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Italian Greenhouse Gas Inventory 1990-2002

National Inventory Report 2004

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AUTORI:

Daniela Romano, Mario Contaldi
Riccardo De Lauretis, Domenico Gaudioso, Barbara Gonella

Servizio Sviluppo Sostenibile e Pressioni Ambientali
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Annual Report for submission under the UN Framework Convention on Climate Change and the European Union's Greenhouse Gas Monitoring Mechanism

CONTACTS

For technical enquiries and further information on specific chapters, please contact the major contributing authors, namely:

Mario Contaldi - Energy
telephone +39 0650072539
fax +39 0650072657
e-mail contaldi@apat.it

Riccardo De Lauretis - Agriculture & Lucf
telephone +39 0650072543
fax +39 0650072657
e-mail delauretis@apat.it

Domenico Gaudioso - Industrial processes
telephone +39 0650072540
fax +39 0650072657
e-mail gaudioso@apat.it

Barbara Gonella - Waste
telephone +39 0650072563
fax +39 0650072657
e-mail gonella@apat.it

Daniela Romano - Cross cutting issues; Solvent and other product use
telephone +39 0650072541
fax +39 0650072657
e-mail romano@apat.it

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

PREMESSA

Il rapporto “Italian Greenhouse Gas Inventory 1990-2002. National Inventory Report 2004” costituisce il documento esplicativo della struttura degli inventari nazionali di gas-serra, realizzati dall’Agenzia per la Protezione dell’Ambiente e per i Servizi Tecnici (APAT) sulla base delle metodologie messe a punto dal Panel Intergovernativo sui Cambiamenti Climatici (IPCC) e delle decisioni della Convenzione-quadro sui cambiamenti climatici (UNFCCC).
La preparazione del rapporto risponde ai principali compiti istituzionali dell’APAT di raccolta, elaborazione e diffusione di dati ed informazioni di interesse ambientale. Essa si inserisce a pieno titolo nelle numerose esperienze dell’APAT nelle tematiche relative alle emissioni in atmosfera, tra cui emerge la realizzazione dell’inventario nazionale correntemente utilizzato per verificare il rispetto degli impegni che l’Italia ha assunto a livello internazionale sulla protezione dell’ambiente atmosferico (Convenzione quadro sui cambiamenti climatici, Convenzione di Ginevra sull’inquinamento atmosferico transfrontaliero, Direttive europee sulla limitazione delle emissioni).
Nel rapporto 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) e del Meccanismo di Monitoraggio dei Gas Serra dell’Unione Europea. Il documento si propone quale strumento indispensabile per la pianificazione e l’attuazione di efficaci politiche ambientali e fornisce alle istituzioni centrali e periferiche un adeguato contributo conoscitivo sulle problematiche inerenti i cambiamenti climatici.
Le emissioni totali dei gas serra considerati nel Protocollo di Kyoto (espressi in termini di CO_2 equivalente) dal 1990 al 2002 sono aumentate di circa il 9% a fronte di un impegno nazionale di riduzione pari al 6,5% entro il periodo 2008-2012 rispetto ai livelli di riferimento. Nuove politiche ed interventi a livello nazionale ed internazionale saranno quindi indispensabili per garantire nel futuro il rispetto degli obiettivi del Protocollo.

Antonio De Maio
Direttore Dipartimento Stato dell’Ambiente
e Metrologia Ambientale

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EXECUTIVE SUMMARY

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

The United Nations Framework Convention on Climate Change (FCCC) was ratified by Italy in the year 1994 through law no.65 of 15/01/1994. As a Party to the Convention, Italy is committed to develop, publish and regularly update national emission inventories of greenhouse gases (GHGs) as well as to formulate, implement, publish and regularly update programmes addressing anthropogenic GHG emissions.
The Kyoto Protocol, adopted in December 1997, has established emission reduction objectives for Annex B Parties (i.e. industrialised countries and countries with economy in transition): in particular, the European Union as a whole is committed to a 8% reduction within the period 2008-2012, in comparison with 1990 levels. As concerns Italy, the EU burden sharing has established a reduction objective of 6.5% in the commitment period, in comparison with 1990 levels.
Subsequently, on 1st June 2002, Italy ratified the Kyoto Protocol with the law no.120 of 01/06/2002. The ratification law prescribed also the preparation of a National Action Plan to reduce greenhouse gas emissions, which was adopted by the Interministerial Committee for Economic Planning (CIPE) on 19th December 2002.
In order to establish compliance with national and international commitments, the national GHG emission inventory is compiled and communicated annually to the competent institutions through compilation of the Common Reporting Format (CRF), according to the guidelines provided by the United Nations Framework Convention on Climate Change and the European Union's Greenhouse Gas Monitoring Mechanism. An annual inventory submission shall consist of a national inventory report (NIR) and the common reporting format (CRF) tables as specified in the Guidelines on reporting and review of greenhouse gas inventories from Parties included in Annex 1 to the Convention, implementing decisions 3/CP.5 and 6/CP.5, doc. FCCC/SBSTA/2002/L.5/Add.1. Detailed information on emission figures as well as estimation procedures, including all the basic data needed to carry out the final estimates, are requested in order to improve the transparency, consistency, comparability, accuracy and completeness of the inventory provided.
The national inventory is updated annually in order to reflect revisions and improvements in the methodology and availability of new information. Adjustments are applied retrospectively to earlier years, which accounts for any difference in previously published data.
This report, which is the second national inventory report, is compiled according to the guidelines on reporting as specified in the document FCCC/SBSTA/2002/L.5. It provides an analysis of the Italian GHG emission inventory communicated to the Secretariat of the Climate Change Convention and to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism for the year 2002, including the entire time series 1990-2002. It should be noted that emission data for the year 2002 are based on preliminary energy statistics.
Emission estimates comprise the six direct greenhouse gases under the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride) which contribute directly to climate change owing to their positive radiative forcing effect and four indirect greenhouse gases (nitrogen oxides, carbon monoxide, non-methane volatile organic compounds, sulphur dioxide).
The CRF files and other related documents can be found at the website www.sinanet.anpa.it/aree/atmosfera/emissioni/emissioni.asp.

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

Total greenhouse gas emissions, in CO_2 equivalent, excluding emissions and removals of CO_2 from land use change, increased by 9% between 1990 and 2002 (from 508 to 554 million CO_2 equivalent tons), while the national Kyoto target is a reduction of 6.5% as compared the base year levels by the period 2008-2012.

The most important greenhouse gas, CO_2, which accounted for 84.7% of total emissions in CO_2 equivalent in 2002, showed an increase of 8.8% between 1990 and 2002. In the energy sector, in particular, emissions in 2002 were 9.6% greater than in 1990.

CH_4 and N_2O emissions were equal, respectively, to 6.2% and 7.6% of the total CO_2 equivalent greenhouse gas emissions in 2002. CH_4 emissions decreased by 7.7% from 1990 to 2002, while N_2O increased by 10.4 %.

Other greenhouse gases, HFCs, PFCs and SF_6, ranged from 0.3% to 1.5% of total emissions; at present, variations in these gases are not relevant to reaching the objectives for emissions reduction.

Table ES.1 illustrates the national trend of greenhouse gases for 1990-2002, expressed in CO_2 equivalent terms, by substance and category.

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

GREENHOUSE GAS EMISSIONS	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	CO_2 equivalent (Gg)													
Net CO_2 emissions/removals	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_2 emissions (without LUCF)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CH_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
N_2O	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HFCs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PFCs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SF_6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total (net CO_2 emissions/removals)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total (without CO_2 from LUCF)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	CO_2 equivalent (Gg)													
1. Energy	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2. Industrial Processes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3. Solvent and Other Product Use	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4. Agriculture	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5. Land Use Change and Forestry	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6. Waste	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7. Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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

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

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

Source category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1A. Energy: fuel combustion	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_2 1. Energy Industries	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_2 2. Manufacturing Industries and Construction	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_2 3. Transport	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_2 4. Other Sectors	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_2 5. Other	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CH_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
N_2O	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1B. Energy: fugitive from oil & gas	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CH_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2. Industrial processes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CH_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
N_2O	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HFCs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PFCs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SF_6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3. Solvent and other product use	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4. Agriculture	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CH_4 Enteric fermentation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CH_4 Manure management	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CH_4 Rice Cultivation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CH_4 Field Burning of Agricultural Residues	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
N_2O Manure management	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
N_2O Agriculture soils	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
N_2O Field Burning of Agricultural Residues	4	4	4	4	4	4	4	4	4	4	4	4	4
5A. Land use change and Forestry	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6. Waste	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CH_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
N_2O	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL EMISSIONS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

The energy sector is the largest contributor to national total GHG emissions with a share, in 2002, of 83% out of the total GHG emissions. Emissions from the energy sector increased by about 9.7% from 1990 to 2002. Substances with the highest increase rates are CO_2, whose levels increased by 10% from 1990 to 2002 and accounts for 96% of the total, and N_2O which shows an increase of 17% but its share out of the total is only 1.5%; CH_4, on the other hand, shows a decrease of 18.3% from 1990 to 2002 but it is not relevant on total emissions, accounting only for 2%.

The most significant increase, in terms of total CO_2 equivalent, is observed in the transport and energy industries sectors, about 24% and 15%, respectively, from 1990 to 2002; these sectors, altogether, account for more than 60% of total emissions.

For the industrial processes sector, emissions, in CO_2 equivalent, show a total increase of 20% from the base year to 2002. Specifically, by substance, CO_2 levels fell down by 7% while N_2O raised up to 28%; these two substances account altogether for 79% of total emissions from industrial processes. A considerable increase is observed in F-gas emissions (about 414%) and the level of these gases on total emissions is 21%.

In contrast, emissions from the solvent and other use sector, which refer totally to CO_2 emissions except for gases other than greenhouse, decreased by 28% from 1990 to 2002 due substantially to a decrease both in the paint application sector (-20%), which accounts for 54%, and in other use of solvents in related activities (-32%), such as domestic solvent use other than painting, printing industries, vehicle dewaxing, which account for 40% of the total. Emissions from metal decreasing and dry cleaning activities, also fell down (-55%) but account for only 6% of the total.

For the agriculture sector, emissions refer to CH_4 and N_2O levels, which account, in 2002, for 42% and

58% of the total, respectively. The small decrease observed in the total emissions (-2%) is mostly due to the decrease of CH_4 emissions from enteric fermentation (-8%) which account for most of the total emissions.

Finally, emissions from the waste sector decreased by 2.5% from 1990 to 2002. The decrease is mostly due to the decrease in the emissions from waste incineration (-16%), which account for 5% of the total, as well as those from solid waste disposal (-2%) which account for 76%.

The most important greenhouse gas in this sector is CH_4 which accounts for 88% of the total and shows an increase of 1% from 1990 to 2002. N_2O levels have increased by 4% while CO_2 decreased by 50%; these gases account for 10% and 2%, respectively.

ES.4. Other information

In Table ES.3 the emission trends of NO_X, CO, NMVOC and SO_2 from 1990 to 2002 are summarised.

Table ES.3. Total emissions of indirect greenhouse gases and SO_2 (1990-2002)

Indirect greenhouse gases and SO_2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Emissions in ktons													
NO_X	1,929	1,983	2,002	1,904	1,823	1,789	1,730	1,652	1,551	1,451	1374	1,359	1,267
CO	7,117	7,408	7,608	7,550	7,345	7,111	6,809	6,667	6,148	5,869	5,179	5,090	4,486
NMVOC	2,038	2,097	2,146	2,102	2,045	2,021	1,974	1,908	1,802	1,710	1,541	1,442	1,340
SO_2	1,774	1,656	1,557	1,455	1,359	1,287	1,228	1,151	1,017	922	772	737	665

All gases show a significant reduction in 2002 compared to 1990 levels. The highest reduction is observed for SO_2 (-63%), while CO reduced by 37% and NO_X and NMVOC emissions showed a decrease by about 34%.

SOMMARIO (ITALIAN)

Nel documento “Italian Greenhouse Gas Inventory 1990-2002. National Inventory Report 2004” si descrive la comunicazione annuale italiana dell’inventario delle emissioni dei gas serra in accordo a quanto previsto nell’ambito della Convenzione Quadro sui Cambiamenti Climatici delle Nazioni Unite (UNFCC) e del Meccanismo di Monitoraggio dei Gas Serra dell’Unione Europea.
Ogni Paese che partecipa alla Convenzione, infatti, oltre a fornire annualmente l’inventario nazionale delle emissioni dei gas serra secondo i formati previsti, deve documentare in un report, il *National Inventory Report*, la serie storica delle emissioni. La documentazione prevede una spiegazione degli andamenti osservati, una descrizione dell’analisi delle sorgenti chiave, *key sources*, e dell’incertezza ad esse associata, le referenze delle metodologie di stima così come le fonti dei dati di base e dei fattori di emissione utilizzati per le stime, una descrizione del sistema di *Quality Assurance/Quality Control* a cui è soggetto l’inventario e le attività di verifica effettuate sui dati.
Il *National Inventory Report* facilita, inoltre, i processi internazionali di *review* a cui le stime di emissione dei gas serra sono sottoposte al fine di verificarne la rispondenza alle proprietà di trasparenza, consistenza, comparabilità, completezza e accuratezza nella realizzazione dell’inventario, richieste esplicitamente dalle Convenzioni suddette. I processi di revisione identificano eventuali errori nel formato di trasmissione, individuano le stime non supportate da adeguata documentazione e giustificazione nella metodologia scelta, invitando quindi il Paese ad una revisione delle stesse.
I dati di emissione dei gas-serra, così come i risultati dei processi di *review*, sono pubblicati sul sito web del Segretariato della Convenzione sui Cambiamenti Climatici www.unfccc.int.
I dati di emissione della serie storica italiana sono disponibili sul sito web www.sinanet.anpa.it/aree/atmosfera/emissioni/emissioni.asp.
Per quanto riguarda l’analisi della serie storica dei dati di emissione dal 1990 al 2002, in sintesi, si evidenzia che le emissioni nazionali totali dei sei gas serra, espresse in CO_2 equivalente, risultano nel 2002 superiori del 9% rispetto all’anno base (corrispondente al 1990 per CO_2, CH_4 e N_2O ed al 1995 per HFC, PFC e SF_6), a fronte di un impegno nazionale di riduzione del 6.5% entro il periodo 2008-2012.
In particolare, le emissioni di CO_2 complessive sono pari all’85% del totale e risultano nel 2002 superiori dell’ 8.8% rispetto al 1990, mentre le emissioni relative al solo settore energetico sono aumentate del 15.3%. Le emissioni di metano e di protossido di azoto sono pari rispettivamente a circa il 6% e l’8% del totale e presentano andamenti in diminuzione per il metano (-7.7%) e in crescita (+10.4%) per il protossido di azoto. Gli altri gas-serra, HFC, PFC e SF_6, hanno un peso complessivo intorno all’1.5% sul totale delle emissioni; le emissioni di questi ultimi gas sono in forte crescita per quanto riguarda gli HFCs ed in diminuzione per gli altri due. Anche se al momento non rilevanti ai fini del raggiungimento degli obiettivi di riduzione delle emissioni, il forte “trend” di crescita li renderà sempre più importanti nei prossimi anni.

1. INTRODUCTION

1.1 Background information on greenhouse gas inventories and climate change

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

The first IPCC report in 1990, although considering the high uncertainties in the evaluation of climate change, emphasised the risk of a global warming due to an unbalance in the climate system originated by the increase of anthropogenic emissions of greenhouse gas (GHGs) caused by industrial development and use of fossil fuels. Hence the need of reducing those emissions, particularly for the most industrialised countries.

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

The Kyoto Protocol, adopted in December 1997, has established emission reduction objectives for Annex B Parties (i.e. industrialised countries and countries with economy in transition): in particular, the European Union as a whole is committed to a 8% reduction within the period 2008-2012, in comparison with 1990 levels. As concerns Italy, the EU burden sharing has established a reduction objective of 6.5% in the commitment period, in comparison with 1990 levels.

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

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; EMEP/CORINAIR, 2001).

Detailed information on emission figures as well as estimation procedures, including all the basic data needed to carry out the final estimates, are requested in order to improve the transparency, consistency, comparability, accuracy and completeness of the inventory provided.

The national inventory is updated annually in order to reflect revisions and improvements in the methodology and the availability of new information. Adjustments are applied retrospectively to earlier years, which accounts for any difference in previously published data.

This report, which is the second national inventory report, is compiled according to the guidelines on reporting as specified in the document FCCC/SBSTA/2002/L.5. It provides an analysis of the Italian GHG emission inventory communicated to the Secretariat of the Climate Change Convention and to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism for the year 2002, including the entire time series 1990-2002. It should be noted that emission data for the year 2002 are based on preliminary energy statistics.
Emission estimates comprise the six direct greenhouse gases under the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride) which contribute directly to climate change owing to their positive radiative forcing effect and four indirect greenhouse gases (nitrogen oxides, carbon monoxide, non-methane volatile organic compounds, sulphur dioxide).
The CRF files and other related documents can be found on the website www.sinanet.anpa.it/aree/atmosfera/emissioni/emissioni.asp.

1.2 Description of the institutional arrangement for inventory preparation

Italy has not developed a national emission inventory system, National System, which involves and attributes specific roles and responsibilities to the different institutions which should collect and communicate basic data necessarily and timely for the GHG inventory compilation.
Notwithstanding, the Agency for the Protection of the Environment and for Technical Services (APAT), is recognized by the competent Ministries and Administrations, as responsible for the compilation of the National Air Emission Inventory through the collection, elaboration and diffusion of data. In particular, as National Reference Centre of the European Environment Agency (EEA), APAT is required to prepare the national atmospheric emission inventory in order to ensure compliance with international commitments concerning the protection of the environment (Framework Convention on Climate Change, Convention on Long Range Transboundary Air Pollution, European Directives on emission ceilings).
The Italian greenhouse gas inventory is compiled and updated annually by the Agency and officially communicated to the Secretariat of the Framework Convention on Climate Change and to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism, after endorsement by the Ministry for the Environment and Territory.
Although there is not a recognised National System, different institutions responsible for statistical data flow and publication are part of a National Statistical System (SISTAN) and therefore are asked periodically to update statistics. Nevertheless, problems regarding timeliness and lack of transparency still remain. In the near future, APAT, on behalf of the Ministry for the Environment and Territory, will draft a plan for the establishment of a robust national system (building on the base of SISTAN), which should have a sound legal basis at a later stage.
The attribution of roles and responsibilities to the different organisations, as regards the GHG inventory, would help to overcome the most important shortcomings such as timeliness, quality and transparency of basic statistical data, completeness of some sectors as well as enable a more organized and timely communication.

1.3 Brief description of the process of inventory preparation

Data collection and timely availability are the main difficulties faced by Italy, up to now, which do not allow the submission of the emission inventory within the time scheduled. In fact, several sectoral statistics are available with significant delay: for instance, energy statistics and fuel consumption are published at the end of the year, or even later (as was the case for the energy balance 2002 which was still provisional in march 2004), and some industrial production statistics as well as agriculture and forestry statistics are published even two years later. Moreover, data are not always available with the necessary details and the use of proxy variables and indicators, even if overcoming these difficulties, would introduce further uncertainties in the estimates. At this aim, ad hoc expert panel, i.e transport, land use change and forestry, have been instituted on a voluntary basis in order to improve the completeness and transparency of the inventory. Generally, the basic data needed for the preparation of the GHG inventory are energy statistics published by the Ministry of Production Activities (MAP) in the National Energy Balance (BEN), statistics on industrial and agricultural production published by the National Statistics Institute (ISTAT), statistics on transportation provided by the Ministry of Transportation, and data supplied directly by the relevant professional associations.

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

As far as industrial sources are concerned, emission data collected through the National Pollutant Emission Register (EPER) are taken into account as a verification of emission inventory estimates. According to the Italian Decree of 23 November 2001, data from the Italian EPER are validated and communicated by APAT to the Ministry of the Environment and the Territory and to the European Community within October of the current year for the previous year. These data are not used directly for the compilation of the inventory because industries communicate emission values only if they exceed specific thresholds; furthermore, basic data such as fuel consumption are not communicated and in some cases production are not split by product but considered as an overall figure. Anyway, EPER is a good basis for data checks and a way to facilitate contacts with industries. In addition, estimates are checked and verified also taking into account figures reported by industries in their annual environmental reports. As concerns emissions of large industrial point sources, they are registered individually, when communicated, based upon detailed information such as fuel consumption. Other small plants communicate their emissions which are also considered individually.

Emission estimates are drawn up for each sector. Final data are communicated to the UNFCC Secretariat filling in the CRF files. The process takes over annually; in the year t final emissions are calculated for the year t-2. In addition, in case of methodological changes or further information, emissions are recalculated from the year 1990 onwards.

All the material, estimates and calculation sheets, as well as the documentation on scientific papers and the basic data needed for the inventory compilation, are stored at the Agency.

1.4 Brief general description of methodologies and data sources used

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

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

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

Methodologies are as far as possible consistent with the Revised 1996 IPCC Guidelines, IPCC Good Practice Guidance and EMEP-CORINAIR Emission Inventory Guidebook (IPCC, 1997; IPCC, 2000; EMEP/CORINAIR 2001); national emission factors are used as well as default emission factors from international guidebooks (IPCC, CORINAIR, EPA), in case national data are not available. The development of national methodologies is supported by background documents, unfortunately not always available in English.

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

In Table 1.2 a summary of the methods and emission factors used in the Italian inventory is reported.

Table 1.2 Methods and emission factors used in the inventory preparation

SUMMARY 3 SUMMARY REPORT FOR METHODS AND EMISSION FACTORS USED

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2		CH_4		N_2O		HFCs		PFCs		SF_6	
	Method applied [1]	Emission factor [2]	Method applied [1]	Emission factor [2]	Method applied [1]	Emission factor [2]	Method applied [1]	Emission factor [2]	Method applied [1]	Emission factor [2]	Method applied [1]	Emission factor [2]
1. Energy												
A. Fuel Combustion												
1. Energy Industries	D, T2	CS	D, T2	D	D, T2	D, CS						
2. Manufacturing Industries and Construction	D, T2	CS	D, T2	D	D, T2	D, CS						
3. Transport	D, T2	CS	D, T2	D, C	D, T2	D, C						
4. Other Sectors	D, T2	CS	D, T2	D, C	D, T2	D, C						
5. Other	D, T2	CS	D, T2	D, C	D, T2	D, C						
B. Fugitive Emissions from Fuels												
1. Solid Fuels			D, C	D, CS								
2. Oil and Natural Gas	C, CS	CS	C, CS	CS								
2. Industrial Processes												
A. Mineral Products	D	D										
B. Chemical Industry	D	D, C, CS	D	D, C, CS	D	D, CS						
C. Metal Production	D, C	D, C, CS	C	C					D, T1, T2	CS		
D. Other Production	D, C	D, C, CS										
E. Production of Halocarbons and SF_6							CS	CS	CS	CS	CS	CS
F. Consumption of Halocarbons and SF_6							D, T2	CS	D, T1	CS	D, T2a	CS
G. Other												
3. Solvent and Other Product Use	D	D										
4. Agriculture												
A. Enteric Fermentation			D, T2	D, CS								
B. Manure Management			D, T1, T2	D, CS	D	D, CS						
C. Rice Cultivation			D	D								
D. Agricultural Soils					D	D, CS						
E. Prescribed Burning of Savannas												
F. Field Burning of Agricultural Residues			D	D	D	D						
G. Other												
5. Land-Use Change and Forestry												
A. Changes in Forest and Other Woody Biomass Stocks	D, CS	D, CS										
B. Forest and Grassland Conversion												
C. Abandonment of Managed Lands	D	D										
D. CO_2 Emissions and Removals from Soil	D	D, CS										
E. Other												
6. Waste												
A. Solid Waste Disposal on Land			D, T2	D, CS								
B. Wastewater Handling			D	D, CS	D	C, CS						
C. Waste Incineration	D	CS	D	CS	D	CS						
D. Other			CS	CS								
7. Other (please specify)												

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

Activity data used in emission calculations and their sources are briefly described herebelow.
In general, basic statistics for estimating emissions from the energy sector are fuel consumption published in the Energy Balance and provided by the Ministry of Production Activities. Additional information for electricity production is provided by the major national electricity producers and for the industry sector by the major national industry corporation. On the other hand, for the transport sector, basic information for road transport, maritime and aviation, such as the number of vehicles, harbour statistics and aircraft landing and take-off cycles are provided in statistical yearbooks published both by the National Statistics Institute and the Ministry of Transportation. Other data are communicated by different associations.
For the other sectors, i.e. industrial process, the annual production is provided by national and international statistical yearbooks; for solvents, the amount of solvent use is provided by environmental publications of sector industries and specific associations as well as international statistics. For agriculture, annual production data and number of animals are provided by the National Statistics Institute. For land use change and forestry, forest and soil surfaces are provided by the National Statistics Institute and the hectares burnt by State Forestry Corps. For waste, the main

activity data are provided by the Agency for the Protection of the Environment and for Technical Services and the Waste Observatory.
In case basic data are not available proxy variables are considered in the estimation process; unpublished data are used only if supported by personal communication and confidentiality of data is respected.
Even though there is not a specific register of these data, all the materials and documents used for the inventory emission estimates are kept at the Agency for the Protection of the Environment and for Technical Services.

1.5 Brief description of key source categories

A key source analysis has been carried out according to the Tier 1 and Tier 2 methods described in the IPCC Good Practice Guidance (IPCC, 2000). A key source category is defined as an emission source that has a significant influence on a country's GHG inventory in terms of the absolute level of emissions, the trend in emissions, or both. Key source categories are those which, when summed together in descending order of magnitude, adds up to over 95% of the total emissions.
National emissions have been disaggregated, as far as possible, into the categories proposed in the Good Practice Guidance; other categories have been added to reflect specific national circumstances. Both level and trend analysis have been applied. As far as both level and trend emission sources are concerned, 29 key sources were totally individuated. Results are reported in Table 1.3.

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

Key source categories	
CO2 stationary combustion liquid fuels	L, T
CO2 stationary combustion solid fuels	L, T
CO2 stationary combustion gaseous fuels	L, T
CO2 Mobile combustion: Road Vehicles	L, T
CO2 Cement production	L, T
CH4 Enteric Fermentation in Domestic Livestock	L, T
CH4 from Solid waste Disposal Sites	L, T
Direct N2O Agricultural Soils	L, T
N2O Adipic Acid	L1, T
Indirect N2O from Nitrogen used in agriculture	L, T2
N2O stationary combustion	L, T2
HFC, PFC substitutes for ODS	L, T
CO2 Mobile combustion: Waterborne Navigation	L1
CH4 Fugitive emissions from Oil and Gas Operations	L, T
N2O Manure Management	L, T2
CH4 Manure Management	L, T2
N2O Mobile combustion: Road Vehicles	L, T
CO2 Mobile combustion: Aircraft	T1
CO2 Other industrial processes	T1
N2O Nitric Acid	T1
CO2 Mobile combustion: Other	T1
CO2 Limestone and Dolomite Use	T1
CO2 Fugitive emissions from Oil and Gas Operations	L2, T
N2O from animal production	L2, T2
CH4 Emissions from Wastewater Handling	L2, T2
CH4 from Rice production	L2
CO2 Emissions from Other Sources (solvent use)	L2, T2
CH4 stationary combustion	L2
N2O Emissions from Wastewater Handling	L2, T2

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

A specific QA/QC system has not been developed yet, even though QA/QC techniques and different verification procedures are already applied as part of the inventory estimation process.

The Italian Atmospheric Emission Inventory and the Italian Greenhouse Gas Inventory are compiled and maintained by the Agency for the Protection of the Environment and for Technical Services which is the Inventory Agency responsible for data submission. The whole inventory is compiled by the agency with the help of other scientific and technical institutions and consultants for improving information both on activity data and emission factors of specific activities. All the measures to guarantee and improve the transparency, consistency, comparability, accuracy and completeness of the inventory are undertaken.

The quality of the inventory has improved over the years and further investigations are planned for all those sectors relevant in terms of contribution to total CO_2 equivalent emissions and with a high uncertainty.

In addition to *routine* control activities related to completeness, consistency in the time series and correctness in the sum of sub-categories, specific quality control activities regard the check and accurate documentation of those cases where methodological and data changes result in recalculations.

Particular attention is paid to the archiving and storing of all inventory data, supporting information, inventory records as well as all the reference documents.

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

All the information used for the inventory compilation is traceable back to its source. The inventory is composed by spreadsheets to calculate emission estimates; activity data and emission factors as well as methodologies are referenced to their data sources, while all information and documentation are held at the Agency so as to be consulted whenever needed.

Quality assurance procedures regard some verification activities of the inventory as a whole and at sectoral level. Drawbacks derive, in particular, from the communication of data to different institutions and/or at local level. The preparation of environmental reports where data are needed at different aggregation levels or refer to different contexts such as environmental and economic accountings is also a check for emission trends. At national level, for instance, emission time series are reported in the Environmental Data Yearbook published by the Agency; they are also published by the Ministry of Environment in the Report on the State of the Environment and communicated to the National Institute of Statistics to be published in their Environmental Statistics Yearbooks and used in the framework of the EUROSTAT NAMEA Project.

Comparisons of national activity data with those stored in international databases are usually carried out in order to find out the main differences and an explanation to them; this results in a better understanding and detail of the basic data. Such a comparison has mainly regarded data for the agriculture and industrial processes sectors. The results are reported in the specific chapters. Additional comparisons of emission estimates from industrial sectors with those published by the industry itself in the Environmental reports are carried out annually in order to assess the quality and the uncertainty of the estimates.

For the evaluation of the Italian policies and measures, a study was carried out by Ecofys to verify the effectiveness of policies and measures undertaken by Italy to reduce greenhouse gas emissions to the levels established by the Kyoto Protocol. In this framework an independent review and checks on emission levels were carried out as well as controls on the transparency and consistency of methodological approaches (Ecofys, 2001).

The quality of the inventory is also improved by the organization and participation in sector specific workshops. Furthermore, follow-up processes are set up in the framework of the WGI under the EC Monitoring Mechanism, which has up to now addressed to the improvement of methodologies in the agriculture and LUCF sectors, involving the Joint Research Centre, as well methodologies to estimate emissions from international bunkers. Regarding this last point, national methodologies used to estimate emissions from aviation and marine bunkers were explained by the different countries at a specific European workshop on bunker fuels held at the EEA in Copenhagen which involved the International Energy Agency and EUROCONTROL. The workshop aimed at comparing methodologies and discussed the most common problems among countries which is the split of fuel into domestic and international.

International reviews also contribute to improve the inventory and identify areas where further improvements are needed. Specifically, the Italian GHG inventory was subjected to a centralised review by the UNFCC Secretariat; in response to it the complete CRF tables for the whole time series were communicated, including the use of notation keys and recalculation tables.

A specific procedure undertaken for improving the inventory regards the establishment of national expert panels (specifically, in road transport, forests and energy production sectors) which involve, on a voluntary basis, different institutions, local agencies and industrial associations which cooperate for improving activity data and emission factors accuracy.

Specific activities relating to QA/QC which were carried out in the last year were:

- *Waste Sector Emissions Review.* A review of emission estimates from the waste sector was undertaken. Specifically, for emissions from wastewater handling, on the basis of new information, wastewater flows and COD concentration values were revised and emissions from the leather industry introduced. As regards emissions from waste incineration, activity data were revised in account of information available at individual plant level; industrial, hospital waste, sludge and waste oil incinerated in each plant with or without energy recovery was therefore specified and emissions recalculated. These modifications applied to the entire time series.
- *Halocarbons and Sulphur Hexafluoride Review.* A review carried out together with industrial associations led to a further improvement of F-gas inventory. Specifically, as concerns PFC emissions from primary aluminium production, the estimates were carried out with the contribution of the only national producer. The Tier 1 method was applied for the time series from 1990-1999, whereas from 2000, the Tier 2 method has been followed using national site specific values, when available. A revision of the time series has concerned HFC emissions on the basis of a major information on leakage rates made available by the European Association of Responsible Use of HFCs in Fire Fighting.
- *Energy Balance Verification.* The task force of energy and inventory experts (Ministry of Production Activities, ENEA and APAT) established to examine differences in basic data between the CRF and the joint EUROSTAT/IEA/UNECE questionnaire submissions and to improve the details of the National Energy Balance finalised its study and reported the results in the document "Energy data harmonization for CO_2 emission calculations: the Italian case" (ENEA/MAP/APAT, 2004).

The expert group within EUROSTAT NAMEA project formed by ISTAT, APAT and Ministry of Production Activities reported the results on the disaggregation of emission estimates by sector in internal documents.

- *Road Transport Emissions Review.* The Italian Expert Panel on Transport, which includes experts from Research Institutes, Universities, Industrial Associations, Local Authorities, Ministries and Public Authorities, has continued its work on the improvement and assessment of emission estimations from road transport. Specifically, this year the group was organised in sub-groups according to different subjects of interest. There has been a considerable improvement on the details of basic data to be used within the COPERT model, both in terms of availability and timeliness. Studies of the expert panel group as well as presentations held in different meetings can be found on the website http://amb-emiss.apat.it/EPTransport.
- *MeditAIRaneo Project.* A three years project involving the Inventory Reference Centres of the European Mediterranean Countries (Italy, Spain, France, Greece, Portugal) started at the end of the year 2000. The aim was to examine in details emissions that are specific and/or typical of the Mediterranean Countries. Four different studies on air emissions from vegetation, agriculture, solvent use and urban road transport in Mediterranean areas were funded by APAT, some of which are still in progress. Common objectives are analysis of methodologies and emission factors used by Mediterranean countries for estimating emissions, individuation of Mediterranean peculiarities, in comparison with other European countries, such as climate, technologies, industrial management, identification of methodological points which need in-depth examination and uncertainty assessment. An Italian case study is also planned for each of the four projects. By mid 2005, all the projects will be concluded and the results will be used in the national inventory to improve country-specific emission factors.
- Data from the Italian Pollutant Emission Register (EPER) from some industrial sectors were used as a check and comparison with the estimates carried out at national level. In particular, this regards the production of non-ferrous metals, some chemical productions such as nitric and sulphuric acid, and the production of iron and steel.

  At the national level, various meetings with industry representatives were held in the process of implementing the emission trading directive; this resulted in a better understanding of some processes and the improvement of national emission factors and activity data. Specifically, this was the case of emissions from refineries, production of lime and cement, iron and steel, primary aluminium, bricks and tiles.
- *Local inventories*. A top-down approach to the preparation of local inventories was used. The estimates are checked out by regional and local environmental agencies and authorities in order to find out the main weak points and contribute with information available and characterising the local environment, this contributing as a feedback to the improvement of the national inventory. The results of this study will be available in the next few months. Further improvements in 2004 will concern: the analysis of other sectoral industrial data from the Italian EPER; a revision of emissions from the solvent and other product use sector, (in particular N_2O emissions not yet estimated will be included); a revision of emissions from solid waste disposal on land, specifically a study on the average degradable organic carbon on the basis of the waste composition in Italy and on the landfill gas recovery system in Italy will be carried out.

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

The IPCC Good Practice Guidance (IPCC, 2000) defines the Tier 1 and Tier 2 approaches to estimating uncertainties in national greenhouse gas inventories. At the moment, quantitative estimates of the uncertainties for the Italian GHG inventory are calculated using a Tier 1 approach, which provides a simplified calculation based on the error propagation equations, whilst a Tier 2 approach, corresponding to the application of Monte Carlo analysis, will be applied in the next submissions. With this regard, a specific study on the comparison of different methodologies which can be used to evaluate uncertainty of emissions was finalised (Romano *et al*., 2004).
The results of the Tier 1 approach are shown in Annex 1. Emission sources are disaggregated into a detailed level and uncertainties are then estimated for these categories.
The Tier 1 approach suggests an uncertainty of 2.5 % in the combined GWP total emissions in 2002. The analysis also estimates an uncertainty of 2.4 % in the trend between 1990 and 2002.

1.8 General assessment of the completeness

The inventory covers all major sources and sinks, as well as direct and indirect gases, included in the IPCC guidelines.
Table 1.4 summarizes the sectoral coverage of the GHG emissions.

As regards CRF sheets, sectoral tables are complete as far as the details of basic information are available. For instance, as concerns emissions from the military sector, sources are not distinguished between stationary and mobile but only mobile emissions are reported separately; stationary emissions are, on the other hand, included in commercial/institutional sector (1.A.4.a).
There are only few cases in which emissions are not estimated yet: CH_4 emissions from waste incineration both for biogenic and plastics and other non-biogenic waste, (not estimated because of lack of emission factors), N_2O emissions from other solvent use, (both activity data and emission factors not being available), and potential emissions of PFCs. Emissions related to N_2O from other solvent use will be included in the next year submission as far as information is available.
Furthermore, sectoral background data for energy as regards fuel consumption disaggregated by type in Manufacturing Industries and Construction, although provided in the CRF and revised as compared to the previous submission, are still subject to modification because such details are not included in the Energy Balance and additional information and work are still needed to overcome this lack. The choice of including emissions for chemicals and food processing, beverages and tobacco in “Other” is due to the fact that for this year efforts have been done to ameliorate the estimates of fuel consumption for the other activities: Iron and steel; Non-ferrous metals; Pulp, paper and print and consumption of other fuels for chemicals. Multilateral operations emissions are not estimated because no activity data are available.
As concerns fugitive emissions, CH_4 emissions from oil exploration are included in those from oil production because no detailed information is available. Emissions from transport and distribution of oil result as not occurring or negligible. CH_4 emissions from gas exploration are also included in those from production while other leakage emissions are included in distribution emission estimates. Further investigation will be done with industry about these estimations.

Table 1.4 Completeness of the Italian GHG inventory

TABLE 7 OVERVIEW TABLE(1) FOR NATIONAL GREENHOUSE GAS INVENTORIES - COMPLETENESS AND QUALITY OF ESTIMATES

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2		CH_4		N_2O		HFCs		PFCs		SF_6		NO_x		CO		NMVOC		SO_2	
	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality
[illegible]	[illegible]																			

[illegible]

CH_4 emissions from gas venting are included with natural gas under 1.B.2.b, production, as not separately supplied by the relevant industries.

As concerns industrial processes, emissions and activity data for limestone and dolomite use are now reported separately, whereas emissions from soda ash use are included in glass and paper production emissions.

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 1990-2002 are reported in Annex 7 in Tables A7.1- A7.5.
The emission figures presented are those sent to the UNFCCC Secretariat and to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism. In agreement with the Convention on Climate Change, the National Greenhouse Gas Inventory is communicated through compilation of the Common Reporting Format.
Total greenhouse gas emissions, in CO_2 equivalent, excluding emissions and removals of CO_2 from land use change, have increased by 9% between 1990 and 2002, varying from 508 to 554 CO_2 equivalent million tons (Mt), whereas the national Kyoto target is a reduction of 6.5%, as compared the base year levels, by the period 2008-2012.
The most important greenhouse gas, CO_2, which accounts for 84.7% of total emissions in CO_2 equivalent, shows an increase by 8.8% between 1990 and 2002. In the energy sector, in particular, emissions in 2002 are 15% greater than in 1990.
CH_4 and N_2O emissions are equal, respectively, to 6.2% and 7.6% of the total CO_2 equivalent greenhouse gas emissions. CH_4 emissions have fallen by 7.7% from 1990 to 2002, while N_2O has increased by 10.4 %.
Other greenhouse gases, HFCs, PFCs and SF_6, range from 0.3% to 1.5% of total emissions; at present, variations in these gases are not relevant to reaching the emission reduction objectives. Figure 2.1 illustrates the national trend of greenhouse gases for 1990-2002, expressed in CO_2 equivalent terms and by substance; CO_2 emissions do not include emissions and removals from land use change.

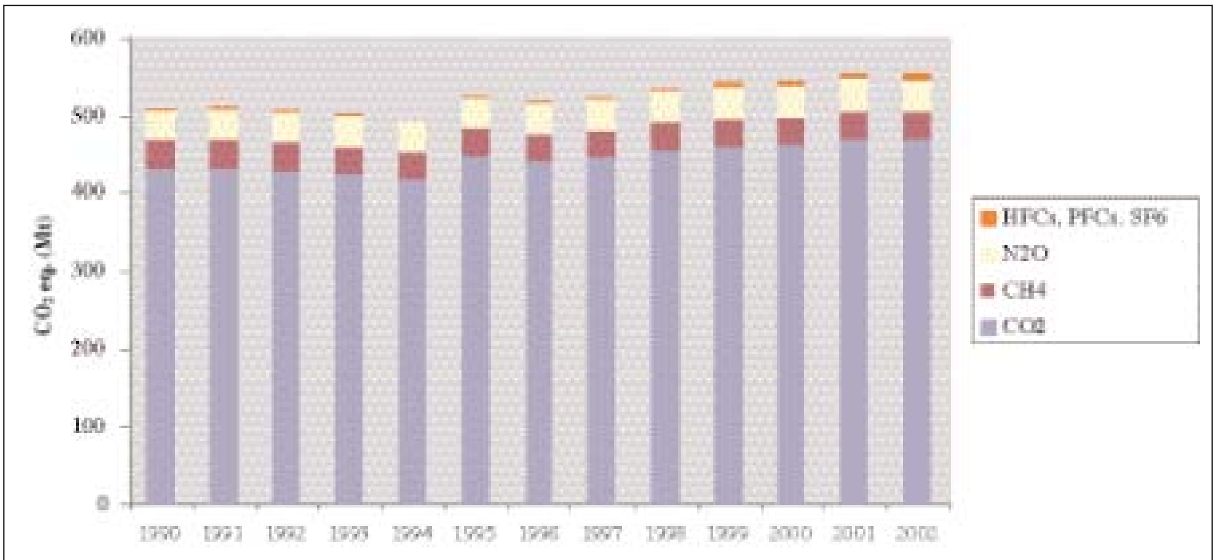

Figure 2.1 National greenhouse gas emissions from 1990 to 2002

As concerns the share of the different sectors in terms of total emissions, it remains nearly unvaried over the period 1990-2002. The greatest part of the total greenhouse gas emissions is to be attributed to the energy sector, with a percentage of 83%, followed by agriculture and industrial processes, both accounting for 7% of total emissions, waste and use of solvents. Figure 2.2 shows the total greenhouse gas emissions subdivided by sector.

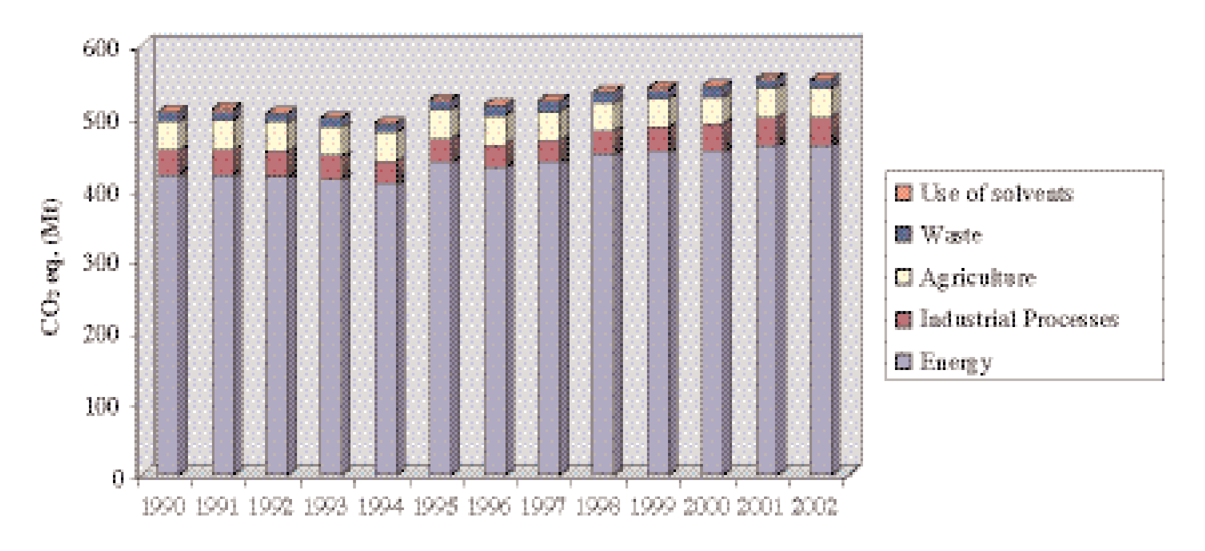

Figure 2.2 Greenhouse gas emissions from 1990 to 2002 by sector

2.2 Description and interpretation of emission trends by gas

2.2.1 Carbon dioxide emissions

CO_2 emissions, excluding emissions and removals from land use change and forestry, have increased by approximately 9% from 1990 to 2002, ranging from 431 to 470 million tons.
The most relevant emissions derive from the energy industries (33%) and transportation (27%). Manufacturing and construction industries account for 18%, non-industrial combustion for 17%, while the remaining emissions derive from industrial processes (5%) and other sectors (1%). The performance of CO_2 emissions by sector is shown in Figure 2.3.
The main sectors responsible for the increase of CO_2 emissions are transport and energy industries; in particular, emissions from transport have increased by 23% from 1990 to 2002 while those from energy industries by 12%. On the other hand, a decrease is observed in the industrial processes, in manufacturing industries and construction and in other sectors.

Figure 2.4 illustrates the performance of the following economic and energy indicators:
• Gross Domestic Product (GDP) at market prices as of 1995 (base year 1990=100);
• Total Energy Consumption;
• CO_2 emissions, excluding emissions and removals from land-use change and forests;
• CO_2 *intensity*, which represents CO_2 emissions per unit of total energy consumption.

