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Agenzia per la protezione
dell'ambiente e per i servizi tecnici

Italian Greenhouse Gas Inventory 1990 - 2001

National Inventory Report 2003

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Dipartimento Stato dell'Ambiente e Metrologia Ambientale

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

PREMESSA

Il rapporto "Italian Greenhouse Gas Inventory 1990-2001. National Inventory Report" (NIR 2003) costituisce in assoluto il primo 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).
Il rapporto, documento eminentemente di tipo tecnico, 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 la qualità dell'aria
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 mette in evidenza che le emissioni totali dei gas serra considerati nel Protocollo di Kyoto (espressi in termini di CO_2 equivalente) dal 1990 al 2001 sono aumentate di circa il 7% 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 rispetto degli obiettivi del Protocollo .

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Direttore Dipartimento Stato dell'Ambiente
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Contents

EXECUTIVE SUMMARY

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

The United Nations Framework Convention on Climate Change (FCCC) was ratified by Italy in the year 1994 with the law n.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 undertake measures for reducing emissions and increase energy saving.
With the adoption of Kyoto protocol, in December 1997, the objectives for the European Union, as a whole, were a stabilisation of CO_2 emissions for the year 2000 to 1990 levels and a 8% reduction within the year 2010 differently distributed among Member States. In particular for Italy, a reduction of 6.5% by 2010 in comparison with 1990 levels was established.
Subsequently, on 1st June 2002, Italy ratified the Kyoto Protocol with the law n.120 of 01/06/2002. The ratification law prescribed also the preparation of a National Action Plan to reduce greenhouse gas emissions, 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), in agreement with 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, 1999).
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 first 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 2001, including the entire time series 1990-2001. It should be noted that emission data for the year 2001 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.apat.it.

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

Total greenhouse gas emissions, in CO_2 equivalent, excluding emissions and absorption of CO_2 from land use change, increased by 7.1% between 1990 and 2001 (from 509 to 545 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 84.5% of total emissions in CO_2 equivalent in 2001, showed an increase by 7.6% between 1990 and 2001. In the energy sector, in particular, emissions in 2001 were 8.6% greater than in 1990.
CH_4 and N_2O emissions were equal, respectively, to 6.7% and 8.1% of the total CO_2 equivalent greenhouse gas emissions in 2001. CH_4 emissions fell by 5.8% from 1990 to 2001, while N_2O increased by 8.5%.
Other greenhouse gases, HFCs, PFCs and SF_6, ranged from 0.2% to 0.7% 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 gas for 1990-2001, 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
	CO2 equivalent (Gg)												
Net CO2 emissions/removals	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
CO2 emissions (without LUCF)	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
CH4	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
N2O	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
HFCs	671	351	355	359	355	482	671	449	751	1.170	1.437	1.986	2.730
PFCs	272	237	231	206	204	212	272	177	184	201	190	232	302
SF6	601	333	356	358	370	416	601	683	729	605	405	493	795
Total (with net CO2 emissions/removals)	**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**
Total (without CO2 from LUCF)	**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**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	CO2 equivalent (Gg)												
1. Energy	420.022	420.022	419.983	418.860	412.290	407.255	432.151	429.152	434.410	445.784	451.661	455.114	454.316
2. Industrial Processes	31.734	31.110	31.299	31.349	28.401	27.426	30.398	28.152	28.770	29.404	30.930	32.232	34.090
3. Solvent and Other Product Use	1.733	1.733	1.724	1.630	1.562	1.507	1.472	1.429	1.419	1.360	1.351	1.331	1.265
4. Agriculture	42.775	42.775	43.822	43.232	43.264	43.100	42.978	42.585	43.575	42.758	42.481	42.005	42.535
5. Land-Use Change and Forestry	-23.532	-23.532	-23.176	-21.817	-20.692	-19.446	-19.598	-20.222	-17.764	-17.426	-17.712	-15.633	-18.655
6. Waste	12.987	12.987	13.379	12.370	12.521	12.881	13.385	13.353	13.424	13.303	12.884	13.069	13.153
7. Other	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.3 provides an overview of the CO_2 equivalent emission trends per IPCC source category.
The energy sector is the largest contributor to national total GHG emissions with a share, in 2001, of 83% out of the total GHG emissions. Emissions from the energy sector increased by about 8% from 1990 to 2001. Substances with the highest percentages of increase are CO_2, whose levels increased by 8.6% from 1990 to 2001 and account for 96% of the total, and N_2O which shows an increase of 11% but its weight out of the total is only 2%; CH_4, on the other hand, shows a decrease of 17.6% from 1990 to 2001 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 12%, respectively, from 1990 to 2001; these sectors, altogether, account for more than 60% of total emissions.
As regards the industrial processes sector, emissions, in CO_2 equivalent, show a total increase of 7.4% from the base year to 2001. Specifically by substance, CO_2 levels fell down by 7% while N_2O raised up to 22%; these two substances account altogether for 88% of total emissions from industrial processes. A considerable increase is observed in F-gases emissions (about 150%) but the level of these gases on total emissions is not relevant (11%) even though increasing.
In contrast, emissions of the solvent and other use sector, which refer totally to CO_2 emissions, except for gases other than greenhouse, decreased by 27% from 1990 to 2001 due substantially to a decrease (19%) both in the paint application sector, which accounts for 54%, and in 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. Emissions from metal decreasing and dry cleaning activities, also fell down (55%) but account for only 6% of the total.
For the agriculture sector, total emissions were substantially stable from 1990 to 2001; emissions refer to CH_4 and N_2O levels, which account for 43% and 57% of the total, respectively. The small decrease observed in the total emissions (-1%) is mostly due to the decrease of emissions from enteric fermentation (-6%) which account for most of the total emissions.
Finally, emissions from the waste sector increased by 1.3% from 1990 to 2001. The increase is mostly due to the increase in the emissions from waste incineration (10%), which account for 10% of the total, as well as those from waste-water handling (1%), which account for 18%. The most important greenhouse gas in this sector is CH_4 which accounts for 85% of the total and shows an increase of 1% from 1990 to 2001. N_2O levels have increased by 6% while CO_2 decreased by 3%; these gases account for 9% and 7%, respectively.

Table ES.3. Summary of emission trend per source category and gas in CO_2 equivalent (Gg)

Source category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1A. Energy: fuel combustion	**412241**	**412601**	**411596**	**405183**	**400123**	**425272**	**422349**	**427637**	**438933**	**444880**	**448274**	**447870**
CO_2: 1. Energy Industries	138957	134858	134714	125801	129005	142785	139231	142246	150342	149379	157835	155279
CO_2: 2. Manufacturing Industries and Construction	84033	80635	80125	80297	81033	83204	80967	83865	80065	81082	80103	77095
CO_2: 3. Transport	102023	104560	108895	110612	110511	112240	113348	115150	118977	120016	120571	125191
CO_2: 4. Other Sectors	75664	80797	76218	76749	67959	74764	76697	73802	77447	81554	77240	78120
CO_2: 5. Other	1041	1192	1276	1443	1455	1435	1178	1532	1036	1107	806	354
CH_4	1556	1627	1690	1693	1743	1831	1832	1877	1738	1816	1745	1723
N_2O	8967	8932	8678	8587	8418	9013	9096	9164	9328	9927	9974	10108
1B2. Energy: fugitives from oil & gas	**7781**	**7382**	**7264**	**7107**	**7131**	**6879**	**6803**	**6773**	**6850**	**6780**	**6840**	**6445**
CO_2	999	754	800	926	1058	1053	1054	1108	1204	1202	1291	1296
CH_4	6782	6629	6464	6182	6074	5826	5749	5665	5647	5578	5548	5149
2. Industrial processes	**31110**	**31299**	**31349**	**28401**	**27426**	**30398**	**28152**	**28770**	**29404**	**30250**	**32232**	**34090**
CO_2	22816	22555	23207	20162	19406	20926	19194	19398	19581	20135	20865	21275
CH_4	121	117	114	114	120	127	116	122	123	120	121	115
N_2O	7252	7684	7105	7195	6791	7801	7534	7585	7724	7964	8535	8874
HFCs	351	355	359	355	482	671	449	751	1170	1437	1986	2730
PFCs	237	231	206	204	212	272	177	184	201	190	232	302
SF_6	333	356	358	370	416	601	683	729	605	405	493	795
3. Solvent and other product use	**1733**	**1724**	**1630**	**1562**	**1507**	**1472**	**1429**	**1419**	**1360**	**1351**	**1331**	**1265**
CO_2	1733	1724	1630	1562	1507	1472	1429	1419	1360	1351	1331	1265
4. Agriculture	**42775**	**43822**	**43232**	**43264**	**43100**	**42978**	**42585**	**43575**	**42758**	**42481**	**42005**	**42535**
CH_4: Enteric fermentation	13625	13875	13278	13020	13201	13357	13195	13168	13001	12767	12673	12781
CH_4: Manure management	4013	3983	3871	3837	3743	3846	3886	3886	3923	3862	3849	3946
CH_4: Rice Cultivation	1539	1474	1545	1655	1685	1709	1696	1663	1590	1577	1574	1554
CH_4: Field Burning of Agricultural Residues	13	14	14	13	13	13	13	12	14	13	12	11
N_2O: Manure management	3846	3990	3843	3746	3835	3986	4021	4070	4134	4114	3976	4213
N_2O: Agriculture soils	19736	20482	20676	20988	20618	20064	19768	20773	20092	20145	19918	20026
N_2O: Field Burning of Agricultural Residues	4	4	4	4	4	4	4	4	4	4	4	4
5A. Land-use change and forestry	**-23532**	**-23176**	**-21817**	**-20692**	**-19446**	**-19598**	**-20222**	**-17764**	**-17426**	**-17712**	**-15633**	**-18655**
CO_2	-23532	-23176	-21817	-20692	-19446	-19598	-20222	-17764	-17426	-17712	-15633	-18655
6. Waste	**12987**	**13379**	**12370**	**12521**	**12881**	**13385**	**13353**	**13424**	**13303**	**12884**	**13069**	**13153**
CO_2	912	903	921	989	1031	1105	1017	1002	1084	761	923	888
CH_4	11010	11350	10346	10417	10732	11148	11224	11284	11092	10984	11024	11142
N_2O	1065	1127	1104	1116	1118	1131	1112	1139	1127	1138	1122	1124
TOTAL EMISSIONS	***508629***	***510208***	***507441***	***498038***	***492169***	***520385***	***514671***	***521598***	***532608***	***538627***	***543751***	***545358***

ES.4. Other information

In Table ES.4 the emission trends of NO_X, CO, NMVOC and SO_2 from 1990 to 2001 are summarised.

Table ES.4. Total emissions for indirect greenhouse gases and SO_2 (1990-2001)

Indirect greenhouse gases and SO_2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Emissions in ktons												
NO_X	1.919	1.973	1.991	1.896	1.813	1.785	1.727	1.650	1.539	1.441	1.360	1.317
CO	7.146	7.492	7.653	7.552	7.362	7.140	6.844	6.696	6.173	5.914	5.221	4.965
NMVOC	2.041	2.109	2.157	2.109	2.055	2.034	1.988	1.920	1.815	1.722	1.557	1.467
SO_2	1.748	1.635	1.533	1.414	1.332	1.263	1.203	1.063	1.002	893	752	709

All gases show a significant reduction in 2001 compared to 1990 levels. The highest reduction is observed for SO_2 (-59%), while CO and NO_X reduced by more than 30% and NMVOC emissions show a decrease by about 28%.

Sommario (*Italian*)

Nel documento "Italian Greenhouse Gas Inventory 1990-2001. National Inventory Report" 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 2001, in sintesi, si evidenzia che le emissioni nazionali totali dei sei gas serra, espresse in CO_2 equivalente, risultano nel 2001 superiori del 7% rispetto all'anno base (corrispondente al 1990 per CO_2, CH_4 e N_2O ed al 1995 per HFCs, PFCs ed 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 2001 superiori del 7.6% rispetto al 1990, mentre le emissioni relative al solo settore energetico sono aumentate dell'8.6%. Le emissioni di metano e di protossido di azoto sono pari rispettivamente a circa il 7% e l'8% del totale e presentano andamenti in diminuzione per il metano (-6%) e in crescita (+8.5%) per il protossido di azoto. Gli altri gas serra, HFCs, PFCs e SF_6, hanno un peso complessivo intorno al-

lo 0.7% sul totale delle emissioni. Le emissioni di questi gas sono in forte crescita per quanto riguarda gli HFCs (+93%) 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, put into evidence the risk of a global warming with terrible effects on climate balance due to the increase of greenhouse gas (GHG) anthropogenic emissions caused by industrial development and use of fossil fuel. Thus the need of reducing those emissions particularly for the most industrialised countries.
The first action was that of the European Union (EU) at the end of 1990 which 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 assume initiatives for the environment protection and the energy efficiency. The contents of EU statement were the base for the negotiation of the United Nations Framework Convention on Climate Change (UNFCCC) which was approved in New York on 9th May 1992 and signed during the summit of the Earth in Ro the Janeiro in June 1992.
Specifically, Italy ratifies the convention with the law n. 65 of 15/1/1994. Parties to the Convention are committed to develop, publish and regularly update national emission inventories of greenhouse gas as well as undertake measures for reducing emissions and increase energy saving.
With the adoption of Kyoto protocol, in December 1997, the objectives for the European Union, as a whole, were a stabilisation of CO_2 emissions for the year 2000 to 1990 levels and a 8% reduction within the year 2010 differently distributed among Member States. In particular for Italy, a reduction of 6.5% by 2010 in comparison with 1990 levels was established.
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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), in agreement with 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, 1999).
Detailed information on emission figures as well as the 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 first 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 2001, as well as a description of the time series 1990-2001. However, it should be noted that emission data for the year 2001 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.apat.it.

1.2 A 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 National Environmental Protection Agency (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, APAT is required to prepare the national atmospheric emission inventory in order to assure the 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 also compiled and updated annually by the Agency and it is officially communicated to the Secretariat of the Framework Convention on Climatic Changes and to the European Commission in the framework of the greenhouse gas monitoring mechanism 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 for statistics updating. The main problem regards, above all, delays in temporal maintenance especially in some strategic sectors.
Concerning GHG inventory, specifically, basic data needed to draw up the inventory are energy statistics published by the Ministry of Production Activities in the National Energy Balance, 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.
As already pointed out, the attribution of roles and responsibilities to the different organisations as regards the GHG inventory would improve the quality and details of basic data, as well as enable a more organized and timely communication.

1.3 Brief description of the process of inventory preparation

Until now, data collection and timing availability are the main difficulties faced by Italy that 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 2001 which was still provisional in march 2003), and regards data of the previous year and some industrial production statistics as well as agriculture and forestry statistics are published 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.
Emission factors and methodologies used in the estimation process are consistent with the IPCC Good Practice Guidance and supported, as far as possible, 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 are not collected through the National Pollutant Emission Register (EPER). In fact, according to the Italian

Degree of 23 November 2001, the first official communication by industries regarding the year 2002 took place on 30 June 2003. Data will be validated by APAT and communicated to the Ministry of the Environment and to the European Community within October 2003. Once available, these data will be taken into account as a verification for emission inventory estimates but not directly for the compilation; in fact industries communicate emission values only if overcoming specific thresholds and furthermore they do not communicate basic data such as fuel consumption. Anyway, estimates are checked also taking into account figures reported by industries in their annual environmental reports. Emissions of large industrial point sources are registered individually, when communicated, based upon detailed information of each individual plant. Other small plants communicate their emissions which are also considered individually.
Emission estimates are finally 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 National Environmental Protection 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.

Methodologies are as far as possible consistent with the Revised 1996 IPCC Guidelines, IPCC Good Practice Guidance and CORINAIR Emission Inventory Guidebook (IPCC, 1997; IPCC, 2000; CORINAIR 1999); national emission factors are integrated by 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 analysis 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 1.1 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 Italian Public Power Corporation
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	National Environmental Protection Agency National Waste Observatory

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, T3	D, C	D, T3	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	CS		
D. Other Production	D, C	D, C, CS										
E. Production of Halocarbons and SF							CS	CS	CS	CS	CS	CS
F. Consumption of Halocarbons and SF_6							D, T2	CS	D, T1	CS	D, T3c	CS
G. Other												
3. Solvent and Other Product Use	**D**	**D**										
4. Agriculture												
A. Enteric Fermentation			D, T1, 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 cells 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 in the following. 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. Added information for electricity production is provided by the Italian Public Power Corporation 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 National Environmental Protection Agency and Waste Observatory.
In case basic data are not available proxy variables are considered in the estimation process; not published data are used only if supported by personal communication and confidentiality of data is respected.
Even though there is not a proper register of these data, all the materials and documents used for the inventory emission estimates are kept at the National Environmental Protection Agency.

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 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, 28 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	
CO_2 stationary combustion gaseous fuels	L, T
CO_2 stationary combustion liquid fuels	L, T
CO_2 Mobile combustion: Road Vehicles	L, T
CO_2 stationary combustion solid fuels	L, T
CO_2 Cement production	L, T2
CH_4 Enteric Fermentation in Domestic Livestock	L, T
CH_4 from Solid waste Disposal Sites	L, T2
Direct N_2O Agricultural Soils	L, T
N_2O Adipic Acid	L, T
Indirect N_2O from Nitrogen used in agriculture	L, T2
N_2O stationary combustion	L, T
CO_2 Mobile combustion: Waterborne Navigation	L1, T
CH_4 Fugitive emissions from Oil and Gas Operations	L, T
N_2O Manure Management	L, T2
CH_4 Manure Management	L, T2
N_2O Mobile combustion: Road Vehicles	L, T
CO_2 Mobile combustion: Aircraft	L1, T1
HFC, PFC substitutes for ODS	L2, T
CO_2 Other industrial processes	T1
N_2O Nitric Acid	T1
CO_2 Mobile combustion: Other	T2
N_2O from animal production	L2, T2
N_2O from Other agricultural soils (wetlands, waters)	L2, T2
CH_4 Emissions from Wastewater Handling	L2, T2
CH_4 from Rice production	L2
CO_2 Emissions from Other Sources (solvent use)	L2, T2
CH_4 stationary combustion	L2
N_2O Emissions from Wastewater Handling	L2, T2

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

A proper QA/QC plan has not been applied even though verification and controls are made by means of different procedures.
The Italian Atmospheric Emissions Inventory and the Italian Greenhouse Gas Inventory are compiled and maintained by the National Environmental Protection Agency 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 ameliorate

the transparency, consistency, comparability, accuracy and completeness of the inventory are undertaken as far as resources constraints.
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.
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.
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, years emissions are recalculated as a matter of course.
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 cooperating for activity data and emission factors accuracy. Development of other expert panels in the agriculture and waste sectors are planned to start in 2004.
Quality control activities, except for usual control activities related to the compilation of the inventory, derive also from drawbacks due to 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 (e.g EUROSTAT NAMEA Project) is another tool of control. International reviews and pilot project activities also contribute to improve the inventory and individuate errors.
Specific activities relating to QA/QC which were carried out in the last years were:

- *Halocarbons and Sulphur Hexafluoride Review.* A review with industrial associations and the electrical company ENEL was undertaken in order to improve the quality of estimates by implementing the use of the Tier2 methodology. As regards sulphur hexafluoride, emission estimates improved thanks to the cooperation with the national electrical company ENEL and the main electrical associations. The inventory of halocarbons was extended to HFC32 gas and emissions from foam blowing were added on account of new information.
- *Policies and measures evaluation.* A study was carried out by Ecofys to verify the effectiveness of policies and measures (Ecofys, 2001) undertaken by Italy to reduce greenhouse gas emissions to the levels established by the Kyoto

protocol. In this framework a review and checks on emission levels were carried out as well as controls on the transparency and consistency of methodological approaches.

- *Energy Balance Verification.* A task force made up of energy and inventory experts (Ministry of Industry, ENEA and APAT) was instituted in order to examine differences in basic data between the CRF and the joint EUROSTAT/IEA/UNECE questionnaire submissions and improve the details of the National Energy Balance.
  Another expert group within EUROSTAT NAMEA project formed by ISTAT, APAT and Ministry of Industry gave the first results on emission disaggregation per sector.
  Both the activities are still in progress and will continue in 2004.
- *Carbon Emission Factors Review.* A sampling and measurement campaign was carried out jointly with the Stazione Sperimentale Combustibili in order to check the CO_2 emission factors used for emission estimation in the energy sector and, specifically, the road transport sector. Representative samples of Italian fuels, specifically gasoline, diesel oil and LPG, were collected and analysed within the period September 2000 - August 2001. Measurements were compared with default CO_2 emission factors proposed by the IPCC in the 1996 Revised Guidelines and those proposed by the EEA and used in COPERT III methodology. Values of national emission factors resulted higher than the default ones for gasoline and LPG, while those of diesel were lower. Emission factors have been substituted for the years 2000 and 2001. The study and the results are described in detail in the APAT report (Contaldi, Ilacqua, 2003).
- *Road Transport Emissions Review.* An ad hoc expert panel (Expert Panel Transport) worked on the improvement and assessment of emission estimations from road transport; different subjects had been dealt with from availability and disaggregation of basic data to methodological issue. The group formed by different participants (Research Institutes, Universities, Industrial Associations, Local Authorities, Ministries and Public Authorities) achieved successful results as regards data to be imputed in COPERT methodology thus ameliorating the final estimates. 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.
- *International bunkers: Aviation and Marine Fuel consumption.* A specific study was conducted by a consultant agency, TECHNE, in order to disaggregate data on aviation and marine fuel consumption, published in the Energy Balance, into domestic and international. As far as the aviation sector is concerned information on national and international flights was collected and consumption of fuel used was carried out by an ad hoc model. Average

national emission factors are thereby derived. For the marine sector, in a similar way, fuel consumption in national harbour and cruise was calculated on the basis of origin-destination statistical data and different types of ships (TECHNE, 2001).

- *MeditAiraneo Project.* A three years project involving Inventory Reference Centres of the European Mediterranean Countries (Italy, Spain, France, Greece, Portugal) started in 2000. Emissions that are specific and/or typical of the Mediterranean Countries are examined in details. Four different studies on air emissions from vegetation, agriculture, solvent use and urban road transport in Mediterranean areas are 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 the other European countries), such as climate, technologies, industrial management, identification of methodological points which need in depth examination and uncertainty evaluation. An Italian case study is also planned for each of the four projects. The results are expected to improve national emission factors.

Further improvements will concern key source categories. Specifically in 2004, in addition to what previously described, industrial sectoral data from the Italian EPER will be analysed, N_2O emission measurements from catalytic converters in road transport will be commissioned and more studies on F-gases basic data and emission will be developed.

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

The IPCC Good Practice Guidance (IPCC, 2000) defines 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. The results of the Tier 1 approach are shown in detail 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 emission in 2001. The analysis also estimates an uncertainty of 2.3% in trend between 1990 and 2001.

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. Minor omissions are related to potential emissions of HFCs, PFCs and SF_6 but the quality and methodology of the estimation is improving. Table 1.4 summarizes the sectoral coverage of the GHG emissions.

Table 1.4 Completeness of the Italian GHG inventory

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

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

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

Note: To fill in the table use the notation key as given in the IPCC Guidelines (Volume 1. Reporting Instructions, Tables. 37).

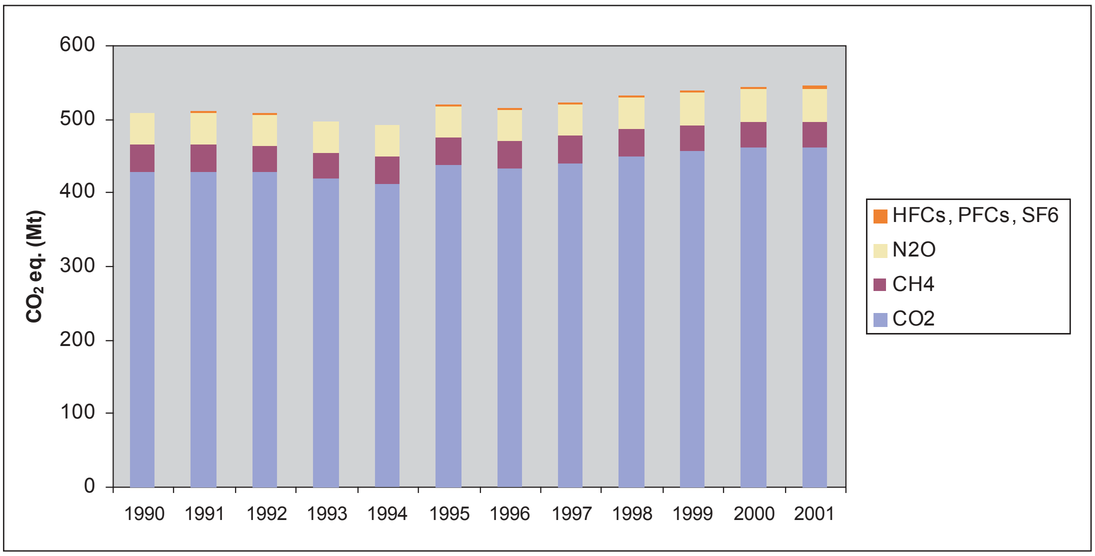
As regards CRF sheets, sectoral tables are complete as far as the details of basic information are available. For instance, as concerns emissions from the military sector, sources are not distinguished between stationary and mobile but only mobile emissions are reported separately; stationary emissions are, on the other hand, included in commercial/institutional sector (1.A.4.a).
There are only two cases in which emissions are not estimated: CH_4 emissions from waste incineration, not estimated because of a lack of emission factors availability; N_2O emissions from other solvent use, both activity data and emission factors not being available at the moment.
Furthermore, sectoral background data for energy as regards fuel consumption disaggregated by type in Manufacturing Industries and Construction, although provided in the CRF, are still subject to modification because such a detail is not included in the Energy Balance and added information needed to overcome this lack is only partial. CH_4 and N_2O emissions from biomass in road transport, referring to biodiesel, are included in diesel oil emissions. Activity data and emissions from marine bunkers by diesel oil are included in residual oil. Multilateral operations emissions are not estimated because no activity data are available.
Sectoral background data for industrial processes do not include limestone and dolomite use activity data and emissions, but emissions are included in cement and lime production (limestone) and ceramic production (dolomite). Emissions from soda ash use are included in glass and paper production emissions.
Confidential data regard the production of HCFC-22 which have not been communicated by the producer.

