Ministry of Environment

SECOND NATIONAL COMMUNICATION UNDER THE UN FRAMEWORK CONVENTION ON CLIMATE CHANGE

ITALY

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Forward

The Second National Communication under the Framework Convention on Climate Change, prepared according to art. 12 of the Convention and the methodologies established by the Secretariat, updates the information and the evaluations contained in the First National Communication regarding both the evolution of CO_2 and other greenhouse gas emissions and the reduction strategies.

Particularly, strategies and measures for the reduction of the greenhouse gas emissions refer to the objective of 7% reduction of domestic emissions with respect the level of 1990, within 2010.

This objective reflects the decision of the EU Council of the Ministers adopted on March 3, 1997, in view of the Third Conference of the Parties, to be held in Kyoto.

Even if, after the Kyoto Conference, the Italian commitment to reduce the greenhouse gas emissions has been decreased to 6.5 % the information provided by the Second National Communication are still valid and correspond to the objectives and criteria defined by the Kyoto Protocol to integrate the policies for preventing the climate changes with other sectorial policies, with the final goal of improving the efficiency of the economy, of the industrial production and the consumptions.

Finally, it should be highlighted that the Second National Communication confirms the Italian commitment to implement domestic policies and measures for the reduction of the greenhouse gas emissions and for the protection of the climate. This commitment takes a significant importance considering Italy has per-capita greenhouse gas emissions lower than the EU average value.

Edo Ronchi
Minister of Environment

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Introduction

THE SECOND NATIONAL COMMUNICATION IN THE PERSPECTIVE OF THE KYOTO PROTOCOL

The Second National Communication has been approved by the Inter-ministerial Committee for Economy Planning on 3rd of December 1997, before the III Conference of the Parties, in Kyoto.

THE KYOTO PROTOCOL

The Kyoto Protocol, adopted on December 10, 1997, has confirmed the general objectives of the Convention, but modifications in the reference frame for the commitments and the instruments for the reduction of the greenhouse gas emissions, which oriented the preparation of the Second National Communication, have been introduced.

a) The Kyoto Protocol established the reduction of six greenhouse gases: the carbon dioxide, coming from the use of fossil fuels in all energy industrial activities, as well as in the transport sector; the nitrogen oxide, the hydrofluorocarbons, the perfluorocarbons, the sulphur hexafluoride used in the manufacturing chemical industries; the methane produced by the landfills, the livestock and the rice cultivation. Moreover the Kyoto Protocol has identified the objective of the protection and expansion of forests for removing the carbon dioxide emissions.

b) the industrialised countries, which are responsible for over 70% of the emissions, have now taken the commitment to reduce their own emissions of 5.2% with respect the levels of 1990, within 2012.
The objectives established for each country range from the emission stabilisation, as for Russia (0%), and reductions shares between 6% for Japan, 7% for US and 8% for the European Countries.
However, it should be considered that, since the reduction and limitation objectives refer to the base years 1990 and 1995, the actual reduction to be achieved within 2008 is given from the difference between the final objective and the emission level detected at the time of adoption of the Protocol, in 1997.
As an example, the US emissions in 1997 have grown as about 8% with respect the base year 1990: therefore, the actual reduction will be about 15% with respect the present value.
On the other hand, the stabilisation objective for Russia should be compared with an estimate of reduction of 20% at 1997, with respect the year 1990. This figure, as result of the economic and industrial crisis in that country, means that Russia has a potential growth for its emissions of about 20% with respect the base year 1990.

c) The Protocol establishes the policies and measures to be adopted for the emission reduction, with a special reference to:
- promotion of energy efficiency in all sectors;
- development of renewable sources for production of energy and innovative technologies for emission reduction;
- protection and expansion of forests for carbon removal;
- promotion of sustainable agriculture;
- limitation and reduction of methane emissions from landfills and other energy sectors;
- emission reduction of the other gases coming from commercial and industrial use;
- proper fiscal measures for discouraging greenhouse gas emissions.

Policies and measures adopted by the countries will be formally identified in their own national ratification act of the Protocol, as well as the identification of the reduction objectives related with the implementation of each single measure.

d) Considering the climate change as a global phenomenon, and taking into account that each greenhouse gas reduction is effective regardless the location on Earth where it takes place, the Protocol establishes that domestic reduction measures can be integrated in multi-country co-operation programs, in order to achieve the best result with the lowest cost:

- Joint Implementation, to carry out common projects among industrialised countries, aimed at emission reduction through dissemination and use of more efficient technologies;
- Clean Development Mechanism, to carry out high energy efficiency projects in the developing countries, by private enterprises coming from the industrialised countries,

Particularly, considering that the enterprises from the industrialised countries should face high costs to further improve the energy efficiency and to reduce the marginal greenhouse emissions, the Clean Development Mechanism assumes an "attractive" aspect. Implementing this mechanism will allow transferring technologies and carrying out management systems with high efficiency from the point of view of energy and environment, at competitive costs, and so substantially reducing those emissions otherwise produced by the use of obsolete and low efficiency technologies, as it occurred, in the last five years, in China, India, Indonesia, Brazil where an increase of 30% of the emissions has been observed.