The figures of CO_2 emissions per total energy unit show that CO_2 emissions in the 1990s essentially mirrored energy consumption, with discrepancy between the curves arising only in recent years,

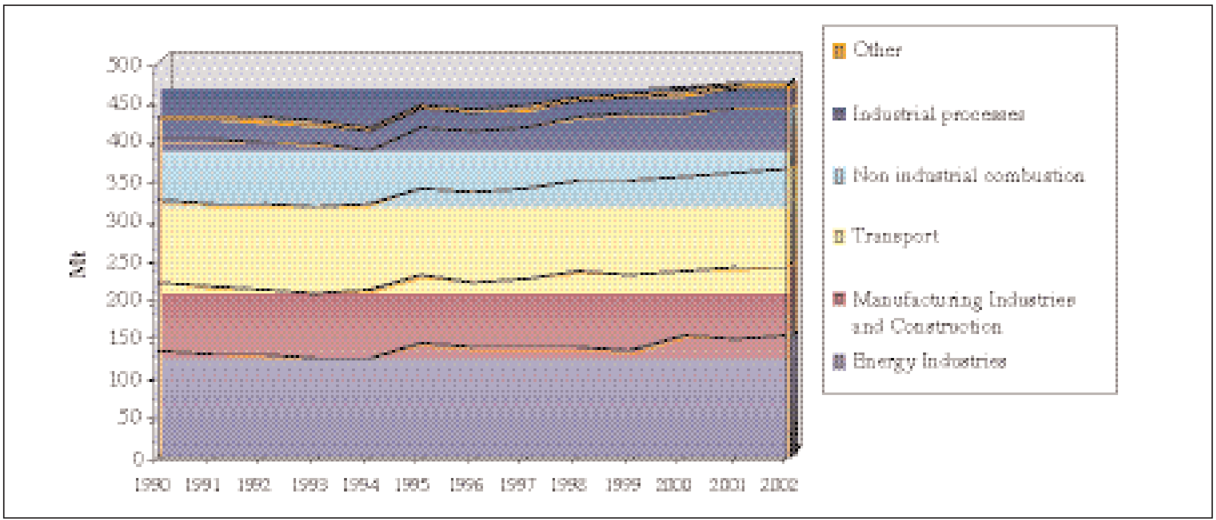

Figure 2.3 National emissions of CO_2 by sector from 1990 to 2002

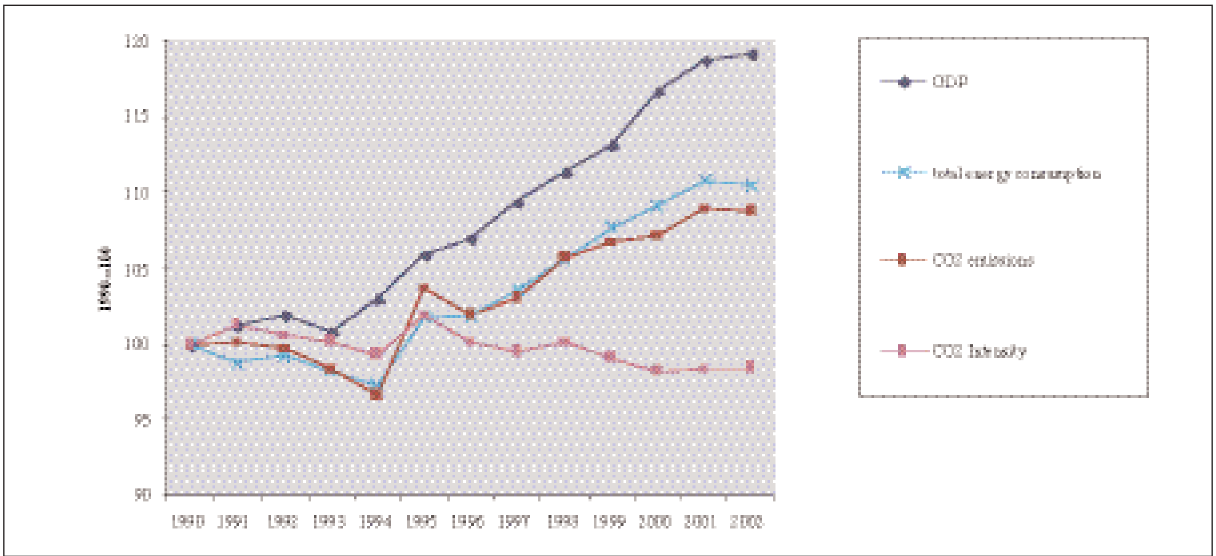

Figure 2.4 Energy-related and economic indicators and CO_2 emissions

mainly as a result of the substitution of fuels with high carbon contents by methane gas in the production of electric energy and in industry. Nevertheless, this trend stopped in the last two years, due to the increase of coal consumption in power plants.

2.2.2 Methane emissions

Methane emissions in 2002 represent 6.2% of total greenhouse gases, equal to 34.3 Mt in CO_2 equivalent, and show a decrease of approximately 3 Mt compared to 1990.
CH_4 emissions are mainly originated from the agricultural sector, which accounts for 48% of total emissions, as well as to the management of waste (31.6%) and to energy (19.9%).
Emissions in the agricultural sector regard the breeding of animals. These emissions do not show significant variations during the period.
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 (-0.9% compared to 1990).
In terms of CH_4 emissions in the energy sector, the reduction (-18%) is the result of two contrasting factors; on the one hand there has been a considerable reduction in emissions caused by leakage from the extraction and distribution of fossil fuels, due to the gradual replacement of natural-gas distribution networks; at the same time, combustion emissions in the road transport sector have increased on account of the overall rise in consumption and, in the civil sector, as the result of increased use of methane in heating systems.
Figure 2.5 shows the emission figures by sector.

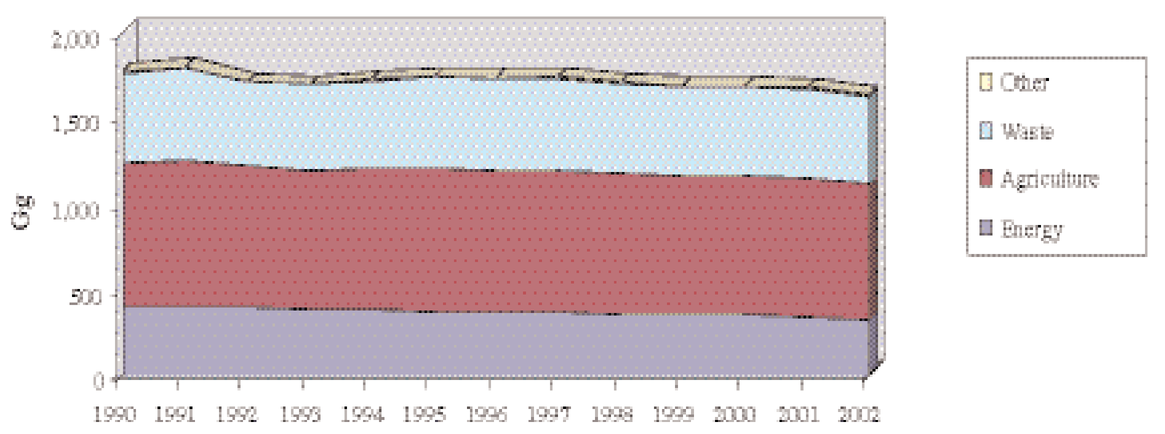

Figure 2.5: National CH_4 emissions by sector from 1990 to 2002

2.2.3 Nitrous oxide emissions

In 2002 nitrous oxide emissions represent 8% of total greenhouse gases, with a growth rate of 10.4% between 1990 and 2002, from 38.2 to 42.2 CO_2 equivalent Mt.
The major source of N_2O emissions is the agricultural sector (54.9%), in particular the use of both chemical and organic fertilisers in agriculture, as well as the management of waste from the raising of animals. These emissions are constant during the period 1990-2002.
Emissions in the energy-use sector (25% of the total) show an increase by approximately 22% from 1990 to 2002; this growth can be traced primarily to the road transport sector and is related to the introduction of catalytic converters. However, a high degree of uncertainty still exists with regard to the N_2O emission factors of catalysed automobiles.
The production of nitric acid, which has decreased in recent years, and of adipic acid, whose levels have grown, account totally for 28% of total emissions.
Other emissions in the waste sector primarily regard the processing of industrial and domestic waste-water.
Figure 2.6 shows national emission figures by sector.

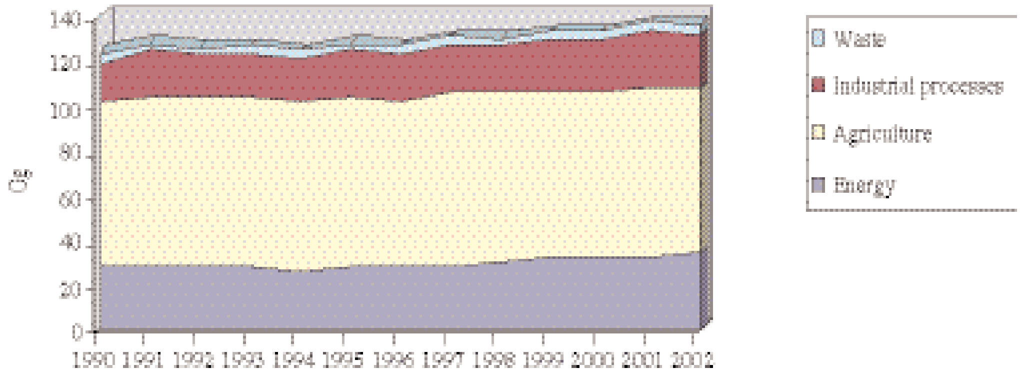

Figure 2.6 National N_2O emissions by sector from 1990 to 2002

2.2.4 Fluorinated gas emissions

Italy has set 1995 as the base year for reduction in the emissions of the fluorinated gases covered by the Kyoto Protocol, that's HFCs, PFCs and SF_6. Taken altogether, the emissions of fluorinated gases represent 1.5% of total greenhouse gases in CO_2 equivalent, and they show an increase of 414% between 1995 and 2002. This increase is the result of different features for different gases.

HFCs, for instance, have increased considerably from 1995 to 2002, from 0.7 to 7.1 CO_2 equivalent Mt. The main sources of emissions are the consumption of HFC-134a, HFC-125, HFC-32 and HFC-143a in refrigeration and air-conditioning devices, together with the use of HFC-134a in pharmaceutical aerosols. Increases during this period are due both to the use of these substances as replacements for gases that destroy the ozone layer and to the greater use of air conditioners in automobiles.

Emissions of PFCs have risen by approximately 23% from 1995 to 2002. The level of these emissions in 2002 is 0.4 Mt in CO_2 equivalent, and it can be traced in equal proportion to the use of the gases in the production of aluminium and in the production of semiconductors. Although the

Figure 2.7 National emissions of fluorinated gases by sector from 1990 to 2002

production of PFCs is equal to zero in Italy from the year 1999 onwards, the upward trend shown by the series is due to their consumption and to their use in metal production.
Emissions of SF_6 are equal to 0.8 Mt in CO_2 equivalent in 2002, with an increase of 26% compared to 1995. Out of the SF_6 emissions, 52% can be traced to the use of gas in magnesium foundries, 40% to the gas contained in electrical equipments. The rest of the emissions results from the gas use in the production of semiconductors. The gas use both in magnesium foundries has been on the rise in recent years, unlike the figures for the gas contained in electrical equipments, which have fallen.
The National Inventory of fluorinated gases has largely improved this year in terms of the sources and the gases identified. Further in-depth examination and controls are required but higher methods have been applied and some difficulties in procuring activity data from the industry overcome. Nevertheless, uncertainty still regards some activity data which are considered of strategic economic importance and therefore kept confidential and not communicated.

2.3 Description and interpretation of emission trends by source

2.3.1 Energy

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

Table 2.1 Total emissions in CO_2 equivalent from the energy sector by source (1990-2002)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total emissions CO_2 equivalent (Gg)	419,591	419,972	417,838	414,733	408,665	435,920	431,665	435,929	447,452	451,497	453,649	459,817	459,887
Fuel Combustion (Sectoral Approach)	409,760	410,323	[illegible]	405,310	398,879	427,093	421,366	427,408	438,464	444,454	445,342	452,610	453,153
Energy Industries	134,709	133,499	129,009	124,924	126,683	142,058	137,271	138,549	152,320	132,954	152,012	148,352	155,425
Manufacturing Industries and Construction	89,625	87,114	[illegible]	85,997	85,222	[illegible]	87,375	93,790	[illegible]	100,461	96,217	[illegible]	[illegible]
Transport	104,332	106,908	111,345	113,164	117,232	115,385	116,542	118,938	122,473	123,879	124,425	126,482	128,246
Other Sectors	78,882	83,381	82,303	81,720	72,202	78,292	80,940	78,232	82,499	86,009	82,888	86,585	82,424
Other	1,114	2,269	1,535	1,581	1,507	1,509	2,238	2,109	2,092	1,154	852	[illegible]	332
Fugitive Emissions from Fuels	9,831	9,619	9,381	9,287	8,987	8,852	8,383	8,527	8,487	7,643	7,319	7,403	7,090
Solid Fuels	117	110	108	81	71	68	60	60	35	37	64	70	66
Oil and Natural Gas	9,714	9,509	9,288	9,206	8,916	8,568	8,323	8,468	8,452	7,606	7,255	7,371	7,024

An upward trend is noted from 1990 to 2002; totally, emissions from this sector increased by about 9.7%.
Substances with the highest increase rate are CO_2, whose levels have increased by 10% from 1990 to 2002 and account for 96% of the total, and N_2O which shows an increase of 17% but its share out of the total is only 1.5%; CH_4, on the other hand, shows a decrease of 18.3% from 1990 to 2002 but this is not relevant on total emissions, accounting for 2%.
Details on these figures are described in the specific chapter.
It should be noted that the most significant increase, in terms of total CO_2 equivalent, is observed in the transport and energy industries sectors, about 24% and 15%, respectively, from 1990 to 2002; these sectors, altogether, account for more than 60% of total emissions.

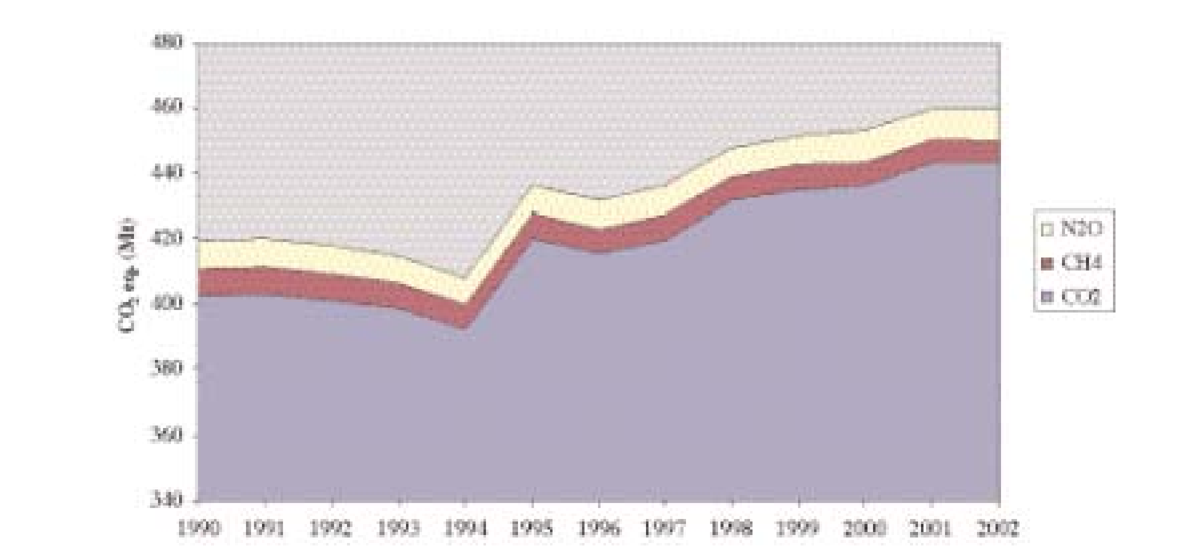

Figure 2.8 Trend of total emissions in CO_2 equivalent from the energy sector by gas (1990-2002)

2.3.2 Industrial processes

Emission trends from industrial processes are reported in Table 2.2 and Figure 2.9.

Table 2.2 Total emissions in CO_2 equivalent from industrial processes sector by gas (1990-2002)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total emissions CO_2 equivalent (Gg)	34,578	34,306	33,748	30,779	29,522	32,681	30,224	31,308	32,609	33,871	36,660	39,144	40,267
CO_2	26,154	25,820	26,363	23,332	22,404	24,247	22,169	22,543	22,635	23,165	24,300	24,795	24,485
CH_4	121	117	114	114	120	127	116	122	123	120	121	115	116
N_2O	5,811	6,234	5,748	5,976	5,747	6,618	6,408	6,444	6,624	6,874	7,301	7,628	7,467
HFC_s	331	353	359	333	402	671	605	1,218	2,351	3,049	4,096	5,560	7,106
PFC_s	1,808	1,425	799	638	355	337	243	252	270	258	346	452	424
SF_6	333	356	356	370	424	681	683	729	605	405	499	795	760

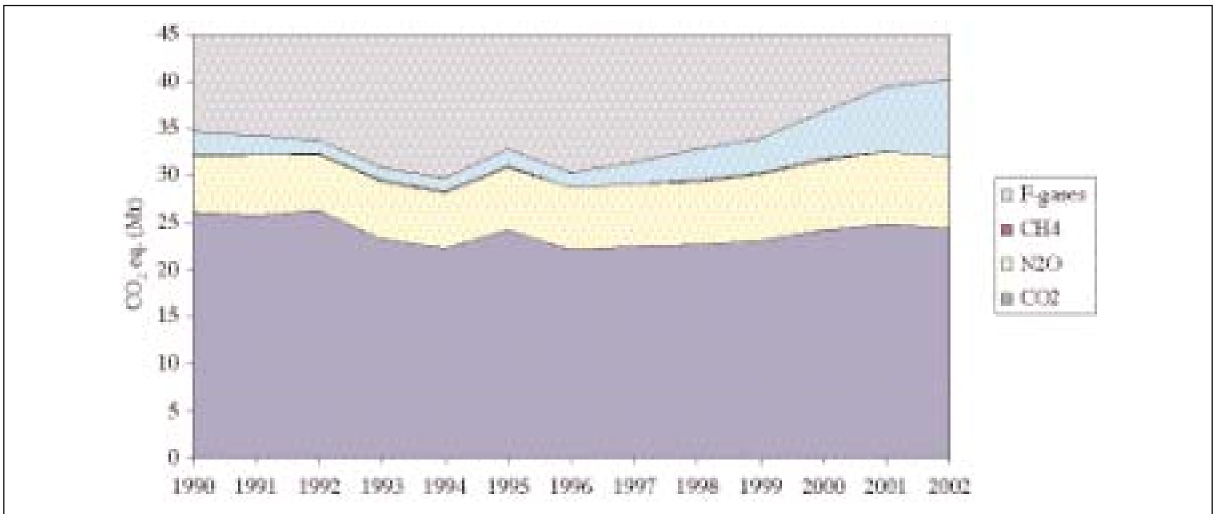

Figure 2.9 Trend of total emissions in CO_2 equivalent from industrial processes by gas (1990-2002)

Total emission levels, in CO_2 equivalent, show an increase of 19%, from the base year to 2002. Taking into account emissions by substance, CO_2 levels fell down by 7% while N_2O raised up to 28%; these two substances account altogether for about 88% of the total emissions from industrial processes. A considerable increase is observed in F-gas emissions (414%) and the share of these gases on the total emissions is 21%.
Details for industrial processes emissions can be found in the specific chapter.

2.3.3 Solvent and other product use

Emissions from the solvent and other product use sector refer totally to CO_2, except for gases other than greenhouse.
A considerable amount of emissions from this sector is, in fact, also to be attributed to NMVOC. Considering CO_2, a decrease by 28% is observed from 1990 to 2002 due substantially to the different sources.
Emission levels from paint application sector, which accounts for 54% of total emissions, decreased by 20%; emissions from other use of solvents in related activities, such as domestic solvent use other than painting, printing industries, vehicle dewaxing, which account for 40% of the total, show a decrease of 32%.
Finally, emissions from metal decreasing and dry cleaning activities, decreased by 56% but account for only 6% of the total.
Further details about this sector can be found in the specific chapter.

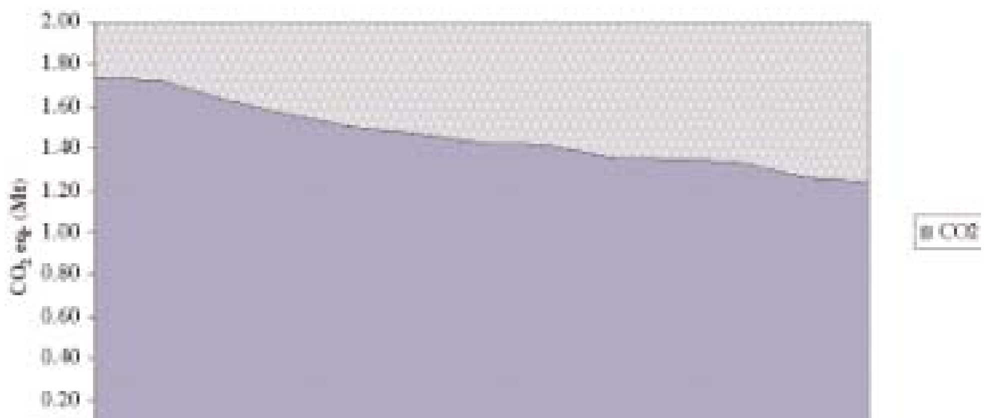

Figure 2.10 Trend of total emissions in CO_2 equivalent from the solvent and other product use sector (1990-2002)

2.3.4 Agriculture

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

Table 2.3 Total emissions in CO_2 equivalent from the agricultural sector by source (1990-2002)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total emissions CO_2 equivalent (Gg)	**40,349**	**41,764**	**41,295**	**41,216**	**41,268**	**41,072**	**40,702**	**41,711**	**40,905**	**40,577**	**40,319**	**40,977**	**39,694**
Enteric Fermentation	12,044	12,567	12,095	11,382	12,111	12,182	12,038	12,023	11,856	11,579	11,603	11,383	11,042
Manure Management	7,872	7,987	7,727	7,596	7,593	7,846	7,822	7,938	8,072	7,992	7,898	8,204	8,089
Rice Cultivation	1,539	1,474	1,545	1,655	1,685	1,709	1,696	1,663	1,590	1,573	1,534	1,554	1,562
Agricultural Soils	18,897	19,718	19,889	20,165	19,861	19,303	19,029	20,035	19,368	19,413	19,244	19,577	18,985
Field Burning of Agricultural Residues	17	19	18	17	18	17	18	16	13	13	16	15	13

Emissions refer to CH_4 and N_2O levels, which account for 42% and 58% of the total emission of the sector, respectively. The small decrease observed in the total emissions (-2%) is mostly due to the decrease of CH_4 emissions from enteric fermentation (-8%) which account for most of the total emissions. Detailed comments can be found in the specific chapter.

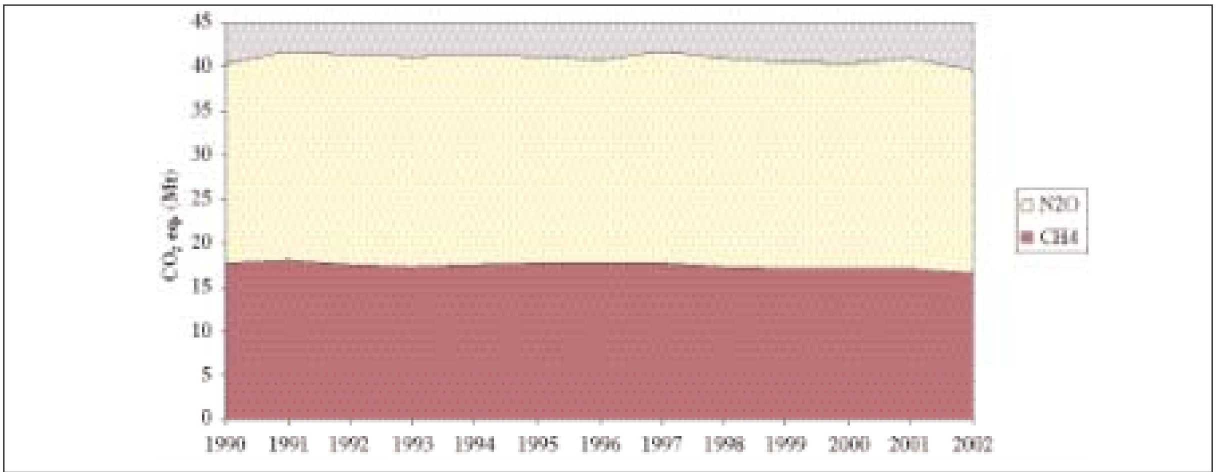

Figure 2.11 Trend of total emissions in CO_2 equivalent from agriculture (1990-2002)

2.3.5 Waste

Emissions from the waste sector are shown in Table 2.4 and Figure 2.12 .
Total emissions in CO_2 equivalent decreased by 2.5% from 1990 to 2002. The decrease is mostly due to the decrease in emissions from waste incineration (-16%), which account for 5% of the total, as well as those from solid waste disposal (-2%) which account for 76%.
Considering emissions by gas, the most important greenhouse gas is CH_4 which accounts for 88% of the total and shows a decrease of 1% from 1990 to 2002. N_2O levels have increased by 4% while CO_2 decreased by 49%; these gases account for 10% and 2%, respectively. Further details can be found in the specific chapter.

Table 2.4 Total emissions in CO_2 equivalent from the waste sector by source (1990-2002)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total emissions CO_2 equivalent (Gg)	**12,626**	**13,009**	**12,011**	**12,852**	**12,400**	**12,802**	**12,876**	**12,569**	**12,546**	**12,557**	**12,442**	**12,626**	**12,308**
Solid Waste Disposal on Land	9,535	9,699	8,751	8,843	9,186	9,602	9,306	9,719	9,557	9,366	9,486	9,609	9,318
Waste-water Handling	2,299	2,307	2,307	2,298	2,308	2,299	2,289	2,298	2,295	2,298	2,311	2,320	2,324
Waste Incineration	793	1,003	953	1,010	986	990	881	950	692	883	643	694	663
Other	0	0	0	0	0	0	0	1	1	1	2	3	3

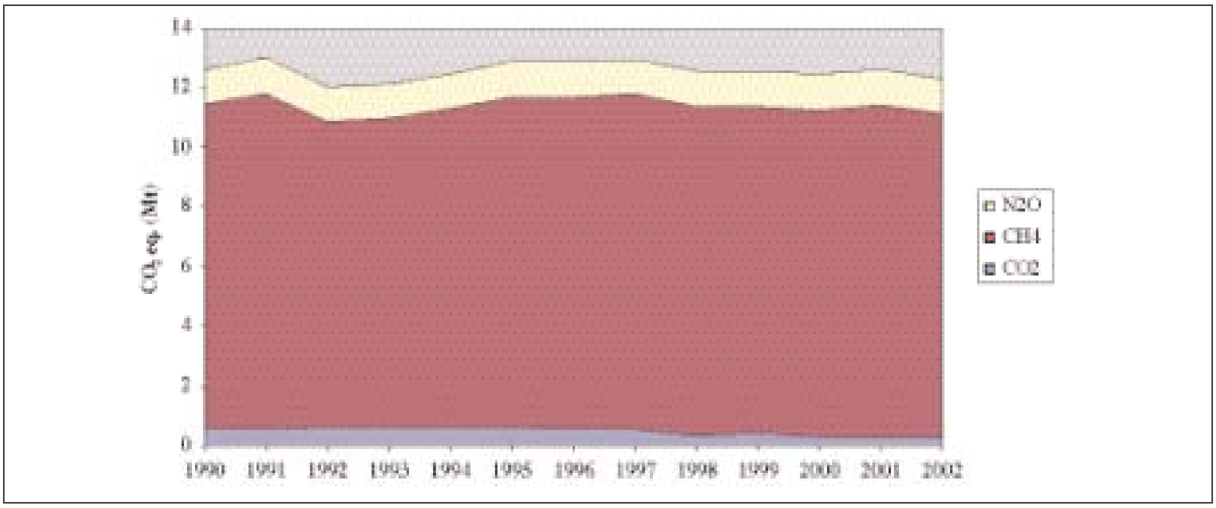

Figure 2.12 Trend of total emissions in CO_2 equivalent from waste (1990-2002)

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 2002 are presented in Table 2.5 and Figure 2.13.

Table 2.5 Total emissions for indirect greenhouse gases and SO_2 (1990-2002)

Indirect greenhouse gases and SO_2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Emissions in ktons													
NO_X	1,929	1,983	2,002	1,904	1,823	1,709	1,730	1,652	1,551	1,451	1,374	1,359	1,267
CO	7,117	7,408	7,608	7,550	7,343	7,111	6,829	6,667	6,148	5,869	5,179	5,090	4,486
NMVOC	2,030	2,097	2,146	2,102	2,045	2,021	1,974	1,908	1,802	1,710	1,541	1,442	1,340
SO_2	1,774	1,656	1,557	1,455	1,359	1,287	1,228	1,151	1,017	922	772	737	665

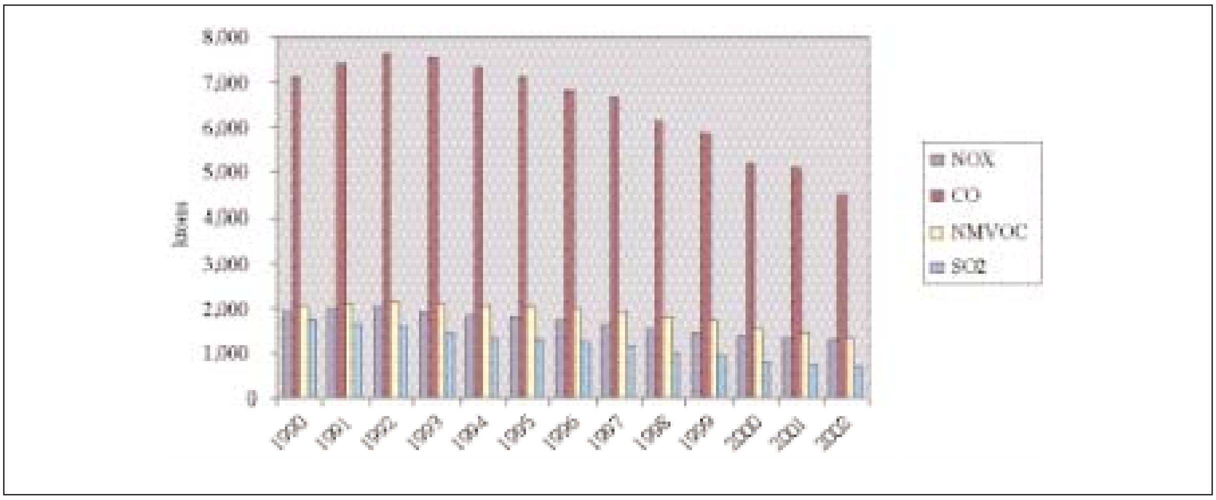

Figure 2.13 Trend of total emissions for indirect greenhouse gases and SO_2 (1990-2002)

All gases show a significant reduction in 2002 compared to 1990 levels. The highest reduction is observed for SO_2 (-63%), CO levels have reduced by 37%, while NO_X and NMVOC show a

decrease by about 34%. A detailed description of the trend by gas and sector as well as the main reduction plans can be found in the Italian National Programme for the progressive reduction of the annual national emissions of SO_2, NO_X, NMVOC and NH_3, as requested by the 2001/81/EC Directive.
The most relevant reductions occurred as a consequence of the Directive 75/716/EC and following European Directives which established maximum levels for sulphur content in liquid fuels and introduced emission standards for combustion installations. As a consequence, in the combustion processes, oil with high sulphur content and coal have been substituted with oil with low sulphur content and natural gas.

3. ENERGY [CRF SECTOR 1]

3.1 Introduction

The aim of this section is to describe in detail the methodology used to estimate the emissions arising from fuel combustion for energy. These sources correspond to IPCC Tables 1A.
Emission inventory is prepared using the energy consumption information available from national statistics and an estimate of the actual use of the fuels. The latter information is available at sectoral level in a great number of publications and it is needed to evaluate emissions of methane and nitrous oxide. Those emissions are related to the actual physical conditions of the combustion process and to environmental conditions.
There is little continuous monitoring of emissions performed in Italy; hence information is rarely available on actual emissions over a specific period of time from an individual emission source. Therefore, the majority of emissions is estimated from other information such as fuel consumption, distance travelled or some other statistical data related to emissions. Estimates for a particular source sector are calculated by applying an emission factor to an appropriate statistic. That is:

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

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

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

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

3.2 Key sources

Key source analysis for 2002 inventory has identified quite a lot of categories in the energy related emissions.
We prefer to address this sector with a comprehensive view instead of a source by source analysis, given the interconnection between the underlining data of most source categories. Herebelow we will list the relevant key sources making reference to the section of the text where they are quoted.

Table 3.1 Energy related key sources and relevant section

KEY SOURCE CATEGORIES, TIER 2	Relevant section	Notes
CO_2 stationary combustion gaseous fuels	3.3 and 3.4	Table 3.9
CO_2 stationary combustion liquid fuels	3.3 and 3.4	Table 3.9
CO_2 Mobile combustion: Road Vehicles	3.5 and 3.5.3	Tables -3.18,-3.19
CO_2 stationary combustion solid fuels	3.3 and 3.4	Table 3.9
N_2O Mobile combustion: Road Vehicles	3.5 and 3.5.3	Tables -3.18,-3.19
CH_4 Fugitive emissions from Oil and Gas Operations	3.11	
N_2O stationary combustion	3.3 and 3.4	Table 3.9
CO_2 Fugitive emissions from Oil and Gas Operations	3.11	
CO_2 Mobile combustion: Waterborne Navigation	3.5.4	Table 3.24

3.3 Methodology for estimation of emissions from combustion

For the pollutants and sources discussed in this section the emission results from the combustion of fuel. The activity statistics used to calculate the emission are fuel consumption statistics provided in the national energy balance ((MAP, 2004 [a])), GRTN (GRTN, 2004) for the power sector and some additional data sources to characterise the technologies used at sectoral level, quoted in the relevant sections.

Emissions are calculated using sector specific spreadsheets according to the equation:

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

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

The pollutants estimated in this way are:
- carbon dioxide (CO_2)
- NO_x as nitrogen dioxide
- nitrous oxide (N_2O)
- methane (CH_4)
- non methane volatile organic compounds (NMVOC)
- carbon monoxide (CO)
- sulphur dioxide (SO_2)

The sources covered by this methodology are:
- Electricity (power plants and Industrial producers)
- Refineries (Combustion)
- Chemical and petrochemical industries (Combustion)
- Construction industries (roof tiles, bricks)
- Other industries (engineering, food, textiles, others)
- Road Transport
- Coastal Shipping
- Railways
- Aircraft

• Domestic
• Commercial
• Public Service
• Fishing
• Agriculture

The fuels covered are listed in Table 3.6, though not all fuels occur in all sources. Sector specific tables specify the emission factors used.

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

The carbon factors used are based on national sources and should be appropriate for Italy. Most of the emission factors have been cross checked with the results of specific studies that evaluate the carbon content of the imported / produced fossil fuels at national level. A comparison of the current factors with the IPCC ones was carried out and the results suggest quite limited variations in liquid fuels and some differences in natural gas, explained by basic hydrocarbon composition, and in solid fuels. In case of differences between IPCC and national emission factors the latter have been usually preferred.

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

– transportation fuels have showed a significant variation around the year 2000 due to the reformulation of gasoline and diesel to comply with EU directive, see section 3.10 for details;
– the most important imported fuels, natural gas, fuel oil and coal show not negligible variations of carbon content from year to year, due to changes in the origin of imported fuel supply; a methodology has been set up to evaluate annually the carbon content of the average fuel used in Italy, see section 3.10 for details.

The Ministry of Production Activities (Ministero delle Attività Produttive, MAP) publishes annually energy balances (MAP, 2004 [a]) of fuels used in Italy. These balances compare total supply based on production, exports, imports, stock changes and known losses with the total demand. The difference between total supply and demand is reported as ‘statistical difference’. In Annex 5 a copy of 2002 data is attached, the full time series is available on the website http://www.minindustria.it/ita/default.htm.

Additionally to fossil fuel the national energy balance (BEN) reports commercial wood and straw combustion estimates for energy use, biodiesel and biogas. The estimate of emissions is based on these data and on other estimates (ENEA, 2004) 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 pollutants are included. CORINAIR methodology (EMEP/CORINAIR, 2001) includes emissions from the combustion of wood in the industrial and domestic sectors as well as the combustion of biomass in agriculture.

The inventory reports also the emissions from the combustion of lubricants based on data collected from waste oil recyclers and quoted in BEN; from 2002 onwards this estimate is included in the column “feedstocks” raw production, see annex 5, Table A5.1 - National energy balance, year 2002, Primary fuels.

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

• Other Industry

• Other Industry Off-road: See paragraph 3.7
• Iron & Steel (Combustion, Blast Furnaces, Sinter Plant): See Annex 4
• Petrochemical industries (Combustion): See Annex 4
• Other combustion with contact industries: glass and tiles: See Annex 4
• Other industries (engineering, food, textiles, others)
• Ammonia Feedstock (natural gas only): See Annex 4
• Ammonia (Combustion) (natural gas only): See Annex 4
• Cement (Combustion): See Annex 4
• Lime Production (non-decarbonising): See Annex 4

Thus the inventory estimate from fuel consumption emission factors refers to stationary combustion in boilers and heaters. The other categories are estimated by more complex methods discussed in the sections indicated. However, for these processes, where emissions arise from fuel combustion for energy production, these are reported under IPCC Table 1A. The fuel consumption of Other Industry is estimated so that the total fuel consumption of these sources is consistent with BEN.
According to the IPCC 1996 Revised Guidelines (IPCC, 1997), electricity generation by companies primarily for their own use is auto-generation, and the emissions produced should be reported under the industry concerned. However, most National Energy Statistics (including Italy) report emissions from electricity generation as a separate category. The Italian inventory makes an overall calculation, see section 3.3.1, and then attempts to report as far as possible according to the IPCC methodology. This includes reporting auto-generators as ‘1.A.2 Manufacturing Industries and Construction’ and ‘1.A.2.f. Other’, however iron and steel auto-generation is included in section 1.A.1c. Those reports are based on ENEL-GRTN (GRTN, 2004) estimates of fuel used for steam generation connected with electricity production.

3.4 Energy industries

3.4.1 Electricity production

The source of the data on fuel consumption is the annual report “Statistical data on electricity production and power plants in Italy” (“Dati statistici sugli impianti e la produzione di energia elettrica in Italia”), edited from 1999 by GRTN (Italian Independent System Operator), a public enterprise that runs the high voltage transmission system. For the period 1990-1998 the same data where published by ENEL (ENEL, several years), the former electricity monopoly. The time series is available since 1963.
In this report the consumptions of all the power plants are presented, either public or privately owned. The base data are collected at plant level on monthly basis, with estimation of physical quantities of fuels and the related energy content, based on laboratory tests. Up to 1999 the fuel consumption was reported at a very detailed level, 17 different fuels, allowing a quite precise estimation of the carbon content. From 2000 onward the published data aggregate all fuels in 5 groups that do not allow for a precise evaluation of the carbon content. In the meantime of recovering the full set of data the estimation of the carbon content is performed on the basis of the historical time series for each fuel group. In table 3.2 a copy of the time series 1990-2002 is reported.

At national level other statistics on the fuel used for electricity production do exist, the most remarkable being the BEN (National Energy Balance), published annually. Moreover the UP (Unione Petrolifera, Oil companies association) and ENI, the former national oil company, regularly publish data on this issue. In the past, up to year 1998, also the association of the industrial electricity producers (UNAPACE) published production data with the associated fuel consumption.

Table 3.2 Time series of power sector production by fuel, kt or 10^6 m3

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

Source: GRTN, 2004

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

– BEN data are prepared on the basis on GRTN reports to IEA, so both data sets come from the same source;
– GRTN data are revised to be adapted to BEN reporting methodology: balance is done on the energy content of fuels and the physical quantities of fuels are converted to energy using standard conversion factors; so the total energy content of the fuels is the “right” information extracted from the GRTN reports and the physical quantities are changed to avoid discrepancies; the resulting information cannot be cross checked with detailed plant data (collected for the point source evaluation) based on the physical quantities;
– up to year 1999 the types of fuel used where much more detailed in GRTN database; in BEN the 17 fuels are added up (using energy content) and reported together in 12 categories: emission factors for certain fuels (coal gases or refinery by-products) are quite different and essential information is lost with this process;
– activity data for “BOF converter gas” are not reported in BEN up to 1999, from year 2000 they are added up to the blast furnace gas;
– finally, the two data sets are never the same, even considering the total energy values of fuels or the produced electricity, there are always small differences, less than 1% - see annex two for details- that increase the already sizable discrepancy between the reference approach and the detailed approach.

In Annex 2 there are summary tables where the differences between BEN and ENEL/GRTN data are detailed by primary fuel for four years: 1990, 1995, 1999 and 2002. The year 1999 is added because in the year 2000 the reported data are quite poor, as already mentioned.
The other two statistical publications quoted before, UP (UP, 2004) and ENI (ENI, 2004), have direct access to fuel consumption data from the associated companies, but both rely on GRTN data for the complete picture. Data from those two sources is used for cross checking and estimation of point source emissions.
To estimate the CO_2 emissions, and also N_2O and CH_4 emissions, a rather complex calculation sheet is used, see APAT, (APAT, 2003 [a], in Italian) for description. The data sheet summarizes all plants existing in Italy divided by technology, about 60 typologies, and type of fuel used; the calculation sheet can be considered a model of the national power system. For each year a run estimates the fuel consumed by each plant type, the pollutant emissions and GHG emissions.
The energy data used for the years 1990, 1995, 1999 and 2000 are reported in Annex 2. The emission factors used are listed in Table 3.7.
The model reports the consumption and GHG emission data according to primary source (oil, coal, natural gas) so that they can be inserted in the CRF. Moreover the model is also able to estimate the energy/emissions data related to the electricity produced and used on site by the main industrial producers. Those data are reported in the industrial sector section, Tables 1.A.1.b/c and 1.A.2 .
The attached Table 3.3 shows an intermediate part of the process, with all energy and emissions summarized by fuel and split in the two main categories of producers: public services and industrial producers for the year 2002. In the period 1990-1997 all the industrial producers energy/emission data were reported in the CRF tables according to the industrial sector (refineries, steel plants, chemical plants and others). From 1998 onwards the expansion of the industrial cogeneration of electricity and the split of the national monopoly has transformed many industrial producers into “independent producers”, regularly supplying the national grid. So part of the energy/emissions of the industrial producers are added to Table 1.A.1.a .

Table 3.3 Power sector, Energy/CO_2 emissions in CRF format, year 2002

	TJ	C, Kt	CO_2, Kt - Gg
For table 1.A.1, a. Public Electricity and Heat Production			
Liquid fuels	5.91189E+05	12,401	45,438.4
Solid fuels	3.41044E+05	8,789	32,202.7
Natural gas	5.64203E+05	8,555	31,346.9
Refinery gases	9.992E+03	169	620.7
Coal gases	4.239E+03	54	198.1
Biomass	3.4020E+04		
Other fuels	5.787E+03	149	546.4
Total	**1.5505E+06**	**30,118**	**11,0353**
Industrial producers (Table 1.A.1, a-b-c) and auto-producers, to table “1.A.2 Manufacturing Industries”			
Liquid fuels	5.8627E+04	1,263	4,628
Solid fuels	1.5E+01	0	1
Natural gas	2.18361E+05	3,311	12,132
Refinery gases	1.8038E+04	306	1,121
Other refinery products	7.3267E+04	1,691	6,198
Coal gases	4.0300E+04	2,580	9,455
Other fuels	2.430E+03	62	228
Total	**4.11E+05**	**9,215**	**33,764**
General total	**1.9615E+06**	**39,332**	**14,4117**

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

Table 3.4 Time series of CO_2 emissions from electricity production

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

3.4.2 Refineries

The consumption data used come from BEN (MAP, 2004 [a]), the same data are also reported by UP (UP, 2004).
The available data in BEN specify the quantities of refinery gas, petroleum coke and other liquid fuels. They are reported in Annex 5, tables “Allegato 1a/b” and “Allegato 2a/b”.
All the fuel used in boilers and processes, the refinery “losses” and the possible losses of crude oil and all distributed fuels that are due to statistical discrepancies are considered to calculate emissions. Both refinery losses and fuel lost in the distribution network are considered as real but not accounted for in the individual end uses sectors.
Part of refinery losses, flares, are reported in CRF table 1.B.2.a and c, using IPCC emission factors, the balance of emissions is reported in CRF table 1.A.1.b. From 2002 particular attention has been used to avoid double counting of the CO_2 emissions checking if the individual refineries report sheets already include losses in the energy balances. It is planned to further investigate this aspect as soon as the new comprehensive reporting requirements of the IPPC directive are routinely used. Additional investigation is also planned to find out the fuel used for steam production, part of which presently seems to be allocated to the general industry.
IPCC Tier 2 emission factors and national emission factors are used, refer to Table 3.7. In Table 3.5 a sample calculation for the year 2002 is reported, with energy and emission data. In Table 3.6 GHG emissions in the years 1990, 1995, 2000 and 2002 are reported.

Table 3.5 Refineries, CO_2 emission calculation, year 2002

REFINERIES and TANK SITES	Consumption Petroleum			CO_2 Emissions Petroleum		
	coke	Ref. gas.	Liquid fuels	coke	Ref. gas.	Liquid fuels
			26,531			1,925
	30,004	101,119	102,818	2,993	6,277	7,649
TOTAL **TJ**			260,472			18,844

Table 3.6 Refineries, GHG emission time series

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

3.4.3 Manufacture of Solid Fuels and Other Energy Industries

In Italy all the iron and steel plants are integrated, so there is no separated reporting for the different part of the process. A few coke and "manufactured gas" producing plants where existing in the early nineties and they have been reported here. Only two manufactured gas producing plants are still in operation from 2000.
In this section emissions from power plants which use coal gases are also reported. In particular we refer to the electricity generated in the steel plant sites (using coal gases and other fuels).