2. TRENDS IN GREENHOUSE GAS EMISSIONS

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

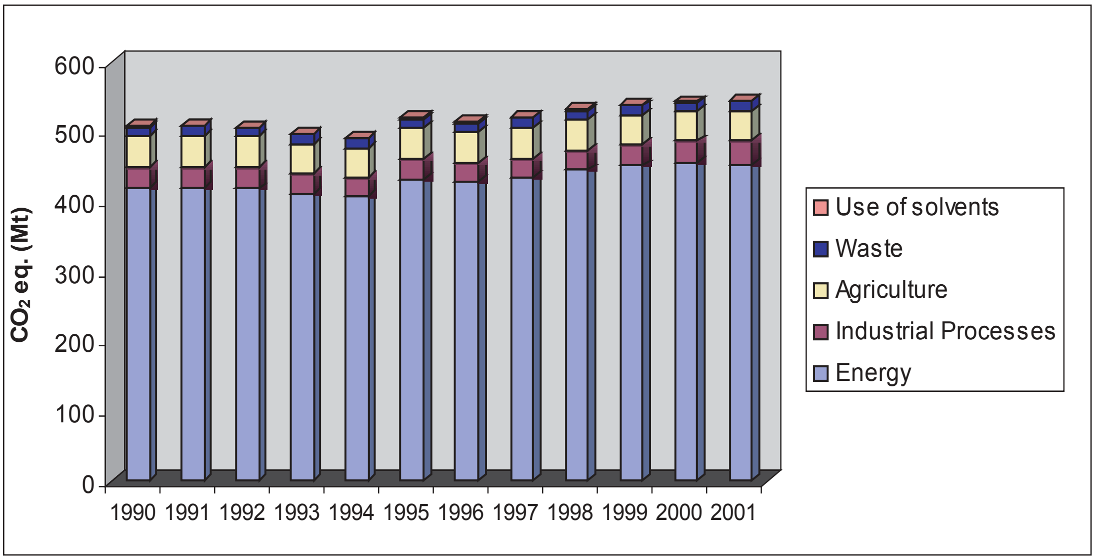
Summary data of the Italian greenhouse gas emissions for the years 1990-2001 are reported in Annex 7 Table A7.1.
The emission figures presented are those sent to the UNFCCC Secretariat and to the European Commission in the framework of the Greenhouse Gas Monitoring Mechanism. In agreement with the Convention on Climatic 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 absorption of CO_2 from land use change, have increased by 7.1% between 1990 and 2001, varying from 509 to 545 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 84.5% of total emissions in CO_2 equivalent, shows an increase by 7.6% between 1990 and 2001. In the energy sector, in particular, emissions in 2001 are 8.6% greater than in 1990. CH_4 and N_2O emissions are equal, respectively, to 6.7% and 8.1% of the total CO_2 equivalent greenhouse gas emissions. CH_4 emissions have fallen by 5.8% from 1990 to 2001, while N_2O has increased by 8.5 %.
Other greenhouse gases, HFCs, PFCs and SF_6, range from 0.2% to 0.7% of total emissions; at present, variations in these gases are not relevant to reaching the objectives for emissions reduction.
Figure 2.1 illustrates the national trend of greenhouse gases for 1990-2001, expressed in CO_2 equivalent terms and by substance; CO_2 emissions do not include emissions and absorptions from land use change.

Figure 2.1 National greenhouse gases emissions from 1990 to 2001



As concerns the percentage distribution of the different sectors in terms of total emissions, it remains nearly unvaried over the period 1990-2001. 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, 8% of total emissions, industrial processes (6%), waste and use of solvents. Figure 2.2 shows the total greenhouse gases emissions subdivided by sector.

Figure 2.2 Greenhouse gas emissions from 1990 to 2001 by sector



2.2 Description and interpretation of emission trends by gas

2.2.1 Carbon dioxide emissions

CO_2 emissions, excluding emissions and absorption from land use change and forestry, have increased by approximately 7.6% from 1990 to 2001, ranging from 428.2 to 460.8 million tons.

The most relevant emissions derive from the energy industries (34%) and transportation (27%). The manufacturing and construction industries and non-industrial combustion each accounts 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 CO_2 increase are transport and energy industries; in particular, emissions from transport have increased by 23% from 1990 to 2001 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 2.3 National emissions of CO_2 by sector from 1990 to 2001

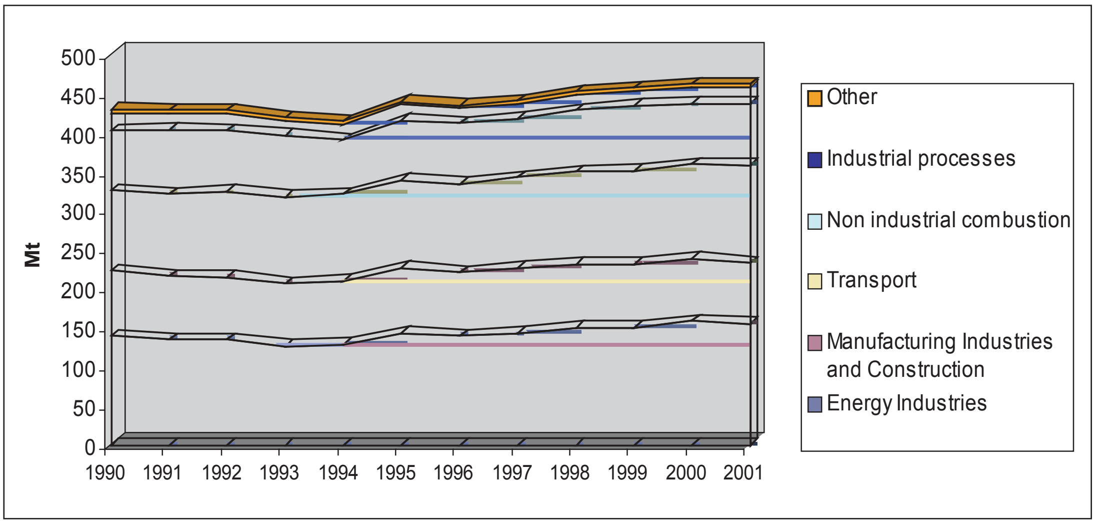


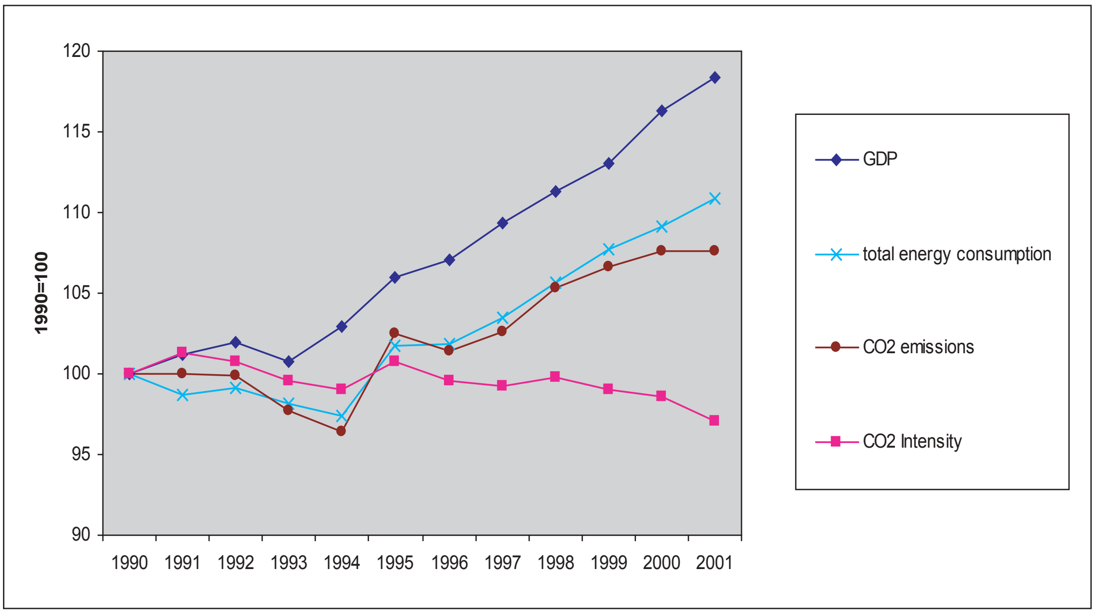
Figure 2.4 illustrates the performance of the following economic and energy indicators:

- Gross National Product (GNP) at market prices as of 1990;
- Total Energy Consumption;

- CO_2 emissions, excluding emissions and absorption from changes in the use of soil 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, primarily as a result of the substitution, in the production of electric energy and in industry, of fuels with high carbon contents by methane gas.

Figure 2.4 Energy-related and economic indicators and CO_2 emissions

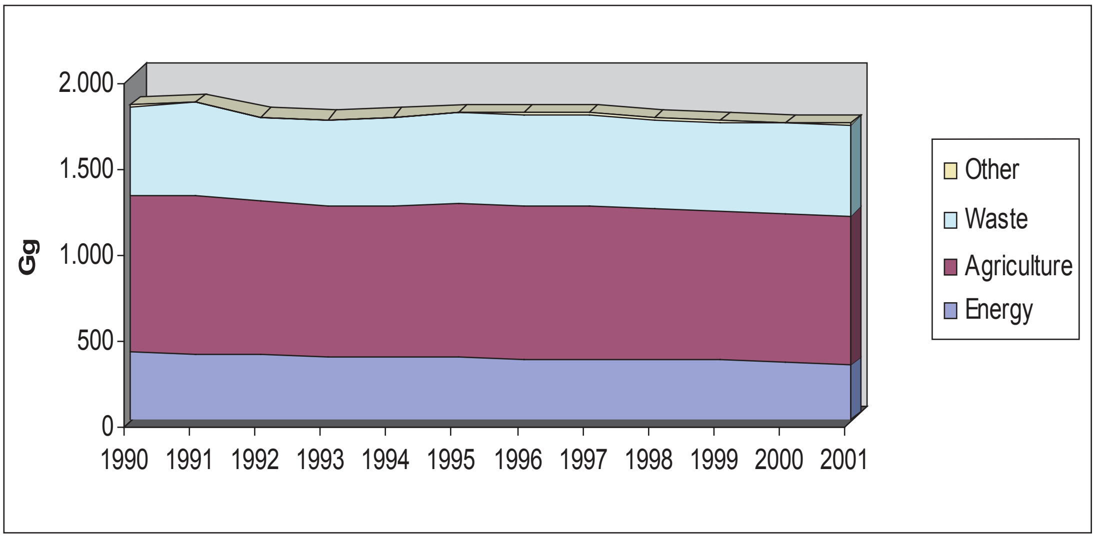


2.2.2 Methane emissions

Methane emissions in 2001 represent 6.7% of total greenhouse gases, equal to 36.4 Mt in CO_2 equivalent, and show a decrease of approximately 2 Mt compared to 1990.
CH_4 emissions are mainly attributed to the agricultural sector, which accounts for 50% of total emissions, as well as to the management of waste (30.6%) and to energy (18.9%).
Emissions in the agricultural sector regard the raising of animals. These emissions remained approximately constant over the period considered, being related to the number of animals, especially cattle and swine.

Activities typically leading to emissions in the waste-management sector are the operation of dumping sites and the treatment of liquid industrial waste. The waste sector shows a growth in emission levels (+1.2% compared to 1990) due to an increase in emissions from the treatment of liquid industrial waste.
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 methane 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 2001

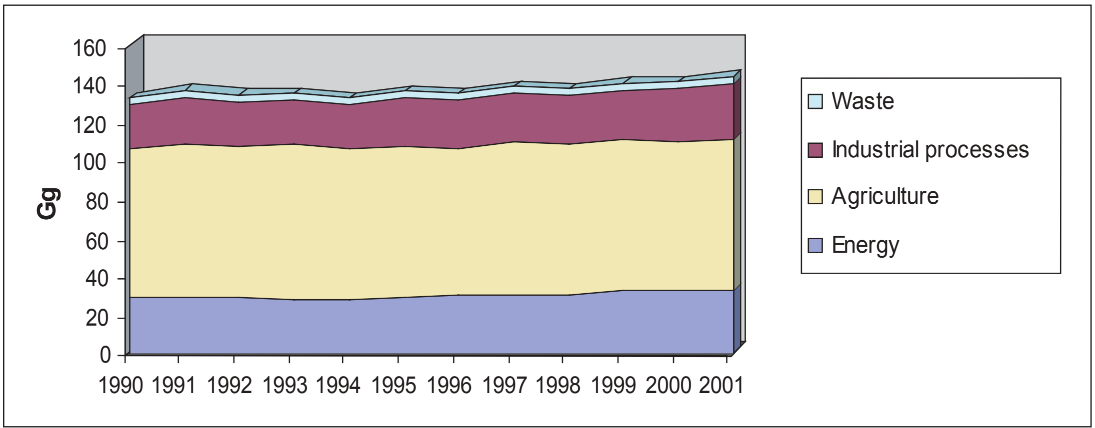


2.2.3 Nitrous oxide emissions

In 2001 nitrous oxide emissions represent 8% of total greenhouse gases, with a growth rate of 8.5% between 1990 and 2001, from 40.9 to 44.3 CO_2 equivalent Mt. The major source of N_2O emissions is the agricultural sector (54.7%), 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 1990-2001.
Emissions in the energy-use sector (23% of the total) show an increase by approximately 13% from 1990 to 2001; this growth can be traced primarily to the

road transport sector and is related to the introduction of catalytic mufflers. 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, accounts for 22% of total emissions.
Other emissions in the waste sector primarily regards the processing of industrial and domestic liquid waste.
Figure 2.6 shows national emission figures by sector.

Figure 2.6 National N_2O emissions by sector from 1990 to 2001

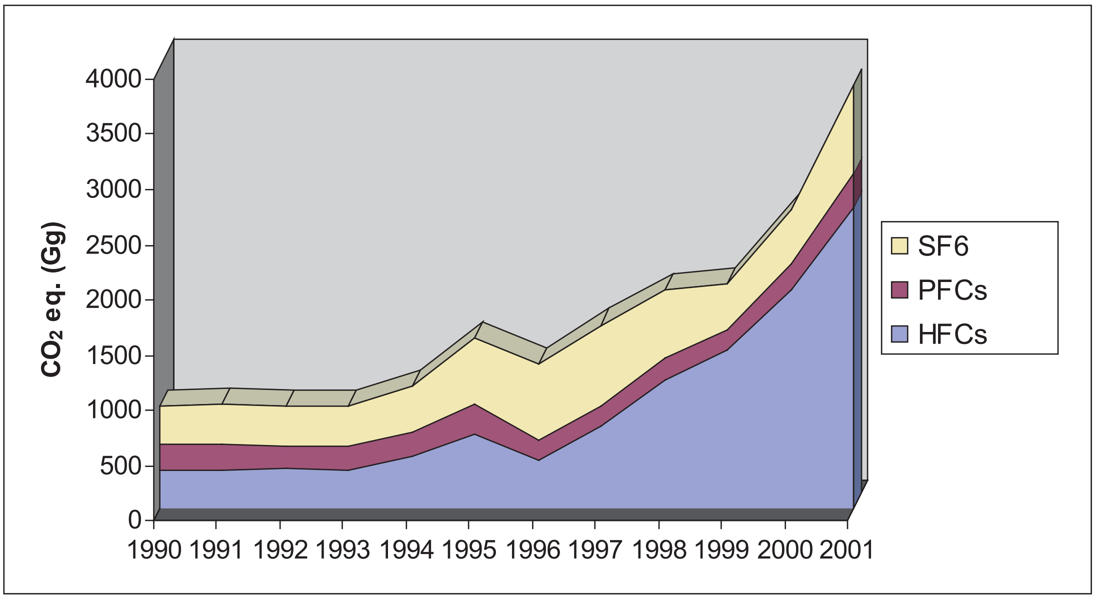


2.2.4 Fluorinated gases emissions

Italy has set 1995 as the base year for reduction in the emissions of the fluorinated gases covered by the Kyoto Protocol, that's HFC, PFC and SF_6. Taken altogether, the emissions of fluorinated gases represent 0.7% of total greenhouse gases in CO_2 equivalent, and they show an increase of 148% between 1995 and 2001. This increase is the result of different features for different gases.
The HFCs, for instance, have increased considerably from 1995 to 2001, from 0.7 to 2.7 CO_2 equivalent Mt. The main sources of emissions concern the consumption of HFC-134a, HFC-125, HFC-32 and HFC-143a in refrigeration and air-conditioning devices, plus 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 11% from 1995 to 2001. The level of these emissions in 2001 is 0.3 Mt in CO_2 equivalent, and it can be traced in equal proportion to the use of the gases in the production of aluminium and in the production of semiconductors. Although the production of PFCs has reached 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 2001, with an increase of 32% compared to 1995. Out of the SF_6 emissions, 57% can be traced to the use of gas in magnesium foundries, 37% 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 and in electrical equipments 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, though complete in terms of the sources and the gases identified, requires further in-depth examination and controls, eventually by the help of different methodologies, as contemplated under the IPCC Good Practice Guidance. Most of the uncertainty regards activity data and the difficulty in procuring them, because they are often considered of strategic economic importance and therefore kept confidential and not communicated.

Figure 2.7 National emissions of fluorinated gases by sector from 1990 to 2001



2.3 Description and interpretation of emission trends by source

2.3.1 Energy

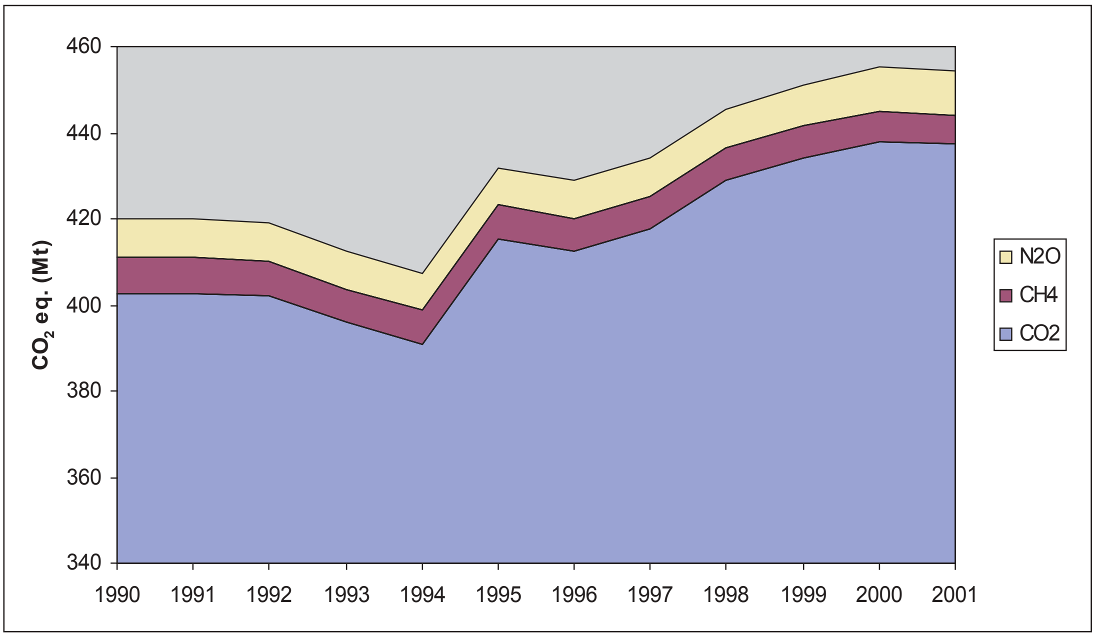
Emissions in CO_2 equivalent from the energy sector are reported in Table 2.1 and Figure 2.8.

Table 2.1 Total emissions in CO_2 equivalent from the energy sector by source (1990-2001)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total emissions CO_2 equivalent	**420.022**	**420.018**	**419.114**	**412.381**	**407.424**	**431.556**	**429.069**	**434.341**	**445.620**	**451.062**	**455.066**	**454.182**
Fuel Combustion (Sectoral Approach)	412.241	412.601	411.596	405.183	400.123	425.272	422.349	427.637	438.933	444.880	448.274	447.870
Energy Industries	*141.556*	*137.382*	*137.074*	*128.073*	*131.356*	*145.348*	*141.714*	*144.716*	*152.661*	*151.696*	*160.231*	*157.977*
Manufacturing Industries and Construction	*85.638*	*82.215*	*81.709*	*81.807*	*82.529*	*84.737*	*82.477*	*85.399*	*81.595*	*82.640*	*81.683*	*78.253*
Transport	*104.525*	*107.123*	*111.579*	*113.390*	*113.440*	*115.364*	*116.660*	*118.610*	*122.734*	*124.002*	*124.587*	*129.447*
Other Sectors	*79.408*	*84.612*	*79.879*	*80.379*	*71.261*	*78.315*	*80.261*	*77.303*	*80.852*	*85.387*	*80.922*	*81.828*
Other	*1.114*	*1.269*	*1.355*	*1.533*	*1.537*	*1.507*	*1.238*	*1.609*	*1.092*	*1.154*	*851*	*365*
Fugitive Emissions from Fuels	7.781	7.382	7.264	7.107	7.131	6.879	6.803	6.773	6.850	6.780	6.840	6.445
Solid Fuels	*117*	*110*	*103*	*81*	*71*	*65*	*60*	*60*	*55*	*53*	*64*	*64*
Oil and Natural Gas	*7.664*	*7.272*	*7.161*	*7.026*	*7.060*	*6.814*	*6.743*	*6.713*	*6.795*	*6.727*	*6.775*	*6.381*

An upward trend is noted from 1990 to 2001.
Substances with the highest percentages of increase are CO_2, whose levels have increased by 8.6% from 1990 to 2001 and account for 96% of the total, and N_2O which shows an increase of 11% but its weight out of the total is only 2%; CH_4, on the other hand, shows a decrease of 17.6% from 1990 to 2001 but it is not relevant on total emissions, accounting for 2%.
Totally the emissions increase is about 8% from 1990 to 2001.
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 12%, respectively, from 1990 to 2001; 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 (1990-2001)



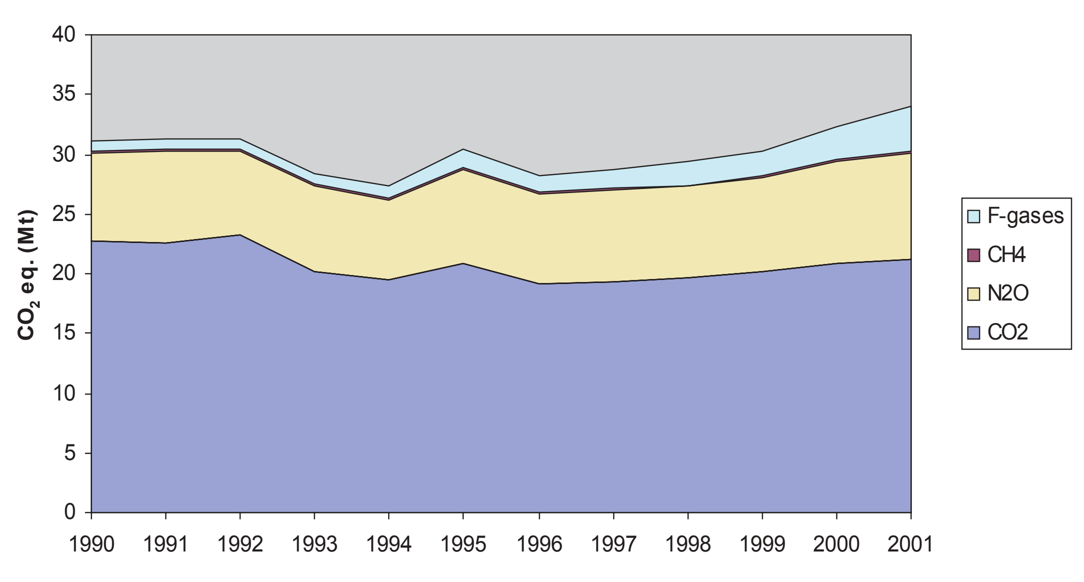
2.3.2 Industrial processes

Emission trends from industrial processes are reported in Table 2.2 and Figure 2.9. Total emissions levels, in CO_2 equivalent, show an increase of 7.4%, from the base year to 2001. Taking into account emissions by substance, CO_2 levels fell down by 7% while N_2O raised up to 22%; these two substances account altogether for about 88% of the total emissions from industrial processes. A considerable increase is observed in F-gases emissions (about 150%) but the importance of these gases on the total emissions is still negligible (11%) even though increasing.
Details for industrial processes emissions can be found in the specific chapter.