Moreover, the Protocol makes provisions for the trade of emissions (Emission Trading) among those industrialised countries who have commitments of emission limitation or reduction. This mechanism will allow to partially replace the domestic reduction measures with purchase of "potential emissions" from those countries who have emission levels lower than the share assigned by the Protocol: this is the case for Russia and the Central Eastern European countries, who, as result of the economic crisis in the early nineties and subsequent closure of energy intensive plants, have experienced a substantial reduction of the greenhouse gas emissions (about -20% between 1990 and 1997 with respect the carbon dioxide emissions).

e) The common reduction target of 8% for EU resulted in a re-assessment of the national reduction shares, already established on March 3, 1997 based upon a common target of 10%. The Counsel of the EU Ministers of Environment has decided on June 17, 1998, among other things:

- Italy must reduce its own emissions of 6.5% with respect the levels of 1990, within 2008-2012. This corresponds to about 100 million tons of equivalent CO_2, considering the growing trend in the EU.
- The reduction targets must be achieved progressively through steps, with reductions starting from 2002 and a significant mid-term result in 2005;
- The Joint Implementation and the Clean Development Mechanism, as well as the Emission Trading will integrate the domestic measures which remain predominant in any case;
- The actual emission reduction will be checked and verified, annually, both at national and EU level.

Moreover, the Council decision of June 17, 1998, explicitly recall the context of the European policies and laws, which will act as a frame for the policies and measures to be implemented for the emission reduction:

- directive IPCC 96/61/CE enforcing the best available techniques in industrial processes, starting from 2000 for new plants and from 2006 for existing plants;
- directive 96/92/CE referring to market liberalisation and efficient use of energy, as well as the directive approved on May 11, 1998, concerning distribution and vectoring of natural gas;
- the White Book on renewable sources, issued by the European Commission on November 26, 1997, assuming the minimal scenario of doubling the production of energy from renewable sources;
- the decisions taken by the Council of the EU Ministers of Energy, on December 8, 1997 and May 11, 1998, highlighting the need to promote the renewable sources, the combined cycles using natural gas, and the energy efficiency, through adequate technical regulations and fiscal measures, in all the Member States;
- the Communication of the European Commission on the combined cycles for energy production referring to the same issue;
- the decision of the EU Ministers of Environment adopted on June 25, 1996, concerning the reduction of fuel consumption of vehicles within 2005 and the voluntary agreements with European car manufacturers;
- the Communication of the European Commission on Transport and CO_2 emissions (COM(98)204) identifying the technological, management and fiscal measures for emission reduction;
- the directive 92/6 on driving safety, which is expected to have significant effects on the reduction of average speed of heavy commercial vehicles;

- the fiscal measures adopted by the EU Council and the EU Commission boosting the renewable sources and low emission sources;
- "Energy Biomass" cultivation promoted in the frame of the Common Agriculture Policy;
- waste management policy adaptation to greenhouse reduction objectives, particularly related to methane emissions from landfills;
- change of land use and cultivation of forests for CO_2 emission removal;
- the need to ensure that liberalisation of gas and electricity market is aimed at guaranteeing environmental targets and consumer interests, both at EU and Member State level.

THE SECOND NATIONAL COMMUNICATION FOR THE FULFILMENT OF KYOTO COMMITMENTS

In the perspective of the Protocol implementation, the Second National Communication offers the assessment and prediction instruments to define the national program of measures which "have a more favourable ratio between the resources involved and the expected results, and at the same time are consistent with the general objectives of the economic policy" as stated in the decision adopted by the Inter-Ministerial Committee for Economy Planning.
In this context, the methodology adopted for the preparation of the Second National Communication assumes a particular importance and allowed to define three different scenarios for the emission reduction:

1. Actions needed in any case for the modernisation of the Italian economy and the protection of the environment

These actions mainly refer to:
a) Increase of energy efficiency in the energy production and industry sectors;
b) Increase of energy production from renewable sources, bio-mass and waste;
c) Adoption of measures to control the urban traffic;
d) Replacement of about 50% of the cars presently circulating with more efficient cars;
e) Construction of rapid transit networks for mass transport in the metropolitan areas and improving of the inter-city railway system;
f) Increasing of the railway share for freight transport;
g) Diffusion of low emission bio-fuels;
h) Improving of the use of methane in the industrial, residential and tertiary sectors;
i) Promotion and diffusion of devices and systems for electric energy saving in the residential and tertiary sectors.