3.5 Manufacturing industries and construction

Energy consumption for this sector is reported in the BEN, reference Annex 5, tables A1.7 and A1.8. The data comprise specification of consumption for 13 sub-sectors and more than 25 fuels. Those very detailed data, combined with industrial production data, allow for a good estimation of all the fuel used by the industrial processes listed in section 3.3, with the exception of coal (see Annex 3). The balance of fuel is assumed as used in boilers and heaters and the emissions are estimated with the emission factors listed in Table 3.7. These factors already contain the correction for the fraction of carbon oxidised (IPCC default values).

Table 3.7 Emission Factors for Power, Industry and Civil sector

	t CO_2 / TJ	t CO_2 / tep
Liquid fuels		
Crude oil	72.549	3.035
Jet kerosene	70.735	2.959
Petroleum Coke	99.755	4.174
Orimulsion	77.733	3.252
TAR	84.581	3.539
Gaseous fuels		
Natural gas (dry) 2002 average	55.560	2.325
Solid fuels		
Steam coal, 2002 average	95.551	3.998
"sub-bituminous" coal	96.234	4.026
Lignite	99.106	4.147
Coke	105.929	4.432
Biomass		
Solid Biomass		(4.495)
National emission factors		
Derived Gases	**t CO_2 / TJ**	**t CO_2 / tep**
Refinery Gas	62.080	2.60
Coke Gas	46.964	1.965
Blast furnace – oxygen converter Gas	269.222	11.264
Fossil fuels, national data		
Fuel oil , 2002 average	76.702	3.209
Coking coal	95.702	4.004
Petrol, 1990-'99, IPCC Europe	68.559	2.868
Petrol, test data, 2000-02	71.145	2.977
Gas oil, 1990-'99, IPCC Europe	73.274	3.066
Gas oil, engines, test data, 2000-02	73.153	3.061
Gas oil, heating, test data, 2000-02	73.693	3.083
LPG, 1990-'99, IPCC	62.392	2.610
LPG, test data, 2000-02	64.936	2.717

3.5.1 Estimation of carbon content of coals used in industry

The preliminary use of the CRF software underlined an unbalance of emissions in the solid fuel rows above 20%. A detailed verification pointed out to an already known fact: the combined use of standard IPCC emission factors for coals, national emission factors for coal gases and CORINAIR methodology emission factors for steel works processes produces double counting of emissions.
The main reason for this is the specific national circumstance of extensive recovery of coal gases from blast furnaces and coke ovens for electricity generation.
To avoid the double counting a specific methodology has been developed: it balance energy and carbon content of coking coals used by steelworks, industry, for non energy purposes and coal gasses used for electricity generation. The detailed procedure is described in Annex 3, here we underline that a balance is made between the input coals for coke production and the quantities of derived fuels used in various sectors. The iron and steel sector gets the resulting quantities of energy and carbon after subtraction of what is used for electricity generation, non energy purposes and other industrial sectors.

3.5.2 Time series

In the following Table 3.8 GHG emissions connected to the use of fossil fuels, process emissions excluded, in the years 1990, 1995 and 2000-2002 are reported. Industrial emissions do show a remarkable reduction from 1990 to 1995, then the data are more stable, with oscillation connected to economic cycles. In Table 3.9 the emissions of energy industries (section 3.4), manufacturing industries (section 3.5) and other sectors (section 3.7) are summarized according to key sources categories.

Table 3.8 Manufacturing industry, GHG emission time series

	1990	1995	2000	2001	2002
CO_2 emissions, kt	80,004	76,379	77,625	76,382	75,909
CH_4 emissions, t	14,957	14,730	14,039	13,844	13,362
N_2O emissions, t	3,325	2,678	2,938	2,935	2,972
Industry, total, kt CO_2 eq	81,349	77,518	78,831	77,582	77,111

Table 3.9 Stationary combustion, GHG emission time series

		1990	1995	2000	2001	2002
CO_2 stationary combustion liquid fuels	kt	153,358	152,973	131,760	129,773	131,356
CO_2 stationary combustion solid fuels	kt	58,539	50,926	49,431	54,171	53,343
CO_2 stationary combustion gaseous fuels	kt	84,882	100,032	131,463	133,858	131,153
CH_4 stationary combustion	t	781	6,382	6,491	6,616	1,004
N_2O stationary combustion	t	6,737	6,382	6,491	6,616	6,726

3.6 Transport

This sector is the one that shows the most pronounced increase in emissions over time, reflecting an increase in fuel consumption.
The mobility demand and particularly the road transportation share have always increased in the time period from 1990 to 2002.

The historical time series of CO_2 , CH_4 and N_2O emissions is reported in Table 3.10.
The emissions in the table comprise all the emissions reported in table 1.A.3 of CRF.
Emission estimates are discussed below for each sub sector.
Increase in N_2O emissions is related to the expansion of the car fleet equipped with exhaust gasses catalytic converters.
On the contrary, methane emissions are quite stable, due to the combined effect of technological improvements that limit VOCs from tail pipe and evaporative emissions and the expansion in petrol consumption.
It has to be underlined that in Italy there is a remarkable fleet of motorbikes and mopeds (about 8.9 millions vehicles in 2002) that are using petrol and are still not subject to tight VOC emissions control.

Table 3.10 GHG emissions for the transport sector

		1990	1995	2000	2001	2002
CO_2	Mt	101.9	112.1	120.4	122.8	124.9
CH_4	Mt	0.77	0.95	0.84	0.71	0.65
N_2O	Mt	1.72	2.17	3.19	3.33	3.65
Total, Mt CO_2 eq.	Mt	104.4	115.2	124.4	126.9	129.2

3.6.1 Aviation

The IPCC requires an estimate of emissions from 1A3ai International Aviation and 1A3aii Domestic both including emissions from the cruise phase of the flight as well as the LTO so a method was devised based on the following assumptions and information:

(i) Total inland deliveries of aviation spirit and aviation turbine fuel to air transport are given in BEN (MAP, 2004 [a]), refer to Annex 5, table “Allegato 3b”. This is the best approximation of aviation bunker fuel consumption available and is assumed to cover international, domestic and military use;

(ii) Data on arrivals and departures of domestic aircraft at Italian airports are reported by Ministry of Transport (MINT) in the national transport statistics yearbooks (MINT, 2004). This was used to estimate total domestic and international landing and take-offs (LTO);

(iii) Data on domestic aircraft passengers - kilometres are also reported in the national transport statistics yearbooks (MINT, 2004);

(iv) Using default fuel consumption factors for domestic LTOs and cruising together with the LTO data and total domestic km flown, an estimate was made of the total fuel consumption of domestic flights.

(v) Total consumption by military aviation is given in BPT (MAP, 2004 [b]), separated by fuel. Emissions from military aircraft are reported under 1A5 Other.

(vi) An estimate of international fuel consumption was made by deducting military fuel and domestic fuel from the inland deliveries of aviation fuel calculated in (i).

Based on these assumptions the total consumptions of aviation turbine fuel and aviation spirit by domestic and international flights were estimated. Hence, it was a simple matter to calculate the carbon dioxide emission using the emission factors given in IPCC Guidelines (IPCC, 1997) and shown in Table 3.11. Data on domestic and international aircraft movements taken from CNT (MINT, 2004) are shown in Table 3.12. Domestic flights are those entirely within Italy.

Table 3.11 CO_2 and SO_2 emission factors for Aviation (kg/t)

	CO_2 [1]	SO_2
Aviation Turbine Fuel	859	1.0[2]
Aviation Spirit	865	1.0[2]

[1] *Emission factor as kg carbon/t.*
[2] *Emission factor for 1990-2002.*

Table 3.12 Aircraft Movement Data

	1990	1995	2000	2001	2002
Domestic flights, LTO cicles, 10^3	179	205	319	307	315
International flights, LTO cicles	141	191	286	313	293
General aviation, LTO cicles	168	110	110	110	110

Source: MINT, 2004

Emissions from international aviation are reported for information only and are not included in national totals. Emissions from non-CO_2 pollutants were calculated according to the methodologies described in EMEP/CORINAIR (EMEP/CORINAIR, 2001) and IPCC (IPCC, 1997). The procedure was:

- Data on the annual number of domestic and international landing and takeoff cycles (MINT, 2004) were used together with the default emission factors in Table 3.13.
- Emission factors and consumption factors for LTO and cruise derive from the results of a specific study which on the basis of detailed information on the Italian air fleet and the origin-destination flights for the year 1999 derive default national values for domestic as well as international flights (Romano *et al*., 1999; ANPA, 2001; Trozzi *et al*., 2002 [a]) on the basis of emission factors reported in the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2001).
- Consumptions are calculated for LTO, both domestic and international, and for domestic cruise using the average consumption factors, whereas consumption for international cruise is derived by difference from the total fuel consumption reported in the national energy balance and the above estimated values.

The current methodology may overestimate emissions from aircraft for the last years. This is because default factors used pertain to older models and the distribution of the international flights between European and extra-European flights has changed from 1999 with an increase of the shortest distances. Currently the use of a more detailed model for estimating aircraft emissions is under consideration, in consideration of the availability of more data on the flights by national and European civil aviation control authorities.

Table 3.13 Non- CO_2 Emission Factors for Aviation

	Units	CH_4	N_2O	NO_x	CO	NMVOC	Fuel
Domestic LTO	kg/LTO	0.167	0.1	7.913	7.163	1.580	647.6
International LTO	kg/LTO	0.354	0.3	10.840	11.607	3.334	878.4
Domestic Cruise	kg/t fuel	0.048	0.048	14.653	1.617	0.448	-
International Cruise	kg/t fuel	0.058	0.011	15.040	1.241	0.546	-
Aircraft Military [a]	kg/t fuel	0.400	0.2	15.800	126.0	3.600	-

[a] *EMEP/CORINAIR, 2001*

Military aviation emissions cannot be estimated in this way since LTO data are not available. A first estimate of military emissions is made using military fuel consumption data and EMEP/CORINAIR cruise defaults shown in Table 3.13. The EMEP/CORINAIR (EMEP/CORINAIR, 2001) factors used are appropriate for military aircraft.

In tables 3.14 and 3.15 the time series resulting from the above described methodology are indicated for both fuel consumption and GHG emissions.

Table 3.14 Aviation fuel consumption, domestic and international travels

	1990	1995	2000	2001	2002
Domestic flights, LTO cycles, kt	121	133	207	199	204
International flights, LTO cycles, kt	123	171	251	274	258
Domestic flights, cruise, kt	387	425	662	636	654

Source: APAT elaborations

Table 3.15 GHG emissions from domestic aviation

		1990	1995	2000	2001	2002
CO_2 Mobile combustion: Aircraft	Mt	1,596	1,736	2,709	2,604	2,677
CH_4 Mobile combustion: Aircraft	kt	1	13	20	19	2
N_2O Mobile combustion: Aircraft	kt	12	13	20	19	20

Source: APAT elaborations

3.6.2 Railways

The electricity used by the railways for electric traction is supplied from the public distribution system, so the emissions arising from its generation are reported under 1A1a Public Electricity.
The CORINAIR methodology reports emissions from diesel trains as railways (freight and passenger). These estimates are based on the gas oil consumption for railways reported in BEN (MAP, 2004 [a]). Emissions from diesel trains are reported under the IPCC category 1A3c Railways.
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 to the very simple EMEP/CORINAIR methodology described in EMEP/CORINAIR (EMEP/CORINAIR, 2001). The emission factors shown in Table 3.16 are aggregate factors so that all factors are reported on the common basis of fuel consumption.

Table 3.16 Railway Emission Factors (kt/Mt)

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

Source: EMEP/CORINAIR, 2001

3.6.3 Road Transport

Emissions from road transport are calculated either from a combination of total fuel consumption data and fuel properties or from a combination of drive related emission factors and road traffic data.

3.6.3.1 Fuel-based emissions

Emissions of carbon dioxide and sulphur dioxide from road transport are calculated from the consumption of petrol, diesel, LPG and natural gas and the carbon - sulphur content of the fuels

consumed. Data on petrol and diesel fuels consumed by road transport in the Italy are taken from the BEN (MAP, 2004 [a]), refer to Annex 5, Table "Allegato 3b".
Emissions of CO_2, expressed as kg carbon per tonne of fuel, are based on the H/C ratio of the fuel; emissions of SO_2 are based on the sulphur content of the fuel. Values of the fuel-based emission factors for CO_2 from consumption of petrol and diesel fuels are shown in Table 3.17.
Values for SO_2 vary annually as the sulphur-content of fuels change and are shown in UP (UP, 2004). These factors already contain the correction for the fraction of carbon oxidised.

Table 3.17 Fuel-Based Emission Factors for Road Transport

National emission factors	t CO_2 / TJ
Mtbe	73.860
Petrol, 1990-'99, IPCC europe[a]	68.559
Petrol, test data, 2000-02[b]	71.145
Gasoil, 1990-'99, IPCC europe[a]	73.274
Gasoil, engines, test data, 2000[b]	73.153
LPG, 1990-'99, IPCC[a]	62.392
LPG, test data, 2000-02[b]	64.936
Natural gas (dry) '2002	55.483
Fuel oil , 2002 average	76.702

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

Emissions of CO_2 and SO_2 can be broken down by vehicle type based on estimated fuel consumption factors and traffic data in a manner similar to the traffic-based emissions described below for other pollutants. The 2002 inventory used fuel consumption factors expressed as g fuel per kilometre for each vehicle type and average speed calculated from the emission functions and speed-coefficients provided by COPERT III (EEA, 2000).
Fuel consumption calculated from these functions are shown in Table 3.18 for each vehicle type, emission regulation and road type in the Italy. A normalisation procedure was used to ensure that the breakdown of petrol and diesel consumption by each vehicle type calculated on the basis of the fuel consumption factors added up to the BEN figures for total fuel consumption in the Italy (adjusted for off-road consumption). Evaporative emissions are not shown in the table.

Table 3.18 Average fuel consumption and mileage for main vehicle categories and road type, 2002

SNAP CODE	Sub sector	Type of fuel	Tons of fuel consumed	Mileage, KM_KVEH
070101	PC Hway	diesel	2,288,280	38,871,148
070101	PC Hway	petrol	2,682,999	47,447,661
070101	PC Hway	lpg	394,240	6,707,715
070102	PC rur	diesel	2,836,899	64,934,516
070102	PC rur	petrol	5,167,812	121,175,106
070102	PC rur	lpg	402,206	8,943,620
070103	PC urb	diesel	1,634,433	16,723,033
070103	PC urb	petrol	6,271,216	66,554,706
070103	PC urb	lpg	516,090	6,707,715
070201	LDV Hway	diesel	754,058	9,148,632
070201	LDV Hway	petrol	56,220	854,549
070202	LDV rur	diesel	1,550,841	25,158,736
070202	LDV rur	petrol	152,744	2,350,009
070203	LDV urb	diesel	1,316,677	11,435,790

(continued)

(continued) **Table 3.18 Average fuel consumption and mileage for main vehicle categories and road type, 2002**

070203	LDV urb	petrol	170,518	1,068,186
070301	HDV Hway	diesel	4,652,563	21,737,420
070301	HDV Hway	petrol	1,320	7,998
070302	HDV rur	diesel	2,887,850	15,112,967
070302	HDV rur	petrol	3,599	23,994
070303	HDV urb	diesel	1,588,496	5,169,325
070303	HDV urb	petrol	1,800	7,998
070400	mopeds	petrol	603,148	18,328,236
070501	Moto Hway	petrol	41,458	1,170,181
070502	Moto rur	petrol	221,750	8,191,269
070503	Moto urb	petrol	418,895	14,042,174
Total				**511,872,683**

Source: APAT elaborations

Notes: PC, passenger cars; LDV, light duty vehicles; HDV, heavy duty vehicles; Moto, motorcycles

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

Table 3.19 GHG emissions from road transport

		1990	1995	2000	2001	2002
CO_2	Mt	93,994	104,153	110,316	113,022	115,125
CH_4	kt	744	2,057	3,064	3,206	612
N_2O	kt	1,608	2,057	3,064	3,206	3,534

3.6.3.2 Traffic-based emissions

Emissions of the pollutants NMVOC, NO_x, CO, CH_4 and N_2O are calculated from emission factors expressed in grams per kilometre and road traffic statistics estimated by APAT on data released from Ministry of Transport (MINT, 2004). The emission factors are based on experimental measurements of emissions from in-service vehicles of different types driven under test cycles with different average speeds calculated from the emission functions and speed-coefficients provided by COPERT III (EEA, 2000). This source provides emission functions and coefficients relating emission factor (in g/km) to average speed for each vehicle type and Euro emission standard derived by fitting experimental measurements to some polynomial functional form. These functions were then used to calculate emission factor values for each vehicle type and Euro emission standard at each of the average speeds of the road and area types.

The road traffic data used are vehicle kilometre estimates for the different vehicle types and different road classifications in the national road network. These data have to be further broken down by composition of each vehicle fleet in terms of the fraction of diesel - and petrol-fuelled vehicles on the road and in terms of the fraction of vehicles on the road made to the different emission regulations which applied when the vehicle was first registered. These are related to the age profile of the vehicle fleet.

Additional data are required for the estimation of consumption of buses, because the available traffic data seldom distinguish beyond “heavy vehicles”. Moreover traffic data on motorcycles are not exhaustive. In both cases the energy consumption is estimated on the basis of the oil companies reports on sold fuels.

It is beyond the scope of this paper to illustrate the COPERT III methodology, in brief the emissions from motor vehicles fall into three different types which are each calculated in a different manner. These are hot exhaust emissions, cold-start emissions and, for NMVOC, evaporative emissions.
Hot exhaust emissions are emissions from the vehicle exhaust when the engine has warmed up to its normal operating temperature. Emissions depend on the type of vehicle, the type of fuel its engine runs on, the driving profile of the vehicle on a journey and the emission regulations which applied when the vehicle was first registered as this defines the type of technology the vehicle is equipped with which effects emissions.
For a particular vehicle, the drive cycle over a journey is the key factor which determines the amount of pollutant emitted.
Key parameters affecting emissions are the acceleration, deceleration, steady speed and idling characteristics of the journey, as well as other factors affecting load on the engine such as road gradient and vehicle weight. However, work has shown that for modelling vehicle emissions for an inventory covering a road network on a national scale, it is sufficient to calculate emissions from emission factors in g/km related to the average speed of the vehicle in the drive cycle (EEA, 2000). Emission factors for average speeds on the road network are then combined with the national road traffic data.
Emissions are calculated from vehicles of the following types:
• Petrol cars
• Diesel cars
• Petrol Light Goods Vehicles (Gross Vehicle Weight (GVW) <= 3.5 tonnes)
• Diesel Light Goods Vehicles (Gross Vehicle Weight (GVW) <= 3.5 tonnes)
• Rigid-axle Heavy Goods Vehicles (GVW > 3.5 tonnes)
• Articulated Heavy Goods Vehicles (GVW > 3.5 tonnes)
• Buses and coaches
• Motorcycles
Detailed data on the national fleet composition can be found in yearly report from ACI (ACI, 2003). In the following tables 3.20, 3.21 and 3.22 are reported detailed data on the relevant vehicles in the circulating fleet between 1990 and 2002, subdivided according to the main emission regulations that applied when the vehicle was sold.

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

	1990	1995	2000	2002
Older than 20 years, PRE ECE	0.005	0.007		
1972 -1977, ECE 15.00/.01	0.142	0.017	0.009	0.010
1978 -1986, ECE 15.02/.03	0.277	0.178	0.039	0.015
1987 -1989, ECE 15.04	0.159	0.103	0.061	0.041
1990 - 1992, ECE 15.04	0.417	0.388	0.264	0.209
91/441/EC, from 1/1/93, euro 1	0.000	0.308	0.218	0.198
94/12/ EC, from 1-1-97 , euro 2		0.000	0.410	0.318
98/69/EC, from 1/1/2001,euro 3				0.210
Totals	**1.000**	**1.000**	**1.000**	**1.000**

Source: APAT elaborations on ACI data

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

	1990	1995	2000	2002
Older than 15 years, PRE ECE	0.006	0.009	-	-
1972 -1977, ECE 15.00/.01	0.008	0.000	0.009	0.012
1978 -1985, ECE 15.02/.03	0.248	0.103	-	-
1985-1989, ECE 15.04	0.359	0.285	0.053	-
1990 - 1992, ECE 15.04	0.378	0.390	0.109	0.064
91/441/EC, from 1/1/93, euro 1	0.000	0.213	0.127	0.083
94/12/ EC, from 1-1-97 , euro 2	-	-	0.702	0.406
98/69/EC, from 1/1/2001,euro 3	-	-	-	0.435
Totals	**1.000**	**1.000**	**1.000**	**1.000**

Source: APAT elaborations on ACI data

Table 3.22 Trucks technological evolution: circulating fleet

	1990	1995	2000	2002
pre -1985	0.60	0.34	0.15	0.11
1985-1989, Dir 88/77/EWG	0.30	0.29	0.08	0.03
1990 - 1992	0.10	0.20	0.18	0.13
1/gen/93 - 31/dic/95	-	0.16	0.14	0.12
from 1/1/96, Dir. 91/542 EEC, euro I	-	0.00	0.12	0.10
from 1/1/97, Dir. 91/542 EEC, euro II	-	-	0.03	0.04
from 1/1/2001, Dir. 99/96, euro III	-	-	-	0.27
Totals	**1.00**	**1.00**	**1.00**	**1.00**

Source: APAT elaborations on ACI data

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

- Urban
- Rural
- Motorway

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

– Ministry of Transport (MINT, 2004) for rural roads and on other motorway; the latter estimates are based on traffic counts from the rotating census and core census surveys of ANAS;
– highway industrial association for fee-motorway;
– local authorities for built-up areas (urban).

Table 3.23 Evolution of fleet consistency and mileage

Year	1990	1995	2000	2002
All passenger vehicles, total mileage (10^9 veh-km/y)	339	394	431	450
Car fleet (10^6)	27.7	31.0	32.9	34.2
Goods transport, total mileage (10^9 veh-km/y)	54	61	68	72
Truck fleet (10^6)	3.0	3.4	3.9	4.0

Source: APAT elaborations

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

3.6.4 Navigation

The CORINAIR methodology estimates emissions from Coastal Shipping, Fishing, Naval Shipping and International Marine. Coastal Shipping has been mapped onto 1A3dii National Navigation and Fishing onto 1A4ciii Fishing.
The emissions reported under Coastal Shipping, Naval Shipping and Fishing are estimated according to the base combustion datasheet using the emission factors given in Table 3.17.
The CORINAIR category International Marine is the same as the IPCC category 1A.3i International Marine. The estimate used is based on the following information and assumptions:
Total deliveries of fuel oil, gas oil and marine diesel oil to marine bunkers are given in BEN (MAP, 2004 [a]).
Naval fuel consumption for "small boat" and ferries is also reported in BEN.
Emission factors and consumption factors for national and international cruise derive from the results of a specific study which on the basis of detailed information on the Italian marine fleet and the origin-destination matrix for the year 1999 estimates default national values (ANPA, 2001; Trozzi *et al.*, 2002 [b]) on the basis of emission factors reported in the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2001).
National cruise consumptions are estimated using the consumption factors derived by the study whereas consumption for international cruise is derived by difference from the total fuel consumption reported in the national energy balance and the above estimated values.
In Table 3.24 are indicated the time series resulting from the above described methodology. The data include the quantities of marine fuels reported by BEN for domestic use, the estimate of bunkers fuels used in the national harbours or for travel within two Italian destinations and the resulting bunker fuels used for international travels. Carbon dioxide emissions relevant to the national total are also reported.

Table 3.24 Marine fuel consumption, domestic and international travels. CO_2 emissions from domestic navigation

		1990	1995	2000	2001	2002
Fuels used for domestic travels,	kt	778	706	875	871	851
Estimate of bunker fuel used in ports (dom+int ships),	kt	748	693	864	860	841
Estimate of international bunkers,	kt	1,326	1,318	1,210	1,365	1,552
CO_2 Mobile combustion: Waterborne Navigation		5,419	5,111	6,223	6,215	6,117

Source: APAT elaborations

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

3.7 Other sectors

The estimation procedure follows that of the base combustion data sheet, emissions are estimated from the energy consumption data and the emission factor illustrated in Table 3.7.
Other sector comprises emissions from agriculture, fisheries, residential, commercial and others. 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 subdivided on the basis of the estimations reported by ENEA in its annual energy report (ENEA, 2004). The CORINAIR Inventory category Public Service is mapped onto 1A.4a Commercial and Institutional.
Emissions from 1A.4b Residential and 1A.4c Agriculture/Forestry/Fishing are disaggregated into those arising from stationary combustion and those from off-road vehicles and other machinery. The estimation of emissions from off-road sources is discussed in Section 3.7.2. Emissions from fishing vessels are estimated from fuel consumption data (MAP, 2004 [a]) and emission factors are shown in Table 3.7.

3.7.1 Other combustion

Emissions from military aircraft and naval vessels are reported under 1A.5b Mobile. The method of estimation is discussed in Sections 3.6.1 and 3.6.4.
Emissions from off-road sources are estimated and are reported under the relevant sectors, i.e. Other Industry, Residential, Agriculture and Other Transport. The methodology of these estimates is discussed in Section 3.7.2.

3.7.2 Other off-road sources

These cover emissions from a range of portable or mobile equipment powered by reciprocating diesel or petrol driven engines. They include agricultural equipment such as tractors and combine harvesters; construction equipment such as bulldozers and excavators; domestic lawn mowers; aircraft support equipment; and industrial machines such as portable generators and compressors. In the CORINAIR inventory they are grouped into four main categories:

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

Those categories are mapped to the appropriate IPCC classes: Aircraft support is mapped to Other Transport and the other categories map to the off-road vehicle subcategories of Residential, Agriculture and Manufacturing Industries and Construction.
The estimates are calculated using a modification of the methodology given in EMEP/CORINAIR (EMEP/CORINAIR, 2001). This involves the estimation of emissions from around seventy classes of off-road source using the following equation for each class:

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

where

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

For petrol engined sources, evaporative NMVOC emissions are also estimated as:

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

where

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

The population data have been revised based on a survey of machinery sales (Frustaci, 1999). Machinery lifetime is estimated on the European averages, see EMEP/CORINAIR (EMEP/CORINAIR, 2001), the annual usage data were taken either from industry or published data (EEA, 2000). The emission factors used came mostly from EMEP/CORINAIR though a few of the more obscure classes were taken from Samaras (EEA, 2000). The load factors were taken from Samaras (EEA, 2000).
It was possible to calculate fuel consumptions for each class based on fuel consumption factors given in EMEP/CORINAIR (EMEP/CORINAIR, 2001). Comparison with known fuel consumption for certain groups of classes (e.g. agriculture and construction) suggested that the population method over estimated fuel consumption by factors of 2-3 especially for industrial vehicles.
Estimates were derived for the fuel consumptions for the years 1990-2002 for each of the main categories:

A. Agricultural power units: Data on gas oil consumption were taken from ENEA (ENEA, 2004). The consumption of petrol was estimated using the population method for 1995 without correction. The same estimate was used for 1990 to 2002;
B. Industrial off-road: The construction component of the gas oil consumption was calculated from the Ministry of production activity data (MAP, 2004 [a]) on building and construction. The industrial component of gas oil was estimated from the population approach. This gave an estimate for 1995 which was used for all years;
C. Domestic house & garden: Petrol and diesel oil consumption were estimated from the EMEP/CORINAIR population approach for 1995 and the same value used for all years.

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

3.8 International Bunkers

The methodology used to estimate the quantities of fuels used from international bunkers in aviation and maritime navigation has been illustrated in the relevant transport sections, 3.6.1 and 3.6.4.
The methodology used implemented the IPCC guidelines according to the available statistical data.

3.9 Feedstock and non-energy use of fuels

In Table 3.25 and 3.26 detailed data on petrochemical for the year 2002 and other non-energy use for the same years are given.
Data are based on a rather detailed yearly report available by MAP. The report summarize answers from a detailed questionnaire that all operator in Italy prepare monthly. The data are more detailed than those normally available by international statistics and refer to:
– input to plants (gross input);
– quantities of fuels returned to the marked (with possibility to estimate the net input);
– fuels used internally for combustion;
– quantities stored in products.
In the energy balances only the input and output quantities from the petrochemical plants are reported, so it may be that the output quantity is greater than the input quantity, due from internal transformation. Therefore it is possible to have negative values for some products mainly gasoline, refinery gas, fuel oil.
With this data it is possible to estimate the quantities of fuels stored in product in percentage on net and gross petrochemical input, see table 3.25 for details by product and table 3.27 for the overall figure. The data of table 3.27 are reported also in a note on CRF table 1.A(d). As can be seen from the value reported for the year 2002 there is a huge difference of the estimated quantities of fuel stored in product if reference is made to “net” or “gross” input. Moreover the estimation of quantities stored in product are quite different from those reported in the Revised 1996 IPCC Guidelines for National GHG Inventories, Reference Manual, ch1, tables 1-5 (IPCC, 1997).
An attempt was made to estimate the quantities stored in products using IPCC percentage values as reported in table 1-5 and the fuels reported as “petrochemical input” in table 3.25. The resulting estimate of about 7143 kt of products for year 2002, is more than 35% bigger than the quantities reported, 5286 kt, see table 3.25 .
At national level we found our methodology the more precise according to the available data. The European Project “Non Energy use - CO_2 emissions” ENV4-CT98-0776 has analyses our methodology performing a mass balance between input fuels and output products in a sample year. The results of the project confirm the reliability of the reported data (Patel and Tosato, 1997).
With reference to the data of table 3.26, those non energy products are mainly outputs of refineries. The estimate referrers to quantities produced that are reported by manufacturers and summarized by BEN. The data should be non controversial. Minor differences in the overall energy content of those products results if the calculation is based on national data or IPCC default values, see the table for details.

Table 3.25 Petrochemical, detailed data from BPT, year 2002 (MAP, 2004 [b])

FUEL TYPE	Internal Petroch. Input kt	Quantity Returns to refin./market kt	% on consumption/ losses kt	stored in products kt	gross input	% on net input	Emission factor (IPCC) t C / t
LPG	518	508	54	-44	-8%	-440%	0.8137
Refinery gas	213	75	853	-715	-336%	-518%	0.8549
Virgin nafta	5,449	0	0	5,449	100%	100%	0.8703
Gasoline	1,028	1,959	0	-931	-91%	100%	0.8467
Kerosene	815	557	0	258	32%	100%	0.8485
Gasoil	1,349	178	0	1,171	87%	100%	0.8569
Fuel oil	1,059	224	695	140	13%	17%	0.8678
Petroleum coke	0	0	0	0			0.955
Others (feedstocks)	227	307	26	-106	-47%	133%	0.8368
Losses			0	0			0.8368
Natural gas	704	0	640	64			0.7100
Total	**11,362**	**3,808**	**2,268**	**5,286**			

Table 3.26 Other non energy uses, year 2002

NON ENERGY FROM REFINERIES	Quantity stored in products kt	Energy content IPCC '96	Emission factor t C / t	Total energy content with IPCC values	With BEN values
bitumen+peat	3,096	40.19	0.8841	124.4	124.5
lubricants	1,331	40.19	0.8038	53.5	53.5
recovered oils	0	40.19	0.8038	0.0	0.0
paraffin	40	40.19	0.8368	1.6	1.0
others (benzene, others)	959	40.19	0.8368	38.5	24.9
Totals				**218.1**	**203.9**

(shows minor inconsistencies between BEN and CRF data)

Table 3.27 Other non energy uses, year 2002

BREAKDOWN OF TOTAL PETROCHEMICAL FLOW	Petroch. Input	Returns to refin./market	Internal consumption / losses	Quantity stored in products
ALL ENERGY CARRIERS, kt	11,362	3,808	2,268	5,286
% of total input		33.5%	20.0%	46.5%
% of net input			30.0%	70.0%

3.10 Country specific issues

3.10.1 National energy balance

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

– it is a balance, every year professional people carry out the exercise described in section 3.8.1 balancing final consumption data with import - export information;
– the balance is made on the energy value of energy carriers, taking into account transformations that may occur in the energy industries (refineries, coke plants, electricity production);
– data are collected regularly by the Ministry of Production Activities, on a monthly basis, from industrial subjects;
– oil products, natural gas and electricity used by industry, civil or transport sectors are taxed with

excise duties linked to the physical quantities of the energy carriers; those excise duties are differentiated between products and between final consumption sectors (i.e. diesel oil for industrial use pays duties lower than for transportation use and higher than for electricity production; even bunker fuels have a specific registration paper that state that they are sold without excise duties;

– from the point of view of energy consumption information this system produces highly reliable data: BEN is always based on registered quantities of energy consumption, not on estimates; uncertainties may be present in the effective final destination of the product but total quantities are reliable;
– coal is an exception to this rule, it is not subject to excise duties; consumption information are estimates; anyway it is nearly all imported and it is used by a limited number of operators; all of them are monitored on a monthly basis by the Industry Ministry.

3.10.2 National emission factors

Monitoring of the carbon content of the fuels used nationally is an ongoing activity at APAT. The principle is to analyse regularly the chemical composition of the used fuel or relevant activity statistics, to estimate the carbon content and the emission factor. National emission factors are reported in tables 3.7 and 3.17.
The specific procedure followed for each primary fuel (natural gas, oil, coal) is reported in Annex 6.

3.11 Fugitive emissions from solid fuels, oil and natural gas

Fugitive emissions in this source category originate from the production and transformation of solid fuels, the production of oil and gas, the transmission and distribution of gas and from oil refining. Trends in the fugitive emissions are summarised in Table 3.28.
Totally, fugitive emissions, in CO_2 equivalent, account for 1.5% out of the total emissions in the energy sector. Both CH_4 and CO_2 emissions show a reduction from 1990 to 2002 by 24% and 37%, respectively.

Table 3.28 Fugitive emissions from oil and gas 1990-2002 (Gg CO_2 eq.)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CO_2-													
Solid fuels	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Oil and natural gas	*3,048*	*2,990*	*2,926*	*3,084*	*2,913*	*2,843*	*2,692*	*2,875*	*2,768*	*2,091*	*2,298*	*2,182*	*1,924*
CH_4													
Solid fuels	*117*	*110*	*103*	*81*	*71*	*65*	*60*	*60*	*55*	*53*	*64*	*70*	*66*
Oil and natural gas	*6,666*	*6,519*	*6,362*	*6,102*	*6,003*	*5,744*	*5,630*	*5,593*	*5,584*	*5,500*	*5,457*	*5,188*	*5,100*

As concerns key source analysis, the results are shown in the following box.

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

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

Specifically, methane emissions from oil and gas operations is a key source according to the level and trend assessment both Tier 1 and Tier 2. CO_2 emissions from oil and gas operations is also a key

source for the level, Tier 2, and trend assessment. The uncertainty in methane emissions is estimated to be 25%; the same value of uncertainty is attributed to CO_2 emissions.
As concern fugitive emissions from solid fuels reported in 1.B.1, they are not relevant. In fact, CH_4 emissions from production refer only to two mines, one underground producing lignite and the other surface producing coal, with very low production in the last ten years; CH_4 emissions from solid fuel transformation refer to the coke production from the iron and steel industry, also decreasing in the last years. CO_2 emissions from 1.B.1 are not occurring.
Fugitive CO_2 emissions reported in 1.B.2 refer to fugitive emissions in refineries during petroleum production processes, such as catalytic cracking, and in flaring. Emissions from other activities in 1.B.2 do not occur.
CH_4 emissions derive mainly from the transmission in pipelines and distribution of natural gas and decrease in the last years in account of the gradual substitution of old pipelines.
As concerns the completeness of the CRF tables pertaining to these emissions, in particular 1.B.2, some notation keys are still missing in the 2004 submission, but the rationale beyond the values reported and not reported is explained below.
CH_4 fugitive emissions from oil exploration are included in those from production because no detailed information is available. Emissions from transport and distribution of oil result as not occurring or negligible. CH_4 emissions from gas exploration are also included in those from production while other leakage emissions are included in distribution emission estimates. Further investigation will be carried out with industry about these estimations.
CH_4 emissions from gas venting are included with natural gas under 1.B.2.b, production, as not separately supplied by the relevant industries.
A summary of the completeness of CH_4 fugitive emissions is shown in the following Table 3.29.

Table 3.29 Completeness of CH_4 fugitive emissions

1.B. 2. a. Oil		
i. Exploration	CH_4	Included in .B.2.a distribution
iii. Transport	CH_4	Not occurring
1.B.2.b. Natural Gas		
iii. Other leakage	CH_4	Included in 1.B.2.b distribution
1.B. 2. c. Venting		
ii. Gas	CH_4	Included in 1.B.2.b

4. INDUSTRIAL PROCESSES [CRF SECTOR 2]

4.1 Overview of sector

Included in this category are by-products or fugitive emissions which originate from industrial processes. Where emissions are released simultaneously from the production process and from combustion (as in the cement industry), these are estimated separately and included in category 1A2. All greenhouse gases as well as CO, NO_x, NMVOC and SO_2 emissions are estimated.

In 2002 industrial processes account for 5.2% of CO_2 emissions, 0.3% of CH_4, 17.7% of N_2O, 100% of PFCs, HFCs and SF_6. In term of CO_2 equivalent, industrial processes share 7.3% of total national greenhouse gas emissions.

The trends of greenhouse gas emissions from the industrial processes sector are summarised in Table 4.1. Emissions are reported in Gg for CO_2, CH_4 and N_2O and in Gg of CO_2 equivalent for F-gases.

An increase in HFC emissions is observed from 1990 to 2002, while CO_2 emissions from chemical and metal industry reduced sharply.

Table 4.1 Trend in greenhouse gas emissions from the industrial process sector, 1990-2002

Gas/ subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CO_2													
2A.													
Mineral Products	21,712.97	21,645.10	22,348.66	20,035.48	19,511.85	21,222.09	19,487.96	19,767.96	19,937.64	20,717.86	21,611.65	22,184.30	22,077.12
2B.													
Chemical Industry	2,236.63	2,114.91	2,131.75	1,354.97	957.66	937.83	638.98	719.39	666.22	588.25	672.60	694.30	551.31
2C.													
Metal Production	2,204.84	2,060.40	1,881.03	1,941.28	1,934.07	2,086.99	2,042.19	2,055.64	2,031.59	1,858.92	2,015.90	1,916.10	1,777.07
CH_4													
2B. Chemical Industry	3.05	3.04	2.99	2.86	3.11	3.34	3.14	3.21	3.34	3.26	3.17	2.96	3.13
2C.													
Metal Production	2.71	2.51	2.43	2.59	2.58	2.71	2.39	2.61	2.52	2.46	2.61	2.51	2.37
N_2O													
2B. Chemical Industry	18.74	20.11	18.54	19.28	18.54	21.35	20.67	20.79	21.37	22.17	23.55	24.61	24.09
HFCs	351.00	355.43	358.78	355.42	481.90	671.29	604.70	1,218.23	2,351.39	3,049.22	4,098.02	5,559.56	7,105.72
PFCs	1,807.65	1,422.87	798.94	630.85	354.77	336.71	243.39	252.08	270.43	258.00	345.85	452.37	413.58
SF_6	332.92	356.39	358.26	370.40	415.66	601.45	682.56	728.64	604.81	404.51	493.43	795.34	760.22

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

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

2A	CO_2	Emissions from cement production	Key (L, T)
2F	HFC, PFC	Emissions from substitutes for ODS	Key (L, T)
2B	N_2O	Emissions from adipic acid	Key (L1, T)
2B	N_2O	Emissions from nitric acid	Key (T1)
2A	CO_2	Emissions from limestone and dolomite use	Key (T1)
2A	CO_2	Emissions from other industrial processes	Key (T1)

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

4.2 Mineral products (2A)

4.2.1. Source category description

In this sector the main source of emissions is CO_2 from cement production (2A1) which is, as already mentioned, a key source and accounts for 3% of the total national emissions.
Limestone and dolomite use, now reported separately, is also a key source for the trend assessment and accounts for 0.56% of the total national emissions.
CO_2 emissions also occur from processes where lime is produced and account for 0.34% of the total national emissions.
CO_2 emissions from decarbonising in glass production have been estimated and reported in other.
CO_2 emissions from soda ash production are also included in this category.
Asphalt roofing and road paving with asphalt activities contribute only with NMVOC emissions.

4.2.2. Methodological issues

IPCC Guidelines and Good Practice Guidance are used to estimate emissions (IPCC, 1997; IPCC, 2000).
Activity data are supplied in the national statistical yearbooks (ISTAT, several years) and by industries. Emission factors are those provided by the IPCC Guidelines (IPCC, 1997) or by other international Guidebooks (USEPA, 1997).
CO_2 emissions from cement production are estimated by the IPCC Tier 1 approach. Activity data comprise data on clinker and on hydraulic lime production provided by ISTAT (ISTAT, several years) and by the Italian Cement Association (AITEC, 2004 [a] and [b]). The estimate average CaO content is the IPCC default value. Activity data have been revised from 1990 onwards including the production of hydraulic lime on account of new information made available by the Italian Cement Association.
CO_2 emissions from limestone and dolomite use have been included in the inventory and they are related to the use of limestone and dolomite in bricks, tiles and ceramic production and iron and steel production. Emission factors are derived by bricks and ceramic industry (ANDIL, 2000; ANDIL, 2004; ASSOPIASTRELLE, 2004 [a], [b]) and iron and steel association (FEDERACCIAI, 2004).
CO_2 emissions from soda ash production have been added on account of new information available on the Solvay process, whereas those from soda ash use are included both in glass and paper production.
CO_2 emissions from lime and glass production and NMVOC emissions from asphalt roofing and road paving have been estimated by production activity data (ISTAT, several years) and default emission factors (IPCC, 1997; EMEP/CORINAIR, 2001).

4.2.3. Uncertainty and time-series consistency

The uncertainty in CO_2 emissions from cement, lime, limestone and dolomite use and glass production is estimated to be less than 8.5% from each activity.
The emission trend is related to the production which is stable.

4.2.4. Source-specific QA/QC and verification

CO_2 emissions have been checked with the relevant industrial associations.

4.2.5. Source-specific recalculations

On account of new information available by the relevant industrial associations, the time series of some activity data have been recalculated. Specifically, the recalculation has regarded the clinker production values. Besides the usual update of data for the last two years, the overall revision of production data has regarded the addition of the hydraulic lime produced by cement plants, which was previously accounted for in the lime production sector estimates. The time series of activity data and the emission recalculations are shown in Table 4.2.
A minor revision of glass production activity data from 1997 onwards has been carried out on account of a revision of national production statistics.

Table 4.2 Production activity data for clinker (kt) and recalculations of CO_2 (Gg) in the cement production sector (1990-2001)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
NIR 2004												
Activity data (clinker+hydr. lime)	31,655	31,488	32,854	28,310	27,708	30,424	27,868	28,249	28,779	30,227	31,347	32,343
CO_2 emissions	16,052	15,968	16,660	14,356	14,051	15,428	14,132	14,325	14,594	15,328	15,896	16,401
NIR 2003												
Activity data (clinker)	29,786	29,497	30,878	26,438	25,923	28,778	26,292	26,753	27,328	28,716	29,562	30,438
CO_2 emissions	15,104	14,958	15,658	13,407	13,146	14,594	13,333	13,566	13,858	14,562	14,991	15,435
Δ emissions (%)	*5.9*	*6.3*	*6.0*	*6.6*	*6.4*	*5.4*	*5.7*	*5.3*	*5.0*	*5.0*	*5.7*	*5.9*

CO_2 emissions from limestone and dolomite use have been estimated and reported for the whole time series in this year submission.
CO_2 emissions from soda ash production have also been included in this year submission and the entire time series recalculated on account of the availability of new information on the Solvay process by industry (Solvay, 2003).

4.2.6. Source-specific planned improvements

Emission factors and activity data could be improved by the analysis of the national EPER data.

4.3 Chemical industry (2B)

4.3.1. Source category description

CO_2, CH_4 and N_2O emissions from chemical productions are estimated and included in this sector. Emissions from adipic acid production are supplied and referenced by the Italian producer (Radici Chimica, 1993; Radici Chimica, 2004). Specifically, for N_2O, adipic acid is a key source at level, with the Tier 1 approach, and trend assessment, both with the Tier 1 and Tier 2 approach. These emissions account for 16.3% of total N_2O emissions in 2002. CO_2 emissions from this source are also estimated and reported in other chemical industry.
N_2O emissions from nitric acid production is also a key source, at trend assessment with the Tier 1. In fact, these emissions show a relevant reduction in the last years as a consequence of the production reduction.
The sharp decreasing trend of CO_2 emissions from ammonia is the main contributor to the assessment of "CO_2 from other Industrial Processes" as a key source for trend with Tier 1 approach and it is due to the reduction in ammonia production.
The time series of production data related to ammonia, nitric and adipic acids are reported in the following Table 4.3.

Table 4.3 Production of ammonia, nitric acid and adipic acid (kt)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Ammonia	1455.0	1392.0	1358.0	885.0	612.0	592.0	397.4	446.0	409.0	367.0	413.8	430.2	334.2
Nitric acid	1036.7	987.8	936.5	724.9	531.9	588.4	545.0	559.6	479.5	431.5	556.3	526.6	492.0
Adipic acid	49.2	54.4	49.8	55.0	55.0	63.6	61.9	62.1	65.1	68.4	71.4	75.3	74.0

4.3.2. Methodological issues

Italian production figures and emission estimates for adipic acid have been provided by the process operator (Radici Chimica, 2004). N_2O emissions from adipic acid production (2B3) have been estimated using the default IPCC emission factor equal to 0.30 kg N_2O/kg adipic acid produced; the previous value of 0.333 has been corrected after further consulting with industry.
With regard to nitric acid production (2B2), production figures are published in the national statistical yearbooks (ISTAT, several years), while the N_2O emission factor is provided by industry and calculated on the basis of new information available in the national registry EPER.