Table 2.2 Total emissions in CO_2 equivalent from industrial processes sector by gas (1990-2001)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total emissions CO_2 equivalent	**31.110**	**31.299**	**31.349**	**28.401**	**27.426**	**30.398**	**28.152**	**28.770**	**29.404**	**30.250**	**32.232**	**34.090**
CO_2	22.816	22.555	23.207	20.162	19.406	20.926	19.194	19.398	19.581	20.135	20.865	21.275
CH_4	121	117	114	114	120	127	116	122	123	120	121	115
N_2O	7.252	7.684	7.105	7.195	6.791	7.801	7.534	7.585	7.724	7.964	8.535	8.874
HFC_S	351	355	359	355	482	671	449	751	1.170	1.437	1.986	2.730
PFC_S	237	231	206	204	212	272	177	184	201	190	232	302
SF_6	333	356	358	370	416	601	683	729	605	405	493	795

Figure 2.9 Trend of total emissions in CO_2 equivalent from industrial processes by gas (1990-2001)



2.3.3 Solvent and other product use

Emissions from the solvent and other product use sector refer totally to CO_2 emissions, except for gases other than greenhouse.

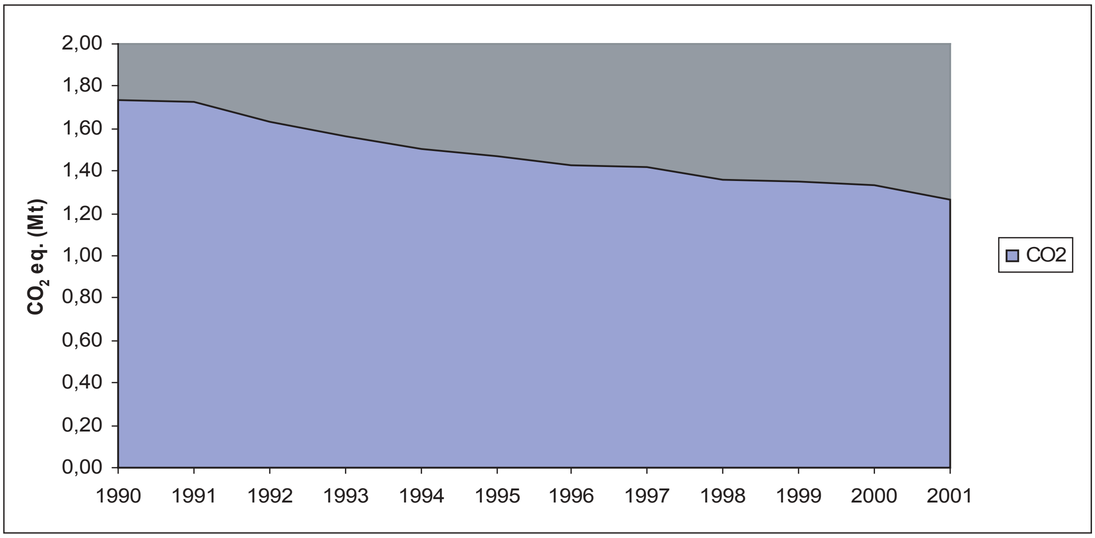
A considerable amount of emissions from this sector is, in fact, also to be attributed to NMVOC. Considering CO_2, a decrease by 27% is observed from 1990 to 2001 due substantially to the different sources.

Emission levels from paint application sector, which accounts for 54% of total emissions, fell down by 19%; 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 30%.

Finally, emissions from metal decreasing and dry cleaning activities, fell by 55% 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 (1990-2001)



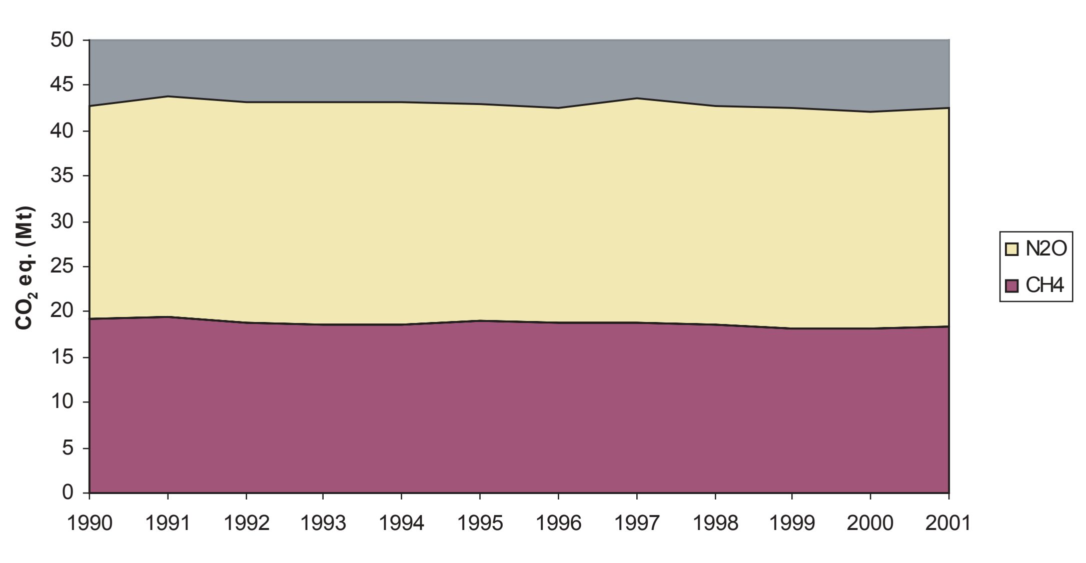
2.3.4 Agriculture

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 (1990-2001)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total emissions CO_2 equivalent	**42.775**	**43.822**	**43.232**	**43.264**	**43.100**	**42.978**	**42.585**	**43.575**	**42.758**	**42.481**	**42.005**	**42.535**
Enteric Fermentation	13.625	13.875	13.278	13.020	13.201	13.357	13.195	13.168	13.001	12.767	12.673	12.781
Manure Management	7.859	7.973	7.714	7.583	7.578	7.832	7.907	7.956	8.057	7.976	7.825	8.160
Rice Cultivation	1.539	1.474	1.545	1.655	1.685	1.709	1.696	1.663	1.590	1.577	1.574	1.554
Agricultural Soils	19.736	20.482	20.676	20.988	20.618	20.064	19.768	20.773	20.092	20.145	19.918	20.026
Field Burning of Agricultural Residues	17	19	18	17	18	17	18	16	18	17	16	15

Figure 2.11 Trend of total emissions in CO_2 equivalent from agriculture (1990-2001)



Total emissions are substantially stable from 1990 to 2001; emissions refer to CH_4 and N_2O levels, which account for 43% and 57% of the total, respectively. The small decrease observed in the total emissions (-1%) is mostly due to the decrease of emissions from enteric fermentation (-6%) which account for most of the total emissions. Detailed comments can be found in the specific chapter.

2.3.5 Waste

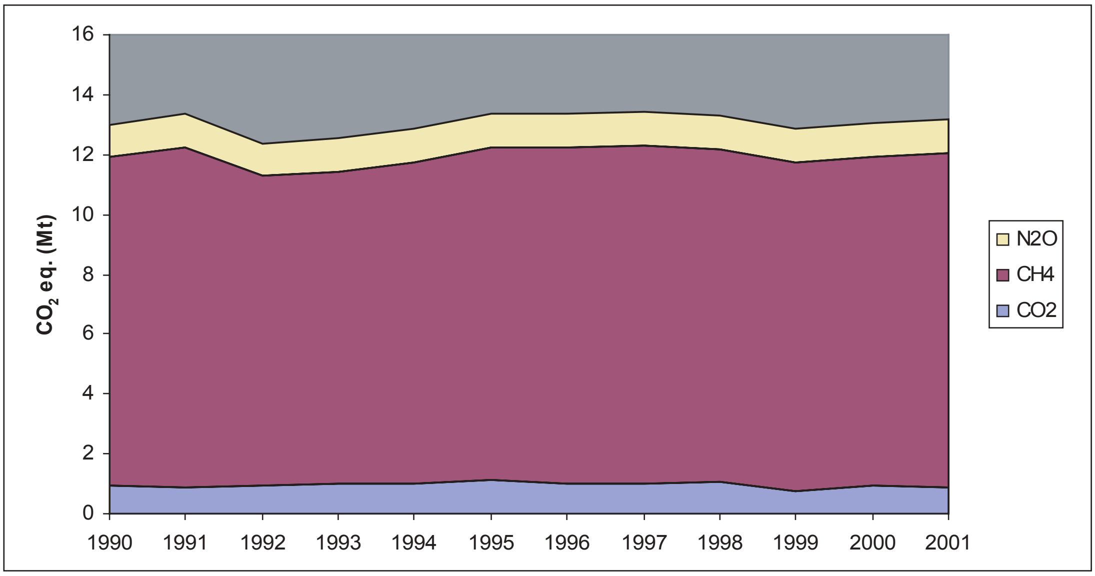
Emissions from the waste sector are shown in Table 2.4 and Figure 2.12 .
Total emissions in CO_2 equivalent increased by 1.3% from 1990 to 2001. The increase is mostly due to the increase in the emissions from waste incineration (10%), which account for 10% of the total, as well as those from waste-water handling (1%), which account for 18%.

Considering emissions by gas, the most important greenhouse gas is CH_4 which accounts for 85% of the total and shows an increase of 1% from 1990 to 2001. N_2O levels have increased by 6% while CO_2 decreased by 3%; these gases account for 9% and 7%, 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 (1990-2001)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total emissions CO_2 equivalent	**12.987**	**13.379**	**12.370**	**12.521**	**12.881**	**13.385**	**13.353**	**13.424**	**13.303**	**12.884**	**13.069**	**13.153**
Solid Waste Disposal on Land	9.526	9.687	8.718	8.804	9.142	9.557	9.659	9.671	9.508	9.335	9.434	9.556
Waste-water Handling	2.292	2.322	2.358	2.322	2.320	2.299	2.319	2.318	2.321	2.330	2.323	2.313
Waste Incineration	1.169	1.371	1.294	1.395	1.418	1.528	1.375	1.434	1.473	1.217	1.310	1.282
Other	0	0	0	0	0	0	0	1	1	1	2	2

Figure 2.12 Trend of total emissions in CO_2 equivalent from waste (1990-2001)



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 2001 are presented in Table 2.5 and Figure 2.13.

Table 2.5 Total emissions for indirect greenhouse gases and SO_2 (1990-2001)

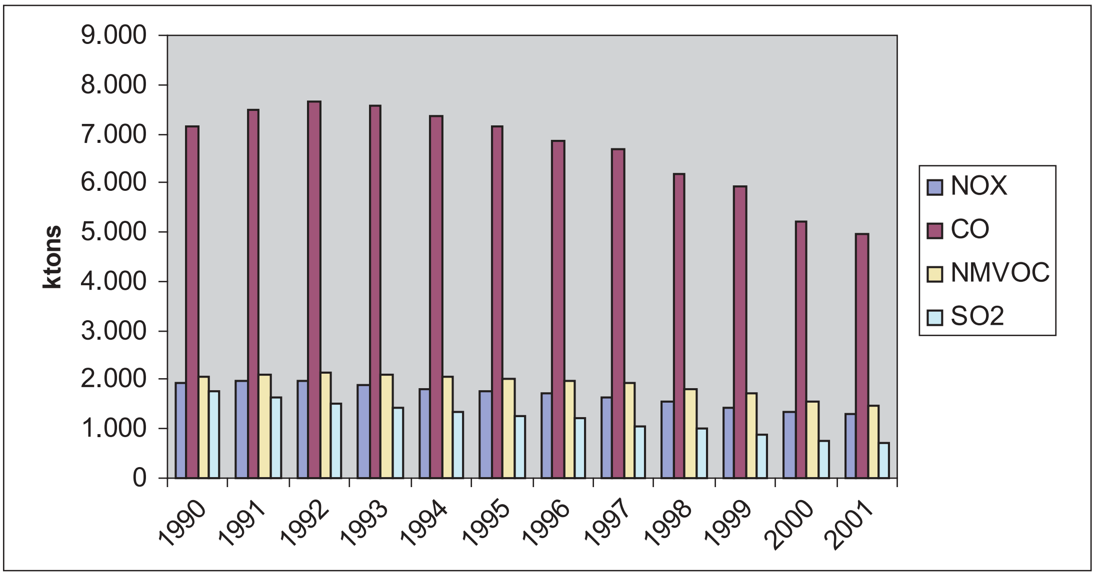
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Emissions in ktons												
NO_X	1.919	1.973	1.991	1.896	1.813	1.785	1.727	1.650	1.539	1.441	1.360	1.317
CO	7.146	7.492	7.653	7.552	7.362	7.140	6.844	6.696	6.173	5.914	5.221	4.965
NMVOC	2.041	2.109	2.157	2.109	2.055	2.034	1.988	1.920	1.815	1.722	1.557	1.467
SO_2	1.748	1.635	1.533	1.414	1.332	1.263	1.203	1.063	1.002	893	752	709

All gases show a significant reduction in 2001 compared to 1990 levels. The highest reduction is observed for SO_2 (-59%), while CO and NO_X have reduced by more than 30% and NMVOC emissions show a decrease by about 28%. 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/CE Directive.

The most relevant reductions occurred as a consequence of the CEE 75/716 Directive and following European Directives which established low levels of sulphur content in liquid fuels and introduced emission restrictive limits to threshold in chimney. 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.

Concerning NO_X, the most relevant emission source is transport, road transport accounting for 50% and off-road for 17% of the total. Combustion in energy and transformation industries accounts for 12%, while that in manufacturing industry for 10%. The remaining percentage is to be attributed to non-industrial combustion plants (6%), waste incineration and production processes (both 1% of the total).

Figure 2.13 Trend of total emissions for indirect greenhouse gases and SO_2 (1990-2001)



3. ENERGY [CRF SECTOR 1]

The time series described in this chapter refer to the period 1990-2000 because, as already pointed out, estimates of the energy sector for the year 2001 are still based on a provisional national energy balance. Nevertheless, all the methodological descriptions are valid for data submitted in the last communication.

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 effective 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 effective 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:

Total Emission = Emission Factor x Activity Statistic

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

Emission = Σ Point Source Emissions

However it is necessary to 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 Methodology for estimation of emission 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 BEN (BEN, 2002), GRTN (GRTN, 2002) for the power sector and some additional data sources to characterise the technologies used at sectoral level, quoted in the relevant sections.
Emissions are calculated using sector specific spreadsheets according to the equation:

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

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

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 specified 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. A comparison of the current factors was carried out based on limited industry and supplier data which suggested little variation in liquid fuels. 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. In case of differences between IPCC and national emission factors the latter have been always 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 in 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 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 Industry Ministry publishes annually energy balances (BEN, 2002) 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 year 2000 data is attached, the full time series is available on the website http://www.minindustria.it/ita/default.htm.
Carbon dioxide emissions from biomass combustion are not included in the National Total as suggested in the IPCC Guidelines but emissions of other pollutants are included. CORINAIR methodology includes emissions from the combustion of wood in the industrial and domestic sectors as well as the combustion of straw in agriculture. The BEN reports wood and straw combustion estimates for energy use, biodiesel and biogas and the estimate of emissions is based on these data. The

inventory reports also the emissions from the combustion of lubricants based on data collected from waste oil recyclers and quoted in BEN.

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-decarbonizing): 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 IPCC 1996 Revised Guidelines, 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, 2002] estimates of fuel used for steam generation connected with electricity production.

3.3 Energy industries

3.3.1 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 (Manager of the National Grid) a public enterprise that runs the high voltage transmission system. For the period 1990-1998 the same data where published by ENEL, 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 summarize the 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 3.1 a copy of the time series 1990-2000 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 Petrolifiera, 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 3.1 Time series of power sector production by fuel, kt or 10^6 m^3

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
national coal	58	21	85	45	2	-	-	25	93	96	Solids
imported coal	10.724	9.628	7.157	5.524	6.786	8.216	7.585	7.053	8.164	8.378	
lignite	1.501	1.554	1.089	995	558	380	296	179	163	62	9.633
Natural gas, m^3	9.731	8.963	8.692	9.752	9.774	11.277	11.861	13.989	16.239	19.766	22.034
BOF(steel converter) gas, m^3	509	541	526	561	398	633	529	454	554	536	Coal
Blast furnace gas, m^3	6.804	6.521	6.550	6.314	6.028	6.428	5.727	7.294	8.616	8.611	gases
Coke gas, m^3	693	666	590	577	543	540	610	725	742	660	8.690
Light distillate	5	4	9	5	4	6	16	29	30	12	oil
Diesel oil	303	234	217	155	164	184	199	119	153	560	products
Heavy fuel oil	21.798	22.091	24.389	23.98	24.278	25.355	24.415	23.664	21.744	17.511	
Refinery gas	211	234	215	248	285	378	382	371	380	409	
Petroleum coke	186	270	276	170	153	189	204	242	231	216	
Orimulsion	-	-	-	-	-	-	-	1	693	1688	19.352
Gases from chemical processes	444	386	334	354	373	803	477	820	974	1.155	Others
Tar	2	10	14	1	-	-	-	-	-	-	
Heat recovered from Pyrite	146	116	120	100	55	3	-	-	-	-	
Other fuels	344	414	476	510	598	697	947	1.044	1.342	1.819	5.153

Source: GRTN, 2000

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 gasses 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 2000. 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, 2002) and ENI (ENI, 2002), 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, 2003 for description, in Italian). 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 3.6.
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 3.2 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 2000. 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 3.2 Power sector, Energy/CO_2 emissions in CRF format, year 2000

	TJ	C, Kt	CO_2, Kt - Gg
For table 1.A.1, a. Public Electricity and Heat Production			
Liquid fuels	6.85669E+05	14364	52631.7
Solid fuels	2.52940E+05	6594	24162.4
Natural gas	6.09652E+05	9227	33808.7
Refinery gasses	1.8255E+04	309	1133.7
Coal gasses	1.6662E+04	1100	4030.9
Biomass	1.5916E+04		
Other fuels	1.629E+03	42	154.1
Total	**1.5848E+06**	**31637**	**115921**
Industrial producers (Table 1.A.1, a-b-c) and auto-producers, to table "1.A.2 Manufacturing Industries"			
Liquid fuels	5.0077E+04	1081	3961
Solid fuels	1.40E+01	0	1
Natural gas	1.79529E+05	2717	9956
Refinery gasses	2.5712E+04	436	1597
Other refinery products	4.3737E+04	1010	3700
Coal gasses	2.3468E+04	1549	5677
Other fuels	1.42E+03	36	134
Total	**3.24E+05**	**6830**	**25025**
General total	**1.9088E+06**	**38467**	**140947**

In Table 3.3 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 emissions are growing again from the year 2000 due to the increase of coal share.

Table 3.3 Time series of CO_2 emissions from electricity production

	1990	1995	1996	1997	1998	1999	2000
Total electricity produced	205.3	219.5	241.9	232.4	251.7	259.8	265.7
Total CO_2 emitted, Mt	122.0	130.3	121.2	133.4	136.0	133.0	141.0
g CO_2/kwh of gross thermo-elettric production	686	666	665	666	660	643	647
g CO_2/kwh of total gross production	564	539	535	529	523	501	510

3.3.2 Refineries

The consumption data used come from BEN (BEN, 2002), the same data are also reported by UP (UP, 2002).
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 eventual crude oil and all distributed fuels that are lost due to statistical discrepancies are considered to calculate emissions. Either the refinery losses that the fuel lost in the distribution network are considered as real but not accounted for in the individual endues sectors. Part of refinery losses are also reported in CRF table 1.B.2.a and c, using IPCC emission factors. This may lead to double counting of the CO_2 emissions if the individual refineries report sheets already include those losses in the energy balances. It is planned to investigate this aspect of the reporting as soon as the new comprehensive reporting requirements of the IPPC directive are routinely used.
IPCC tier 2 emission factors and national emission factors are used, refer to Table 3.6 . In Table 3.4 a sample calculation for the year 2000 is reported, with energy and emission data. In Table 3.5 GHG emissions in the years 1990, 1995 and 2000 are reported. Emissions from this sector are quite stable with time.

Table 3.4 Refineries, CO_2 emission calculation in year 2000

		Consumption			CO_2 Emissions	
REFINERIES and TANK SITES	Petroleum coke	Ref. gas	Liquid fuels	Petroleum coke	Ref. gas	Liquid fuels
			5983			12
	31079	80768	125015	3100	5014	9245
TOTAL **TJ**			242844			17371
Mtep			5.804			

Table 3.5 Refineries, GHG emission time series

	1990	1995	1998	1999	2000
CO_2 emissions, Mt	18.0	18.4	19.9	18.12	17.4
CH_4 emissions, kt	0.78	0.82	0.86	0.81	0.73
N_2O emissions, kt	1.42	1.45	1.39	1.38	1.64
Refinery, total, Mt CO_2 eq	18.5	18.9	20.4	18.7	17.9

3.3.3 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 by 2000.
In this section the emissions from the power plants that are using coal gasses are also reported. In particular we refer to the electricity generated in the steel plant sites (using coal gasses and other fuels) and used "on site".

3.4 Manufacturing industries and construction

Energy consumption for this sector is reported by 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 3.2, with the exception of coal (see section 3.4.1). The balance of fuel is assumed as used in boilers and heaters and the emissions are estimated with the emission factors listed in Table 3.6. These factors already contain the correction for the fraction of carbon oxidised.

Table 3.6 Emission Factors for Industry and Civil sector (boilers- heaters)

	t CO_2 / TJ	t CO_2 / tep
Liquid fuels		
Crude oil	72.549	3.035
Jet kerosene	70.735	2.9595
Petroleum Coke	99.755	4.174
Orimulsion	77.733	3.252
TAR	84.581	3.539
Gaseous fuels		
Natural gas (dry) 2000 average	55.483	2.321
Solid fuels		
Steam coal, 2000 average	95.526	3.997
Coking coal	92.643	3.876
"sub-bituminos" coal	96.234	4.026
Lignite	99.106	4.147
Coke	105.929	4.432
Biomass		
Solid Biomass		(4.495)
National emission factors	t CO_2 / TJ	t CO_2 / tep
Derived Gasses		
Refinery Gas	62.080	2.60
Coke Gas	46.964	1.965
Blast furnace – oxi converter Gas	266.461	11.149
Fossil fuels, national data		
Fuel oil, 2000 average	76.702	3.209
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

3.4.1 Estimation of carbon content of coals used in industry

The preliminary use of 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 balances energy and carbon content of coking coals used by steelworks, industry, for non energy purposes and coal gasses used for electricity generation. The detailed procedure is described in Annex 3, here we underline that a balance is made

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

3.4.2 Time series

In the following Table 3.7 GHG emissions connected to the use of fossil fuels, process emissions excluded, in the years 1990, 1995 and 1998-2000 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.

Table 3.7 Manufacturing industry, GHG emissions time series

	1990	1995	1998	1999	2000
CO_2 emissions, kt	87144	78630	79298	76016	76593
CH_4 emissions, t	4644	3973	4459	15935	16473
N_2O emissions, t	3364	2623	2713	2995	2986
Industry, total, kt CO_2 eq	88583	79799	80463	77529	78128

3.5 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 2000.
The historical time series of CO_2 , CH_4 and N_2O emissions is reported in Table 3.8.
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 connected to the expansion of the car fleet equipped with exhaust gasses catalytic converters.
Methane emissions are instead quite stable, due to the combined effect of technological improvements that limit VOC tail pipe and evaporative emissions and the expansion in petrol consumption.
It has to be underlined that in Italy there is a remarkable fleet of motorbikes and mopeds (about 9 millions vehicles in 2000) that are using petrol and are still not subject to strict VOC emissions control.

