	6.97	Total consumption + losses and prod.	20.45	
Carbon balance, coke ovens		**Carbon balance, blast furnace**			
0.4		-0.2	Difference in physical emissions		
3%		-3%	Unbalance in %		
Emissions					
13.60			Carbon in produced coke		
0.97			Transformation losses		
0.52			non energy use	0.52	0.52
14.61			Coal input to coke ovens		
5.22			Coal input to blast furnace		
-0.55			Coke import + stock change		
19.28			Total carbon input		19.28

The flowchart of carbon - cycle for the year 2010 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 2010. The amount of carbon stored in steel produced was estimated and subtracted from the balance to avoid the subsequent overestimation of CO_2.

CO_2 emission calculation
Year 2010





* It results from the carbon balance:
= 10,290 Gg CO2 – 4,875 Gg CO2
Coke Imports/Stock change -564 Gg CO2
Steam coal and Anthracite
Lime
Iron Ore, Pellets, Sinter
74 Gg CO2
Carbon stored in steel produced
STEEL
Coking coal 15,245 Gg CO2
Coke oven
Coke
*5,415 Gg CO2
Blast Furnace
Pig Iron
Basic Oxygen Furnace (BOF)
Burned in coke oven
154 Gg CO2
Coke Oven by products (no energy)
Coke Oven Gas
Blast Furnace gas
BOF steel gas
Energy transformation
969 Gg CO2
Burned in coke oven and blast furnaces
30 Gg CO2
Reheating furnaces and thermoelectric power plants
583 Gg CO2
Industrial, Domestic and civil uses
66 Gg CO2
Burned in coke oven and blast furnaces
9 Gg CO2
Reheating furnaces and thermoelectric power plants
6,914 Gg CO2
Reheating furnaces and thermoelectric power plants
468 Gg CO2

ANNEX 4: CO_2 REFERENCE APPROACH

A4.1 Introduction

The IPCC Reference Approach is a 'top down' inventory based on data on production, imports, exports and stock changes of crude oils, feedstock, natural gas and solid fuels. Estimates are made of the carbon stored in manufactured products, the carbon consumed as international bunker fuels and the emissions from biomass combustion.
The methodology follows the IPCC Guidelines (IPCC, 1997); table 1.A(b) of the Common Reporting Format "Sectoral background data for energy - CO_2 from Fuel Combustion Activities - Reference Approach" is a self sustaining explanation of the methodology.
However it was necessary to make a few adaptations to allow full use of the Italian energy and emission factor data (ENEA, 2002 [a]), and these are described in the following. The BEN (MSE, several years [a]) reports the energy balances for all primary and secondary fuels, with data on imports, exports and production. See Annex 5, Tables A5.1-A5.10, for an example of the year 2010 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 2000 because it is explicitly excluded by the IPCC methodology.

   From 2001 onward a careful check with the team in charge to prepare the energy balances induced the inventory team to revise its position on this matter[48];

[48] 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 2001 those fuel streams are needed to close the energy balances, which now

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) Biomass fuel consumption activity data for 2010 reported in the National Energy Balance has been calculated with a different methodology with respect to the past. In consideration of the large differences time series of biomass fuel consumption in the sector has been revised from 2001 accordingly, taking into account the increase in the use of biomass in the last years as a consequence of governmental incetives. Further investigations are in progress also considering that unofficial estimates show much bigger, up to 50% more, quantities of used biomass, for example ENEA (ENEA, several years).

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

First of all, the IPCC Reference total can be compared with the IPCC Table 1A total. Results show the IPCC Reference totals are between 0-3 percent lower than the comparable ‘bottom up’ totals. The highest difference between the two approaches is observed in 1999 and is equal to 3.0%; 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

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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.

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.

Table A4.1 Reference and sectoral approach CO_2 emission estimates 1990-2010 (Mt) and percentage differences

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Sectoral approach	401.1	414.0	433.8	457.3	452.7	444.1	435.2	391.8	401.7
Reference approach	395.7	406.1	424.8	445.9	442.5	432.0	427.3	386.9	394.6
Δ %	-1.35	-1.90	-2.08	-2.50	-2.24	-2.74	-1.81	-1.27	-1.77

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.

A4.3 Comparison of the the sectoral approach with the reference approach and international statistics

A verification of national energy balance and CO_2 emissions with data communicated to the joint EUROSTAT/IEA/UNECE questionnaire was carried out in 2004 and results are reported in the document "Energy data harmonization for CO_2 emission calculations: the Italian case" (ENEA/MAP/APAT, 2004).

The analysis enhanced the main differences and the critical points to harmonize the data and their reporting. The most critical issues concerned the caloric value, EUROSTAT and MAP should apply the same calorific value; the distribution of fuel consumptions to the relevant sectors, e.g., in some cases EUROSTAT assigned "building materials industry" consumptions in "glass, pottery and building materials industry" consumptions, in other cases in "other industries"; the definition of coke, in particular, the distribution of consumptions

between the iron and steel sector final consumption and transformation input; the definition of derived gases have to be harmonized, because differences in allocation of steelworks gases and gas from chemical processes were found.
In addition, “exchange and transfers, returns” and “statistical difference” rows were used in the national statistics to balance the energy resources with the energy uses whereas in the international statistics the two items, in some cases, were cancelled.
From 2004 some improvements were implemented both in the national and international statistics also through the revision of the questionnaire but difference in apparent consumptions still occur.
At European level, further examination is in progress. In the framework of the Monitoring Mechanism Decision jointly with EUROSTAT, a project which compares Eurostat energy data with energy data included in the CRF has been developed. The background of the project is the Energy Statistics Regulation (EC/1099/2008), which is the legal basis of the reporting of energy data to Eurostat, in particular Article 6, paragraph 2, of the regulation stipulating that: “Every reasonable effort shall be undertaken to ensure coherence between energy data declared in the energy statistics regulation, and data declared in accordance with Commission Decision No 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol”. Member States’ reference approach data as submitted in CRF Table 1A(b) under the EU GHG Monitoring Mechanism (as available by 15 May 2011) were compared with Eurostat energy data as available in the Eurostat database in April 2011: http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/database. The comparison was carried out for the years 2009 and 2008. Specifically, for Italy, major discrepancies identified were only related to the consumption of refinery feedstocks which differs considerably between annual Eurostat data and the CRF: Annual Eurostat consumption is 30% and 40% lower than the CRF for 2008 and 2009 respectively. The same issue was identified during the last review process and corrected in this year submission.
In terms of CO_2 emissions, for Italy the preliminary comparison results in a difference in total equal to 2% in 2009, with higher differences for solid and other fuels.
Further investigation is planned to reduce these differences.

ANNEX 5: NATIONAL ENERGY BALANCE, YEAR 2010

The following table reproduces the part expressed in amount of energy consumed of the National Energy Balance (BEN) of the year 2010 (MSE, several years).

The complete balance, containing the physical quantities as well as the amount of energy and a consistent time series from the year 1998 onwards, is also available on the website: http://dgerm.sviluppoeconomico.gov.it/dgerm/.

Sectors and fuel definition have been translated here in English, but, of course, the tables on Internet are in Italian language. Definitions are very similar to their English equivalents so this should not be an obstacle to independent verifications of energy data sources for previous years.

The national energy balance is comprised of two “sets” of tables: from page 2 to page 10 the energy vectors are represented in physical quantities (Gg or Mm^3) while from page 12 to page 20 they are expressed in energy equivalents (10^9 kcal).
Recalling what already said in Annex 2 related to the BEN reporting methodology (that prefers to use always the same lower heat value for each primary fuel in various years, to better follow the variable energy content of each shipment), we make reference here to the second set of tables. This means, for example, that the primary fuel quantities of two shipments of imported coal are “adjusted” using their energy content as the main reference (see Table A5.1) and the value reported in page 2 of the national energy balance (non reproduced here) is an “adjusted” quantity of Gg or Mm^3. This process is routinely applied for most primary sources, including imported and nationally produced natural gas.
For the final uses of energy (Tables A5.7-8 and Tables A5.9-10) the same methodology is applied but it runs the other way: the physical quantities of energy vectors are the only values actually measured on the market and the energy content is actually estimated using fixed average estimates of lower heat value. Experience on the measure of the actual energy content of fuels shows minor variations from one to another year, especially for liquid fuels.

In the case of natural gas the use of a fixed heat value to summarize all transactions was particularly complicated due to the fact that we use fuel from four main different sources: Russia, Netherlands, Algeria and national production. From 2003-2004 onwards Norway and Libya have also been added to the supply list. The big customers were actually billed according to the measured heat value of the natural gas delivered. After the end of the state monopoly on this market the system has recently been changed. From 2004 onwards, the price makes reference to the energy content of natural gas and the metered physical quantities of gas delivered to all final customers are billed according to an energy content variable from site to site and from year to year. The BEN still tries to summarize all production and consumption using only one conventional heat value.

So for the estimations of liquid fuels used in the civil and transportation sector the most reliable data is the physical quantity and this is used to calculate emissions, using updated data for the emission factors, estimated from samples of marketed fuels.
For this reason we attach also the copies of tables, page 8 and 9 of BEN (see Tables A5.9-10), mirror sheet of the tables, page 18 and 19 of BEN (see Tables A5.7-8), that are the base for our emission calculation in the civil and transport sectors.

Table A5.1 – National Energy Balance, year 2010, 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	642	0	0	7,150	68,845	50,800	25,160	112,457	11,827	24,270	14,184	23,986	17,675	7,111	364,107
2. IMPORTS	37,488	107,080	1,310	15	0	617,149	786,200	71,010	0	0	0	0	10,715	0	7,102	1,638,069
3. EXPORTS		19	15			1,155	3,960	13,820					145	0	899	19,743
4. Stock changes (d)	-585	3,366	74	0	0	4,275	470	6,500	0	0	0	0	0	0	249	14,201
5. TOTAL RESOURCES	**38,073**	**104,337**	**1,369**	**15**	**7,150**	**680,564**	**832,840**	**75,850**	**112,457**	**11,827**	**24,270**	**14,184**	**34,556**	**17,675**	**13,065**	**1,968,232**
6. Transformations (Enclosure 1/a)	37,688	90,047		0	7,151	246,181	908,690	0	112,457	11,827	24,270	14,184	128	17,675	0	1,470,298
7. Consumptions and Losses (Encl.2/a)	385	0	0	0	-1	14,473	0	0	0	0	0	0	0	0	0	14,857
8. Final Consumptions (Enclosure 3/a)	0	14,290	1,369	15	0	419,910	0	0				0	34,428	0	13,065	483,077
a) Agriculture	0	0	0	0	0	1,425	0	0	0	0	0	0	1,375	0	0	2,800
b) Industry	0	14,290	1,325	15	0	128,175		0				0	2,065	0	0	145,870
c) Services						6,953							0	0	13,065	20,018
d) Domestic and civil uses			44	0		277,698		0					30,988	0	0	308,730
Total (a+b+c+d)	**0**	**14,290**	**1,369**	**15**	**0**	**414,251**		**0**				**0**	**34,428**	**0**	**13,065**	**477,418**
e) Non energy uses						5,659	0	0	0	0	0	0	0	0	0	5,659

BALANCE	PRIMARY SOURCES															
	Coking coal	**Steam coal**	**Coal other uses**	**Lignite**	**Subproducts (a)**	**Natural Gas**	**Crude oil**	**Refinery feedstocks**	**Hydraulic Energy (e)**	**Geothermal Energy**	**Wind and Photovoltaic Energy**	**Waste**	**Wood**	**Biomass (f)**	**Biodiesel**	**TOTAL PRIMARY SOURCES**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Conversion factor (b)	*7.400*	*6.350*	*7.400*	*2.500*	*2.500*	*8.190*	*10.000*	*10.000*	*2.200*	*2.200*	*2.200*	*2.500*	*2.500*	*2.500*	*8.900*	
TOTAL ENERGY CONSUMPTIONS (7+8)	**385**	**14,290**	**1,369**	**15**	**-1**	**434,383**	**0**	**0**	**0**	**0**		**0**	**34,556**	**0**	**13,065**	**497,934**
9. Non energy final uses																
10. BUNKERS																
12. TOTAL USES	**38,073**	**104,337**	**1,369**	**15**	**7,150**	**680,564**	**908,690**	**0**	**112,457**	**11,827**	**24,270**	**14,184**	**34,556**	**17,675**	**13,065**	**1,968,232**

(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 2010, Secondary fuels, 10^9kcal

BALANCE	SECONDARY SOURCES																		
	Electric Energy	Char- coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	17	18	19	20	22	23	21	24	25	26	27	28	29	30	31	32	33	34	35
Conversion factor (b)	*0.860*	*7.500*	*7.246*	*4.250*	*0.900*	*7.400*	*4.250*	*11.000*	*12.000*	*10.400*	*10.500*	*10.400*	*10.300*	*10.200*	*9.800*	*9.800*	*8.300*	*6.513*	
1. PRODUCTIONS (c)	256,944	31	29,781	3,494	6,385	1,258	0	20,504	42,360	40,373	199,773	33,322	11,505	378,991	(g) 67,512	49,853	13,014	44,822	1,199,922
2. IMPORTS	39,549	518	130					22,605	0	17,316	1,397	9,277	4,213	24,745	(h) 4,263	5,223	19,663	4,051	152,950
3. EXPORTS	1,570	8	2,196			229		5,214		8,642	93,482	1,425	12,556	98,440	19,531	13,573	1,527	20,503	278,896
4. Stock changes (d)		0	-819					264		1,747	-1,208	530	-525	-2,570	1,029	-1,117	-581	1,661	-1,589
5. TOTAL RESOURCES	**294,923**	**541**	**28,534**	**3,494**	**6,385**	**1,029**	**0**	**37,631**	**42,360**	**47,300**	**108,896**	**40,644**	**3,687**	**307,866**	**51,215**	**42,620**	**31,731**	**26,709**	**1,075,565**
6. Transformations (Encl.1/a)			5,652	3,324	(c) 6,272	0		0	3,522	124	0	0	0	1,411	23,511	10,544	1,184	0	55,544
7. Consumptions and Losses (Encl.2/a)	37,512	0	0	168	9	1	0	429	28,386	137	-1	1	31	210	5,171	10,976	9,042	59	92,039
8. Final Consumptions (Encl.3/a)	257,411	541	22,883	0	104	1,029	0	37,202	10,452	47,039	108,897	40,643	3,656	299,431	4,656	11,388	21,505	3,432	893,202
a) Agriculture	4,825							682	0	0	116	0	0	21,920	0	0	0	0	27,543
b) Industry	104,618	120	22,883	0	104		0	3,553	2,400	0	305	208	10	4,998	3,088	8,360	21,505	3,432	175,584
c) Services	39,329							13,409			104,465	40,435	72	240,587	0	0	0	0	438,297

BALANCE	SECONDARY SOURCES																		
	Electric Energy	**Char- coal**	**Coke**	**Coke oven gas**	**Blast furnace Gas**	**Non energy use of coal products**	**Gas works Gas**	**L. P. G.**	**Refinery gas**	**Light Distillates (naphtha)**	**Gasoline**	**Jet fuel**	**Kerosene**	**Gas Oil / Diesel Oil**	**Residual Oil, HS**	**Residual Oil, LS**	**Petroleum Coke**	**Non energy use of petroleum products**	**TOTAL SECONDARY SOURCES**
	17	18	19	20	22	23	21	24	25	26	27	28	29	30	31	32	33	34	35
Conversion factor (b)	*0.860*	*7.500*	*7.246*	*4.250*	*0.900*	*7.400*	*4.250*	*11.000*	*12.000*	*10.400*	*10.500*	*10.400*	*10.300*	*10.200*	*9.800*	*9.800*	*8.300*	*6.513*	
d) Domestic and civil uses	108,639	421	0				0	19,558	0	0	0		93	19,115	0	588	0	0	148,414
Total (a+b+c+d)	**257,411**	**541**	**22,883**	**0**	**104**	**0**	**0**	**37,202**	**2,400**	**0**	**104,886**	**40,643**	**175**	**286,620**	**3,088**	**8,948**	**21,505**	**3,432**	**789,838**
e) No energetic uses				0		1,029		0	8,052	47,039	4,011	0	3,481	12,811	1,568	2,440	0	22,933	103,364
TOTAL ENERGY CONSUMPTIONS (7+8)	**294,923**	**541**	**22,883**	**168**	**113**	**1,030**	**0**	**37,631**	**38,838**	**47,176**	**108,896**	**40,644**	**3,687**	**299,641**	**9,827**	**22,364**	**30,547**	**3,491**	**962,400**
9. Non energy final uses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22,932	22,932
10. BUNKERS	0	0	0	0	0	0	0	0	0	0	0	0	0	6,814	17,877	9,712	0	286	34,689
12. TOTAL USES	**294,923**	**541**	**28,535**	**3,494**	**6,385**	**1,209**	**0**	**27,631**	**42,360**	**47,300**	**108,896**	**40,644**	**3,687**	**307,866**	**51,215**	**42,620**	**31,731**	**26,709**	**1,075,566**

Table A5.3 -National Energy Balance, year 2010, 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													128	128
b) Coking	37,688													37,688
c) Town gas Workshop														
d) Blast furnaces														
e) Petroleum refineries							908,690							908,690
f) Hydroelectric power plants									112,457					112,457
g) Geothermal power plants										11,827				11,827
h) Thermoelectric power plants		90,047			7,151	246,181						14,184	17,674	375,237
i) Wind / Photovoltaic power plants						-					24,270			24,270
TOTAL	**37,688**	**90,047**			**7,151**	**246,181**	**908,690**		**112,457**	**11,827**	**24,270**	**14,184**	**17,802**	**1,470,297**
2) OUTPUT QUANTITY														
A) Obtained sources														
a) Charcoal pit													65	65

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*	
b) Coking	33,966													33,966
c) Town gas Workshop														
d) Blast furnaces														
e) Petroleum refineries							857,228							857,228
f) Hydroelectric power plants									43,960					43,960
g) Geothermal power plants										4,623				4,623
h) Thermoelectric power plants		34,172			1,766	131,354						3,538	6,341	177,171
i) Wind / Photovoltaic power plants											9,487			9,487
Sub-Total A	**33,966**	**34,172**			**1,766**	**131,354**	**857,228**		**43,960**	**4,623**	**9,487**	**3,538**	**6,406**	**1,126,500**
B) Losses of transformation														
a) Charcoal pit													63	63
b) Coking	2,420													2,420
c) Town gas Workshop														
d) Blast furnaces														
e) Petroleum refineries							6,640							6,640

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*	
f) Hydroelectric power plants									68,497					68,497
g) Geothermal power plants										7,204				7,204
h) Thermoelectric power plants		55,875			5,385	114,827						10,646	11,333	198,066
i) Wind / Photovoltaic power plants											14,783			14,783
Sub-Total B	**2,420**	**55,875**			**5,385**	**114,827**	**6,640**		**68,497**	**7,204**	**14,783**	**10,646**	**11,396**	**297,673**
C) Non energy products														
a) Coke ovens (c)	1,302													1,302
b) Town Gas Workshop														
c) Petroleum refineries (d)							44,822							44,822
Sub-Total C	**1,302**						**44,822**							**46,124**
TOTAL A+B+C	**37,688**	**90,047**			**7,151**	**246,181**	**908,690**		**112,457**	**11,827**	**24,270**	**14,184**	**17,802**	**1,470,297**

(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 2010, Secondary fuels used by transformation industries, "Enclosure 1/a", 10^9kcal

TRANSFORMATIONS	SECONDARY SOURCES																		
	Electric Energy	**Char- coal**	**Coke**	**Coke oven gas**	**Blast furnace Gas**	**Non energy use of coal products**	**Gas works Gas**	**L. P. G.**	**Refinery gas**	**Light Distillates (naphtha)**	**Gasoline**	**Jet fuel**	**Kerosene**	**Gas Oil / Diesel Oil**	**Residual Oil, HS**	**Residual Oil, LS**	**Petroleum Coke**	**Non energy use of petroleum products**	**TOTAL SECONDARY SOURCES**
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor (b)	*0.860*	*7.500*	*7.513*	*4.250*	*0.900*	*7.400*	*4.250*	*11.000*	*12.000*	*10.400*	*10.500*	*10.400*	*10.300*	*10.200*	*9.800*	*9.800*	*8.300*	*6.170*	
1) INPUT QUANTITY																			
a) Charcoal pit																			
b) Coking																			
c) Town gas Workshop																			
d) Blast furnaces			5,652																5,652
e) Petroleum refineries																			
f) Hydroelectr.power plants																			
g) Geothermal power plants																			
h) Thermoelectr. power plants				3,324	6,272				**3,522**	**124**				1,411	23,511	10,544	1,184		49,892
i) Wind / Photovoltaic power plants																			
TOTAL			**5,652**	**3,324**	**6,272**				**3,522**	**124**				**1,411**	**23,511**	**10,544**	**1,184**		**55,544**
2) OUTPUT QUANTITY																			
A) Obtained sources																			
a) Charcoal pit																			

TRANSFORMATIONS	SECONDARY SOURCES																		
	Electric Energy	**Char- coal**	**Coke**	**Coke oven gas**	**Blast furnace Gas**	**Non energy use of coal products**	**Gas works Gas**	**L. P. G.**	**Refinery gas**	**Light Distillates (naphtha)**	**Gasoline**	**Jet fuel**	**Kerosene**	**Gas Oil / Diesel Oil**	**Residual Oil, HS**	**Residual Oil, LS**	**Petroleum Coke**	**Non energy use of petroleum products**	**TOTAL SECONDARY SOURCES**
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor (b)	*0.860*	*7.500*	*7.513*	*4.250*	*0.900*	*7.400*	*4.250*	*11.000*	*12.000*	*10.400*	*10.500*	*10.400*	*10.300*	*10.200*	*9.800*	*9.800*	*8.300*	*6.170*	
b) Coking																			33,966
c) Town gas Workshop																			
d) Blast furnaces			5.652															5,652	5,652
e) Petroleum refineries																			857,228
f) Hydroelectric power plants																			43,960
g) Geothermal power plants																			4,623
h) Thermoelectric power plants				1,326	2,511				1,754	88			481	10,784	4,218	543		21,705	198,876
i) Wind / Photovoltaic power plants																			9,487
Sub-Total A			**5,652**	**1,326**	**2,511**				**1,754**	**88**			**481**	**10,784**	**4,218**	**543**			**1,153,857**
B) Losses of transformation																			
a) Charcoal pit																			63
b) Coking																			2,420
c) Town gas Workshop																			
d) Blast furnaces																			
e) Petroleum refineries																			6,640
f) Hydroelectric																			68,497