The implementation of these actions will allow a reduction in the emission trend of about 77 million tons of equivalent CO_2, corresponding to the 80% of the reduction share assigned to Italy by EU to fulfil the Kyoto Protocol commitments.
The investments required to implement the actions are estimated as 71,000 billion liras, mostly devoted to ensure the natural modernisation of the economy and the productive system.

2. Additional actions to reduce greenhouse gas emissions up to the target established by EU

These actions mainly refer to:
a) Increase in the use of renewable sources for energy production and heating in the civil sector;
b) Increase of the share of natural gas in the industrial processes;
c) Further increase of efficiency in the industrial processes;
d) Reduction of electric and heating consumption in the residential and tertiary sectors;
e) Increase of efficiency in livestock;
f) Increase of differentiated collection of aluminium, paper and glass.

The implementation of these actions will allow a further reduction of emissions up to about 108 million tons of equivalent CO_2, corresponding to 10% of the reduction share assigned to Italy by EU to fulfil the Kyoto Protocol commitments (-7.1% versus the target of -6.5%).

The investments required to implement the actions, mostly devoted to fulfil the commitments of emission reduction, are estimated as 20,000 billion liras, to which a net value of 30,000 billion liras (1997 currency value) corresponds as equivalent primary energy saving.

3. Further actions to reduce greenhouse gas emissions

These actions are more problematic with respect the previous ones, both from the point of view of the implementation because they require the achieving of sectoral agreements at EU level, and from the point of view of the general economy efficiency. These actions refer to:
a) further increase of efficiency in livestock
b) further reduction of consumption in house heating
c) promotion of very low fuel consumption cars
The implementation of these actions could allow a reduction of emissions up to 137 million tons of equivalent CO_2, corresponding to about 140% of the reduction share assigned to Italy by EU to fulfil the Kyoto Protocol commitments (-9.5% versus the target of -6.5%).
The investments required to implement these further actions, are estimated as about 30,000 billion liras, mostly paid by the government, corresponding to an equal net value as equivalent primary energy saving.

Considering that the national target of emission reduction assigned by the EU, has been decreased from 7% to 6.5%, and taking into account that the Kyoto Protocol makes provisions for integrative measures, such as international co-operation and emission trading, the first two scenarios defined in the Second National Communication together identify, in an exhaustive manner, the “menu” of measures required to fulfil the commitments under the Kyoto Protocol, with net costs not higher that 20,000 billion liras in 12 years.
The “Guidelines for policies and measures to reduce the greenhouse gas emissions”, prepared by the Inter-ministerial working group created by the Prime Minister for the implementation of the Kyoto Protocol and enclosed to the Second National Communication, refer to these scenarios.

CORRADO CLINI
President of the Inter-ministerial working
group for the implementation
of the Kyoto Protocol

1. Preliminary remarks and summary

1.1 FORWARD

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

The first IPCC report in 1990, even if pointing out the borders of scientific uncertainties still present in the evaluation of climate change, put in evidence the risk of a global warming, with terrible effects on climate balance, because of the increase of greenhouse gas anthropogenic emissions, caused by industrial development, since the end of nineteen century, and the greater and greater use of fossil fuel.

The IPCC report, while indicating the need to go further with scientific researches on a national and global level, pointed out with strength the urgency of reducing greenhouse gas anthropogenic emissions, beginning from carbon dioxide.

Particularly, the most industrialised countries were called to undertake the commitment of reducing emissions: in 1990 49.7% of carbon dioxide emissions from the energy sector originated from the OECD countries, 22.3% from east and central Europe countries, 28.1% from developing countries (table 1.1).