Table 3.8 GHG emissions for the transport sector

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO_2	Mt	100,4	102,7	107,0	108,8	108,5	110,3	111,5	114,2	117,7	119,0	119,8
CH_4	kt	0,9	0,9	1,0	1,0	0,97	0,97	0,95	0,90	0,90	0,89	0,85
N_2O	kt	2,0	2,0	2,0	2,2	2,42	2,60	2,78	3,00	3,30	3,44	3,59
Total, Mt CO_2 eq.	Mt	103,3	105,6	110,0	112,0	111,8	113,9	115,3	118,1	121,9	123,4	124,3

3.5.1 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 (BEN, 2002), 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 CNT (CNT, 2002). This was used to estimate total domestic and international landing and take-offs (LTO).
(iii) Data on domestic aircraft passengers - kilometers are also reported by CNT (CNT, 2002).
(iv) Using IPCC 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 (BPT, 2002), 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 3.9. Data on domestic and international aircraft movements taken from CNT (2002) are shown in Table 3.10. Domestic flights are those entirely within Italy.

Table 3.9 Carbon Dioxide 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] APAT (2001). Factor for 2000.

Table 3.10 Aircraft Movement Data

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Domestic flights, LTO cycles, 10^3	179	186	194	194	197	205	228	241	262	291	319
International flights, LTO cycles	141	139	157	163	170	191	214	221	240	257	286
General aviation, LTO cycles	168	182	144	102	106	110	110	110	110	110	110

Source: CNT, various years

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 very simple EMEP/CORINAIR/IPCC methodology described in EMEP/CORINAIR (1996) and IPCC (1997). The procedure was:

1. Data on the annual number of domestic and international landing and takeoff cycles (CNT, 2002) were used together with the default emission factors in Table 5.3 to estimate the emissions within the take-off and landing phase of the domestic and international flights.
2. The fuel consumptions within the cruise phases of the domestic and international flights were then calculated by subtracting the LTO fuel consumption from the total domestic and international consumptions.
3. The emissions within the cruise phase were calculated using the cruise emission factors in Table 3.11 together with the cruise fuel consumption.

The current methodology may overestimate emissions from aircraft. This is because only a few aircraft types are considered and the default factors used pertain to older models. Currently the use of a more detailed model for estimating aircraft emissions is under consideration.

Table 3.11 Non- CO_2 Emission Factors for Aviation

	Units	CH_4	N_2O	NO_x	CO	NMVOC	Fuel
Domestic LTO	kg/LTO	0.394[a]	0.1[b]	9.0[a]	16.9[a]	3.706[a]	1000
International LTO	kg/LTO	6.96[a]	0.2[b]	23.6[a]	101.3[a]	65.54[a]	2400
Domestic Cruise	kg/t fuel	0[b]	0.1[b]	11[b]	7[b]	0.7[b]	-
International Cruise	kg/t fuel	0[b]	0.1[b]	17[b]	5[b]	2.7[b]	-
Aircraft Military	859[a]	0.106[ad]	0.1[g]	8.5[ad]	8.2[ad]	0.994[ad]	1.0[z]
a EMEP/CORINAIR (1996) b IPCC(1997)							

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 IPCC (1997) and EMEP/CORINAIR (1999) cruise defaults shown in Table 3.11. The EMEP/CORINAIR (1999) factors used are appropriate for military aircraft.
In table 3.12 the time series resulting from the above described methodology are indicated.

Table 3.12 Aviation fuels consumption, domestic and international travels

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Domestic flights, LTO cycles, kt	121	120	125	126	128	133	148	156	170	189	207
International flights, LTO cycles, kt	123	124	138	146	154	171	188	195	210	226	251
Domestic flights, cruise, kt	386.5	385.4	402.1	402.9	408.9	424.8	473.4	499.6	543.5	604.1	661.8
Source: APAT elaborations											

3.5.2 Railways

The electricity used by the railways for electric traction is supplied from the public distribution system, so the emissions arising from its generation are reported under 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 (BEN, 2002). Emissions from diesel trains are reported under the IPCC category 1A3c Railways.
Carbon dioxide, sulphur dioxide and N_2O emissions are calculated based 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 (1996). The emission factors shown in Table 3.13 are aggregate factors so that all factors are reported on the common basis of fuel consumption.

Table 3.13 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 (1996)							

3.5.3 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.

3.5.3.1 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 (BEN, 2000), 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 3.14.

Values for SO_2 vary annually as the sulphur-content of fuels change and are shown in UP (UP, 2000). These factors already contain the correction for the fraction of carbon oxidised.

Table 3.14 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[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[b]	64.936
Natural gas (dry) '2000	55.483
Fuel oil, 2000 average	76.702

a IPCC
b Emission factor in kg carbon/tonne, based on APAT (2002)
c 1999 emission factor calculated from UP (2000) figures on the weighted average sulphur-content of fuels delivered in the Italy in 1999
d see paragraph 9

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 2000 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 (European Environment Agency, 2000).
Fuel consumption calculated from these functions are shown in Table 3.15 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 3.15 Average fuel consumption and mileage for main vehicle categories and road type, 2000

SNAP	FUEL	TON	KM_KVEH
PC highway	diesel	1,787,601	29,702,846
PC highway	petrol	2,983,602	52,811,342
PC highway	lpg	422,463	7,311,404
PC rural	diesel	2,352,548	49,110,116
PC rural	petrol	5,708,320	125,263,244
PC rural	lpg	439,017	9,748,539
PC urban	diesel	1,049,574	12,560,665
PC urban	petrol	6,006,333	66,838,010
PC urban	lpg	562,328	7,311,404
LDV highway	diesel	678,164	8,113,436
LDV highway	petrol	58,290	902,390
LDV rural	diesel	1,406,589	22,311,948
LDV rural	petrol	160,500	2,481,572
LDV urban	diesel	1,149,681	10,141,795
LDV urban	petrol	170,791	1,127,987
HDV highway	diesel	4,288,326	19,521,798
HDV highway	petrol	1,409	8,542
HDV rural	diesel	2,843,208	14,766,988
HDV rural	petrol	3,844	25,626
HDV urban	diesel	1,659,325	5,336,762
HDV urban	petrol	1,922	8,542
mopeds	petrol	729,638	22,827,914
Moto highway	petrol	40,488	1,128,364
Moto rural	petrol	213,882	7,898,547
Moto urban	petrol	402,950	13,540,365
total		35,120,791	490,800,144

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

3.5.3.2 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 (CNT, 2002). 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 (European Environment Agency, 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 busses, 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 (Zachariadis and Samaras, 1997).

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, 2000).
In the following tables 3.16, 3.17 and 3.18 are reported detailed data on the relevant vehicles in the circulating fleet between 1990 and 2000, subdivided according to the main emission regulations that applied when the vehicle was sold.

Table 3.16 Petrol cars technological evolution: circulating extraurban fleet calculated as stock data multiplied by effective mileage

	1990	1995	2000
Older than 20 years, PRE ECE	**0.0050**	**0.0070**	
1972 - 1977, ECE 15.00/.01	0.142	0.017	**0.009**
1978 - 1986, ECE 15.02/.03	0.277	0.178	0.038
1987 -1989, ECE 15.04	0.159	0.103	0.061
1990 - 1992, ECE 15.04	0.417	0.388	0.263
91/441/EC, da 1/1/93 (euro 1)	0.000	0.308	0.216
94/12/ EC, da 1-1-97 (euro 2)		0.000	0.413
totals	**1.000**	**1.000**	**1.000**
Source: APAT elaborations on ACI data			

Table 3.17 Diesel cars technological evolution: circulating extra-urban fleet calculated as stock data multiplied by effective mileage

	1990	1995	2000
Older than 15 years, PRE ECE	**0.006**	**0.009**	
1972 -1977, ECE 15.00/.01	0.008		**0.013**
1978 -1985, ECE 15.02/.03	0.248	0.103	0.000
1985-1990, ECE 15.04	0.359	0.285	0.051
media 1990, ECE 15.04	0.378	0.390	0.106
91/441/EC, da 1/1/93 (euro1)	0.000	0.213	0.124
94/12/ EC, da 1-1-97 (euro 2)			0.705
totale	**1.000**	**1.000**	**1.000**
Source: APAT elaborations on ACI data			

Table 3.18 Trucks technological evolution: circulating fleet

	1990	1995	2000
pre -1985	0.60	0.34	0.11
1985-1990, Dir 88/77/EWG	0.30	0.29	0.23
media 1990	0.10	0.20	0.18
da 1/1/93, euro I		0.16	0.14
da 1/1/96, Dir. 91/542 EEC, euro I		0.00	0.06
da 1/1/97, Dir. 91/542 EEC, euro II			0.28
totale	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 on the basis of data from various sources, see table 3.15 and 3.19:

- Ministry of Transport (CNT, 2000) 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 3.19 Evolution of fleet consistency and mileage

Year	1990	1995	2000
All passenger vehicles, total mileage (10^9 veh-km/y)	339	407	450
Car fleet (10^6)	27,7	31,0	33.1
Goods transport, total mileage (10^9 veh-km/y)	54	50	59
Truck fleet (10^6)	3.0	3.4	3.9
Source: APAT elaborations			

When a vehicle's 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 NMVOC takes account of changes in ambient temperature and fuel volatility.

3.5.4 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 5.1.

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:

(i) Total deliveries of fuel oil, gas oil and marine diesel oil to marine bunkers are given in BEN (2000).
(ii) Naval fuel consumption for “small boat” and ferries is also reported in BEN.
(iii) The consumption connected to coastal shipping of all kinds of ships that travel between two Italian ports is estimated by APAT using navigation data and detailed fuel consumption database for ships (EMEP/CORINAIR,1996).
(iii) The fuel consumption associated with international marine is the marine bunkers total minus the coastal consumption. The emissions were estimated using the emission factors shown in table 3.6

In table 3.20 the time series resulting from the above described methodology are indicated. 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.

Table 3.20 Marine fuels consumption, domestic and international travels

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Fuels reported and used for domestic travels, kt	378	394	385	393	411	435	431	435	426	443	425
Estimate of bunker fuel used for domestic travels + ports, kt	1527	1649	1585	1507	1445	1399	1596	1668	1756	1703	1775
Estimate of international bunkers, kt	1326	1163	1119	1200	1193	1318	1035	1074	1215	1046	1240
Source: APAT elaborations											

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

3.6 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 3.6.
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, 2002).
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 3.6.2. Emissions from fishing vessels are estimated from fuel consumption data (BEN, 2000) and emission factors are shown in Table 3.6.

3.6.1 Other combustion

Emissions from military aircraft and naval vessels are reported under 1A.5b Mobile. The method of estimation is discussed in Sections 3.5.1 and 3.5.4.
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 3.6.2.

3.6.2 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, 1996). This involves the estimation of emissions from around seventy classes of off-road source using the following equation for each class:

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

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 (ENEA, 1999). Machinery lifetime is estimated on the European averages, see EMEP/CORINAIR (EMEP/CORINAIR, 1996), the annual usage data were taken either from the PRI poll or published data (Samaras et al., 1993,1994). The emission factors used came mostly from EMEP/CORINAIR (EMEP/CORINAIR,1996) though a few of the more obscure classes were taken from Samaras (Samaras et al., 1993). The load factors were taken from Samaras (1996).
It was possible to calculate fuel consumptions for each class based on fuel consumption factors given in EMEP/CORINAIR (EMEP/CORINAIR, 1996). 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 1990-2000 for each of the main categories:

A. Agricultural power units: Data on gas oil consumption were taken from ENEA (ENEA, 2000). The consumption of petrol was estimated using the population method for 1995 without correction. The same estimate was used for 1990 to 2000.
B. Industrial off-road: The construction component of the gas oil consumption was calculated from Industry Ministry data (BEN, 2000) on building and contracting. 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.

3.7 International Bunkers

The methodology used to estimate the quantities of fuels used fro international bunkers in aviation and maritime navigation has been illustrated in the relevant transport sections, 3.5.1 and 3.5.4 .

The methodology used implemented the IPCC guidelines according to the available statistical data.

3.8 Feedstock and non-energy use of fuels

In Table 3.21 and 3.22 detailed data on petrochemical for year 2000 and other non-energy use for the same years are given.

Table 3.21 Petrochemical, detailed data from BPT, year 2000

FUEL TYPE	Petroch. Input kt	Returns to refin. /market kt	Internal consumption /losses kt	Quantity stored in products kt	Net calorific value TJ / kt	Emission factor (IPCC) t C / t
LPG	609	561	13	35	46.25	0.8137
Refinery gas /	258	129	1010	-881	50.21	0.85494
Virgin nafta	5549	0	0	5549	43.54	0.8708
Gasoline	1111	2009	0	-898	43.93	0.8467
Kerosene	1238	881	0	357	43.12	0.8409
Gasoil	1326	169	0	1157	42.68	0.8753
Fuel oil	821	108	952	-239	41.04	0.8678
Petroleum coke	0	0	0	0	34.73	0.955
Others feedstoks	207	160	24	23	41.84	0.8368
Losses			0	0	41.84	0.8368
Natural gas	795	0	795	0	48.95	0.747
total	11914	4017	2794	5103		

Table 3.22 Other non energy uses, year 2000
(include estimation of inconsistencies between BEN and CRF data)

NON ENERGY FROM REFINERIES	Quantity stored in products kt	Energy content from IPCC '96	from IPCC '96	Total energy content with IPCC values	With BEN values	
bitumen+peat	2,888.0	40.19	0.8841	22.0	116.1	116.12
lubricants	1,264.0	40.19	0.8033	20.0	50.8	50.77
recovered oils	172.0	40.19	0.8033	20.0	6.9	4.47
paraffina	40.0	40.19	0.8033	20.0	1.6	1.04
others (benzolo, others)	819.0	40.19	0.8033	20.0	32.9	21.26

3.9 Country specific issues

3.9.1 National energy balance

Italian energy statistics are based mainly on BEN, National Energy Balance, that is annually edited by Industry Ministry. 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 attempt the exercise described in section 3.7.1 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 Industry Ministry, 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.

3.9.2 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 EF. For each primary fuel (natural gas, oil, coal) a specific procedure has been established.

Natural gas

IPCC methodology reports an EF for this energy carrier. Initially to estimate the

methane content of the fuel, so that the correct EF 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 EF is estimated. The list of factors for the years of interest is reported in Table 3.23.

Table 3.23 Natural gas carbon EF and methane content

	t CO_2 / TJ	t CO_2 / tep	k CH_4 / TJ
Natural gas (dry) '1990	55.208	2.310	43.53
Natural gas (dry) '1995	55.379	2.317	43.85
Natural gas (dry) '1998	55.443	2.320	43.41
Natural gas (dry) '1999	55.460	2.320	43.27
Natural gas (dry) '2000	55.483	2.321	42.88

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" are checked against the emission factors used in the Reference Approach of the Intergovernmental Panel for Climate Change (IPCC, 1996

Revised Guidelines for National Greenhouse Gas Inventories) and the emission factors considered in the COPERT III programme of the European Environment Agency (EEA).
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 EF, 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 EF.
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 EF 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 EF is used as a default.
For petrol instead the IPCC-OECD EF 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 EF 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 factors for the different years is reported in Table 3.24.

Table 3.24 Fuels, national production, carbon EF

	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 EF 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 vary 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 year 1990 the produced and imported quantities of fuel oil, divided between high and low sulphur products and to estimate the average carbon EF for the years of interest, see Table 3.25 for details.

Table 3.25 Fuel oil, average of national and imported products, carbon EF

	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, 1998/99 average	76.706	3.209
Fuel oil, 2000 average	76.702	3.209

The systematic evaluation of the carbon content of crude oil imports, very important to "close" the carbon balance in the refineries, is planned.

Coal imports
With reference to coal the information available was again about a sizable difference in carbon content that is linked to the hydrogen content of the fuel and to its LHV.
IPCC EF generally refers to the lower HV product. The data where elaborated from literature and from an extensive series of samples (more than 200) analysed by ENEL and made available to APAT.
According to 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 the years of interest, see table 3.26 for details.

Table 3.26 – Coal, average carbon EF

	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 '98	94.528	3.955
Steam coal '99	95.706	4.004
Steam coal '00	95.526	3.997

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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 will be estimated separately and included in category 1A2. All greenhouse gases as well as CO, NO_x, NMVOC and SO_2 emissions are estimated.

In 2001 industrial processes account for 4.6% of CO_2 emissions, 0.3% of CH_4, 20.0% of N_2O, 100% of PFCs, HFCs and SF_6. In term of CO_2 equivalent, industrial processes share 6.2% 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 F-gases emissions is observed from 1990 to 2001, while CO_2 emissions from chemical and metal industry reduced sharply.

Table 4.1 Trend in greenhouse gas emissions from the industrial processes sector, 1990-2001

Gas/subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2												
2A. Mineral Products	18.222,53	18.171,07	18.896,85	16.643,21	16.325,40	17.767,71	16.301,59	16.513,49	16.721,56	17.487,87	18.060,65	18.473,43
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
2C. Metal Production	1.804,19	1.672,17	1.497,57	1.541,66	1.532,88	1.659,67	1.668,51	1.659,12	1.626,66	1.480,90	1.592,12	1.584,97
2D. Other Production	552,52	596,39	681,06	622,59	590,15	560,31	584,85	506,50	566,94	577,72	539,39	521,95
CH_4												
2B. 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
2C. 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
N_2O												
2B. Chemical Industry	23,39	24,79	22,92	23,21	21,91	25,16	24,30	24,47	24,91	25,69	27,53	28,63
HFCs	351,00	355,43	358,78	355,42	481,90	671,29	448,64	750,79	1.169,57	1.436,58	1.985,96	2.730,30
PFCs	237,50	231,35	205,84	203,57	212,48	272,46	176,79	184,26	201,37	190,02	231,66	301,70
SF_6	332,92	356,39	358,26	370,40	415,66	601,45	682,56	728,64	604,81	404,51	493,43	794,96

As regards key sources analysis, five key sources have been identified for this sector, for level and trend assessment, using both 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

CO_2 Cement production	L, T2
N_2O Adipic Acid	L, T
N_2O Nitric Acid	T1
CO_2 Other industrial processes	T1
HFC, PFC substitutes for ODS	L2, T

CO_2 emissions from cement production are included in the category 2A; N_2O emissions from adipic acid and nitric acid refer both to 2B; CO_2 emissions from other industrial processes include ammonia and other chemical production emissions (2B), glass production (2A), aluminium and ferroalloys production (2C) and other production (2D); 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 emission is CO_2 from cement production (2A1) which is, as above underlined, a key source and accounts for 2.8% of the total national emissions.
The other processes included in the sector are not key sources.
Emissions from limestone and dolomite use are estimated and included in the figures reported under cement and lime production emissions, for limestone, and ceramic production emissions, for dolomite.
Emissions from soda ash production are equal to zero because in Italy those emissions refer only to the Solvay Process which does not account for CO_2; emissions from soda ash use are included in other industrial processes (paper, glass, etc…) where this product is used.
NMVOC emissions occur from asphalt roofing and road paving with asphalt and they are reported in the CRF.
CO_2 emissions from decarbonising in glass production have been estimated and reported in other.

4.2.2. Methodological issues

IPCC Guidelines and Good Practice Guidance are used to estimate emissions.
Activity data are supplied by the National Institute of Statistics (ISTAT) and by industries. Emission factors refer to IPCC or other international guidebooks.
The complete time series of CO_2 emissions from cement production has been recalculated according to the IPCC Good Practice Guidance, applying GPG emission factors to the clinker production data published by ISTAT. In the past, the time series of clinker production was not entirely available and emissions were estimated on the basis of cement production and IPCC guidelines respective emission factors. As a result a relevant reduction in emission values were observed for the whole time series from 1990 to 2001.
CO_2 emissions from lime production have been also revised. The revision has regarded basic activity data and only lime decarbonised products have been considered.

4.2.3. Uncertainties and time-series consistency

The uncertainty in CO_2 emissions from cement, lime and glass production is estimated less than 10%. The emissions trend is related to the production which is stable.

4.3 Chemical industry (2B)

4.3.1. Source category description

CO_2, CH_4 and N_2O emissions from chemical productions are estimated and included in this sector.
Adipic acid, at level and trend assessment, both with the Tier 1 and Tier 2 approach, and nitric acid production, at trend assessment with the Tier 1, are key sources.
N_2O from adipic acid production in 2001 accounts for 17.5% of total N_2O emissions.
N_2O from nitric acid production has reduced relevantly in these years as consequence of a reduction in the production.
CO_2 emissions from adipic acid production are supplied and referenced by the only Italian producer and are reported in other chemical industry added to other chemical production emissions.
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.

4.3.2. Methodological issues

N_2O emissions from adipic acid production (2B3) have been estimated using an emission factor provided by the national industrial producer (0.33 kg N_2O/kg adipic acid produced). The plant is not equipped with abatement technologies at present.
With regard to N_2O emissions from nitric acid production (2B2), high values of emission factors have been used considering that, in Italy, HNO_3 is produced, mainly, by plants which use medium-high removals processes.

4.3.3. Uncertainties and time-series consistency

The uncertainty in N_2O emissions from adipic and nitric acid production is estimated about 10%. 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.
CO_2 emissions from chemical production have decreased as a result of a relevant reduction in ammonia production.

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.
Regarding the steel production from arc furnaces, the amount of recycled steel production is about 15,000 kilotonnes; the amount of scraps used in the pig iron production has not been estimated.
CO_2 fugitive emissions from pig iron, sinter and coke production are not relevant and by the way 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 2001, for 0.3% of the national total CO_2 emissions, and to 7.5% of the total CO_2 from industrial processes.

The share of CH_4 emissions out of the total is less than 0.2%. N_2O emissions do not occur.
The share of F-gases emissions from metal production out of the national total F-gases levels was 5.1% in the base-year 1995 and 13.9% (0.098% of the national total greenhouse gas emissions) in the year 2001.

4.4.2. Methodological issues

CO_2 and CH_4 emissions from the sector have been estimated on the basis of activity data published by ISTAT and industry and emission factors reported in the EMEP/CORINAIR emission factor guidebook 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 Bref Report and the EMEP/CORINAIR Guidebook and refer to basic oxygen furnace, electric furnaces and rolling mills.
For the estimation of PFC emissions from aluminium production, the IPCC Tier 1 Method (production-based emission factors) is used, since the only available information is the annual metal production. The emission factors for CF_4 and C_2F_6 were provided by the national producer; the Italian plants have been recently renovated which use a "pre-bake" technology with point feeding (CWPB), characterised by the lowest emission factors.
For SF_6 used in magnesium foundries, according to the IPCC Guidelines, emissions are estimated from consumption data made available by the company which operates the only magnesium foundry located in Italy.

4.4.3. Uncertainties and time-series consistency

The uncertainty in PFC emissions from primary aluminium production is estimated to be about 50% and the uncertainty for SF_6 emissions from magnesium foundries is estimated to be about 7%. The uncertainty in CO_2 emissions from the sector is estimated less than 10% and the uncertainty in CH_4 emissions is about 50%.
In Table 4.2 the emission trend of F-gases per compound from metal production is given.

Table 4.2 Actual emissions of F-gases per compound from metal production in $GgCO_2eq$ (1990-2001)

Compound	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CF_4 (PFC-14)	90,4	85,0	62,7	60,7	68,5	69,3	71,9	73,2	72,9	73,0	74,0	73,1
C_2F_6 (PFC-16)	12,8	12,0	8,9	8,6	9,7	9,8	10,2	10,4	10,3	10,3	10,5	10,4
total PFC emissions from aluminium production	*103,2*	*97,1*	*71,5*	*69,3*	*78,2*	*79,2*	*82,1*	*83,6*	*83,3*	*83,3*	*84,5*	*83,5*
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*
Total F-gases emissions from metal production	**103,2**	**97,1**	**71,5**	**69,3**	**78,2**	**79,2**	**94,0**	**99,1**	**107,2**	**119,2**	**256,6**	**533,4**

PFC emissions from aluminium production are in line with trends in annual production of primary aluminium, which show a 33% decrease from 1990 to 1993, a 21% increase from 1993 to 1997, and then fluctuate around the value reached in 1997. SF_6 from magnesium foundries has increased from 0 $GgCO_2eq$. in 1995 to 449,9 $GgCO_2eq$. in 2001, in line with trends in recycling of magnesium products.

4.5 Other production (2D)

4.5.1. Source category description

In this sector are reported CO_2 no-energy emissions from food and drink production, especially wine and bread.
As above already underlined, these emissions together with other industrial processes CO_2 emissions, are key sources at Tier 1 level assessment, especially due to ammonia production emission trend.
Emissions from bread and wine production account for 2.5% of industrial processes emissions and 0.1% of total CO_2 emissions.

4.5.2. Methodological issues

CO_2 emissions have been estimated on the basis of CITEPA emission factors (CITEPA, 1993) and activity data supplied by ISTAT and industry. No CO_2 emissions derive from the beer production in Italy, as supplied by the industrial association.