TRANSFORMATIONS	SECONDARY SOURCES																		
	Electric Energy	**Char- coal**	**Coke**	**Coke oven gas**	**Blast furnace Gas**	**Non energy use of coal products**	**Gas works Gas**	**L. P. G.**	**Refinery gas**	**Light Distillates (naphtha)**	**Gasoline**	**Jet fuel**	**Kerosene**	**Gas Oil / Diesel Oil**	**Residual Oil, HS**	**Residual Oil, LS**	**Petroleum Coke**	**Non energy use of petroleum products**	**TOTAL SECONDARY SOURCES**
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor (b)	*0.860*	*7.500*	*7.513*	*4.250*	*0.900*	*7.400*	*4.250*	*11.000*	*12.000*	*10.400*	*10.500*	*10.400*	*10.300*	*10.200*	*9.800*	*9.800*	*8.300*	*6.170*	
power plants																			
g) Geothermal power plants																			7,204
h) Thermoelectric power plants				1,998	3,761				1,768	36			930	12,727	6,326	641		28,187	226,253
i) Wind / Photovoltaic power plants																			14,783
Sub-Total B				**1,998**	**3,761**				**1,768**	**36**			**930**	**12,727**	**6,326**	**641**		**28,187**	**352,860**
C) Non energy products																			
a) Coking																			1,302
b) Town Gas Workshop																			
c) Petroleum refineries																			44,822
Sub-Total C																			**46,124**
TOTAL A+B+C			**5,652**	**3,324**	**6,272**				**3,522**	**124**			**1,411**	**23,511**	**10,544**	**1,184**		**55,544**	**1,525,841**

Table A5.5 -National Energy Balance, year 2010, Primary fuels losses, "Enclosure 2/a", 10^9kcal

CONSUMPTIONS AND LOSSES (d)	PRIMARY SOURCES													
	Coking coal	Steam coal	Coal other uses	Lignite	Subproducts (a)	Natural Gas	Crude oil	Refinery feedstocks	Hydraulic Energy	Geothermal Energy	Wind and Photovoltaic Energy	Waste	Biomass	TOTAL PRIMARY SOURCES
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Conversion factor (b)	*7.400*	*6.350*	*7.400*	*2.500*	*2.500*	*8.190*	*10.000*	*10.000*	*2.200*	*2.200*			*2.500*	
1) Consumptions for production														
of primary sources														
a) Biomass														
b) Coal														
c) Lignite														
d) Nuclear fuels														
e) Natural Gas						3,579								3,579
f) Natural gas liquids														
g) Crude oil														
h) Hydraulic Energy														
i) Geothermal Energy														
Sub-total						**3,579**								**3,579**
2) Consumptions for production														
of secondary sources (c)														
a) Charcoal pit														
b) Coke ovens	385													385
c) Town Gas Workshop														
d) Blast furnaces														
e) Petroleum refineries						5,070								5,070
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	**385**					**5,070**								**5,455**
3) Consumptions and Losses of														
transport and distribution						5,823								5,823
4) Differences :														
- Statistics														
- of conversion					-1	1								
TOTAL (1+2+3+4)	**385**				**-1**	**14,473**								**14,857**

(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 2010, Secondary fuels losses, "Enclosure 2/a", 10^9kcal

CONSUMPTIONS AND LOSSES	SECONDARY SOURCES																		
	Electric Energy	Char- coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor (b)	*0.860*	*7.500*	*7.513*	*4.250*	*0.900*	*7.400*	*4.250*	*11.000*	*12.000*	*10.400*	*10.500*	*10.400*	*10.300*	*10.200*	*9.800*	*9.800*	*8.300*	*6.170*	
1) Consumptions for production																			
of primary sources						1													1
a) Biomass																			
b) Coal	33																		33
c) Lignite	2																		2
d) Nuclear fuels	5																		5
e) Natural Gas		327																	327
f) Natural gas liquids																			
g) Crude oil																			
h) Hydraulic Energy	1,001	(d)																	1,001
i) Geothermal Energy	-																		
Sub-total	**1,368**					**1**													**1,369**
2) Consumptions for production																			
of secondary sources (c)																			
a) Charcoal pit																			
b) Coke ovens	156			168	8														332
c) Town Gas Workshop	222																		222

CONSUMPTIONS AND LOSSES	SECONDARY SOURCES																		
	Electric Energy	**Char- coal**	**Coke**	**Coke oven gas**	**Blast furnace Gas**	**Non energy use of coal products**	**Gas works Gas**	**L. P. G.**	**Refinery gas**	**Light Distillates (naphtha)**	**Gasoline**	**Jet fuel**	**Kerosene**	**Gas Oil / Diesel Oil**	**Residual Oil, HS**	**Residual Oil, LS**	**Petroleum Coke**	**Non energy use of petroleum products**	**TOTAL SECONDARY SOURCES**
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Conversion factor (b)	*0.860*	*7.500*	*7.513*	*4.250*	*0.900*	*7.400*	*4.250*	*11.000*	*12.000*	*10.400*	*10.500*	*10.400*	*10.300*	*10.200*	*9.800*	*9.800*	*8.300*	*6.170*	
d) Blast furnaces																			
e) Petroleum refineries	5,039							**429**	**28,380**	**135**			**31**	**214**	**5,173**	**10,975**	**9,039**		59,474
f) Hydraulic power plants	526																		526
g) Geothermal power plants	283																		283
h) Thermoelectric power plants	8,827																		8,827
i) Wind / Photovoltaic power plants	94																		
Sub-total	**15,147**			**168**	**8**			**429**	**28,380**	**135**			**31**	**214**	**5,173**	**10,975**	**9,039**		**69,664**
3) Consumptions and Losses of																			
transport and distribution	20,997																		20,997
4) Differences :																			
- Statistics	-																		
- of conversion			-1		1				6	2	-1	1		-4	-2	1	3		6
TOTAL (1+2+3+4)	**37,512**		**-1**	**168**	**9**	**1**		**429**	**28,386**	**137**	**-1**	**1**	**31**	**210**	**5,171**	**10,976**	**9,042**	**59**	**92,036**

Table A5.7 -National Energy Balance, year 2010, 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						1,425							1,375		2.800
II- Fishing															
Sub-Total						**1,425**							**1,375**		**2,800**
2) INDUSTRY															
I- Iron and steel industry		10,878	895			17,166									28,939
II- Other industry		3,412	430	15		111,009							2,065		116,931
a) Mining industry						410									410
b) Non-Ferrous Metals			44			4,095									4,139
c) Metal works factories						18,018									18,018
d) Food Processing, Beverages						14,742									14,742
e) Textile and clothing						6,634									6,634
f) Construction industries (cement, bricks)		3,412	371	15		6,134							2.065		12,006
g) Glass and pottery						18,264									18,264
h) Chemical			15			20,885									20,900
i) Petrochemical															
l) Pulp, paper and						18,100									18,100

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*	
print															
m) Other industries						3,718									
n) Building and civil works															
Sub-Total		**14,290**	**1,325**	**15**		**128,175**							**2.065**		**145,870**
3) SERVICES															
I - Railways															
II - Navigation															
III - Road transportation						6,953								13,065	20,018
IV - Civil aviation															
V - Other transportation															
VI - Public Service															
Sub-Total						**6,953**								**13,065**	**20,018**
4) DOMESTIC AND COMMERCIAL USES			44			277,698							30,988		308,730
TOTAL (1+2+3+4)		**14,290**	**1,369**	**15**		**414,251**							**34,428**	**13,065**	**477,418**
5) NON ENERGY USE (b)															
I - Chemical industry															
II - Petrochemical						5,659									5,659
III - Agriculture															

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*	
IV - Other sectors															
Sub-Total						**5,659**									**5,659**
TOTAL (1+2+3+4+5)		**14,290**	**1,369**	**15**		**419,910**							**34,428**	**13,065**	**483,077**

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

(b) - Non energy uses of energetic sources

Table A5.8-National Energy Balance, year 2010, 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	4,825							660			105			20,084					25,674
II- Fishing								22			11			1,836					1,869
Sub-Total	**4,825**							**682**			**116**			**21,920**					**27,543**
2) INDUSTRY																			
I- Iron and steel industry	16,061		22,738		104			242											40,014
II- Other industry	88,557	120	145					3,311	2,400		305	208	10	4,794	2,676	8,115	21,497	3,432	135,570
a) Mining industry	791							33						255	88	10			1,177
b) Non-Ferrous Metals	3,898		14					220						71	216				4,419
c) Metal works factories	21,606							770			305	208	10	1,418	666	941			25,924
d) Food Processing, Beverages	10,998	75						385						561	902	1,519			14,440
e) Textile and clothing	5,897							165						418	10	598			7,048
f) Construction industries (cement, bricks)	5,931		87					770						500	333	470	21,422	3,432	32,945

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*	
g) Glass and pottery	4,277							605						204		1,558			6,644
h) Chemical	17,943	45	22					44						245		647	75		19,021
i) Petrochemical	1,357							143							245	1,833			5,978
l) Pulp, paper and print	8,394							88						255		402			9,139
m) Other industries	5,998		22					77						357	216	137			6,807
n) Building and civil works	1,507							11						510					2,028
Sub-Total	**104,618**	**120**	**22,883**		**104**			**3,553**	**2,400**		**305**	**208**	**10**	**4,998**	**3,088**	**8,360**	**21,505**	**3,432**	**175,584**
3) SERVICES																			
I - Railways	4,613													643					5,256
II - Navigation	41													1,836					1,877
III - Road transportation	4,327							13,354			104,076			235,691					357,448
IV - Civil aviation	192										200	39,114	72						39,578
V - Other transportation	20,489																		20,489
VI - Public Service	9,667							55			189	1,321		2,417					13,649
Sub-Total	**39,329**							**13,409**			**104,465**	**40,435**	**72**	**240,587**					**438,297**

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*	
4) DOMESTIC AND COMMERCIAL USES	108,639	421						19,558					93	19,115		588			148,414
TOTAL (1+2+3+4)	**257,411**	**541**	**22,883**		**104**			**37,202**	**2,400**		**104,886**	**40,643**	**175**	**286,620**	**3,088**	**8,948**	**21,505**	**3,432**	**789,838**
5) NON ENERGY USE (b)																			
I - Chemical industry																			
II - Petrochemical									8,052	47,039	4,011		3,481	12,811	1,568	2,440		221	79,623
III - Agriculture						11													111
IV - Other sectors						918												22,712	23,630
Sub-Total						**1,029**			**8,052**	**47,039**	**4,011**		**3,481**	**12,811**	**1,568**	**2,440**		**22,933**	**103,364**
TOTAL (1+2+3+4+5)	**257,411**	**541**	**22,883**		**104**	**1,029**		**37,202**	**10,452**	**47,039**	**108,897**	**40,643**	**3,656**	**299,431**	**4,656**	**11,388**	**21,505**	**26,365**	**893,202**

(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 2010, 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						174							550	
II- Fishing														
Sub-Total	**0**	**0**	**0**	**0**		**174**	**0**	**0**	**0**	**0**			**550**	
2) INDUSTRY														
I- Iron and steel industry		1,713	121			2,096								
II- Other industry	0	537	58	6		13,554		0	0			0	826	
a) Mining industry						50								
b) Non-Ferrous Metals				6		500								
c) Metal works factories						2,200								
d) Food Processing, Beverages						1,800								
e) Textile and clothing						810								
f) Construction industries (cement, bricks)		537	50	6		750							826	
g) Glass and pottery						2,230								
h) Chemical			2			2,550								
i) Petrochemical						0								
l) Pulp, paper and print						2,210								
m) Other industries						454								
n) Building and civil works														
Sub-Total	**0**	**2,250**	**179**	**6**	**0**	**15,650**	**0**	**0**	**0**	**0**		**0**	**826**	
3) SERVICES														
I - Railways														

FINAL CONSUMPTIONS	PRIMARY SOURCES													
	Coking coal	**Steam coal**	**Coal other uses**	**Lignite**	**Subproducts**	**Natural Gas**	**Crude oil**	**Refinery feedstocks**	**Hydraulic Energy**	**Geothermal Energy**	**Wind and Photovoltaic Energy**	**Waste**	**Biomass**	**TOTAL PRIMARY SOURCES**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Unit of measurement	kt	kt	kt	kt		Mmc	kt	kt	GWh	GWh	GWh	kt	kt	
II - Navigation														
III - Road transportation						849							(b) 1,468	
IV - Civil aviation														
V - Other transportation														
VI - Public Service														
Sub-Total	**0**	**0**	**0**	**0**		**849**	**0**	**0**	**0**	**0**			**1,468**	
4) DOMESTIC AND COMMERCIAL USES			6			33,907							(b) 12,395	
TOTAL (1+2+3+4)	**0**	**2,250**	**185**	**6**		**50,580**	**0**	**0**	**0**	**0**			**15,239**	
5) NON ENERGY USE (a)														
I - Chemical industry														
II - Petrochemical														
III - Agriculture														
IV - Other sectors														
Sub-Total	**0**	**0**	**0**	**0**		**691**	**0**	**0**	**0**	**0**			**-**	
TOTAL (1+2+3+4+5)	**0**	**2,250**	**185**	**6**		**51,271**	**0**	**0**	**0**	**0**			**15,239**	

(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 2010, 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	5,610							60			10			1,969					
II- Fishing								2			1			180					
Sub-Total	**5,610**	**0**	**0**	**0**	**0**		**0**	**62**	**0**	**0**	**11**	**0**	**0**	**2,149**	**0**	**0**	**0**	**0**	
2) INDUSTRY																			
I- Iron and steel industry	18,675		3,138		116			22											
II- Other industry	102,974	16	20	0	0	0	0	301	200	0	29	20	1	470	273	828	2,590	527	
a) Mining industry	920							3						25	9	1			
b) Non-Ferrous Metals	4,533		2					20						7	22	0			
c) Metal works factories	25,123							70			29	20	1	139	68	96			
d) Food Processing, Beverages	12,789	10						35						55	92	155			
e) Textile and clothing	6,810							15						41	1	61			
f) Construction industries (cement, bricks)	6,896		12					70						49	34	48	2,581	527	
g) Glass and pottery	4,974							55						20	0	159			
h) Chemical	20,864	6	3					4						24	0	66	9		
i) Petrochemical	1,578							13	200					0	25	187			

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	
l) Pulp, paper and print	9,760							8						25	0	41			
m) Other industries	6,795		3					7						35	22	14			
n) Building and civil works	1,752							1						50					
Sub-Total	**121,649**	**16**	**3,158**	**0**	**116**	**0**	**0**	**323**	**200**	**0**	**29**	**20**	**1**	**490**					
3) SERVICES																			
I - Railways	5,364													63					
II - Navigation	48													180					
III - Road transportation	5,031							1,214			(b) 9,912			23,107					
IV - Civil aviation	223										19	3,761	7						
V - Other transportation	23,823																		
VI - Public Service	11,241							**(a) 5**			18	127		(a) 237					
Sub-Total	**45,730**	**0**	**0**	**0**	**0**	**0**	**0**	**1,219**	**0**	**0**	**9,949**	**3,888**	**7**	**23,587**	**0**	**0**	**0**	**0**	
4) DOMESTIC AND COMMERCIAL USES	126,325	53						1,778					9	1,874					
TOTAL (1+2+3+4)	**299,314**	**72**	**3,158**	**0**	**116**	**0**	**0**	**3,382**	**200**	**0**	**9,989**	**3,908**	**17**	**28,100**	**315**	**913**	**2,591**	**527**	**29,583**
5) NON ENERGY USE																			
I - Chemical industry																			
II - Petrochemical									671	4,523	382	0	338	1,256	160	249	0	34	

FINAL CONSUMPTIONS	SECONDARY SOURCES																		
	Electric Energy	Char- coal	Coke	Coke oven gas	Blast furnace Gas	Non energy use of coal products	Gas works Gas	L. P. G.	Refinery gas	Light Distillates (naphtha)	Gasoline	Jet fuel	Kerosene	Gas Oil / Diesel Oil	Residual Oil, HS	Residual Oil, LS	Petroleum Coke	Non energy use of petroleum products	TOTAL SECONDARY SOURCES
	15	16	17	18	20	21	19	22	23	24	25	26	27	28	29	30	31	32	33
Unit of measurement	GWh	kt	kt	Mmc	Mmc	kt	Mmc	kt	kt	kt		kt	kt	kt	kt	kt	kt	kt	
III - Agriculture						15													
IV - Other sectors						124												3,487	
Sub-Total	**-**	**0**	**0**	**0**	**0**	**136**	**0**	**0**	**671**	**4,523**	**382**	**0**	**338**	**1,256**	**160**	**249**	**0**	**3,521**	
TOTAL (1+2+3+4+5)	**299,314**	**72**	**3,158**	**0**	**116**	**139**	**0**	**3,382**	**871**	**4,523**	**10,371**	**3,908**	**355**	**29,356**	**475**	**1,162**	**2,591**	**4,408**	

(c) 48 kt of gas oil and 2 kt of LPG used for heating for Public Service

ANNEX 6: NATIONAL EMISSION FACTORS

Monitoring of the carbon content of the fuels used nationally is an ongoing activity at ISPRA. The purpose is to analyse regularly the chemical composition of the used fuel or relevant commercial statistics to estimate the carbon content / emission factor (EF) of the fuels. For each primary fuel (natural gas, oil, coal) a specific procedure has been established.

A6.1 Natural gas

The national market is characterized by the commercialisation of gases with different chemical composition in variable quantities from one year to the other. Since 1990 natural gas has been produced in Italy and imported by pipelines from Russia, Algeria and the Netherlands. Moreover an NGL facility is importing gas from Algeria and Libya. From 2003-2004 onwards Norway and Libya have also been added to the supply list, through new pipeline connections, and from 2008 a new NGL facility has entered into service, using mainly liquefied gas from Oman. There are also sizeable underground storage facilities and additional pipelines/NGL facilities are planned.
The estimation of an average EF for natural gas is the only way to calculate total emissions from this source in Italy, because the origin of the gas used by final consumers can not be tracked trough the national statistics and it is subject to variations during the year, according to supply. Only the main industrial installations perform routine checks to estimate the average chemical composition / energy content of natural gas used.
Another task connected to the use of natural gases of different origin and composition is linked to the estimation of an average content of methane to estimate fugitive emissions of this gas from the transmission / distribution network. Since the beginning of the inventory estimations, the average EF of the used gas in Italy has been estimated by the inventory team and it changes every year.
From 2008 in the energy balance, BEN 2008, (MSE, several years [a]) some modifications have occurred; a new average lower heat value has been derived from Eurostat methodology. This new conversion factor did imply a methodological revision to estimate the average national EF. Additionally, the IPCC 2006 guidelines, see table A6.1, contain important information to consider: the recognition of a certain variability of the EF for this source; the estimation of a lower and upper bound for the EFs; the link between energy content and EF; the statement that, by converting to energy units all EFs, their variability can be reduced. Moreover default oxidation factor is estimated to be equal to 1 (full oxidation). The 2006 guidelines do not apply in the national inventory up to 2012, but some of the scientific information could and should be considered in the estimation of the national emission factors (IPCC, 2006).
Each of natural gases transmitted by the grid operator is regularly analysed at import gates, for budgetary reasons. Energy content for cubic meters, percentage of methane and other substances are calculated. For example, methane content can considerably vary: national produced gas sold to the grid is almost 99% methane (% moles), the one coming from Algeria has less than 85% of methane and significant quantities of propane-butane. Also carbon content varies significantly.
Natural gas properties are more stable referring to the country of origin, with small variations in chemical composition from year to year. Speciation of gas from each import manifold is regularly published by national transmission grid operator (Snam Rete Gas, several years). Other information is also available from the main final users (TERNA, several years).
So, for each year, the average methane and carbon content of the natural gas used in Italy are estimated, using international trade statistical data, and a national emission factor is estimated.
The list of factors for the years of interest is reported in Table A6.1.
In the 2012 submission, the average emission factor for the year 2009 has been updated. As shown in the table, the ranges of national EFs are within the lower and upper threshold of the IPCC 2006 guidelines.

Table A6.1 Natural gas carbon emission factors

	$t\ CO_2$ / TJ (stechiometric)	$t\ CO_2$ / TJ	$t\ CO_2$ / 10^3 std cubic mt	$t\ CO_2$ / toe
		(with oxidation factor equal to 0.995)		
Natural gas (dry) IPCC '96	56.061	55.780	1.925	2.334
Natural gas, IPCC '06 average	56.100			
lower	54.100			
upper	58.100			
National Emission Factors				
Natural gas , 1990	55.606	55.328	1.942	2.315
Natural gas, 1995	55.702	55.423	1.961	2.319
Natural gas , 2000	55.751	55.472	1.971	2.321
Natural gas , 2001	55.699	55.421	1.960	2.319
Natural gas , 2002	56.255	55.974	1.965	2.342
Natural gas, 2003	55.874	55.594	1.961	2.326
Natural gas, 2004	55.874	55.595	1.945	2.326
Natural gas, 2005	55.869	55.590	1.944	2.326
Natural gas, 2006	55.946	55.666	1.949	2.329
Natural gas, 2007	55.917	55.637	1.947	2.328
Natural gas, 2008	56.025	55.745	1.950	2.332
Natural gas, 2008, with 8190 lhv	57.196	56.910	1.950	2.381
Natural gas, 2009	56.050	55.769	1.958	2.333
Natural gas, 2009, with 8190 lhv	57.419	57.132	1.958	2.390
Natural gas, 2010	56.000	55.720	1.962	2.331
Natural gas, 2010, with 8190 lhv	57.532	57.244	1.962	2.395

Source: ISPRA elaborations

The methodology used to estimate the EF is based on the available data. Each year the quantities of natural gas imported or produced in Italy are published on the web by the MSE http://dgerm.sviluppoeconomico.gov.it/dgerm/bilanciogas.asp.Those data are produced by the national grid operator and are concerned on all imported gas by point of entrance in the country and all natural gas produced. To compare quantities of different gases, the physical quantities of imported/produced gas are normalized to a higher heat value (hhv) equal to 9100 kcal/m^3 and standard conditions. Other data input used in the estimation are the average chemical composition and the hhv of the gas at each import "gate" and for the national production. Those data are published by Snam Rete Gas in its yearly "Bilancio di Sostenibilità" (Snam Rete Gas, several years) and with them it is possible to estimate the average carbon content of the fuel. Those data are referred to the physical quantities of imported / produced gas.
So the total quantities of imported gas (normalized at the hhv of 9100) published by MSE are transformed back to the physical quantities of actually imported gas using the hhv ratio and then average carbon content of the total gas imported or produced in Italy can be estimated. Those data are then referred back to the normalized quantities of gas used in national statistics.