4.3.3. Uncertainty and time-series consistency

The uncertainty in N_2O emissions from adipic and nitric acid production is estimated 5.8%, for each activity. Emission trends are directly related to the production because the plants have not been equipped with abatement technologies. Adipic acid production is increasing whereas nitric acid production shows a decrease in the last years.
Total CO_2 emissions from chemical production have decreased as a result of a relevant reduction in ammonia production.

4.3.4. Source-specific QA/QC and verification

Emissions from adipic and nitric acid production have been checked with the relevant process operators.

4.3.5. Source-specific recalculations

On account of new information available by industry, N_2O emissions have been recalculated for the entire time series using the default IPCC emission factor for the adipic acid and the national EF value for nitric acid. The recalculation accounts for a decrease of 14% in N_2O emissions.

4.3.6. Source-specific planned improvements

Emission factors and activity data could be improved by the analysis of the national EPER data.

4.4 Metal production (2C)

4.4.1. Source category description

The sub-sector metal production comprises four sources: “Iron and steel production”, “Ferroalloys production”, “Aluminium production” and “Magnesium foundries”, all identified as non-key sources.
CO_2 emissions from steel production refer to basic oxygen furnaces and electric furnaces.
For the steel production from arc furnaces, the amount of steel recycled is about 15,000 kilotonnes.
CO_2 fugitive emissions from pig iron, sinter and coke production are not relevant and estimated and included in the combustion processes (1A2a).
CH_4 emissions from steel production are entered in “Other” because not allowed elsewhere.
CH_4 emissions from coke production are fugitive emissions during solid fuel transformation and have been reported in Table 1B1b of the CRF.
The share of CO_2 emissions from metal production accounts, in the year 2002, for 0.4% of the national total CO_2 emissions, and 7.3% of the total CO_2 from industrial processes.
The share of CH_4 emissions out of the total is less than 0.02%. N_2O emissions do not occur.
The share of F-gas emissions from metal production out of the national total F-gas levels was 8.9% in the base-year 1995 and 7.2% (0.11% of the national total greenhouse gas emissions) in the year 2002.

4.4.2. Methodological issues

CO_2 and CH_4 emissions from the sector have been estimated on the basis of activity data published in the national statistical yearbooks (ISTAT, several years) and industrial reports and emission factors used are those reported in the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2001), in sectoral studies (ANPA, 2000; CTN/ACE, 2000) or supplied directly by industry.
CH_4 emissions from steel production reported in “Other” have been estimated on the basis of emission factors derived from the IPPC specific BREF Report (available at http://eippcb.jrc.es) and the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2001) and refer to basic oxygen furnace, electric furnaces and rolling mills.

For the estimation of PFC emissions from aluminium production, both IPCC Tier 1 and Tier 2 methods are used. These emissions, specifically CF_4 and C_2F_6, have been calculated on the basis of the information provided by the national primary aluminium producer, with reference to the document drawn up by International Aluminium Institute (IAI, 2003) and the IPCC Good Practice Guidance (IPCC, 2000).

The Tier 1 has been used to calculate PFC emissions relating to the entire period 1990-1999. As from the year 2000, the more accurate Tier 2 method has been followed, based on default technology specific slope and overvoltage coefficients.

As concerns the Tier 1 methodology, the emission factors for CF_4 and C_2F_6 were provided, whereas for the Tier 2 site specific values and, where they were not available, default coefficients were provided. In the following tables (Tables 4.4, 4.5, 4.6, 4.7) the EFs and the default parameters used are reported; site specific values are confidential but they have been supplied to the inventory team.

Table 4.4 Historical default Tetrafluoromethane (CF_4) emission values by reduction technology type

	Technology specific emissions (kg CF_4 / t Al)		
	1990 - 1993	1994 - 1997	1998 - 2000
Center Work Prebake	0.4	0.3	0.2
Point Fed Prebake	0.3	0.1	0.08
Side Work Prebake	1.4	1.4	1.4
Vertical Stud Søderberg	0.6	0.5	0.4
Horizontal Stud Søderberg	0.7	0.6	0.6

Table 4.5 Multiplier factor for calculation of Hexafluoroethane (C_2F_6) by technology type

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

Table 4.6 Coefficients used for estimation with the Tier 2 methodology by plant

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

** site specific value*
*** default value*

Table 4.7 Coefficients used for estimation with the Tier 2 methodology by plant

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

At present in Italy there are two primary aluminium production plants, which use a prebake technology with point feeding (CWPB), characterised by low emissions. These plants have been progressively upgraded from a Side Work Prebake technology to Point Fed Prebake technology; three old plants with Side Work Prebake technology and Vertical Stud Søderberg technology stopped operation in 1991 and 1992.

For SF_6 used in magnesium foundries, according to the IPCC Guidelines (IPCC, 1997), emissions are estimated from consumption data made available by the company which operates the only magnesium foundry located in Italy.

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 8.5%, for each activity, while for CH_4 emissions about 50%.
In Table 4.8 the emission trend of F-gases per compound from metal production is given.

Table 4.8 Actual emissions of F-gases per compound from metal production in Gg CO_2eq (1990-2002)

Compound	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CF_4 (PFC-14)	1,289.2	986.8	520.1	395.7	176.5	115.6	119.9	122.0	122.8	122.0	168.1	198.1	168.1
C_2F_6 (PFC-16)	384.1	301.7	144.5	100.8	44.0	27.8	28.8	29.4	29.5	29.3	30.6	36.0	30.6
total PFC emissions from aluminium production	*1,673.4*	*1,288.6*	*664.6*	*496.5*	*220.5*	*143.4*	*148.7*	*151.4*	*152.3*	*151.3*	*198.7*	*234.1*	*198.6*
total SF_6 emissions from magnesium foundries	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*12.0*	*15.5*	*23.9*	*35.9*	*172.1*	*449.9*	*400.1*
Total F-gas emissions from metal production	**1,673.4**	**1,288.6**	**664.6**	**496.5**	**220.5**	**143.4**	**160.6**	**166.9**	**176.2**	**187.2**	**370.8**	**684.0**	**598.7**

4.4.4. Source-specific recalculations

As suggested by the ERT, a review of emission factors for PFCs from aluminium production has been carried out, since the EFs provided by the national producer were much lower than the IPCC default emission factors reported (in the table 3.10) in the Good Practice Guidance (IPCC, 2000). Taking into account the new emission factors provided the recalculation of the whole time series has therefore been performed.
In the following Table 4.9. differences with PFC emissions submitted last year are reported.

Table 4.9 Differences between updated time series and time series reported in the 2002 NIR

	Emission recalculations (Gg)											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CF_4 (PFC-14)	1,198.8	901.8	457.4	335.0	108.0	46.3	48.0	48.8	49.9	49.0	94.1	125.0
C_2F_6 (PFC-16)	371.3	289.7	135.6	92.2	34.3	18.0	18.6	19.0	19.2	19.0	20.1	25.6
total PFC emissions	1,570.2	1,191.6	593.0	427.2	142.3	64.3	66.6	67.8	69.1	68.0	114.2	150.6

On the basis of specific information supplied by industry CO_2 emission factor for electric arc furnaces steel production has been revised taking in account of the carbon content in scraps, in graphite and in electrodes. Emission factors changed from 8.5 to 35.1 kg per tonnes steel produced. Results in emissions are an increase equal to 0.4 CO_2 Mt. Recalculation has been applied to the time series.

4.5 Other production (2D)

4.5.1. Source category description

Only indirect gas and SO_2 emissions occur from these sources.
In this sector, we report non-energy emissions from pulp and paper as well as food and drink production, especially wine and bread. CO_2 from Food and Drink Production (e.g. gasification of water) can be of biogenic or non-biogenic origin but only information on CO_2 emissions of non-biogenic origin should be reported in the CRF. According to the information provided by industrial associations, CO_2 emissions do not occur, but only NMVOC emissions originate from these activities. CO_2 emissions from food and beverage included in the previous submissions have been removed since they are originated from sources of carbon that are part of a closed cycle.
As regards the pulp and paper production, NO_x and NMVOC emissions as well as SO_2 are estimated.

4.6 Production of halocarbons and SF6 (2E)

4.6.1. Source category description

The sub-sector production of halocarbons and SF_6 consists of two sources, "HFC-23 emissions from HCFC-22 manufacture" and "Fugitive emissions", identified as non-key sources.
The share of emissions of F-gases from the production of halocarbons and SF_6 in the national total of F-gases was 43.2% in the base-year 1995 and 0.3% in 2002; the share in the national total greenhouse gas emissions was 0.14% in the base-year and 0.005% in 2002.

4.6.2. Methodological issues

For source category "HFC-23 emissions from HCFC-22 manufacture", the IPCC Tier 2 method is used, based on plant-level data communicated by the national producer (Solvay-Solexis S.p.A., 2004); since 1996, data are adjusted for HCFC-22 destruction.
Also for source category "Fugitive emissions", emission estimates are based on plant-level data communicated by the national producer (Solvay-Solexis S.p.A., 2004).

4.6.3. Uncertainty and time-series consistency

The uncertainty in F-gas emissions from production of halocarbons and SF_6 is estimated to be about 11% in annual emissions. In Table 4.10 an overview of the emissions from production of halocarbons and SF_6 is given for the 1990-2002 period, per compound.
HFC-23 emissions from HCFC-22 had already been drastically reduced in 1988 due to the installation of a thermal afterburner in the plant located in Spinetta Marengo. Productions and emissions from 1990 to 1995 are constant as supplied by industry; from 1996, untreated leaks have been collected and sent to the thermal afterburner, thus allowing reduction of emissions to zero.
PFC and SF_6 emissions are constant from 1990 to 1995 and from 1996 to 1998, reducing to zero from 1999. Emissions are reported as supplied by Solvay-Solexis; further investigations on these values will be carried out in 2004. As concerns fugitive emissions, emissions of HFC-134a have

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

Table 4.10 Actual emissions of F-gases per compound from production of halocarbons and SF_6 in Gg CO_2eq (1990-2002)

Compound	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
HFC 23	351.0	351.0	351.0	351.0	351.0	351.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
total HFC 23 emissions from HCFC 22 manufacture	*351.0*	*351.0*	*351.0*	*351.0*	*351.0*	*351.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
HFC 125	0.0	2.8	5.6	2.8	5.6	28.0	22.4	98.0	56.0	5.6	2.8	5.6	5.6
HFC 134a	0.0	1.3	1.3	0.0	0.0	39.0	41.6	52.0	65.0	15.6	15.6	15.6	15.6
HFC 143a	0.0	0.0	0.0	0.0	0.0	22.8	22.8	30.4	38.0	3.8	3.8	3.8	3.8
HFC 227ea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CF_4	97.5	97.5	97.5	97.5	97.5	97.5	32.5	32.5	32.5	0.0	0.0	0.0	0.0
PFC C2÷C3	36.8	36.8	36.8	36.8	36.8	36.8	9.2	9.2	9.2	0.0	0.0	0.0	0.0
SF_6	119.5	119.5	119.5	119.5	119.5	119.5	47.8	47.8	47.8	0.0	0.0	0.0	0.0
total F gas fugitive emissions	*253.8*	*257.9*	*260.7*	*256.6*	*259.4*	*343.6*	*176.3*	*269.9*	*248.5*	*25.0*	*22.2*	*25.0*	*25.0*
Total F-gas emissions from production of halocarbons and SF_6	**604.8**	**608.9**	**611.7**	**607.6**	**610.4**	**694.6**	**176.3**	**269.9**	**248.5**	**25.0**	**22.2**	**25.0**	**25.0**

4.7 Consumption of halocarbons and SF6 (2F)

4.7.1. Source category description

The sub-sector consumption of halocarbons and SF_6 consists of three sources, "HFC, PFC emissions from ODS substitutes", key source at level and trend assessment, both Tier 1 and 2 approaches "PFC, HFC, SF_6 emissions from semiconductor manufacturing", "SF_6 emissions from electrical equipment", that are non-key sources. The share of emissions of F-gases from the consumption of halocarbons and SF_6 in the national total of F-gases was 47.9% in the base-year 1995 and 92.5% in 2002; the share in the national total greenhouse gas emissions was 0.15% in the base-year and 1.4% in 2002.

4.7.2. Methodological issues

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

Sub-sources of F-gas emissions and calculation methods

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

Basic data have been supplied by industry: specifically, for the air conditioning equipment the

national motor company and the agent's union of foreign motor-cars vehicles has provided the yearly consumptions (FIAT, 2004; IVECO, 2004; UNRAE, 2004); pharmaceutical industry has provided aerosols/metered dose inhaler data (AVENTIS, 2004; Boehringer Ingelheim Italia S.p.A., 2004; Chiesi Farmaceutici S.p.A., 2004; GSK, 2004; LUSOFARMACO, 2004; Menarini, 2004); the semiconductor manufacturing industry has supplied consumption data for four national plants (ST Microelectronics, 2004; MICRON, 2004); finally, for the sub-source fire extinguishers, the European Association for Responsible Use of HFCs in Fire Fighting have been contacted (ASSURE, 2004).
SF_6 emissions from electrical equipment from 1990 to 1994 have been estimated according to IPCC Tier 2a approach. SF_6 leaks from installed equipment have been estimated on the basis of the total amount of sulphur hexafluoride accumulated and of average leakage rates; leakage data published in environmental reports have also been used for major electricity producers (ANIE, 2004).
IPCC Tier 1a method has been used to calculate potential emissions, using production, import, export and destruction data provided by the national producer (ANIE, 2004).

4.7.3. Uncertainty and time-series consistency

The combined uncertainty in F-gas emissions from HFC, PFC emissions from ODS substitutes and PFC, HFC, SF_6 emissions from semiconductor manufacturing is estimated to be about 58% in annual emissions; the uncertainty in SF_6 emissions from electrical equipment is estimated to be 11.1% in annual emissions, 5% and 10% concerning respectively activity data and emission factors.
In Table 4.11 an overview of the emissions from consumption of halocarbons and SF_6 is given for the 1990-2002 period, per compound.
In Table 4.12 an overview of the potential emissions is given for the 1990-2002 period, per compound.

Table 4.11 Actual F-gas emissions per compound from the consumption of halocarbons and SF_6 in Gg CO_2eq (1990-2002)

Compound	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
HFC 23	0.0	0.0	0.0	0.0	0.0	1.6	2.3	3.0	3.8	4.5	5.3	6.0	6.8
HFC 32	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5	12.1	21.3	50.3	93.1	146.7
HFC 125	0.0	0.0	0.0	0.0	0.0	1.8	10.8	24.3	96.2	178.3	381.7	671.7	1,029.6
HFC 134	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
HFC 134a	0.0	0.3	0.9	1.6	125.3	224.3	333.0	508.1	785.8	945.2	1,136.8	1,365.1	1,622.0
HFC 143a	0.0	0.0	0.0	0.0	0.0	2.7	15.5	34.4	63.7	125.3	234.9	381.2	556.5
total HFC emissions from refrigeration and air conditioning equipment	*0.0*	*0.3*	*0.9*	*1.6*	*125.3*	*230.5*	*361.8*	*570.3*	*961.5*	*1,274.7*	*1,809.0*	*2,517.2*	*3,361.7*
HFC 134a emissions from foam blowing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.3	36.3	41.1	45.7	51.6
HFC 227ea emissions from fire extinguishers	0.0	0.0	0.0	0.0	0.0	0.0	156.1	467.5	1,182.0	1,612.7	2,112.2	2,826.6	3,537.5
HFC 134a emissions from aerosols/metered dose inhalers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	80.6	108.4	137.6	123.7
total HFC emissions from ODS substitutes	*0.0*	*0.3*	*0.9*	*1.6*	*125.3*	*230.5*	*517.9*	*1,037.8*	*2,174.8*	*3,004.3*	*4,070.6*	*5,527.1*	*7,074.5*
HFC 23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.6	19.9	5.1	7.4	6.2
HFC 134a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
CF_4	0.0	0.0	0.0	0.0	0.0	24.4	21.9	24.4	27.2	40.9	64.8	107.8	106.2

segue

segue **Table 4.11 Actual F-gas emissions per compound from the consumption of halocarbons and SF_6 in Gg CO_2eq (1990-2002)**

C_2F_6	0.0	0.0	0.0	0.0	0.0	34.6	31.1	34.6	49.2	65.6	82.0	99.1	108.0
C_4F_8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	11.3	0.8
SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	55.6	62.1	20.9	49.4	53.3
total PFC, HFC, SF_6 emissions from semiconductor manufacturing	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*59.0*	*53.0*	*59.0*	*149.6*	*188.7*	*173.2*	*275.1*	*274.4*
SF_6 emissions from electrical equipment	213.4	236.9	238.8	250.9	296.2	482.0	622.8	665.3	477.5	306.5	300.4	296.0	306.8
Total F-gas emissions from consumption of halocarbons and SF_6	**213.4**	**237.2**	**239.6**	**252.5**	**421.5**	**771.4**	**1,193.7**	**1,762.1**	**2,801.9**	**3,499.6**	**4,544.3**	**6,098.2**	**7,655.8**

Table 4.12 Potential F-gas emissions per compound from the consumption of halocarbons and SF_6, 1990-2002, in Gg CO_2eq

Compound	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
HFC 32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.4	3.3	-5.2
HFC 125	0.0	0.0	0.0	0.0	0.0	148.4	-36.4	47.6	-109.2	260.4	268.8	1,671.6	803.6
HFC 134a	0.0	16.9	106.6	565.5	438.1	1,739.4	2,059.2	1,886.3	4,101.5	3,367.0	2,107.3	4,371.9	2,960.1
HFC 143a	0.0	0.0	0.0	0.0	0.0	11.4	45.6	-11.4	60.8	266.0	68.4	258.4	79.8
HFC 227ea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	40.6	72.5	133.4	89.9
SF_6	3,752.3	2,652.9	2,079.3	3,298.2	5,066.8	3,675.8	3,451.2	4,612.7	11,495.9	3,465.5	3,919.6	5,903.3	3,689.2
total F-gases	**3,752.3**	**2,669.8**	**2,185.9**	**3,863.7**	**5,504.9**	**5,575.0**	**5,519.6**	**6,535.2**	**15,551.9**	**7,399.5**	**6,447.0**	**12,341.9**	**7,617.4**

4.7.4. Source-specific recalculations

The time series of HFC emissions has been revised due to a major information on leakage rates by the European Association of Responsible Use of HFCs in Fire Fighting (ASSURE, 2004). Compared to the leakage rates of fire fighting substances used in the last submission (10% leakage rate during the manufacturing and no emissions during service), an update has been done; the leakage rate during the manufacturing of fire fighting products has been assumed 0%, whereas a 50% value has been assumed for the leakage rate during service, including extinction.
In Table 4.13 the comparison between total estimation recalculated and previous estimation of the sector is given from 1990 to 2001, for every gases.

Table 4.13 Comparison between recalculated and previous F-gas emissions from the consumption of halocarbons and SF_6 per gas in Gg CO_2eq (1990-2001)

Compound	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
HFCs												
NIR 2004	351.0	355.4	358.8	355.4	481.9	671.3	604.7	1,218.2	2,351.4	3,049.2	4,098.0	5,559.6
NIR 2003	351.0	355.4	358.8	355.4	481.9	671.3	448.6	750.8	1,169.6	1,436.6	1,986.0	2,730.3
PFCs												
NIR 2004	1,807.7	1,422.9	798.9	630.8	354.8	336.7	243.4	252.1	270.4	258.0	345.8	452.4
NIR 2003	237.5	231.4	205.8	203.6	212.5	272.5	176.8	184.3	201.4	190.0	231.7	301.7
SF_6												
NIR 2004	332.9	356.4	358.3	370.4	415.7	601.5	682.6	728.6	604.8	404.5	493.4	795.3
NIR 2003	332.9	356.4	358.3	370.4	415.7	601.5	682.6	728.6	604.8	404.5	493.4	795.0

5. SOLVENT AND OTHER PRODUCT USE [CRF SECTOR 3]

5.1 Overview of sector

In this sector all non-combustion emissions from other industrial sectors than the manufacturing and energy industry are reported.

Solvent use is responsible, in 2002, for 0.3% of CO_2 emissions and 34.3% of NMVOC emissions.

CO_2 emissions from solvent use is a key source in the Tier 2 analysis at a level and trend assessment, especially because of the high level of uncertainty in the estimates and a strong reduction of emissions in these years.

The trends of NMVOC and CO_2 emissions are summarised in Table 5.1. Emissions from paint application and other use of solvents for NMVOC and CO_2 are about 80% and 90% of the total in the sector respectively.

Table 5.1 Trend in NMVOC and CO_2 emissions from the solvent use sector 1990-2002 (Gg)

Gas/subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
NMVOC													
3A. Paint Application	269.27	264.70	261.27	252.56	252.11	251.51	242.84	241.85	227.02	226.59	224.26	218.49	216.06
3B. Degreasing and dry cleaning	56.66	52.98	50.72	43.20	37.05	34.12	31.92	30.22	28.59	27.12	26.40	25.70	25.02
3C. Chemical products	58.64	59.57	60.77	54.49	57.31	58.42	58.86	57.66	60.81	60.49	64.30	61.82	60.97
3D. Other	230.21	235.45	210.83	205.45	194.41	186.74	183.55	183.11	180.62	179.75	175.86	161.09	157.04
CO_2													
3A. Paint Application	839.32	825.08	814.38	787.23	785.81	783.96	756.94	753.86	707.64	706.28	699.01	681.03	673.45
3B. Degreasing and dry cleaning	176.62	165.15	158.09	134.65	115.48	106.34	99.50	94.20	89.12	84.52	82.27	80.09	77.98
3D. Other	717.56	733.91	657.14	640.38	605.99	582.07	572.14	570.75	562.99	560.28	548.15	502.11	489.51

5.2 Solvent use (3A-3D)

5.2.1. Source category description

In accordance with the indications in the IPCC Guidelines (IPCC, 1997), the carbon contained in oil-based solvents, or released from these products, has been considered both as NMVOC and CO_2 emissions as final oxidation of NMVOC. Emissions from the following sub-sectors are estimated: solvent use in paint application (3A), degreasing and dry cleaning (3B), manufacture and processing of chemical products (3C), other solvent use, such as printing industry, glues application, use of domestic products, (3D).

CO_2 emissions have been estimated and included in this sector as they are not already accounted for in the energy and industrial processes sectors.

Use and emissions of N_2O have not been estimated because no activity data and emission factors are available at present.

5.2.2. Methodological issues

Emissions of non-methane volatile organic compounds from solvent use have been estimated

according to the CORINAIR methodology with a bottom-up approach, applying both national and international emission factors (Vetrella, 1994; EMEP/CORINAIR, 2001). All the activities in the Selected Nomenclature for Air Pollutant classification, SNAP97, have been estimated.
Country specific emission factors provided by manufactures have been used extensively, in particular for paint application, solvent use in dry cleaning, solvent use in the printing and in the tanning industries. Basic information on percentage reduction of the solvent content in paints and other products has been derived from industry and applied to the EMEP/CORINAIR emission factors in order to evaluate the reduction in emission during the considered period.
The conversion of NMVOC emissions into CO_2 emissions has been carried out taking into account a specific factor calculated on the basis of molecular weights and suggested by the European Environmental Agency for the CORINAIR project (EEA, 1997), except for emissions from the 3.C sub-sector to avoid double-counting as suggested in the Common Reporting Format.

5.2.3. 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.
The decrease in emission levels from 1990 to 2002 is due to the solvent content reduction in products as a consequence of the application of International Protocols as well as National and European Directive on NMVOC emissions. A further reduction is expected in the next years (MATT, 2003).

5.2.4. Source-specific QA/QC and verification

In the framework of the MeditAIRaneo project, APAT commissioned specific activities aimed at evaluating basic data and information on emission factors collected at local level and comparing them with values used both for the national inventory (TECHNE, 2001) and other European inventories (TECHNE, 2003). The final results will be used to improve the next inventory submission.

5.2.5. Source-specific recalculations

A double counting in NMVOC emissions from chemical manufacturing activities has been deleted. It results in less than 0.6% of the total NMVOC levels in the sector.
This recalculation has not had any effect in CO_2 emission levels.

5.2.6. Source-specific planned improvements

A revision of emission factors on the basis of the verification activities already mentioned for specific processes will be carried out.
Estimation of N_2O emissions from anaesthesia, fire extinguisher and aerosol could also ameliorate the inventory and are planned for next year.

6. AGRICULTURE [CRF SECTOR 4]

6.1 Overview of sector

The agriculture sector in the Italian inventory comprises five source categories:
- enteric fermentation (4A);
- manure management (4B);
- rice cultivation (4C);
- agriculture soils (4D);
- field burning of agriculture residues (4F).

Savannas areas (4E) are not present in Italy and other sources have been not estimated.
In 2002, agriculture was responsible for 48.2% of CH_4 and 54.9% of N_2O emissions. There are no CO_2, HFC, PFC, and SF_6 emissions.
The trends in greenhouse gas emissions of the agriculture sector are summarised in Table 6.1. The table shows that methane emissions from enteric fermentation and N_2O emissions from direct agriculture soils are the most relevant source categories in this sector; in fact these emissions are ranked among the top-10 key level and trend sources and account for more than 75% of emission of the sector in CO_2 equivalent terms. Their individual share in national total greenhouse gas emissions is about 2% and 3.4% respectively in 2002.

Table 6.1 Trend in greenhouse gas emissions from the agriculture sector 1990-2002 (Gg)

Gas/subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CH_4													
4A. Enteric Fermentation	573.55	573.55	598.42	574.99	561.06	576.71	580.10	573.24	572.72	564.59	551.40	552.72	551.77
4B. Manure management	191.71	191.71	190.30	184.97	183.36	178.93	183.84	185.73	185.72	187.53	184.63	183.97	188.70
4C. Rice cultivation	73.26	73.26	70.17	73.58	78.81	80.24	81.36	80.78	79.18	75.73	75.08	74.93	74.01
4F. Field burning of agricultural residues	0.62	0.62	0.68	0.66	0.64	0.64	0.62	0.64	0.57	0.64	0.62	0.58	0.53
N_2O													
4B. Manure management	12.41	12.87	12.40	12.08	12.37	12.86	12.97	13.13	13.33	13.27	13.02	13.68	13.45
4D. Agriculture soils	60.96	63.61	64.16	65.05	64.07	62.32	61.38	64.63	62.48	62.62	62.08	63.15	61.24
4F. Field burning of agricultural residues	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Key and non-key sources of the agriculture sector, based on level and/or trend assessment, are presented in the following box. It can be observed that methane emissions from enteric fermentation, manure management and rice cultivation and N_2O emissions from manure management and agriculture soil (direct, indirect and from animal production) are key sources according to level and trend assessment.

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

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

6.2. Enteric fermentation (4A)

6.2.1. Source category description

As mentioned above, methane from enteric fermentation is a major key source, both in terms of level and trend, for Tier 1 and Tier 2 approaches. Its share of CH_4 emissions in the national greenhouse total is presently 32.2% (32.4% in the base year). The main livestock sources of emissions are dairy and non-dairy cattle that share 35.3% and 45.7% of enteric fermentation methane emissions respectively (40.9% and 41.6% in the base year).
All livestock categories have been estimated except for camels and llamas that are not present in Italy. Emissions from rabbits have been estimated and included in other. No methane emissions occur from poultry for this sub-sector.

6.2.2. Methodological issues

The estimation of enteric emissions has been carried out by defining an emission factor for each livestock category which has been multiplied by the population of the same category. Population data per each livestock category are published by the National Institute of Statistics (ISTAT, several years [a] and [b]) and are estimated on the basis of the general agriculture census (every ten years) and yearly surveys. For non-dairy cattle figures have been sorted according to the age of the animal and the type of production.
Emission factors for dairy cattle are calculated on the basis of the IPCC Tier 2 method suggested in the Good Practice Guidance (IPCC, 2000). Parameters values used in the formulas to calculate the time series of emission factors are reported in the following scheme:

Parameters for the calculation of Dairy cattle emissions from enteric fermentation

Average weight (kg)	650
Coefficient NEm for cattle lactating	0.335
Pasture (%)	10
Weight gain (kg/d)	0
Fat content of milk (%)	3.58
Hours of work per day	0
Portion of cows giving birth (%)	92
Milk production for head/day	13.7-17.1
Digestibility of feed (%)	68-70
Conversion into methane of the energy ingested (%)	5.5-5.0
Mj/kg methane	55.65

Different sources have been used as reference for the different parameters; specifically national value have been used for the average weight and percentage of pasture (CRPA, 2000), for average fat content of milk and portion of cows giving birth (AIA, 2001), conversion into methane of the energy ingested (CRPA, 2000), digestibility of feed (CRPA, 1996 [a]), average milk production per head per day (ISTAT, several years [a]; OSSLATTE, several years); the other parameters value are suggested by the IPCC Guidelines (IPCC, 1997).
For the digestibility of feed and the conversion of energy ingested, different values have been assumed for the years 1990-1994, 1995-1998, 1999-2002 taking into account an increase in the quality of food during these years (CRPA, 2000). Resulting average emission factors per head are reported in Table 6.4.

As consequence of a more efficient use in ingested energy and a reduction in percentage of methane converted, the value of emission factor for dairy cattle decreased from 1990 to 2002.

Emission factors for non-dairy cattle are based on the ingestion of dry matter and on the protein content of the feed, as well as on the coefficients for conversion into methane of the energy ingested (Borgioli, 1981; Crutzen et al., 1986; CRPA, 1996 [a]; CRPA, 2000; Holter and Young, 1992; INRA, 1988; NRC, 1984; Sauvant, 1995).

In order to quantify emissions in line with the method described in the IPCC Guidelines, a detailed procedure was used. Estimates were drawn taking into account Italian conditions, considering the availability of specific data for this situation and including information on the type of diet. Average emission factors reflect national circumstances and vary according to the age class distribution of animals and average daily feed intake. In Table 6.2 the age class distribution of non-dairy cattle is reported from 1990 to 2002.

Table 6.2 Age class distribution of non-dairy cattle 1990-2002

	<1 year		1-2 years Males		1-2 years Females		>2 years Males	>2 years Females			TOTAL
	for slaughter	others	breeding	for slaughter	breeding	for slaughter	all	breeding	for slaughter	others	
1990	300,000	2,127,959	72,461	708,329	749,111	186,060	128,958	467,216	57,654	312,649	5,110,397
1991	300,000	2,060,091	71,191	732,421	1,077,802	197,078	82,957	498,136	59,281	503,041	5,581,998
1992	300,000	2,036,527	65,656	654,622	1,019,928	197,507	102,182	464,814	49,749	534,632	5,425,617
1993	300,000	2,002,856	63,214	639,922	995,481	175,146	95,929	449,996	47,921	551,683	5,322,148
1994	300,000	1,794,806	63,926	651,708	1,040,424	145,475	107,640	451,864	31,569	569,429	5,156,841
1995	438,614	1,716,503	67,282	688,442	1,021,294	154,470	113,424	459,140	33,734	576,906	5,269,809
1996	405,986	1,802,849	29,877	721,323	700,300	166,000	116,390	416,100	32,717	696,400	5,087,942
1997	354,006	1,910,283	62,983	600,315	699,133	160,238	162,187	413,383	63,765	668,553	5,094,846
1998	392,432	1,865,065	25,454	611,973	677,915	166,266	115,269	413,456	60,962	684,530	5,013,322
1999	420,000	1,783,000	27,953	672,047	719,000	165,000	92,000	484,000	53,000	571,000	4,987,000
2000	408,000	1,783,000	26,715	642,285	736,000	160,000	93,000	500,000	51,000	588,000	4,988,000
2001	386,000	1,694,000	26,196	629,804	721,000	164,000	83,000	480,000	39,000	625,000	4,848,000
2002	410,000	1,794,000	24,439	587,561	723,000	160,000	98,000	431,000	53,000	588,000	4,869,000

In Table 6.3 the average weight, percentage of feed ingested, average daily feed intake (kilograms per head) and percentage of methane converted for each age class of non-dairy cattle are reported.

Table 6.3 Main parameters for non-dairy cattle CH_4 emission estimations 1990-2002

	<1 year		1-2 years Males		1-2 years Females		>2 years Males	>2 years Females		
	for slaughter	others	breeding	for slaughter	breeding	for slaughter	all	breeding	for slaughter	others
Average weight (kg)	0	190	550	450	450	450	900	550	550	750
% weight ingested	0	2.6	1.9	2.1	2.1	2.1	1.9	2.1	2.1	1.9
Daily feed intake (kg/head)	0	4.8	10.6	9.4	9.5	9.4	17.1	11.5	11.5	14.3
Daily Gross Energy (Mj /head)	0	89.4	194.8	173.5	174.3	173.5	315.5	212.2	212.2	262.9
% CH4 conversion	0	4	4.5	4	6	4	6	6	6	6

A simplified procedure was used for swine, sheep, goats, horses, mules and asses. In these cases emission factors suggested by the Guidelines have been used (IPCC,1997).

For rabbits emission factors suggested by CRPA (CRPA, 2000) have been used. Emission factor values have been obtained from some measurements and comparison with other livestock on the basis

of average weight. Daily feed intakes are equal to 0.13 kg/d and 0.11 kg/d, for brood-rabbits and rabbits respectively. Methane conversion percentage has been assumed equal to 0.6%. Activity data are published for some years by the National Institute of Statistics (ISTAT, several years [a] and [b]) and are based on the ten years general census of Agriculture. The time series have been reconstructed with the livestock production index. Data reported by FAO (FAO, 2004) refer to meat production.
In Table 6.4 resulting average CH_4 emission factors for dairy and non-dairy cattle are reported from 1990 to 2002.

Table 6.4 Average CH_4 emission factors for dairy and non-dairy cattle 1990-2002 (kg/head/year)

	Dairy cattle	Non-dairy cattle
1990	88.723	46.64
1991	95.596	49.72
1992	95.358	50.00
1993	91.324	50.09
1994	98.325	51.60
1995	94.267	50.76
1996	93.302	50.40
1997	91.428	51.06
1998	89.261	50.24
1999	86.177	49.37
2000	86.262	49.87
2001	84.436	50.57
2002	84.436	49.40

6.2.3. Uncertainty and time-series consistency

The uncertainty in CH_4 emissions from enteric fermentation is estimated to be about 30% in annual emissions as combination of 20% of uncertainty in both activity data and emission factors.
CH_4 emission trend for enteric fermentation is summarised in Table 6.5. The decreasing figure is due mainly to the reduction of dairy cattle emissions. The livestock population dropped from about 2,600,000 cows in 1990 to 2,200,000 in 2002.
In the estimation of national dairy cattle emissions, the number of cows, the total amount of milk produced, the digestibility of feed and the percentage of ingested energy converted in methane are the main factors that influence the quantity of CH_4 released.

Table 6.5 Trend in CH_4 emissions due to enteric fermentation 1990-2002 (Gg)

	Dairy cattle	Non-dairy cattle	Buffalo	Sheep	Goats	Horse	Other equines	Sows	Swine	Rabbits	TOTAL
1990	234,385	238,371	4,707	69,914	6,295	5,375	0,734	0,976	11,633	1,157	**573,547**
1991	223,649	277,562	3,964	67,177	6,305	5,654	0,663	0,962	11,252	1,233	**598,420**
1992	204,676	271,275	5,061	67,684	6,777	5,685	0,569	1,031	10,955	1,274	**574,989**
1993	193,514	266,579	5,310	69,356	7,044	5,819	0,494	0,973	10,687	1,284	**561,060**
1994	197,823	266,091	5,588	79,713	8,290	5,832	0,430	0,937	10,696	1,313	**576,713**
1995	192,825	267,497	8,162	85,344	6,865	5,546	0,445	0,974	11,117	1,329	**580,103**
1996	193,163	256,421	9,422	87,574	7,096	5,617	0,341	1,089	11,167	1,354	**573,244**
1997	190,023	260,163	8,882	87,150	6,757	5,634	0,300	1,040	11,399	1,368	**572,716**
1998	188,891	251,894	10,245	87,152	6,655	5,595	0,296	1,061	11,422	1,375	**564,588**
1999	181,490	246,200	9,240	88,136	6,985	5,440	0,296	1,046	11,168	1,400	**551,398**
2000	178,130	248,764	10,560	88,712	6,875	5,537	0,296	1,062	11,399	1,388	**552,723**
2001	181,875	245,147	10,560	87,616	6,635	5,537	0,296	1,076	11,601	1,425	**551,767**
2002	185,675	240,535	9,790	65,104	4,940	5,537	0,296	1,056	11,444	1,425	**525,800**

6.2.4. Source-specific QA/QC and verification

In the framework of the MeditAIRaneo project, APAT commissioned specific activities to evaluate basic data and information on emission factors collected at local level and compare them both with the national emission factors and the international ones; this for all the activities related to the agriculture sectors including enteric fermentation. The work is still in progress and results will be used for the future submissions.

6.2.5. Source-specific recalculations

For dairy cattle, the Tier 2 approach as defined in the Good Practice Guidance has been applied. Differences with the old estimation are relevant.
In Table 6.6 old and new average emission factors for dairy cattle from 1990 to 2002 are reported.

Table 6.6 CH_4 average emission factors for dairy cattle enteric fermentation from 1990 to 2002 (kg/head per year)

	FE CH_4 Older estimation	FE CH_4 GPG
1990	117.211	88.723
1991	122.224	95.596
1992	122.056	95.358
1993	119.147	91.324
1994	124.124	98.325
1995	121.619	94.267
1996	119.913	93.302
1997	117.572	91.428
1998	115.024	89.261
1999	113.028	86.177
2000	113.088	86.262
2001	111.775	84.436
2002	111.775	84.436

The new emission factors are by 21% to 24% lower than those used in the previous submissions.
Previous emission factors were calculated on the basis of CORINAIR methodology, which formulas are based on milk production (EMEP/CORINAIR, 2001). Differences in milk production at regional level and in the intake of dry matter and nitrogenous waste excreted were considered; gross energy was calculated by the IPCC formula, and then methane conversion percentages have been applied.
The differences in the emission factors are therefore to be explained only by difference in methodology and not in activity data.
Further research is planned.

6.2.6. Source-specific planned improvements

No specific activities are planned except for MeditAIRaneo project.

6.3. Manure management (4B)

6.3.1 Source category description

As mentioned above, CH_4 and N_2O emissions from manure management are key sources at level assessment, both Tier 1 and Tier 2, and Tier 2 trend assessment. In 2002 emissions of this sub-sector account for 11.4% and 9.9% of CH_4 and N_2O total emissions, respectively.

6.3.2. Methodological issues

Estimates of methane emissions from manure management, drawn up on a regional basis, depend on the specific manure management practices and environmental conditions (Safley *et al.*, 1992; Steed and Hashimoto, 1995; Husted, 1994), specifically on the following factors:
• average monthly temperature by region (emissions are considered negligible below 10°C);
• amount of waste in solid form (or at least suitable for being handled) or liquid waste;
• management techniques during the period when the manure is used for agricultural purposes.
In line with the IPCC Guidelines, when quantifying natural gas emissions from livestock a detailed procedure for estimating emission factors for cattle and swine has been used. The procedure takes into account specific national features regarding rearing methods (feeding, rates of production, breeds reared, etc.) and manure management. Furthermore, the procedure recognises the considerable importance of these categories of animals within the framework of livestock resources and it allows to obtain the necessary data bases to carry out detailed estimates. Emissions have been estimated for the years 1990 and 1995 at provincial level and on monthly basis. Hence, average emission factors for detailed categories of cattle and swine have been calculated and applied to the whole time series. A conservative approach in estimating CH_4 emissions from cattle has been followed considering all the waste produced, liquid and solid, as recovered and stocked, including also waste deposited on pastures.
A detailed description of the methodology is reported by CRPA (CRPA, 2000).
Emission factors for cattle have been elaborated on the basis of research studies for the methodology (Husted, 1993; Husted, 1994) and national parameters (CRPA,1993); for swine emission factors have been calculated on the basis of national figures (CRPA, 1996 [b]) and results have been compared with those calculated following the methodology indicated by Husted (Husted, 1994).
Emission factors proposed by the Guidelines in relation to the climatic region, which is “cold” for Italy (13°C as yearly average temperature), have been used for the remaining categories of relevant livestock (IPCC, 1997).
As concerns livestock manure management systems and N_2O emissions, the starting point of the methodology is the consideration that nitrogen present either in an organic form or in the form of ammonia, in the manure at the exit of livestock housing, encounters transformation processes (nitrification, denitrification) which could lead to different types of N_2O emissions, depending on whether or not the effluent is in liquid or solid form (loadable). In the second case N_2O emissions are greater, since the presence of aerobic conditions in part of the load allows the formation of oxidised forms of nitrogen, which are not present to a significant extent in manure which has not undergone specific treatment. The proposed methodology allows for the following:
• definition of the population for every livestock category;
• estimate of the nitrogen excreted by every livestock category;

- for every livestock category, to estimate the fraction of nitrogen excreted for every manure management system (the most important objective being the estimation of the amount present in the waste in loadable and liquid form);
- the application of emission factors (kg N_2O/kg waste) appropriate to every management system.

When estimating emissions from manure, the amount relating to manure excreted while grazing is subtracted since this is taken into account in emissions from soils.

Nitrogen excretion factors by livestock are calculated on the basis of recent European literature (Smith and Frost, 2000; Smith et al., 2000; Jongbloed et al., 1999) as described by CRPA (CRPA, 2000).

Estimate of emissions from manure management systems was made on the basis of the methodology and emission factors suggested by the IPCC Guidelines. Data on livestock population, already used to estimate CH_4 emissions, was referred to, while among the many management systems listed by the IPCC only those relating to slurry, solid waste and chicken-dung drying process system were studied, since these are the only systems relevant in Italy.

6.3.3. Uncertainty and time-series consistency

The uncertainty in CH_4 and N_2O emissions from manure management is estimated to be about 50% and 100%, respectively. Trends for CH_4 and N_2O emissions from manure management are related to the variation in livestock, especially cattle, swine and poultry subdivided by age and type of production. Neither emission factors and N excretion factors nor animal waste management system percentages change much over time, therefore emissions are stable.

6.3.4. Source-specific QA/QC and verification

In the framework of the MeditAIRaneo project, APAT commissioned specific activities to evaluate basic data and information on emission factors collected at local level and compare them both with the national emission factors and the international ones; this for all the activities related to the agriculture sectors including manure management. The work is still in progress and first results will be used for the next inventory submission.

6.3.5. Source-specific recalculations

No specific recalculation has been carried out with exception of the updating of some basic data for 2000 and 2001.

6.3.6. Source-specific planned improvements

No specific activities are planned except for MeditAIRaneo project.

6.4. Rice cultivation (4C)

6.4.1. Source category description

Methane emissions from rice cultivation are estimated. Other emissions of greenhouse gases do not

occur. N_2O emissions from fertilisation of rice surfaces are estimated and reported in agriculture soil emissions (4D).
Rice cultivation regime in Italy refers to irrigated regime. Neither rainfed nor deep water regime of cultivation are present in Italy.
As mentioned above, methane emissions from rice cultivation are a level key source in the Tier 2 approach. In 2002 they share for 4.5% of total CH_4 emissions.

6.4.2. Methodological issues

A specific study on Italian paddies was carried out in 2000; description of the methodology and results are reported in Tani (Tani, 2000) and summarised in the following.
In Italy rice cropping occurs exclusively in flat fields with one harvest per year.
Therefore harvested surfaces coincide with cropped and harvested surfaces, differing from tropical countries where more than one harvest per year is possible. Moreover the particularly expensive crop establishment excludes the possibility of non harvested cropped fields.
Field water regime is man managed, following the theoretical continuously flooded agronomic technique, which involves overflowing of rice paddies with 15-25 centimetres of water usually from April-May to August.
During the period of this field submersion, the following assumptions are made: two or three water drainage periods, lasting from 2 to 4 days each, occur in 85% of rice paddies; a clearly uninterrupted submersion in 13-14 %; about one month delayed submersion in 1-2 %. In the Po valley (except for the Milan rice paddies area) drainage periods are usually short, scarce or non existent. In the Milan area, but mainly in the South of Italy and in the islands where water is scarce, more than three drainage periods per year may occur, sometimes longer than 4 days, (Russo and Nardi, 1996; Spanu and Pruneddu, 1996), and can be more or less voluntary.
Physical-chemical characteristics of involved soils are extremely variable, even within the same province, and a geographical distinction, which might improve the quantity and distribution of emissions assessment, is not possible at present.
Mineral fertilisation is always used and, seldom, manure. Usually fertilisers are surface applied, without deep incorporation. Organic fertilisers used are litters, commercial products and manure. Rice straws are often burned in the field, otherwise plowed into the soil (50% in both cases has been assumed); when buried, little quantities of nitrogen are also added. The above-mentioned applications are usually used in two or three periods, the first of which always before sowing, that is on dry soil, and the others during the growing season.
The IPCC Guidelines (IPCC, 1997) have been followed to estimate methane emissions.
The method considers reduction factors related with water regime, referred to a maximum value, equal to the unit, of continuously flooded areas.
A coefficient equal to 0.5 has been attributed to “Irrigated, intermittently flooded, multiple aeration“, considering it as representative either of the short and modest drainage periods in the Po valley or of the more important one in the South of Italy.
For “Irrigated, intermittently flooded, single aeration” a value of 0.75 was attributed in consideration that one month or more delayed field submersions are responsible for about 25% of emission reduction with respect to continuous floods. This value has been deduced from the results of Schütz (Schütz et al.,1989 [a]), assuming that the flooding delay generates a proportional reduction of the emissions.