4.5.3. Uncertainties and time-series consistency

The uncertainty in CO_2 emissions from the sector is estimated less than 10%.

4.6 Production of halocarbons and SF_6 (2E)

4.6.1. Source category description

The sub-sector production of halocarbons and SF_6 consists of two sources, "HFC-23 emissions from HCFC-22 manufacture" and "Fugitive emissions", identified as non-key sources.
The share of emissions of F-gases from the production of halocarbons and SF_6 in the national total of F-gases was 45.0% in the base-year 1995 and 0.6% (0.004% in the national total greenhouse gas emissions) in the last reported year.

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; since 1996, data are adjusted for HFC-23 destruction.
Also for source category "Fugitive emissions", emission estimates are based on plant-level data communicated by the national producer.

4.6.3. Uncertainties and time-series consistency

The uncertainty in F-gases emissions from production of halocarbons and SF_6 is estimated to be about 70% in annual emissions.
In Table 4.3 an overview of the emissions from production of halocarbons and SF_6 is given for the 1990-2001 period, per compound.

Table 4.3 Actual emissions of F-gases per compound from production of halocarbons and SF_6 in $GgCO_2eq$ (1990-2001)

Compound	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
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
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*
HFC 125	0,0	2,8	5,6	2,8	5,6	28,0	22,4	98,0	56,0	5,6	2,8	2,8
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
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
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
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
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
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
total F gases fugitive emissions	*253,8*	*257,9*	*260,7*	*256,6*	*259,4*	*343,6*	*176,3*	*269,9*	*248,5*	*25,0*	*22,2*	*22,2*
total F gases 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	22,2

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; in 1996, untreated leaks have been collected and sent to the thermal afterburner, thus allowing reduction of emissions to zero.
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.

4.7 Consumption of halocarbons and SF_6 (2F)

4.7.1. Source category description

The sub-sector consumption of halocarbons and SF_6 consists of three sources, "HFC, PFC emissions from ODS substitutes", key source at level, Tier 2 approach, 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 51.6% in the base-year 1995 and 86.8% (0.595% in the national total greenhouse gas emissions) in 2001.

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-gases 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

SF_6 emissions from electrical equipment from 1990 to 1994 have been estimated according to IPCC Tier 2a approach.
IPCC Tier 1a method has been used to calculate potential emissions, using production, import, export and destruction data provided by the national producer.

4.7.3. Uncertainties and time-series consistency

The uncertainty in F-gases emissions from HFC, PFC emissions from ODS substitutes and PFC, HFC, SF_6 emissions from semiconductor manufacturing is estimated to be about 70% in annual emissions; the uncertainty in SF_6 emissions from electrical equipment is estimated to be about 10%.
In Table 4.4 an overview of the emissions from consumption of halocarbons and SF_6 is given for the 1990-2001 period, per compound.

Table 4.4 Actual F-gases emissions per compound from the consumption of halocarbons and SF_6 in $GgCO_2eq$ (1990-2001)

Compound	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
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
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
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
HFC 134	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	64,6
HFC 134a	0,0	0,3	0,9	1,6	125,3	224,3	333,0	508,1	785,8	945,2	1136,8	1365,1
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
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*	*1274,7*	*1809,0*	*2581,8*
HFC 134a emissions from foam blowing	0,0	0,0	0,0	0,0	0,0	26,0	26,0	26,0	31,3	37,6	43,8	49,8
HFC 227ea emissions from fire extinguishers	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,1	0,1	0,1	0,1
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
total HFC emissions from ODS substitutes	*0,0*	*0,3*	*0,9*	*1,6*	*125,3*	*256,5*	*387,8*	*596,4*	*992,9*	*1393,0*	*1961,3*	*2769,3*
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
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
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
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
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
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
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*
total 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*	*295,7*
total F-gases emissions from consumption of halocarbons and SF_6	213,4	237,2	239,6	252,5	421,5	797,4	1063,6	1320,7	1620,1	1888,2	2434,9	3340,0

In Table 4.5 an overview of the potential emissions is given for the 1990-2001 period, per compound.

Table 4.5 Potential F-gases emissions per compound from the consumption of halocarbons and SF_6, 1990-2001, in $GgCO_2eq$

Compound	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
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
HFC 125	0,0	0,0	0,0	0,0	0,0	148,4	-36,4	47,6	-109,2	260,4	268,8	1671,6
HFC 134a	0,0	16,9	106,6	565,5	438,1	1739,4	2059,2	1886,3	4101,5	3367,0	2107,3	4371,9
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
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
SF_6	3752,3	2652,9	2079,3	3298,2	5066,8	3675,8	3451,2	4612,7	11495,9	3465,5	3919,6	5903,3
total F-gases	3752,3	2669,8	2185,9	3863,7	5504,9	5575,0	5519,6	6535,2	15551,9	7399,5	6447,0	12341,9

4.7.4. Source-specific recalculations

The time series of HFC emissions has been revised due to the addition of a new compound (HFC-134 uses in mobile air conditioners, since 1998) and a new sub-source (foam blowing).
SF_6 emissions from electrical equipment from 1990 to 1994, estimated according to IPCC Tier 2a approach, have also been revised using new activity data made available by the producers of these equipment.
In Table 4.6 the comparison between total estimation recalculated and previous estimation of the sector is given from 1990 to 2000, for every gases.

Table 4.6 Comparison between F-gases emissions recalculate and the previous estimates per gas from the consumption of halocarbons and SF_6 sector in $GgCO_2eq$ (1990-2000)

Compound	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
<u>HFCs</u>											
CRF 2003	351,0	355,4	358,8	355,4	481,9	671,3	448,6	750,8	1.169,6	1.986,0	1.986,0
CRF 2002	351,0	355,4	358,8	355,4	481,9	671,3	448,6	750,8	1.138,3	1.400,3	1.961,7
<u>PFCs</u>											
CRF 2003	237,5	231,4	205,8	203,6	212,5	272,5	176,8	184,3	201,4	231,7	231,7
CRF 2002	237,5	231,4	205,8	203,6	212,5	272,5	176,8	184,3	201,4	190,0	231,7
<u>SF_6</u>											
CRF 2003	332,9	356,4	358,3	370,4	415,7	601,5	682,6	728,6	604,8	493,4	493,4
CRF 2002	333,6	357,8	360,5	373,4	387,7	469,8	527,3	562,1	454,8	274,0	327,7

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

5.1 Overview of sector

Solvent use is responsible, in 2001, for 0.3% of CO_2 emissions and 32.2% 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.

5.2 Solvent use (3A-3D)

5.2.1. Source category description

In accordance with the indications in the IPCC Guidelines, the carbon contained in oil-based solvents, or released from these products, have been considered both as NMVOC emissions and in CO_2 emissions. 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).
Use and emissions of N_2O have not been estimated because no activity data and emission factors are at present available.

5.2.2. Methodological issues

Emissions of non-methane volatile organic compounds from solvent use have been estimated according to the CORINAIR method, applying numerous emission factors which are typical of the national productivity situation, in particular for paint application, solvent use in dry cleaning, solvent use in the printing and in the tanning industries.
The conversion of NMVOC emissions into CO_2 emissions has been made on the basis of specific factors suggested by ETC/ACC for the CORINAIR project, except for the 3.C sub-sector as suggested in the Common Reporting Format.
Activity data for 3.D have not been reported in the Common Reporting Format because they refer to different units (solvent amount, inhabitants, glues and ink production).

5.2.3. Uncertainty and time-series consistency

The uncertainty in CO_2 emissions from solvent use is estimated equal to 45%.
The decrease in emission levels from 1990 to 2001 is due to the reduction of solvent content in the products as a consequence of the application of International Protocols as well as National and European Directive concerning NMVOC emission reduction.
A further reduction is expected in the next years.

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 2001, agriculture was responsible for 50.2% of CH_4 and 54.7% 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.

Table 6.1 Trend in greenhouse gas emissions from the agriculture sector 1990-2001 (Gg)

Gas/ subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CH_4												
4A. Enteric Fermentation	648,81	660,72	632,29	620,02	628,62	636,05	628,34	627,05	619,11	607,95	603,48	608,60
4B. Manure management	191,08	189,68	184,34	182,73	178,25	183,15	185,04	185,04	186,80	183,89	183,27	187,91
4C. Rice cultivation	73,26	70,17	73,58	78,81	80,24	81,36	80,78	79,18	75,73	75,08	74,93	74,01
4F. Field burning of agriculture residues	0,62	0,68	0,66	0,64	0,64	0,62	0,64	0,57	0,64	0,62	0,58	0,53
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	12,83	13,59
4D. Agricul-ture soils	63,66	66,07	66,70	67,70	66,51	64,72	63,77	67,01	64,81	64,98	64,25	64,60
4F. Field burning of agriculture 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

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 (both direct and indirect, from animal production and from wetlands and waters) 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 soils emission	Key (L, T)
4D2	N_2O	Emissions from animal production	Key (L2, T2)
4D3	N_2O	Indirect emissions	Key (L, T2)
4D4	N_2O	Emissions from wetlands and waters	Key (L2, 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 35.1% (35.2% in the base year). The main livestock sources of emissions are dairy cattle and non-dairy cattle that shares respectively for 39.2% and 40.3% of enteric fermentation methane emissions (47.7% and 36.7% 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 every livestock category which has been multiplied by the population of each livestock category. Population data per each livestock category are published by the National Institute of Statistics (ISTAT) 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.
Concerning emission factors for cattle, they are based on the ingestion of dry matter (Crutzen et al., 1986; CRPA, 1994; INRA, 1988; NRC, 1984; Borgioli, 1981; Sauvant, 1985; Holter and Young, 1992) and on the protein content of the feed, as well as on the coefficients for conversion into methane of the energy ingested.
In order to quantify emissions in line with the method described in the IPCC Guidelines, a detailed procedure for bovines was used. Estimates were drawn taking into account Italian conditions, considering the availability of specific data for this situation and including information on milk productivity per head and type of diet. For dairy cows, account was taken of the significant differences in milk production at regional level and, consequently, of the intake of dry matter and nitrogenous waste excreted. The detailed methodology is described in CRPA 2000 (CRPA, 2000).
For dairy cattle, the Tier 2 approaches defined both in the guidelines and in the Good Practice Guidance were applied with the aim to check differences between the resulting emission factors and the national ones. In Table 6.2 average emission factors for dairy cattle from 1990 to 2001 are presented. National emission factors result from 3% to 8% higher than those derived by the application of the Tier 2 methods.

Table 6.2 CH_4 average emission factors for dairy cattle enteric fermentation from 1990 to 2001 (kg/head year)

	FE CH_4 National	FE CH_4 IPCC96	FE CH_4 GPG
1990	117,2	108,2	109,2
1991	122,2	116,9	117,9
1992	122,1	116,6	117,6
1993	119,1	111,5	112,5
1994	124,1	120,3	121,4
1995	121,6	117,7	118,7
1996	119,9	116,5	117,5
1997	117,6	114,1	115,1
1998	115,0	111,4	112,4
1999	113,0	109,7	110,7
2000	110,8	105,8	106,7
2001	110,8	105,8	106,7

The application of the Tier 2 methods requires the availability of various basic parameters, such as digestibility of feed and portion of cows giving birth, information which is not available at national level and therefore use of default values is necessary. For this reason, the national methodology is preferred although investigation on the information needed to apply the Tier 2 approaches is in progress. The value of emission factor for dairy cattle has reduced from 1990 to 2001 as a consequence of a more efficient use in ingested energy and a reduction in percentage of methane converted, from 5.5% to 5.0% (CRPA, 2000).
A simplified procedure was used for swine, sheep, goats, horses, mules and asses and rabbits. In these cases emission factors suggested by the Guidelines have been used.

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.
CH_4 emission trend for enteric fermentation is summarised in Table 6.1. 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 2,100,000 in 2001.
In the estimation of national dairy cattle emissions, the number of cows, the total amount of milk produced and the percentage of ingested energy converted in methane are the main factors that influence the quantity of CH_4 released.

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 2001 emissions of this sub-sector amount respectively for 10.8% and 9.5% of CH_4 and N_2O total emissions.

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 capable of 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 account of specific national features regarding rearing methods (feeding, rates of production, breeds reared, etc.) and of manure management. Furthermore, the procedure recognises the considerable importance of these categories of animals within the framework of livestock resources and the probability of obtaining the necessary data bases to allow detailed estimates. The detailed methodology is published in CRPA 2000 (CRPA, 2000).
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.
Regarding 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:

1. definition of the population for every livestock category;
2. estimate of the nitrogen excreted by every livestock category;
3. 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);
4. 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 have been updated on the basis of recent European literature (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.

6.4. Rice cultivation (4C)

6.4.1. Source category description

Methane emissions from rice cultivation are estimated. Other 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 2001 they share for 4.2% of total CH_4 emissions.

6.4.2. Methodological issues

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 (Tani, 2000).
During this field submersion time two or three water drainage periods, 2 to 4 days each, can happen in 85% of rice paddies, a clearly uninterrupted submersion in 13-14 % and 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 Italian South and in the Islands where water is scarce, drainage periods may be more than three per year and/or longer than 4 days (Russo 1997, Spanu et al. 1997), and can be more or less voluntary.
Physical-chemical characteristics of involved soils are extremely variable even within each 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 usually are 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 (Tani, 2000).
IPCC Guidelines have been followed to estimate methane emissions.
The method considers reduction factors related with water regime, referred to a maximum value 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 short and modest drainage periods in the Po valley, or of that more important in the South of Italy.
Similarly to "Irrigated, intermittently flooded, single aeration" it has been attributed the meaning of unique, one month or more delayed field submersion, assuming it

responsible for about 25% total emission reduction, therefore a value of 0.75. This value has been deduced from the results of Schütz (Schütz et al.,1989), assuming that the flooding delay generates a proportional reduction of the emissions (Tani, 2000).
As reference emission factor, 33 g/m^2 CH_4 per year has been chosen (Schütz et al.1989), which is an experimental value averaged over 3 years of measurements, referred to only the growing period, in the continuously flooded rice paddies in Pianura Padana, without organic matter amendment or mineral fertilisation (Tani, 2000).
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 (Tani, 2000).
Assuming that the area involved in rice straw and other organic matter amendments is 50% of total, the increment factor of 2 (Schütz et al.1989a, Yagi et al. 1990) has been applied, thus the average increment factor becomes 1.5 (50%*1+50%*2) (Tani, 2000).

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 1990 to 2001 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 estimate equal to 50%.
Lack of experimental data and of precise knowledge about the importance and the 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 (Tani, 2000).
The obvious relationship between emissions and temperature could encourage to use it in distinguishing provincial based emissions, thus improving assessments. Nevertheless, considering that the largest Italian rice production is in the Po valley, where monthly temperatures of the rice paddies are similar, and considering the uncertain knowledge of other emission control factors, the temperature emended emission factor couldn't introduce a substantial improvement in the uncertainty assessment (Tani, 2000).

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 82.6% of total N_2O agriculture emissions and 45.2% 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)
N_2O from Other agricultural soils (wetlands, waters)	Key (L2, T2)

6.5.2. Methodological issues

With regard to emissions from soils, the IPCC methodology greatly broadens the previously proposed procedure that only considered emissions derived from applications of synthetic nitrogen (commercial fertilisers).
According to the new 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:

1. amount of nitrogen from synthetic fertilisers;
2. amount of nitrogen from animal waste (excluding quantities excreted while grazing);
3. amount of nitrogen (or rather the nitrogen which remains in the soil) as a result of nitrogen fixation from nitrogen-fixing crops;
4. 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 (kg N_2O/ha cultivated per year). Emissions from animal waste excreted while grazing should also be calculated (in this case 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 (FAO database http://apps.fao.org/page/collections) 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 (survey on organic waste in Emilia Romagna). 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 supplied by the ISSD of Florence (Source: Carta Pedologica Mancini, 1961) have been used. 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 9000 hectares. Emission factors has been updated as suggested from the IPCC Good Practice Guidance from 5000 to 8000 kg N_2O per ha.
Nitrogen amount from animal waste and implied emission factors reflect national circumstances, as above 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 2001 an average percentage is equal to 38%), instead of applying the default IPCC emission factor equal to 20%.
N_2O emissions from wetland and waters have been estimated on the basis of basic data published by the National Environmental Ministry (MAMB, 1992) and CORINAIR emission factors (CITEPA, 1990) and reported under “other emissions”.

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. Concerning the livestock, data supplied by the National Institute of Statistics have been used (see above 6.2 and 6.3 paragraphs). Concerning the synthetic fertilisers and the N content, a comparison with the international FAO database has been done as indicated in the review processes. In Table 6.3 national and FAO time series of total N applied is reported.

Table 6.3 Total annual N in fertiliser applied from 1990 to 2001 (tonnes)

Year	National data	FAO database
1990	757.509	857.000
1991	837.402	906.000
1992	884.121	909.000
1993	945.290	918.000
1994	875.536	882.000
1995	797.500	875.000
1996	756.057	876.000
1997	856.945	855.000
1998	774.707	845.000
1999	791.982	868.000
2000	790.253	828.000
2001	790.253	

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.

6.6. 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).
Residue/crop ratio, dry matter fraction of residue and fractions burned in fields come from national data (CESTAAT, 1996; CNR-CRPA,1999).

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 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 18,7 Mt of CO_2 removals from the atmosphere in 2001. This is as a result of the availability of data from national statistics and from research at national and regional level, which have made it possible to apply the method contained in the 1996 IPCC Guidelines (for categories 5A, 5C and 5D) in their entirety or to adapt them to the present situation in Italy (category 5B).
Emissions of this sector have not been included in the key source analysis.

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 1990-2001 (Federici, Valentini, 2002).
To this end the annual increase per hectare of coppice and high forest was calculated on the basis of regional forest inventories, the National Forest Inventory (ISAFA, 1985), and the application of specific curves for the different species. This increase was about 3.9-4.8 m3/ha/year for coppice and 7.7 m3/ha/year for high forest (as an average for areas of broad leaved high forest and coniferous high forest). These values were then multiplied by the biomass densities, which, were taken as equal to 607,5 g/m3 for coppices, and as 440.7 kg/m3 for high forests, average values, taking into account the diversity of species in the Italian forests, to obtain the annual increase expressed in tonnes/ha (Federici, Valentini, 2002). The last value was then multiplied by the data for the area of forest in hectares shown in the National statistics, subdivided according to type (high forest or coppice), always referring to 1990-2001. In this way the annual increase in woody biomass was obtained for the whole country.
A carbon content of 0.5 was considered to calculate total annual C uptake. Carbon amount released by forest fires was subtracted to the total uptake.
The C content of removed biomass (timber use) was subtracted from this figure. Timber use for construction and energy purposes was estimated, expressed for coppices and high forests in m3 from national statistics. These figures were multiplied by biomass densities, which allows the data for m3 to be converted into dry matter.

7.3 Forest and grassland conversion (5B)

In Italy, in consideration of national normative, forest fires can not affect changes in land use. Then conversion of Forest and Grassland does not take place in Italy. Anyway emissions from forest fires are estimated and counted in Table 5.A. 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 of it is used as fuel off-site. The situation is different in Italy: fires are not managed events, as in tropical countries, but are nearly always an undesirable occurrence. Despite this, man causes more than 95% of fires and there fore the emissions are considered to be from anthropogenic.
Immediate emissions of CO_2 from the site of the fire 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 biomass which has been burnt in the years 1990-2001, national statistics on areas affected by fire according to forestry use- high forest (resinous, broadleaves, resinous and associated broadleaves) and coppice (simple, compound and degraded) and according to region were used.
To estimate the biomass in these areas, reference was made to a detailed research (Bovio,1996), which sets out the different types of vegetation in the Italian regions with different figures for burnable biomass per hectare. These figures were multiplied by the areas hit by fire, to obtain the total biomass burnt for every vegetation type per region. This data was put together to provide a figure for biomass burnt nationally between 1990 and 2001. The figure for 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 calculation of emissions from decayed biomass was made in the same way as calculation of immediate emissions from biomass. The average for decayed biomass was then multiplied by the average figure proposed by the method (0.5), which represents the fraction of biomass that is left to decay over a period of time.
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 2001.

The IPCC method was followed for CH_4, CO, N_2O, NO_x emissions, multiplying the amount of C released in 1990-2001 by the emission factors suggested.
The 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 2001 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 emission and removals from soil (5D)

To estimate emissions or removals in relation to 1990-2001 we have considered the changes in areas by type of agricultural practices in terms of surface area in the twenty years periods 1970-1990, …, 1981-2001. The data used for land area were those provided by the National Statistics Institute. Around 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. 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 (Reference Manual, Table 5-10) 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. The figures obtained are equivalent to 1,4 Tg CO_2 for 1990, 2,3 Tg CO_2 for 2001. The figures refer to CO_2 emission, illustrating 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 results in an increase in the decomposition of carbon 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 that have 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.

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 9C, 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 1990-2001 (Gg)

Gas/ subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
<u>CO_2</u>												
6C. Waste incineration	911,7	902,9	920,6	989,0	1031,1	1105,3	1017,1	1001,8	1083,5	761,1	922,9	887,6
<u>CH_4</u>												
6A. Solid waste disposal on land	453,6	461,3	415,2	419,3	435,4	455,1	460,0	460,5	452,8	444,5	449,2	455,0
6B. Waste-water handling	63,1	64,5	65,9	64,2	63,9	62,9	63,6	63,5	63,7	64,1	63,7	63,2
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	12,2
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

(continued)

(continued)

Gas/ subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
N_2O												
6B. Waste-water handling	3,1	3,1	3,1	3,1	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2
6C. Waste incineration	0,3	0,5	0,4	0,5	0,5	0,5	0,4	0,5	0,5	0,5	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 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 (L, T)
6B	N_2O	Emissions from wastewater handling	Key (T2)
6C	CO_2	Emissions from waste incineration	Key (T1)
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 1.75% (and was 1.87% in the base year 1990).

8.2.2. Methodological issues

In order to calculate the methane emissions from all the landfill sites in Italy, the simplifying assumption was made that all the wastes are assumed to be 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 kinetics (Equation 5 of the 1996 IPCC Guidelines). This is equivalent to an IPCC Tier 2 methodology.
Since methane emissions from landfills are a key source (see above), the present methodology does comply with the IPCC Good Practice Guidance (IPCC, 2000).
Apart from solid urban 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.

Parameter values used in the landfill emissions model are:

- total amount of land filled waste;
- fraction of Degradable Organic Carbon (DOC);
- methane generation (i.e. decomposition) rate constant (k);
- methane oxidation factor;
- fraction methane in land filled waste;
- fraction of DOC actually dissimilated (DOC_F);
- methane conversion factor (IPCC parameter).

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, a percentage of degradable organic carbon of 11% has been obtained. A CH_4 generation rate constant of 0.4 has been assumed, due to the high moisture content in Italian landfill sites. The fraction of degradable organic carbon actually dissimilated has assumed to be 0.1. Methane conversion factors of 1.0 for managed landfills and 0.6 for unmanaged sites have been assumed. CH_4 fraction in landfill gas has been assumed equal to 50%.

8.2.3. Uncertainty and time-series consistency

The uncertainty in CH_4 emissions from solid waste disposal sites is estimated to be about 30% in annual emissions.

The CH_4 emission trend for landfills is summarised in Table 8.2: this table also shows the amount of CH_4 that has been recovered (mostly for energy use).
In the period 1990-2001 the emissions of CH_4 show only slight changes, despite a 43.7% increase in the amount of waste which is land filled. This decrease is due to the seven-fold increase of the amount of methane recovered in solid waste disposal sites.
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.

Table 8.2 Net methane emissions and methane recovered from solid waste disposal sites 1990-2001 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Land filled waste	13797	14963	16134	17825	18590	18202	18725	19432	19852	21231	21778	19826
CH_4 emissions (net)	459,9	467,9	422,2	426,7	443,2	463,3	468,3	468,9	461,1	452,8	457,7	462,3
CH_4 recovered/ flared	24,4	44,0	119,0	142,7	158,7	166,1	170,9	175,8	180,7	185,6	190,5	195,4
% 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	29,7

8.3 Wastewater handling (6B)

8.3.1. Source category description

In Italy sewage is treated mainly using aerobic treatment plants. 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.
Emissions from sludge disposal have not been accounted for in this source category; they have been included in the source category corresponding to the final disposal (land filling, spreading on agricultural land, incineration).

8.3.2. Methodological issues

As concerns domestic and commercial wastewaters, the default approach suggested by the IPCC Guidelines, and updated in the Good Practice Guidance, based on

population and per capita BOD_5 output value provided in Table 6-5 has been used. However, the total organic load has been used to estimate only N_2O emissions, since no CH_4 emissions are assumed to be released by aerobic treatment systems.
The estimation concerning industrial wastewaters makes use of the IPCC method based on wastewater output and the respective Degradable Organic Component for each major industrial wastewater source.
As recommended by the Good Practice Guidance for key source categories, data have been collected for several industrial sectors (food and beverage, paper and pulp, organic chemicals, iron and steel, textile industry).
In the last submission, new figures provided by the national pulp and paper industry have been used.