Data on final consumption of gas refers to the lower heat value (lhv). In particular the electricity production companies regularly estimate the actual lhv of the gas they are using and this figure is published yearly by TERNA. Operator's data are used to verify the calculation results. Weighted average lhv of the imported / produced natural gas in 2010 is 8309 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 from 2008 do not change using both EFs reported in the table because the total energy content of the natural gas use changes according to the statistical methodology used.

A6.2 Diesel oil, petrol and LPG

APAT (now ISPRA) has made an investigation of the carbon content of the main transportation fuels sold in Italy: petrol, diesel and LPG, with the aim of testing the average fuels sold in the year 2000 and collecting available information on previous year fuels. The goal of this work is the verification of CO_2 emission factors of Italian energy system, with a particular focus on the transportation sector. The results of analysis of fuel samples performed by "Stazione Sperimentale Combustibili" (APAT, 2003) were compared with emission factors used in Reference Approach of the Intergovernmental Panel for Climate Change (IPCC, 1997) and emission factors considered in the COPERT 4 programme (EMISIA SA, 2011).
These two methodologies are widely used to prepare data at the international level but, when applied to the Italian data set produce results with significant differences, around 2- 4%. The reason has been traced back to the emission factors that are referred to the energy content of the fuel for IPCC and to the physical quantities for the COPERT methodology.
The results of the study link the chemical composition of the fuel to the lhv for a series of fuels representative of the national production in the years 2000-2001, allowing for more precise evaluations of the emission factors.

IPCC 1996 emission factors for diesel fuels and IPCC-Europe for LPG are almost identical to the experimental results (less than 1% difference), and it has been decided to use IPCC emission factors for the period 1990-1999 and the measured EF from the year 2000 onwards.
Relevant quantities of LPG used in Italy are imported. The measured values refer only to the products produced in Italy, IPCC emission factors is used as a default for the imported quantities.

Concerning petrol, instead, IPCC 1996 emission factors is quite low and it has to be updated, the reason may be linked to the extensive use of additives in recent years to reach a high octane number after the lead has been phased out. For 2000 and the following years the experimental factor will be used, for the period 1990-1999 it has been decided to use an interpolate factor between IPCC emission factors and the measured value, using the lhv as the link between the national products and the international database. No other information was available.
The list of emission factors for the different years is reported in Table A6.2.

Table A6.2 Fuels, national production, carbon emission factors, with oxidation factor equal to 0.99

	t CO_2 / TJ	t CO_2 / t	t CO_2 / toe
Petrol, IPCC / OECD	68.559	3.071	2.868
Petrol, IPCC Europe	72.270	3.148	3.024
Petrol (Italian National Energy Balance), interpolated emission factor 1990-1999	71.034	3.121	2.972
Petrol, experimental averages 2000-2010	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 2000-2010	73.153	3.138	3.061
Gas oil, heating, experimental averages 2000-2010	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

A6.3 Fuel oil

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

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

	t CO_2 / TJ (stechiometric)	t CO_2 / TJ (with oxidation factor equal to 0.99)	t CO_2 / t	t CO_2 / toe
Fuel oil , IPCC, 1996	77.310	76.539	3.148	3.202
Fuel oil , IPCC, 2006 average	77.400			
lower	75.200			
upper	79.600			
National emission factors				
Fuel oil, average 1990	77.339	76.565	3.111	3.203
Fuel oil, average 1995	77.425	76.650	3.127	3.207
Fuel oil, average 2000	76.665	75.898	3.124	3.176
Fuel oil, average 2001	76.665	75.889	3.122	3.175
Fuel oil, average 2002	76.709	75.942	3.125	3.177
Fuel oil, average 2003	76.921	76.151	3.131	3.186
Fuel oil, average 2004	76.939	76.170	3.132	3.187
Fuel oil, average 2005	75.875	75.116	3.110	3.143
Fuel oil, average 2006	75.952	75.193	3.111	3.146
Fuel oil, average 2007	76.326	75.562	3.113	3.162
Fuel oil, average 2008	76.393	75.629	3.111	3.164
Fuel oil, average 2009	76.449	75.684	3.112	3.167
Fuel oil, average 2010	76.424	75.660	3.110	3.166

Source: ISPRA elaborations

Data for all years are within IPCC 2006 ranges, but it can be noticed that are on the lower side from year 2000 onwards. The change from an average to a low EF is due to the harmful emissions limits and fuel regulations introduced in Italy between 1990 and 2000. Most of the fuel used from 2000 onwards is not heavy, high sulphur, fuel oil but light type, low sulphur.

A6.4 Coal

Italy has only negligible national production of coal; most part is imported from various countries and there are differences in carbon content of coal mined in different parts of the world. The variations in carbon content can be linked to the hydrogen content and to the LHV of the coal.
An additional national circumstance refers to the absence of long term import contracts. The quantities shipped by the main exporters change considerably from year to year. Detailed data are available in BPT (MSE, several years [b]) supplied from the Ministry of Economic Development and reported for 2010 in Table A6.4.

Table A6.4 – Coal imported by country in 2010 (Mg)

Country	Coking coal	Coke	Steam coal	Lignite	Other	Total Coal	Pet-Coke
CYPRUS	0	0	715,556	0	0	715,556	0
FRANCE	0	0	0	0	199	199	0
GERMANY	0	0	162	6,217	244	6,623	0
LITHUANIA	0	0	0	0	0	0	0
SPAIN	0	0	995,148	0	0	995,148	24,658
TOTAL EU	**0**	**0**	**1,710,866**	**6,217**	**443**	**1,717,526**	**24,658**
ARGENTINA	0	0	0	0	0	0	0
AUSTRALIA	1,895,862	0	597,895	0	0	2,493,757	0
CANADA	864,524	0	0	0	0	864,524	0
CHILE	0	0	0	0	0	0	8,013
COLOMBIA	0	0	1,761,504	0	0	1,761,504	0
GEORGIA	0	0	0	0	0	0	475
INDIA	0	18,206	0	0	0	18,206	0
INDONESIA	0	0	7,026,617	0	0	7,026,617	0
RUSSIA	0	0	1,297,658	0	17,684	1,315,342	0
SOUTH AFRICA	0	0	3,919,245	0	0	3,919,245	0
UCRAINA	0	0	0	0	88,864	88,864	0
Former SOVIET UNION	0	0	42,005	0	20,642	62,647	0
U.S.A.	2,306,274	0	459,702	0	0	2,765,976	1,418,684
VENEZUELA	0	0	47,553	0	50,480	98,033	167,061
TOTAL NON-EU	**5,066,660**	**18,206**	**15,152,179**	**0**	**177,670**	**20,414,715**	**1,594,233**
TOTAL	**5,066,660**	**18,206**	**16,863,045**	**6,217**	**178,113**	**22,132,241**	**1,618,891**

Source: MSE, several years [b]

Therefore an attempt was made to find out a methodology allowing for a more precise estimation of the carbon content of this fuel. It is possible, using literature data for the coals and detailed statistical records of international trade, to find out the weighted average of carbon content and of the LHV of the fuel imported to Italy each year. The still unresolved problem is how to properly link statistical data, referred to the coal "as it is" without specifying moisture and ash content of the product, to the literature data, referring to sample coals.

We envisage improving the quality of the collected statistical data including moisture content of coals; currently we overcome this obstacle with the following procedure:

- using an ample set of experimental data on coals imported in a couple of years on an extensive series of samples, more than 200, analysed by ENEL (the main electricity producing company in Italy) it was possible to correlate "as it is" LHV and carbon content to the average properties of the coals imported in the same period of time and calculated from literature data (EMEP/CORINAIR, 2007);
- for each inventory year, it was possible to calculate the weighted average of LHV and carbon content of imported coals using available literature data;
- using this calculated data and the correlation found out, the estimate of carbon content of the average "as it is" coal reported in the statistics was possible.

Using this methodology and the available statistical data, it was possible to trace back to the year 1990 the average LHV of the imported coal and estimate average carbon EF for each year, see Table A6.4 for detailed data. The results do not show impressive changes yearly; anyway a noticeable difference in the emission factor is highlighted in the table. In Table A6.5 updated coal EFs from IPCC 2006 have been also reported. As can be seen, average values for steam coals have been slightly reduced in the updated methodology. National emission factors result in the range given by the old and new average values for "other bituminous coal".

From the 2011 submission, with the aim to improve the estimation of the coal CO_2 emission factors an in depth analysis of data reported in the framework of the European emissions trading scheme has been carried out. In consideration that these data referring to emission factors and activity data are validated and the amount of fuel reported accounts for more than 90% of the national coal fuel consumption, the average coal CO_2 emission factors, resulting from ETS data, have been applied for the years 2005-2010.

Table A6.5 – Coal, average carbon emission factors

	t CO_2 / TJ (stechiometric)	t CO_2 / TJ (with oxidation factor 0.98)	t CO_2 / t	t CO_2 / toe
Sub bituminous coal, IPCC 1996	98.200	96.234	2.557	4.026
Other Bituminous coal, IPCC 2006, av	94.600			
lower	87.300			
upper	102.500			
National emission factors				
Steam coal, 1990	96.512	94.582	2.502	3.960
Steam coal, 1995	95.926	94.007	2.519	3.936
Steam coal, 2000	93.312	91.446	2.404	3.826
Steam coal, 2001	95.304	93.398	2.434	3.908
Steam coal, 2002	94.727	92.832	2.423	3.884
Steam coal, 2003	95.385	93.478	2.435	3.911
Steam coal, 2004	95.382	93.474	2.430	3.911
Steam coal, 2005	94.403	92.515	2.419	3.871
Steam coal, 2006	94.630	92.737	2.368	3.880
Steam coal , 2007	95.192	93.288	2.386	3.903
Steam coal , 2008	93.775	91.900	2.242	3.845
Steam coal , 2009	93.913	92.035	2.285	3.851
Steam coal , 2010	93.781	91.905	2.290	3.845

Source: ISPRA elaborations

A6.5 Other fuels

From this year submission, country specific emission factors have been calculated for other fuels and included in the inventory on account of the analysis of data reported by plants in the framework of the European emissions trading scheme. In consideration that these data referring to emission factors and activity data are validated and the amount of fuels reported accounts for more than 90% of the national fuels consumption, the average CO_2 emission factors have been applied for the years 2005-2010.
In the following, values of CO_2 emission factors are specified for the different fuels. From 2005, figures result from a weighted average of ETS data; before that period, emission factors derive from literature data or other national data collection.

Table A6.6 – Refinery gas, average carbon emission factors

Refinery gas	t CO_2 / TJ (stechiometric)	t CO_2 / TJ (with oxidation factor 0.995)	t CO_2 / t	t CO_2 / toe
National emission factors				
Refinery gas, 1990-2004	62.392	62.080	3.117	2.597
Refinery gas, 2005	58.255	57.963	2.749	2.425
Refinery gas, 2006	56.969	56.889	2.619	2.373
Refinery gas, 2007	56.204	56.700	2.603	2.340
Refinery gas, 2008	58.187	57.896	2.691	2.422
Refinery gas, 2009	57.625	57.337	2.684	2.399
Refinery gas, 2010	57.796	57.331	2.710	2.406

Source: ISPRA elaborations

Table A6.7 – Coke oven gas, average carbon emission factors

Coke oven gas	$t\ CO_2$ / TJ (stechiometric)	$t\ CO_2$ / TJ	$t\ CO_2$ / 10^3 std cubic mt	$t\ CO_2$ / toe
		(with oxidation factor 0.995)		
National emission factors				
Coke oven gas, 1990-1999	47.200	46.964	0.835	1.965
Coke oven gas, 2000-2004	42.111	41.900	0.802	1.753
Coke oven gas, 2005	42.306	42.094	0.753	1.761
Coke oven gas, 2006	43.267	43.051	0.750	1.801
Coke oven gas, 2007	43.013	42.798	0.744	1.791
Coke oven gas, 2008	43.139	42.924	0.743	1.796
Coke oven gas, 2009	44.109	43.888	0.775	1.836
Coke oven gas, 2010	42.171	41.960	0.734	1.756

Source: ISPRA elaborations

Table A6.8 – Blast furnace gas, average carbon emission factors

Blast furnace gas	$t\ CO_2$ / TJ (stechiometric)	$t\ CO_2$ / TJ	$t\ CO_2$ / 10^3 std cubic mt	$t\ CO_2$ / toe
		(with oxidation factor 0.995)		
National emission factors				
Blast furnace gas, 1990-1999	243.220	242.004	0.780	10.125
Blast furnace gas, 2000-2004	270.575	269.222	0.948	11.264
Blast furnace gas, 2005	261.590	260.282	0.882	10.890
Blast furnace gas, 2006	257.939	256.650	0.862	10.738
Blast furnace gas, 2007	264.077	262.757	0.853	10.994
Blast furnace gas, 2008	259.115	257.819	0.846	10.787
Blast furnace gas, 2009	258.152	256.861	0.865	10.747
Blast furnace gas, 2010	260.483	259.181	0.860	10.844

Source: ISPRA elaborations

Table A6.9 – Oxygen furnace gas, average carbon emission factors

Oxygen furnace gas	$t\ CO_2$ / TJ (stechiometric)	$t\ CO_2$ / TJ	$t\ CO_2$ / 10^3 std cubic mt	$t\ CO_2$ / toe
		(with oxidation factor 0.995)		
National emission factors				
Oxygen furnace gas, 1990-2004	195.086	194.111	1.495	8.122
Oxygen furnace gas, 2005	197.579	196.591	1.514	8.225
Oxygen furnace gas, 2006	202.372	201.360	1.551	8.425
Oxygen furnace gas, 2007	195.871	194.892	1.501	8.154
Oxygen furnace gas, 2008	196.465	195.483	1.273	8.179
Oxygen furnace gas, 2009	196.970	195.986	1.277	8.200
Oxygen furnace gas, 2010	197.029	196.044	1.217	8.202

Source: ISPRA elaborations

Table A6.10 – Heavy residual fuels, average carbon emission factors

Heavy residual fuels	t CO_2 / TJ (stechiometric)	t CO_2 / TJ (with oxidation factor 0.99)	t CO_2 / t	t CO_2 / toe
National emission factors				
Heavy residual fuels, 1999-2005	80.317	79.514	3.121	3.327
Heavy residual fuels, 2006	81.817	80.999	3.179	3.389
Heavy residual fuels, 2007	81.823	81.005	3.179	3.389
Heavy residual fuels, 2008	81.823	81.005	3.179	3.389
Heavy residual fuels, 2009	79.319	78.526	3.082	3.286
Heavy residual fuels, 2010	79.259	78.466	3.085	3.283

Source: ISPRA elaborations

Table A6.11 – Synthesis gas, average carbon emission factors

Synthesis gas	t CO_2 / TJ (stechiometric)	Oxidation factor	t CO_2 / TJ	t CO_2 / t	t CO_2 / toe
National emission factors					
Synthesis gas, 1999-2004	96.800	1.000	96.800	0.895	4.050
Synthesis gas, 2005	98.103	0.994	97.527	0.927	4.080
Synthesis gas, 2006	98.566	0.994	97.958	1.032	4.099
Synthesis gas, 2007	98.321	0.992	97.545	0.899	4.081
Synthesis gas, 2008	98.860	0.992	98.085	0.961	4.104
Synthesis gas, 2009	97.555	0.990	96.579	0.947	4.041
Synthesis gas, 2010	101.930	0.990	100.911	0.902	4.222

Source: ISPRA elaborations

Table A6.12 – Residual gas of chemical processes, average carbon emission factors

Residual gas of chemical processes	t CO_2 / TJ (stechiometric)	Oxidation factor	t CO_2 / TJ	t CO_2 / t	t CO_2 / toe
National emission factors					
Residuals gas of chemical processes, 1990-2007	51.500	0.995	51.243	2.276	2.144
Residuals gas of chemical processes, 2008	51.308	0.995	51.052	2.485	2.136
Residuals gas of chemical processes, 2009	50.588	0.995	50.342	2.515	2.106
Residuals gas of chemical processes, 2010	50.425	0.996	50.209	2.527	2.101

Source: ISPRA elaborations

Table A6.13 – Petroleum coke, average carbon emission factors

Petroleum coke	t CO_2 / TJ (stechiometric)	Oxidation factor	t CO_2 / TJ	t CO_2 / t	t CO_2 / toe
National emission factors					
Petroleum coke, 1990-2004	100.762	0.990	99.755	3.464	4.174
Petroleum coke, 2005	92.955	0.998	92.787	3.169	3.882
Petroleum coke, 2006	93.290	0.998	93.118	3.192	3.896
Petroleum coke, 2007	93.428	0.998	93.244	3.188	3.901
Petroleum coke, 2008	93.531	0.998	93.351	3.200	3.906
Petroleum coke, 2009	93.722	0.991	92.881	3.177	3.886
Petroleum coke, 2010	94.023	0.990	93.104	3.199	3.895

Source: ISPRA elaborations

ANNEX 7: AGRICULTURE SECTOR

Additional information used for estimating categories 4A and 4B from the agriculture sector is reported in this section.

A7.1 Enteric fermentation (4A)

Following suggestions from the UNFCCC ERT the time series of the parameters used for estimating the Dairy Cattle EF using the Tier 2 approach, are reported in Table A.7.1 (UNFCCC, 2009). Information on the equations used for estimating the different net energy (NE_m, NE_g, etc.) is described in IPCC Good Practice (IPCC, 2000).

Table A.7.1 Parameters used for the Tier 2 approach - dairy cattle

	NE_m (MJ/day)	NE_a (MJ/day)	NE_g (MJ/day)	NE_l (MJ/day)	NE_w (MJ/day)	NE_p (MJ/day)	NE_{ma}/DE	NE_{ga}/DE	GE (MJ/day)
1990	40.75	0.35	0.99	33.52	0.00	3.97	0.51	0.31	**240.23**
1991	40.75	0.35	0.99	37.71	0.00	3.96	0.51	0.31	**252.77**
1992	40.75	0.35	0.99	40.42	0.00	3.91	0.51	0.31	**260.76**
1993	40.75	0.35	0.99	40.25	0.00	3.89	0.51	0.31	**260.17**
1994	40.75	0.35	0.99	42.53	0.00	3.92	0.51	0.31	**267.10**
1995	40.75	0.35	0.99	43.38	0.00	3.86	0.51	0.31	**269.45**
1996	40.75	0.35	0.99	45.11	0.00	3.86	0.51	0.31	**274.63**
1997	40.75	0.35	0.99	45.46	0.00	3.85	0.51	0.31	**275.65**
1998	40.75	0.35	0.99	45.25	0.00	3.79	0.51	0.31	**274.86**
1999	40.75	0.35	0.99	45.17	0.00	3.75	0.51	0.31	**274.47**
2000	40.75	0.35	0.99	44.31	0.00	3.78	0.51	0.31	**271.99**
2001	40.75	0.35	0.99	43.74	0.00	3.73	0.51	0.31	**270.14**
2002	40.75	0.35	0.99	47.60	0.00	3.72	0.51	0.31	**281.66**
2003	40.75	0.35	0.99	47.57	0.00	3.72	0.51	0.31	**281.56**
2004	40.75	0.35	0.99	49.68	0.00	3.66	0.51	0.31	**287.72**
2005	40.75	0.35	0.99	50.84	0.00	3.71	0.51	0.31	**291.34**
2006	40.75	0.35	0.99	51.17	0.00	3.67	0.51	0.31	**292.23**
2007	40.75	0.35	0.99	51.15	0.00	3.65	0.51	0.31	**292.09**
2008	40.75	0.35	0.99	52.43	0.00	3.65	0.51	0.31	**295.94**
2009	40.75	0.35	0.99	51.00	0.00	3.67	0.51	0.31	**291.71**
2010	40.75	0.35	0.99	55.30	0.00	3.67	0.51	0.31	**304.57**

Source: ISPRA elaborations

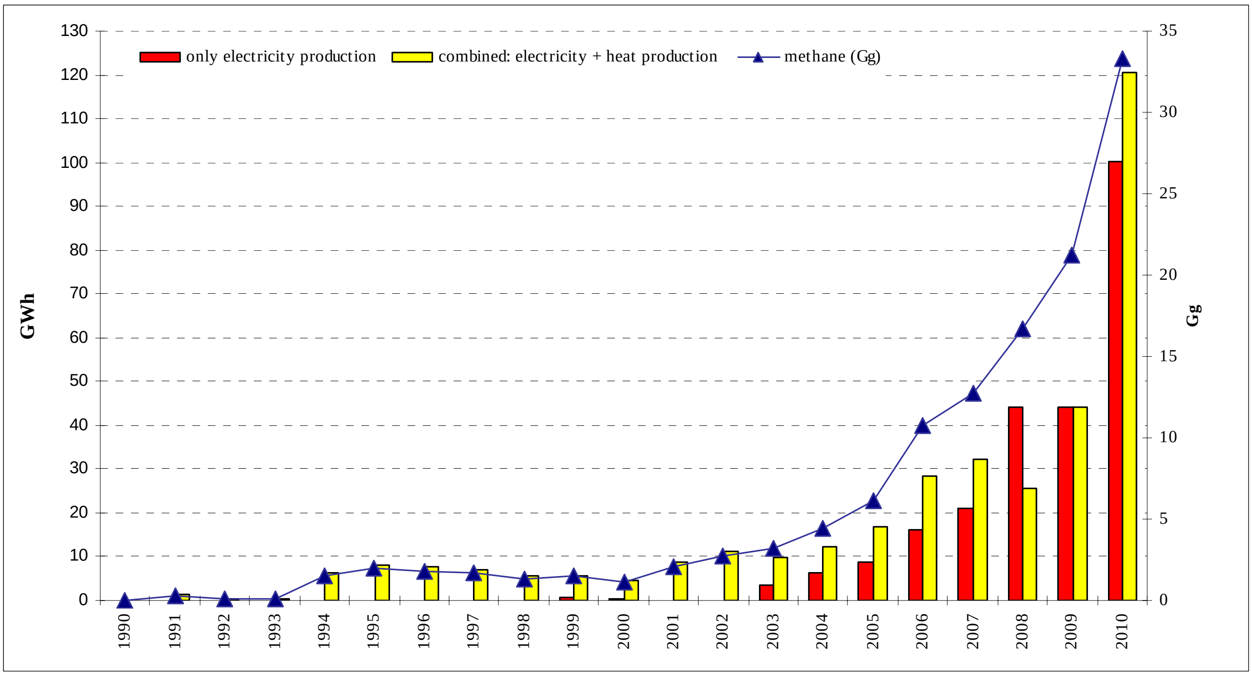
A7.2 Manure management (4B)

In this section the time series used to apply the methane emission reduction to the 4B Manure management category from the agriculture sector are reported. The source of information is the National Electric Network (TERNA, 2012). 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.