The emission factor chosen, equal to 33 g/m^2 CH_4 per year and derived by research studies (Schütz et al.,1989 [a] and [b]), is an experimental value averaged over 3 years of measurements, referred to only the growing period, in the continuously flooded rice paddies in the Po Valley, without organic matter amendment or mineral fertilisation.
The value has been increased by 20% to take into consideration post harvest emissions (Wassmann et al., 1994), therefore it becomes 39.6 g/m^2 CH_4 per year.
Assuming that the area involved in rice straw and other organic matter amendments is about 50% of the total, the increment factor of 2 (Schütz et al.,1989 [a], Yagi and Minami, 1990) has been applied, thus the final average increment factor is 1.5 (50%*1+50%*2).

6.4.3. Uncertainty and time-series consistency

Methane emissions from Italian rice paddies show a general increase from 1990 to 1996 and a decrease from 1997 to 2002 related with the cropped surface. They share about 10% of agricultural activity emissions and about 4% of total methane released in Italy.
Uncertainty in methane emissions is estimated equal to 50%.
Lack of experimental data and of knowledge about the occurrence and duration of drainage periods in Italy is the major cause of uncertainty in the assessments. The assumption of the same water regime surfaces assessment for all previous years introduces another important uncertainty in the results.
The assessment of the estimates would improve by carrying out provincial estimates on the basis of the relation between emissions and temperature; nevertheless there would be only a limited improvement considering that the largest Italian rice production is in the Po valley, where monthly temperatures of the rice paddies are similar, but uncertainty in other emission control factors would remain.

6.4.4. Source-specific QA/QC and verification

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

6.4.5. Source-specific recalculations

No specific recalculations have been carried out.

6.4.6. Source-specific planned improvements

No specific activities are planned.

6.5. Agriculture soils (4D)

6.5.1. Source category description

Under this source category, N_2O emissions from agriculture soils have been reported. Direct and indirect emissions to soil and emissions from animal production have been estimated. N_2O emissions from wetland and waters has been estimated and reported in other (4D4).

Agriculture soil emissions share 82.0% of total N_2O agriculture emissions and 45.0% of total N_2O emissions.
As shown in the following box all single activities are key sources at level and trend assessment.

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

Direct N_2O Agricultural Soils	Key (L, T)
Indirect N_2O from Nitrogen used in agriculture	Key (L, T2)
N_2O from animal production	Key (L2, T2)

6.5.2. Methodological issues

For this category source, the IPCC methodology greatly broadens the previously proposed procedure that only considered emissions derived from applications of synthetic nitrogen such as commercial fertilisers.
According to the methodology direct and indirect emissions from soils must be quantified.
Direct emissions are quantified by applying suitable emission factors for the different types of nitrogen applied to cultivated soils. In particular, the following must be quantified:
• amount of nitrogen from synthetic fertilisers;
• amount of nitrogen from animal waste (excluding quantities excreted while grazing);
• amount of nitrogen (or rather the nitrogen which remains in the soil) as a result of nitrogen fixation from nitrogen-fixing crops;
• amount of nitrogen (or rather nitrogen which remains in the soil) following the incorporation of crop residues from non nitrogen-fixing crops.
Emissions from the cultivation of organic soils (Histosoils) should also be quantified, as direct N_2O emissions, using the appropriate emission factor in kg N_2O/ha cultivated per year. Emissions from animal waste excreted while grazing should also be calculated, from the nitrogen excreted in this phase, using an appropriate emission factor, kg N_2O/kg N excreted while grazing.
Indirect emissions from soils include emissions from the atmospheric deposition and surface runoff of nitrogenous products. In both cases the starting point is an estimate of the nitrogen supply; emissions are therefore calculated by appropriate emission factors, kg N_2O/kg N supplied by atmospheric deposition and surface runoff respectively.
Regarding soil emissions, the IPCC methodology has been modified taking into account some national specifics. In particular, the IPCC method for the calculation of total nitrogen which returns to the soil as a result of nitrogen-fixing crops does not include crops which are important in Italy, such as forage legumes, and seems not too accurate in the calculation of the total biomass produced. Instead, data for cultivated areas (ISTAT, several years [a] and [b]) and the quantities of N fixed per hectare (Giardini, 1977) were used for the principal leguminous crops. To estimate the amount of nitrogen from nitrogen-fixing and non nitrogen-fixing crops, returning to the soil with crop residues, national estimates of protein residues gathered from ad hoc surveys were used (residue production in relation to the product or to the area cultivated and protein content of the residue in relation to dry matter content). For cereals, apart from sorghum, for field vegetables (potatoes, beetroot, tomatoes) and for cabbage and artichokes, the net harvest quantities were used, as well as the ratio of product/by product, the dry matter content of the residue and the protein content estimated from CESTAAT (CESTAAT, 1992). The N content is obtained by dividing the quantity of proteins by 6.25. For all other crops, estimation of the dry matter content of by products was according to those obtained by the

CNR-CRPA survey on organic waste in Emilia Romagna (CRPA/CNR, 1992). It is estimated, for all crops except for rice, that 90% is re-incorporated into the soil, assuming that combustion accounts for 10% and that, in the case of straw or other residues used as bedding, the nitrogen returns to the soil with the droppings, for example in the form of manure, while for rice is 50%.
Finally, regarding nitrogen from cultivation of organic soils, the data for surface area, reproduced in the national soil map of the year 1961, have been supplied by the Experimental Institute for the study and protection of soil of Florence (ISSDS). These values have been verified with related data for Emilia Romagna, the region where this type of soil is most prevalent. The national data estimates approximately 9,000 hectares. Emission factors has been updated as suggested from the IPCC Good Practice Guidance from 5,000 to 8,000 kg N_2O per ha.
Nitrogen amount from animal waste and implied emission factors reflect national circumstances, as reported in paragraph 6.3. NH_3 and NO_x emissions have been calculated according to animal type and subtracted to direct soil N emissions; in 2002 an average percentage is equal to 38.7% as compared the default IPCC emission factor, FRAC_gasm, equal to 20%.

6.5.3. Uncertainty and time-series consistency

The uncertainty in CH_4 emissions from agriculture soil is estimated to be about 30% concerning direct soil emissions, 50% for indirect emissions and 100% regarding animal production and other annual emissions.
Emissions are mainly related to the variation in livestock and in the amount of synthetic fertiliser applied.
Livestock data have been supplied by the National Institute of Statistics (see above 6.2 and 6.3 paragraphs) as well as synthetic fertilisers and their N content (ISTAT, several years [a]).

6.5.4. Source-specific QA/QC and verification

Synthetic fertilisers and their N content have been compared with the international FAO database. In Table 6.7 national and FAO time series of total N applied is reported.

Table 6.7 Total annual N in fertiliser applied from 1990 to 2002 (tonnes)

Year	National data	FAO database
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	774.707	845.000
1999	791.982	868.000
2000	790.253	828.000
2001	815.314	773.161
2002	831.969	785.314

Differences could be attributed to different factors. Firstly, national data are more disaggregated by substance than FAO data and the national N content is considered for each substance instead of default FAO values. Besides very different figures have been found concerning the detailed list of products and the N total amounts, so differences in the figures could derive from different products classification associated to the use of default N content.

6.5.5. Source-specific recalculations

During the compilation of the inventory for the year 2002 an error in one of the parameters used for the calculation of the indirect N_2O emissions (FRAC_gasm) in the agriculture sector was detected; the emission factors was different from that used in the calculation of direct emissions.
The revised EF value has been applied to the whole time series.
Emissions from wetlands have been revised and allocated in N_2O emissions from human sewage in the waste sector.
Basic data regarding livestock, fertiliser amount and cultivated surfaces have been updated for the years 2000 and 2001.

6.5.6. Source-specific planned improvements

Improvements will derive from the results of the MeditAIRaneo project above quoted.

6.6. Field burning of agriculture residues (4F)

6.6.1. Source category description

CH_4 and N_2O emissions from agriculture residues burning in field are estimated and reported in 4F. Both emission activities are not key sources.

6.6.2. Methodological issues

Annual crops are supplied by the National Institute of Statistics (ISTAT, several years [a] and [b]). Residue/crop ratio, dry matter fraction of residue and fractions burned in fields come from national data (CESTAAT, 1992; CRPA-CNR,1992; ANPA-ONR, 2001).

6.6.3. Uncertainty and time-series consistency

The uncertainty of CH_4 and N_2O emissions from field burning of agriculture residues is estimate by about 50%.
Variations in time series are related to the cereal production by species.

7. LUCF [CRF SECTOR 5]

7.1 Overview of sector

CO_2 emissions and removal occur as a result of changes in land-use and from forests.
The sector is responsible for 20.6 Mt of CO_2 removals from the atmosphere in 2002.
The 1996 IPCC Guidelines have been entirely applied for the categories 5A, 5C and 5D of this sector as detailed data were available from national statistics and from researches at national and regional level, whereas for category 5B guidelines have been adapted to the actual Italian situation.
CO_2 emissions from forest fires are estimated and considered in the calculation of biomass stocks reported in 5A; other non-CO_2 emissions from forest fires are estimated and reported under 5E. Emissions of this sector have not been included in the key source analysis and a quantitative analysis of the uncertainty has not been carried out.

7.2 Changes in forest and other woody biomass stocks (5A)

All steps suggested in the IPCC Guidelines have been followed for this category. Carbon removals due to the annual biomass increase in the Italian forests have been calculated for the years 1990-2002.
Basic parameters to estimate the annual increase per hectare of coppice and high forest were derived from the national forest inventory (MAF/ISAFA, 1988) as well as regional forest inventories (http://www.politicheagricole.it). Weibull growth curves were therefore applied to ten different Italian species (Federici and Valentini, 2002).
The estimations include only carbon stored in the above-ground woody biomass; carbon stored in roots, in leaves, in dead wood, in the litter and in the soil has not been estimated because no reliable information is available up to now. Nonetheless, a conservative approach has been followed.
The resulting average increase was about 3.9-4.8 m^3/ha/year for coppice and 7.7 m^3/ha/year for high forest; these values were then multiplied by the biomass densities to obtain the annual increase expressed in tonnes/ha. Taking into account the diversity of species in the Italian forests the average biomass densities are equal to 607,5 g/m^3 for coppices and 440.7 kg/m^3 for high forests. The value of the increase was then multiplied by the forest area, in hectares, which is available by type, specifically high forest and coppice, in the national statistics (ISTAT, several years [c]).
A carbon content of 0.5 was considered to calculate the annual total C uptake.
Carbon amount released by forest fires was subtracted to the total uptake. The calculation to estimate emissions from forest fires is explained in paragraph 7.3.
In addition, the C content of removed biomass for timber use was subtracted from the resulting figure. Data of wood use for construction and energy purposes is reported in m^3, for coppices and high forests, in the national statistics. These figures were multiplied by the same biomass densities values as above, which allows the conversion into dry matter. A carbon content of 0.5 was considered to calculate the annual total C release by commercial harvest.

7.3 Forest and grassland conversion (5B)

In Italy, in consideration of national regulations, forest fires do not result in changes in land use; therefore conversion of Forest and Grassland does not take place. Anyway CO_2 emissions from forest fires are estimated and accounted for in the calculation of changes in forest and other biomass stocks reported in Table 5.A. Non-CO_2 emissions are estimated and reported under 5E category because they are not related to a land use change.
In the following, the method of estimating the Italian emissions from forest fires is described.
The IPCC method for category 5B, forest and grassland conversion, refers specifically to tropical countries, where the vegetative biomass is removed to convert the land for agricultural use or grazing.
Once the vegetation has been cut most of it is burnt on-site and some other is used as fuel off-site. The situation is different in Italy: fires are not managed events, as in tropical countries, but are almost always an undesirable occurrence. Despite this, man causes more than 95% of fires and therefore emissions are considered anthropogenic.
Immediate emissions of CO_2 from the site where the fire blazes and those from the vegetation left to decay, as well as other greenhouse gas emissions (CH_4, N_2O, NO_x, CO), are calculated in accordance with the IPCC method. To calculate the biomass burnt in the years 1990-2002, 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 [c], several years).
To estimate the biomass in these areas, reference was made to a detailed research which sets out the different types of vegetation in the Italian regions with different coefficients for burnable biomass per hectare (Bovio, 1996). These values were multiplied by the areas hit by fire to obtain the total biomass burnt for each vegetation type per region. The national total biomass burnt between 1990 and 2002 was therefore calculated. Burned biomass was multiplied by the fraction for oxidised biomass (suggested coefficient = 0.9) and afterwards by the C fraction for wood (0.5) and by the conversion factor for CO_2.
Regarding calculation of CO_2 emissions from vegetation left to decay after a fire, the IPCC method was used, calculating the decaying vegetation ("burnable" according to Bovio) in tons/year as an average for the previous 10 years emissions. This approach was necessary because of variations in the fire phenomenon. The ten years average for decayed biomass was then multiplied by the fraction of biomass that is left to decay over a period of time equal to 0.5 and then by the C fraction (0.5).
Total CO_2 emissions as a result of fire were obtained by adding the CO_2 immediately released to that emitted from decayed vegetation during the previous 10 years. There are huge annual variations between 1990 and 2002.
The IPCC method was followed for CH_4, CO, N_2O, NO_x emissions, multiplying the amount of C released in 1990-2002 by the emission factors suggested in the IPCC guidelines (IPCC, 1997).
The CO_2 emissions calculated in this way were subtracted to the total uptake in the category 5A.

7.4 Abandonment of managed lands (5C)

With regard to this emission category (abandonment of managed lands), the decline in areas cultivated for permanent forage crops, fields and pastures, since 1970 has been considered as abandoned lands. This data was then smoothed using a moving averages method in order to obtain a clear indication of the phenomenon of abandonment that could be used as a basis for evaluating the proportion of these lands that could re-grow into forest.

In the years between 1975 and 2002 the phenomenon of abandonment related to around 20% of fields and pastures. Land previously used for agricultural purposes, especially land affected by the EU regulations on set-aside, have not been included since they remain in someone's ownership and therefore managed and potentially productive. It is thought very likely that in these cases the natural vegetation will not re-grow.

The IPCC method has been strictly followed and national statistics have been used in the estimations. In accordance with the IPCC Guidelines, abandonment of managed lands has been quantified and estimated adding up the average hectares annual differences for 20 years in areas cultivated for permanent forage crops; average hectares for each year are estimated by 5 years moving average.

These figures were then multiplied by the annual rate of biomass growth per hectare provided by the IPCC method (2 t/dry matter/ha) for broadleaves, since the vegetation mainly re-grows into broadleaves, given that these are the main form of spontaneous vegetation in Italy. In this way the biomass, expressed in tons, grown on abandoned lands in the past twenty years, was obtained. This figure was then multiplied by the fraction of C (0.5) in wood and by the factor for conversion to CO_2, to obtain the biomass stored up over 20 years. The figure is close to 3 million tons of absorbed CO_2, which is equivalent to around 0.15 Mt on average per year. Calculation for periods longer than twenty years were not made, since after such a period of time abandoned lands would be considered as forests. Emissions and removals from them should then be included in the relevant category (5A).

7.5 CO_2 emissions and removals from soil (5D)

To estimate emissions or removals in relation to 1990-2002 we have considered the changes in areas by type of agricultural practices in terms of surface area in the twenty years periods 1970-1990, …, 1982-2002. The data used for land area were those provided by the National Statistics Institute (ISTAT, several years [a], [b], [c]). About 50% of the national territory is dedicated to agriculture at present.

According to the indications of national experts, the carbon content of one hectare of land with a soil depth of 30 cm can be estimated as equal to 44.5 +/- 10 tons. The carbon content of forest soils can be estimated as equal to 73 +/- 15 tons (Ciccarese *et al*., 2000). For every type of soil (long term cultivated, forest, permanent pasture, set-aside), the surface area was multiplied by the unit content of carbon and by the average coefficients suggested by the IPCC in the Reference Manual, Table 5-10 (IPCC, 1997) which take account of the different tillage systems and of the amount of crop residues left to decompose (tillage factor and input factor respectively). Thus we have estimated the stock of carbon at the beginning and end of the period examined and as a result the quantities of CO_2 stored or released as a result of agricultural practises. CO_2 emissions obtained are equivalent to 1.4 Tg CO_2 for 1990, 2.0 Tg CO_2 for 2002; this outlined the importance of the phenomenon of abandonment of cultivated land.

The IPCC method takes account of CO_2 emissions from organic soils, which refer to the conversion of organic soils into agricultural soils (soils which have undergone intense agricultural production). These soils have large quantities of fertilisers which result in an increase of the carbon

decomposition in the soil and higher CO_2 emissions. This situation is not found in Italy, where, if anything, the policy of set aside creates a contrasting scenario.
Moreover, the method stresses that organic soils present in natural ecosystems, with a stable or increase in carbon content, are not included. Step 5 of the IPCC Guidelines, which deals with the addition of carbonates to acid soils, relates to practises that are uncommon in our country.

7.6 Uncertainty and time series consistency

Even though a quantitative analysis of the uncertainties for emissions from LUCF has been not performed, the main sources of uncertainties are known. Specifically, for emissions from changes in forest and other woody biomass stocks a comparison between the official statistics (ISTAT, several years [a], [b], [c]) and other data sources such as FAO statistics (TBFRA, 2000) and regional forest inventories, have been carried out. The actual forest area results 3 million hectares higher than that reported in the official ISTAT figures. On the contrary, data on biomass removed in commercial harvest published by ISTAT are probably underestimated, particularly concerning fuelwood consumption (Ciccarese *et al*., 1999).
Generally, emissions from this sector are still affected by a high degree of uncertainty both for the uncertainty in activity data and in the parameters used to draw out the estimates (Ciccarese *et al*., 1998; MATT, 2002). Nevertheless, the estimates will improve through the application of the new IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2003).
In addition, the participation at workshops and pilot projects also contributes to a better estimation of the emissions. 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). Critical issues and uncertainties in the estimations are highlighted.
A verification of CO_2 emissions from carbon stocks was carried out through the comparison between the national figures reported in the CRFs and those calculated by the CSEM model for the estimation of forest carbon balance in Italy (APAT, 2002). The comparison showed slight differences traceable back to the underlying assumptions of the models.

7.7 Source-specific planned improvements

Improvements will regard the implementation of the new national forest inventory by the year 2006 and the use of the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2003).
In the next submission GPG will be applied, new refined growth curves will be applied and the estimation of carbon stored in roots, leaves, dead wood and in the litter will also improve the inventory.
Improvements will be also related to the outcome of European research projects on carbon stock inventories in Europe. Specifically for Italy, two projects are in progress: INFOCARB- Carbon fluxes and Pools in Forest Ecosystems and Progetto Kyoto which should estimate the carbon amount in the Lombardy region. Details of the projects can be found at the website links: http://www.cealp.it, http://www.flanet.org.

8. WASTE [CRF SECTOR 6]

8.1 Overview of sector

- The waste sector comprises four source categories:
- solid waste disposal on land (6A);
- wastewater handling (6B);
- waste incineration (6C);
- other waste (6D).

The trends in greenhouse gas emissions from the waste sector are summarised in Table 8.1. It clearly shows that methane emissions from solid waste disposal sites (landfills) are by far the largest source category within this sector; in fact these emissions rank among the top-10 key level and key trend sources.
Emissions from waste incineration facilities without energy recovery are reported under category 6C, whereas emissions from waste incineration facilities which produce electricity or heat for energetic purposes are reported under categories 1A2 (Manufacturing industries and construction) and 1A4a (according to the IPCC reporting guidelines).
Under 6D, CH_4 (and NMVOC) emissions from compost production are reported.

Table 8.1 Trend in greenhouse gas emissions from the waste sector 1990-2002 (Gg)

Gas/subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CO_2													
6C. Waste incineration	544.9	542.8	587.3	615.4	615.2	585.9	540.6	537.8	330.6	440.6	279.5	298.4	279.9
CH_4													
6A. Solid waste disposal on land	454.0	461.8	416.7	421.1	437.4	457.2	462.2	462.8	455.1	446.9	451.7	457.6	443.7
6B. Wastewater handling	59.7	60.4	60.2	59.7	60.0	59.0	58.8	59.1	59.0	58.6	59.7	60.1	60.0
6C. Waste incineration	7.6	14.7	11.6	12.6	11.8	12.9	10.9	13.2	11.7	14.3	11.9	13.0	12.6
6D. Other (compost production)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2
N_2O													
6B. Wastewater handling	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
6C. Waste incineration	0.3	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.4

From the following box, in which the key and non-key sources of the waste sector are presented based on level, trend or both, we can conclude that methane emissions from landfills and from wastewater handling, and nitrous oxide emissions from wastewater handling, are key sources according to both level and trend assessment.

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

6A	CH_4	Emissions from solid waste disposal sites	Key (L, T)
6B	CH_4	Emissions from wastewater handling	Key (L2, T2)
6B	N_2O	Emissions from wastewater handling	Key (L2, T2)
6C	CO_2	Emissions from waste incineration	Non-key
6C	CH_4	Emissions from waste incineration	Non-key
6C	N_2O	Emissions from waste incineration	Non-key
6D	CH_4	Emissions from other waste (compost production)	Non-key

8.2 Solid waste disposal on land (6A)

8.2.1. Source category description

As mentioned above, methane from landfills is a major key source, both in terms of level and trend. Its share of CH_4 emissions in the national greenhouse total is presently 1.68% (and was 1.88% in the base year 1990).
The main factors that influence the quantity of CH_4 released are the total amount of waste disposed of on land, the percentage which is disposed of into controlled landfills and the amount of methane which is collected and flared.

8.2.2. Methodological issues

In order to calculate CH_4 emissions from all the landfill sites in Italy, the simplifying assumption was made that all waste is land filled on one landfill site, which started operation in 1975 (although characteristics of individual sites vary substantially). As concerns emission estimation, annual changes in waste production have been taken into account when quantifying annual natural gas emissions from solid waste disposal on lands, using first order decay model, equation 5 of the IPCC Guidelines (IPCC, 1997), that corresponds to an IPCC Tier 2 methodology.
Since CH_4 emissions from landfills are a key source (see above), the present methodology does comply with the IPCC Good Practice Guidance (IPCC, 2000).
Apart from municipal solid waste, industrial waste which is land filled and sludge from wastewater handling plants have also been considered. The share of waste disposed of into uncontrolled landfills, which was 52.7% in 1975, gradually decreases thanks to the enforcement of new regulations, and it has been assumed equal to 0 in the year 2000, although emissions are released due to the waste disposed in the past years. The unmanaged sites have been considered 50% deep and 50% shallow.
Parameter values used in the landfill emissions model are:
• total amount of land filled waste;
• fraction of Degradable Organic Carbon (DOC);
• fraction of DOC actually dissimilated (DOC_F);
• fraction methane in land filled waste (F);
• methane oxidation factor (O_X);
• methane correction factor (MCF);
• methane generation (i.e. decomposition) rate constant (k).

Composition of land filled waste (%)

Paper and paperboard	30.13%
Food and garden waste	30.79%
Glass	6.00%
Textiles	5.13%
Other	12.95%
- inert	5.00%
- organic	7.95%

On the basis of data available on waste composition reported in the table above (Ferrari, 1996) and the DOC contents for each land filled waste typology (Andreottola and Cossu, 1996), methane generation potential values (L_0) have been generated.

The fraction of DOC dissimilated and the MCF are IPCC default values. The MCF value for unmanaged landfill results as average of the default IPCC values reported for deep and shallow sites.

It is assumed that landfill gas composition is 50% carbon dioxide and 50% methane: non methane volatile organic compounds are 1.3 weight per cent of methane (Gaudioso et al., 1993). In the following table the parameters used for the estimation are reported.

Landfill	MCF	DOC	DOC_F	F	16/12	O_X	L_0 (m^3/Mg)
managed	1.0	0.114	0.5	0.5	1.33	0.1	46.22
unmanaged	0.6	0.114	0.5	0.5	1.33	0	30.81

The maximum methane generation rate constant of 0.4 per year has been assumed, as suggested by the IPCC Guidelines (IPCC, 1997), due to the high moisture content in Italian landfill sites.

8.2.3. Uncertainty and time-series consistency

The combined uncertainty in CH_4 emissions from solid waste disposal sites is estimated to be 22.4% in annual emissions, 10% and 20%, respectively, for activity data and emission factors, values suggested by the IPCC Good Practice Guidance (IPCC, 2000).

The CH_4 emission trend for landfills is summarised in Table 8.2. It has to be noted that the amount of methane recovered has increased more than eight-fold: gas recovery is leading mostly for energy use.

Table 8.2 Net methane emissions and methane recovered from solid waste disposal sites 1990-2002 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Land filled waste (managed)	16,106	17,260	18,503	20,265	21,238	21,205	21,652	21,631	22,095	23,671	24,480	22,695	20,630
Land filled waste (unmanaged)	6,462	6,519	6,039	5,627	5,086	3,751	2,898	1,843	916	513	0	0	0
CH_4 net emissions (managed)	339.5	346.1	299.8	306.3	326.5	352.2	369.2	383.0	390.5	398.1	415.9	433.5	427.6
CH_4 net emissions (unmanaged)	114.4	115.7	116.9	114.8	110.9	105.0	93.0	79.8	64.6	48.9	35.8	24.0	16.1
CH_4 recovered/flared	24.1	43.4	117.5	140.9	156.7	163.9	168.7	173.5	178.4	183.2	188.0	192.8	197.6
% of gross emissions	5.0	8.6	22.0	25.1	26.4	26.4	26.7	27.3	28.2	29.1	29.4	29.6	30.8

8.2.4. Source-specific QA/QC and verification

A comparison of the national emission factors and parameters used for the estimation with the default IPCC values is reported in Table 8.3. The main difference refers to the average degradable organic carbon in the waste and depends on the Italian waste composition.

Table 8.3 National emission factors and IPCC default values

Landfill	MCF	DOC	DOC_F	F	16/12	O_X	L_0 (kg/ton)	L_0 (m^3/ton)
managed	1.0	0.114	0.5	0.5	1.33	0.1	34.20	46.22
unmanaged	0.6	0.114	0.5	0.5	1.33	0	22.80	30.81
IPCC default value	***1.0***	***0.191***	***0.5***	***0.5***	***1.33***	***0.1***	***57.16***	***77.24***

A review of activity data has been done (Colombari *et al*., 1998; De Stefanis *et al*., 1998; De Poli and Pasqualini, 1997; Ferrari, 1996).
The complete database from 1975 of waste production, waste disposal in managed and unmanaged landfills and sludge disposal in landfills has been reconstructed on the basis of available data reported in different sources (MATT, several years; ANPA-ONR, 2001 [b]; APAT-ONR, 2002; APAT-ONR, 2003; APAT, 2002; ANPA-ONR, 1999 [b]; FEDERAMBIENTE, 1992), national legislation (Legislative Decree 5 February 1997, no.22) and regression models based on population.

8.2.5. Source-specific recalculations

Methane emissions from landfills have not been recalculated in this year submission. Nevertheless the amount of non methane volatile organic compound in landfill gas has been updated for the whole time series on the basis of national literature (Gaudioso *et al*., 1993); this results in higher CH_4 emissions for the whole time series. Differences with the figures reported previously are very small (less than 0.5%).

8.2.6. Source-specific planned improvements

The update for the estimation of the waste composition is planned. The average waste composition for the last years could differ from that reported due to the increase of the waste recycling and recovering and changes in the household consumption reflecting in the domestic solid waste production.
Furthermore a specific research work is planned concerning the landfill gas recovery system in Italy.

8.3 Wastewater handling (6B)

8.3.1. Source category description

In Italy wastewater handling is managed mainly using aerobic treatment plants, where the complete-mix activated sludge process is more frequently designed. It is assumed that domestic and commercial wastewaters are treated 100% aerobically, whereas industrial wastewaters are treated 85% aerobically and 15% anaerobically.
Consequently, there are no CH_4 emissions from the treatment of domestic and commercial wastewaters, but only N_2O emissions from human sewage. Since there are not further N_2O emissions, they are reported exclusively in human sewage.
The stabilization of sludge, both in domestic and industrial wastewater treatment plants, occur in aerobic or anaerobic reactors; whereas anaerobic digestion is used, the reactors are of course covered and provided of gas recovery; therefore, emissions from sludge disposal do not occur.

8.3.2. Methodological issues

As concerns N_2O emissions, the default approach suggested by the IPCC Guidelines (IPCC, 1997), and updated in the Good Practice Guidance (IPCC, 2000), based on population and per capita BOD_5

has been followed. Fraction of nitrogen protein (Frac $_{NPR}$) 0.16 kg N/kg BOD_5 and emission factor (EF_6) default values 0.01 kg N-N_2O/kg N produced have been used, whereas the value 60 g BOD_5/capita◊d of protein intake have been used, as defined by national legislation and expert estimations (Legislative Decree 11 May 1999, no.152; Masotti, 1996; Metcalf and Eddy, 1991).
The methane estimation concerning industrial wastewaters makes use of the IPCC method based on wastewater output and the respective Degradable Organic Carbon for each major industrial wastewater source. No country specific emission factors of methane per Chemical Oxygen Demand are available so the default value of 0.25 kg CH_4/kg DC, suggested in the IPCC Good Practice Guidance (IPCC, 2000), had been used for the whole time series.
As recommended by the Good Practice Guidance (IPCC, 2000) for key source categories, data have been collected for several industrial sectors (food and beverage, paper and pulp, organic chemicals, iron and steel, textile, leather industry). National data have been used in the calculation of the total amount of both COD produced and wastewater output for: pulp & paper sector (ANPA-FLORYS, 2001; Assocarta, several years), beer (Assobirra, 2004), wine, milk and sugar sectors (ANPA-ONR, 2001 [a]). The introduction of leather sector (ANPA-FLORYS, 2000; UNIC, 2003) has improved the emission estimation.
Because of this, the whole time series has been recalculated.

8.3.3. Uncertainty and time-series consistency

The combined uncertainty in CH_4 emissions from wastewater handling is estimated to be about 58% in annual emissions 50% and 30% respectively for activity data and emission factor uncertainty coming from expert judgement and IPCC Good Practice Guidance (IPCC, 2000). The uncertainty in N_2O emission is 30% both for activity data and emission factor as suggested in the GPG (IPCC, 2000).
CH_4 emission trend for industrial wastewater handling for different sectors is shown in Table 8.4; neither wastewater flow nor average COD value change much over time, therefore emissions are stable.
The emission trend for N_2O emissions both from industrial wastewater handling and human sewage is shown in Table 8.5.

8.3.4. Source-specific QA/QC and verification

A review of activity data has been done. On the basis of new information available, estimates for some sectors have been checked and revised. Industrial new specific documentation in the sectors of pulp and paper, food and beverages, leather, such as Environmental Report or technical documentation has been used with the aim to verify wastewater flows and COD concentrations (ANPA-FLORYS, 2001; Assocarta, several years; Assobirra, 2004; ANPA-ONR, 2001 [a]; ANPA-FLORYS, 2000; UNIC, 2003). Average amount of wastewater per annual production has been compared with those reported in the IPCC Guidelines (IPCC, 1997) and in the technical reports developed in the framework of the Integrated Pollution and Prevention Control (IPPC) Directive of the European Union (http://eippcb.jrc.es). Emissions from the leather industry have been introduced because of the high national production. For chemicals and refineries total COD amount have been supplied by industry (UP, 2003), while for iron and steel and textile industry IPCC default values have been applied to production data (ISTAT, 2003 [a] [b]; MAP, 2004).

Table 8.4 CH_4 emissions from industrial wastewater handling 1990-2002

Iron and steel													
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
CH_4 emissions (Gg)	0.036	0.034	0.030	0.028	0.030	0.029	0.028	0.029	0.029	0.028	0.025	0.027	0.023
Wastewater (1000000m^3)	9.5	9.1	8.1	7.4	7.9	7.8	7.4	7.8	7.8	7.5	6.8	7.2	6.1
COD (g/m^3)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Oil refinery													
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
CH_4 emissions (Gg)	5.850	5.850	5.850	5.850	5.775	5.625	5.000	4.800	4.925	4.580	4.250	4.750	4.750
Annual COD (Gg/yr)	156.0	156.0	156.0	156.0	154.0	150.0	133.3	128.0	131.3	122.1	113.3	126.7	126.7
Organic chemicals													
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
CH_4 emissions (Gg)	23.801	23.739	23.796	23.775	23.879	23.921	23.946	24.044	24.053	24.115	24.184	24.140	24.153
Wastewater (1000000m^3)	211.0	209.7	211.3	211.3	212.3	212.4	212.8	213.8	214.0	214.4	215.1	214.4	214.3
COD (g/m^3)	3008.4	3018.4	3003.5	3001.2	2999.9	3003.8	3001.4	2998.2	2996.8	2999.5	2998.1	3003.1	3006.2
Food and beverage													
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
CH_4 emissions (Gg)	21.873	22.878	23.056	22.466	22.118	21.200	21.597	22.035	21.484	21.944	22.684	22.994	23.210
Wastewater (1000000m^3)	169.0	176.8	178.5	172.9	170.7	169.0	172.4	171.6	171.5	175.1	175.8	174.5	174.6
COD (g/m^3)	3450.7	3450.6	3443.4	3464.3	3454.8	3345.2	3339.6	3423.5	3341.0	3341.2	3440.7	3513.8	3545.0
Pulp and paper													
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
CH_4 emissions (Gg)	0.923	0.923	0.940	0.927	0.990	0.985	0.972	1.033	1.057	1.045	1.041	1.007	1.045
Wastewater (1000000m^3)	377.2	376.9	384.0	378.6	404.4	402.6	414.3	432.6	405.6	394.2	382.3	369.6	383.6
COD (g/m^3)	65.3	65.3	65.3	65.3	65.3	65.3	62.6	63.7	69.5	70.7	72.6	72.6	72.6
Textile industry													
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
CH_4 emissions (Gg)	4.067	3.901	3.639	3.609	3.877	3.864	3.881	3.954	3.916	3.588	3.809	3.755	3.514
Wastewater (1000000m^3)	108.5	104.0	97.0	96.2	103.4	103.0	103.5	105.4	104.4	95.7	101.6	100.1	93.7
COD (g/m^3)	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0
Leather industry													
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
CH_4 emissions (Gg)	3.190	3.083	2.925	3.053	3.289	3.378	3.404	3.232	3.564	3.301	3.676	3.429	3.318
Wastewater (1000000m^3)	23.6	22.8	21.6	22.6	24.3	25.0	25.2	23.9	26.4	24.4	27.2	25.4	24.6
COD (g/m^3)	3603.2	3603.2	3603.2	3603.2	3603.2	3603.2	3603.2	3603.2	3603.2	3603.2	3603.2	3603.2	3603.2

Table 8.5 N_2O emissions from industrial wastewater handling and human sewage 1990-2002 (Gg)

N_2O emissions (Gg)													
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Industrial wastewater	0.225	0.225	0.225	0.222	0.231	0.230	0.234	0.239	0.232	0.228	0.227	0.223	0.223
Human sewage	3.144	3.125	3.136	3.146	3.153	3.157	3.164	3.170	3.172	3.176	3.185	3.191	3.209

8.3.5. Source-specific recalculations

Recalculation of CH_4 and N_2O emissions has been done for domestic and industrial wastewater treatment. A comparison with the previous estimation, both in absolute and percentage terms, is reported in Table 8.6. Recalculated emissions from industrial wastewater are lower than those in the last submission while emissions from human sewage are higher.

Table 8.6 Differences between time series reported in the 2002 NIR and updated time series

	Emission recalculations (Gg)											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CH_4 Industrial wastewater	-3.313	-4.054	-5.682	-4.470	-3.932	-3.889	-4.811	-4.405	-4.633	-5.513	-4.048	-3.130
N_2O Industrial wastewater	-0.031	-0.033	-0.039	-0.035	-0.033	-0.032	-0.033	-0.030	-0.033	-0.034	-0.031	-0.030
N_2O Human sewage	0.278	0.260	0.260	0.261	0.262	0.263	0.263	0.264	0.263	0.264	0.265	0.265
	Emission recalculations (%)											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CH_4 Industrial wastewater	-5.3	-6.3	-8.6	-7.0	-6.2	-6.2	-7.6	-6.9	-7.3	-8.6	-6.4	-4.9
N_2O Industrial wastewater	-12.0	-12.9	-14.7	-13.7	-12.4	-12.2	-12.5	-11.2	-12.5	-12.9	-11.9	-12.0
N_2O Human sewage	+9.7	+9.1	+9.1	+9.1	+9.1	+9.1	+9.1	+9.1	+9.1	+9.1	+9.1	+9.1

8.3.6. Source-specific planned improvements

Some verification activities are planned to better evaluate the percentage of anaerobic wastewater treatment out of the total.

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 industrial waste, hospital waste, sewage sludge and waste oil.
As mentioned above, emissions from waste incineration facilities with energy recovery are reported under categories 1A2 (Manufacturing industries and construction) and 1A4a (Combustion activity, commercial/institutional sector), whereas emissions from other types of waste incineration facilities are reported under category 6C (Waste incineration).
Emissions from removable residues from agricultural production are included in the same IPCC category. They refer mainly to olives and wine residues: the total residues amount and carbon content have been estimated by both IPCC and national factors.

8.4.2. Methodological issues

In order to improve emission estimations from incinerators, a complete data base of these plants has been built; for each plant a lot of information has been included, among which the year of the construction and possible upgrade, the typology of combustion chamber and gas treatment section, if it is provided of energy recovery (thermal or electric), the type and amount of waste incinerated (municipal, industrial, etc.). Various available sources relating to the period 1990-2002 were used, extrapolating data for the years for which there was no available information (MATT, several years; ANPA-ONR, 1999 [a]; ANPA-ONR, 2001 [b]; APAT-ONR, 2002; APAT-ONR, 2003; APAT, 2002; ANPA-ONR, 1999 [b]; AUSITRA-Assoambiente, 1995; Morselli, 1998; FEDERAMBIENTE, 1998; FEDERAMBIENTE, 2001; AMA-Comune di Roma, 1996; Ambiente S.p.A. 2001; http://www.coou.it).
Different procedures were used to estimate emission factors, according to the data available for each type of waste.

Specifically:

- for municipal waste, emission data from a large sample of Italian incinerators were used (these plants represent around 50% in terms of the quantities of waste disposed of annually);
- for industrial waste and waste oil, reference was made to the allowed levels in the authorisation for the management of a group of incinerators taken as a sample;
- for hospital waste, which is usually disposed of alongside municipal waste, the emission factors used for industrial waste were also used;
- for sewage sludge, in absence of specific data, reference was made to the emission limits prescribed by the Guidelines for the authorisation of existing plants issued on the 12th July 1990.

With regard to municipal waste, on the basis of the IPCC Guidelines (IPCC, 1997) and referring to the average content analysis on a national scale (FEDERAMBIENTE, 1992), a distinction was made between CO_2 from fossil fuels (generally plastics) and CO_2 from renewable organic sources (paper, wood, other organic materials). Only emissions from fossil fuels, which are equivalent to 35% of the total, were included in the inventory.

On the other hand, CO_2 emissions from the incineration of sewage sludge were not included at all, while all emissions relating to the incineration of hospital and industrial waste were included.

Removable residues from agriculture production are estimated for each crop type (cereal, green crop, permanent cultivation) taking in account the amount of crop produced, the ratio of removable residue in the crop, dry matter content of removable residue, the ratio of removable residue burned, the fraction of residues oxidised in burning, the carbon and nitrogen content of the residues. On the basis of these parameters CH_4 and N_2O emissions have been calculated. CO_2 emissions have been calculated but not included in the inventory as biomass. All these parameters refer both to the IPCC Guidelines (IPCC, 1997) and country-specific values, when available (CESTAAT, 1992; Borgioli, 1981). Emissions from olives and wine residues are more than 65% of the total emissions from removable residues.

8.4.3. Uncertainty and time-series consistency

The combined uncertainty in CO_2 emissions from waste incineration is estimated to be about 25% in annual emissions, 5% and 25% concerning respectively activity data and emission factors.

The emission trend for CO_2 emissions from waste incineration is shown in Table 8.7 both for plants without energy recovery, reported under 6C, and plants with energy recovery, reported under 1A. In the period 1990-2002, total emissions increased by 22.9%; but whereas emissions from plants with energy recovery have doubled, emissions from plants without energy recovery decreased by 48.6%.

Table 8.7 CO_2 emissions from waste incineration (without and with energy recovery), 1990-2002 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Incineration of municipal solid wastes	124.2	120.0	102.8	71.1	71.1	91.7	64.4	85.1	74.9	74.6	46.6	42.8	32.1
Incineration of industrial wastes (except flaring)	289.8	288.8	333.4	379.7	379.8	344.9	332.4	311.8	148.6	294.7	174.4	198.8	190.7
Incineration of hospital wastes	122.9	122.9	141.5	160.0	160.0	147.9	142.5	139.7	105.9	70.2	57.8	56.1	56.6
Incineration of waste oil	8.0	11.1	9.7	4.6	4.3	1.4	1.3	1.3	1.2	1.1	0.8	0.7	0.4
Waste incineration (6C)	**544.9**	**542.8**	**587.3**	**615.4**	**615.2**	**585.9**	**540.6**	**537.8**	**330.6**	**440.6**	**279.5**	**298.4**	**279.9**
Manufacturing industries and construction (1A2)	177.9	169.0	134.2	83.2	68.0	64.7	49.6	48.8	32.4	31.7	58.1	44.5	40.6
Commercial/Institutional (1A4a)	311.5	326.5	335.5	453.4	453.4	549.5	514.6	527.9	575.9	660.6	777.2	909.4	950.9
MSW incineration reported under 1A	489.4	495.5	469.7	536.6	521.4	614.2	564.2	576.7	608.3	692.3	835.2	953.9	991.5
Total waste incineration	**1034.3**	**1038.3**	**1057.0**	**1152.0**	**1136.6**	**1200.0**	**1104.8**	**1114.6**	**938.9**	**1133.0**	**1114.8**	**1252.4**	**1271.3**

8.4.4. Source-specific QA/QC and verification

A review of activity data has been done during the building of the incineration plant database. The database include 242 plants. In 2002 only 143 plants are in activity. Different sources (MATT, several years; ANPA-ONR, 1999 [a]; ANPA-ONR, 2001 [b]; APAT-ONR, 2002; APAT-ONR, 2003; APAT, 2002; ANPA-ONR, 1999 [b]; AUSITRA-Assoambiente, 1995; Morselli, 1998; FEDERAMBIENTE, 1998; FEDERAMBIENTE, 2001; AMA-Comune di Roma, 1996; Ambiente S.p.A. 2001; http://www.coou.it) have been used and compared with the aim to reconstruct the time series of municipal, industrial, hospital waste, sludge and waste oil incinerated in each plant with or without energy recovery.

8.4.5. Source-specific recalculations

The whole time series has been recalculated as a consequence of the revision of waste amount incinerated in plants with or without energy recovery. At present, only emissions from plants without energy recovery are reported under activity 6C (Waste incineration), whereas the other emissions are reported in 1A2 Manufacturing industries and construction and 1A4a Combustion activity, commercial/institutional sector.
In table 8.8 differences with CO_2 emission reported last year both in percentages and absolute values are reported. Emissions reported in 6C category have been diminished while those reported in 1A category increased. The revision of estimation accounted for a reduction of about 20% in total emission estimates.

Table 8.8 Differences between time series reported in the 2002 NIR and updated time series

	Emission recalculations (Gg)											
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Incineration of municipal solid wastes	24.3	31.0	18.0	-13.7	-60.5	-45.6	-46.2	-66.5	-81.0	-26.8	-49.3	-29.5
Incineration of industrial wastes (except flaring)	-389.5	-389.5	-350.6	-360.3	-355.8	-480.8	-450.3	-435.1	-676.0	-262.3	-550.8	-514.7
Incineration of hospital wastes	-1.6	-1.6	-0.6	0.4	0.4	9.9	22.5	40.3	6.5	-29.1	-41.6	-43.2
Incineration of waste oil	0.0	0.0	0.0	0.0	0.0	-2.8	-2.5	-2.7	-2.5	-2.3	-1.6	-1.8
Waste incineration (6C)	**-366.8**	**-360.1**	**-333.2**	**-373.6**	**-415.9**	**-519.4**	**-476.5**	**-463.9**	**-753.0**	**-320.4**	**-643.4**	**-589.2**
Manufacturing industries and construction (1A2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-13.6
Commercial/Institutional (1A4a)	73.9	67.1	47.7	141.4	131.0	196.0	170.8	174.6	168.3	148.9	202.0	270.6
MSW incineration reported under 1A	73.9	67.1	47.7	141.4	131.0	196.0	170.8	174.6	168.3	148.9	201.9	257.0
Total waste incineration	**-292.9**	**-293.0**	**-285.6**	**-232.2**	**-284.9**	**-323.5**	**-305.7**	**-289.3**	**-584.7**	**-171.5**	**-441.4**	**-332.1**
Incineration of domestic or municipal wastes	24.4%	34.9%	21.2%	-16.2%	-46.0%	-33.2%	-41.8%	-43.9%	-52.0%	-26.4%	-51.4%	-40.8%
Incineration of industrial wastes (except flaring)	-57.3%	-57.4%	-51.3%	-48.7%	-48.4%	-58.2%	-57.5%	-58.3%	-82.0%	-47.1%	-76.0%	-72.1%
Incineration of hospital wastes	-1.3%	-1.3%	-0.4%	0.3%	0.3%	7.2%	18.8%	40.6%	6.6%	-29.3%	-41.9%	-43.5%
Incineration of waste oil	0.0%	0.0%	0.0%	0.0%	0.0%	-66.7%	-66.7%	-66.7%	-66.7%	-66.7%	-66.7%	-72.7%
Waste incineration (6C)	**-40.2%**	**-39.9%**	**-36.2%**	**-37.8%**	**-40.3%**	**-47.0%**	**-46.9%**	**-46.3%**	**-69.5%**	**-42.1%**	**-69.7%**	**-66.4%**
Manufacturing industries and construction (1A2)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	-0.1%	0.1%	-0.1%	-23.3%
Commercial/Institutional (1A4a)	31.1%	25.9%	16.6%	45.3%	40.6%	55.4%	49.7%	49.4%	41.3%	29.1%	35.1%	42.4%
MSW incineration reported under 1A	17.8%	15.7%	11.3%	35.8%	33.6%	46.9%	43.4%	43.4%	38.3%	27.4%	31.9%	36.9%
Total waste incineration	**-22.1%**	**-22.0%**	**-21.3%**	**-16.8%**	**-20.0%**	**-21.2%**	**-21.7%**	**-20.6%**	**-38.4%**	**-13.1%**	**-28.4%**	**-2.01%**

8.4.6. Source-specific planned improvements

No specific activities are planned.