8.3.3. Uncertainty and time-series consistency

The uncertainty in CH_4 emissions from wastewater handling is estimated to be about 100% in annual emissions.
The emission trend for CH_4 emissions from industrial wastewater handling is shown in Table 8.3; neither wastewater flow nor average COD value change much over time, therefore emissions are stable.

Table 8.3 CH_4 emissions from industrial wastewater handling 1990-2001

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CH_4 emissions (Gg)	63,1	64,5	65,9	64,2	63,9	62,9	63,6	63,5	63,7	64,1	63,7	63,2
Wastewaters (1000000 m^3)	1022,5	1033,8	1055,5	1028,8	1055,2	1048,0	1069,6	1076,9	1060,5	1047,3	1030,9	1014,0
Average COD value (g/m^3)	61,7	62,4	62,5	62,4	60,5	60,0	59,5	59,0	60,0	61,2	61,8	62,4

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 9C (Waste incineration).
Emissions from removable residues from agricultural production were included in the same IPCC category.

8.4.2. Methodological issues

Specifically, all emissions from the incineration of industrial, hospital, sewage sludge and waste oil waste have been included in 6C, together with a percentage of emissions from municipal waste and other land filled waste equivalent to 29.6% in 1990 and 10.2% in 2001.
To quantify the amount of waste incinerated, various available sources relating to the period 1990-2001 were used (RSA 1992; RSA 1997; Assoambiente 1995; ENEA 1995; ENEA 1996; Di Marzio, 1994; ANPA 2000; APAT/ONR, 2002), using deductions for the years for which there was no available data. Activity data have been collected by waste type, as required by the Good Practice Guidance for key sources.
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 was 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 the absence of specific data, reference was made to the emission limits prescribed by the Guidelines for the authorisation of existing plans issued on the 12.7.90.

With regard to municipal waste, on the basis of the IPCC guidelines 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.

8.4.3. Uncertainty and time-series consistency

The uncertainty in CO_2 emissions from waste incineration is estimated to be about 25% in annual emissions.
The emission trend for CO_2 emissions from industrial waste incineration is shown in Table 8.4 both for plants without energy recovery, reported under 6C, and plants with energy recovery, reported under 1A.
In the period 1990-2001, total emissions have increased by 19.4%; but whereas emissions from plants with energy recovery have increased by 67.7%, emissions from plants without energy recovery have decreased by 2.6%.

Table 8.4 CO_2 emissions from waste incineration (without and with energy recovery), 1990-2001 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Incineration of domestic or municipal wastes	99,9	88,9	84,8	84,8	131,6	137,3	110,5	151,6	155,9	101,4	95,9	72,3
Incineration of industrial wastes (except flaring)	679,3	678,3	684,0	739,9	735,6	825,7	782,8	746,9	824,6	556,9	725,2	713,5
Incineration of hospital wastes	124,5	124,5	142,1	159,6	159,6	138,0	120,0	99,3	99,3	99,3	99,3	99,3
Incineration of waste oil	8,0	11,1	9,7	4,6	4,3	4,2	3,8	4,0	3,7	3,4	2,5	2,5
Waste incineration (6C)	911,7	902,9	920,6	989,0	1031,1	1105,3	1017,1	1001,8	1083,5	761,1	922,9	887,6
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	58,1
Commercial/ Institutional (1A4a)	237,6	259,4	287,8	312,0	322,4	353,5	343,8	353,3	407,6	511,7	575,2	638,8
MSW incineration reported under 1A	415,6	428,4	422,0	395,2	390,4	418,2	393,4	402,1	440,0	543,4	633,3	696,9
Total waste incineration	**1327,3**	**1331,2**	**1342,5**	**1384,1**	**1421,5**	**1523,4**	**1410,5**	**1403,9**	**1523,5**	**1304,4**	**1556,2**	**1584,5**

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 10-fold increase in Italy from 363,519 in 1990 to 3,440,000 in 2001.

8.5.2. Methodological issues

Since no methodology is provided by the IPCC for these emissions, literature data (Hogg, 2001) have been used for the emission factor (0.029 kgCH_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. Thus the improvement of the inventory quality. Specifically this year, in addition to the usual updating of activity data, which can affect also previous years information, methodological revisions have regarded the use of the IPCC Good Practice Guidance.

CRF tables on recalculation have not been filled in terms of quantity values (also because CRF files have not been compiled and submitted for the entire time series 1990-2001), but major changes have been explained by means of methodological clarifications.

Table 10.1 shows the main explanations with regard to discrepancies from the last year submission.

9.2 Implications for emission levels

The most relevant changes affected the last year as well as the base year.

The time series reported in Table 10s5 of the CRF 2000 and CRF 2001 have been compared. Both the series are shown in Table 10.2.

9.3 Implications for emission trends, including time series consistency

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 inventory estimates.

In comparison with the submission 2002, the base year emission levels (total emissions in CO_2 equivalent without CO_2 emissions from LUCF) decreased by 2.3%. Specifically, for CO_2 there has been a decrease of 2.5%, CH_4 levels have fallen by 1.8%, N_2O has increased by 0.2%, while for the F-gases there has been an overall revision.

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.

Table 9.1 Explanations of the main recalculations in the submission of the CRF 2001

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

Italy
2001
2003

Specify the sector and source/sink category(1) where changes in estimates have occurred:		GHG	RECALCULATION DUE TO			
			CHANGES IN:			Addition/removal/ replacement of source/sink categories
			Methods (2)	Emission factors (2)	Activity data (2)	
6B1	Industrial Waste-water handling	CH4, N2O		National data from pulp and paper industry have been used	National data from pulp and paper industry have been used	
4D	Agriculture Soil	N2O	Methodology has been improved substracting from N-N20 produced, NH3 and NOx emission estimated instead of a 20% default value as reported in the guidelines			
2B3	Adipic acid	N2O		Conservative emission factor supplied by industry was adopted (0,333 instead of 0,300)		
2A2	Lime production	CO2			Revision of basic data considering only decarbonised products	
2A1	Cement Production	CO2	Good Practice Guidance has been used, calculating emission on the basis of clinker production instead of cement production		Clinker production instead of cement production	
1A1	Energy Industries	CO2, CH4, N2O			Preliminary revision of National Energy data and their sectoral distribution as result of a review work in progress. Double counting has been corrected.	
1A2	Manufacturing Industries	CO2, CH4, N2O			Preliminary revision of National Energy data and their sectoral distribution as result of a review work in progress. Double counting has been corrected.	
1A3	Transport	CO2, CH4, N2O			Update of 2000 data concerning maritime and aviation basic data.	Natural gas for Road Transport estimation has been added

(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 Mt CO2 equivalent.

Table 9.2 Comparison of the time series submitted in the CRF 2000 and CRF 2001

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	404.645,70	404.645,70	404.801,07	405.968,50	397.850,10	393.518,39	419.386,66	413.892,43	421.758,96	433.668,97	438.875,18	445.332,00	442.107,83
CO2 emissions (without LUCF) (6)	428.178,18	428.178,18	427.977,17	427.785,83	418.542,02	412.964,43	438.984,51	434.114,76	439.522,90	451.095,13	456.587,11	460.964,76	460.762,75
CH4	38.659,15	38.659,15	39.068,12	37.321,92	36.931,26	37.310,93	37.856,83	37.712,70	37.676,25	37.128,34	36.716,85	36.546,32	36.420,06
N2O	40.869,97	40.869,97	42.219,21	41.410,52	41.635,46	40.783,85	41.998,13	41.535,83	42.735,40	42.408,65	43.291,56	43.529,07	44.348,52
HFCs	671,29	351,00	355,43	358,78	355,42	481,90	671,29	448,64	750,79	1.169,57	1.436,58	1.985,96	2.730,30
PFCs	272,46	237,50	231,35	205,84	203,57	212,48	272,46	176,79	184,26	201,37	190,02	231,66	301,70
SF6	601,45	332,92	356,39	358,26	370,40	415,66	601,45	682,56	728,64	604,81	404,51	493,43	794,96
Total (with net CO2 emissions/removals)	**485.720,03**	**485.096,24**	**487.031,58**	**485.623,84**	**477.346,21**	**472.723,21**	**500.786,82**	**494.448,96**	**503.834,30**	**515.181,71**	**520.914,69**	**528.118,45**	**526.703,37**
Total (without CO2 from LUCF) (6) (8)	**509.252,51**	**508.628,72**	**510.207,68**	**507.441,17**	**498.038,13**	**492.169,25**	**520.384,67**	**514.671,28**	**521.598,24**	**532.607,86**	**538.626,62**	**543.751,20**	**545.358,30**

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	420.022,42	420.022,42	419.983,17	418.860,19	412.290,01	407.254,69	432.150,99	429.152,44	434.409,64	445.783,69	451.660,68	455.114,09	454.315,83
2. Industrial Processes	31.734,16	31.110,37	31.298,76	31.349,16	28.400,77	27.426,31	30.398,27	28.152,28	28.769,88	29.403,77	30.929,79	32.231,96	34.090,13
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	1.428,58	1.418,81	1.359,74	1.351,09	1.330,78	1.264,72
4. Agriculture	42.775,45	42.775,45	43.822,19	43.231,89	43.263,75	43.100,21	42.978,39	42.584,50	43.575,46	42.757,94	42.481,44	42.005,15	42.534,72
5. Land-Use Change and Forestry (7)	-23.532,48	-23.532,48	-23.176,10	-21.817,32	-20.691,92	-19.446,03	-19.597,85	-20.222,33	-17.763,94	-17.426,15	-17.711,93	-15.632,76	-18.654,92
6. Waste	12.986,98	12.986,98	13.379,44	12.370,31	12.521,34	12.880,76	13.384,65	13.353,47	13.424,44	13.302,72	12.883,56	13.069,22	13.152,91
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

(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.

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

Italy
2000
2002

GREENHOUSE GAS EMISSIONS	Base year(1)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	CO2 equivalent (Gg)											
Net CO2 emissions/removals	415.945,64	415.945,64	414.501,36	415.475,44	405.237,17	400.227,06	425.411,33	418.843,21	424.351,95	436.925,74	439.484,95	446.937,01
CO2 emissions (without LUCF) (6)	439.478,11	439.478,11	437.677,47	437.292,77	425.929,09	419.673,09	445.009,19	439.065,54	442.115,89	454.351,89	457.201,90	463.381,26
CH4	39.387,33	39.387,33	39.780,43	38.019,22	37.612,11	38.110,11	38.739,30	38.567,74	38.639,11	38.135,25	37.743,10	37.825,91
N2O	40.783,39	40.783,39	42.165,77	41.483,99	41.744,55	40.754,45	42.016,17	41.656,55	42.859,01	42.433,87	43.213,51	43.176,52
HFCs	671,29	351,00	355,43	358,78	355,42	481,90	671,29	448,64	750,79	1.138,30	1.400,29	1.961,68
PFCs	272,46	237,50	231,35	205,84	203,57	212,48	272,46	176,79	184,26	201,37	190,02	231,66
SF6	469,80	333,56	357,85	360,49	373,38	387,67	469,80	527,26	562,06	454,79	273,97	327,72
Total (with net CO2 emissions/removals)	**497.529,91**	**497.038,41**	**497.392,20**	**495.903,76**	**485.526,20**	**480.173,66**	**507.580,35**	**500.220,18**	**507.347,18**	**519.289,32**	**522.305,84**	**530.460,50**
Total (without CO2 from LUCF) (6) (8)	**521.062,38**	**520.570,88**	**520.568,30**	**517.721,08**	**506.218,12**	**499.619,70**	**527.178,20**	**520.442,51**	**525.111,11**	**536.715,48**	**540.022,80**	**546.904,75**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year(1)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	CO2 equivalent (Gg)											
1. Energy	425.200,98	425.200,98	423.613,04	422.673,80	415.553,14	409.984,97	435.209,04	430.075,06	433.112,55	444.647,29	447.694,29	452.520,09
2. Industrial Processes	37.089,95	36.598,45	36.689,74	36.516,19	32.065,41	30.733,21	32.609,72	31.533,22	32.014,02	33.238,32	33.984,14	36.241,67
3. Solvent and Other Product Use	1.679,72	1.679,72	1.675,29	1.581,28	1.514,46	1.459,60	1.425,19	1.378,38	1.366,19	1.307,78	1.298,60	1.293,02
4. Agriculture	43.354,53	43.354,53	44.477,07	43.859,44	43.854,71	43.767,08	43.663,97	43.223,27	44.263,17	43.266,80	42.895,49	42.638,57
5. Land-Use Change and Forestry (7)	-23.532,48	-23.532,48	-23.176,10	-21.817,32	-20.691,92	-19.446,03	-19.597,85	-20.222,33	-17.763,94	-17.426,15	-17.716,96	-16.444,25
6. Waste	13.737,20	13.737,20	14.113,16	13.090,37	13.230,40	13.674,83	14.270,29	14.232,57	14.355,19	14.255,29	14.150,28	14.211,39
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

(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.

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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 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.
However, a trend analysis has been performed even though the GHG emission inventory has not been communicated till now in CRF formats for the base year,

specifically 1990 and 1995 for fluorurate gases. Nevertheless, the update of the national GHG inventory from 1990 onwards is available in excel files according to CRF disaggregation.
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 sources arises from the level assessment or the trend assessment.
As far as level emission sources are concerned 25 key sources were individuated accounting for the 95% of the total emission. For the trend, 26 key sources were selected. Jointly for both the level and trend, 28 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 production of SF_6.

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

TIER 1						
CATEGORIES	2001 Gg CO_2eq	Level assessment	Cumulative Percentage	CATEGORIES	% Contribution to trend	Cumulative Percentage
CO2 stationary combustion gaseous fuels	131.741	0,24	0,24	CO2 stationary combustion gaseous fuels	0,32	0,32
CO2 stationary combustion liquid fuels	127.690	0,23	0,48	CO2 stationary combustion liquid fuels	0,31	0,62
CO2 Mobile combustion: Road Vehicles	114.835	0,21	0,69	CO2 Mobile combustion: Road Vehicles	0,11	0,73
CO2 stationary combustion solid fuels	51.064	0,09	0,78	CO2 stationary combustion solid fuels	0,08	0,81
CO2 Cement production	15.435	0,03	0,81	N2O Adipic Acid	0,02	0,83
CH4 Enteric Fermentation in Domestic Livestock	12.781	0,02	0,83	HFC, PFC substitutes for ODS	0,02	0,85
CH4 from Solid waste Disposal Sites	9.556	0,02	0,85	CH4 Fugitive emissions from Oil and Gas Operati	0,02	0,87
Direct N2O Agricultural Soils	8.898	0,02	0,87	CO2 Other industrial processes	0,02	0,88
N2O Adipic Acid	7.772	0,01	0,88	CH4 Enteric Fermentation in Domestic Livestock	0,01	0,90
Indirect N2O from Nitrogen used in agriculture	7.461	0,01	0,89	N2O Mobile combustion: Road Vehicles	0,01	0,91
N2O stationary combustion	6.645	0,01	0,91	N2O Nitric Acid	0,01	0,92
CO2 Mobile combustion: Waterborne Navigation	6.639	0,01	0,92	CO2 Mobile combustion: Aircraft	0,01	0,93
CH4 Fugitive emissions from Oil and Gas Operation	5.085	0,01	0,93	N2O stationary combustion	0,01	0,93
N2O Manure Management	4.213	0,01	0,93	Direct N2O Agricultural Soils	0,01	0,94
CH4 Manure Management	3.946	0,01	0,94	CO2 Mobile combustion: Other	0,01	0,95
N2O Mobile combustion: Road Vehicles	3.268	0,01	0,95	CO2 Mobile combustion: Waterborne Navigation	0,01	0,96
CO2 Mobile combustion: Aircraft	2.722	0,00	0,95	CO2 Cement production	0,01	0,96
HFC, PFC substitutes for ODS	2.701	0,00	0,96	CH4 from Solid waste Disposal Sites	0,01	0,97
CO2 Lime production	2.570	0,00	0,96	CO2 Emissions from Other Sources (solvent use)	0,00	0,97
CO2 Other industrial processes	2.282	0,00	0,97	SF6 Magnesium production	0,00	0,97
N2O from animal production	2.188	0,00	0,97	HFC-23 from HFC-22 Manufacture	0,00	0,98
CH4 from Rice production	1.554	0,00	0,97	CO2 Lime production	0,00	0,98
N2O from Other agricultural soils (wetlands, waters)	1.478	0,00	0,98	CH4 Manure Management	0,00	0,98
CO2 Mobile combustion: Other	1.349	0,00	0,98	CO2 Fugitive emissions from Oil and Gas Operati	0,00	0,98
CH4 Emissions from Wastewater Handling	1.328	0,00	0,98	SF6 Electrical Equipment	0,00	0,99
CO2 Fugitive emissions from Oil and Gas Operation	1.296	0,00	0,98	PFC, HFC, SF6 Semiconductor manufacturing	0,00	0,99
CO2 Emissions from Other Sources (solvent use)	1.265	0,00	0,99	N2O from animal production	0,00	0,99
N2O Nitric Acid	1.102	0,00	0,99	Indirect N2O from Nitrogen used in agriculture	0,00	0,99
CO2 Iron and Steel production	988	0,00	0,99	SF6 Production of SF6	0,00	0,99
N2O Emissions from Wastewater Handling	986	0,00	0,99	N2O Mobile combustion: Other	0,00	0,99
CH4 stationary combustion	918	0,00	0,99	N2O from Other agricultural soils (wetlands, wate	0,00	0,99
CO2 Emissions from Waste Incineration	888	0,00	1,00	N2O Manure Management	0,00	0,99
CH4 Mobile combustion: Road Vehicles	775	0,00	1,00	CH4 from Rice production	0,00	0,99
SF6 Magnesium production	450	0,00	1,00	CH4 Emissions from Wastewater Handling	0,00	1,00
SF6 Electrical Equipment	296	0,00	1,00	CO2 Emissions from Waste Incineration	0,00	1,00
PFC, HFC, SF6 Semiconductor manufacturing	275	0,00	1,00	CH4 Emissions from Waste Incineration	0,00	1,00
CH4 Emissions from Waste Incineration	256	0,00	1,00	CH4 stationary combustion	0,00	1,00
N2O Emissions from Waste Incineration	138	0,00	1,00	N2O Mobile combustion: Waterborne Navigation	0,00	1,00
N2O Mobile combustion: Waterborne Navigation	119	0,00	1,00	CH4 Fugitive emissions from Coal Mining and Ha	0,00	1,00
CH4 Industrial Processes	115	0,00	1,00	N2O Emissions from Wastewater Handling	0,00	1,00
PFC Aluminium production	83	0,00	1,00	N2O Emissions from Waste Incineration	0,00	1,00
CH4 Fugitive emissions from Coal Mining and Handling	64	0,00	1,00	CO2 Iron and Steel production	0,00	1,00
N2O Mobile combustion: Other	56	0,00	1,00	CH4 Mobile combustion: Road Vehicles	0,00	1,00
CH4 Mobile combustion: Waterborne Navigation	26	0,00	1,00	CH4 Industrial Processes	0,00	1,00
HFC-23 from HFC-22 Manufacture	22	0,00	1,00	N2O Mobile combustion: Aircraft	0,00	1,00
N2O Mobile combustion: Aircraft	21	0,00	1,00	CH4 Mobile combustion: Waterborne Navigation	0,00	1,00
CH4 Agricultural Residue Burning	11	0,00	1,00	CH4 Agricultural Residue Burning	0,00	1,00
N2O Agricultural Residue Burning	4	0,00	1,00	CH4 Mobile combustion: Other	0,00	1,00
CH4 Mobile combustion: Other	3	0,00	1,00	CH4 Emissions from Other Waste	0,00	1,00
CH4 Emissions from Other Waste	2	0,00	1,00	PFC Aluminium production	0,00	1,00
CH4 Mobile combustion: Aircraft	1	0,00	1,00	N2O Agricultural Residue Burning	0,00	1,00
SF6 Production of SF6	0	0,00	1,00	CH4 Mobile combustion: Aircraft	0,00	1,00
CH4 Savanna Burning	0	0,00	1,00	SF6 Other sources of SF6	0,00	1,00
N2O Savanna Burning	0	0,00	1,00	CH4 from Other agriculture	0,00	1,00
CH4 from Other agriculture	0	0,00	1,00	CH4 Savanna Burning	0,00	1,00
SF6 Other sources of SF6	0	0,00	1,00	N2O Savanna Burning	0,00	1,00

The application of the Tier 1 gives as a result 17 key sources accounting for the 95% of the total levels uncertainty; when applying the trend analysis the key sources decreased to 16 with 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 A1.2 Results of the uncertainty analysis (Tier1).

Tier 1 Uncertainty calculation and reporting

IPCC Sorce category	Gas	Base year emissions 1990/1995	Year t emissions 2001	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
CO2 stationary combustion liquid fuels	CO2	156.432	127.690	3%	3%	0,042	0,010	-0,078	0,251	-0,002	0,011
CO2 stationary combustion solid fuels	CO2	57.387	51.064	3%	3%	0,042	0,004	-0,020	0,100	-0,001	0,004
CO2 stationary combustion gaseous fuels	CO2	84.835	131.741	3%	3%	0,042	0,010	0,080	0,259	0,002	0,011
CH4 stationary combustion	CH4	780	918	3%	50%	0,501	0,001	0,000	0,002	0,000	0,000
N2O stationary combustion	N2O	7.166	6.645	3%	50%	0,501	0,006	-0,002	0,013	-0,001	0,001
CO2 Mobile combustion: Road Vehicles	CO2	93.984	114.835	3%	3%	0,042	0,009	0,028	0,225	0,001	0,010
CH4 Mobile combustion: Road Vehicles	CH4	741	775	3%	10%	0,104	0,000	0,000	0,002	0,000	0,000
N2O Mobile combustion: Road Vehicles	N2O	1.597	3.268	3%	50%	0,501	0,003	0,003	0,006	0,002	0,000
CO2 Mobile combustion: Waterborne Navigation	CO2	5.419	6.639	3%	3%	0,042	0,001	0,002	0,013	0,000	0,001
CH4 Mobile combustion: Waterborne Navigation	CH4	29	26	3%	10%	0,104	0,000	0,000	0,000	0,000	0,000
N2O Mobile combustion: Waterborne Navigation	N2O	39	119	3%	50%	0,501	0,000	0,000	0,000	0,000	0,000
CO2 Mobile combustion: Aircraft	CO2	1.547	2.722	3%	3%	0,042	0,000	0,002	0,005	0,000	0,000
CH4 Mobile combustion: Aircraft	CH4	1	1	3%	10%	0,104	0,000	0,000	0,000	0,000	0,000
N2O Mobile combustion: Aircraft	N2O	12	21	3%	50%	0,501	0,000	0,000	0,000	0,000	0,000
CO2 Mobile combustion: Other	CO2	2.113	1.349	3%	5%	0,058	0,000	-0,002	0,003	0,000	0,000
CH4 Mobile combustion: Other	CH4	5	3	3%	50%	0,501	0,000	0,000	0,000	0,000	0,000
N2O Mobile combustion: Other	N2O	152	56	3%	50%	0,501	0,000	0,000	0,000	0,000	0,000
CH4 Fugitive emissions from Coal Mining and Handling	CH4	117	64	3%	300%	3,000	0,000	0,000	0,000	0,000	0,000
CO2 Fugitive emissions from Oil and Gas Operations	CO2	999	1.296	3%	25%	0,252	0,001	0,000	0,003	0,000	0,000
CH4 Fugitive emissions from Oil and Gas Operations	CH4	6.665	5.085	3%	25%	0,252	0,002	-0,004	0,010	-0,001	0,000
CO2 Cement production	CO2	15.104	15.435	3%	8%	0,085	0,002	-0,001	0,030	0,000	0,001
CO2 Lime production	CO2	2.762	2.570	3%	8%	0,085	0,000	-0,001	0,005	0,000	0,000
CO2 Iron and Steel production	CO2	946	988	3%	8%	0,085	0,000	0,000	0,002	0,000	0,000
CO2 Other industrial processes	CO2	4.004	2.282	3%	8%	0,085	0,000	-0,004	0,004	0,000	0,000
N2O Adipic Acid	N2O	5.083	7.772	3%	10%	0,104	0,001	0,005	0,015	0,000	0,001
N2O Nitric Acid	N2O	2.169	1.102	3%	10%	0,104	0,000	-0,002	0,002	0,000	0,000
CH4 Industrial Processes	CH4	121	115	3%	50%	0,501	0,000	0,000	0,000	0,000	0,000
PFC Aluminium production	PFC	79	83	5%	50%	0,502	0,000	0,000	0,000	0,000	0,000
SF6 Magnesium production	SF6	0	450	5%	5%	0,071	0,000	0,001	0,001	0,000	0,000
SF6 Electrical Equipment	SF6	482	296	5%	10%	0,112	0,000	0,000	0,001	0,000	0,000
SF6 Other sources of SF6	SF6	0	0	50%	50%	0,707	0,000	0,000	0,000	0,000	0,000
SF6 Production of SF6	SF6	120	0	50%	50%	0,707	0,000	0,000	0,000	0,000	0,000
PFC, HFC, SF6 Semiconductor manufacturing	PFC-HF	59	275	50%	50%	0,707	0,000	0,000	0,001	0,000	0,000
HFC, PFC substitutes for ODS	HFC	365	2.701	50%	50%	0,707	0,004	0,005	0,005	0,002	0,004
HFC-23 from HFC-22 Manufacture	HFC	441	22	50%	50%	0,707	0,000	-0,001	0,000	0,000	0,000
CH4 Enteric Fermentation in Domestic Livestock	CH4	13.625	12.781	20%	20%	0,283	0,007	-0,004	0,025	-0,001	0,007
CH4 Manure Management	CH4	4.013	3.946	20%	50%	0,539	0,004	-0,001	0,008	0,000	0,002
N2O Manure Management	N2O	3.846	4.213	20%	100%	1,020	0,008	0,000	0,008	0,000	0,002
CH4 Savanna Burning	CH4	0	0			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
CH4 Agricultural Residue Burning	CH4	13	11	50%	20%	0,539	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
Direct N2O Agricultural Soils	N2O	9.263	8.898	20%	25%	0,320	0,005	-0,002	0,017	-0,001	0,005
Indirect N2O from Nitrogen used in agriculture	N2O	7.125	7.461	20%	50%	0,539	0,007	0,000	0,015	0,000	0,004
CH4 from Rice production	CH4	1.539	1.554	3%	50%	0,501	0,001	0,000	0,003	0,000	0,000
CH4 from Other agriculture	CH4	0	0			0,000	0,000	0,000	0,000	0,000	0,000
N2O from animal production	N2O	1.869	2.188	20%	100%	1,020	0,004	0,000	0,004	0,000	0,001
N2O from Other agricultural soils (wetlands, waters)	N2O	1.478	1.478	20%	100%	1,020	0,003	0,000	0,003	0,000	0,001
CH4 from Solid waste Disposal Sites	CH4	9.526	9.556	20%	20%	0,283	0,005	-0,001	0,019	0,000	0,005
CH4 Emissions from Wastewater Handling	CH4	1.324	1.328	100%	30%	1,044	0,003	0,000	0,003	0,000	0,004
N2O Emissions from Wastewater Handling	N2O	968	986	30%	30%	0,424	0,001	0,000	0,002	0,000	0,001
CO2 Emissions from Waste Incineration	CO2	912	888	5%	25%	0,255	0,000	0,000	0,002	0,000	0,000
CH4 Emissions from Waste Incineration	CH4	160	256	5%	100%	1,001	0,000	0,000	0,001	0,000	0,000
N2O Emissions from Waste Incineration	N2O	97	138	5%	100%	1,001	0,000	0,000	0,000	0,000	0,000
CH4 Emissions from Other Waste	CH4	0	2	10%	100%	1,005	0,000	0,000	0,000	0,000	0,000
CO2 Emissions from Other Sources (solvent use)	CO2	1.733	1.265	30%	30%	0,424	0,001	-0,001	0,002	0,000	0,001
							0,025				