Table A.7.2 Time series of gross production of biogas from animal manure

	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**
2009	44.3	44.1	88.4	**21.20**
2010	100.3	120.7	221.0	**33.33**

Source: ISPRA elaboration on TERNA data



Source: ISPRA elaborations

Figure A7.1 Time series of gross production of biogas from animal manure

A7.3 Agricultural soils (4D)

In this section parameters used for estimating direct and indirect N_2O emissions from sewage sludge applied to soils are presented.

Table A.7.3 Time series of sewage sludge activity data

Year	**Total amount sewage sludge for agriculture** (t dry matter)	N content (%)	N sewage sludge (t)
1990	98,164	5.0	4,875
1991	102,840	5.0	5,107
1992	94,675	5.0	4,702
1993	90,039	5.0	4,472
1994	127,505	5.0	6,332
1995	157,512	5.0	7,823
1996	174,505	5.0	8,667
1997	217,747	5.0	10,814
1998	194,314	5.3	10,292
1999	215,024	4.0	8,706
2000	217,424	5.0	10,954
2001	293,253	5.5	16,076
2002	302,112	5.1	15,339
2003	297,861	4.9	14,648
2004	195,161	4.1	8,055
2005	215,742	4.1	8,874
2006	189,555	4.1	7,778
2007	202,098	4.1	8,305
2008	194,666	4.5	8,841
2009	289,620	3.9	11,365
2010	323,357	3.9	12,689

Source: ISPRA elaborations from MATTM (2010)

ANNEX 8: Additional information to be considered as part of the annual inventory submission and the *supplementary information required under Article 7, paragraph 1*, of the Kyoto Protocol or other useful reference information

A8.1 Annual inventory submission

This appendix shows a copy of Tables 10s1-10s5 from the Common Reporting Format 2010, submitted in 2012, 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 2010 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

Inventory 2010 Submission 2012 v1.2

CO_2

ITALY

(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)
1. Energy	**404,427.06**	**404,295.83**	**403,417.85**	**400,044.56**	**393,877.98**	**417,195.59**	**413,267.41**	**417,124.91**	**428,329.35**	**433,486.75**
A. Fuel Combustion (Sectoral Approach)	401,083.51	401,028.72	400,203.54	396,662.20	390,649.32	414,018.01	410,229.94	413,879.25	425,208.63	431,079.82
1. Energy Industries	136,502.92	130,586.47	130,325.22	124,848.67	127,316.71	139,841.41	135,043.26	137,027.71	148,064.92	145,892.04
2. Manufacturing Industries and Construction	85,631.02	83,254.32	81,799.00	82,283.79	83,364.06	85,244.42	83,434.52	86,038.11	79,650.53	81,429.60
3. Transport	101,268.85	103,786.58	108,033.55	109,632.46	109,239.86	111,445.03	112,669.95	114,359.93	118,142.99	119,687.91
4. Other Sectors	76,634.39	82,204.76	78,764.85	78,449.21	69,269.50	76,047.16	77,900.09	75,228.73	78,310.91	82,959.84
5. Other	1,046.34	1,196.59	1,280.93	1,448.07	1,459.19	1,439.99	1,182.11	1,224.77	1,039.27	1,110.43
B. Fugitive Emissions from Fuels	3,343.55	3,267.12	3,214.31	3,382.37	3,228.66	3,177.58	3,037.47	3,245.66	3,120.72	2,406.93
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2. Oil and Natural Gas	3,343.55	3,267.12	3,214.31	3,382.37	3,228.66	3,177.58	3,037.47	3,245.66	3,120.72	2,406.93
2. Industrial Processes	**28,434.49**	**27,992.04**	**28,539.49**	**25,278.77**	**24,204.52**	**26,037.93**	**23,490.76**	**23,616.25**	**23,645.56**	**23,775.07**
A. Mineral Products	21,302.86	21,256.87	22,067.74	19,612.09	19,121.11	20,976.08	19,282.70	19,528.94	19,787.55	20,595.65
B. Chemical Industry	3,253.76	3,110.90	3,048.80	2,115.60	1,650.97	1,659.19	1,250.42	1,358.27	1,337.32	1,224.53
C. Metal Production	3,877.87	3,624.28	3,422.94	3,551.09	3,432.45	3,402.65	2,957.64	2,729.04	2,520.69	1,954.89
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	1,642.80	1,628.14	1,629.14	1,577.88	1,504.86	1,463.35	1,405.30	1,416.58	1,332.27	1,336.49
4. Agriculture										
A. Enteric Fermentation										

Table A8.1.1.1 CO_2 emissions trends, CRF year 2010 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

CO_2

(Part 1 of 2)

Inventory 2010
Submission 2012 v1.2
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
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)										
A. Forest Land	**-34,757.76**	**-45,031.61**	**-44,678.73**	**-30,635.48**	**-44,699.28**	**-48,219.53**	**-48,860.19**	**-38,249.65**	**-37,259.46**	**-42,878.76**
B. Cropland	-18,484.17	-32,867.18	-31,462.73	-19,564.40	-31,832.68	-35,402.77	-34,898.86	-26,109.59	-24,554.42	-30,735.69
C. Grassland	-18,320.48	-13,108.90	-14,523.31	-13,659.57	-13,883.24	-12,849.91	-14,274.70	-12,657.05	-13,359.34	-11,313.67
D. Wetlands	-479.96	-1,576.46	-1,214.67	66.47	-1,506.44	-2,492.27	-2,159.42	-1,957.24	-1,821.21	-3,306.72
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
F. Other Land	2,526.85	2,520.93	2,521.99	2,522.02	2,523.08	2,525.43	2,472.79	2,474.23	2,475.52	2,477.32
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Waste	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
A. Solid Waste Disposal on Land	**507.18**	**531.86**	**531.33**	**491.25**	**494.32**	**453.89**	**453.58**	**477.66**	**470.17**	**393.47**
B. Waste-water Handling										
C. Waste Incineration	507.18	531.86	531.33	491.25	494.32	453.89	453.58	477.66	470.17	393.47
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Table A8.1.1.1 CO_2 emissions trends, CRF year 2010 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

CO_2

(Part 1 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Total CO_2 emissions including net CO_2 from LULUCF	**400,253.78**	**389,416.27**	**389,439.09**	**396,756.98**	**375,382.40**	**396,931.23**	**389,756.87**	**404,385.75**	**416,517.90**	**416,113.02**
Total CO_2 emissions excluding net CO_2 from LULUCF	**435,011.53**	**434,447.87**	**434,117.81**	**427,392.46**	**420,081.68**	**445,150.76**	**438,617.06**	**442,635.40**	**453,777.35**	**458,991.78**
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 2010 (years 2000 – 2010)

TABLE 10 EMISSION TRENDS

CO_2

(Part 2 of 2)

Inventory 2010
Submission 2012 v1.2
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**436,436.68**	**441,555.17**	**443,763.30**	**458,603.47**	**460,577.78**	**459,446.84**	**454,855.51**	**446,317.07**	**437,477.42**	**394,007.05**	**404,020.67**	**-0.10**
A. Fuel Combustion (Sectoral Approach)	433,848.86	439,112.37	441,498.39	455,763.78	458,423.53	457,329.90	452,661.84	444,136.30	435,213.09	391,836.95	401,698.61	0.15
1. Energy Industries	151,893.98	154,498.04	161,400.59	161,982.20	159,962.44	159,755.81	161,068.85	160,869.58	156,217.34	131,153.20	132,633.94	-2.83
2. Manufacturing Industries and Construction	82,451.84	80,711.99	76,797.12	82,388.42	83,191.51	78,704.77	77,479.71	74,198.65	70,866.22	54,650.44	60,015.69	-29.91
3. Transport	120,100.81	122,177.89	124,138.07	125,097.18	127,081.10	125,824.54	127,145.29	127,209.39	122,272.57	117,896.87	117,383.75	15.91
4. Other Sectors	78,596.13	81,370.50	78,849.04	85,635.83	87,097.49	91,847.10	85,986.38	80,962.50	85,119.19	87,292.10	91,037.74	18.79
5. Other	806.10	353.94	313.56	660.15	1,090.98	1,197.69	981.61	896.19	737.77	844.34	627.48	-40.03
B. Fugitive Emissions from Fuels	2,587.83	2,442.81	2,264.92	2,839.69	2,154.25	2,116.94	2,193.67	2,180.77	2,264.33	2,170.11	2,322.06	-30.55
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
2. Oil and Natural Gas	2,587.83	2,442.81	2,264.92	2,839.69	2,154.25	2,116.94	2,193.67	2,180.77	2,264.33	2,170.11	2,322.06	-30.55
2. Industrial Processes	**24,570.91**	**25,391.76**	**25,380.25**	**26,542.68**	**27,404.60**	**27,186.45**	**27,205.40**	**27,684.14**	**25,066.08**	**20,078.04**	**20,804.08**	**-26.84**
A. Mineral Products	21,455.32	22,329.47	22,392.53	23,310.95	23,896.04	23,480.87	23,536.18	24,000.38	21,702.53	17,593.58	17,675.81	-17.03
B. Chemical Industry	1,361.64	1,345.67	1,426.49	1,679.37	1,838.90	1,783.68	1,727.00	1,759.05	1,488.19	1,177.67	1,662.94	-48.89
C. Metal Production	1,753.95	1,716.63	1,561.23	1,552.36	1,669.66	1,921.91	1,942.23	1,924.71	1,875.37	1,306.80	1,465.33	-62.21
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
E. Production of Halocarbons and SF_6												
F. Consumption of Halocarbons and SF_6												
G. Other	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	0.00
3. Solvent and Other Product Use	1,275.92	1,286.13	1,290.29	1,295.50	1,299.51	1,304.06	1,314.05	1,277.82	1,218.61	1,131.01	1,031.78	-37.19
4. Agriculture												

Table A8.1.1.2 CO_2 emissions trends, CRF year 2010 (years 2000 – 2010)

Inventory 2010
Submission 2012 v1.2
ITALY

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	2009	2010	Change from base to latest reported year
	(Gg)	(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)]	**-43,203.66**	**-49,620.00**	**-54,918.73**	**-47,489.87**	**-51,033.24**	**-53,655.14**	**-55,036.54**	**-35,747.64**	**-52,239.28**	**-56,021.66**	**-56,658.65**	**63.01**
A. Forest Land	-29,462.47	-36,284.46	-40,576.08	-33,509.77	-38,770.88	-39,870.81	-40,301.88	-22,364.40	-36,618.67	-40,206.95	-39,947.42	116.12
B. Cropland	-13,043.58	-12,507.38	-12,979.65	-12,644.54	-10,365.32	-11,532.32	-11,863.72	-12,297.81	-12,140.84	-12,161.74	-12,457.66	-32.00
C. Grassland	-3,177.73	-4,160.04	-4,702.07	-4,681.42	-5,250.20	-5,613.88	-6,241.23	-4,462.88	-6,879.66	-7,061.93	-7,657.83	1,495.52
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
E. Settlements	2,480.12	3,331.88	3,339.08	3,345.87	3,353.16	3,361.87	3,370.29	3,377.45	3,399.90	3,408.96	3,404.27	34.72
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
6. Waste	**201.57**	**222.26**	**170.87**	**196.81**	**180.11**	**225.56**	**238.76**	**206.76**	**200.03**	**218.37**	**230.11**	**-54.63**
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	NA,NO	0.00
B. Waste-water Handling												
C. Waste Incineration	201.57	222.26	170.87	196.81	180.11	225.56	238.76	206.76	200.03	218.37	230.11	-54.63
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**

Table A8.1.1.2 CO_2 emissions trends, CRF year 2010 (years 2000 – 2010)

TABLE 10 EMISSION TRENDS

CO_2

(Part 2 of 2)

Inventory 2010
Submission 2012 v1.2

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Total CO_2 emissions including net CO_2 from LULUCF	**419,281.43**	**418,835.32**	**415,685.99**	**439,148.59**	**438,428.76**	**434,507.77**	**428,577.17**	**439,738.16**	**411,722.88**	**359,412.82**	**369,428.00**	**-7.70**
Total CO_2 emissions excluding net CO_2 from LULUCF	**462,485.09**	**468,455.33**	**470,604.71**	**486,638.46**	**489,462.00**	**488,162.90**	**483,613.72**	**475,485.80**	**463,962.15**	**415,434.48**	**426,086.64**	**-2.05**
Memo Items:												
International Bunkers	**12,196.09**	**12,824.92**	**12,862.42**	**14,809.34**	**15,426.56**	**16,029.88**	**17,274.95**	**18,185.82**	**18,524.22**	**16,225.87**	**16,449.09**	**92.39**
Aviation	8,015.50	8,011.06	7,312.69	8,526.80	8,620.09	9,110.86	9,833.14	10,430.30	10,087.15	8,968.33	9,440.35	126.89
Marine	4,180.59	4,813.86	5,549.73	6,282.54	6,806.47	6,919.02	7,441.81	7,755.53	8,437.07	7,257.54	7,008.74	59.68
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
CO_2 Emissions from Biomass	9,381.98	10,788.05	11,708.03	13,916.03	16,714.69	16,179.57	17,377.82	20,247.56	23,170.72	26,278.62	26,128.82	398.27

Table A8.1.2.1 CH_4 emission trends, CRF year 2010 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

CH_4

(Part 1 of 2)

Inventory
2010
Submission
2012 v1.2

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	421.54	422.73	427.82	422.54	413.85	402.96	395.60	394.52	396.76	386.64
A. Fuel Combustion (Sectoral Approach)	68.22	71.35	74.03	74.26	74.60	75.25	73.16	73.80	71.88	71.17
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	37.23	39.23	41.80	43.30	41.87	41.37	40.27	38.79	37.04	34.63
4. Other Sectors	14.73	16.33	16.95	15.98	17.53	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	**825.23**	**834.15**	**812.42**	**809.54**	**811.49**	**824.63**	**827.66**	**827.88**	**821.36**	**827.92**

Table A8.1.2.1 CH_4 emission trends, CRF year 2010 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

CH_4

(Part 1 of 2)

Inventory 2010
Submission 2012 v1.2
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
A. Enteric Fermentation	584.69	597.01	578.70	572.58	577.53	587.98	591.74	593.23	589.27	595.82
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	75.06	71.64	74.39	78.00	79.98	79.56	78.37	77.82	73.50	72.00
D. Agricultural Soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
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	**8.70**	**2.66**	**3.95**	**10.01**	**4.16**	**1.87**	**1.79**	**5.55**	**6.38**	**3.54**
A. Forest Land	8.70	2.66	3.95	10.01	4.16	1.87	1.79	5.55	6.38	3.54
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**828.79**	**881.82**	**831.23**	**830.00**	**855.15**	**876.10**	**913.33**	**940.49**	**940.70**	**955.23**
A. Solid Waste Disposal on Land	726.38	768.40	717.80	712.65	737.49	757.56	795.95	819.36	820.62	832.10
B. Waste-water Handling	94.76	98.63	101.80	104.73	105.83	105.62	106.46	107.85	108.27	108.66
C. Waste Incineration	7.65	14.78	11.61	12.61	11.81	12.91	10.89	13.24	11.75	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 A8.1.2.1 CH_4 emission trends, CRF year 2010 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

CH_4

(Part 1 of 2)

Inventory 2010
Submission 2012 v1.2
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Total CH_4 emissions including CH_4 from LULUCF	**2,089.43**	**2,146.32**	**2,080.25**	**2,076.96**	**2,089.72**	**2,110.93**	**2,141.37**	**2,171.68**	**2,168.31**	**2,176.37**
Total CH_4 emissions excluding CH_4 from LULUCF	**2,080.72**	**2,143.65**	**2,076.30**	**2,066.95**	**2,085.56**	**2,109.05**	**2,139.58**	**2,166.12**	**2,161.93**	**2,172.84**
Memo Items:										
International Bunkers	0.47	0.39	0.38	0.41	0.41	0.45	0.34	0.37	0.39	0.41
Aviation	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.08	0.09
Marine	0.42	0.34	0.33	0.35	0.35	0.39	0.27	0.29	0.31	0.32
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass										

Table A8.1.2.2 CH_4 emission trends, CRF year 2010 (years 2000 – 2010)

TABLE 10 EMISSION TRENDS

CH_4

(Part 2 of 2)

Inventory 2010
Submission 2012 v1.2
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	372.92	355.79	353.83	347.93	342.37	338.27	313.02	312.92	316.09	310.20	319.74	-24.15
A. Fuel Combustion (Sectoral Approach)	67.03	66.81	66.39	66.80	69.32	66.37	67.51	74.19	74.50	74.59	77.27	13.27
1. Energy Industries	6.85	5.95	5.92	6.14	6.21	6.34	6.17	5.72	5.65	5.16	4.95	-46.56
2. Manufacturing Industries and Construction	5.72	5.79	5.69	5.83	5.76	6.28	6.24	6.53	6.24	4.18	5.51	-19.21
3. Transport	31.52	29.60	27.53	25.36	22.88	20.82	19.53	18.32	16.97	16.00	15.41	-58.60
4. Other Sectors	22.81	25.39	27.19	29.37	34.34	32.78	35.45	43.52	45.56	49.18	51.33	248.54
5. Other	0.13	0.09	0.07	0.10	0.14	0.16	0.13	0.11	0.07	0.07	0.06	-62.61
B. Fugitive Emissions from Fuels	305.89	288.98	287.44	281.13	273.05	271.90	245.51	238.73	241.59	235.60	242.47	-31.38
1. Solid Fuels	3.48	3.85	3.72	4.50	3.05	3.27	2.56	4.00	3.45	2.12	3.10	-46.45
2. Oil and Natural Gas	302.41	285.13	283.72	276.62	270.00	268.62	242.94	234.73	238.13	233.48	239.37	-31.12
2. Industrial Processes	**3.01**	**2.83**	**2.71**	**2.77**	**2.91**	**3.06**	**3.14**	**3.08**	**2.91**	**1.82**	**2.50**	**-51.50**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
B. Chemical Industry	0.40	0.33	0.33	0.31	0.33	0.33	0.32	0.34	0.30	0.28	0.33	-86.53
C. Metal Production	2.61	2.50	2.38	2.46	2.58	2.72	2.81	2.75	2.61	1.54	2.17	-19.79
D. Other Production												
E. Production of Halocarbons and SF_6												
F. Consumption of Halocarbons and SF_6												
G. Other	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	0.00
3. Solvent and Other Product Use												
4. Agriculture	**806.07**	**769.87**	**753.47**	**755.63**	**743.26**	**740.39**	**724.51**	**746.73**	**731.24**	**736.04**	**708.43**	**-14.15**
A. Enteric Fermentation	583.14	543.96	528.92	530.19	519.41	519.73	509.48	528.51	523.60	524.14	511.05	-12.60

Table A8.1.2.2 CH_4 emission trends, CRF year 2010 (years 2000 – 2010)

TABLE 10 EMISSION TRENDS

CH_4

(Part 2 of 2)

Inventory 2010
Submission 2012 v1.2
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
B. Manure Management	156.10	159.19	155.42	154.89	150.14	149.93	144.20	145.43	140.99	136.79	122.25	-25.84
C. Rice Cultivation	66.26	66.19	68.52	70.00	73.04	70.11	70.23	72.18	65.99	74.51	74.54	-0.70
D. Agricultural Soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field Burning of Agricultural Residues	0.58	0.53	0.60	0.55	0.67	0.62	0.60	0.61	0.65	0.60	0.59	-4.61
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
5. Land Use, Land-Use Change and Forestry	**5.03**	**3.30**	**1.84**	**3.86**	**2.28**	**2.29**	**1.82**	**11.71**	**2.75**	**3.27**	**2.06**	**-76.31**
A. Forest Land	5.03	3.30	1.84	3.86	2.28	2.29	1.82	11.71	2.75	3.27	2.06	-76.31
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
6. Waste	**998.92**	**999.72**	**978.24**	**936.36**	**889.24**	**882.79**	**851.28**	**819.77**	**779.65**	**773.79**	**757.62**	**-8.59**
A. Solid Waste Disposal on Land	874.15	869.64	844.96	800.29	746.31	738.78	707.20	675.89	636.40	630.32	613.89	-15.49
B. Waste-water Handling	112.73	116.97	120.53	123.05	126.55	129.67	130.40	130.77	129.62	129.66	131.04	38.29
C. Waste Incineration	11.94	12.98	12.59	12.85	16.20	14.14	13.46	12.89	13.43	13.59	12.44	62.74
D. Other	0.10	0.12	0.16	0.18	0.18	0.20	0.21	0.22	0.21	0.21	0.25	2,210.84
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**

Table A8.1.2.2 CH_4 emission trends, CRF year 2010 (years 2000 – 2010)

TABLE 10 EMISSION TRENDS

CH_4

(Part 2 of 2)

Inventory 2010
Submission 2012 v1.2
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Total CH_4 emissions including CH_4 from LULUCF	**2,185.95**	**2,131.51**	**2,090.08**	**2,046.54**	**1,980.06**	**1,966.80**	**1,893.77**	**1,894.22**	**1,832.64**	**1,825.11**	**1,790.35**	**-14.31**
Total CH_4 emissions excluding CH_4 from LULUCF	**2,180.92**	**2,128.20**	**2,088.24**	**2,042.68**	**1,977.78**	**1,964.51**	**1,891.95**	**1,882.51**	**1,829.89**	**1,821.84**	**1,788.29**	**-14.05**
Memo Items:												
International Bunkers	0.51	0.58	0.65	0.74	0.80	0.83	0.88	0.87	0.93	0.81	0.79	69.06
Aviation	0.11	0.12	0.12	0.14	0.15	0.17	0.17	0.13	0.12	0.12	0.12	154.86
Marine	0.40	0.46	0.53	0.60	0.65	0.66	0.71	0.74	0.81	0.69	0.67	59.53
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
CO_2 Emissions from Biomass												