8.5 Other waste (6D)

8.5.1. Source category description

Under this source category, CH_4 emissions from compost production have been reported. The amount of waste treated in composting plants has shown a nearly 15-fold increase in Italy from 363,319 in 1990 to 5,361,471 in 2002.

8.5.2. Methodological issues

Since no methodology is provided by the IPCC for these emissions, literature data (Hogg, 2001) has been used for the emission factor, 0.029 gCH_4/kg treated waste.

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.

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 previous submissions and changes due to error corrections. Revisions apply to the entire time series.

Specifically this year, in addition to the usual updating of activity data, which can also affect information of previous years, methodological revisions have regarded the use of the IPCC Good Practice Guidance for every sector.

The complete time series of CRF tables has been submitted this year. For the year 2001, CRF tables on recalculation have been filled in terms of quantity values. The major recalculations affecting the entire time series have also been pointed out as explanatory information in the specific CRF table of the last year submitted.

Table 9.1 shows the main explanations with regard to discrepancies from the last year submission.

The revisions that lead to relevant changes in GHG emissions have been already pointed out in the specific sectoral chapters and summarized in the following section 9.4.1.

9.2 Implications for emission levels

The most relevant changes affected the last year as well as the whole time series.

The time series reported in the CRF 2001 of the last year submission (year 2003) and that reported in the CRF 2002 (year 2004) have been compared and shown in Table 9.2. Specifically, by gas, the comparison and differences in emission levels are reported in Table 9.3.

Improvements in the calculation of emission estimates have led to a recalculation of the entire time series of the national inventory. Considering the total GHG emissions without CO_2 from LUCF, the emission levels of the base year decreased by 0.2% in comparison to the last year submission, whereas those of the year 2001 showed and increase by 1.6%.

Detailed explanations of these recalculations are provided in the sectoral chapters. In general, the most relevant changes affected F-gas emissions, specifically PFCs and HFCs, due to the revision of the methodologies and new information available. Other important recalculations concerned N_2O and CH_4 emissions according to the methodological revisions of emission estimates from enteric fermentation in the agriculture sector and from waste incineration.

Table 9.1 Explanations of the main recalculations in the submission of the CRF 2002

TABLE 8(b) RECALCULATION - EXPLANATORY INFORMATION
(Sheet 1 of 1)

Italy
2002
2004

Specify the sector and source/sink category[1] where changes in estimates have occurred:		GHG	RECALCULATION DUE TO CHANGES IN: Methods[2]	Emission factors[2]	Activity data[2]	Addition/removal/ replacement of source/sink categories
2C	PFCs from Aluminium pr.	CF4, C2F6	The Tier 2 approach has been used from 2000	Emission factors have been revised from 1990 to 2000 onwards on the basis of new information available by industry		
2A	Mineral products	CO2				Emissions from limestone and dolomite use as well as soda ash production and use have been added. Emissions from food and beverage have been removed since they are originated from sources of carbon that are from a closed cycle
6C	Waste incineration	CO2	Methodology has improved due to the analysis of national incineration plants data		Activity data have changed for the amount of incinerated waste treated with/without energy recovering	
4A	Enteric Fermentation		Emissions for the whole time series and pollutants have been revised using the Tier 2 IPCC GPG approach			
4D4	Other					Emissions from the wetlands have been deleted because now they are estimated [illegible] emissions
2B3	Adipic acid	N2O		The previous value of 0.003 has been checked again with industry and corrected with the default IPCC value equal to 0.30		
2B2	Nitric Acid	N2O		Emission factor has been revised from 1995 onwards on the basis of new information available by industry		

[1] Enter the identification code of the source/sink category (e.g. 1.B.1) in the first column and the name of the category (e.g. Fugitive Emissions from Solid Fuels) in the second column of the table (see Table 8(a)).
[2] Explain changes in methods, emission factors and activity data that have resulted in recalculation of the estimate of the source/sink as indicated in Table 8(a). Include relevant changes in the assumptions and coefficients under the "Methods" column.

Documentation box: Use the documentation box to report the justifications of the changes as to improvements in the accuracy, completeness and consistency of the inventory.
Other minor modifications of the time series or single years are result of basic data updating. These modifications do not account more than 0,3% of CO2 equivalent.

Table 9.2 Comparison of the time series submitted in the CRF 2001 (year 2003) and CRF 2002 (year 2004)

TABLE 10 EMISSION TRENDS (SUMMARY)
(Sheet 5 of 5)

Italy
2002
2004

GREENHOUSE GAS EMISSIONS	Base year(1)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	CO2 equivalent (Gg)													
Net CO2 emissions/removals	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO2 emissions (without LUCF) (6)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CH4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
N2O	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HFCs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PFCs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SF6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total (with net CO2 emissions/removals)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total (without CO2 from LUCF) (6)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year(1)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	CO2 equivalent (Gg)													
1. Energy	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2. Industrial Processes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3. Solvent and Other Product Use	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4. Agriculture	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5. Land-Use Change and Forestry (7)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6. Waste	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7. Other	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(6) The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report CO2 emissions and removals from Land-Use Change and Forestry.
(7) Net emissions.
(8) The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions or removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table Summary2 if Parties report non-CO2 emissions from LUCF.

TABLE 10 EMISSION TRENDS (SUMMARY)
(Sheet 5 of 5)

Italy
2001
2003

GREENHOUSE GAS EMISSIONS	Base year(1)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	CO2 equivalent (Gg)												
Net CO2 emissions/removals	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO2 emissions (without LUCF) (6)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CH4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
N2O	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HFCs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PFCs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SF6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total (with net CO2 emissions/removals)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total (without CO2 from LUCF) (6)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year(1)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	CO2 equivalent (Gg)												
1. Energy	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2. Industrial Processes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3. Solvent and Other Product Use	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4. Agriculture	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5. Land-Use Change and Forestry (7)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6. Waste	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7. Other	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(6) The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report CO2 emissions and removals from Land-Use Change and Forestry.
(7) Net emissions.
(8) The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions or removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table Summary2 if Parties report non-CO2 emissions from LUCF.

Table 9.3 Differences between NIR 2003 and NIR 2004 for the whole time series due to recalculations.

		Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Net CO_2 emissions/removals	NIR 2003	404.646	404.646	404.801	405.969	397.850	393.518	419.387	413.892	421.759	433.669	438.875	445.332	442.108
(Gg CO_2-eq.)	NIR 2004	407.624	407.624	408.096	407.934	403.326	397.131	426.984	419.422	426.416	438.371	442.363	445.131	451.214
Difference		*0.7%*	*0.7%*	*0.8%*	*0.5%*	*1.4%*	*0.9%*	*1.8%*	*1.3%*	*1.1%*	*1.1%*	*0.8%*	*0.0%*	*2.1%*
CO_2 emissions (without LUCF)	NIR 2003	428.178	428.178	427.977	427.786	418.542	412.964	438.985	434.115	439.523	451.095	456.587	460.965	460.763
(Gg CO_2-eq.)	NIR 2004	431.156	431.156	431.272	429.752	424.018	416.577	446.582	439.644	444.180	455.797	460.075	462.076	469.515
Difference		*0.7%*	*0.7%*	*0.8%*	*0.5%*	*1.3%*	*0.9%*	*1.7%*	*1.3%*	*1.1%*	*1.0%*	*0.8%*	*0.2%*	*1.9%*
CH_4 (Gg CO_2-eq.)	NIR 2003	38.659	38.659	39.068	37.322	36.931	37.311	37.857	37.713	37.676	37.128	36.717	36.546	36.420
	NIR 2004	37.196	37.196	37.737	36.102	35.771	36.257	36.687	36.484	36.555	36.023	35.505	35.516	35.370
Difference		*-3.8%*	*-3.8%*	*-3.4%*	*-3.3%*	*-3.1%*	*-2.8%*	*-3.1%*	*-3.3%*	*-3.0%*	*-3.0%*	*-3.3%*	*-2.8%*	*-2.9%*
N_2O (Gg CO_2-eq.)	NIR 2003	40.870	40.870	42.219	41.411	41.635	40.784	41.998	41.536	42.735	42.409	43.292	43.529	44.349
	NIR 2004	38.234	38.234	39.637	38.995	39.269	38.619	39.730	39.341	40.546	40.314	41.212	41.481	42.591
Difference		*-6.4%*	*-6.4%*	*-6.1%*	*-5.8%*	*-5.7%*	*-5.3%*	*-5.4%*	*-5.3%*	*-5.1%*	*-4.9%*	*-4.8%*	*-4.7%*	*-4.0%*
HFCs (Gg CO_2-eq.)	NIR 2003	671	351	355	359	355	482	671	449	751	1.170	1.437	1.986	2.730
	NIR 2004	671	351	355	359	355	482	671	605	1.218	2.351	3.049	4.098	5.560
Difference		*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*34.8%*	*62.3%*	*101.0%*	*112.3%*	*106.3%*	*103.6%*
PFCs (Gg CO_2-eq.)	NIR 2003	272	237	231	206	204	212	272	177	184	201	190	232	302
	NIR 2004	337	1.808	1.423	799	631	355	337	243	252	270	258	346	452
Difference		*23.6%*	*661.1%*	*515.0%*	*288.1%*	*209.9%*	*67.0%*	*23.6%*	*37.7%*	*36.8%*	*34.3%*	*35.8%*	*49.3%*	*49.9%*
SF_6 (Gg CO_2-eq.)	NIR 2003	601	333	356	358	370	416	601	683	729	605	405	493	795
	NIR 2004	601	333	356	358	370	416	601	683	729	605	405	493	795
Difference		*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*
Total (with net CO_2 emissions/	NIR 2003	485.720	485.096	487.032	485.624	477.346	472.723	500.787	494.449	503.834	515.182	520.915	528.118	526.703
removals) (Gg CO_2-eq.)	NIR 2004	484.664	485.546	487.604	484.547	479.723	473.259	505.011	496.778	505.716	517.934	522.792	527.065	535.982
Difference		*-0.22%*	*0.09%*	*0.12%*	*-0.22%*	*0.50%*	*0.11%*	*0.84%*	*0.47%*	*0.37%*	*0.53%*	*0.36%*	*-0.20%*	*1.76%*
Total (without CO_2 from LUCF)	NIR 2003	509.253	508.629	510.208	507.441	498.038	492.169	520.385	514.671	521.598	532.608	538.627	543.751	545.358
(Gg CO_2-eq.)	NIR 2004	508.196	509.078	510.781	506.364	500.415	492.705	524.609	517.000	523.480	535.360	540.504	544.010	554.284
Difference		*-0.2%*	*0.1%*	*0.1%*	*-0.2%*	*0.5%*	*0.1%*	*0.8%*	*0.5%*	*0.4%*	*0.5%*	*0.3%*	*0.0%*	*1.6%*

9.3 Implications for emission trends, including time series consistency

The recalculations, in general, account for an improvement in the overall emission trend and consistency in time series. It is important to note that any changes that have occurred till now have affected the base year negatively thus confirming the conservative approach of the national inventory estimates.
In comparison with the submission 2003, the base year emission levels (total emissions in CO_2 equivalent without CO_2 emissions from LUCF) decreased by 0.2%. Specifically, CH_4 levels have fallen by 3.8%, N_2O by 6.4%; on the other hand, an increase in emission levels affected CO_2 by 0.7%, as compared the previous base year submission, and PFCs for which the revision of the base year account for 23.6%. As concerns the year 2001, changes affected positively CO_2 (+1.9%) as well F-gas levels (+104% for HFCs and +50% for PFCs); CH_4 and N_2O level, instead, show an decrease by 2.9% and 4%, respectively.
Due to these recalculations the trend 'base year-year 2001' shows an increase by 9% in this year submission, while the increase for the same period was by 7% if considering the last year submission. In addition to the methodological changes already explained, it should be noted that emissions for the year 2001 (2003 submission) were based on provisional energy balance data.
The improvement of the methodologies in the inventory compilation will guarantee better estimates and minor changes from one year to another in the entire time series.

9.4 Recalculations, response to the review process and planned improvements

This chapter summarises the recalculations and improvements made to the Italian GHG inventory since the 2001 inventory was issued.
Besides the inclusion of a new year, the inventory is updated by a revision of the existing activity data and emission factors each year in order to include new information available; the update could also reflect the revision of methodologies. The revision applies to the whole time series.
The inventory may also be expanded by including categories not previously estimated if sufficient information on activity data and suitable emission factors have been identified and collected.

9.4.1 Recalculations

The key differences that have occurred in emission estimates since the last year submission are reported in Table 9.2 and Table 9.3. A more detailed recalculation for the year 2001 is summarised in Table 9.4
Besides the usual updating of activity data, recalculations may be distinguished in methodological changes, source allocation and error corrections.
As far as methodological changes are concerned all sectors were involved. Specifically:
Energy. N_2O and CH_4 emission factors for natural gas in road transport have been revised; these revisions account for an evident change only for CH_4 emissions, which decreased by 12%. For other fuels used in combustion activities, N_2O and CH_4 emission factors for fuel combustion have also been checked and revised where needed.
Emissions from railways have been better characterized by subtracting the relevant part which was previously included in the maritime sector.

Table 9.4 Recalculated data of the year 2001

TABLE 8(a) RECALCULATION - RECALCULATED DATA
Recalculated year: 2001
(Sheet 1 of 2)

Italy
2001
2004

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		CO2 Previous submission	CO2 Latest submission	CO2 Difference[1]	CH4 Previous submission	CH4 Latest submission	CH4 Difference[1]	N2O Previous submission	N2O Latest submission	N2O Difference[1]
		CO_2 equivalent (Gg)		(%)	CO_2 equivalent (Gg)		(%)	CO_2 equivalent (Gg)		(%)
Total National Emissions and Removals		442,397.87	451,714.29	2.96	36,428.96	35,578.26	-2.38	44,343.57	42,598.57	-3.90
1. Energy		437,326.79	443,259.11	1.35	6,571.60	6,922.14	8.95	10,101.16	9,955.83	-1.50
1.A.	Fuel Combustion Activities	436,020.46	440,976.62	1.13	1,722.61	1,680.52	-2.44	10,101.16	9,955.83	-1.44
1.A.1.	Energy Industries	[illegible]	[illegible]	[illegible]	266.97	258.10	[illegible]	[illegible]	[illegible]	[illegible]
1.A.2.	Manufacturing Industries and Construction	77,095.07	89,862.03	16.56	95.47	130.41	[illegible]	1,039.46	1,640.38	58.08
1.A.3.	Transport	125,191.38	122,825.29	-1.89	802.36	713.58	-11.06	3,453.45	3,327.04	-3.67
1.A.4.	Other Sectors	78,120.34	81,158.30	3.89	332.96	341.00	2.38	3,134.47	3,231.22	3.07
1.A.5.	Other	355.94	355.94	0.00	1.83	1.83	0.00	9.66	9.66	0.00
1.B.	Fugitive Emissions from Fuels	1,296.33	2,282.49	69.36	3,149.07	3,256.50	2.12	0.00	0.00	0.00
1.B.1.	Solid Fuel	0.00	0.00	0.00	64.15	70.25	9.51	0.00	0.00	0.00
1.B.2.	Oil and Natural Gas	1,296.33	2,282.49	69.36	3,084.93	3,186.06	2.08	0.00	0.00	0.00
2. Industrial Processes		21,774.49	24,794.79	13.88	174.53	184.95	5.97	8,375.99	7,627.58	-14.05
2.A.	Mineral Products	18,473.45	22,156.30	20.04	0.00	0.00	0.00	0.00	0.00	0.00
2.B.	Chemical Industry	694.30	694.30	0.00	42.13	62.13	0.00	8,375.99	7,627.58	-14.05
2.C.	Metal Production	1,384.97	1,984.10	30.09	32.80	32.80	0.00	0.00	0.00	0.00
2.D.	Other Production	325.95	0.00	-100.00						
2.G.	Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3. Solvent and Other Product Use		1,264.72	1,283.24	-4.12				0.00	0.00	0.00
4. Agriculture		0.00	0.00	0.00	18,295.34	17,118.18	-6.43	24,342.58	23,822.21	-1.73
4.A.	Enteric Fermentation				12,390.65	11,567.10	[illegible]			
4.B.	Manure Management				3,946.12	3,962.71	0.42	4,213.40	4,241.36	0.66
4.C.	Rice Cultivation				1,374.17	1,374.17	0.00			
4.D.	Agricultural Soils(2)	0.00	0.00	0.00	0.00	0.00	0.00	20,055.58	19,577.29	-2.38
4.E.	Prescribed Burning of Savannas				0.00	0.00	0.00	0.00	0.00	0.00
4.F.	Field Burning of Agricultural Residues				17.22	17.22	0.00	3.52	3.52	0.00
4.G.	Other				0.00	0.00	0.00	0.00	0.00	0.00
5. Land-Use Change and Forestry (net)(3)		-18,624.97	-18,901.22	-1.48	0.00	55.24	100.00	0.00	5.64	100.00
5.A.	Changes in Forest and Other Woody Biomass Stocks	-27,113.39	-26,913.26	-0.74						
5.B.	Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.C.	Abandonment of Managed Lands	-153.30	-148.87	-2.90						
5.D.	CO2 Emissions and Removals from Soil	8,611.72	8,761.17	1.73						
5.E.	Other	0.00	0.00	0.00	0.00	55.24	100.00	0.00	5.64	100.00

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

TABLE 8(a) RECALCULATION - RECALCULATED DATA
Recalculated year: 2001
(Sheet 2 of 2)

Italy
2001
2004

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		CO2 Previous submission	CO2 Latest submission	CO2 Difference[1]	CH4 Previous submission	CH4 Latest submission	CH4 Difference[1]	N2O Previous submission	N2O Latest submission	N2O Difference[1]
		CO_2 equivalent (Gg)		(%)	CO_2 equivalent (Gg)		(%)	CO_2 equivalent (Gg)		(%)
6. Waste		807.48	298.49	-63.03	11,146.73	11,146.79	0.00	1,125.49	1,192.80	[illegible]
6.A.	Solid Waste Disposal on Land	0.00	0.00	0.00	9,655.52	9,658.65	[illegible]			
6.B.	Wastewater Handling				1,337.85	1,262.17	[illegible]	953.58	1,038.35	[illegible]
6.C.	Waste Incineration	807.02	298.43	[illegible]	150.25	225.19	[illegible]	170.03	125.06	[illegible]
6.D.	Other	0.00	0.00	0.00	3.11	3.62	25.40	0.00	0.00	0.00
7. Other (please specify)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				0.00			0.00			0.00
Memo Items:										
International Bunkers		12,877.50	12,258.39	-4.81	12.42	14.48	16.72	69.81	71.36	2.58
Multilateral Operations		NA	NA		0.00	0.00	0.00	0.00	0.00	0.00
CO2 Emissions from Biomass		9,596.02	[illegible]	[illegible]						

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		HFCs Previous submission	HFCs Latest submission	HFCs Difference[1]	PFCs Previous submission	PFCs Latest submission	PFCs Difference[1]	SF_6 Previous submission	SF_6 Latest submission	SF_6 Difference[1]
		CO_2 equivalent (Gg)		(%)	CO_2 equivalent (Gg)		(%)	CO_2 equivalent (Gg)		(%)
Total Actual Emissions		2,738.38	5,459.54	101.62	301.70	452.37	49.94	794.86	795.34	0.06
2.C.3.	Aluminium Production				83.48	234.14	180.49	449.89	449.89	0.00
2.E.	Production of Halocarbons and SF6	22.20	25.00	12.61	0.00	0.00	0.00	0.00	0.00	0.00
2.F.	Consumption of Halocarbons and SF6	2,716.18	5,434.54	[illegible]	218.22	218.22	0.00	345.06	345.44	0.11
	Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potential Emissions from Consumption of HFCs/PFCs and SF_6				0.00			0.00			0.00

	Previous submission	Latest submission	Difference[1]
	CO_2 equivalent (Gg)		(%)
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry(3)	526,705.37	535,982.54	1.76
Total CO_2 Equivalent Emissions without Land-Use Change and Forestry(3)	545,330.30	554,283.53	1.64

Industrial sector. Most of the relevant recalculations affected the industrial processes sector.
CO_2 emissions from limestone and dolomite use as well as emissions from soda ash production and use have been added.
CO_2 emissions from food and beverage were deleted because originating from carbon sources which are from a closed cycle.
The N_2O emission factor for adipic acid was checked and corrected.
A higher tier was used to estimate PFC emissions from aluminium production from 2000 onwards; the previous years could not be estimated following the same approach because detailed information was not available.
A revision of the time series has also concerned HFC emissions on account of a major information on leakage rates made available by the relevant industry.
Agriculture. A higher tier was used to recalculate emissions from the agriculture sector, specifically those related to the enteric fermentation for dairy cattle.
LUCF. Non-CO_2 emissions from forest fires were estimated and reported in the CRF.
Waste sector. The entire emission time series of municipal, industrial, hospital waste, sludge and waste oil incinerated in each plant with or without energy recovery was recalculated considering the national incineration plants database built this year and reallocated in the waste and in the energy sector.
CH_4 emissions from industrial wastewater handling have been revised on the basis of new national information on wastewater flows and COD concentration values. Emissions from the leather industry have been added.
Source allocation was improved in the following cases:
In the framework of the implementation of the EU emission trading directive, meetings with the industry sector were held. This results in a better understanding of emissions allocation particularly in the refineries, iron and steel, lime and cement and non ferrous metal sectors.
Clinker production data has been revised according to the information from industry on the hydraulic lime produced by the cement plants which was previously accounted for in the lime production sector.
Emissions from wetlands have been revised and allocated in N_2O emissions from human sewage.
During the compilation of the inventory for the year 2002 an error in one of the parameters used for the calculation of the indirect N_2O emissions (FRAC_gasm) in the agriculture sector was detected. The revised EF value has been applied to the whole time series.

9.4.2 Response to the UNFCC review process

In 2003 the Italian GHG inventory was subject to the following reviews by the Climate Secretariat: Country section of Synthesis and Assessment report on the GHG inventory and a centralized review on the GHG inventory and NIR submitted in 2003.
Following the assessment report, a NIR was submitted to provide explanations and references on the methodologies used to calculate emissions for the different sectors as well as an analysis of key sources and quantitative uncertainty estimates.
In response to the centralized review, a complete set of CRF tables was submitted for all the years 1990-2002. Recalculation tables have been compiled for the year 2001 in order to improve the transparency and assess the consistency of the time series. Notation keys were used to cover the gaps not filled in last year. Major gaps in emission estimates have been covered.

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

There are still some emission values missing: potential PFCs, N_2O from category 3.D, other solvent use, and CH_4 emissions from waste incineration both for biogenic and plastics and other non-biogenic waste. For these categories, emissions will be included in the next submission as far as information availability.

Emission factors and activity data could improve by the analysis of the national registry EPER.

Data collected by plant in the framework of the implementation of the EU emission trading directive could also improve the inventory.

Other improvements will concern the establishment of a National System under the responsibility of the Ministry for the Environment and Territory, who delegated the practical co-ordination to APAT.

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ANNEX 1: KEY SOURCES

A1.1 Introduction

The IPCC Good Practice Guidance (IPCC, 2000) recommends as good practice the identification of key source categories in national GHG inventories. A key source category is defined as an emission source that has a significant influence on a country's GHG inventory in terms either of the absolute relative level of emissions or the trend in emissions, or both.
Key source categories therefore are those found in the accumulative 95% of the total annual emissions in the last reported year or belonging to the total trend, when ranked in descending order of magnitude.
The assessment of national key source categories is important because key source categories should receive special consideration in terms of methodological aspects and quality assurance and quality control verification.
Two different approaches are reported in the Good Practice according to whether or not a country has performed an uncertainty analysis of the inventory: the Tier 1 and Tier 2.
When using the Tier 1, key sources categories are identified by means of a pre-determined cumulative emissions threshold, usually fixed at 95% of the total. The threshold is based on an evaluation of several inventories and is aimed at establishing a general level where key source categories should cover up to 90% of inventory uncertainty.
If inventory source-level uncertainties are carried out, the Tier 2 can be used to identify key source categories. The Tier 2 approach is a more detailed analysis that builds on the Tier 1; in fact, the results of the Tier 1 are multiplied by the relative uncertainty of each source category. Key source categories are those that represent 95% of the uncertainty contribution, instead of applying the pre-determined cumulative emissions threshold.
So the factors which make a source a key source are a high contribution to the total, a high contribution to the trend and a high uncertainty.
If both the Tier 1 and Tier 2 are applied it is good practice to use the results of the Tier 2 analysis.
For the Italian inventory, a key source analysis has been carried out according to both the Tier 1 and Tier 2 methods. National emissions have been disaggregated, as far as possible, into the categories proposed in the Good Practice; other categories have been added to reflect specific national circumstances. Both level and trend analysis have been applied.
Summary of the results of the key source analysis is reported in Table 1.3 of chapter 1.
The same categorisation and the same estimates of uncertainty as performed in Table A1. have been used. The table indicates whether a key source arises from the level assessment or the trend assessment.
As far as level emission sources are concerned 24 key sources were individuated accounting for the 95% of the total emission. For the trend, 21 key sources were selected. Jointly for both the level and trend, 29 key sources were totally individuated.

A1.2 Tier 1 key source assessment

As described in the IPCC Good Practice Guidance (IPCC, 2000), the Tier 1 method for identifying key

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

Source Category Level Assessment = Source Category Estimate/Total Estimate

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

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

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

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

A1.3 Uncertainty assessment (IPCC Tier 1)

The Tier 2 method for the identification of key sources implies the assessment of the uncertainty analysis to an emission inventory.
As already mentioned, the IPCC Tier 1 has been applied to the Italian GHG inventory to estimate uncertainties in national greenhouse gas inventories.
The results of the approach are reported in Table A1.2.

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

TIER 1

CATEGORIES	2002 Gg CO2eq	Level assessment	Cumulative Percentage
CO2 stationary combustion liquid fuels	131,356	0.24	0.24
CO2 stationary combustion gaseous fuels	131,153	0.24	0.47
CO2 Mobile combustion: Road Vehicles	115,126	0.21	0.68
CO2 stationary combustion solid fuels	53,343	0.10	0.78
CO2 Cement production	16,347	0.03	0.81
CH4 Enteric Fermentation in Domestic Livestock	11,042	0.02	0.83
CH4 from Solid waste Disposal Sites	9,318	0.02	0.84
Direct N2O Agricultural Soils	9,095	0.02	0.86
Indirect N2O from Nitrogen used in agriculture	8,187	0.01	0.88
HFC, PFC substitutes for ODS	7,025	0.01	0.89
N2O Adipic Acid	6,882	0.01	0.90
N2O stationary combustion	6,726	0.01	0.91
CO2 Mobile combustion: Waterborne Navigation	6,117	0.01	0.92
CH4 Fugitive emissions from Oil and Gas Operations	5,180	0.01	0.93
N2O Manure Management	4,188	0.01	0.94
CH4 Manure Management	3,521	0.01	0.95
N2O Mobile combustion: Road Vehicles	3,434	0.01	0.95
CO2 Limestone and Dolomite Use	3,125	0.01	0.95
CO2 Mobile combustion: Aircraft	2,677	0.00	0.96
CO2 Fugitive emissions from Oil and Gas Operations	1,504	0.00	0.97
CO2 Lime production	1,877	0.00	0.97
N2O Nitric acid production	1,743	0.00	0.97
CO2 Other industrial processes	1,784	0.00	0.98
CH4 from Rice production	1,562	0.00	0.98
CO2 Iron and Steel production	1,353	0.00	0.98
CO2 Mobile combustion: Other	1,339	0.00	0.99
CH4 Emissions from Wastewater Handling	1,280	0.00	0.99
CO2 Emissions from Other Sources (forest fires)	1,241	0.00	0.99
N2O Emissions from Wastewater Handling	1,064	0.00	0.99
CH4 stationary combustion	1,004	0.00	0.99
CH4 Mobile combustion: Road Vehicles	612	0.00	0.99
N2O Nitric Acid	888	0.00	1.00
SF6 Magnesium production	400	0.00	1.00
SF6 Electrical Equipment	307	0.00	1.00
CO2 Emissions from Waste Incineration	288	0.00	1.00
PFC, HFC, SF6 Semiconductor manufacturing	274	0.00	1.00
CH4 Emissions from Waste Incineration	264	0.00	1.00
PFC Aluminium production	199	0.00	1.00
N2O Emissions from Waste Incineration	119	0.00	1.00
CH4 Industrial Processes	116	0.00	1.00
CH4 Fugitive emissions from Coal Mining and Handling	68	0.00	1.00
N2O Mobile combustion: Other	65	0.00	1.00
N2O Mobile combustion: Waterborne Navigation	44	0.00	1.00
CH4 Mobile combustion: Waterborne Navigation	34	0.00	1.00
HFC-23 from HFC-22 Manufacture and HFC fugitive emissions	25	0.00	1.00
CH4 Emissions from Other Sources (forest fires)	25	0.00	1.00
N2O Mobile combustion: Aircraft	26	0.00	1.00
CH4 Agricultural Residue Burning	13	0.00	1.00
N2O Agricultural Residue Burning	6	0.00	1.00
CH4 Emissions from Other Waste	5	0.00	1.00
CH4 Mobile combustion: Other	3	0.00	1.00
N2O Emissions from Other Sources (forest fires)	3	0.00	1.00
CH4 Mobile combustion: Aircraft	2	0.00	1.00
SF6 Production of SF6	0	0.00	1.00
SF6 Other sources of SF6	0	0.00	1.00
CH4 Savanna Burning	0	0.00	1.00
N2O Savanna Burning	0	0.00	1.00
CH4 from Other agriculture	0	0.00	1.00
N2O from Other agricultural soils (wetlands, waters)	0	0.00	1.00

CATEGORIES	% Contribution to trend	Cumulative Percentage
CO2 stationary combustion gaseous fuels	0.30	0.30
CO2 stationary combustion liquid fuels	0.28	0.58
CO2 Mobile combustion: Road Vehicles	0.10	0.68
CO2 stationary combustion solid fuels	0.08	0.76
HFC, PFC substitutes for ODS	0.06	0.82
CO2 Other industrial processes	0.02	0.83
CH4 Fugitive emissions from Oil and Gas Operations	0.02	0.85
CH4 Enteric Fermentation in Domestic Livestock	0.02	0.87
N2O Adipic Acid	0.01	0.88
N2O Mobile combustion: Road Vehicles	0.01	0.90
CO2 Fugitive emissions from Oil and Gas Operations	0.01	0.91
CO2 Cement production	0.01	0.92
CH4 from Solid waste Disposal Sites	0.01	0.92
CO2 Mobile combustion: Aircraft	0.01	0.93
Direct N2O Agricultural Soils	0.01	0.94
N2O Nitric Acid	0.01	0.94
CO2 Mobile combustion: Other	0.01	0.95
CO2 Limestone and Dolomite Use	0.01	0.96
CO2 Emissions from Other Sources (forest fires)	0.01	0.96
N2O stationary combustion	0.00	0.96
CH4 Manure Management	0.00	0.97
HFC-23 from HFC-22 Manufacture and HFC fugitive emissions	0.00	0.97
Indirect N2O from Nitrogen used in agriculture	0.00	0.98
SF6 Magnesium production	0.00	0.98
CO2 Emissions from Waste Incineration	0.00	0.98
N2O Nitric acid production	0.00	0.98
SF6 Electrical Equipment	0.00	0.98
CO2 Mobile combustion: Waterborne Navigation	0.00	0.99
PFC, HFC, SF6 Semiconductor manufacturing	0.00	0.99
CH4 Mobile combustion: Road Vehicles	0.00	0.99
CH4 Emissions from Other Sources (forest fires)	0.00	0.99
CH4 stationary combustion	0.00	0.99
SF6 Production of SF6	0.00	0.99
CH4 from Rice production	0.00	0.99
CO2 Iron and Steel production	0.00	1.00
CH4 Emissions from Wastewater Handling	0.00	1.00
CH4 Emissions from Waste Incineration	0.00	1.00
CO2 Lime production	0.00	1.00
N2O Mobile combustion: Other	0.00	1.00
N2O Emissions from Wastewater Handling	0.00	1.00
CH4 Fugitive emissions from Coal Mining and Handling	0.00	1.00
PFC Aluminium production	0.00	1.00
N2O Manure Management	0.00	1.00
N2O Emissions from Waste Incineration	0.00	1.00
CH4 Industrial Processes	0.00	1.00
N2O Emissions from Other Sources (forest fires)	0.00	1.00
N2O Mobile combustion: Aircraft	0.00	1.00
CH4 Emissions from Other Waste	0.00	1.00
CH4 Mobile combustion: Other	0.00	1.00
CH4 Mobile combustion: Waterborne Navigation	0.00	1.00
CH4 Agricultural Residue Burning	0.00	1.00
N2O Mobile combustion: Waterborne Navigation	0.00	1.00
CH4 Mobile combustion: Aircraft	0.00	1.00
N2O Agricultural Residue Burning	0.00	1.00
SF6 Other sources of SF6	0.00	1.00
CH4 Savanna Burning	0.00	1.00
N2O Savanna Burning	0.00	1.00
CH4 from Other agriculture	0.00	1.00
N2O from Other agricultural soils (wetlands, waters)	0.00	1.00

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

Tier 1 Uncertainty calculation and reporting

IPCC Source category	Gas	Base year emissions 1990/1995	Year t emissions 2002	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
CO2 stationary combustion liquid fuels	CO2	131,205	131,206	3%	3%	0.042	0.010	-0.070	0.256	-0.002	0.011	0.011
CO2 stationary combustion solid fuels	CO2	38,209	29,348	3%	3%	0.042	0.004	-0.033	0.103	-0.001	0.004	0.004
CO2 stationary combustion gaseous fuels	CO2	66,802	138,153	3%	3%	0.042	0.010	0.078	0.270	0.002	0.011	0.011
CH4 stationary combustion	CH4	701	1,084	3%	50%	0.501	0.002	0.000	0.002	0.000	0.000	0.000
N2O stationary combustion	N2O	6,757	4,726	3%	50%	0.501	0.006	-0.003	0.013	-0.001	0.001	0.001
CO2 Mobile combustion. Road Vehicles	CO2	80,864	111,123	3%	3%	0.042	0.009	0.025	0.217	0.001	0.010	0.010
CH4 Mobile combustion. Road Vehicles	CH4	748	612	3%	40%	[illegible]	0.000	0.000	0.001	0.000	0.000	0.000
N2O Mobile combustion. Road Vehicles	N2O	1,608	3,534	3%	50%	0.501	0.003	0.004	0.007	0.002	0.000	0.002
CO2 Mobile combustion. Waterborne Navigation	CO2	1,409	6,117	3%	3%	0.042	0.000	0.000	0.012	0.000	0.001	0.001
CH4 Mobile combustion. Waterborne Navigation	CH4	29	36	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion. Waterborne Navigation	N2O	39	48	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion. Aircraft	CO2	1,596	2,677	3%	3%	0.042	0.000	0.002	0.005	0.000	0.000	0.000
CH4 Mobile combustion. Aircraft	CH4	1	2	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion. Aircraft	N2O	12	20	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Mobile combustion. Other	CO2	1,000	1,339	3%	3%	0.050	0.000	-0.001	0.003	0.000	0.000	0.000
CH4 Mobile combustion. Other	CH4	2	3	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
N2O Mobile combustion. Other	N2O	131	67	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Fugitive emissions from Coal Mining and H	CH4	177	46	3%	300%	3.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Fugitive emissions from Oil and Gas Operati	CO2	3,940	1,926	3%	25%	0.252	0.003	-0.005	0.004	-0.001	0.000	0.001
CH4 Fugitive emissions from Oil and Gas Operati	CH4	6,688	5,188	3%	25%	0.252	0.002	-0.004	0.010	-0.001	0.000	0.001
CO2 Cement production	CO2	16,002	16,347	3%	8%	0.085	0.003	-0.002	0.032	0.000	0.001	0.001
CO2 Lime production	CO2	1,640	1,277	3%	8%	0.085	0.000	0.000	0.004	0.000	0.000	0.000
CO2 Limestone and Dolomite Use	CO2	3,401	3,123	3%	8%	0.085	0.000	-0.001	0.008	0.000	0.000	0.000
CO2 Iron and Steel production	CO2	1,346	1,353	3%	8%	0.085	0.000	0.000	0.003	0.000	0.000	0.000
CO2 Other industrial processes	CO2	3,624	1,758	3%	8%	0.085	0.000	-0.004	0.003	0.000	0.000	0.000
N2O Adipic Acid	N2O	4,579	6,982	3%	5%	0.058	0.001	0.004	0.018	0.000	0.001	0.001
N2O Nitric Acid	N2O	1,202	585	3%	5%	0.058	0.000	-0.001	0.001	0.000	0.000	0.000
CH4 Industrial Processes	CH4	121	116	3%	50%	0.501	0.000	0.000	0.000	0.000	0.000	0.000
PFC Aluminium production	PFC	140	189	3%	10%	0.102	0.000	0.000	0.000	0.000	0.000	0.000
SF6 Magnesium production	SF6	0	488	3%	5%	0.071	0.000	0.001	0.001	0.000	0.000	0.000
SF6 Electrical Equipment	SF6	402	307	3%	10%	0.102	0.000	0.000	0.001	0.000	0.000	0.000
SF6 Other sources of SF6	SF6	0	0			0.000	0.000	0.000	0.000	0.000	0.000	0.000
SF6 Production of SF6	SF6	120	0	3%	10%	0.102	0.000	0.000	0.000	0.000	0.000	0.000
PFC, HFC, SF6 Semiconductor manufacturing	PFC	59	276	30%	50%	0.583	0.000	0.000	0.001	0.000	0.000	0.000
HFC, PFC substitutes for ODS	HFC	363	7,075	30%	50%	0.583	0.007	0.013	0.014	0.007	0.006	0.009
HFC-23 from HCFC-22 Manufacture and HFC Fug	HFC	441	25	3%	10%	0.102	0.000	-0.001	0.000	0.000	0.000	0.000
CH4 Enteric Fermentation in Domestic Livestock	CH4	12,044	11,082	10%	20%	0.283	0.006	-0.004	0.022	-0.001	0.006	0.006
CH4 Manure Management	CH4	4,026	3,921	20%	50%	0.539	0.004	-0.001	0.008	0.000	0.002	0.002
N2O Manure Management	N2O	3,846	4,168	20%	100%	1.020	0.008	0.000	0.008	0.000	0.002	0.002
CH4 Savanna Burning	CH4	0	0			0.000	0.000	0.000	0.000	0.000	0.000	0.000
N2O Savanna Burning	N2O	0	0			0.000	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Agricultural Residue Burning	CH4	13	13	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
N2O Agricultural Residue Burning	N2O	4	4	50%	20%	0.539	0.000	0.000	0.000	0.000	0.000	0.000
Direct N2O Agricultural Soils	N2O	9,133	9,033	20%	25%	0.320	0.005	-0.002	0.018	0.000	0.005	0.005
Indirect N2O from Nitrogen used in agriculture	N2O	7,894	8,187	20%	50%	0.539	0.008	-0.001	0.016	0.000	0.005	0.005
CH4 from Rice production	CH4	1,339	1,362	3%	40%	0.401	0.000	0.000	0.000	0.000	0.000	0.000
CH4 from Other agriculture	CH4	0	0			0.000	0.000	0.000	0.000	0.000	0.000	0.000
N2O from animal production	N2O	3,269	1,748	20%	100%	1.020	0.008	-0.003	0.003	-0.003	0.001	0.004
N2O from Other agricultural soils (wetlands, wat	N2O	0	0			0.000	0.000	0.000	0.000	0.000	0.000	0.000
CH4 from Solid waste Disposal Sites	CH4	9,353	8,322	10%	20%	0.224	0.004	-0.002	0.016	0.000	0.003	0.003
CH4 Emissions from Wastewater Handling	CH4	1,233	1,280	20%	30%	0.355	0.000	0.000	0.002	0.000	0.001	0.002
N2O Emissions from Wastewater Handling	N2O	1,044	1,084	30%	30%	0.424	0.002	0.000	0.002	0.000	0.001	0.001
CO2 Emissions from Waste Incineration	CO2	345	288	3%	25%	0.255	0.000	-0.001	0.001	0.000	0.000	0.000
CH4 Emissions from Waste Incineration	CH4	103	268	50%	20%	0.539	0.000	0.000	0.001	0.000	0.000	0.000
N2O Emissions from Waste Incineration	N2O	19	13	3%	100%	1.001	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Emissions from Other Waste	CH4	0	1	10%	100%	1.005	0.000	0.000	0.000	0.000	0.000	0.000
CO2 Emissions from Other Sources (solvent use)	CO2	1,739	1,241	10%	50%	0.510	0.001	-0.001	0.002	-0.001	0.000	0.001
N2O Emissions from Other Sources (forest fires)	N2O	17	3	10%	50%	0.510	0.000	0.000	0.000	0.000	0.000	0.000
CH4 Emissions from Other Sources (forest fires)	CH4	163	25	10%	50%	0.510	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL		**440,196**	**493,780**				0.023					0.018

Emission sources are disaggregated into a detailed level (59 sources) according to the IPCC list in the Good Practice Guidance which has been slightly revised taking into account national circumstances and importance. Uncertainties are therefore estimated for these categories. To estimate the uncertainty for both activity data and emission factors, information provided in the IPCC Good Practice Guidance as well as expert judgement has been used; standard deviations have also been considered whenever measurements were available.
The general approach which was followed for attributing quantitatively 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 has on the value. For instance a low value (e.g. 3-5%) has been attributed to all those activity data from the energy balance and statistical yearbooks, medium-high uncertainty within a range of 20-50% for all the data which are not directly or only partially derived from census or sample surveys or are estimations. The uncertainties set for emission factors are higher than those for activity data. IPCC uncertainty values are used when the emission factor is a default value; low values are used for measured data otherwise the uncertainty values are high.
Details can be found in Table A1.2.
The Tier 1 approach suggests an uncertainty of 2.5% in the combined GWP total emission in 2002. The analysis also estimates an uncertainty of 2.4 % in the trend between 1990 and 2002.
Further investigation is needed to better quantify the uncertainty values for some specific source, nevertheless it should be noted that a conservative approach has been followed.