Emission sources are disaggregated into a detailed level (56 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 2001. The analysis also estimates an uncertainty of 2.3 % in the trend between 1990 and 2001.
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 23 key sources accounting for the 95%

of the total levels uncertainty; when applying the trend analysis the key sources decreased to 22 with differences with respect to the previous list.

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

TIER 2

CATEGORIES	Level assessment with uncertainty	Relative level assessment with uncertainty	Cumulative Percentage	CATEGORIES	Trend assessment with uncertainty	Relative Trend assessment with uncertainty	Cumulative Percentage
CO2 stationary combustion gaseous fuels	0,0102	0,10	0,10	CO2 stationary combustion gaseous fuels	0,01	0,13	0,13
CO2 stationary combustion liquid fuels	0,0099	0,09	0,19	CO2 stationary combustion liquid fuels	0,01	0,13	0,26
CO2 Mobile combustion: Road Vehicles	0,0089	0,08	0,27	CO2 Mobile combustion: Road Vehicles	0,01	0,11	0,37
N2O Manure Management	0,0079	0,07	0,35	CH4 Enteric Fermentation in Domestic Livestock	0,01	0,08	0,46
Indirect N2O from Nitrogen used in agriculture	0,0074	0,07	0,42	CH4 from Solid waste Disposal Sites	0,01	0,06	0,52
CH4 Enteric Fermentation in Domestic Livestock	0,0066	0,06	0,48	Direct N2O Agricultural Soils	0,00	0,06	0,58
N2O stationary combustion	0,0061	0,06	0,54	HFC, PFC substitutes for ODS	0,00	0,05	0,63
Direct N2O Agricultural Soils	0,0052	0,05	0,59	CO2 stationary combustion solid fuels	0,00	0,05	0,68
CH4 from Solid waste Disposal Sites	0,0050	0,05	0,63	Indirect N2O from Nitrogen used in agriculture	0,00	0,05	0,73
N2O from animal production	0,0041	0,04	0,67	CH4 Emissions from Wastewater Handling	0,00	0,04	0,78
CO2 stationary combustion solid fuels	0,0040	0,04	0,71	N2O Manure Management	0,00	0,03	0,80
CH4 Manure Management	0,0039	0,04	0,74	CH4 Manure Management	0,00	0,03	0,83
HFC, PFC substitutes for ODS	0,0035	0,03	0,78	N2O Mobile combustion: Road Vehicles	0,00	0,02	0,85
N2O Mobile combustion: Road Vehicles	0,0030	0,03	0,81	CO2 Cement production	0,00	0,02	0,86
N2O from Other agricultural soils (wetlands, waters)	0,0028	0,03	0,83	N2O from animal production	0,00	0,01	0,88
CH4 Emissions from Wastewater Handling	0,0025	0,02	0,86	N2O stationary combustion	0,00	0,01	0,89
CO2 Cement production	0,0024	0,02	0,88	CO2 Emissions from Other Sources (solvent use)	0,00	0,01	0,91
CH4 Fugitive emissions from Oil and Gas Operations	0,0023	0,02	0,90	CH4 Fugitive emissions from Oil and Gas Operations	0,00	0,01	0,92
N2O Adipic Acid	0,0015	0,01	0,91	N2O from Other agricultural soils (wetlands, waters)	0,00	0,01	0,93
CH4 from Rice production	0,0014	0,01	0,93	N2O Emissions from Wastewater Handling	0,00	0,01	0,94
CO2 Emissions from Other Sources (solvent use)	0,0010	0,01	0,94	N2O Adipic Acid	0,00	0,01	0,95
CH4 stationary combustion	0,0008	0,01	0,94	CO2 Mobile combustion: Waterborne Navigation	0,00	0,01	0,95
N2O Emissions from Wastewater Handling	0,0008	0,01	0,95	HFC-23 from HFC-22 Manufacture	0,00	0,01	0,96
CO2 Fugitive emissions from Oil and Gas Operations	0,0006	0,01	0,96	PFC, HFC, SF6 Semiconductor manufact	0,00	0,01	0,96
CO2 Mobile combustion: Waterborne Navigation	0,0005	0,00	0,96	CO2 Other industrial processes	0,00	0,00	0,97
CH4 Emissions from Waste Incineration	0,0005	0,00	0,97	CH4 Fugitive emissions from Coal Mining	0,00	0,00	0,97
CO2 Emissions from Waste Incineration	0,0004	0,00	0,97	N2O Nitric Acid	0,00	0,00	0,98
CO2 Lime production	0,0004	0,00	0,97	CO2 Mobile combustion: Aircraft	0,00	0,00	0,98
CO2 Other industrial processes	0,0004	0,00	0,98	CO2 Lime production	0,00	0,00	0,98
PFC, HFC, SF6 Semiconductor manufacturing	0,0004	0,00	0,98	CH4 Emissions from Waste Incineration	0,00	0,00	0,98
CH4 Fugitive emissions from Coal Mining and Handling	0,0004	0,00	0,98	CH4 from Rice production	0,00	0,00	0,99
N2O Emissions from Waste Incineration	0,0003	0,00	0,99	CO2 Fugitive emissions from Oil and Gas Operations	0,00	0,00	0,99
CO2 Mobile combustion: Aircraft	0,0002	0,00	0,99	CO2 Mobile combustion: Other	0,00	0,00	0,99
N2O Nitric Acid	0,0002	0,00	0,99	CO2 Emissions from Waste Incineration	0,00	0,00	0,99
CO2 Iron and Steel production	0,0002	0,00	0,99	SF6 Production of SF6	0,00	0,00	0,99
CH4 Mobile combustion: Road Vehicles	0,0001	0,00	0,99	CH4 stationary combustion	0,00	0,00	0,99
CO2 Mobile combustion: Other	0,0001	0,00	0,99	N2O Mobile combustion: Other	0,00	0,00	0,99
N2O Mobile combustion: Waterborne Navigation	0,0001	0,00	1,00	CO2 Iron and Steel production	0,00	0,00	1,00
CH4 Industrial Processes	0,0001	0,00	1,00	SF6 Magnesium production	0,00	0,00	1,00
PFC Aluminium production	0,0001	0,00	1,00	N2O Mobile combustion: Waterborne Navigation	0,00	0,00	1,00
SF6 Electrical Equipment	0,0001	0,00	1,00	N2O Emissions from Waste Incineration	0,00	0,00	1,00
SF6 Magnesium production	0,0001	0,00	1,00	CH4 Mobile combustion: Road Vehicles	0,00	0,00	1,00
N2O Mobile combustion: Other	0,0001	0,00	1,00	SF6 Electrical Equipment	0,00	0,00	1,00
HFC-23 from HFC-22 Manufacture	0,0000	0,00	1,00	CH4 Industrial Processes	0,00	0,00	1,00
N2O Mobile combustion: Aircraft	0,0000	0,00	1,00	CH4 Agricultural Residue Burning	0,00	0,00	1,00
CH4 Agricultural Residue Burning	0,0000	0,00	1,00	PFC Aluminium production	0,00	0,00	1,00
CH4 Mobile combustion: Waterborne Navigation	0,0000	0,00	1,00	N2O Mobile combustion: Aircraft	0,00	0,00	1,00
CH4 Emissions from Other Waste	0,0000	0,00	1,00	N2O Agricultural Residue Burning	0,00	0,00	1,00
N2O Agricultural Residue Burning	0,0000	0,00	1,00	CH4 Emissions from Other Waste	0,00	0,00	1,00
CH4 Mobile combustion: Other	0,0000	0,00	1,00	CH4 Mobile combustion: Waterborne Navigation	0,00	0,00	1,00
CH4 Mobile combustion: Aircraft	0,0000	0,00	1,00	CH4 Mobile combustion: Other	0,00	0,00	1,00
SF6 Production of SF6	0,0000	0,00	1,00	CH4 Mobile combustion: Aircraft	0,00	0,00	1,00
SF6 Other sources of SF6	0,0000	0,00	1,00	SF6 Other sources of SF6	0,00	0,00	1,00
CH4 Savanna Burning	0,0000	0,00	1,00	CH4 Savanna Burning	0,00	0,00	1,00
N2O Savanna Burning	0,0000	0,00	1,00	N2O Savanna Burning	0,00	0,00	1,00
CH4 from Other agriculture	0,0000	0,00	1,00	CH4 from Other agriculture	0,00	0,00	1,00

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 year 1990, 1995, 1999 and 2000 is reported. The year 1999 is added because in year 2000 the reported data are quite poor. For each year data from three different sources are reported:

- output of the model used to estimated 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 can be seen from the following tables there are not negligible differences in total consumption between GRTN and BEN. Both data sets are supposed to be based on the same data and the fact that there is such a difference 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 from the modeller choice: 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, rather small, between 0,1% and 0.6% with the exception of year 1995 that shows a very high value, 3%. The same discrepancy when expressed in percentage values, can be found in the data referring to the amount of energy consumed.
Not surprisingly the differences between the fuels quantities, when expressed in physical values are much bigger, range from 4 to 7%, with year 1995 going up to an astonishing 14%.
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 (with the exception of year 1995) but it should not be there because both data sets are derived from the same source. This consideration may raise disturbing questions on the quality assurance of the process and the discrepancy should be cancelled.

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

Fuels	Output Modello			GRTN / ENEL			BEN		
	GWe lordi	kt	TJ	GWe lordi	kt	T.e.p./TJ	GWe lordi	kt	kcal / TJ
carbone	32057	11101	2.936E+08	31007	10782	6812	32042	10782	68120
lignite				1035	1501	264		1056	2640
tot	32057	11101	2.936E+08	32042	12283	2.961E+08	32042	11838	2.961E+08
gas cokeria	1183	689	1.226E+07	1177	693	296	1177	693	2960
gas d'altoforno	1930	5759	2.170E+07	1929	6804	524	1929	5822	5240
gas convertitore	432	682	2569860	446	509	106			
tot	3545	7130	3.653E+07	3552	8690	3.874E+07	3106	8690	3.431E+07
tot carbone			3.301E+08			3.348E+08			3.304E+08
distillati leggeri				26	5	4		26	5 40
gasolio	1189	332	13813267	1025	303	302	1026	303	3020
olio combustibile atz	99383	21765	8.881E+08	99682	21798	21210	99681	21798	212100
btz							0	0	0
gas residui di raffineria	1765	363	14889594	1149	211	250	1149	211	2500
coke di petrolio	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 residui di processi chimici				627	444	97			
tar / catrame				6	2	2			
calore di recupero da pirite				163	146	36			
altri	415	89	1319174	192	344	39			
tot	415	89	1.319E+06	988	5153	7.280E+06		0	0.000E+00
oil+residui	103627	22689	9.239E+08	103706	24505	9.238E+08	102717	22503	9.165E+08
gas naturale ENEL	27081	7070	2.47E+08						
gas naturale altri	11999	2658	9.18E+07						
	39080	9728	3.386E+08	39082	9731	3.383E+08 8308	39083	9731	3.383E+08
biogas	111								
tot controllo	178419	50648	1.593E+09	178382	55209	1.597E+09	176948	52762	1.585E+09
differenze							0.8%	4.6%	0.7%

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

Fuels		Output Modello			GRTN / ENEL			BEN		
		GWe lordi	kt	TJ	GWe lordi	kt	T.e.p./TJ	GWe lordi	kt	kcal / TJ
carbone		24164	8492	223563850	23970	8216	5245 6384	23970	8216	52450
lignite tot		 24164	 8492	 2.236E+08	152 24122	380 8596	43 2.212E+08	152 24122	172 8388	430 2.212E+08
gas cokeria	25.9%	996	mc 522	9286688	985	mc 540	231 0.0%	985	540	2310
gas d'altoforno	67.4%	1998	6424	24204548	1921	6428	496 0.0%	1921	5511	4960
gas convertitore	6.7%	420	636	2395611	537	633	132 0.0%			
tot		3414	7581	3.589E+07	3443	7601	3.594E+07	2906	8690	3.042E+07
tot carbone							2.572E+08			2.517E+08
distillati leggeri					48	6	6	48	6	60
gasolio		797	211	8.84E+06	697	184	184	697	184	1840
olio combustibile	atz	117043	25306	1.03E+09	117022	25355	24619	117022	25355	246190
	btz									
gas residui di raffineria		2253	298	1.43E+07	2261	378	407	2260	378	4070
coke di petrolio		780	189	5.94E+06	755	189	156	755	189	1560
oriemulsion		0	0	0.00E+00	0		0			
tot		120873	26003	1.062E+09	120783	26112	1.062E+09	120781	26112	1.062E+09
gas residui di processi chimici					556	803	89			
tar / catrame										
calore di recupero da pirite					3	3	1			
altri		826	375	6454448	405	697	94			

(continued)

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Fuels	**Output Modello**			**GRTN / ENEL**			**BEN**		
	GWe lordi	kt	TJ	GWe lordi	kt	T.e.p./TJ	GWe lordi	kt	kcal / TJ
tot	826	375	6.454E+06	964	1503	7.699E+06			
oil+residui	121699	26378	1.068E+09	121747	27615	1.069E+09	120781	26112	1.062E+09
gas naturale ENEL	25819	6867	2.387E+08						
gas naturale altri	20621	4440	1.538E+08						
	46440	11307	3.924E+08	46442	11277	3.923E+08 8313	46442	11277	3.923E+08
biogas	65								
RSU	331								
tot controllo	196113	53758	1.720E+09	195754	55089	1.719E+09	194252	54467	1.705E+09
	195717						0.8%	1.1%	0.78%

Table A2.3 - Energy consumption for electricity production, year 1999

Fuels	Output Modello			GRTN / ENEL			BEN		
	GWe lordi	kt	TJ	GWe lordi	kt	T.e.p./TJ	GWe lordi	kt	kcal / TJ
carbone	23779	8401	2.178E+08	23551	8378	5122	23812	8137	51670
lignite				261	158	54		36	90
tot	23779	8401	2.178E+08	23812	8536	2.166E+08	23812	8173	2.166E+08
gas cokeria	1282	656	1.167E+07	1282	660	281	1280	661	2809
gas d'altoforno	2654	8305	2.780E+07	2654	8611	663	2653	7367	6630
gas convertitore	478	533	4.684E+06	477	536	112			
tot	4414	9494	4.415E+07	4413	9807	4.418E+07	3934	8028	3.949E+07
tot carbone			2.620E+08			2.607E+08			2.561E+08
distillati leggeri	337	50	2.110E+06	103	12	13	109	13	135
gasolio	1340	211	1.348E+07	2186	560	571	2185	560	5712
olio combustibile atz	81114	17528	7.146E+08	80683	17511	17063	34286	7425	72765
btz							51393	11137	109143
gas residui di raffineria	2413	457	2.008E+07	2471	409	439	2470	366	4392
coke di petrolio	864	216	7.487E+06	864	216	178	866	214	1776
oriemulsion	5286	1790	4.916E+07	1688	1108	178			
tot	91354	20252	8.070E+08	91286	20396	7.868E+08	91309	19715	8.114E+08
gas residui di processi chimici	605	645	4.455E+06	766	1155	143			
tar / catrame	1500	363	1.414E+07						
calore di recupero da pirite									
altri	361	407	3.188E+06	1917	1819	406	1992	1658	4145
tot	2466	1416	2.179E+07	2683	2974	4.577E+07	1992	1658	1.734E+07
oil+residui	93820	21667	8.287E+08	93969	23370	8.325E+08	93301	21373	8.287E+08
gas naturale ENEL	44917	11249	3.939E+08						

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Fuels	Output Modello			GRTN / ENEL			BEN		
	GWe lordi	kt	TJ	GWe lordi	kt	T.e.p./TJ	GWe lordi	kt	kcal / TJ
gas naturale altri	39139	8522	2.977E+08						
	84056 85970	19770	6.916E+08	86217	19766	6.927E+08 8375	86222	20067	6.927E+08
biogas	309								
RSU	932						1826	1564	3910
turboespansori	672								
tot controllo	207983	59333	1.782E+09	208411	61479	1.786E+09	207269	57641	1.777E+09
	206741						0.6%	6.7%	0.5%

Table A2.4 - Energy consumption for electricity production, year 2000

Fuels		**Output Modello**			**GRTN / ENEL**			**BEN**		
		GWe lordi	kt	TJ	GWe lordi	kt	T.e.p./TJ	GWe lordi	kt	kcal / TJ
carbone		26277	9527	2.530E+08	26272	9633	6052 6283	26273	9259	60509
lignite									1	9
tot		26277	9527	2.530E+08	26272	9633	2.532E+08	26273	9260	2.532E+08
gas cokeria	26.3%	1188	599	1.065E+07				1422	660	2807
gas d'altoforno	62.9%	2612	7613	2.548E+07				2601	7064	6358
gas convertitore	10.8%	450	498	4.373E+06						
tot		4249	8710	4.050E+07	4252	8690	4.050E+07	4023	8690	3.835E+07
tot carbone							2.937E+08			2.916E+08
distillati leggeri		227	37	1.533E+06				162	21	223
gasolio		1773	410	1.728E+07				3745	762	7772
olio combustibile	atz	70844	15640	6.368E+08				31437	7084	69418
	btz							47157	10625	104127
gas residui di raffineria		4629	895	3.932E+07				5905	870	10444
coke di petrolio		1098	274	9.520E+06				1067	274	2276
oriemulsion		7208	2529	6.945E+07						
tot		85778	19785	7.739E+08	85878	19352	7.868E+08	89473	19637	8.128E+08
gas residui di processi chimici		546	671	4.636E+06						
tar / catrame		4800	1124	4.374E+07						
calore di recupero da pirite										
altri		353	385	3.050E+06				1166	1054	2635
tot		5699	2180	5.142E+07	5660	5153	4.577E+07	1166	1054	1.102E+07
oil+residui		91478	21965	8.253E+08	91538	24505	8.325E+08	90640	20691	8.238E+08
gas naturale ENEL		50062	12473	4.362E+08						

(continued)

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Fuels	Output Modello			GRTN / ENEL			BEN		
	GWe lordi	kt	TJ	GWe lordi	kt	T.e.p./TJ	GWe lordi	kt	kcal / TJ
gas naturale altri	45644	10094	3.529E+08						
	95706	22567	7.891E+08	97607	22034	7.877E+08	97609	22819	7.877E+08
						8544			
	97601								
biogas	544			566.1					
RSU	1352			1340.1			1905	1723	
tot controllo	219605	62769	1.908E+09	219669	64862	1.914E+09	220451	61460	1.903E+09
	217709						-0.35%	5.5%	0.57%

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

The preliminary use of CRF software underlined an unbalance of emissions in the solid fuel rows above 20%. A detailed verification pointed out an already known fact: the combined use of standard IPCC emission factors for coals, national EF for coal gasses 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 gasses from blast furnaces and coke ovens for electricity generation.
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 balance 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 group 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 do 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, 2000, 10^9kcal

coke	coke gas	Blast furnace gas	
9,177			For blast furnace
0	2,807	6,358	For electricity prod.
23,541	1,607	1,353	For steel industries
1,594	0	0	For other industries use
630	43		For domestic use
34,942	4,457	7,711	Total consumption
685	370	1,430	Consumption for production of secondary fuels
23	-1	36	Losses of transformation
35,650	4,826	9,177	Total consumption + losses and prod.
Energy balance coke ovens	Energy balance, blast furnace		
405.0	0.0		
1.1%	0.0%		
36,312			Coke oven output
10,930			Transformation losses, coke ovens
1,665			non energy use
48,907			sub total
48,907			Coke input to coke ovens
7,775			Blast fornace coal input
3,759			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, 2000, Mt CO_2

coke	coke gas	Blast furnace gas		totals
4.07			From blast furnace	4.07
0.00	0.55	7.09	From electricity prod.	7.64
10.43	0.32	1.51	From steel industries	12.26
0.71	0.00	0.00	From other industries use	0.71
0.28	0.01		From domestic use	0.29
15.49	0.88	8.60	Total emissions	24.97
0.28	0.07	1.59	Consumption for production of secondary fuels	1.94
0.01	0.00	0.04	Losses of transformation	0.05
15.78	0.95	10.23	Total consumption + losses and prod.	26.96
Carbon balance, cokerie		Carbon balance, blast furnace		
0.99		6.16		
7%		60%		
14.07			Carbon in produced coke	
4.24			Transformation losses	
0.65			non energy use	
18.96			sub total	
18.96			Coal input to coke ovens	
2.96			Coal input to blast furnace	
1.67			import + stock change	

ANNEX 4: CO_2 REFERENCE APPROACH
(edited by 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 IPCC (1997), table 1.A(b) of CRF "Sectoral background data for energy" - CO2 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, and these are described in subsequent sections. The BEN reports the energy balances for all primary and secondary fuels, with data on imports, exports and production. Refer to Annex 1, tables A1 and A2, for an example of year 2000 and to the Industry Ministry web site for time series.
Starting from those data and using the emission factors reported in table 3.6 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 refers 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 section 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 the 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 CRF 2000, the main energy data source is the BEN. In all this section we make reference to the BEN tables reproduced in Annex 1, in particular tables A1.1 and A1.2. In particular, from top to the bottom, the following data is available in BEN:

1) crude oil data;
2) NGL 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 derives from foreign trade statistics, estimated by an ENEA consultant for the period 1990-1998. BPT data 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" has been ignored because it is explicitly exclude by the IPCC methodology and because it is referred 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 section 3.10) are from foreign trade statistics or SNAM fiscal budgets; natural gas data shows not negligible variations from source to source, with particular reference to the underground stocked quantities;
8) from year 1990 to year 2000 biomass consumption data are those reported in BEN; it is well known that other estimates shows much bigger (up to 50% more) quantities of used biomass, for example ENEA (ENEA, 2002); but the same source quotes BEN biomass consumption estimates as official statistics up to year 2001, pending further investigations; the inventory follows the same methodology.