Table A8.1.3.1 N_2O emission trends, CRF year 2010 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

N_2O

(Part 1 of 2)

Inventory 2010
Submission 2012 v1.2
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**14.69**	**14.67**	**15.00**	**16.03**	**19.02**	**21.94**	**23.95**	**24.62**	**25.02**	**25.21**
A. Fuel Combustion (Sectoral Approach)	14.65	14.63	14.96	15.99	18.98	21.90	23.91	24.58	24.97	25.17
1. Energy Industries	1.67	1.58	1.55	1.47	1.49	1.67	1.61	1.61	1.64	1.58
2. Manufacturing Industries and Construction	4.93	4.89	4.90	4.51	4.47	4.52	4.42	4.47	4.49	4.51
3. Transport	3.31	3.49	3.75	4.96	8.10	10.62	12.76	13.39	13.68	13.80
4. Other Sectors	4.51	4.43	4.52	4.78	4.66	4.88	4.93	4.88	4.99	5.13
5. Other	0.23	0.24	0.24	0.28	0.25	0.21	0.18	0.21	0.17	0.14
B. Fugitive Emissions from Fuels	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2. Oil and Natural Gas	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2. Industrial Processes	**21.54**	**22.81**	**21.11**	**21.65**	**20.36**	**23.35**	**22.66**	**22.78**	**23.06**	**23.56**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry	21.54	22.81	21.11	21.65	20.36	23.35	22.66	22.78	23.06	23.56
C. Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	2.62	2.47	2.46	2.50	2.46	2.49	2.96	2.96	3.40	3.33
4. Agriculture	**75.51**	**77.43**	**77.22**	**78.38**	**76.62**	**74.88**	**73.95**	**77.31**	**75.36**	**76.10**
A. Enteric Fermentation										
B. Manure Management	12.65	12.63	12.09	11.98	11.93	12.20	12.34	12.44	12.70	12.89
C. Rice Cultivation										
D. Agricultural Soils	62.84	64.79	65.12	66.39	64.67	62.67	61.60	64.86	62.65	63.20

Table A8.1.3.1 N_2O emission trends, CRF year 2010 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

N_2O

(Part 1 of 2)

Inventory 2010
Submission 2012 v1.2
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
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	**0.29**	**0.29**	**0.29**	**0.30**	**0.29**	**0.29**	**0.26**	**0.22**	**0.18**	**0.14**
A. Forest Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Cropland	0.29	0.29	0.29	0.29	0.29	0.29	0.25	0.22	0.18	0.14
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**6.19**	**6.47**	**6.32**	**6.19**	**6.18**	**6.15**	**6.25**	**6.29**	**6.40**	**6.64**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	5.91	5.98	5.92	5.78	5.79	5.74	5.89	5.86	6.02	6.18
C. Waste Incineration	0.28	0.49	0.40	0.42	0.39	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	**120.84**	**124.14**	**122.41**	**125.05**	**124.93**	**129.11**	**130.02**	**134.18**	**133.42**	**134.97**
Total N_2O emissions excluding N_2O from LULUCF	**120.54**	**123.85**	**122.11**	**124.75**	**124.64**	**128.82**	**129.76**	**133.96**	**133.24**	**134.83**
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

Table A8.1.3.1 N_2O emission trends, CRF year 2010 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

N_2O

(Part 1 of 2)

Inventory
2010
Submission
2012 v1.2

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass										

Table A8.1.3.2 N_2O emission trends, CRF year 2010 (years 2000 – 2010)

TABLE 10 EMISSION TRENDS

N_2O

(Part 2 of 2)

Inventory 2010
Submission 2012 v1.2
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**17.42**	**17.66**	**17.70**	**17.99**	**18.43**	**17.15**	**17.36**	**17.41**	**16.81**	**16.10**	**16.10**	**9.61**
A. Fuel Combustion (Sectoral Approach)	17.38	17.62	17.65	17.94	18.38	17.11	17.32	17.36	16.77	16.06	16.06	9.64
1. Energy Industries	1.67	1.75	1.82	1.84	1.91	1.90	1.89	1.87	1.88	1.67	1.67	0.08
2. Manufacturing Industries and Construction	4.66	4.74	4.77	4.93	5.03	5.02	5.05	4.98	4.64	3.98	4.01	-18.66
3. Transport	5.80	5.73	5.62	5.34	5.23	3.93	4.19	4.14	3.83	3.69	3.68	11.14
4. Other Sectors	5.11	5.37	5.42	5.70	5.93	5.96	5.95	6.15	6.22	6.47	6.57	45.53
5. Other	0.14	0.03	0.02	0.13	0.28	0.29	0.24	0.23	0.20	0.24	0.13	-41.90
B. Fugitive Emissions from Fuels	0.04	0.04	0.04	0.04	0.04	0.05	0.04	0.04	0.04	0.04	0.04	0.98
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
2. Oil and Natural Gas	0.04	0.04	0.04	0.04	0.04	0.05	0.04	0.04	0.04	0.04	0.04	0.98
2. Industrial Processes	**25.54**	**26.55**	**25.49**	**24.38**	**27.24**	**25.03**	**8.54**	**6.10**	**3.44**	**3.64**	**2.09**	**-90.31**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
B. Chemical Industry	25.54	26.55	25.49	24.38	27.24	25.03	8.54	6.10	3.44	3.64	2.09	-90.31
C. Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
D. Other Production												
E. Production of Halocarbons and SF_6												
F. Consumption of Halocarbons and SF_6												
G. Other	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	0.00
3. Solvent and Other Product Use	3.31	3.00	3.00	2.81	2.73	2.66	2.61	2.54	2.35	2.21	2.02	-22.87
4. Agriculture	**74.86**	**74.30**	**73.15**	**72.49**	**72.34**	**70.37**	**69.52**	**69.99**	**66.64**	**62.32**	**60.85**	**-19.41**
A. Enteric Fermentation												

Table A8.1.3.2 N_2O emission trends, CRF year 2010 (years 2000 – 2010)

TABLE 10 EMISSION TRENDS

N_2O

(Part 2 of 2)

Inventory 2010
Submission 2012 v1.2
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
B. Manure Management	12.46	12.91	12.42	12.33	11.98	11.96	11.61	12.19	12.18	12.30	11.94	-5.62
C. Rice Cultivation												
D. Agricultural Soils	62.39	61.38	60.72	60.15	60.34	58.39	57.89	57.79	54.45	50.01	48.90	-22.19
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field Burning of Agricultural Residues	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-1.86
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
5. Land Use, Land-Use Change and Forestry	**0.10**	**0.10**	**0.10**	**0.10**	**0.10**	**0.10**	**0.08**	**0.07**	**0.04**	**0.02**	**0.27**	**-6.52**
A. Forest Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-76.31
B. Cropland	0.10	0.10	0.10	0.10	0.10	0.10	0.08	0.06	0.04	0.02	0.27	-5.86
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
6. Waste	**6.57**	**6.44**	**6.42**	**6.40**	**6.62**	**6.57**	**6.55**	**6.57**	**6.74**	**6.74**	**6.74**	**8.84**
A. Solid Waste Disposal on Land												
B. Waste-water Handling	6.21	6.04	6.05	6.02	6.15	6.15	6.15	6.18	6.34	6.34	6.37	7.79
C. Waste Incineration	0.36	0.39	0.37	0.38	0.47	0.42	0.40	0.38	0.39	0.40	0.37	30.90
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**

Table A8.1.3.2 N_2O emission trends, CRF year 2010 (years 2000 – 2010)

TABLE 10 EMISSION TRENDS

N_2O

(Part 2 of 2)

Inventory 2010
Submission 2012 v1.2
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Total N_2O emissions including N_2O from LULUCF	**127.81**	**128.06**	**125.86**	**124.17**	**127.45**	**121.88**	**104.66**	**102.67**	**96.01**	**91.03**	**88.07**	**-27.11**
Total N_2O emissions excluding N_2O from LULUCF	**127.71**	**127.96**	**125.76**	**124.07**	**127.35**	**121.78**	**104.58**	**102.61**	**95.97**	**91.00**	**87.80**	**-27.16**
Memo Items:												
International Bunkers	**0.35**	**0.36**	**0.35**	**0.37**	**0.38**	**0.39**	**0.41**	**0.44**	**0.45**	**0.41**	**0.40**	**74.53**
Aviation	0.25	0.24	0.21	0.21	0.21	0.21	0.22	0.24	0.24	0.22	0.23	88.54
Marine	0.11	0.12	0.14	0.16	0.17	0.18	0.19	0.20	0.21	0.18	0.18	59.53
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
CO_2 Emissions from Biomass												

Table A8.1.4.1 HFC, PFC and SF_6 emission trends, CRF year 2010 (1990 – 1999)

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 1 of 2)

Inventory 2010
Submission 2012 v1.2
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs[(3)] - (Gg CO_2 equivalent)	**351.00**	**355.43**	**358.78**	**355.42**	**481.90**	**671.29**	**450.33**	**755.74**	**1,181.72**	**1,523.65**
HFC-23	0.03	0.03	0.03	0.03	0.03	0.03	0.00	0.00	0.00	0.00
HFC-32	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00	0.02	0.05
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-125	NA,NO	0.00	0.00	0.00	0.00	0.01	0.01	0.04	0.05	0.08
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-134a	NA,NO	0.00	0.00	0.00	0.10	0.20	0.29	0.43	0.68	0.85
HFC-152a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.01	0.01	0.02	0.03	0.03
HFC-227ea	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00	0.00	0.01
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed HFCs[(4)] - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of PFCs[(3)] - (Gg CO_2 equivalent)	**2,486.74**	**2,149.93**	**1,567.24**	**1,444.45**	**1,233.11**	**1,266.38**	**1,038.26**	**1,066.25**	**1,103.90**	**1,110.77**
CF_4	0.32	0.28	0.21	0.20	0.17	0.17	0.15	0.15	0.16	0.16
C_2F_6	0.05	0.04	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
C_3F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO

Table A8.1.4.1 HFC, PFC and SF_6 emission trends, CRF year 2010 (1990 – 1999)

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 1 of 2)

Inventory 2010
Submission 2012 v1.2

ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
c-C_4F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed PFCs(4) - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of SF6(3) - (Gg CO_2 equivalent)	**332.92**	**356.39**	**358.26**	**370.40**	**415.66**	**601.45**	**682.56**	**728.64**	**604.81**	**404.51**
SF_6	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.02

Table A8.1.4.2 HFC, PFC and SF_6 emission trends, CRF year 2010 (2000 – 2010)

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 2 of 2)

Inventory 2010
Submission 2012 v1.2
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Emissions of HFCs(3) - (Gg CO_2 equivalent)	**1,985.67**	**2,549.75**	**3,191.29**	**3,901.91**	**4,635.03**	**5,400.56**	**6,106.19**	**6,855.26**	**7,512.98**	**8,163.94**	**8,755.35**	**2,394.40**
HFC-23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-90.19
HFC-32	0.08	0.12	0.17	0.23	0.29	0.36	0.43	0.49	0.55	0.60	0.66	100.00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-125	0.13	0.20	0.28	0.38	0.48	0.59	0.69	0.79	0.89	0.98	1.08	100.00
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-134a	1.01	1.19	1.31	1.50	1.67	1.83	1.96	2.14	2.26	2.39	2.47	100.00
HFC-152a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-143a	0.06	0.08	0.11	0.15	0.19	0.24	0.28	0.32	0.36	0.40	0.44	100.00
HFC-227ea	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.05	0.06	100.00
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Unspecified mix of listed HFCs(4) - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Emissions of PFCs(3) - (Gg CO_2 equivalent)	**1,217.43**	**1,342.04**	**1,333.92**	**1,676.71**	**1,733.21**	**1,715.00**	**1,713.61**	**1,652.10**	**1,500.59**	**1,062.81**	**1,330.83**	**-46.48**
CF_4	0.17	0.18	0.18	0.23	0.25	0.25	0.25	0.25	0.22	0.16	0.20	-38.27
C_2F_6	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	-92.12
C_3F_8	NA,NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
$c-C_4F_8$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00

Table A8.1.4.2 HFC, PFC and SF_6 emission trends, CRF year 2010 (2000 – 2010)

TABLE 10 EMISSION TRENDS

HFCs, PFCs and SF_6

(Part 2 of 2)

Inventory 2010
Submission 2012 v1.2
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Unspecified mix of listed PFCs(4) - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Emissions of SF6(3) - (Gg CO_2 equivalent)	**493.43**	**795.34**	**739.72**	**467.56**	**502.14**	**465.39**	**405.87**	**427.55**	**435.53**	**398.02**	**373.27**	**12.12**
SF_6	0.02	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	12.12

Table A8.1.5.1 Total emission trends, CRF year 2010 (years 1990 – 1999)

TABLE 10 EMISSION TRENDS

SUMMARY

(Part 1 of 2)

Inventory 2010
Submission 2012 v1.2
ITALY

GREENHOUSE GAS EMISSIONS	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)
CO_2 emissions including net CO_2 from LULUCF	400,253.78	389,416.27	389,439.09	396,756.98	375,382.40	396,931.23	389,756.87	404,385.75	416,517.90	416,113.02
CO_2 emissions excluding net CO_2 from LULUCF	435,011.53	434,447.87	434,117.81	427,392.46	420,081.68	445,150.76	438,617.06	442,635.40	453,777.35	458,991.78
CH_4 emissions including CH_4 from LULUCF	43,877.95	45,072.67	43,685.16	43,616.12	43,884.05	44,329.52	44,968.81	45,605.25	45,534.61	45,703.81
CH_4 emissions excluding CH_4 from LULUCF	43,695.15	45,016.73	43,602.26	43,405.93	43,796.72	44,290.15	44,931.27	45,488.60	45,400.62	45,629.56
N_2O emissions including N_2O from LULUCF	37,459.01	38,483.85	37,946.22	38,764.06	38,728.73	40,024.58	40,306.00	41,595.14	41,359.80	41,841.90
N_2O emissions excluding N_2O from LULUCF	37,368.25	38,393.47	37,855.51	38,672.55	38,637.58	39,933.45	40,226.80	41,527.49	41,303.99	41,798.29
HFCs	351.00	355.43	358.78	355.42	481.90	671.29	450.33	755.74	1,181.72	1,523.65
PFCs	2,486.74	2,149.93	1,567.24	1,444.45	1,233.11	1,266.38	1,038.26	1,066.25	1,103.90	1,110.77
SF_6	332.92	356.39	358.26	370.40	415.66	601.45	682.56	728.64	604.81	404.51
Total (including LULUCF)	**484,761.39**	**475,834.53**	**473,354.75**	**481,307.43**	**460,125.85**	**483,824.46**	**477,202.83**	**494,136.76**	**506,302.73**	**506,697.65**
Total (excluding LULUCF)	**519,245.60**	**520,719.82**	**517,859.87**	**511,641.21**	**504,646.65**	**531,913.48**	**525,946.27**	**532,202.11**	**543,372.39**	**549,458.56**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)
1. Energy	417,833.09	417,721.74	417,052.21	413,887.28	408,463.51	432,460.47	428,998.64	433,041.26	444,417.06	449,420.52
2. Industrial Processes	38,389.92	38,028.62	37,469.02	34,263.50	32,752.96	35,928.88	32,749.71	33,297.42	33,749.64	34,180.85
3. Solvent and Other Product Use	2,455.02	2,393.84	2,392.69	2,351.69	2,267.92	2,234.94	2,321.81	2,333.28	2,386.93	2,369.79
4. Agriculture	40,736.72	41,519.92	41,000.13	41,296.96	40,793.91	40,529.50	40,306.09	41,352.49	40,609.64	40,976.61
5. Land Use, Land-Use Change and Forestry(5)	-34,484.21	-44,885.29	-44,505.12	-30,333.78	-44,520.80	-48,089.02	-48,743.44	-38,065.35	-37,069.66	-42,760.91
6. Waste	19,830.85	21,055.71	19,945.81	19,841.78	20,368.36	20,759.69	21,570.02	22,177.67	22,209.11	22,510.78
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)(5)	**484,761.39**	**475,834.53**	**473,354.75**	**481,307.43**	**460,125.85**	**483,824.46**	**477,202.83**	**494,136.76**	**506,302.73**	**506,697.65**

Table A8.1.5.2 Total emission trends, CRF year 2010 (years 2000 – 2010)

TABLE 10 EMISSION TRENDS

SUMMARY

(Part 2 of 2)

Inventory
2010
Submission
2012 v1.2
ITALY

GREENHOUSE GAS EMISSIONS	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change from base to latest reported year
	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	(%)
CO_2 emissions including net CO_2 from LULUCF	419,281.43	418,835.32	415,685.99	439,148.59	438,428.76	434,507.77	428,577.17	439,738.16	411,722.88	359,412.82	369,428.00	-7.70
CO_2 emissions excluding net CO_2 from LULUCF	462,485.09	468,455.33	470,604.71	486,638.46	489,462.00	488,162.90	483,613.72	475,485.80	463,962.15	415,434.48	426,086.64	-2.05
CH_4 emissions including CH_4 from LULUCF	45,905.05	44,761.61	43,891.73	42,977.29	41,581.23	41,302.80	39,769.21	39,778.64	38,485.45	38,327.36	37,597.36	-14.31
CH_4 emissions excluding CH_4 from LULUCF	45,799.42	44,692.30	43,853.06	42,896.33	41,533.39	41,254.65	39,730.94	39,532.71	38,427.71	38,258.73	37,554.06	-14.05
N_2O emissions including N_2O from LULUCF	39,620.99	39,699.48	39,016.03	38,493.10	39,509.94	37,782.07	32,443.83	31,828.39	29,763.86	28,217.94	27,302.33	-27.11
N_2O emissions excluding N_2O from LULUCF	39,589.16	39,667.82	38,984.51	38,461.38	39,478.38	37,750.51	32,418.38	31,808.03	29,750.43	28,210.51	27,217.50	-27.16
HFCs	1,985.67	2,549.75	3,191.29	3,901.91	4,635.03	5,400.56	6,106.19	6,855.26	7,512.98	8,163.94	8,755.35	2,394.40
PFCs	1,217.43	1,342.04	1,333.92	1,676.71	1,733.21	1,715.00	1,713.61	1,652.10	1,500.59	1,062.81	1,330.83	-46.48
SF_6	493.43	795.34	739.72	467.56	502.14	465.39	405.87	427.55	435.53	398.02	373.27	12.12
Total (including LULUCF)	**508,504.01**	**507,983.54**	**503,858.67**	**526,665.16**	**526,390.31**	**521,173.59**	**509,015.89**	**520,280.11**	**489,421.28**	**435,582.89**	**444,787.15**	**-8.25**
Total (excluding LULUCF)	**551,570.21**	**557,502.57**	**558,707.21**	**574,042.35**	**577,344.16**	**574,749.01**	**563,988.70**	**555,761.44**	**541,589.39**	**491,528.49**	**501,317.66**	**-3.45**

Table A8.1.5.2 Total emission trends, CRF year 2010 (years 2000 – 2010)

TABLE 10 EMISSION TRENDS

SUMMARY

(Part 2 of 2)

Inventory
2010
Submission
2012 v1.2
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change from base to latest reported year
	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	(%)
1. Energy	449,669.09	454,501.88	456,679.72	471,485.85	473,480.30	471,868.02	466,811.26	458,285.38	449,325.97	405,510.91	415,726.54	-0.50
2. Industrial Processes	36,249.03	38,370.33	38,603.76	40,203.98	42,779.10	42,591.89	38,143.47	38,574.57	35,641.87	30,870.66	31,962.93	-16.74
3. Solvent and Other Product Use	2,302.43	2,217.38	2,219.27	2,168.11	2,144.38	2,127.50	2,122.37	2,065.83	1,945.89	1,814.59	1,658.22	-32.46
4. Agriculture	40,134.30	39,201.07	38,500.00	38,338.72	38,032.87	37,362.03	36,765.94	37,378.52	36,014.32	34,775.46	33,741.17	-17.17
5. Land Use, Land-Use Change and Forestry(5)	-43,066.20	-49,519.03	-54,848.54	-47,377.18	-50,953.84	-53,575.42	-54,972.81	-35,481.33	-52,168.11	-55,945.60	-56,530.51	63.93
6. Waste	23,215.36	23,211.92	22,704.47	21,845.69	20,907.50	20,799.56	20,145.66	19,457.13	18,661.34	18,556.87	18,228.79	-8.08
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total (including LULUCF)(5)	**508,504.01**	**507,983.54**	**503,858.67**	**526,665.16**	**526,390.31**	**521,173.59**	**509,015.89**	**520,280.11**	**489,421.28**	**435,582.89**	**444,787.15**	**-8.25**

A8.2 Supplementary information under Article 7, paragraph 1

A8.2.1 KP-LULUCF

Table A8.2.1.1 Table NIR1. Summary Table

Activity coverage and other information relating to activities under Article 3.3 and elected activities under Article 3.4

Activity		Change in carbon pool reported[1]					Greenhouse gas sources reported[2]						
		Above-ground biomass	Below-ground biomass	Litter	Dead wood	Soil	Fertilization[3]	Drainage of soils under forest management	Disturbance associated with land-use conversion to croplands	Liming	Biomass burning[4]		
							N_2O	N_2O	N_2O	CO_2	CO_2	CH_4	N_2O
Article 3.3 activities	Afforestation and Reforestation	R	R	R	R	R	NO			NO	IE	R	R
	Deforestation	R	R	R	R	R			NO	NO	NO	NO	NO
Article 3.4 activities	Forest Management	R	R	R	R	NR	NO	NO		NO	IE	R	R
	Cropland Management	NA	NA	NA	NA	NA			NA	NA	NA	NA	NA
	Grazing Land Management	NA	NA	NA	NA	NA				NA	NA	NA	NA
	Revegetation	NA	NA	NA	NA	NA				NA	NA	NA	NA

Table A8.2.1.2 Table NIR2. Land Transition Matrix – 2008

Areas and changes in areas between the previous and the current inventory year (1), (2), (3)