The first answer given to the IPCC report was that of the European Union already at the end of 1990. With the joined statement from the EC Councils of Environment and Energy, on 29th October 1990, that was planned and adopted under the Italian Presidency, the Member States acknowledge the common aim and engagement for the prevention of climate change and the reduction of greenhouse gas emissions. Action should start from carbon

Table 1.1: CO_2 global emission in 1990

		Year 1990	%
World Total	Emissions	22.04	100
	Energy	8647	100
	GDP	18990	100
	Population	5450	100
Developed Countries	Emissions	10.95	49.7
	Energy	4633	53.6
	GDP	16077	84.7
	Population	1210	22.2
from which: USA	Emissions	4.90	22.2
	Energy	2106	24.4
	GDP	5490	28.9
	Population	255	4.7
European Union	Emissions	3.32	14.9
	Energy	1324	15.3
	GDP	5620	29.6
	Population	371	6.7
of which ITALY	Emissions	0.44	1.8
	Energy	163	1.8
	GDP	1098	5.8
	Population	57	1.1
Japan	Emissions	1.13	5.1
	Energy	452	5.2
	GDP	3141	16.5
	Population	125	2.3
CEEC/CIS	Emissions	4.91	22.3
	Energy	1847	21.2
	GDP	945	5.0
	Population	390	7.2
Developing Countries	Emissions	6.19	28.0
	Energy	2169	25.1
	GDP	2899	15.3
	Population	3850	70.6
of which: China	Emissions	2.29	10.4
	Energy	677	7.8
	GDP	327	1.7
	Population	1187	21.8
India	Emissions	0.58	2.6
	Energy	193	2.2
	GDP	204	1.1
	Population	880	16.1

Units of measure: emissions (Gt CO_2); energy (Mtoe); GDP (G$ 90, purchase parity); population (millions); CEEC = Central and East European Countries; CIS = Community of Independent States.

dioxide produced by the use of fossil fuel for energy production, in industrial activities and in transport. Particularly, the commitment adopted by the Community for the stabilisation of carbon dioxide emissions by the year 2000 at the levels of 1990, requests Member States to plan and assume initiatives for the environment reconversion and the energy efficiency of industry, of energy production, of transport, of public services, of civil field. Moreover, this statement binds the Member States to protect and expand the absorption of carbon dioxide, referring to forests in particular.

The contents and the engagements of the European Union statement have largely formed the base for the negotiation for the Framework Convention on Climate Change.

1.1.2. THE FRAMEWORK CONVENTION ON CLIMATE CHANGE

The Framework Convention on Climate Change, adopted in Rio de Janeiro during the "Summit of the Earth" in June 1992, after a long and complex negotiation, established that:

"the ultimate objective of the Convention is to achieve, ..., stabilization of greenhouse gas[1] concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and enable economic development to proceed in a sustainable manner.
....
The Parties should protect the climate system for the benefit of the present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities, and respective capabilities. Accordingly, the developed countries Parties should take the lead in combating climate change and the adverse effects thereof".

The Convention has defined the commitments of the Signatories, and, particularly, the article 4 establishes that:

- each Party has to adopt programmes and measures that aim to prevent, control and mitigate climate change, through the establishment of national programs and, in case, regional ones;

- the more developed countries, that are included in Annex 1 (OECD countries and countries with economies in transition[2]) has to single out and adopt policies and measures in order to return, individually or jointly, in the year 2000, to 1990 levels of anthropogenic emissions of carbon dioxide or other greenhouse gases that are not controlled by the Montreal Protocol.

1.1.3. THE SECOND ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

In December 1995 the Italian Ministry of the Environment organised and gave hospitality to the IPCC plenary session in Rome, which was attended by the representatives of more than 80 countries.
The plenary session approved the "Second Assessment Report" on global climate, that is the result of a long analysis and evaluation process of available information and forecasts, developed during four years of work, between 1991 and 1995.

The Report asserts, among other things, that:

- there is a discerned anthropogenic influence on global climate, caused by the greenhouse gas emissions which are produced during human activities;
- without specific policies and measures to mitigate climate changes, the global, superficial, average temperature of 1990, is expected to rise of about 2 °C (among 1.5 and 3.5 °C) in 2100;
- the average level of seas is doomed to rise of about 50 cm (among 15 and 95 cm) in 2100, in comparison with the level of 1990, compromising vast expanses of coastal lands that are intensively peopled;
- global warming will be able to determine important changes in climatic cycles, causing the intensification of extreme meteors (strong precipitation with alluvial events, which leave place to long

1 The most important greenhouse gases are (warming potential equivalent in terms of carbon dioxide, in the time horizon of 100 years, / with a concentration – in 1990 – in parts per million): carbon dioxide (1/350 ppm), methane (21/1.7 ppmv), nitrogen protoxide 310/0.31), halogenated compounds (chlorofluorocarbons, hydrochlorofluorocarbons, bromides, and so on), controlled by the Montreal Protocol, fluorocarbons, ozone (stratospheric and tropospheric), aerosol.