A1.4 Tier 2 key source assessment

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

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

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

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

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

TIER 2							
CATEGORIES	Level assessment with uncertainty	Relative level assessment with uncertainty	Cumulative Percentage	CATEGORIES	Trend assessment with uncertainty	Relative Trend assessment with uncertainty	Cumulative Percentage
CO_2 stationary combustion liquid fuels	0.0101	0.10	0.10	CO_2 stationary combustion gaseous fuels	0.01	0.13	0.13
CO_2 stationary combustion gaseous fuels	0.0100	0.10	0.20	CO_2 stationary combustion liquid fuels	0.01	0.13	0.27
CO_2 Mobile combustion: Road Vehicles	0.0088	0.09	0.28	CO_2 Mobile combustion: Road Vehicles	0.01	0.11	0.38
Indirect N_2O from Nitrogen used in agriculture	0.0080	0.08	0.36	HFC, PFC substitutes for ODS	0.01	0.11	0.48
N_2O Manure Management	0.0077	0.07	0.43	CH_4 Enteric Fermentation in Domestic Livestock	0.01	0.07	0.56
HFC, PFC substitutes for ODS	0.0074	0.07	0.51	Direct N_2O Agricultural Soils	0.01	0.06	0.62
N_2O stationary combustion	0.0061	0.06	0.56	Indirect N_2O from Nitrogen used in agriculture	0.00	0.05	0.68
CH_4 Enteric Fermentation in Domestic Livestock	0.0058	0.05	0.62	CO_2 stationary combustion solid fuels	0.00	0.05	0.73
Direct N_2O Agricultural Soils	0.0052	0.05	0.67	CH_4 from Solid waste Disposal Sites	0.00	0.03	0.76
CO_2 stationary combustion solid fuels	0.0041	0.04	0.71	N_2O Manure Management	0.00	0.03	0.79
CH_4 Manure Management	0.0038	0.04	0.75	CH_4 Manure Management	0.00	0.03	0.81
CH_4 from Solid waste Disposal Sites	0.0036	0.04	0.78	N_2O Mobile combustion: Road Vehicles	0.00	0.02	0.84
N_2O from animal production	0.0032	0.03	0.81	CH_4 Emissions from Wastewater Handling	0.00	0.02	0.86
N_2O Mobile combustion: Road Vehicles	0.0032	0.03	0.85	CO_2 Cement production	0.00	0.02	0.87
CO_2 Cement production	0.0025	0.02	0.87	CO_2 Emissions from Other Sources (solvent use)	0.00	0.01	0.89
CH_4 Fugitive emissions from Oil and Gas Operations	0.0023	0.02	0.89	CH_4 Fugitive emissions from Oil and Gas Operations	0.00	0.01	0.90
CH_4 Emissions from Wastewater Handling	0.0013	0.01	0.91	N_2O from animal production	0.00	0.01	0.91
CO_2 Emissions from Other Sources (solvent use)	0.0013	0.01	0.92	N_2O Emissions from Wastewater Handling	0.00	0.01	0.93
CH_4 from Rice production	0.0011	0.01	0.93	N_2O Stationary combustion	0.00	0.01	0.94
CH_4 stationary combustion	0.0009	0.01	0.94	CO_2 Fugitive emissions from Oil and Gas Operations	0.00	0.01	0.94
CO_2 Fugitive emissions from Oil and Gas Operations	0.0009	0.01	0.95	N_2O Adipic Acid	0.00	0.01	0.95
N_2O Emissions from Wastewater handling	0.0008	0.01	0.95	CO_2 Mobile combustion: Waterborne Navigation	0.00	0.01	0.96
N_2O Adipic Acid	0.0007	0.01	0.96	CO_2 Other industrial processes	0.00	0.00	0.96
CO_2 Limestone and Dolomite Use	0.0006	0.00	0.97	CH_4 Emissions from Waste incineration	0.00	0.00	0.97
CO_2 Mobile combustion: Waterborne Navigation	0.0005	0.00	0.97	CH_4 Fugitive emissions from Coal Mining and Handling	0.00	0.00	0.97
CH_4 Fugitive emissions from Coal Mining and Handling	0.0004	0.00	0.97	PFC, HFC, SF_6 Semiconductor manufacturing	0.00	0.00	0.97
CO_2 Lime production	0.0003	0.00	0.98	CO_2 Limestone and Dolomite Use	0.00	0.00	0.98
PFC, HFC, SF_6 Semiconductor manufacturing	0.0003	0.00	0.98	CO_2 Mobile combustion: Aircraft	0.00	0.00	0.98
CO_2 Other industrial processes	0.0003	0.00	0.98	CH_4 stationary combustion	0.00	0.00	0.98
CH_4 Emissions from Waste incineration	0.0003	0.00	0.98	CO_2 Emissions from Waste incineration	0.00	0.00	0.98
N_2O Emissions from Waste incineration	0.0002	0.00	0.99	CH_4 from Rice production	0.00	0.00	0.99
CO_2 Iron and Steel production	0.0002	0.00	0.99	CO_2 Lime production	0.00	0.00	0.99
CO_2 Mobile combustion: Aircraft	0.0002	0.00	0.99	CH_4 Emissions from Other Sources (forest fires)	0.00	0.00	0.99
CO_2 Mobile combustion: Other	0.0001	0.00	0.99	CO_2 Mobile combustion: Other	0.00	0.00	0.99
CO_2 Emissions from Waste incineration	0.0001	0.00	0.99	CO_2 Iron and Steel production	0.00	0.00	0.99
CH_4 Mobile combustion: Road Vehicles	0.0001	0.00	0.99	HFC-23 from HFC-22 Manufacture and HFC fugitive emissions	0.00	0.00	0.99
CH_4 Industrial Processes	0.0001	0.00	1.00	N_2O Nitric Acid	0.00	0.00	0.99
SF_6 Electrical Equipment	0.0001	0.00	1.00	N_2O Mobile combustion: Other	0.00	0.00	1.00
N_2O Nitric Acid	0.0001	0.00	1.00	SF_6 Magnesium production	0.00	0.00	1.00
N_2O Mobile combustion: Other	0.0001	0.00	1.00	CH_4 Mobile combustion: Road Vehicles	0.00	0.00	1.00
SF_6 Magnesium production	0.0001	0.00	1.00	SF_6 Electrical Equipment	0.00	0.00	1.00
PFC Aluminium production	0.0000	0.00	1.00	N_2O Emissions from Waste incineration	0.00	0.00	1.00
N_2O Mobile combustion: Waterborne Navigation	0.0000	0.00	1.00	PFC Aluminium production	0.00	0.00	1.00
CH_4 Mobile combustion: Waterborne Navigation	0.0000	0.00	1.00	SF_6 Production of SF_6	0.00	0.00	1.00
CH_4 Emissions from Other Sources (forest fires)	0.0000	0.00	1.00	CH_4 Industrial Processes	0.00	0.00	1.00
N_2O Mobile combustion: Aircraft	0.0000	0.00	1.00	CH_4 Agricultural Residue Burning	0.00	0.00	1.00
CH_4 Agricultural Residue Burning	0.0000	0.00	1.00	N_2O Emissions from Other Sources (forest fires)	0.00	0.00	1.00
CH_4 Emissions from Other Waste	0.0000	0.00	1.00	N_2O Mobile combustion: Aircraft	0.00	0.00	1.00
HFC-23 from HFC-22 Manufacture and HFC fugitive emissions	0.0000	0.00	1.00	CH_4 Emissions from Other Waste	0.00	0.00	1.00
N_2O Agricultural Residue Burning	0.0000	0.00	1.00	N_2O Agricultural Residue Burning	0.00	0.00	1.00
CH_4 Mobile combustion: Other	0.0000	0.00	1.00	N_2O Mobile combustion: Waterborne Navigation	0.00	0.00	1.00
N_2O Emissions from Other Sources (forest fires)	0.0000	0.00	1.00	CH_4 Mobile combustion: Waterborne Navigation	0.00	0.00	1.00
CH_4 Mobile combustion: Aircraft	0.0000	0.00	1.00	CH_4 Mobile combustion: Other	0.00	0.00	1.00
SF_6 Production of SF_6	0.0000	0.00	1.00	CH_4 Mobile combustion: Aircraft	0.00	0.00	1.00
SF_6 Other sources of SF_6	0.0000	0.00	1.00	SF_6 Other sources of SF_6	0.00	0.00	1.00
CH_4 Savanna Burning	0.0000	0.00	1.00	CH_4 Savanna Burning	0.00	0.00	1.00
N_2O Savanna Burning	0.0000	0.00	1.00	N_2O Savanna Burning	0.00	0.00	1.00
CH_4 from Other agriculture	0.0000	0.00	1.00	CH_4 from Other agriculture	0.00	0.00	1.00
N_2O from Other agricultural soils (wetlands, waters)	0.0000	0.00	1.00	N_2O from Other agricultural soils (wetlands, waters)	0.00	0.00	1.00

ANNEX 2: DETAILED TABLES OF ENERGY CONSUMPTION FOR POWER GENERATION

In the following tables the detailed breakdown of total fuels consumed for electricity generation in the years 1990, 1995, 2000, 2001 and 2002 is reported. For each year data from three different sources are reported:
output of the model used to estimate consumption and emissions for each plant type;
detailed report by GRTN;
data available in BEN.
For each source three kind of data are presented: electricity produced, physical quantities of consumed fuels and amount of energy used.
As one can notice from the following tables, there are not negligible differences in total consumption figures between GRTN and BEN. Both data sets are supposed to be based on the same data and the fact that such a difference occurs poses some questions on the quality assurance process of the National Statistical System (SISTAN). Differences between those two data sets and the model output are also present, they can be improved (i.e. reduced) and depend on the modeller choice: a compromise between GRTN and the BEN data according to cross check done with other sources (UP or point source data).
As already said in paragraph 3.2, differences may be partially explained by the process of adapting GRTN data to BEN methodology, that considers for each fuel always the same heat value, adjusting the physical quantities accordingly. This calculation process combined with the reduction of fuel types from 17 to 12 may add a rounding error and this may be responsible for the small difference between the energy value and the estimation of the total electricity produced.
As a first observation there are discrepancies in the estimates of the total electricity produced, see last row of each table, first value. They are rather small, between 0.1% and 0.8% . Also the data referring to the amount of energy consumed show a similar discrepancy, see the last value of the last row of each table. Not surprisingly the differences between the fuel quantities, when expressed in physical values are much bigger, range from 4 to 7%, with the year 2002 going up to an astonishing 15%.
An additional problem connected with the emission calculation is that the carbon content is linked to the correct physical quantities of a fuel or to its energy content. The use of a conventional energy content may add an additional error to the estimate.
In conclusion the main question is connected to the unexplained discrepancy between BEN and GRTN in the estimates of electricity produced and of the energy content of the used fuels. The difference is small but it should occur because both data sets are derived from the same source. On the basis of this consideration, we decided to base the inventory on GRTN data, that are expected to be more reliable.

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

Fuels	Model Output			GRTN / ENEL			BEN		
	Gwe, gross	kt	TJ	Gwe, gross	kt	T.o.e./TJ	Gwe, gross	kt	kcal / TJ
Coal	32057	11213	2.966E+08	31007	10782	68126318	32042	10782	68120
Lignite				1035	1501	264	1056	2640	
tot	32057	11213	2.966E+08	32042	12283	2.961E+08	32042	11838	2.961E+08
Coke oven gas	1183	689	1.226E+07	1177	693	296	1177	693	2960
Blast furnace gas	1930	6272	2.363E+07	1929	6804	524	1929	5822	5240
Oxi converter gas	432	682	2569860	446	509	106			
tot	3545	7643	3.846E+07	3552	8690	3.874E+07	3106	8690	3.431E+07
tot coal			3.350E+08			3.348E+08			3.304E+08
Light distillates				26	5	4	26	5	4
Diesel	1189	332	13813267	1025	303	302	1026	303	3020
Fuel oil atz	99383	21765	8.881E+08	99682	21798	21210	99681	21798	212100
btz							0	0	0
Refinery gas	1765	363	14889594	1149	211	250	1149	211	2500
Petroleum coke	875	139	5721952	836	186	139	836	186	1390
Oriemulsion	0	0	0						
tot	103212	22599	9.226E+08	102718	19352	9.165E+08	102717	22503	9.165E+08
Gas from chemical proc.				627	444	97			
Heavy residuals/ tar				6	2	2			
Recovered heat from pirite				163	146	36			
Others	415	89	1319174	192	344	39			
tot	415	89	1.319E+06	988	5153	7.280E+06		0	0.000E+00
oil+residues	103627	22689	9.239E+08	103706	24505	9.238E+08	102717	22503	9.165E+08
Natural gas	39080	9728	3.386E+08	39082	9731	3.383E+08	39083	9731	3.383E+08
Bio - gas	111								
totals	**178419**	**51272**	**1.597E+09**	**178382**	**55209**	**1.597E+09**	**176948**	**52762**	**1.585E+09**
BEN/ GRTN differences							0.8%	4.6%	0.7%

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

Fuels	Model Output			GRTN / ENEL			BEN		
	Gwe, gross	kt	TJ	Gwe, gross	kt	T.o.e./TJ	Gwe, gross	kt	kcal / TJ
Coal	24164	8537	2.247E+08	23970	8216	5245	23970	8216	52450
Lignite				152	380	43	152	172	430
tot	24164	8537	2.247E+08	24122	8596	2.212E+08	24122	8388	2.212E+08
		mc			mc				
Coke oven gas	996	523	9297651	985	540	231	985	540	2310
Blast furnace gas	1998	6425	24211400	1921	6428	496	1921	5511	4960
Oxi converter gas	420	649	2447086	537	633	132			
tot	3414	7597	3.596E+07	3443	7601	3.594E+07	2906	8690	3.042E+07
tot coal						2.572E+08			2.517E+08
Light distillates				48	6	6	48	6	60
Diesel	797	211	8.84E+06	697	184	184	697	184	1840
Fuel oil atz	116855	25261	1.03E+09	117022	25355	24619	117022	25355	246190
btz									
Refinery gas	2253	298	1.43E+07	2261	378	407	2260	378	4070
Petroleum coke	780	189	5.94E+06	755	189	156	755	189	1560
Oriemulsion	0	0	0.00E+00	0		0			
tot	1201511	26333	1.060E+09	120783	26112	1.062E+09	120781	26112	1.062E+09
Gas from chemical proc.				556	803	89			
Heavy residuals/ tar									
Recovered heat from pirite				3	3	1			
Others	826	375	6454448	405	697	94			
tot	826	375	6.454E+06	964	1503	7.699E+06			
oil+residues	121511	26333	1.066E+09	121747	27615	1.069E+09	120781	26112	1.062E+09
Natural gas	46433	11304	3.923E+08	46442	11277	3.923E+08	46442	11277	3.923E+08
Biogas	65								
Municipal waste	331								
tot control	195919	53771	1.719E+09	195754	55089	1.719E+09	194252	54467	1.705E+09
							0.8%	1.1%	0.78%

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

Fuels	Model Output			GRTN / ENEL			BEN		
	Gwe, gross	kt	TJ	Gwe, gross	kt	T.o.e./TJ	Gwe, gross	kt	kcal / TJ
Coal	26297	9556	2.538E+08	26272	9633	6052 6283	26273	9259	60509
Lignite								1	9
tot	26297	9556	2.538E+08	26272	9633	2.532E+08	26273	9260	2.532E+08
Coke oven gas	1372	675	1.201E+07				1422	660	2807
Blast furnace gas	2602	7449	2.493E+07				2601	7064	6358
Oxi converter gas	290	329	2.891E+06				229		1.984E+06
tot	4263	8453	3.984E+07	4252	8690	4.050E+07	4252	8690	4.033E+07
tot coal						2.937E+08			2.935E+08
Light distillates	277	44	1.880E+06				162	21	223
Diesel	1773	410	1.728E+07				3745	762	7772
Fuel oil atz	68573	15529	6.322E+08				31437	7084	69418
btz							47157	10625	104127
Refinery gas	4429	863	3.792E+07				5905	870	10444
Petroleum coke	1098	274	9.520E+06				1067	274	2276
Oriemulsion 7065	2554	7.015E+07	4.916E+07						
tot 83215	19675	7.690E+08	8.070E+08	85878	19352	7.868E+08	89473	19637	8.128E+08
Gas from chemical proc.	396	485	3.346E+06						
Heavy residuals/ tar	5800	1392	5.418E+07						
Recoverd heat from pirite									
Others	361	407	3.188E+06						
tot	2466	1416	2.179E+07	3753.8	5153	4.577E+07	38	0	3.100E+06
oil+residues	93820	21667	8.287E+08	89632	24505	8.325E+08	89511	19637	8.159E+08
Natural gas	97608	22586	7.897E+08	97607	223347.877E+08 8429		97609	22819	7.877E+08
Biogas	559			566.1					
Municipal waste	1352			1340.1			1826	1564	3910
tot control	219845	62531	1.913E+09	219669	65162	1.914E+09	219551	60406	1.897E+09
							0.05%	7.9%	0.9%

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

Fuels	Model Output			GRTN / ENEL			BEN		
	Gwe, gross	kt	TJ	Gwe, gross	kt	T.o.e./TJ	Gwe, gross	kt	kcal / TJ
Coal	26297	9556	2.538E+08	26272	9633	6052	26273	9259	60509
Lignite								1	9
tot	26297	9556	2.538E+08	26272	9633	2.532E+08	26273	9260	2.532E+08
Coke oven gas	1372	675	1.201E+07				1422	660	2807
Blast furnace gas	2602	7449	2.493E+07				2601	7064	6358
Oxi converter gas	290	329	2.891E+06				229		1.984E+06
tot	4263	8453	3.984E+07	4252	8690	4.050E+07	4252	8690	4.033E+07
tot coal						2.937E+08			2.935E+08
Light distillates	277	44	1.880E+06				162	21	223
Diesel	1773	410	1.728E+07				3745	762	7772
Fuel oil atz	68573	15529	6.322E+08				31437	7084	69418
btz							47157	10625	104127
Refinery gas	863	3.792E+07					5905	870	10444
Petroleum coke	274	9.520E+06					1067	274	2276
Oriemulsion 7065	7065	2554	7.015E+07						
tot 83215	83215	19675	7.690E+08	85878	19352	7.868E+08	89473	19637	8.128E+08
Gas from chemical proc.	485	3.346E+06					38		3.100E+06
Heavy residuals/ tar	5800	1392	5.418E+07						
Recoverd heat from pirite									
Others	353	385	3.050E+06						
tot	6549	2261	6.057E+07	3753.8	5153	4.577E+07	38	0	3.100E+06
oil+residues	89765	21936	8.296E+08	89632	24505	8.325E+08	89511	19637	8.159E+08
Natural gas	97608	22586	7.897E+08	97607	22334	7.877E+08	97609	22819	7.877E+08
Biogas	559			566.1					
Municipal waste	1352			1340.1			1905	1723	
tot control	219845	62531	1.913E+09	219669	65162	1.914E+09	219551	60406	1.897E+09
							0.05%	7.9%	0.89%

Table A2.4 - Energy consumption for electricity production, year 2002

Fuels	Model Output			GRTN / ENEL			BEN		
	Gwe, gross	kt	TJ	Gwe, gross	kt	T.o.e./TJ	Gwe, gross	kt	kcal / TJ
Coal	35445	12841	3.411E+08	35446.9	13088	8163	35449	12855	81629
tot	35445	12841	3.411E+08	35447	13088	3.415E+08	35449	12855	3.415E+08
Coke oven gas	1390	670	1.191E+07				1384	646	2746
Blast furnace gas	3344	8982	3.007E+07				3341	8152	7337
Oxi converter gas	284	292	2.566E+06				276		2.456E+06
tot	5018	9944	4.454E+07	5021	10034	4.485E+07	5000	8690	4.464E+07
tot carbone						3.864E+08			3.862E+08
Light distillates	426	67	2.916E+06				170	21	218
Diesel	665	154	6.486E+06				1601	316	3223
Fuel oil atz	66035	14438	5.878E+08				32659	6839	67022
btz							48169	10489	102792
Refinery gas	3279	532	2.339E+07				2386	350	4200
Petroleum coke	1098	274	9.520E+06				1081	270	2241
Oriemulsion	4916	1620	4.449E+07						
tot	76418	17085	6.746E+08	76997	17694	6.956E+08	86066	9722	7.518E+08
Gas from chemical proc.	417	471	3.251E+06				699		8.708E+06
Heavy residuals/ tar	9200	1946	7.327E+07						
Recoverd heat from pirite									
Others	726	1170	8.217E+06						
tot	10343	3586	8.473E+07	9998.6	8563	5.489E+07	699	8563	8.708E+06
oil+residues	86761	20671	7.593E+08	86996	26257	7.505E+08	86765	18285	7.606E+08
Natural gas	99595	22421	7.826E+08	99414	22362	7.793E+08	99413	22577	7.793E+08
Biogas	937			943.1	769	9.791E+06			
Municipal waste	2484			2479.5		2.53E+07	3387		4.29E+07
tot control	230240	65878	1.927E+09	230300	71741	1.916E+09	230014	62407	1.926E+09
							0.1%	15.0%	-0.5%

ANNEX 3: ESTIMATION OF CARBON CONTENT OF COALS USED IN INDUSTRY

The preliminary use of the CRF software underlined an unbalance of emissions in the solid fuel rows above 20%. A detailed verification pointed out to an already known fact for Italy: the combined use of standard IPCC emission factors for coals, national emission factors for coal gases and CORINAIR methodology emission factors for steel works processes produces double counting of emissions.

The main reason for this is the specific national circumstance of extensive recovery of coal gases from blast furnaces, coke ovens and oxygen converters for electricity generation. The emissions from those gasses are separately accounted for and reported in the electricity generation section.

An other specific national circumstance is the concentration of steel works in only two sites, with integrated steel plants, coke ovens and electricity self-production. Limited quantities of coke are produced also in two additional locations. This has allowed for careful check of the processes involved and the emissions estimates at site level and, with reference to other countries, may or may not have exacerbated the unbalances in carbon emissions due to the use of EF developed for other industrial sites.

To avoid the double counting a specific methodology has been developed: it balances energy and carbon content of coking coals used by steelworks, industry, for non energy purposes and coal gasses used for electricity generation.

A balance is made between the coal used for coke production and the quantities of derived fuels used in various sectors. The iron and steel sector gets the resulting quantities of energy and carbon after subtraction of what is used for electricity generation, non energy purposes and other industrial sectors.

The base statistical data are all reported by BEN, with one exception, the methodology starts with a verification of the energy balance reported by BEN, see also Annex 5, table A5.3/.4, that seldom presents problems, and then apply the standard EFs to the energy carriers, trying to balance the carbon inputs with emissions. The exception mentioned refers to the recovered gasses of BOFs (Basic Oxygen Furnace) that are used to produce electricity but are not accounted for by BEN from year 1990 up to year 1999. From year 2000 those gasses are (partially) include in the estimate of blast furnace gas. The data used to estimate the emissions from 1990 to 1999 are reported by GRTN. The consideration of the BOF gasses do not change the following discussion, its contribution to the total emissions is quite limited.

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

In the first box from top of the table we can see the quantities of coke, coke gas and blast furnace gas uses by the different sectors. In the second box are reported the quantities of the same energy carriers that are self-used, used for the production of coke of wasted.

Then in the final part of the table, the two coloured groups of cells report the verification of the input-output of two processes: coke ovens and the blast furnaces. The input –output is generally balanced for all the considered years, the small differences can be explained by statistical discrepancies. The following data are just memo summary of the quantities of fuels imported or exported by the system.

If we now look at Table A3.2, in the first two boxes from top we found the same energy data of table A3.1 valuated for their carbon content, according to the standard EF reported in Table 3.6 of the

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

Table A3.1 Energy balance, 2002, 10^9kcal

coke	coke gas	Blast furnace gas	
7,658			For blast furnace
0	2,746	7,337	For electricity prod.
23,324	94	145	For steel industries
1,624	0	0	For other industries use
161	0		For domestic use
32,767	2,839	7,482	Total consumption
836	247	144	Consumption for production of secondary fuels
35	0	32	Losses of transformation
33,638	3,086	7,658	Total consumption + losses and prod..
Energy balance coke ovens		Energy balance, blast furnace	
838		0.1	
2.7%		0.0%	
31,539			Coke oven output
8,199			Transformation losses, coke ovens
1,265			non energy use
41,003			sub total
			Coke input to coke ovens
41,003			Blast fornace coal input
6,331			import + stock change

So in the end the methodology actually foresees the calculation of the total carbon inputs (imported fuels plus standard IPCC EFs) and then the attribution to blast furnaces of the resulting quantities after subtraction of carbon emissions estimated for coke ovens, electricity production, other coal uses and, eventually, process emissions estimated with CORINAIR emission factors.

The resulting carbon quantities are correct but, when reported in the CRF format, they seems to be produced using very low EFs for coal produced CO_2, near to the natural gas EF, for the steel making process and quite high carbon emissions for the coal use to produce electricity.
Further investigations are planned, with a verification of the carbon content of the imported coals and of the coal gasses produced at various stages of the process, coke gas, blast furnace gas and BOF gas.

Table A3.2 Carbon balance, 2002, Mt CO_2

coke	coke gas	Blast furnace gas		totals
3.39			From blast furnace	
0.00	0.54	8.18	From electricity prod.	8.72
10.34	0.02	0.16	From steel industries	10.52
0.72	0.00	0.00	From other industries use	0.72
0.07	0.00		From domestic use	0.07
14.52	0.56	8.34	Total emissions	23.42
0.32	0.05	0.16	Consumption for production of secondary fuels	
0.02	0.00	0.04	Losses of transformation	
14.86	0.61	8.54	Total consumption + losses and prod..	24.01
Carbon balance, cokerie		Carbon balance, blast furnace		
0.9		5.1		
7%		60%		
12.63			Carbon in produced coke	
3.28			Transformation losses	
0.51			non energy use	
16.42			sub total	
15.89			Coal input to coke ovens	
2.84			Coal input to blast furnace	
1.93			import + stock change	

ANNEX 4: CO2 REFERENCE APPROACH

(with contributions from Sergio La Motta, ENEA)

A4.1 Introduction

The IPCC Reference Approach is a ‘top down’ inventory based on data on production, imports, exports and stock changes of crude oils, feedstock, natural gas and solid fuels. Estimates are made of the carbon stored in manufactured products, the carbon consumed as international bunker fuels and the emissions from biomass combustion.
The methodology followed is that outlined in the IPCC Guidelines (IPCC, 1997); table 1.A(b) of the Common Reporting Format “Sectoral background data for energy” - CO_2 from Fuel Combustion Activities - Reference Approach is a self sustaining explanation of the methodology.
However it was necessary to make a few adaptations to allow full use of Italian energy and emission factor data (ENEA, 2002 [a]), and these are described in the following. The BEN (MAP, 2004 [a]) reports the energy balances for all primary and secondary fuels, with data on imports, exports and production. Refer to Annex 5, tables from A5.1 to A5.8, for an example of the year 2002 and to the web site of the Ministry of Production Activities, http://www.minindustria.it/ita/default.htm, for the whole time series.
Starting from those data and using the emission factors reported in chapter 3, Table 3.3, it is possible to estimate the total carbon entering in the national energy system. With time it has been developed a direct connection between relevant cells of the CRF tables and the BEN tables and a procedure to insert some additional activity data needed.
The ‘missing’ data refer to import – export of lubricants, petrol additives, asphalt, other chemical products with energy content, energy use of exhausted lubricants and the evaluation of marine and aviation bunkers fuels used for national traffic.
Those ‘missing’ data are in fact reported in the BEN but all mixed up together with other substances as sulphur and petrochemicals. The aggregate data do not allow the use of the proper emission factor so inventory is based on more detailed statistics from foreign trade surveys.
The carbon stored in products is estimated according to the procedure illustrated in the paragraph 3.9 and directly subtracted to the emission balance by the CRF software. It may be the case to underline that non direct subtraction of the energy content of the feedstock is performed by CRF. In the cases, as Italy, where those products are not considered in the energy balances this bring to an unbalanced control sheet, as discussed in the next session.

With reference to table 1.A(b) of the CRF 2002, the main energy data source is the BEN. We make reference to the BEN tables reported in Annex 5. In particular the following data are available:
1) crude oil imports and production;
2) natural gas data import;
3) import-export data of petrol, aviation fuel, other kerosene, diesel, fuel oil, LPG and virgin naphtha;
4) import-export data of bitumen and motor oil derive from foreign trade statistics, estimated by an ENEA consultant for the period 1990-1998. BPT data (MAP, 2004 [b]) are used from 1999 onwards;
5) import-export data of petroleum coke and refinery feedstock are also found in BEN; it has to be

underlined that the data reported as “feedstock production” have been ignored because it is explicitly excluded by the IPCC methodology referring to petrochemical feedstock coming back to the refineries, subtracted from the non energy use estimate; therefore it cannot be considered as additional carbon inserted in the energy system;

6) all coal data are available in BEN, coke import-export included;
7) total natural gas import-export balance reflects BEN estimate (energy section), but the detailed quantities coming from different countries (relevant for the carbon EF estimate, see paragraph 3.9) are from foreign trade statistics or SNAM, the former national gas monopoly, fiscal budgets; natural gas data show not negligible variations from source to source, with particular reference to the underground stocked quantities;
8) from 1990 to 2002 biomass consumption data are those reported in BEN; it is well known that other estimates show much bigger, up to 50% more, quantities of used biomass, for example ENEA (ENEA, 2004); but the same source quotes BEN biomass consumption estimates as official statistics up to the year 2002, pending further investigations; the inventory follows the same methodology.

The following additional information is needed to complete table 1.A(b) of CRF 2002 and it is found in other sources:

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, 2004), the former electricity monopoly, presently the only user of this fuel, in their environmental report. As long as the emission factors are quite different, a note is needed in the BEN, at least as a warning.

Motor oils and bitumen.

Data on those materials are mixed up in the non energy use by BEN, detailed data are available in BPT (MAP, 2004 [b]). The quantities of those materials are quite relevant for the non energy use of oil.

In the BEN those materials are estimated in bulk with other products to have an energy content of about 5100 kcal/kg. Average OECD data 9000 kcal/kg for bitumen and 9800 kcal/kg for motor oils. In the CRF those products are estimated with the OECD energy contend and this may explain part of the unbalance between imported oil and used products (see section 3.7.1).

For further information please refer to the paper by ENEA (ENEA, 2002 [b]) in Italian.

A4.2 Comparison of the sectoral approach with the reference approach

The detailed inventory contains a number of sources not accounted for in the IPCC Reference Approach and so gives a higher estimate of CO_2 emissions. The unaccounted sources are:

- Land use change and forestry
- Offshore flaring and well testing
- Waste incineration
- Non-Fuel industrial processes

In principal the IPCC Reference total can be compared with the IPCC Table 1A total plus the fugitive emissions arising from fuel consumption reported in 1B1 Solid Fuel Transformation and Table 2 Industrial Processes (Iron and Steel and Ammonia Production). Results show the IPCC Reference totals are between 0-5 % lower than the comparable ‘bottom up’ totals.

Differences between emissions estimated by the sectoral and reference approach are reported in the following Table A4.1.

Table A4.1 Sectoral and Reference approach CO_2 emission estimates 1990-2002 (Mt) and percentage differences

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Sectoral approach	399.7	400.2	398.2	395.4	389.1	417.4	412.8	416.8	428.7	433.0	433.9	441.0	441.1
Reference approach	396.2	393.3	398.5	391.3	384.9	406.1	404.4	407.0	415.5	416.4	420.1	427.8	434.3
Δ %	0.9	1.7	-0.1	1.0	1.1	2.8	2.1	2.4	3.2	4.0	3.3	3.1	1.6

There are a number of reasons why the totals differ and these arise from differences in the methodologies and the statistics used.
Explanations for the discrepancies:

1. The IPCC Reference Approach is based on statistics of production, imports, exports and stock changes of fuels whilst the 'bottom-up' approach uses fuel consumption data. The two sets of statistics can be related using mass balances (MAP, 2004 [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 consider the process of "balancing" the import – production data with the consumption ones and the differences between the two data sets, a sizable part of the discrepancy may be connected to this reason only. An investigation is planned as soon as resources became available.
3. The 'bottom up' approach only includes emissions from the non-energy use of fuel where they can be specifically identified and estimated such as with fertilizer production and iron and steel production. The IPCC Reference approach implicitly treats the non-energy use of fuel as if it were combustion. A correction is then applied by deducting an estimate of carbon stored from non-energy fuel use. The carbon stored is estimated from an approximate procedure which does not identify specific processes. The result is that the IPCC Reference approach is based on a higher estimate of non-energy use emissions than the 'bottom-up' approach.

The IPCC Reference Approach uses data on primary fuels such as crude oil and natural gas liquids which are then corrected for imports, exports and stock changes of secondary fuels. Thus the estimates obtained will be highly dependent on the default carbon contents used for the primary fuels.
The 'bottom-up' approach is based wholly on the consumption of secondary fuels where the carbon contents are known with greater certainty. In particular the carbon contents of the primary liquid fuels are likely to vary more than those of secondary fuels. Carbon content of solid fuels and of natural gas is quite precisely accounted for, a specific methodology for estimate carbon content of liquid fuel imports is at the moment only planned.

ANNEX 5: NATIONAL ENERGY BALANCE, YEAR 2002

The following table reproduces the part expressed in amount of energy consumed of the National Energy Balance of the year 2002.
The complete balance, containing the physical quantities as well as the amount of energy and a consistent time series from the year 1994 onwards is also available on the web site: http://www.minindustria.it/ita/default.htm.
Sectors and fuel definition are in Italian language, they are very similar to their English equivalents so, for consistency with other national data sets, we prefer to leave them not translated.

Table A5.1- National energy balance, year 2002, Primary fuels, 10^9 kcal

Anno 2002							(cifre espresse in 10E9 kcal)							
BILANCIO							**FONTI PRIMARIE**							
	Carbon fossile Cokerie	**Carbone da vapore**	**Carbone altri usi**	**Lignite**	**Sottopro -dotti (a)**	**Gas naturale**	**Petrolio greggio**	**Semi-lavorati**	**Energia idraulica**	**Energia geotermica**	**Eolico + Fotovoltaico**	**Rifiuti**	**Biomasse**	**TOTALE FONTI PRIMARIE**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Coeff. di conversione (c)	7.400	6.350	7.400	2.500	2.500	8.250	10.000	10.000	2.200	2.200	2.200	2.500	2.500	
1. PRODUZIONI (d)		1,035		0.0	4,360	120,640	55,350	21,120	86,944	10,256	3,098	4,880	15,690	323,373
2. IMPORTAZIONI	37,992	89,148	281.2	25.0	0.0	489,151	809,530	87,770	0	0	0	0	5,158	1,519,054
3. Esportazioni						429.0	0.0	3,950					15.0	4,394
4. VAR.SCORTE (e)	-3,848	-686	-30	-0.5	0.0	28,083	130	1,020	0	0	0	0	0	24,669
5. TOTALE RISORSE	41,840	90,869	311	25.5	4,360	581,279	864,750	103,920	86,944	10,256	3,098	4,880	20,833	1,813,363
6. Trasformazioni (All.1)	41,003	81,629		0.0	4,360	186,260	968,670	0	86,944	10,256	3,098	4,880	6,358	1,393,458
7. Consumi e Perdite (All.2)	836	6	0.0	0.5	0.0	4,579	0	0	0	0	0	0	0.0	5,422
8. Consumi Finali (All.3)		9,233	311	25	0	390,440	0	0				0	14,475	414,483
a) Agricoltura		0				1,213	0	0		0			1,260	2,473
b) Industria		9,233	303	23	0	167,104		0				0	1,890	178,553
c) Servizi						3,647		0					1,360	5,007
d) Usi domestici e civili			7.4	2.5		209,204		0					9,965	219,178
Totale (a+b+c+d)	0.0	9,233	311	25	0	381,167		0				0	14,475	405,210
e) Usi non energetici						9,273		0					0.0	9,273
TOTALE CONSUMI ENERGETICI (7+8)	836	9,239	311	26	0.0	395,017	0	0	0	0		0	14,475	419,904
9.Consumi finali														
non energetici														0
10. Bunkeraggi														0
12. TOTALE IMPIEGHI	41,840	90,869	311	26	4,360	581,278	968,670	0	86,944	10,256	3,098	4,880	20,833	1,813,362

Table A5.2 – National Energy Balance, year 2002, Secondary fuels, 10^9 kcal

Segue: 2002																		(cifre espresse in 10E9 kcal)
BILANCIO	**FONTI SECONDARIE**																	
	Energia elettrica	**Carbone di legna**	**Coke da cokeria**	**Gas di cokeria**	**Gas di officina**	**Gas. di altofor.**	**Prodotti da carb. non ener. (f)**	**G. P. L. residui di raffin.**	**Gas leggeri**	**Distillati**	**Benzine**	**Carbo turbo**	**Petrolio**	**Gasolio**	**O.C. ATZ**	**O.C. B.T.Z.**	**Coke di di petrolio**	**Prodotti petrolif. non ener. (d)**
	15	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
Coeff. di conversione (c)	0.860	7.500	7.000	4.250	4.250	0.900	7.400	11.000	12.000	10.400	10.500	10.400	10.300	10.200	9.800	9.800	8.300	6.020
1. PRODUZIONI (d)	237,927	615	28,455	3,086	0	7,658	1,265	27,192	33,684	25,199	218,684	41,839	2,915	397,729	76,842	91,620	11,620	35,007
2. IMPORTAZIONI	44,306	308	4,690					17,490	0	16,942	6,006	198	1,844	10,343	36,975	68,610	17,214	3,883
3. Esportazioni	793		896				148.0	4,961		7,114	50,474	7,977	2,101	96,686	21,932	2,166	166	13,214
4. VAR.SCORTE (e)		0	-553					-2,233		-2,236	-767	822	-597	10,628	-10,868	11,887	-1,469	596
5. TOTALE RISORSE	281,440	923	32,802	3,086	0	7,658	1,117	41,954	33,684	37,263	174,983	33,238	3,255	300,757	102,753	146,177	30,137	25,080
6. Trasformazioni (All.1/a)			7,658	2,746		7,337	0	0	4,200	218	0	0	0	3,223	67,022	102,792	2,241	0
7. Consumi e Perdite (All.2/a)	38,338	0	35	247	0	176	0	517	24,168	2,766	116	0	10	2,927	10,457	7,781	7,171	187
8. Consumi Finali (All.3/a)	243,102	923	25,109	94	0	145	1,117	41,437	5,316	34,278	174,867	33,238	3,245	287,630	5,517	32,546	20,725	975
a) Agricoltura	4,206							737		0	336	0	0	25,214	0	0	0	0
b) Industria	117,875	225	24,948	94	0	145		4,675	480	0	3,770	187	155	4,488	4,390	28,724	20,725	975
c) Servizi	32,722							14,465			168,347	33,051		203,572	0	0		0
d) Usi domestici e civili	88,300	698	161		0			21,032			0		525	40,004	0	3,283		
Totale (a+b+c+d)	243,102	923	25,109	94	0	145	0	40,909	480	0	172,452	33,238	680	273,278	4,390	32,007	20,725	975
e) Usi non energetici				0			1,117	528	4,836	34,278	2,415		2,565	14,351	1,127	539	0	23,508
TOTALE CONSUMI																		
ENERGETICI (7+8)	281,440	923	25,144	340	0	321	1,117	41,954	29,484	37,045	174,983	33,238	3,255	290,557	15,974	40,327	27,896	1,162
9.Consumi finali																		
non energetici																		23,508
10. Bunkeraggi														6,977	19,757	3,058		409
12. TOTALE IMPIEGHI	281,440	923	32,802	3,086	0	7,658	1,117	41,954	33,684	37,263	174,983	33,238	3,255	300,757	102,753	146,177	30,137	25,080

Table A5.3 – National Energy Balance, year 2002, primary fuels used by transformation industries, “Allegato 1/a” , 10^9 kcal

Anno 2002	**TRASFORMAZIONI DELLE FONTI DI ENERGIA**													
Allegato 1/a	(cifre espresse in 10E9 kcal)													
TRASFORMAZIONI	**FONTI PRIMARIE**													
	Carbon fossile Cokerie	**Carbone da vapore**	**Carbone altri usi**	**Lignite**	**Sottopro -dotti (a)**	**Gas naturale**	**Petrolio greggio**	**Semi-lavorati**	**Energia idraulica**	**Energia geotermica**	**Eolico + Fotovoltaico**	**Rifiuti**	**Biomasse**	**TOTALE FONTI PRIMARIE**
Coeff. di conversione b)	7.400	6.350	7.400	2.500		8.250	10.000	10.000	2.200	2.200	2.200	2.500	2.500	
1) QUANTITA’ INPUT														
a) Carbonaie	0	0	0	0		0	0	0	0	0			993	993
b) Cokerie	41,003							0	0	0			0	41,003
c) Officine del gas	0	0	0	0		0	0	0	0	0			0	0
d) Altiforni	0	0	0	0		0	0	0	0	0			0	0
e) Raffinerie di petr.	0	0	0	0		0	968,670	0	0	0			0	968,670
f) Centrali idroel.	0	0	0	0		0	0	0	86,944	(c)			0	86,944
g) Centrali geoterm.	0	0	0	0			0	0	0	10,256			0	10,256
h) Centrali termoel.	0	81,629		0.0	4,360	186,260	0.00	0.00	0.00	0.00		4,880	5,365	282,495
i) Centrali eoliche/fotovoltaiche	0	0	0	0		0	0	0	0	0	3,098		0	3,098
TOTALE	41,003	81,629	0	0.0	4,360	186,260	968,670	0	86,944	10,256	3,098	4,880	6,358	1,393,458
2) QUANTITA’ OUTPUT (b)														
A) Fonti ottenute														
a) Carbonaie	0	0	0	0		0	0	0	0	0			617.5	618
b) Cokerie	31,539	0	0	0		0	0	0	0	0			0	31,539
c) Officine del gas	0	0	0	0		0	0	0	0	0			0	0
d) Altiforni	0	0	0	0		0	0	0	0	0			0	0
e) Raffinerie di petrolio	0	0	0	0		0	927,323	0	0	0			0	927,323
f) Centrali idroelettriche	0	0	0	0		0	0	0	**33,987**	0			0	33,987
g) Centrali geotermiche	0	0	0	0		0	0	0		4,009			0	4,009
h) Centrali termoelettriche	0	30,486	0	0.0	1,710	85,495	0	0	0	0		1,215	1,697.5	120,604
i) Centrali eoliche/fotovoltaiche	0	0	0	0		0	0	0	0	0	**1,211**		0	1,211
Sub-Totale A	31,539	30,486	0	0.0	1,710	85,495	927,323	0	33,987	4,009	1,211	1,215	2,315	1,119,291
B) Perdite di trasformazione														
a) Carbonaie	0	0	0	0		0	0	0	0	0			375	375
b) Cokerie	8,199	0	0	0		0	0	0	0	0			0	8,199
c) Officine del gas	0	0	0	0		0	0	0	0	0			0	0
d) Altiforni	0	0	0	0		0	0	0	0	0			0	0
e) Raffinerie di petrolio	0	0	0	0		0	6,340	0	0	0			0	6,340

Table A5.3 – National Energy Balance, year 2002, primary fuels used by transformation industries, “Allegato 1/a” , 10^9 kcal (segue)

Anno 2002	TRASFORMAZIONI DELLE FONTI DI ENERGIA													
Allegato 1/a									(cifre espresse in 10E9 kcal)					
TRASFORMAZIONI							**FONTI PRIMARIE**							
	Carbon fossile Cokerie	**Carbone da vapore**	**Carbone altri usi**	**Lignite**	**Sottopro -dotti (a)**	**Gas naturale**	**Petrolio greggio**	**Semi-lavorati**	**Energia idraulica**	**Energia geotermica**	**Eolico + Fotovoltaico**	**Rifiuti**	**Biomasse**	**TOTALE FONTI PRIMARIE**
f) Centrali idroelettriche	0	0	0	0		0	0	0	52,957	0			0	52,957
g) Centrali geotermiche	0	0	0	0		0	0	0	0	6,247			0	6,247
h) Centrali termoelettriche	0	51,143		0.0	2,650	100,766	0	0	0	0		3,665	3,668	161,891
i) Centrali eoliche/fotovoltaiche	0	0	0	0		0	0	0	0	0	1,887		0	1,887
Sub-Totale B	8,199	51,143	0	0.0	2,650	100,766	6,340	0	52,957	6,247	1,887	3,665	4,043	237,896
C) Prodotti non energetici														
a) Cokerie (d)	1,265	0	0	0		0	0	0	0	0			0	1,265
b) Officine del gas	0	0	0	0		0	0	0	0	0			0	0
c) Raffinerie di petrolio (e)	0	0	0	0		0	35,007	0	0	0			0	35,007
Sub-Totale C	1,265	0	0	0		0	35,007	0	0	0	0	0	0	36,272
TOTALE A+B+C	41,003	81,629	0	0.0	4,360	186,260	968,670	0	86,944	10,256	3,098	4,880	6,358	1,393,458

Table A5.4 – National Energy Balance, year 2002, secondary fuels used by transformation industries, “Allegato 1/a” , 10^9 kcal

2002														TRASFORMAZIONI DELLE FONTI DI ENERGIA					
Allegato 1/a																(cifre espresse in 10E9 kcal)			
TRASFORMAZIONI								F O N T I S E C O N D A R I E											
	Energia elettrica	Carbone di legna	Coke da cokeria	Gas di cokeria	Gas di officina	Gas. di altofor.	Prodotti da carb. non ener. (f)	G. P. L.	Gas residui di raffin.	Distillati leggeri	Benzine	Carbo turbo	Petrolio	Gasolio	O.C. ATZ	O.C. B.T.Z.	Coke di di petrolio	Prodotti petrolif. non ener. (d)	TOTALI FONTI SECOND
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Coeff. di conversione (b)	0.860	###	7.000	4.250	4.250	0.900	7.400	#####	12.000	####	###	###	###	10.200	9.800	9.800	8.300	6.020	
1) QUANTITA’ INPUT																			
a) Carbonaie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
b) Cokerie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
c) Officine del gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
d) Altiforni	0	0	7,658	0	0	0	0	0	0	0	0	0	0	0	0		0	0	7,658
e) Raffinerie di petrolio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
f) Centrali idroelettriche	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
g) Centrali geotermiche	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
h) Centrali termoelettriche	0	0	0	2,746		7,337		0	4,200	218	0	0	0	3,223	67,022.2	102,792	2,241		189,779
i) Centrali eoliche/fotovoltaiche	0	0	0																0
TOTALE	0	0	7,658	2,746	0	7,337	0	0	4,200	218	0	0	0	3,223	67,022.2	102,792	2,241	0	197,437
2) QUANTITA’ OUTPUT (b)																			
A) Fonti ottenute																			
a) Carbonaie																			0
b) Cokerie																			0
c) Officine del gas								0		0									0
d) Altiforni			7,658																7,658
e) Raffinerie di petrolio																			0
f) Centrali idroelettriche																			0
g) Centrali geotermiche																			0
h) Centrali termoelettriche				1,190		2,873			2,052	146				1,377	28,087	41,425	930		78,078
i) Centrali eoliche/fotovoltaiche																			0
Sub-Totale A	0	0	7,658	1,190	0	2,873	0	0	2,052	146		0	0	1,377	28,087	41,425	930	0	85,736
B) Perdite di trasformazione																			
a) Carbonaie	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0	0
b) Cokerie	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0	0
c) Officine del gas	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0	0
d) Altiforni	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0	0

Table A5.4 – National Energy Balance, year 2002, secondary fuels used by transformation industries, “Allegato 1/a” , 10^9 kcal (segue)

2002																			
	TRASFORMAZIONI DELLE FONTI DI ENERGIA																		
Allegato 1/a	(cifre espresse in 10E9 kcal)																		
TRASFORMAZIONI	**FONTIS ECONDARIE**																		
	Energia elettrica	**Carbone di legna**	**Coke da cokeria**	**Gas di cokeria**	**Gas di officina**	**Gas. di altofor.**	**Prodotti da carb. non ener. (f)**	**G. P. L.**	**Gas residui di raffin.**	**Distillati leggeri**	**Benzine**	**Carbo turbo**	**Petrolio**	**Gasolio**	**O.C. ATZ**	**O.C. B.T.Z.**	**Coke di di petrolio**	**Prodotti petrolif. non ener. (d)**	**TOTALI FONTI SECOND**
	15	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**
e) Raffinerie di petrolio	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0	0
f) Centrali idroelettriche	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0	0
g) Centrali geotermiche	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0	0
h) Centrali termoelettriche	0	0	0	1,556	0	4,464	0	0	2,148	73		0	0	1,846	38,935	61,368	1,311		111,701
i) Centrali eoliche/fotovoltaiche	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0	0
Sub-Totale B	0	0	0	1,556	0	4,464	0	0	2,148	73		0	0	1,846	38,935	61,368	1,311	0	111,701
C) Prodotti non energetici																			
a) Cokerie	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0	0
b) Officine del gas	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0	0
c) Raffinerie di petrolio	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0	0
Sub-Totale C	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0	0
TOTALE A+B+C	0	0	7,658	2,746	0	7,337	0	0	4,200	218	0	0	0	3,223	67,022	102,792	2,241	0	197,437