From previous inventory year \ To current inventory year		Article 3.3 activities: Afforestation and Reforestation	Article 3.3 activities: Deforestation	Article 3.4 activities: Forest Management (if elected)	Article 3.4 activities: Cropland Management (if elected)	Article 3.4 activities: Grazing Land Management (if elected)	Article 3.4 activities: Revegetation (if elected)	Other (5)	Total area at the beginning of the current inventory year(6)
		(kha)							
Article 3.3 activities	Afforestation and Reforestation	1,401.04	NO						1,401.04
	Deforestation		12.28						12.28
Article 3.4 activities	Forest Management (if elected)		0.72	7,449.84					7,450.57
	Cropland Management(4) (if elected)	NA	NA		NA	NA	NA		NA
	Grazing Land Management(4) (if elected)	NA	NA		NA	NA	NA		NA
	Revegetation(4) (if elected)	NA			NA	NA	NA		NA
Other (5)		78.63	0.00	0.00	0.00	0.00	0.00	21,191.09	21,269.72
Total area at the end of the current inventory year		1,479.67	13.00	7,449.84	0.00	0.00	0.00	21,191.09	30,133.60

Table A8.2.1.3 Table NIR2. Land Transition Matrix - 2009

Areas and changes in areas between the previous and the current inventory year [(1), (2), (3)]

To current inventory year / From previous inventory year		Article 3.3 activities		Article 3.4 activities				Other [(5)]	Total area at the beginning of the current inventory year[(6)]
		Afforestation and Reforestation	Deforestation	Forest Management (if elected)	Cropland Management (if elected)	Grazing Land Management (if elected)	Revegetation (if elected)		
		(kha)							
Article 3.3 activities	Afforestation and Reforestation	1,479.67	NO						1,479.67
	Deforestation		13.00						13.00
Article 3.4 activities	Forest Management (if elected)		0.72	7,449.12					7,449.84
	Cropland Management[(4)] (if elected)	NA	NA		NA	NA	NA		NA
	Grazing Land Management[(4)] (if elected)	NA	NA		NA	NA	NA		NA
	Revegetation[(4)] (if elected)	NA			NA	NA	NA		NA
Other [(5)]		78.63	0.00	0.00	0.00	0.00	0.00	21,112.46	21,191.09
Total area at the end of the current inventory year		1,558.30	13.72	7,449.12	0.00	0.00	0.00	21,112.46	30,133.60

Table A8.2.1.4 Table NIR2. Land Transition Matrix - 2010

Areas and changes in areas between the previous and the current inventory year (1), (2), (3)

From previous inventory year / To current inventory year		Article 3.3 activities: Afforestation and Reforestation	Article 3.3 activities: Deforestation	Article 3.4 activities: Forest Management (if elected)	Article 3.4 activities: Cropland Management (if elected)	Article 3.4 activities: Grazing Land Management (if elected)	Article 3.4 activities: Revegetation (if elected)	Other (5)	Total area at the beginning of the current inventory year(6)
		(kha)							
Article 3.3 activities	Afforestation and Reforestation	1,558.30	NO						1,558.30
	Deforestation		13.72						13.72
Article 3.4 activities	Forest Management (if elected)		0.72	7,448.40					7,449.12
	Cropland Management(4) (if elected)	NA	NA		NA	NA	NA		NA
	Grazing Land Management(4) (if elected)	NA	NA		NA	NA	NA		NA
	Revegetation(4) (if elected)	NA			NA	NA	NA		NA
Other (5)		78.63	0.00	0.00	0.00	0.00	0.00	21,033.83	21,112.46
Total area at the end of the current inventory year		1,636.93	14.44	7,448.40	0.00	0.00	0.00	21,033.83	30,133.60

Table A8.2.1.5 Table NIR3. Summary overview for key categories for LULUCF activities under Kyoto Protocol

TABLE NIR 3. SUMMARY OVERVIEW FOR KEY CATEGORIES FOR LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER THE KYOTO PROTOCOL

KEY CATEGORIES OF EMISSIONS AND REMOVALS	GAS	CRITERIA USED FOR KEY CATEGORY IDENTIFICATION			COMMENTS [3]
		Associated category in UNFCCC inventory[1] is key (indicate which category)	Category contribution is greater than the smallest category considered key in the UNFCCC inventory [1], [4] (including LULUCF)	Other [2]	
Specify key categories according to the national level of disaggregation used[1]					
Forest Management	CO2	Forest land remaining forest land	yes	no	no
Afforestation and Reforestation	CO2	Conversion to forest land	yes	no	category identified only for trend assessment with Tier2

Table A8.2.1.6 Table 5(KP). Report of supplementary information for LULUCF activities under Kyoto Protocol - 2008

TABLE 5(KP). REPORT OF SUPPLEMENTARY INFORMATION FOR LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER THE KYOTO PROTOCOL [(1), (2)]

ITALY

Inventory 2008

Submission 2012 v1.2

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Net CO_2 emissions/ removals[(3), (4)]	CH_4 [(5)]	N_2O [(6)]	Net CO_2 equivalent emissions/removals
	(Gg)			
A. Article 3.3 activities				**-5,691.73**
A.1. Afforestation and Reforestation [(7)]	-6,100.48	0.97	0.00	-6,079.98
A.1.1. Units of land not harvested since the beginning of the commitment period	-6,100.48	0.97	0.00	-6,079.98
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA
A.2. Deforestation	388.26	NA	NA	388.26
B. Article 3.4 activities				**-36,804.81**
B.1. Forest Management (if elected)	-36,852.57	2.26	0.00	-36,804.81
B.2. Cropland Management (if elected)	NA	NA	NA	NA
B.3. Grazing Land Management (if elected)	NA	NA	NA	NA
B.4. Revegetation (if elected)	NA	NA	NA	NA

Information item:				
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA

Table A8.2.1.7 Table 5(KP). Report of supplementary information for LULUCF activities under Kyoto Protocol - 2009

TABLE 5(KP). REPORT OF SUPPLEMENTARY INFORMATION FOR LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER THE KYOTO PROTOCOL (1), (2)

ITALY

Inventory 2009

Submission 2012 v1.2

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Net CO_2 emissions/ removals(3), (4)	CH_4 (5)	N_2O (6)	Net CO_2 equivalent emissions/removals
	(Gg)			
A. Article 3.3 activities				**-6,278.42**
A.1. Afforestation and Reforestation (7)	-6,689.11	0.98	0.00	-6,668.39
A.1.1. Units of land not harvested since the beginning of the commitment period	-6,689.11	0.98	0.00	-6,668.39
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA
A.2. Deforestation	389.97	NA	NA	389.97
B. Article 3.4 activities				**-34,447.80**
B.1. Forest Management (if elected)	-34,496.08	2.29	0.00	-34,447.80
B.2. Cropland Management (if elected)	NA	NA	NA	NA
B.3. Grazing Land Management (if elected)	NA	NA	NA	NA
B.4. Revegetation (if elected)	NA	NA	NA	NA

Information item:				
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA

Table A8.2.1.8 Table 5(KP). Report of supplementary information for LULUCF activities under Kyoto Protocol - 2010

TABLE 5(KP). REPORT OF SUPPLEMENTARY INFORMATION FOR LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER THE KYOTO PROTOCOL [(1), (2)]

ITALY

Inventory 2010

Submission 2012 v1.2

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Net CO_2 emissions/ removals[(3), (4)]	CH_4 [(5)]	N_2O [(6)]	Net CO_2 equivalent emissions/removals
	(Gg)			
A. Article 3.3 activities				**-6,314.67**
A.1. Afforestation and Reforestation [(7)]	-6,719.64	0.62	0.00	-6,706.42
A.1.1. Units of land not harvested since the beginning of the commitment period	-6,719.64	0.62	0.00	-6,706.42
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA
A.2. Deforestation	391.75	NA	NA	391.75
B. Article 3.4 activities				**-36,214.91**
B.1. Forest Management (if elected)	-36,245.36	1.44	0.00	-36,214.91
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	2012
Reported year	2011
Commitment period	1

Table 1. Total quantities of Kyoto Protocol units by account type at beginning of reported year

	Unit type					
Account type	**AAUs**	**ERUs**	**RMUs**	**CERs**	**tCERs**	**lCERs**
Party holding accounts	2185496062	287848	NO	15698709	NO	NO
Entity holding accounts	230840741	2158	NO	19175903	NO	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	NO	NO		
Non-compliance cancellation accounts	NO	NO	NO	NO		
Other cancellation accounts	NO	NO	NO	NO	NO	NO
Retirement account	NO	NO	NO	NO	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	2416336803	290006	NO	34874612	NO	NO

Table A8.2.2.2.a Annual internal transactions

Party	Italy
Submission year	2012
Reported year	2011
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	567758394	752006	NO	28577753	NO	NO

Table A8.2.2.2.b Annual external transactions

Party	Italy
Submission year	2012
Reported year	2011
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	13607803	NO	NO	NO	NO	NO	NO	NO	NO
AT	537141	NO	NO	NO	NO	NO	19204	NO	NO	NO	NO	NO
BE	597059	NO	NO	182778	NO	NO	329210	NO	NO	22239	NO	NO
BG	263332	NO	NO	NO	NO	NO	NO	NO	NO	90633	NO	NO
CZ	2304020	NO	NO	35952	NO	NO	116752	NO	NO	NO	NO	NO
DK	150000	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
EE	NO	NO	NO	NO	NO	NO	488140	NO	NO	NO	NO	NO
FR	4455614	10000	NO	1913328	NO	NO	15689652	NO	NO	1070955	NO	NO
DE	1464738	5866	NO	1391743	NO	NO	4914268	4000	NO	1048265	NO	NO
GR	240340	NO	NO	NO	NO	NO	2712	NO	NO	228126	NO	NO
HU	427006	NO	NO	NO	NO	NO	20979	NO	NO	NO	NO	NO
IE	NO	NO	NO	700000	NO	NO	NO	NO	NO	NO	NO	NO
LI	126000	NO	NO	3369500	NO	NO	200000	NO	NO	61000	NO	NO
NL	2198865	657528	NO	2774847	NO	NO	5508020	NO	NO	538643	NO	NO
NO	NO	NO	NO	NO	NO	NO	70000	NO	NO	870	NO	NO
PL	197996	NO	NO	139128	NO	NO	44000	NO	NO	25100	NO	NO
PT	2000	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
RO	78000	NO	NO	NO	NO	NO	NO	NO	NO	14000	NO	NO
SK	5669840	286000	NO	3745918	NO	NO	1708236	100000	NO	2081973	NO	NO
SI	NO	NO	NO	1379	NO	NO	17379	NO	NO	NO	NO	NO
ES	1700296	25800	NO	10739989	NO	NO	10343478	NO	NO	269155	NO	NO
CH	NO	NO	NO	2179906	NO	NO	NO	NO	NO	1021691	NO	NO

	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Transfers and acquisitions												
GB	19751581	2372000	NO	13307225	NO	NO	33787220	686000	NO	30061044	NO	NO
Sub-total	40163828	3357194	NO	54089496	NO	NO	73259250	790000	NO	36533694	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)	40163828	3357194	NO	54089496	NO	NO	73259250	790000	NO	36533694	NO	NO

Table A8.2.2.3 Expiry, cancellation and replacement

Party	Italy
Submission year	2012
Reported year	2011
Commitment period	1

Table 3. Expiry, cancellation and replacement

Transaction or event type	Expiry, cancellation and requirement to replace		Replacement					
	Unit type		Unit type					
	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Temporary CERs (tCERS)								
Expired in retirement and replacement accounts	NO							
Replacement of expired tCERs			NO	NO	NO	NO	NO	
Expired in holding accounts	NO							
Cancellation of tCERs expired in holding accounts	NO							
Long-term CERs (lCERs)								
Expired in retirement and replacement accounts		NO						
Replacement of expired lCERs			NO	NO	NO	NO		
Expired in holding accounts		NO						
Cancellation of lCERs expired in holding accounts		NO						
Subject to replacement for reversal of storage		NO						
Replacement for reversal of storage			NO	NO	NO	NO		NO
Subject to replacement for non-submission of certification report		NO						
Replacement for non-submission of certification report			NO	NO	NO	NO		NO
Total			NO	NO	NO	NO	NO	NO

Table A8.2.2.4 Total quantities of Kyoto Protocol units by account type at end of reported year

Party	Italy
Submission year	2012
Reported year	2011
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	1602189698	NO	NO	NO	NO	NO
Entity holding accounts	213293289	2105194	NO	23852661	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	567758394	752006	NO	28577753	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	2383241381	2857200	NO	52430414	NO	NO

Table A8.2.2.5.a Summary information on additions and subtractions

Party	Italy
Submission year	2012
Reported year	2011
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)	182734218	1340006	NO	20643648	NO	NO	1.93E+08	1050000	NO	13493232	NO	NO
Year 4 (2011)	40163828	3357194	NO	54089496	NO	NO	73259250	790000	NO	36533694	NO	NO
Year 5 (2012)	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	263307645	4697200	NO	1.17E+08	NO	NO	2.96E+08	1840000	NO	64371513	NO	NO
Total	2679585543	4697200	NO	1.17E+08	NO	NO	2.96E+08	1840000	NO	64371513	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

Year	Retirement					
	Unit type					
	AAUs	**ERUs**	**RMUs**	**CERs**	**tCERs**	**lCERs**
Year 1 (2008)	NO	NO	NO	NO	NO	NO
Year 2 (2009)	NO	NO	NO	NO	NO	NO
Year 3 (2010)	NO	NO	NO	NO	NO	NO
Year 4 (2011)	5.68E+08	752006	NO	28577753	NO	NO
Year 5 (2012)	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	5.68E+08	752006	NO	28577753	NO	NO

A8.2.3 National registry

A8.2.3.1 Changes to national registry

Changes to national registry are described in Chapter 13.

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A8.2.3.2 Reports

i) **list of discrepancies**
   list of discrepancies is reported in the separate documentation submitted along with the NIR "SIAR Report 2012- sheet 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 77 registered CDM projects where Italy is involved (as for 15/02/2012)

Title	Host Parties	Other Parties	Impacts assessment
Project for GHG emission reduction by thermal oxidation of HFC 23 in Gujarat, India.	India(+,a)	Switzerland, Japan, Netherlands, **Italy**, United Kingdom of Great Britain and Northern Ireland	-
La Esperanza Hydroelectric Project	Honduras (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Austria, Luxembourg, Belgium, Sweden, Germany, Switzerland, Japan, Norway, Spain	Nussbaumer (2009) + CDCF (*)
Santa Rosa	Peru (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Austria, Luxembourg, Belgium, Sweden, Germany, Switzerland, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
DSL Biomass based Power Project at Pagara	India (a)	**Italy**, Germany, United Kingdom of Great Britain and Northern Ireland	Sirohi (2007)
GHG emission reduction by thermal oxidation of HFC 23 at refrigerant (HCFC-22) manufacturing facility of SRF Ltd	India (b)	Netherlands, **Italy,** France, Germany, United Kingdom of Great Britain and Northern Ireland, Switzerland	Sirohi (2007)
Biogas Support Program – Nepal (BSP-Nepal) Activity-1	Nepal (a)	Canada, Netherlands, **Italy,** Denmark, Finland, Sweden, Luxembourg, Switzerland, Austria, Germany, Belgium, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
Biogas Support Program – Nepal (BSP-Nepal) Activity-2	Nepal (a)	Canada, Netherlands, **Italy**, Denmark, Finland, Sweden, Luxembourg, Switzerland, Austria, Germany, Belgium, Japan, Norway, Spain	Nussbaumer (2009) + CDCF
Olavarría Landfill Gas Recovery Project	Argentina ©	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)

Title	Host Parties	Other Parties	Impacts assessment
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 ©	**Italy**	-
Project for HFC23 Decomposition at Zhejiang Dongyang Chemical Co., Ltd., China	China (b)	Switzerland, Netherlands, **Italy,** United Kingdom of Great Britain and Northern Ireland	-
Project for HFC23 Decomposition at Limin Chemical Co., Ltd. Linhai, Zhejiang Province, China	China (b)	Switzerland, Netherlands, **Italy**, United Kingdom of Great Britain and Northern Ireland	-
Recovery of associated gas that would otherwise be flared at Kwale oil-gas processing plant, Nigeria	Nigeria (b)	**Italy**	-
Facilitating Reforestation for Guangxi Watershed Management in Pearl River Basin	China (d)	**Italy**, Spain	Cóndor et al. (2010)
Landfill Gas Recovery and Flaring for 9 bundled landfills in Tunisia	Tunisia ©	**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	China (b)	Switzerland, Netherlands, **Italy**, United Kingdom of Great Britain and Northern Ireland	-

Title	Host Parties	Other Parties	Impacts assessment
Chenguang Research Institute of Chemical Industry, Zigong, SiChuan Province, China			
Allain Duhangan Hydroelectric Project (ADHP)	India (c)	**Italy**	-
Rongcheng Dongchudao Wind Farm	China (c)	**Italy**, Switzerland	-
Landfill gas recovery and electricity generation at "Mtoni Dumpsite", Dar Es Salaam, Tanzania	United Republic of Tanzania (**)	**Italy**	-
Laizhou Diaolongzui Wind Farm	China (c)	**Italy**	-
Quezon City Controlled Disposal Facility Biogas Emission Reduction Project	Philippines (a)	Switzerland, **Italy**	-
Laguna de Bay Community Waste Management Project: Avoidance of methane production from biomass decay through composting -1	Philippines (a)	Canada, Netherlands, **Italy**, Denmark, Luxembourg, Belgium, Germany, Switzerland, Japan, Norway, Spain	-
Guyana Skeldon Bagasse Cogeneration Project	Guyana (c)	Canada, Netherlands, **Italy**, Denmark, Finland, Luxembourg, Belgium, Germany, Switzerland, Spain	-
Guizhou Zhenyuan Putian Hydropower Station	China (a)	**Italy**	-
Kunming Dongjiao Baishuitang LFG Treatment and Power Generation Project	China (c)	**Italy**	-
Shenyang Laohuchong LFG Power Generation Project	China (c)	**Italy**	-
Expansion Project of Huadian Inner Mongolia Huitengxile Wind Farm	China (c)	**Italy**	-
Moldova Soil Conservation Project	Republic of Moldova(**)(d)	Canada, Netherlands, Italy, Finland, Luxembourg, France, Sweden, United Kingdom of Great Britain and Northern Ireland, Japan, Norway, Spain	Cóndor et al. (2010)
Hubei Eco-Farming Biogas Project Phase I	China (a)	Canada, Netherlands, **Italy**, Denmark, Luxembourg, Switzerland, Sweden, Belgium, Japan, Norway, Spain	-
Salta Landfill Gas Capture Project	Argentina (a)	Canada, Netherlands, **Italy**, Denmark, Luxembourg , Switzerland, Sweden, Belgium, Japan, Norway, Spain	-
Coke Dry Quenching (CDQ) Waste Heat Recovery for Power Generation Project of Wugang No. 9 and 10	China (c)	**Italy**	-

Title	Host Parties	Other Parties	Impacts assessment
Coke Ovens			
Yingpeng HFC23 Decomposition Project	China (b)	**Italy**, Ireland United Kingdom of Great Britain and Northern Ireland	-
Animal Manure Management System (AMMS) GHG Mitigation Project , Shandong Minhe Livestock Co. Ltd., Penglai, Shandong Province, P.R. of China	China (c)	Canada, Netherlands, **Italy**, Denmark, Finland, Luxembourg, Sweden, Germany, Belgium, Japan, Norway, Spain	-
Uganda Nile Basin Reforestation Project No.3	Uganda (d)	**Italy,** Canada, Spain	-
NISCO Converter Gas Recovery and Utilization for Power Generation Project	China (c)	**Italy**	-
Assisted Natural Regeneration of Degraded Lands in Albania	Albania (d)	**Italy**	Cóndor et al. (2010)
Sichuan Mabian Yi Minority Autonomous County Yonglexi Hydropower Station	China (**,a)	**Italy**	
Yunnan Maguan Mihu River 3rd Level Hydropower Station	China (**,c)	**Italy**	
Jinping Maocaoping Hydropower Station	China (**,a)	**Italy**	
Xianggelila Huajiaopo Hydropower Station	China (**,a)	**Italy**	
Chongqing Wanzhou Xiangjiazui Hydropower Station	China (**,a)	**Italy**	
Landfill biogas extraction and combustion plant in El Inga I and II landfill (Quito, Ecuador)	Ecuador (**,c)	**Italy**	
Jinping Maguo River Hydropower Station	China (**,a)	**Italy**	
Community-Based Renewable Energy Development in the Northern Areas and Chitral (NAC), Pakistan	Pakistan(+,a)	Canada**,** Netherlands, **Italy**, Denmark, Finland, Switzerland, Sweden, Austria, Germany, Belgium, Japan, Norway, Spain	
Humbo Ethiopia Assisted Natural Regeneration Project	Ethiopia(+,d)	Canada, Japan, **Italy,** Spain, France	CCB
Rwanda Electrogaz Compact Fluorescent Lamp (CFL) distribution project	Rwanda(+,a)	Canada**,** Netherlands, **Italy**, Denmark, Finland, Switzerland, Sweden, Austria, Germany, Belgium, Japan, Norway, Spain	
Olkaria II Geothermal Expansion Project	Kenya(+,c)	**Italy**	
Wugang Gas-Steam Combined Cycle Power Plant (CCPP) Project	China(+,c)	**Italy**	
Wugang Waste Gas Recovery and Power Generation Project	China(+,c)	**Italy**	
Mungcharoen Green Power - 9.9 MW Rice Husk Fired	Thailand(+,a)	**Italy**	

Title	Host Parties	Other Parties	Impacts assessment
Power Plant Project			
AES Tietê Afforestation/Reforestation Project in the State of São Paulo, Brazil	Brazil(+,d)	Canada, **Italy**, France	
Improving Rural Livelihoods Through Carbon Sequestration By Adopting Environment Friendly Technology based Agroforestry Practices	India(+,d)	Canada, **Italy**, France	
Yunnan Yingjiang Zhina River 2nd Level Hydropower Station Phase 1 and Phase 2	China(+,c)	**Italy**	
Yunnan Er'yuan Misha River Longdi Hydropower Station	China(+,a)	**Italy**	
Southern Nicaragua CDM Reforestation Project	Nicaragua(+,d)	Canada**,** Japan**, Italy**, Spain, France	
Yunnan Yingjiang Zhina River 1st Level Hydropower Station	China(+,a)	**Italy**	
Shanxi Shuangliang Cement Company LTD. 4.5MW Waste Heat for Power Generation Project	China(+,c)	**Italy**	
Aberdare Range/ Mt. Kenya Small Scale Reforestation Initiative Kamae-Kipipiri Small Scale A/R Project	Kenya(+,d)	Canada, **Italy,** France	
Uganda Nile Basin Reforestation Project No.5	Uganda(+,d)	**Italy**	
India-FaL-G Brick and Blocks Project No.2.	India(+,a)	Netherlands, **Italy**	
Jiangsu Hantian Cement Waste Heat Recovery Power Generation Project	China(+,c)	**Italy**	
Uganda Nile Basin Reforestation Project No 2	Uganda(+,d)	**Italy**	
Uganda Nile Basin Reforestation Project No 1	Uganda(+,d)	**Italy**	
Uganda Nile Basin Reforestation Project No 4	Uganda(+,d)	**Italy**	

(a)AMS, Small scale; (b) AM - Large scale; (c) ACM - Consolidated Methodologies; (d) Afforestation/reforestation; (*) project which is included in the UNEP Risoe Centre Database that also is classified as Gold Standard projects (validation); (**) New CDM projects respect to 2010 submission; (+) New CDM projects respect to 2011 submission; CCB= obtained the CCB standards (UNEP Risoe database); CDCF= Community Development Carbon Fund

ANNEX 9: METHODOLOGIES, DATA SOURCES AND EMISSION FACTORS

This appendix shows methodologies, data sources and emission factors used for the Italian greenhouse gas emission inventory.