The following additional information is needed to complete table 1.A(b) of CRF 2000 and it is found in other sources:

1) Orimulsion, this fuel is mixed up with imported fuel oil (on the base of the energy content), the quantities used for electricity generation are reported by ENEL (presently the only user of this fuel) in the environmental report. As long as the emission factor are quite different, a note is needed in the BEN, at least as a warning.
2) Motor oils and bitumen.
   a) Data on those materials are mixed up in the non energy use by BEN, detailed data are available in an other report of the Industry Ministry (BPT, 2000). The quantities of those materials are quite relevant for the non energy use of oil.
   b) In the BEN those materials are estimated in bulk with other products to

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

For further information please refer to the paper "Calcolo delle emissioni di CO_2, reference approach - manuale d'uso per la compilazione del foglio elettronico 1a(b) e 1a(d) del common reference framework (CRF)", by Sergio La Motta and Piero Ancona, edited by ENEA, 2002, 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 emissions arising from fuel consumption in 1B1 Solid Fuel Transformation and Table 2 Industrial Processes (Iron and Steel and Ammonia Production). Results shown the IPCC Reference totals are between 1-2 % higher than the comparable 'bottom up' totals. 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 (BEN, 2000), 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 statistics from producers are used in the detailed approach, 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 outlined in Annex 2, 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.
4. 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 2000

The following table reproduces the part expressed in amount of energy consumed of the National Energy Balance of year 2000.

The complete balance, containing the physical quantities as well as the amount of energy and a consistent time series from 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 2000, Primary fuels, 10^9 kcal

Anno 2000 (cifre espresse in 10E9 kcal)														
BILANCIO	**FONTI PRIMARIE**													
	Carbon fossile Cokerie	Carbone da vapore	Carbone altri usi	Lignite	Sotto-prodotti (a)	Gas naturale	Petrolio greggio	Semi-lavorati	Energia idraulica	Energia geotermica	Eolico + Foto voltaico	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)		743		35.0	2,634	137,222	45,850	26,260	97,251	10,351	1,252	1,938	13,095	336,631
2. IMPORTAZIONI	53,265	74,079	1,117.4	30.0	0.0	473,938	836,530	66,280	0	0	0	0	4,878	1,510,117
3. Esportazioni						412.5	0.0	5,200					17.5	5,630
4. VAR.SCORTE (e)	3,996	3,556	-740	-10.5	0.0	27,101	7,120	520	0	0	0	0	0	41,543
5. TOTALE RISORSE	49,269	71,266	1,857	75.5	2,634	583,646	875,260	86,820	97,251	10,351	1,252	1,938	17,956	1,799,575
6. Trasformazioni (All.1)	48,907	60,509		9.0	2,635	188,260	962,080	0	97,251	10,351	1,252	1,938	3,682	1,376,874
7. Consumi e Perdite (All.2)	362	749	7.0	2.0	-1.0	6,679	0	0	0	0	0	0	1.0	7,799
8. Consumi Finali (All.3)		10,008	1,850	65	0	388,708	0	0				0	14,275	414,906
a) Agricoltura		0				1,180		0		0			1,335	2,515
b) Industria		10,008	1,828	65	0	167,467		0				0	2,070	181,438
c) Servizi						3,292		0						3,292
d) Usi domestici e civili			22.2			206,927		0					10,870	217,819
Totale (a+b+c+d)	0.0	10,008	1,850	65	0	378,866		0				0	14,275	405,064
e) Usi non energetici						9,842		0					0.0	9,842
TOTALE CONSUMI														
ENERGETICI (7+8)	362	10,757	1,857	67	-1.0	395,386	0	0	0	0		0	14,276	422,704
9.Consumi finali														
non energetici														0
10. Bunkeraggi														0
12. TOTALE IMPIEGHI	49,269	71,266	1,857	76	2,634	583,646	962,080	0	97,251	10,351	1,252	1,938	17,958	1,799,578

Table A5.2 – National Energy Balance, year 2000, Secondary fuels, 10^9 kcal

BILANCIO ENERGETICO ITALIANO																	
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 -turbo	Benzine	Carbo	Petrolio	Gasolio	O.C. ATZ	O.C. B.T.Z.	Coke di petrolio	Prodotti petrolif. non ener.(d)
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	6.205
1. PRODUZIONI (d)	232,143	585	31,528	4,781	44	9,177	1,665	29,843	31,332	31,179	203,091	42,775	3,739	372,167	101,303	89,356	15,845	33,879
2. IMPORTAZIONI	38,555	293	3,542					21,758	0	19,687	6,279	218	3,049	8,599	47,481	67,610	17,057	4,306
3. Esportazioni	416		861				37.0	4,488		9,599	41,853	6,552	2,060	87,577	44,404	1,744	374	9,748
4. VAR.SCORTE (e)		0	-1,078					1,122		1,362	-13,493	-936	299	10,353	4,214	1,156	2,664	3,766
5. TOTALE RISORSE	270,282	878	35,287	4,781	44	9,177	1,628	45,991	31,332	39,905	181,010	37,377	4,429	282,836	100,166	154,066	29,864	24,671
6. Trasformazioni (All.1/a)			9,177	2,807		6,358	0	44	10,444	223	0	0	0	7,772	69,418	104,127	2,276	0
7. Consumi e Perdite (All.2/a)	35,589	1	345	367	2	1,466	0	680	19,304	838	74	151	1	1,738	10,834	9,277	7,428	142
8. Consumi Finali (All.3/a)	234,694	878	25,765	1,607	43	1,353	1,628	45,267	1,584	38,844	180,937	37,226	4,428	265,462	4,704	36,702	20,161	813
a) Agricoltura	4,220							770		0	546	0	0	24,204	0	0	0	0
b) Industria	117,264	210	25,135	1,607	0	1,353		4,378	624	0	420	187	112	4,264	4,704	32,174	20,161	813
c) Servizi	30,241							15,666			175,519	37,039		181,139	0	0		0
d) Usi domestici e civili	82,969	668	630		43			22,011			0		484	41,249	0	3,234		
Totale (a+b+c+d)	234,694	878	25,765	1,607	43	1,353	0	42,825	624	0	176,485	37,226	596	250,856	4,704	35,408	20,161	813
e) Usi non energetici				0			1,628	2,442	960	38,844	4,452		3,832	14,606	0	1,294	0	23,356
TOTALE CONSUMI																		
ENERGETICI (7+8)	270,283	879	26,110	1,974	45	2,819	1,628	45,947	20,888	39,682	181,011	37,377	4,429	267,200	15,538	45,979	27,589	955

(continued)

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BILANCIO ENERGETICO ITALIANO																		
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 -turbo	Benzine	Carbo	Petrolio	Gasolio	O.C. ATZ	O.C. B.T.Z.	Coke di petrolio	Prodotti petrolif. non ener.(d)
9. Consumi finali non energetici																		23,356
10. Bunkeraggi														7,864	15,210	3,959		360
12. TOTALE IMPIEGHI	270,283	879	35,287	4,781	45	9,177	1,628	45,991	31,332	39,905	181,011	37,377	4,429	282,836	100,166	154,065	29,865	24,671

Table A5.3 – National Energy Balance, year 2000, primary fuels used by transformation industries, "Allegato 1/a" , 10^9 kcal

TRASFORMAZIONI	Carbon fossile Cokerie	Carbone da vapore	Carbone altri usi	Lignite	Sotto-prodotti (a)	Gas naturale	Petrolio greggio	Semi-lavorati	Energia idraulica	Energia geotermica	Eolico Foto-voltaico	Rifiuti	Biomasse	TOTALE FONTI PRIMARIE
Coeff. di conversione b)	7.400	6.350	7.400	2.500	2.500	8.250	10.000	10.000	2.200	2.200	2.200	2.500	2.500	
1) QUANTITÀ INPUT														
a) Carbonaie													1,310	1,310
b) Cokerie	48,907													48,907
c) Officine del gas														
d) Altiforni														
e) Raffinerie di petr.							962,080							962,080
f) Centrali idroel.									**97,251**					97,251
g) Centrali geoterm.										**10,351**				10,351
h) Centrali termoel.		60,509		9	2,635	188,260						1,938	2,370	255,721
i) Centrali eoliche/											**1,252**			1,252
fotovoltaiche														
TOTALE	48,907	60,509		9	2,635	188,260	962,080		97,251	10,351	1,252	1,938	3,680	1,376,872
2) QUANTITÀ OUTPUT (b)														
A) Fonti ottenute														
a) Carbonaie													655	655
b) Cokerie	36,312													36,312
c) Officine del gas														
d) Altiforni														
e) Raffinerie di petrolio							899,910							899,910
f) Centrali idroelettriche									38,016					38,016
g) Centrali geotermiche										4,046				4,046
h) Centrali termoelettriche		**22,587**		8	1,003	83,943						690	949	109,180
i) Centrali eoliche/ fotovoltaiche											204			204

(continued)

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TRASFORMAZIONI	Carbon fossile Cokerie	Carbone da vapore	Carbone altri usi	Lignite	Sotto-prodotti (a)	Gas naturale	Petrolio greggio	Semi-lavorati	Energia idraulica	Energia geotermica	Eolico Foto-voltaico	Rifiuti	Biomasse	TOTALE FONTI PRIMARIE
Sub-Totale A	36,312	22,587		8	1,003	83,943	899,910		38,016	4,046	204	690	1,604	1,088,323
B) Perdite di trasformazione														
a) Carbonaie													655	655
b) Cokerie	10,930													10,930
c) Officine del gas														
d) Altiforni														
e) Raffinerie di petrolio							7,570							7,570
f) Centrali idroelettriche									59,235					59,235
g) Centrali geotermiche										6,305				6,305
h) Centrali termoelettriche		**37,922**		1	1,632	104,317						1,248	1,422	146,542
i) Centrali eoliche/ fotovoltaiche											1,048			1,048
Sub-Totale B	10,930	37,922		1	1,632	104,317	7,570		59,235	6,305	1,048	1,248	2,077	232,285
C) Prodotti non energetici														
a) Cokerie (d)	1,665													1,665
b) Officine del gas														
c) Raffinerie di petrolio (e)							54,600							54,600
Sub-Totale C	1,665						54,600							56,265
TOTALE A+B+C	48,907	60,509		9	2,635	188,260	962,080		97,251	10,351	1,252	1,938	3,681	1,376,873

Table A5.4 – National Energy Balance, year 2000, secondary fuels used by transformation industries, "Allegato 1/a" , 10^9 kcal

	Energia elettrica	Carbone di legna	Coke da cokeria	Gas di cokeria	Gas di officina	Gas di altofor.	Coal-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 petrolio	Prodotti petrolif. non ener. (d)	TOTALE FONTI SECOND.
Coeff. di conversione (b)	0.860	7.500	7.000	4.250	4.250	0.900	7.400	11.000	12.000	10.400	10.500	10.400	10.300	10.200	9.800	9.800	8.300	5.109	
1) QUANTITÀ INPUT																			
a) Carbonaie																			
b) Cokerie																			
c) Officine del gas								44											44
d) Altiforni			9,177																9,177
e) Raffinerie di petrolio																			
f) Centrali idroelettriche																			
g) Centrali geotermiche																			
h) Centrali termoelettriche				2,807		6,358			10,444	224				7,772	69,418	104,127	2,276		203,426
i) Centrali eoliche/ fotovoltaiche																			
TOTALE			9,177	2,807		6,358		44	10,444	224				7,772	69,418	104,127	2,276		212,647
2) QUANTITÀ OUTPUT (b)																			
A) Fonti ottenute																			
a) Carbonaie																			
b) Cokerie																			

(continued)

(continued)

	Energia elettrica	Carbone di legna	Coke da cokeria	Gas di cokeria	Gas di officina	Gas di altofor.	Coal-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 petrolio	Prodotti petrolif. non ener. (d)	TOTALE FONTI SECOND.
c) Officine del gas								44											44
d) Altiforni petrolio			9,177																9,177
e) Raffinerie di petrolio																			
f) Centrali idroelettriche																			
g) Centrali geotermiche																			
h) Centrali termoelettriche				1,223		2,237			5,079	139				3,220	27,036	40,555	918		80,407
i) Centrali eoliche/ fotovoltaiche																			
Sub-Totale A			9,177	1,223		2,237		44	5,079	139				3,220	27,036	40,555	918		89,628
B) Perdite di trasformazione																			
a) Carbonaie																			
b) Cokerie																			
c) Officine del gas																			
d) Altiforni																			
e) Raffinerie di petrolio																			
f) Centrali idroelettriche																			

(continued)

(continued)

	Energia elettrica	Carbone di legna	Coke da cokeria	Gas di cokeria	Gas di officina	Gas di altofor.	Coal-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 petrolio	Prodotti petrolif. non ener. (d)	TOTALE FONTI SECOND.
g) Centrali geotermiche																			
h) Centrali termoelettriche				1,584		4,121			5,365	85				4,552	42,382	63,572	1,358		123,019
i) Centrali eoliche/ fotovoltaiche																			
Sub-Totale B				1,584		4,121			5,365	85				4,552	42,382	63,572	1,358		123,019
C) Prodotti non energetici																			
a) Cokerie																			
b) Officine del gas																			
c) Raffinerie di petrolio																			
Sub-Totale C																			
TOTALE A+B+C			9,177	2,807		6,358		44	10,444	224				7,772	69,418	104,127	2,276		212,647

Table A5.5 – National Energy Balance, year 2000, primary fuels losses

	Carbon fossile Cokerie	Carbone da vapore	Carbone altri usi	Lignite	Sotto-prodotti (a)	Gas naturale	Petrolio greggio	Semi-lavorati	Energia idraulica	Energia geotermica	Eolico + Foto-voltaico	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														
b) Carbon fossile														
c) Lignite														
d) Combustibili nucleari														
e) Gas naturale						528								528
f) Condensati di petrolio														
g) Petrolio greggio														
h) Energia idraulica														
i) Energia geotermica Sub-totale						528								528
2) Consumi di produzione di fonti secondarie (c)														
a) Carbonaie														
b) Cokerie	363													363
c) Officine del gas														
d) Altiforni														
e) Raffinerie di petrolio														
f) Centrali idrauliche														
g) Centrali geotermiche														
h) Centrali termoelettriche														
Sub-totale	363													363
3) Consumi e perdite di trasporto e distribuzione		743				6,155								6,898

(continued)

(continued)

	Carbon fossile Cokerie	Carbone da vapore	Carbone altri usi	Lignite	Sotto-prodotti (a)	Gas naturale	Petrolio greggio	Semi-lavorati	Energia idraulica	Energia geotermica	Eolico + Foto-voltaico	Rifiuti	Biomasse	TOTALE FONTI PRIMARIE
4) Differenze :														
- Statistiche														
- Di conversione	-1	6	7	2	-1	-7								6
TOTALE (1+2+3+4)	362	749	7	2	-1	6,676								7,795

Table A5.6 – National Energy Balance, year 2000, secondary fuels losses

	Energia elettrica	Carbone di legna	Coke da cokeria	Gas di cokeria	Gas di officina	Gas di altofor.	Coal-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 petrolio	Prodotti petrolif. non ener. (d)	TOTALE FONTI SECOND.
Coeff. di conversione (b)	0.860	7.500	7.000	4.250	4.250	0.900	7.400	11.000	12.000	10.400	10.500	10.400	10.300	10.200	9.800	9.800	8.300	5.109	
1) Consumi di produzione di fonti primarie																			
a) Combustibili vegetali																			
b) Carbon fossile	19																		19
c) Lignite																			
d) Combustibili nucleari	2																		2
e) Gas naturale	168																		168
f) Condensati di petrolio																			
g) Petrolio greggio																			
h) Energia idraulica	2,094	(d)																	2,094
i) Energia geotermica	4																		4
Sub-totale	2,287																		2,287
2) Consumi di produzione di fonti secondarie (c)																			
a) Carbonaie																			
b) Cokerie	135		322	17		682													1,156

(continued)

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	Energia elettrica	Carbone di legna	Coke da cokeria	Gas di cokeria	Gas di officina	Gas di altofor.	Coal-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 petrolio	Prodotti petrolif. non ener. (d)	TOTALE FONTI SECOND.
c) Officine del gas	181																		181
d) Altiforni	65			353		748													1,166
e) Raffinerie di petrolio	3,695							484	19,308	842	74			1,275	10,447	9,055	7,429	118	52,727
f) Centrali idrauliche	576																		576
g) Centrali geotermiche	245																		245
h) Centrali termoelettriche	10,643																		10,643
i) Centrali eoliche/ fotovoltaiche	1																		
Sub-totale	15,541		322	370		1,430		484	19,308	842	74			1,275	10,447	9,055	7,429	118	66,694
3) Consumi e perdite di trasporto e distribuzione	17,760		28			37		198				156	10	459	382	225			19,255
4) Differenze :																			
- Statistiche																			
- Di conversione	2		-5.0	-3.0	1.0	-1.0			-4	-5.0	-1.0	-1.0	-9.0	1	5.0	-3.0	-2.0	1	-24
TOTALE (1+2+3+4)	35,590		345	367	1	1,466		682	19,304	837	73	155	1	1,735	10,834	9,277	7,427	119	88,212

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

	Carbon fossile Cokerie	Carbone da vapore	Carbone altri usi	Lignite	Sotto-prodotti (a)	Gas naturale	Petrolio greggio	Semi-lavorati	Energia idraulica	Energia geotermica	Eolico + Foto-voltaico	Rifiuti	Biomasse	TOTALE FONTI PRIMARIE
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						1,180							1,335	2,515
II- Pesca														
Sub-Totale						1,180							1,335	2,515
2) INDUSTRIA														
I- Siderurgia		6,598	1,177			18,860								26,635
II- Altre industrie		3,410	651	65		148,609							2,070	154,805
a) Estrattive						264								264
b) Metalli non ferrosi			252			3,779								4,031
c) Meccanica			229	30		22,069								22,328
d) Agroalimentare						18,505								18,505
e) Tessili e abbigliamento			96			13,192								13,288
f) Materiali da costruzione		3,410		25		10,733							2,070	16,238
g) Vetro/ceramica						25,377								25,377
h) Chimica			22			30,294								30,316
i) Petrolchimica														
l) Cart/graf.			30			16,261								16,291
m) Altre manifatturiere			22	10		8,135								8,167
n) Edilizia e costruz. civili														
Sub-Totale		10,008	1,828	65		167,469							2,070	181,440
3) SERVIZI														
I - Trasp.ferroviari														
II - Trasp. via acqua														
III - Trasp. stradali						3,292								3,292

(continued)

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	Carbon fossile Cokerie	Carbone da vapore	Carbone altri usi	Lignite	Sotto-prodotti (a)	Gas naturale	Petrolio greggio	Semi-lavorati	Energia idraulica	Energia geotermica	Eolico + Foto-voltaico	Rifiuti	Biomasse	TOTALE FONTI PRIMARIE
IV - Trasp. aerei														
V - Altri pubblici														
VI - Pubblica Amm.														
Sub-Totale						3,292								3,292
4) USI DOMESTICI														
COMMERCIALI E ARTIG.			22			206,927							10,870	217,819
TOTALE (1+2+3+4)		10,008	1,850	65		378,868							14,275	405,066
5) NON ENERGETICI (a)														
I - Industria chimica														
II - Petrolchimica						9,842								9,842
III - Agricoltura														
IV - Altri settori														
Sub-Totale						9,842								9,842
TOTALE (1+2+3+4+5)		10,008	1,850	65		388,710							14,275	414,908

Table A5.8 – National Energy Balance, year 2000, secondary fuels used by end use sectors, “Allegato 3/a” , 10^9 kcal

	Energia elettrica	Carbone di legna	Coke da cokeria	Gas di cokeria	Gas di officina	Gas di altofor.	Coal-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 petrolio	Prodotti petrolif. non ener. (d)	TOTALE FONTI SECOND.
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	9.800	8.300	5.109	
1) AGRICOLTURA E PESCA																			
I- Agricoltura	4,220	0	0	0	0	0	0	748	0	0	525	0	0	22,154	0	0	0	0	27,647
II- Pesca	0	0	0	0	0	0	0	22	0	0	21	0	0	2,050	0	0	0	0	2,093
Sub-Totale	4,220	0	0	0	0	0	0	770	0	0	546	0	0	24,204	0	0	0	0	29,740
2) INDUSTRIA																			
I- Siderurgia	17,433	0	23,541	1,607	0	1,353	0	242	0	0	0	0	5	82	0	637	33	0	44,933
II- Altre industrie 168,330	99,830	211	1,594	0	0	0	0	4,136	624	0	420	187	107	4,183	4,704	31,537	20,128	669	
a) Estrattive	999	0	14	0	0	0	0	33	0	0	0	0	0	204	49	216	0	0	1,515
b) Metalli non ferrosi	4,653	0	53	0	0	0	0	231	0	0	0	0	16	51	0	588	0	0	5,592
c) Meccanica	21,639	0	458	0	0	0	0	968	0	0	420	187	31	1,163	1,078	3,332	0	0	29,276
d) Agroalimentare	10,014	158	304	0	0	0	0	473	0	0	0	0	12	459	343	4,949	0	0	16,712
e) Tessili e abbigliamento	(b) 11,210	0	0	0	0	0	0	451	0	0	0	0	1	469	216	2,989	0	0	15,336
f) Materiali da costruzione	7,039	0	273	0	0	0	0	902	0	0	0	0	5	235	1,960	5,145	20,086	669	36,314
g) Vetro/ ceramica	4,741	0	0	0	0	0	0	715	0	0	0	0	-2	51	0	2,117	0	0	7,622
h) Chimica	22,404	53	56	0	0	0	0	55	0	0	0	0	31	306	0	1,196	42	0	24,143
i) Petrolchimica	(d) 1,623	0	0	0	0	0	0	0	624	0	0	0	0	0	0	8,046	0	0	10,293
l) Cart/graf.	8,686	0	0	0	0	0	0	77	0	0	0	0	1	194	0	1,313	0	0	10,271
m) Altre manifatturiere	5,762	0	436	0	0	0	0	231	0	0	0	0	12	541	1,058	1,646	0	0	9,686

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	Energia elettrica	Carbone di legna	Coke da cokeria	Gas di cokeria	Gas di officina	Gas di altofor.	Coal-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 petrolio	Prodotti petrolif. non ener. (d)	TOTALE FONTI SECOND.
n) Edilizia e costruz. civili	1,060	0	0	0	0	0	0	0	0	0	0	0	0	510	0	0	0	0	1,570
Sub-Totale	117,264	210	25,135	1,607	0	1,353	0	4,378	624	0	420	187	112	4,265	4,704	32,174	20,161	669	213,263
3) SERVIZI																			
I - Trasp. ferroviari	4,569	0	0	0	0	0	0	0	0	0	0	0	0	1,397	0	0	0	0	5,966
II - Trasp. via acqua	16	0	0	0	0	0	0	0	0	0	0	0	0	2,040	0	0	0	0	2,056
III - Trasp. stradali	2,625	0	0	0	0	0	0	15,642	0	0	175,119	0	0	174,797	0	0	0	0	368,183
IV - Trasp. aerei	109	0	0	0	0	0	0	0	0	0	116	35,350	0	0	0	0	0	0	35,575
V - Altri pubblici	15,150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15,150
VI - Pubblica Amm.	7,770	0	0	0	0	0	0	22	0	0	284	1,685	0	2,907	0	0	0	0	12,668
Sub-Totale	30,239	0	0	0	0	0	0	15,664	0	0	175,519	37,035	0	181,141	0	0	0	0	439,598
4) USI DOMESTICI COMMERCIALI E ARTIG.	82,970	668	630	0	43	0	0	22,011	0	0	0	0	484	41,249	0	3,234	0	0	151,289
TOTALE (1+2+3+4)	234,693	878	25,765	1,607	43	1,353	0	42,823	624	0	176,485	37,222	596	250,859	4,704	35,408	20,161	669	833,890
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	2,442	960	38,844	4,452	0	3,832	14,606	0	1,294	0	123	66,553
III - Agricoltura	0	0	0	0	0	0	215	0	0	0	0	0	0	0	0	0	0	0	215
IV - Altri settori	0	0	0	0	0	0	1,413	0	0	0	0	0	0	0	0	0	0	19,108	20,521
Sub-Totale	0	0	0	0	0	0	1,628	2,442	960	38,844	4,452	0	3,832	14,606	0	1,294	0	19,231	87,289
TOTALE (1+2+3+4+5)	234,693	878	25,765	1,607	43	1,353	1,628	45,265	1,584	38,844	180,937	37,222	4,428	265,465	4,704	36,702	20,161	19,900	921,179