Table A5.5 – National Energy Balance, year 2002, primary fuels losses

2002												CONSUMI E PERDITE DEL SETTORE ENERGETICO (a)		
Allegato 2/a												(cifre espresse in 10E9 kcal)		
CONSUMI E PERDITE							**FONTI PRIMARIE**							
	Carbon fossile Cokerie	**Carbone da vapore**	**Carbone altri usi**	**Lignite**	**Sottopro -dotti (a)**	**Gas naturale**	**Petrolio greggio**	**Semi-lavorati**	**Energia idraulica**	**Energia geotermica**	**Eolico + Fotovoltaico**	**Rifiuti**	**Biomasse**	**TOTALE FONTI PRIMARIE**
Coeff. di conversione (b)	7.400	6.350	7.400	2.500		8.250	10.000	10.000	2.200	2.200			2.500	
1) Consumi di produzione di fonti primarie														
a) Combustibili vegetali														0
b) Carbon fossile	0	0	0	0		0	0	0	0	0			0	0
c) Lignite	0	0	0	0		0	0	0	0	0			0	0
d) Combustibili nucleari	0	0	0	0		0	0	0	0	0			0	0
e) Gas naturale	0	0	0	0		569	0	0	0	0			0	569
f) Condensati di petrolio	0	0	0	0		0	0	0	0	0			0	0
g) Petrolio greggio	0	0	0	0		0	0	0	0	0			0	0
h) Energia idraulica	0	0	0	0		0	0	0	0	0			0	0
i) Energia geotermica									0					0
Sub-totale	0	0	0	0	0	569	0	0	0	0	0	0	0	569
2) Consumi di produzionedi fonti secondarie (c														
a) Carbonaie	0	0	0	0		0	0	0	0	0			0	0
b) Cokerie	836	0	0	0		0	0	0	0	0			0	836
c) Officine del gas	0	0	0	0		0	0	0	0	0			0	0
d) Altiforni	0	0	0	0		0	0	0	0	0			0	0
e) Raffinerie di petrolio	0	0	0	0		0	0	0	0	0			0	0
f) Centrali idrauliche	0	0	0	0		0	0	0	0	0			0	0
g) Centrali geotermiche	0	0	0	0		0	0	0	0	0			0	0
h) Centrali termoelettriche	0	0	0	0		0	0	0	0	0			0	0
Sub-totale	836	0	0	0		0	0	0	0	0			0	836
3) Consumi e perdite di														
trasporto e distribuzione	0	0	0	0		4,010	0	0	0	0			0	4,010
4) Differenze :														
- Statistiche	0	6	0	0	0	0	0	0	0	0	0	0	0	6
- Di conversione	0	0	0	1	0	0.0	0	0	0	0	0	0	0	0
TOTALE (1+2+3+4)	836	6	0	1	0	4,579	0	0	0	0	0	0	0	5,422

Table A5.6 – National Energy Balance, year 2002, secondary fuels losses

2002 — **CONSUMI E PERDITE DEL SETTORE ENERGETICO (a)**

Allegato 2/a — (cifre espresse in 10E9 kcal)

CONSUMI E PERDITE	Energia elettrica	Carbone di legna	Coke da cokeria	Gas di cokeria	Gas di officina	Gas. di altofor.	Prodotti da carb. non ener. (f)	G. P. L.	Gas residui di raffin.	Distillati leggeri	Benzine	Carbo turbo	Petrolio	Gasolio	O.C. ATZ	O.C. B.T.Z.	Coke di di petrolio	Prodotti petrolif. non ener. (d)	TOTALI FONTI SECOND
	F O N T I S E C O N D A R I E																		
Coeff. di conversione (b)	0.860	7.500	7.000	4.250	4.250	0.900	7.400	11.000	12.000	10.400	####	10.400	#####	10.200	9.800	9.800	8.300	6.020	
1) Consumi di produzione di fonti primarie																			
a) Combustibili vegetali																			0
b) Carbon fossile	32																		32
c) Lignite	0																		0
d) Combustibili nucleari	4																		4
e) Gas naturale	206																		206
f) Condensati di petrolio																			0
g) Petrolio greggio																			0
h) Energia idraulica	2,503	(d)																	2,503
i) Energia geotermica	0																		0
Sub-totale	2,745	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,745
2) Consumi di produzione di fonti secondarie																			
a) Carbonaie																			0
b) Cokerie	164		0	17		144													325
c) Officine del gas	206				0														206
d) Altiforni	65			230		0													294
e) Raffinerie di petrolio	4,667							517	24,168	2,766	116	0	10	2,927	10,457	7,781	7,171.2	186.6	60,767
f) Centrali idrauliche	553																		553
g) Centrali geotermiche	238																		238
h) Centrali termoelettriche	10,920																		10,920
i) Centrali eoliche/fotovoltaiche	1																		
Sub-totale	16,814	0	0	247	0	144	0	517	24,168	2,766	116	0	10	2,927	10,457	7,781	7,171	187	73,304
3) Consumi e perdite di																			
trasporto e distribuzione	18,779	0	35	0	0	32	0	0	0	0	0	0	0	0	0	0	0.0	0.0	18,846
4) Differenze :																			
- Statistiche	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Di conversione	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTALE (1+2+3+4)	38,338	0	35	247	0	176	0	517	24,168	2,766	116	0	10	2,927	10,457	7,781	7,171	187	94,895

Table A5.7 – National Energy Balance, year 2000, primary fuels used by end use sectors, "Allegato 3/a" , 10^9 kcal

2002	C O N S U M I F I N A L I D I E N E R G I A													
Allegato 3/a	(cifre espresse in 10E9 kcal)													
CONSUMI FINALI	**FONTI PRIMARIE**													
	Carbon fossile Cokerie	**Carbone da vapore**	**Carbone altri usi**	**Lignite**	**Sottopro -dotti (a)**	**Gas naturale**	**Petrolio greggio**	**Semi-lavorati**	**Energia idraulica**	**Energia geotermica**	**Eolico + Fotovoltaico**	**Rifiuti**	**Biomasse**	**TOTALE FONTI PRIMARIE**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Coeff. di conversione (a)	7.400	6.350	7.400	2.500	2.500	8.250	10.000	10.000	2.200	2.200	2.200	2.500	2.500	
1) AGRICOLTURA E PESCA														
I- Agricoltura	0	0	0	0	0	1,212.8	0	0	0	0	0	0	1,260	2,473
II- Pesca	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Totale	0	0	0	0	0	1,212.8	0	0	0	0	0	0	1,260	2,473
2) INDUSTRIA														
I- Siderurgia	0	6,286.5	44.4	0	0	18,991.5	0	0	0	0	0	0	0	25,322
II- Altre industrie	0	2,946	259.0	22.5	0	148,112.3	0	0	0	0	0	0	1,890.0	153,230
a) Estrattive	0	0	0.0	0.0	0	272.3	0	0	0	0	0	0	0	272
b) Metalli non ferrosi	0	0	14.8	0.0	0	3,844.5	0	0	0	0	0	0	0	3,859
c) Meccanica	0	0	14.8	0.0	0	22,118.3	0	0	0	0	0	0	0	22,133
d) Agroalimentare	0	0	0.0	0.0	0	18,455.3	0	0	0	0	0	0	0	18,455
e) Tessili e abbigliamento	0	0	7.4	0.0	0	13,340.3	0	0	0	0	0	0	0	13,348
f) Materiali da costruzione	0	2,946	170.2	22.5	0	10,568.3	0	0	0	0	0	0	1,890.0	15,597
g) Vetro/ceramica	0	0	0.0	0.0	0	25,434.8	0	0	0	0	0	0	0	25,435
h) Chimica	0	0	22.2	0.0	0	29,213.3	0	0	0	0	0	0	0	29,235
i) Petrolchimica	0	0	0.0	0.0	0	0.0	0	0	0	0	0	0	0	0
l) Cart/graf.	0	0	14.8	0.0	0	16,450.5	0	0	0	0	0	0	0	16,465
m) Altre manifatturiere	0	0	14.8	0	0	8,415.0	0	0	0	0	0	0	0	8,430
n) Edilizia e costruz. civili	0	0	0.0	0	0	0.0	0	0	0	0	0	0	0	0
Sub-Totale	0	9,233	303.4	22.5	0	167,103.8	0	0	0	0	0	0	1,890	178,553
3) SERVIZI														
I - Trasp.ferroviari	0	0	0	0	0	0	0	0	0	0	0	0	0	0
II - Trasp. via acqua	0	0	0	0	0	0	0	0	0	0	0	0	0	0
III - Trasp. stradali	0	0	0	0	0	3,646.5	0	0	0	0	0	0	1,360	5,007
IV - Trasp. aerei	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V - Altri pubblici	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VI - Pubblica Amm.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Totale	0	0	0	0	0	3,646.5	0	0	0	0	0	0	1,360	5,007
4) USI DOMESTICI														

Table A5.7 – National Energy Balance, year 2000, primary fuels used by end use sectors, “Allegato 3/a” , 10^9 kcal (segue)

2002	C O N S U M I F I N A L I D I E N E R G I A													
Allegato 3/a	(cifre espresse in 10E9 kcal)													
CONSUMI FINALI	**FONTI PRIMARIE**													
	Carbon fossile Cokerie	**Carbone da vapore**	**Carbone altri usi**	**Lignite**	**Sottopro -dotti (a)**	**Gas naturale**	**Petrolio greggio**	**Semi-lavorati**	**Energia idraulica**	**Energia geotermica**	**Eolico + Fotovoltaico**	**Rifiuti**	**Biomasse**	**TOTALE FONTI PRIMARIE**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
COMMERCIALI E ARTIG.	0	0	7.4	2.5	0	209,203.5	0	0	0	0	0		9,965.0	219,178
TOTALE (1+2+3+4)	0	9,233	311	25	0	381,166.5	0	0	0	0	0	0	14,475	405,210
5) NON ENERGETICI (a)														
I - Industria chimica	0	0	0	0	0	9,273.0	0	0	0	0	0	0	0	9,273
II - Petrolchimica	0	0	0	0	0	0	0	0	0	0	0	0	0	0
III - Agricoltura	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IV - Altri settori	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Totale	0	0	0	0	0	9,273.0	0	0	0	0	0	0	0	9,273
TOTALE (1+2+3+4+5)	0	9,233	311	25	0	390,439.5	0	0	0	0	0	0	14,475	414,483

Table A5.8 – National Energy Balance, year 2002, secondary fuels used by end use sectors, "Allegato 3/a" , 10^9 kcal

Segue: **2002** — **CONSUMI FINALI DI ENERG A**

Allegato 3/a — (cifre espresse in 10E9 kcal)

CONSUMI FINALI	FONTI SECONDARIE																	
	Energia elettrica	**Carbone di legna**	**Coke da cokeria**	**Gas di cokeria**	**Gas di officina**	**Gas. di altofor.**	**Prodotti da carb. non ener. (f)**	**G. P. L.**	**Gas residui di raffin.**	**Distillati leggeri**	**Benzine**	**Carbo turbo**	**Petrolio**	**Gasolio**	**O.C. ATZ**	**O.C. B.T.Z.**	**Coke di di petrolio**	**Prodotti petrolif. non ener. (d)**	**TOTALI FONTI SECOND**
	15	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**
Coeff. di conversione (a)	0.860	7.500	7.000	4.250	4.250	0.900	7.400	11.000	12.000	10.400	10.500	10.400	10.300	10.200	9.800		8.300	6.020	
1) AGRICOLTURA E PESCA																			
I- Agricoltura	4,206	0	0	0	0	0	0	715.0	0	0	315.0	0	0	22,848	0	0	0	0	28,084
II- Pesca	0	0	0	0	0	0	0	22.0	0	0	21.0	0	0	2,366	0	0	0	0	2,409
Sub-Totale	4,206	0	0	0	0	0	0	737.0	0	0	336.0	0	0	25,214	0	0	0	0	30,493
2) INDUSTRIA																			
I- Siderurgia	17,107	0	23,324	93.5	0	145	0	220.0	0	0	0	0	0.0	81.6	0	784.0	33	0	41,788
II- Altre industrie	100,768	225.0	1,624	0	0	0	0	4,455.0	480.0	0.0	3,769.5	187.2	154.5	4,406	4,390	27,940	20,692	975	170,067
a) Estrattive	920	0	14.0	0	0	0	0	33.0	0	0	0	0	0.0	183.6	58.8	176.4	0	0	1,386
b) Metalli non ferrosi	4,808	0	49.0	0	0	0	0	198.0	0	0	0	0	20.6	51.0	0	578.2	0	0	5,705
c) Meccanica	22,415	0	378.0	0	0	0	0	869.0	0	0	304.5	187.2	82.4	1,111.8	1,480	3,832	0	0	30,659
d) Agroalimentare	10,630	172.5	301.0	0	0	0	0	451.0	0	0	0	0	20.6	489.6	343.0	6,605	0	0	19,013
e) Tessili e abbigliamento	#######	0	0.0	0	0	0	0	407.0	0	0	0	0	0.0	591.6	205.8	3,303	0	0	15,202
f) Materiali da costruzione	7,341	0	147.0	0	0	0	0	814.0	0	0	0	0	0.0	316.2	931.0	176.4	20,600.6	819	31,145
g) Vetro/ceramica	4,968	0	0.0	0	0	0	0	682.0	0	0	0	0	0.0	132.6	0	2,852	0	0	8,634
h) Chimica	21,120	52.5	357.0	0	0	0	0	55.0	0	0	0	0	20.6	326.4	0	1,460	91.3	0	23,483
i) Petrolchimica	(d) 1,843	0	0.0	0	0	0	0	682.0	480.0	0	3,465	0	0.0	0.0	0	3,548	0	157	10,175
l) Cart/graf.	9,012	0	0.0	0	0	0	0	66.0	0.0	0	0	0	0.0	193.8	0	1,617	0	0	10,889
m) Altre manifatturiere	5,877	0	378.0	0	0	0	0	198.0	0.0	0	0	0	10.3	499.8	1,372	3,793	0	0	12,127
n) Edilizia e costruz. civili	1,140	0	0.0	0	0	0	0	0.0	0.0	0	0	0	0.0	510.0	0	0	0	0	1,650
Sub-Totale	117,875	225.0	24,948	94	0	145	0	4,675	480.0	0	3,769.5	187.2	154.5	4,488	4,390	28,724	20,725	975	211,855
3) SERVIZI																			
I - Trasp.ferroviari	4,549	0	0	0	0	0	0	0	0	0	0	0	0	1,244.4	0	0	0	0	5,793
II - Trasp. via acqua	20	0	0	0	0	0	0	0	0	0	0	0	0	2,366.4	0	0	0	0	2,386
III - Trasp. stradali	3,014	0	0	0	0	0	0	14,443.0	0	0	167,979	0	0	196,829	0	0	0	0	382,265
IV - Trasp. aerei	128	0	0	0	0	0	0	0.0	0	0	126.0	32,240	0	0	0	0	0	0	32,494
V - Altri pubblici	16,779.7	0	0	0	0	0	0	0.0	0	0	0.0	0	0	0	0	0	0	0	16,780
VI - Pubblica Amm.	8,231	0	0	0	0	0	0	22.0	0	0	241.5	811.2	0.0	3,131.4	0	0	0	0	12,437
Sub-Totale	32,722	0	0	0	0	0	0	14,465.0	0	0	168,347	33,051	0	203,572	0	0	0	0	452,157

Table A5.8 – National Energy Balance, year 2002, secondary fuels used by end use sectors, “Allegato 3/a” , 10^9 kcal

Segue: **2002**	C O N S U M I F I N A L I D I E N E R G I A																		
Allegato 3/a															(cifre espresse in 10E9 kcal)				
CONSUMI FINALI	F O N T I S E C O N D A R I E																		
	Energia elettrica	**Carbone di legna**	**Coke da cokeria**	**Gas di cokeria**	**Gas di officina**	**Gas. di altofor.**	**Prodotti da carb. non ener. (f)**	**G. P. L.**	**Gas residui di raffin.**	**Distillati leggeri**	**Benzine**	**Carbo turbo**	**Petrolio**	**Gasolio**	**O.C. ATZ**	**O.C. B.T.Z.**	**Coke di di petrolio**	**Prodotti petrolif. non ener. (d)**	**TOTALI FONTI SECOND**
	15	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**
4) USI DOMESTICI																			
COMMERCIALI E ARTIG.	88,300	697.5	161.0	0	0.0	0	0	21,032.0	0	0	0	0	525.3	40,004.4	0	3,283.0	0	0	154,003
TOTALE (1+2+3+4)	243,102	922.5	25,109	94	0.0	145	0	40,909	480.0	0	172,452	33,238	680	273,278	4,390	32,007	20,725	975	848,507
5) NON ENERGETICI (g)																			
I - Industria chimica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
II - Petrolchimica	0	0	0	0	0	0	0	528	4,836	34,278	2,415	0	2,565	14,351	1,127	539	0	476	61,115
III - Agricoltura	0	0	0	0	0	0	170	0	0	0	0	0	0	0	0	0	0	0	170
IV - Altri settori	0	0	0	0	0	0	947	0	0	0	0	0	0	0	0	0	0	23,033	23,980
Sub-Totale	0	0	0	0	0	0	1,117	528	4,836	34,278	2,415	0	2,565	14,351	1,127	539	0	23,508	85,265
TOTALE (1+2+3+4+5)	243,102	922.5	25,109	94	0.0	145	1,117	41,437	5,316	34,278	174,867	33,238	3,245	287,630	5,517	32,546	20,725	24,484	933,773

ANNEX 6: NATIONAL EMISSION FACTORS

Monitoring of the carbon content of the fuels used nationally is an ongoing activity at APAT. The principle is to analyse regularly the chemical composition of the used fuel or relevant activity statistics, to estimate the carbon content and the emission factor. For each primary fuel (natural gas, oil, coal) a specific procedure has been established.

Natural gas

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

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

Each of those natural gasses has peculiar properties and it is regularly analysed at the import gates, for budgetary reasons. Energy content for cubic meters and percentage of methane can vary considerably: national produced gas sold to the grid is almost 99% methane (% moles), the one coming from Algeria has less than 85% of methane and significant quantities of propane-butane. Carbon content vary significantly also.

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

So, for each year, the average methane and carbon content of the natural gas used in Italy are estimated using the international trade statistical data and a national emission factor is estimated. The list of factors for the years of interest is reported in Table A6.1.

Table A6.1 Natural gas carbon emission factors

	t CO_2 / TJ	t CO_2 / tep
Natural gas (dry) ‘1990	55.281	2.313
Natural gas (dry) ‘1995	55.379	2.317
Natural gas (dry) ‘2000	55.528	2.323
Natural gas (dry) ‘2002	55.560	2.325

Diesel oil, petrol and LPG, national production

APAT has made an investigation of the carbon content of the main transportation fuels sold in Italy: petrol, diesel and LPG. The job has been aimed to test the average fuels sold in the year 2000 and to collect the available information on previous years fuels. The aim of this work is the verification of CO_2 emission factors of the Italian energy system and specifically of the transportation sector. The results of analysis of fuel samples performed by “Stazione Sperimentale Combustibili” (APAT, 2003) are checked against the emission factors used in the Reference Approach of the Intergovernmental Panel for Climate Change (IPCC, 1997) and the emission factors considered in the COPERT III programme of the European Environment Agency (EEA, 2000).

Those two methodologies are widely used to prepare data at the international level but, when applied to the Italian data set produces results with significant differences, around 2-4%. The reason has been traced back to the emission factors, that is referred to the energy content of the fuel for IPCC and to the physical quantities for the COPERT methodology.
The results of the study performed by APAT link the chemical composition of the fuel to the LHV for a series of fuels representative of the national production in the years 2000-2001, allowing for more precise evaluations of the emission factors.
IPCC-OECD emission factors for diesel fuels and LPG are almost identical to the experimental results (less than 1% difference), and it has been decided to use IPCC emission factors for the period 1990-1999 and the measured EF from the year 2000 onwards.
Relevant quantities (about 50%) of LPG used in Italy are imported. The measured values refer only to the products produced in Italy, IPCC emission factors is used as a default.
For petrol instead the IPCC-OECD emission factors is quite low and it has to be upgraded, the reason may be linked to the extensive use of additives in recent years to reach a high octane number after the lead has been phased out. For 2000 and the following years the experimental factor will be used, for the period 1990-1999 it has been decided to use an interpolate factor between IPCC emission factors and the measured value, using the LHV as the link between the national products and the international database. No other information was available.
The list of emission factors for the different years is reported in Table A6.2.

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

	t CO_2 / TJ	**t CO_2 / tep**
Petrol, 1990-’99, IPCC europe	68.559	2.868
Petrol, test data, 2000	71.145	2.977
Gasoil, 1990-’99, IPCC europe	73.274	3.066
Gasoil, engines, test data, 2000	73.153	3.061
Gasoil, heating, test data.	73.693	3.083
LPG, 1990-’99, IPCC	62.392	2.610
LPG, test data, 2000	64.936	2.717

Fuel oil, imported and produced

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

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

	t CO_2 / TJ	t CO_2 / tep
Fuel oil, 1990 average	75.016	3.139
Fuel oil, 1995 average	76.688	3.209
Fuel oil, 2000 average	76.702	3.209
Fuel oil, 2002 average	76.686	3.209

Coal imports

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

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

So an attempt was made to find out a methodology that allow for a more precise estimation of the carbon content of this fuel. It is possible, using literature data for the coals and detailed statistical records of international trade, to find out the weighted average of carbon content and of the LHV of the fuel imported to Italy each year. The actually still unresolved problem is how to properly link statistical data, referred to the coal "as is" without specifying the moisture and ash content of the product, to the literature data that refer to sample coals.

We envisage to improve the quality of the collected statistical data including moisture content of coals but presently we overcome this obstacle with the following procedure:

– using an ample set of experimental data on coals imported in a couple of years on an extensive series of samples, more than 200, analysed by ENEL (the main electricity producing company in Italy) it was possible to correlate "as is" LHV and carbon content to the average properties of the coals imported in the same period of time and calculated from literature data (EMEP/CORINAIR, 2001);
– for each inventory year it is possible to calculate the weighted average of LHV and carbon content of imported coals using available literature data;
– using this calculated data and the correlation found out it is possible to estimate the carbon content of the average "as is" coal reported in the statistics.

Using this methodology and the available statistical data, it was possible to trace back to the year 1990 the average LHV of the imported coal and estimate the average carbon EF for each year, see table A6.4 for same details. The results do not show impressive changes from year to year, any way a noticeable difference of about 1.5% in the emission factor is highlighted in the table.

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

Table A6.4 – Coal, average carbon emission factors

	t CO_2 / TJ	t CO_2 / tep
Solid fuels		
Steam coal '90	94.582	3.960
Steam coal '95	94.007	3.936
Steam coal '00	95.526	3.997
Steam coal '01	94.424	3.951
Steam coal '02	95.551	3.998

ANNEX 7: CRF TREND TABLES FOR GREENHOUSE GASES

This appendix shows a copy of Tables 10s1-10s5 from the Common Reporting Format 2002, reporting time series of emission estimates for the following gases:

- CO_2
- CH_4
- N_2O
- HFCs, PFCs, SF_6
- All gases and sources categories

Table A7.1 CO_2 emissions trends, CRF year 2002

TABLE 10 EMISSIONS TRENDS (CO_2)
(Sheet 1 of 5)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	(Gg)													
1. Energy	402,723.39	402,723.39	405,188.01	401,173.22	396,506.99	392,050.58	420,277.07	415,305.86	419,480.33	431,471.16	455,118.62	456,166.47	443,159.11	443,034.55
A. Fuel Combustion (Sectoral Approach)	399,675.70	399,675.70	402,194.76	398,247.19	393,425.13	389,137.13	417,433.70	412,613.47	416,805.77	428,703.51	453,027.43	453,868.96	440,976.62	441,110.29
1. Energy Industries	130,811.51	130,811.51	127,586.95	127,383.44	123,207.50	124,930.92	138,976.05	135,343.15	136,575.40	135,775.64	131,209.80	130,055.12	146,748.07	153,150.54
2. Manufacturing Industries and Construction	87,845.83	87,845.83	85,377.93	82,717.74	82,948.06	83,575.01	86,354.88	85,720.97	89,076.64	95,107.07	98,685.56	94,519.60	89,865.03	84,949.30
3. Transport	101,856.61	101,856.61	104,347.93	108,669.08	110,393.89	110,909.60	112,066.36	113,329.78	114,909.28	118,726.38	119,878.89	120,409.24	122,821.29	124,944.01
4. Other Sectors	78,120.96	78,120.96	81,690.50	78,200.90	78,057.86	68,866.46	75,600.90	77,342.81	74,712.10	78,060.27	82,146.29	78,084.91	81,188.30	77,738.89
5. Other	1,040.79	1,040.79	1,191.68	1,276.05	1,443.04	1,455.14	1,455.48	1,177.55	1,532.38	1,035.95	1,106.87	806.10	353.94	319.56
B. Fugitive Emissions from Fuels	3,047.89	3,047.89	2,990.25	2,926.05	3,088.86	2,913.45	2,843.37	2,692.39	2,674.55	2,767.88	2,091.19	2,297.51	2,182.49	1,924.26
1. Solid Fuels														
2. Oil and Natural Gas	3,047.89	3,047.89	2,990.25	2,926.05	3,088.86	2,913.45	2,843.37	2,692.39	2,674.55	2,767.88	2,091.19	2,297.51	2,182.49	1,924.26
2. Industrial Processes	26,154.44	26,154.44	25,840.61	26,361.46	23,331.73	22,403.58	24,246.91	22,229.13	22,572.99	22,715.45	23,165.03	24,300.15	24,794.70	24,405.50
A. Mineral Products	21,712.97	21,712.97	21,645.30	22,348.66	20,035.48	19,511.85	21,222.09	19,487.96	19,767.96	19,997.64	20,717.86	21,611.65	22,184.30	22,077.12
B. Chemical Industry	2,236.63	2,236.63	2,114.91	2,131.75	1,354.97	957.66	957.83	698.98	719.39	666.22	588.25	672.60	694.30	551.31
C. Metal Production	2,204.84	2,204.84	2,080.40	1,881.05	1,941.28	1,934.07	2,066.99	2,042.19	2,085.64	2,051.59	1,858.92	2,015.90	1,916.10	1,777.07
D. Other Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Production of Halocarbons and SF6														
F. Consumption of Halocarbons and SF6														
G. Other														
3. Solvent and Other Product Use	1,733.49	1,733.49	1,724.13	1,629.62	1,562.27	1,507.29	1,472.38	1,428.38	1,418.81	1,359.74	1,351.09	1,329.49	1,263.24	1,240.94
4. Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A. Enteric Fermentation														
B. Manure Management														
C. Rice Cultivation														
D. Agricultural Soils (2)														
E. Prescribed Burning of Savannas														
F. Field Burning of Agricultural Residues														
G. Other														
5. Land-Use Change and Forestry (3)	-23,352.48	-23,352.48	-23,176.10	-21,817.32	-20,691.92	-19,446.03	-19,597.88	-20,222.33	-17,763.94	-17,426.13	-17,711.95	-16,944.68	-18,301.22	-20,383.45
A. Changes in Forest and Other Woody Biomass Stocks	-28,425.24	-28,425.24	-28,955.52	-28,311.96	-27,424.72	-26,976.17	-27,315.58	-27,886.27	-27,255.27	-25,745.11	-25,667.98	-25,542.63	-26,913.51	-27,582.75
B. Forest and Grassland Conversion														
C. Abandonment of Managed Lands	-102.01	-102.01	-103.73	-119.25	-131.77	-141.82	-148.26	-151.17	-153.41	-153.52	-153.48	-151.44	-148.87	-135.66
D. CO2 Emissions and Removals from Soil	5,174.77	5,174.77	5,882.95	6,613.88	6,864.57	7,671.95	7,865.97	7,815.11	9,644.75	8,472.48	8,109.54	8,749.41	8,761.17	7,332.96
E. Other														
6. Waste	544.92	544.92	542.81	587.53	615.41	613.25	583.85	540.56	537.84	530.57	440.63	279.52	298.45	279.87
A. Solid Waste Disposal on Land														
B. Waste-water Handling														
C. Waste Incineration	544.92	544.92	542.81	587.53	615.41	613.25	583.85	540.56	537.84	530.57	440.63	279.52	298.448	279.869
D. Other														
7. Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Emissions/Removals with LUCF (4)	407,623.97	407,623.97	408,096.25	407,934.27	403,326.49	397,130.66	428,984.57	419,421.80	426,416.08	438,570.76	442,383.44	445,130.92	451,214.28	448,575.42
Total Emissions without LUCF (4)	431,156.45	431,156.45	431,272.36	429,751.60	424,018.41	416,576.69	446,582.22	439,644.12	444,179.96	455,796.92	460,075.37	462,075.38	469,515.50	468,958.85
Memo Items:														
International Bunkers	8,452.46	8,452.46	8,478.08	8,303.44	8,678.94	8,844.44	9,578.85	8,801.34	9,174.48	9,728.96	10,459.91	11,641.13	12,038.39	11,894.91
Aviation	4,048.56	4,048.56	4,875.19	4,826.40	4,985.59	5,164.41	5,527.90	5,951.55	6,102.65	6,634.83	7,366.87	7,786.48	7,664.51	6,901.64
Marine	4,403.91	4,403.91	3,602.89	3,477.04	3,693.35	3,680.03	4,050.95	2,849.82	3,071.79	3,094.13	3,093.03	3,854.69	4,373.87	4,993.27
Multilateral Operations														
CO2 Emissions from Biomass	5,891.61	5,891.61	6,148.30	6,509.61	6,510.52	7,478.03	8,124.14	7,902.51	8,634.69	7,731.44	9,021.46	9,601.92	10,615.17	11,618.70

Table A7.2 CH_4 emission trends, CRF year 2002

TABLE 10 EMISSIONS TRENDS (CH_4)
(Sheet 2 of 5)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	(Gg)													
Total Emissions	**1,771.23**	**1,771.23**	**1,797.80**	**1,789.13**	**1,783.40**	**1,726.83**	**1,747.80**	**1,737.36**	**1,748.71**	**1,716.37**	**1,690.71**	**1,671.22**	**1,684.30**	**1,620.37**
1. Energy	**397.27**	**397.27**	**393.13**	**388.58**	**375.41**	**372.51**	**364.29**	**358.65**	**358.92**	**351.67**	**351.09**	**346.48**	**330.42**	**324.72**
A. Fuel Combustion (Sectoral Approach)	74.27	74.27	77.47	80.73	81.01	83.28	87.68	87.67	89.73	83.13	86.67	83.51	80.03	78.76
1. Energy Industries	15.05	15.05	14.71	14.29	14.06	13.67	16.01	16.05	16.81	11.49	12.64	12.94	13.56	17.93
2. Manufacturing Industries and Construction	6.76	6.76	6.64	6.46	6.66	6.64	7.06	6.52	6.93	6.92	6.70	6.62	6.64	6.60
3. Transport	38.90	38.90	39.12	42.13	43.12	44.28	45.20	46.00	44.96	43.61	43.70	40.00	33.97	30.80
4. Other Sectors	13.39	13.39	17.02	17.66	16.95	18.49	19.18	18.90	20.67	20.95	23.45	24.47	25.78	23.27
5. Other	0.17	0.17	0.19	0.20	0.22	0.21	0.22	0.19	0.35	0.16	0.18	0.13	0.09	0.07
B. Fugitive Emissions from Fuels	322.99	322.99	315.66	307.85	294.41	289.23	276.61	270.99	269.19	268.54	264.42	262.93	250.40	245.97
1. Solid Fuels	5.58	5.58	5.25	4.91	3.86	3.39	3.07	2.88	2.85	2.63	2.52	3.05	3.35	3.12
2. Oil and Natural Gas	317.41	317.41	310.41	302.94	290.56	285.84	273.53	268.11	266.34	265.91	261.90	259.87	247.05	242.84
2. Industrial Processes	**5.76**	**5.76**	**5.56**	**5.42**	**5.45**	**5.69**	**6.04**	**5.53**	**5.83**	**5.86**	**5.72**	**5.78**	**5.47**	**6.09**
A. Mineral Products														
B. Chemical Industry	3.05	3.05	3.04	2.99	2.86	3.11	3.34	3.14	3.21	3.34	3.26	3.17	2.96	3.12
C. Metal Production	2.71	2.71	2.51	2.43	2.59	2.58	2.71	2.39	2.61	2.52	2.46	2.61	2.51	2.97
D. Other Production														
E. Production of Halocarbons and SF_6														
F. Consumption of Halocarbons and SF_6														
G. Other														
3. Solvent and Other Product Use														
4. Agriculture	**839.14**	**839.14**	**859.57**	**834.20**	**821.86**	**836.52**	**845.92**	**846.39**	**838.19**	**828.50**	**811.74**	**812.20**	**815.01**	**787.50**
A. Enteric Fermentation	573.55	573.55	598.42	574.98	561.06	576.71	580.10	573.24	572.72	564.39	551.40	552.72	551.77	525.80
B. Manure Management	191.71	191.71	190.30	184.97	183.36	178.93	183.84	185.73	185.72	187.53	184.63	183.97	188.70	186.73
C. Rice Cultivation	73.26	73.26	70.17	73.58	76.81	80.24	81.36	86.78	79.18	75.73	75.08	74.93	74.01	74.96
D. Agricultural Soils														
E. Prescribed Burning of Savannas														
F. Field Burning of Agricultural Residues	0.62	0.62	0.68	0.68	0.64	0.64	0.62	0.64	0.57	0.84	0.62	0.58	0.53	0.60
G. Other														
5. Land-Use Change and Forestry	**7.75**	**7.75**	**1.55**	**2.40**	**3.23**	**2.64**	**1.61**	**0.87**	**2.38**	**3.43**	**2.19**	**3.36**	**2.64**	**1.18**
A. Changes in Forest and Other Woody Biomass Stocks														
B. Forest and Grassland Conversion														
C. Abandonment of Managed Lands														
D. CO_2 Emissions and Removals from Soil														
E. Other	7.75	7.75	1.55	2.40	3.23	2.64	1.61	0.87	2.38	3.43	2.19	3.36	2.64	1.18
6. Waste	**521.31**	**521.31**	**536.79**	**488.52**	**493.42**	**509.27**	**529.13**	**531.38**	**535.21**	**525.94**	**519.97**	**523.40**	**530.76**	**516.47**
A. Solid Waste Disposal on Land	453.96	453.96	461.84	416.71	421.12	437.42	457.24	462.20	462.83	455.11	446.95	451.72	457.58	443.73
B. Waste-water Handling	59.74	59.74	60.41	60.24	59.71	59.94	59.00	58.83	59.13	59.03	58.80	59.67	60.10	60.01
C. Waste Incineration	7.60	7.60	14.33	11.56	12.57	11.77	12.87	10.36	13.20	11.72	14.35	11.91	12.96	12.57
D. Other	0.01	0.01	0.01	0.01	0.02	0.03	0.02	0.02	0.05	0.08	0.07	0.10	0.12	0.16
7. Other (please specify)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Memo Items:														
International Bunkers														
Aviation	**0.54**	**0.54**	**0.47**	**0.47**	**0.50**	**0.50**	**0.56**	**0.46**	**0.48**	**0.50**	**0.51**	**0.62**	**0.67**	**0.73**
Marine	0.12	0.12	0.12	0.14	0.14	0.13	0.17	0.19	0.19	0.21	0.22	0.25	0.27	0.26
Multilateral Operations	0.42	0.42	0.34	0.33	0.35	0.33	0.39	0.27	0.29	0.29	0.29	0.37	0.42	0.48
CO_2 Emissions from Biomass														

Table A7.3 N_2O emission trends, CRF year 2002

TABLE 10 EMISSIONS TRENDS (N_2O)
(Sheet 3 of 5)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[(1)]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	(Gg)													
Total Emissions	123.34	123.34	127.86	125.79	126.47	124.58	128.16	126.91	130.79	130.84	132.94	133.81	137.30	136.12
1. Energy	27.51	27.51	27.41	26.50	26.42	25.70	27.00	28.10	28.37	29.05	30.99	31.35	32.11	33.51
A. Fuel Combustion (Sectoral Approach)	27.51	27.51	27.41	26.50	26.42	25.70	27.00	28.10	28.37	29.03	30.99	31.35	32.11	33.51
1. Energy Industries	5.39	5.39	5.13	4.88	4.53	4.75	5.33	5.13	5.09	4.87	4.78	5.47	5.55	6.12
2. Manufacturing Industries and Construction	5.25	5.25	5.22	5.25	4.83	4.86	4.97	4.89	4.96	5.20	5.27	5.11	5.30	5.33
3. Transport	5.55	5.55	5.59	5.78	6.01	6.43	7.00	7.57	8.09	9.14	9.92	10.28	10.73	11.79
4. Other Sectors	11.09	11.09	11.24	10.75	10.70	9.51	10.29	10.33	10.02	9.66	10.87	10.35	10.49	10.25
5. Other	0.23	0.23	0.24	0.24	0.28	0.22	0.21	0.18	0.22	0.17	0.14	0.14	0.03	0.02
B. Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Solid Fuels														
2. Oil and Natural Gas														
2. Industrial Processes	18.74	18.74	20.11	18.54	19.28	18.54	21.35	20.67	20.79	21.37	22.17	23.55	24.61	24.00
A. Mineral Products														
B. Chemical Industry	18.74	18.74	20.11	18.54	19.28	18.54	21.35	20.67	20.79	21.37	22.17	23.55	24.61	24.00
C. Metal Production														
D. Other Production														
E. Production of Halocarbons and SF_6														
F. Consumption of Halocarbons and SF_6														
G. Other														
3. Solvent and Other Product Use														
4. Agriculture	73.38	73.38	76.49	76.57	77.12	76.45	75.19	74.37	77.77	75.83	75.91	75.11	76.85	74.70
A. Enteric Fermentation														
B. Manure Management	12.41	12.41	12.87	12.40	12.08	12.37	12.86	12.97	13.13	13.33	13.27	13.02	13.68	13.45
C. Rice Cultivation														
D. Agricultural Soils	60.96	60.96	63.61	64.16	65.03	64.07	62.32	61.38	64.63	62.48	62.62	62.08	63.15	61.25
E. Prescribed Burning of Savannas														
F. Field Burning of Agricultural Residues	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
G. Other														
5. Land-Use Change and Forestry	0.05	0.05	0.01	0.02	0.04	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01
A. Changes in Forest and Other Woody Biomass Stocks														
B. Forest and Grassland Conversion														
C. Abandonment of Managed Lands														
D. CO_2 Emissions and Removals from Soil														
E. Other	0.05	0.05	0.01	0.02	0.04	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01
6. Waste	3.66	3.66	3.84	3.76	3.79	3.78	3.82	3.76	3.84	3.78	3.86	3.78	3.81	3.81
A. Solid Waste Disposal on Land														
B. Waste-water Handling	3.37	3.37	3.35	3.36	3.37	3.38	3.39	3.40	3.41	3.41	3.40	3.41	3.41	3.43
C. Waste Incineration	0.29	0.29	0.49	0.40	0.42	0.40	0.43	0.36	0.44	0.37	0.46	0.37	0.40	0.38
D. Other														
7. Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Memo Items:														
International Bunkers	0.17	0.17	0.15	0.15	0.16	0.16	0.18	0.16	0.17	0.17	0.18	0.21	0.24	0.24
Aviation	0.06	0.06	0.06	0.05	0.07	0.07	0.08	0.09	0.09	0.10	0.10	0.11	0.13	0.12
Marine	0.11	0.11	0.09	0.10	0.09	0.09	0.10	0.07	0.08	0.08	0.08	0.10	0.11	0.12
Multilateral Operations														
CO_2 Emissions from Biomass														

Table A7.4 HFC, PFC and SF_6 emission trends, CRF year 2002

TABLE 10 EMISSION TRENDS (HFCs, PFCs and SF_6)
(Sheet 4 of 5)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year [1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	(Gg)													
Emissions of HFCs [5] - CO_2 equivalent (Gg)	671.29	351.00	355.43	358.78	355.42	481.90	671.29	604.78	1,218.23	2,351.39	3,049.22	4,098.02	5,559.56	7,105.72
HFC-23	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.08	0.14	0.23
HFC-41														
HFC-43-10mee														
HFC-125	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.04	0.05	0.07	0.14	0.24	0.37
HFC-134	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-134a	0.20	0.00	0.00	0.00	0.00	0.10	0.20	0.29	0.43	0.68	0.83	1.00	1.20	1.39
HFC-152a														
HFC-143														
HFC-143a	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.03	0.06	0.10	0.15
HFC-227ea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.16	0.41	0.56	0.73	0.97	1.22
HFC-236fa														
HFC-245ca														
Emissions of PFCs [5] - CO_2 equivalent (Gg)	336.71	1,007.65	1,422.87	790.94	630.25	354.77	336.71	263.39	252.08	270.43	258.00	345.25	452.37	413.58
CF_4	0.04	0.21	0.17	0.10	0.08	0.04	0.04	0.03	0.03	0.03	0.03	0.04	0.05	0.04
C_2F_6	0.01	0.05	0.04	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
C_3F_8														
C_4F_{10}														
$c\text{-}C_4F_8$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C_5F_{12}														
C_6F_{14}														
Emissions of SF_6 [5] - CO_2 equivalent (Gg)	601.45	332.92	356.39	350.26	370.40	415.66	601.45	682.56	720.64	606.81	604.51	493.43	795.34	760.22
SF_6	0.03	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.02	0.02	0.03	0.03

[1] Enter information on the actual emissions. Where estimates are only available for the potential emissions, specify this in a comment to the corresponding cell. Only in this row the emissions are expressed as CO_2 equivalent emissions in order to facilitate

Table A7.5 Total emission trends, CRF year 2002

TABLE 10 EMISSION TRENDS (SUMMARY)

(Sheet 5 of 5)

Italy

2002

2004

GREENHOUSE GAS EMISSIONS	Base year(1)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	CO2 equivalent (Gg)													
Net CO2 emissions/removals	407,623.97	407,623.97	408,096.25	407,954.27	403,326.49	397,130.66	425,904.57	419,421.30	426,416.02	438,370.76	442,343.44	445,130.92	451,214.20	448,575.42
CO2 emissions (without LUCF) (6)	431,156.45	431,156.45	431,272.36	429,731.60	424,013.41	416,376.60	446,302.22	439,644.12	444,179.96	455,706.93	460,075.37	462,075.38	469,515.90	468,960.83
CH4	37,193.85	37,193.85	37,736.92	36,101.67	35,771.44	36,237.17	36,606.90	36,484.46	36,555.15	36,028.33	35,504.86	35,515.60	35,370.36	34,343.53
N2O	38,234.38	38,234.38	39,636.61	38,994.02	39,308.71	38,618.50	39,730.38	39,340.60	40,546.12	40,313.39	41,212.26	41,481.12	42,590.33	42,197.44
HFCs	671.29	351.00	335.42	338.78	355.42	481.90	671.29	604.70	1,218.23	2,331.39	3,049.22	4,098.02	5,519.36	7,105.72
PFCs	336.71	1,807.65	1,422.87	798.94	630.83	334.72	336.71	343.39	252.08	270.43	238.00	345.83	452.37	413.58
SF6	601.45	332.92	336.39	338.26	370.40	415.60	601.45	682.56	728.64	604.31	404.31	495.43	795.34	700.22
Total (with net CO2 emissions/removals)	484,663.66	485,545.77	487,604.47	484,546.54	479,723.38	473,258.66	505,011.12	496,777.58	505,716.23	517,933.80	522,792.28	527,064.93	535,982.34	533,295.20
Total (without CO2 from LUCF) (6) (8)	508,196.13	509,078.25	510,788.58	506,363.87	500,415.22	492,704.69	524,608.97	516,999.91	523,480.16	535,359.95	540,504.28	544,009.59	554,263.55	553,781.64

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year(1)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	CO2 equivalent (Gg)													
1. Energy	419,592.97	419,592.97	419,942.20	417,673.05	414,584.49	407,066.12	436,544.92	431,748.79	436,013.58	440,161.38	452,097.63	453,161.27	460,050.97	460,242.39
2. Industrial Processes	33,695.73	34,577.84	34,306.13	33,739.38	30,779.11	29,522.48	32,600.77	30,223.65	31,307.88	32,609.11	33,878.79	36,660.04	39,344.40	40,267.05
3. Solvent and Other Product Use	1,733.40	1,733.40	1,724.13	1,629.62	1,563.27	1,507.29	1,472.38	1,428.58	1,410.81	1,359.74	1,331.09	1,329.43	1,263.24	1,240.94
4. Agriculture	40,369.05	40,369.05	41,763.62	41,254.92	41,216.30	41,267.79	41,071.76	40,703.46	41,711.11	40,904.73	40,577.39	40,338.93	40,937.42	39,694.35
5. Land-Use Change and Forestry (7)	-23,533.21	-23,533.21	-23,140.32	-21,761.78	-20,378.53	-19,534.98	-19,500.61	-20,203.18	-17,704.26	-17,346.73	-17,661.22	-16,866.89	-18,240.04	-20,358.12
6. Waste	12,625.62	12,625.62	13,008.70	12,011.15	12,151.73	12,480.13	12,881.90	12,876.28	12,969.09	12,545.35	12,558.58	12,442.15	12,626.24	12,308.39
7. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

(6) The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report CO2 emissions and removals from Land-Use Change and Forestry.

(7) Net emissions.

(8) The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table Summary2 if Parties report non-CO2 emissions from LUCF.