Table A9.1 Methods, activity data and emission factors used for the Italian Inventory

Information on methods used could be the tier method, the model or a country-specific approach. Activity data could be from national statistics or plant-specific. Emission factors could be the IPCC default emission factors as outlined in the revised 1996 IPCC guidelines for national greenhouse gas inventories and in the IPCC good practice guidance, country-specific emission factors, plant-specific emission factors or CORINAIR emission factors developed under the 1979 Convention on Long-Range Transboundary Air Pollution.

Table I -1: Summary report for methods, activity data and emission factors used (Energy)

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)
1. Energy												
A. Fuel Combustion												
1. Energy Industries												
a. Public Electricity and Heat Production												
Liquid fuels	Yes	T3	NS, PS	CS	Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
Solid fuels	Yes	T3	NS, PS	CS	Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
Gaseous fuels	Yes	T3	NS, PS	CS	Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
Biomass	No				No				No			
Other fuels	Yes	T3	NS, PS	CS	Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
b. Petroleum Refining												
Liquid fuels	Yes	T3	NS, PS	CS	Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
Solid fuels	No				No				No			
Gaseous fuels	Yes	T3	NS, PS	CS	Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
c. Manufacture of Solid Fuels and Other Energy Industries												
Liquid fuels	Yes	T3	NS, PS	CS	Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
Solid fuels	Yes	T3	NS, PS	CS	Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
Gaseous fuels	Yes	T3	NS, PS	CS	Yes	T3	NS, PS	CR, D	Yes	T3	NS, PS	CR, D
2. Manufacturing Industries and Construction												
a. Iron and Steel												

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source [(1)]	Method applied [(2)]	Activity data [(3)]	Emission factor [(4)]	Key source [(1)]	Method applied [(2)]	Activity data [(3)]	Emission factor [(4)]	Key source [(1)]	Method applied [(2)]	Activity data [(3)]	Emission factor [(4)]
Liquid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Solid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Gaseous fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
b. Non-Ferrous Metals												
Liquid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Solid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Gaseous fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
c. Chemicals												
Liquid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Solid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Gaseous fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Biomass	No				No				No			
Other fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
d. Pulp, Paper and Print												
Liquid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Gaseous fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Biomass	No				No				No			
e. Food Processing, Beverages and Tobacco												
Liquid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Gaseous fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Biomass	No				No				No			
f. Other												
Liquid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Solid fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Gaseous fuels	Yes	T2	NS, PS	CS	Yes	T2	NS, PS	CR, D	Yes	T2	NS, PS	CR, D
Biomass	No				No				No			
3. Transport												

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)
a. Civil Aviation												
Aviation gasoline	No				No				No			
Jet kerosene	No				No				No			
b. Road Transportation												
Gasoline	Yes	COPERT IV	NS, AS	CS	No				No			
Diesel oil	Yes	COPERT IV	NS, AS	CS	No				No			
LPG	Yes	COPERT IV	NS, AS	CS	No				No			
Gaseous fuel	Yes	COPERT IV	NS, AS	CS	No				No			
Biomass	No				No				No			
c. Railways												
Liquid fuels	No				No				No			
d. Navigation												
Gas/Diesel oil	Yes	T1, T2	NS	CS	No				No			
Residual Oil	Yes	T1, T2	NS	CS	No				No			
Gasoline	Yes	T1, T2	NS	CS	No				No			
e. Other Transportation												
Gaseous Fuels	No				No				No			
4. Other Sectors												
a. Commercial/Institutional												
Liquid fuels	Yes	T2	NS	CS	No				No			
Solid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
Biomass	No				No				No			
Other fuels	Yes	T2	NS	CS	No				No			
b. Residential												
Liquid fuels	Yes	T2	NS	CS	No				No			
Solid fuels	Yes	T2	NS	CS	No				No			

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)**
Gaseous fuels	Yes	T2	NS	CS	No				No			
Biomass	No				No				No			
c. Agriculture/Forestry /Fisheries												
Liquid fuels	Yes	T2	NS	CS	No				No			
Gaseous fuels	Yes	T2	NS	CS	No				No			
Biomass	No				No				No			
5. Other												
b. Mobile												
Liquid fuels	No				No				No			
B. Fugitive Emissions from Fuels												
1. Solid Fuels												
a. Coal Mining					No							
b. Solid Fuel Transformation					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				
c. Venting and Flaring	Yes	T1, T2	NS	D, CS	No				No			
d. Other	Yes	T1, T2	NS	D, CS	No				No			

Table I -2: Summary report for methods, activity data and emission factors used (Industrial Processes)

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O				HFCs				PFCs				SF_6			
CATEGORIES	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)
2. Industrial Processes																								
A. Mineral Products																								
1. Cement Production	Yes	T2	NS	CS, PS	No				No															
2. Lime Production	No				No				No															
3. Limestone and Dolomite Use	Yes	T2	NS	D, CS,PS	No				No															
4. Soda Ash Production and Use	No				No				No															
5. Asphalt Roofing	No				No				No															
6. Road Paving with Asphalt	No				No				No															
7. Other	No				No				No															
B. Chemical Industry																								
1. Ammonia Production	Yes	T2	NS, PS	PS	No				No															
2. Nitric Acid Production	No				No				Yes	T2	PS	D, PS												
3. Adipic Acid Production	No				No				Yes	T2	PS	D, PS												
4. Carbide Production	No				No				No															
5. Other					No																			
C. Metal Production																								
1. Iron and Steel Production	Yes	T2	NS	CR, CS, PS	No				No								No				No			
2. Ferroalloys Production	No				No				No								No				No			
3. Aluminium Production	No				No				No								Yes	T1, T2	PS	PS	No			
4. SF_6 Used in Aluminium and Magnesium Foundries	No				No				No								No				No			
5. Other	No				No				No								No				No			

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O				HFCs				PFCs				SF_6			
CATEGORIES	**Key source (1)**	**Method applied (2)**	**Activity data (3)**	**Emission factor (4)**	**Key source (1)**	**Method applied (2)**	**Activity data (3)**	**Emission factor (4)**	**Key source (1)**	**Method applied (2)**	**Activity data (3)**	**Emission factor (4)**	**Key source (1)**	**Method applied (2)**	**Activity data (3)**	**Emission factor (4)**	**Key source (1)**	**Method applied (2)**	**Activity data (3)**	**Emission factor (4)**	**Key source (1)**	**Method applied (2)**	**Activity data (3)**	**Emission factor (4)**
D. Other Production																								
1. Pulp and Paper	No																							
2. Food and Drink	No																							
E. Production of Halocarbons and SF_6																								
1. By-product Emissions													No				No				No			
2. Fugitive Emissions													No				No				No			
3. Other													No				No				No			
F. Consumption of Halocarbons and SF_6																								
1. Refrigeration and Air Conditioning Equipment													Yes	CS	AS	CS	No				No			
2. Foam Blowing													Yes	CS	AS	CS	No				No			
3. Fire Extinguishers													Yes	CS	AS	CS	No				No			
4. Aerosols/ Metered Dose Inhalers													Yes	CS	AS	CS	No				No			
5. Solvents													No				No				No			
6. Other applications using ODS substitutes													No				No				No			
7. Semiconductor Manufacture													No				No				No			
8. Electrical Equipment													No				No				No			
9. Other													No				No				No			
G. Other													No											

Table I -3: Summary report for methods, activity data and emission factors used (Solvent and Other Product Use, Agriculture)

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)
3. Solvent and Other Product Use	Yes	CR, CS	NS, AS	CR, CS	No				No			
4. Agriculture												
A. Enteric Fermentation in Domestic Livestock					Yes	T1, T2	NS	D, CS				
B. Manure Management					Yes	T1, T2	NS	D, CS	Yes	T2	NS	D, CS
C. Rice Cultivation					No							
D. Agricultural Soils												
1. Direct Soil Emissions					No				Yes	T1, CS	NS	D, CS
2. Pasture, range and paddock manure					No				Yes	T1, CS	NS	D, CS
3. Indirect Emissions					No				Yes	T1, CS	NS	D, CS
F. Field Burning of Agricultural Residues					No				No			

Table I -4: Summary report for methods, activity data and emission factors used (Land-Use Change and Forestry, Waste, Other)

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)
5. Land-Use, Land-Use Change and Forestry												
A. Forest Land												
1. Forest Land remaining Forest Land	Yes	T1, T2, T3	NS	D, CS	No				No			
2. Land converted to Forest Land	Yes	T1, T2, T3	NS	D, CS	No				No			
B. Cropland												
1. Cropland remaining Cropland	Yes	T1, T2, T3	NS	D, CS	No				No			
2. Land converted to Cropland	Yes	T1, T2, T3	NS	D, CS	No				No			
C. Grassland												
1. Grassland remaining Grassland	Yes	T1, T2, T3	NS	D, CS	No				No			
2. Land converted to Grassland	Yes	T1, T2, T3	NS	D, CS	No				No			
D. Wetlands												
1. Wetlands remaining Wetlands												
2. Land converted to Wetlands												
E. Settlements												
1. Settlements remaining Settlements												
2. Land converted to Settlements	Yes	T1	NS	D, CS	No				No			
F. Other Land												
1. Other Land remaining Other Land												
2. Land converted to Other Land	No				No				No			
6. Waste												
A. Solid Waste Disposal on Land												
1. Managed Waste Disposal on Land	No				Yes	T2	NS	CS				
2. Unmanaged Waste Disposal Sites	No				Yes	T2	NS	CS				
B. Wastewater Handling												
1. Industrial Wastewater					No				No			
2. Domestic and Commercial Wastewater					Yes	D	NS	D	No			
C. Waste Incineration	No				No				No			

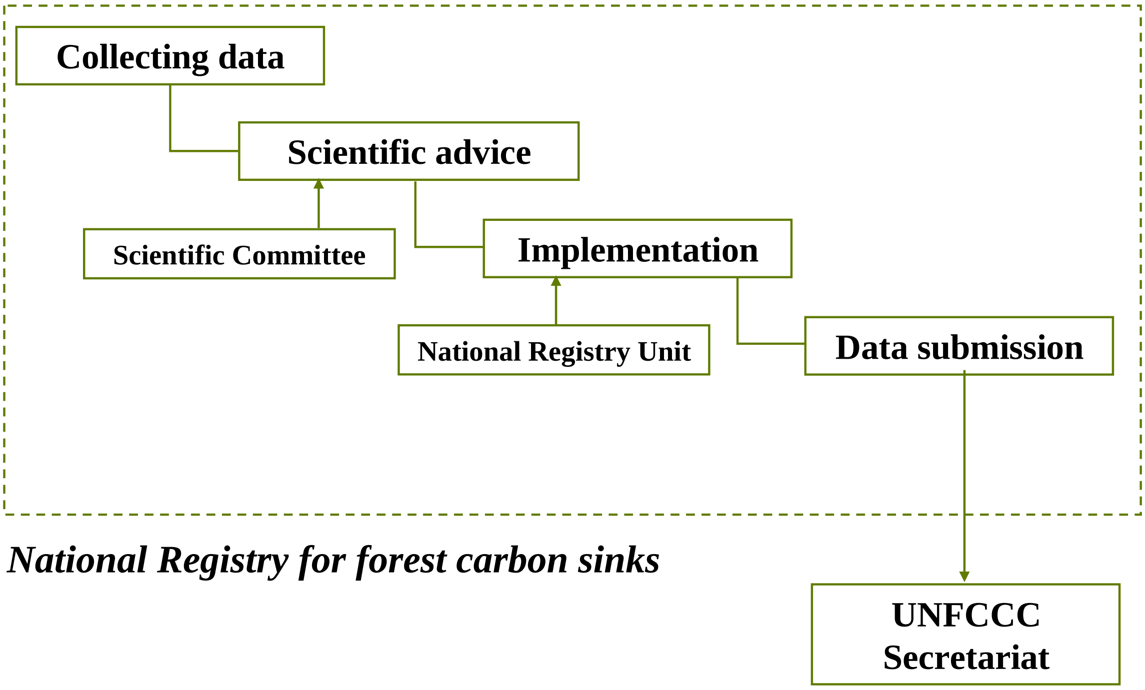
GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)
D. Other					No							

Legend for tables I -1 to I -4

(1) Key categories of the Italian inventory.		
(2) Method applied:		
D (IPCC default),	**T1a, T1b, T1c** (IPCC Tier 1a, Tier 1b and Tier 1c, respectively),	**CR** (CORINAIR), **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)
(3) Activity data used :		
NS (national statistics),	**IS** (International statistics),	**AS** (associations, business organizations)
RS (regional statistics),	**PS** (Plant Specific data).	**Q** (specific questionnaires, surveys)
(4) Emission factor used:		
D (IPCC default),	**CS** (Country Specific),	
CR (CORINAIR),	**PS** (Plant Specific).	

ANNEX 10: THE NATIONAL REGISTRY FOR FOREST CARBON SINKS

The so-called "National Registry for forest carbon sinks" is part of the Italian National System; it is the instrument to estimate, in accordance with the COP/MOP decisions, the IPCC Good Practice Guidance on LULUCF and every relevant IPCC guidelines, the greenhouse gases emissions by sources and removals by sinks in *forest land* and related land-use changes and to account for the net removals in order to allow the Italian Registry to issue the relevant amount of RMUs.



Italy has approved the National Plan for greenhouse gases reduction (PNR_{GHG}) with the CIPE (*Interministerial Economic Planning Committee*) decision n. 123, of 19 December 2002. The PNR_{GHG} sets policies and measures to act in order to achieve the national target of the Kyoto Protocol; Italy has committed to 6.5% reduction below 1990 greenhouse gases emission levels. The article 7.4 of CIPE decision (123/2002) states that Ministry for the Environment, Land and Sea (MATTM), in agreement with Ministry of Agriculture, Food and Forest Policies (MIPAAF) has to constitute, the National Registry for the forest carbon sinks to account for the net removals in the period 2008 – 2012, from *afforestation*, *reforestation* and *deforestation* activities (art. 3.3 KP) and from elected activities under article 3.4 of Kyoto Protocol (*forest management*). The National Registry for Carbon sinks, instituted by a Ministerial Decree on 1st April 2008, is part of National Greenhouse Gas Inventory System in Italy (ISPRA, 2011 [a]) and includes information on units of lands subject of activities under Article 3.3 and activities elected under Article 3.4 and related carbon stock changes. The National Registry for Carbon sinks is the instrument to estimate, in accordance with the COP/MOP decisions, the IPCC Good Practice Guidance on LULUCF and every relevant IPCC guidelines, the greenhouse gases emissions by sources and removals by sinks in forest land and related land-use changes and to account for the net removals in order to allow the Italian Registry to issue the relevant amount of RMUs. In 2009, a technical group, formed by experts from different institutions (ISPRA; Ministry of the Environment, Land and Sea; Ministry of Agriculture, Food and Forest Policies and University of Tuscia), set up the methodological plan of the activities necessary to implement the registry and defined the relative funding. Some of these activities (in particular IUTI, inventory of land use) have been completed, resulting in land use classification, for all national territory, for the years 1990, 2000 and 2008. A process of validation and verification of IUTI data has been put in place and is expected to supply data useful to update and improve the estimations.

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[49] and TERRAITALY[50]), 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:

[49] http://www.cgrit.it/prodotti/voli_italia.html
[50] http://www.terraitaly.it/

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:

Table A10.1: IUTI classification system

IPCC Category Level I	IUTI Category Level II	IUTI Subcategory Level III	Code
1. Forest land	*Woodland*		**1.1**
	Wooded land temporarily unstocked		**1.2**
2. Cropland	*Arable land and other herbaceous cultivations*		**2.1**
	Arboreal cultivations	*Fruit orchards and plant nurseries*	**2.2.1**
		Wood product plantations	**2.2.2**
3. Grassland	*Grassland, pastures and uncultivated herbaceous areas*		**3.1**
	Other wooded land		**3.2**
4. Wetlands	*Marshlands and open waters*		**4**
5. Settlements	*Urban development*		**5**
6. Other land	*Non-productive areas or areas with scarce or absent vegetation*		**6**

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.

Table A10.2: Classification hierarchy

A. LAND WITH ITS ORIGINAL CHARACTERISTICS OF PHYSIOGNOMY AND VEGETATION SIGNIFICANTLY MODIFIED BY HUMAN ACTION, CULTIVATED, CLEARED OR SUBJECT TO URBANIZATION WORK, AND DOMINATED BY ANTHROPIC ARTEFACTS DUE TO RESIDENTIAL, INDUSTRIAL, SOCIO-CULTURAL AND AGRICULTURAL ACTIVITIES.

AI. **Land occupied by other agricultural cultivations**

AI1. Herbaceous cultivations in open fields, subject to regular rotation, for the production of cereals, pulses, other food products or forage.

ARABLE

AI2. Arboreal cultivations not subject to regular rotation, destined permanently to the production of fruit or wood products.

AI2a. *Arboreal cultivations destined prevalently to the production of fruit for nutritional purposes (apple orchards, vineyards, olive groves, etc) or for the production of arboreal or shrub species for ornamental purposes*

ORCHARDS and NURSERIES

AI2b. *Arboreal cultivations destined prevalently to the production of wood products or of woody biomass for energy generation purposes*

ARBOREAL CULTIVATIONS FOR WOOD PRODUCTS

AII. **Areas with residential and industrial buildings and services, transport routes, infrastructures and urban green areas (parks and gardens)**

SETTLEMENTS

B. NATURAL OR SEMI-NATURAL LAND NOT SIGNIFICANTLY MODIFIED BY HUMAN ACTION OR IN PHASE OF RENATURALIZATION.

BI. **Formations constituted by trees able to reach the height on maturity *in situ* of 5 m, but temporarily lacking in canopy cover following accidental events or anthropic action.**

WOODED LAND TEMPORARILY WITHOUT ABOVE-GROUND COVER

BII. **Formations constituted by trees able to reach the height on maturity *in situ* of 5 m and procuring a degree of canopy cover on the terrain of ≥ 5%.**

BII1. Formation with a degree of cover < 10%

OTHER WOODED AREAS

BII2. Formation with a degree of cover ≥ 10%

WOODLAND

BIII. **Formations never as above**

BIII1. Formations constituted by shrubs or trees not able to reach a height on maturity *in situ* of 5 m, and procuring a degree of canopy cover on the terrain of ≥ 10%

OTHER WOODED LAND

BIII2. Formations constituted by shrubs or trees not able to reach a height on maturity *in situ* of 5 m and procuring a degree of canopy cover on the terrain of < 10%, and silvi-pastural formations with canopy cover from trees able to reach a height on maturity *in situ* of 5 m but with cover < 5%

BIII2a. *Natural herbaceous formations of ground species with a degree of herbaceous cover of ≥ 40%.*

PASTURES, MEADOWS and UNCULTIVATED HERBACEOUS AREAS

BIII2b. *Natural herbaceous formations with a degree of herbaceous cover of < 40% or land completely lacking herbaceous cover*

BIII2b1. *Land without vegetation or with sporadic herbaceous vegetation. Rocky outcrops and beaches.*

OTHER LANDS

C. AREAS WITHOUT VEGETATION AND COVERED BY STILL OR FLOWING WATER OR AREAS OCCUPIED BY PARTICULAR ECOSYSTEMS OTHER THAN TERRESTRIAL ECOSYSTEMS (FLOATING VEGETATION, WET VEGETATION, SALTWATER VEGETATION, ETC).

MARSHLANDS AND OPEN WATERS

To achieve land use classification, a 0.5 ha neighbourhood of the sample plot is investigated. The operative procedure consists in digital orthophotos processing, considering sampling points: for each point identified on the territory by coordinates in a known reference system, the land use category, defined according to the classification system, must be established.
A grid, composed of 9 squares (3 x 3) of 2500 m² each, for an overall surface area of 22,500 m² is used. This graphic object, at the centre of which the sampling point must be situated, allows to assess whether area intercepted by the sampling point has an extension equal to or greater than the established threshold (equivalent to the surface area of 2 of the 9 cells displayed).
If the surface area value is very close to the threshold and the use of the cells still leaves doubts, a graphic tool for surface area measurement is used for the classification process. The contour of the polygon containing the sampling point is mapped, computing the extent of the area.
In Figures A10.1, A10.2 and A10.3, examples from land use classification system are reported. In particular, in figure 1 the sampling point is classified as 3.1 Grassland, given that trees covering the sampling point have a surface area between 500 and 5000 m². In Figure A10.2, the sampling point is classified as 1.1 Woodland, while in Figure A10.3, the sampling point is classified as 3.1 Grassland.

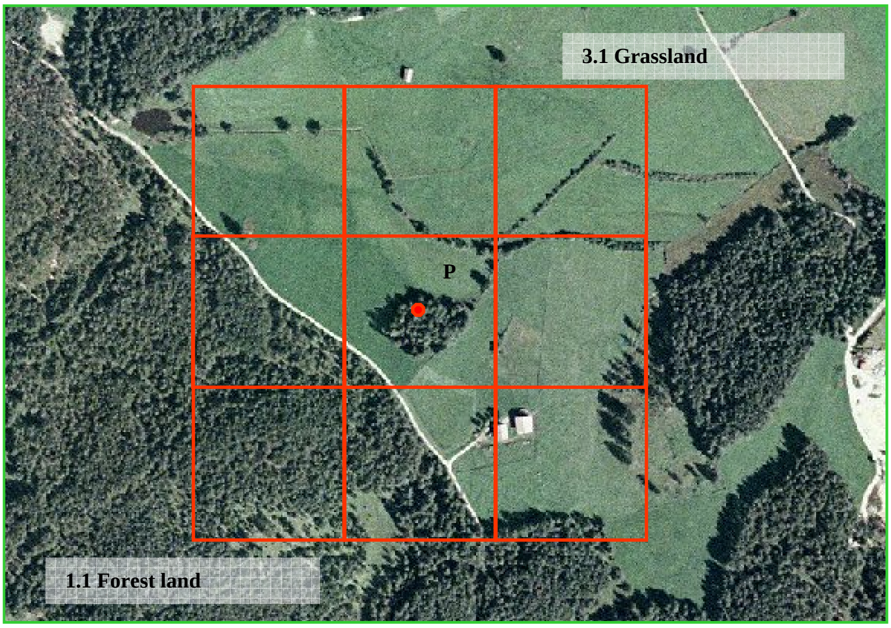


Figure A10.1: Land use classification system - grassland

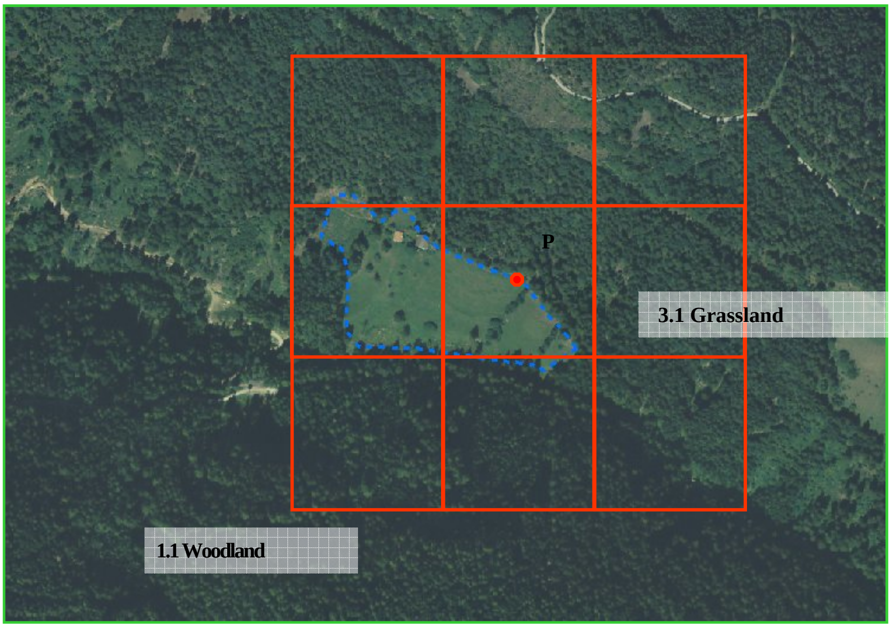


Figure A10.2: Land use classification system - Woodland

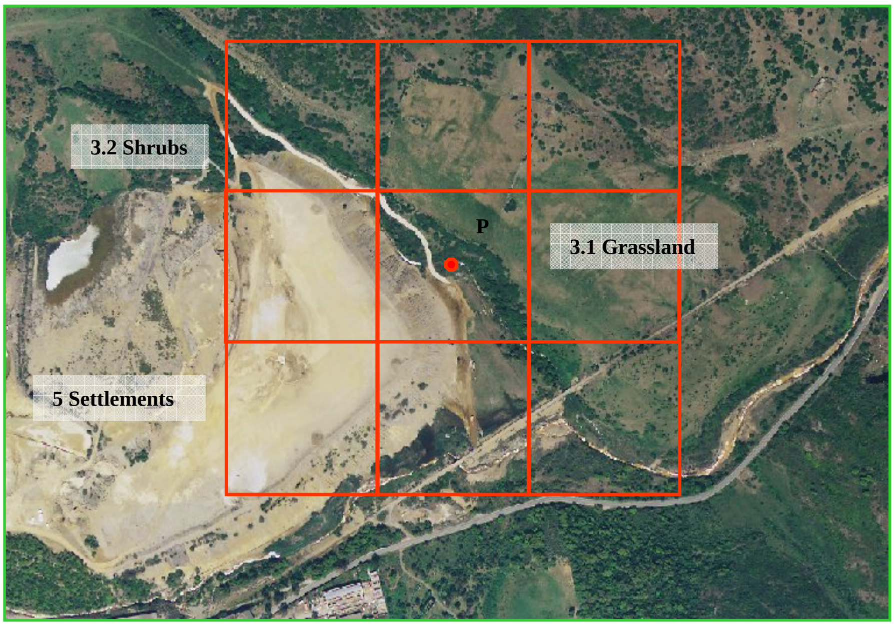


Figure A10.3: Land use classification system – grassland

National Inventory of Carbon Stocks (ISCI)
The National Inventory of the Carbon Stocks is a sampling of carbon stocks related to the different land-use categories.
The National Inventory of the Carbon Stocks includes:

- carbon stock changes in the land-use category forest land, the dataset is derived by the 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

According to Article 7 of the Kyoto Protocol each Party included in Annex I shall incorporate in its annual greenhouse gas inventory the necessary supplementary information for the purposes of ensuring compliance with Article 3 of the Kyoto Protocol.
Supplementary information under article 7, paragraph 1, with regards to units holdings and transactions during the year 2011, is reported in the SEF submission (figures are also included in Tables A8.2.2.1 - A8.2.2.5c of this document).
This annex reports supplementary information under article 7, paragraph 2, with regards to the national registry and in accordance with the guidelines set down in Annex I.II of UNFCCC's Decision 22/CP.8.

More detailed information can be found in the relevant annexes of the new *Readiness Questionnaire* that have been submitted to UNFCCC along with this document.

(a) ***The name and contact information of the registry administrator designated by the Party to maintain the national registry***
The Italian Registry is administrated by ISPRA (former APAT) under the supervision of the national Competent Authority for the implementation of the European directive 2003/87/CE, jointly established by the Ministry for Environment, Land and Sea and the Ministry for Economic Development. ISPRA, as Registry Administrator, is responsible for the management and functioning of the Registry, including Kyoto protocol obligations.

The contact person is: Mr Riccardo Liburdi
address: Via Vitaliano Brancati 48 – 00144 Rome – Italy
telephone: +390650072544
fax: +390650072657
e-mail: riccardo.liburdi@isprambiente.it

(b) ***The names of the other Parties with which the Party cooperates by maintaining their national registries in a consolidated system***
The Italian national registry is not a part of any consolidated registry system. However, the VPN connection to the ITL is shared with several countries using the same tunnel.

(c) ***A description of the database structure and capacity of the national registry***
The registry system uses a Microsoft SQL Server 2005 relational database with a dedicated data model for supporting the registry operations.
At the new hosting premises current total capacity is 70 GB and current database size is 5464 MB.

The registry is based on the *Greta* software. During the reported year new versions of the software have been developed (5.1, 5.2 and 5.3). The scope of the new versions was to develop a software that was further more compatible with the UNFCCC Data Exchange Standard (DES ver. 1.1.7). A number of architectural improvements have been implemented: these improvements have enhanced registry performance, reliability and scalability. Before implementation the new software versions were thoroughly tested: the tests were performed by the developers and a working group consisting of Greta licensees and finally through an acceptance test with the CITL.
Italy upgraded the Greta software in production environment from version 4.3 to version 5.1 in January 2011 and from 5.1 to 5.3 in September 2011. Greta version 5.2 was not implemented in the production environment but the improvements and new functionality are included in version 5.3.

The improvements and functions implemented in the new software releases include:

Greta Version 5.1:
1. Manual Selection for Surrender
2. Simplification to the Compliance Process
3. Rewrite of Reconciliation Processing

4. Removal of Bulk Block Account Application
5. Security Fixes
6. Maintenance bug fixes raised from support
7. Reporting services updates

Greta Version 5.2:
1. Transaction Finalisation
2. Account Confidentiality Service
3. Maintenance Fixes
a. Mantis bug fixes
b. High priority fixes from V5.1
4. Security Enhancements

Greta Version 5.3:
1. Security Enhancements
2. Data Migration Enhancements
3. Out of hours lock
4. Trusted Accounts
5. Maintenance Fixes

More detailed information about the improvements and functions implemented is reported in the release notes (ETR 5.1 Release Notes_1.2.pdf; ETR 5.2 Release Notes_1.0.pdf; ETR 5.3 Release Notes 1.2.pdf) submitted along with this document.

(d) ***A description of how the national registry conforms to the technical standards for data exchange between registry systems for the purpose of ensuring the accurate, transparent and efficient exchange of data between national registries, the clean development mechanism registry and the transaction log (decision 19/CP.7, paragraph 1)***

The Greta registry software is developed for the EU Emissions Trading Scheme by SFW Ltd. The scheme requires Member States' registries to be compliant with the UN Data Exchange Standards (DES) specified for the Kyoto Protocol.

The software contains the functionality to perform issuance, conversion, external transfer, (voluntary) cancellation, retirement and reconciliation processes using XML messages and web services as specified in the UN DES document.

In addition, it also contains: 24-hour clean-up, transaction status enquiry, time synchronization, data logging requirements (including transaction log, reconciliation log, internal audit log and message archive) and the different identifier formats specified in the UN DES document.

The software development has always occurred in close contact with the ITL administrator and development team within the UNFCCC Secretariat during the development of the ITL functions.

(e) ***A description of the procedures employed in the national registry to minimize discrepancies in the issuance, transfer, acquisition, cancellation and retirement of ERUs, CERs, tCERs, lCERs, AAUs and/or RMUs, and replacement of tCERS and lCERs, and of the steps taken to terminate transactions where a discrepancy is notified and to correct problems in the event of a failure to terminate the transactions***

In order to minimise discrepancies between the registry and the transaction log, the following approach has been adopted for the registry system development under the EU ETS and UN DES:

- communication between the national registry and the ITL is via web services using XML messages. These web services, XML message format and the processing sequence are as specified in the UN DES document;
- as far as possible, the registry validates data entries against the list of checks that are performed by the ITL – as documented in Annex E of the UN DES Annexes document – before forwarding the request to the ITL for processing. This will help to minimise the sending of incorrect information to the ITL for approval. This also holds for any incoming transaction or message relating to a transaction. The registry validates all communication using checks described in the DES and the EC ETS regulation before processing the request further. If any check fails, the process is terminated and rolled back according to the requirements;

- all units that are involved in a transaction shall be earmarked internally within the registry, thereby preventing the units from being involved in another transaction until a response has been received from the ITL and the current transaction completed;
- the web service that sends the message to the ITL for processing will ensure that an acknowledgement message is received from the ITL before completing the submission of the message. Where no acknowledgement message is received following a number of retries, the web service will terminate the submission and roll back any changes made to the unit blocks that were involved;
- where a 24-hour clean-up message is received from the ITL, the web service will roll back any pending transactions and the units that were involved, thereby preventing any discrepancies in the unit blocks between the registry and the ITL;
- finally, if an unforeseen failure were to occur, the data discrepancies between the registry and the ITL can be corrected via a manual intervention function within the registry. Following this, reconciliation will be performed to validate that the data is synchronised between the registry and the ITL.

As the number and size of transactions kept increasing, it was necessary to enhance the robustness of the system. This resulted in the software upgrades described below:

- the update from Greta version 4.3 to version 5.1 improved performance and reliability by changing the processing of reconciliation messages from a synchronous to an asynchronous process. This ensured that the Registry responds to ITL messages within an appropriate time period, thus eliminating time-out errors. A windows service is used to process the reconciliation messages, improving reliability and making the process more robust by enabling processing failures to be retried. In addition, the reconciliation function was streamlined thus becoming more efficient. Additionally, improvements have been made to the handling of transaction messaging: due to the complexity of the previous implementation and the conceptual simplicity of the requirements, it was decided to completely replace it with a new brand new implementation utilising the new SAM service. Together these changes have resulted in increased reliability of the registry when operating under a higher work load. This effectively increases the capacity of the registry.
- In Greta version 5.2 (integrated in Greta 5.3) a new message flow was introduced. In Q3 2009, the UNFCCC raised a change request to alter the message flow for external transfers. The new message flow introduces an additional step that marks the transaction and unit blocks as proposed in the acquiring registry until the acquiring registry has confirmed acceptance of the unit blocks and the ITL has completed the transaction. The purpose of the additional step is to ensure that a registry cannot transfer units received by external transfer until the ITL have completed the transaction. The new message flow helps reducing the number of discrepant transactions in production.

(f) ***An overview of security measures employed in the national registry to prevent unauthorized manipulations and to prevent operator error and of how these measures are kept up to date***

For the Italian registry the following security measures have been taken:

- four-eyes principle is implemented for transaction processing: from January 2011 all accounts need to have an additional representative for the approval of transactions proposed by an account representantive;
- access to the registry can be secured with an SMS-based 2-factor authentication system, which also includes transaction confirmation by SMS;
- the actions that a user can perform are controlled by a permissions matrix, hence preventing unauthorised access to restricted actions;
- access to the servers and the database, as well as other related material, is limited to personnel members of Innofactor Plc who have passed a background security check by the Finnish Security Police (SUPO);
- a dedicated Greta development team is available to make any further security enhancements as and when required;
- in order to prevent operator error, the registry software incorporates the following design: validation of all user inputs to ensure that only valid details are submitted for processing;
- the procedures are regularly reviewed and maintained where necessary. One example of the maintenance measures taken is the recent introduction of the background inspection (Finnish

Security Police (SUPO)) for personnel working with the registry and who have access to the registry servers;
- enhanced scrutiny of documentation required for account application to the Italian registry (called KYC on the model used by financial institutions) was introduced in 2011 in order to capture the account holders with dubious purposes of trading;
- exchange of encrypted information in the communication with other Member States and the European Commission has increased.

(g) ***A list of the information publicly accessible by means of the user interface to the national registry***
Non-confidential information required by Decision 13/CMP.1 annex II.E paragraphs 44-48, is publicly accessible through the registry website. All required information is provided with the following exceptions:
- paragraph 45(e): representative name and contact information is deemed as confidential according to Annex XVI of the EU Registry Regulation No 916/2007/EC;
- paragraph 46: no Article 6 (Joint Implementation) project is reported as conversion to an ERU under an Article 6 project did not occur in the specified period;
- paragraph 47(a)(d)(f): holding and transaction information is provided on an account type level, due to more detailed information being declared confidential by article 75 of EC Regulation 920/2010 as emended by EC Regulation 1193/2011.

(h) ***The Internet address of the interface to its national registry***
The Italian registry can be accessed at the following URL:
http://www.greta.sinanet.isprambiente.it/
A support portal, with news, procedures, documentation, is also available for the public at:
http://www.info-ets.isprambiente.it/

(i) ***A description of measures taken to safeguard, maintain and recover data in order to ensure the integrity of data storage and the recovery of registry services in the event of a disaster***
In the event of a serious malfunction the following recovery procedures have been incorporated in the design of the registry system:
- Physically database is stored on raid-array structure with automatic error detection and recovery. Therefore, any single database failure would be alerted and the registry would automatically switch over to use information from the remaining uncorrupted databases;
- Data is also archived every 24 hours to an off-site recovery location, and there is also a Disaster Recovery site that can be used for taking over the live registry in the event that the main site becomes inoperable. This will then be followed by the reconciliation (with the ITL) and manual intervention processes in order to check for any inconsistencies that may exist in the registry and to restore data as needed.

(j) ***The results of any test procedures that might be available or developed with the aim of testing the performance, procedures and security measures of the national registry undertaken pursuant to the provisions of decision 19/CP.7 relating to the technical standards for data exchange between registry systems.***
Due to the transfer of the Registry to new hosting premises, new connectivity tests (SSL and VPN) have been performed and successfully passed.
In spring 2011 the European Commission required to all Member States vulnerability and penetration testing (such as black box) which were performed in February-March 2011 on the new hardware infrastructure to identify potential security flaws. Test results are confidential and might be provided on request.
During 2011 two software upgrades have been performed (Greta version 5.1 and Greta version 5.3): no annex H testing was required by the UNFCCC Secretariat but performance of the system was tested with the European Commission (CITL).
Results of the test performed on the new software versions are submitted along with this document (SFW V5.1 Test Report_v1.0.pdf; SFW V5.2 Test Report_1.0.pdf; SFW V5.3 Test Report 1.1.pdf).

ANNEX 12: OVERVIEW OF THE CURRENT SUBMISSION IMPROVEMENTS

During the last review process, some issues were raised which have been taken into account to improve the current submission. Improvements are described in the following table.

Subject	Improvement
Energy – comparison with international data	Additional information on the comparison has been included in Annex 4
Energy – international marine bunkers	The inconsistency has been resolved
Energy – feedstock and non-energy use of fuels	In order to enhance transparency and consistency, a detailed description related to quantity stored for each fuel has been included in the NIR (§par. 3.8.2).
Energy – CO_2 – stationary combustion: petroleum refining liquid and solid fuels	A detailed description related to trend and drivers of CO_2 emissions has been included in the NIR (§par. 3.1).
Energy – CO_2 – stationary combustion: solid fuel - iron and steel	Additional information related to the decreasing trend in CO_2 implied emission factors has been included in the NIR (§par. 3.1, Annex 3).
Energy – CO_2 – Road transportation: liquid fuels	Further information has been included in the NIR to better detail on the trend of CO_2 emission factors used in the estimation process (§par. 3.5.3.2.1, Annex 6).
Energy – CH_4 – Navigation: gasoline	The composition of the fleet of gasoline fuelled recreational craft has been updated from 2001 revising the two strokes and four strokes engine distribution. (§par. 3.5.4.5).
Energy - CH_4, CO_2 - Fugitive emissions	Information on average chemical composition and main parameters of national mix of natural gas has been added in order to improve the transparency of the NIR (§par. 3.9.2)
Energy - CH_4 - Fugitive emissions - Oil and natural gas: liquid fuels	The notation key for fugitive emissions from oil transport was NA instead of IE. The error has been corrected and a description has been provided in the NIR to clarify how the refining/storage sub-category includes emissions from oil transportation (§par. 3.9.2).
Industrial processes – CO_2 – Cement production	In order to enhance transparency on the verification of the EU-ETS as well as the EPRTR registry, clarifications have been included in the NIR (§par. 4.2.2). A more detailed description of the monitoring and reporting procedure of emissions and verification activities in the framework of EU-ETS have been included in NIR (§par. 1.4).
Industrial processes – N_2O - Adipic acid	In order to enhance transparency on abatement technology installed in adipic acid production additional information has been provided in the NIR (§par. 4.3.2).
Industrial processes – N_2O – Adipic acid	The formula used to estimate emissions from adipic acid production has been included in the NIR (§par. 4.3.2) to provide a more transparent description of the estimation process.
Industrial processes – CO_2, PFCs – Aluminium production	In order to clarify the methodological approaches used in the emissions estimation process, additional information has been included in the NIR (§par. 4.4.2), concerning time series consistency and conservativeness of the applied approach. In addition, a number of attempts have been tried for the last years by inventory team to retrieve the same information related to 1990-1999, those data cannot be retrieved.

Industrial processes – SF_6, Substitutes for ODS – Electrical equipment	In order to enhance transparency, additional information has been added in the NIR (§par. 4.7.2).
Agriculture – general	Inconsistency between the NIR and CRF, on the reporting of the methodologies used, has been corrected.
Agriculture - CH_4 - Manure management	Additional information on the comparison of country specific and IPCC default emission factors focusing on the share of different population species for each climate region has been added in the NIR (§par. 6.3.2).
LULUCF – carbon stock changes in mineral soils for land use conversion categories	Italy has decided to use the IPCC default land use transition period of 20 years, in the estimation process of carbon stock changes in mineral soils related to land use changes. In particular the 20-years transition period has been applied to estimate carbon stock changes from the following land use changes: Land converted to Forest land, Land converted to Cropland, Land converted to Grassland and for Art. 3.3 activities (Afforestation/Reforestation). Once a land has converted to a land use category, the annual changes in carbon stocks in mineral soils have been reported for 20 years subsequent the conversion. For the remaining land use change (Land converted to Settlements and Art. 3.3 - Deforestation) Italy has decided to use a land use transition period equal to 1 year, taking into account the nature of final land use category (Settlements) and assuming that soils organic matter content of previous land use category is lost in the conversion year. SOC reference value, for Settlements category, has been assumed to be zero. (§par. 7.1.1, 7.2.4, 7.3.4, 7.4.4, 7.6.4).
LULUCF – carbon stock changes in mineral soils for land use categories	Italy has decided to apply the IPCC Tier1, assuming that, for forest land remaining forest land, the carbon stock in soil organic matter does not change, regardless of changes in forest management, types, and disturbance regimes; in other words it has to be assumed that the carbon stock in mineral soil remains constant so long as the land remains forest. Therefore carbon stock changes in soils pool, for forest land remaining forest land, have been not reported. (§par. 7.2.4, 7.3.4, 7.4.4).
LULUCF – cropland - plantations	Additional information related to plantations management system has been included in NIR (§par. 7.3.2), in order to better details reasons of the inclusion of plantations into cropland category.
Waste - CH_4 - Solid waste disposal on land	Further information is added about the methane generation rate constant (k), the method used to estimate the amount of CH4 recovered using the energy conversion efficiency factor and the procedure used to establish the time series for the amount of waste disposed in managed and unmanaged landfill sites ((§par. 8.2)
Waste - CH_4 - Wastewater handling	Further information is added about collected and uncollected, treated and untreated wastewater (§par. 8.3)
Waste - CO_2 , N_2O - Incineration	Activity data for industrial waste are reported in Table 8.27 distinguishing those with or without energy recovery (§par. 8.4)
KP-LULUCF – CO_2 - Afforestation/reforestation: carbon stock changes in mineral soils	Italy has decided to use the IPCC default land use transition period of 20 years, to estimate carbon stock changes in soils pools for afforestation/reforestation activities under art. 3.3 of the Kyoto Protocol (§par. 10.3.1.1, 10.3.1.4).
KP-LULUCF – CO_2 – Forest Management: carbon stock changes in mineral soils	Italy has decided to apply the IPCC Tier1, assuming that, for land under Forest Management activities, the carbon stock in soil organic matter does not change, regardless of changes in forest management, types, and disturbance regimes. Therefore carbon stock changes in soils pool, for land subject to Forest Management, have been not reported, and transparent and verifiable information that the pool is not a net source for Italy is provided in NIR. (§par. 10.3.1.1, 10.3.1.2, 10.3.1.4).