2 The so-called nations in Annex 1 include OECD countries (Austria, Australia, Belgium, Canada, Finland, France, Germany, Japan, Greece, Ireland, Iceland, Italy, Luxemburg, Norway, New Zealand, Netherlands, Portugal, United Kingdom, Russia, Spain, Sweden, Switzerland, United States of America, Turkey), the Central East European Countries associated to the European Union ('CEEC': Bulgaria, Czech Republic, Esthonia, Latvia, Lithuania, Poland, Rumania, Slovakia, Slovenia and Hungary) and three countries of the Community of Independent States (Belorussia, Russia and Ukraine).

periods of dry weather), alterations of earthly and aquatic ecosystems (effects on the degradation and drying of soils, modifications of agricultural productions);
- the rising of temperature will have effect on health, that will be direct (increase in the number of deaths and diseases, because of the so-called "heat-waves") and indirect (increase and spreading, even in the temperate zones, of contagious diseases that are typical of the tropical zones);
- in order to assure that, in 2100, the greenhouse gas concentrations are restrained within "compatible" levels, that is to say, in order to achieve the aim of stabilising atmospheric CO_2 concentration at twice pre-industrial levels, global emissions shall correspond to the half of the present ones.

According to the Panel forecasts, CO_2 world emissions coming from the energy sector, that are more than 95% among total emissions, without mitigation efforts, tend to rise of 30-50% in 2010, because of the rising of energy needs, that are essential for the world economic development.
Particularly, it is to expect that developing countries will be responsible, in 2010, for more than 50% of the global energy consumption, in comparison with 27% during 1990.

1.1.4. THE CONFERENCES OF THE SIGNATORY PARTIES OF THE CONVENTION ON CLIMATE CHANGE IN BERLIN (1995) AND GENEVA (1996): TOWARDS THE KYOTO PROTOCOL FOR THE REDUCTION OF GREENHOUSE GAS EMISSIONS

The First Conference of the Signatories of the Convention, that was held in Berlin in April 1995, established that, within the end of 1997, on the occasion of the Third Conference of the Parties, it should be adopted a protocol – that is to say a legally binding treaty – that would fix the time - frames and the size of the reduction of greenhouse gas emissions, produced by developed countries, beginning from 2000.

The Second Conference of the Parties, in Berlin in 1996, confirmed the Protocol objective, even if it had to take note of the difficulties of the negotiation process.

Moreover, such difficulties have been well emphasised even during the G8 Summit in Denver in June 1997, and in the following Special Session of the General Assembly of the United Nations "five years later Rio de Janeiro":

Mainly, these difficulties come from two elements:

- the reduction of greenhouse gases requires a change in the national policies about energy and transport; a changing which will be much more difficult if there is a very high consumption, that is to say, if the industrial and economic system of the developed countries has very high energy consumption;

- it might not be enough to reduce the emissions of the developed countries for preventing climate changes, if it will continue the increase of the emissions in the developing countries (particularly China, India, south-east Asia, Brazil): that is to say, the programmes of reducing emissions should allow the developed countries to achieve the national goals in this field even through investments which should be realised in the developing countries, thanks to the supplying and the installation of industrial or energy plants and systems, or in the transport field, highly efficient equipment and with low emissions ("joint implementation" and "trade emissions").

The Conference of the Parties in Kyoto (in December 1997) provided a first answer, adopting a Protocol that can define, at the same time, effective (considerably reducing emissions) and possible (flexible rules) engagements: anyway, this is the trend that has been fixed in the conclusive paper of the G8 Summit in Denver, confirmed by the Special Session of the General Assembly of the United Nations (22-27 June 1997).

1.1.5. THE EUROPEAN UNION COMMITMENT

The stabilisation of CO_2 emissions for the year 2000
The objective of the stabilisation of carbon dioxide emissions to the year 2000 to 1990 levels, fixed by the European Union on 29th of October 1990, should be achieved by the European Union as a whole: this is the forecast given by the Management Committee of the European Monitoring System in regard to CO_2 emissions.

The single Member States contribute in different ways to the achievement of this goal, according to their respective starting points about emissions, too (absolute quantities and per capita emissions, table 1.2).

The European Union objective for the reduction to the year 2010
The European Union Environment Council on 3rd of March 1997 has fixed a first objective of 10%

Table 1.2: CO_2 emission in 1990 of the European Union and of Member States

Member States	Emissions 1990 Mton CO_2	Emissions 1990 %	Population Millions	Population %	ton CO_2/capita
Austria	59.1	1.8	8.0	2.2	7.4
Belgium	115.5	3.5	10.1	2.7	11.4
Denmark	58.1	1.7	5.2	1.4	11.2
Finland	60.0	1.8	5.1	1.4	11.8
France	366.3	11.0	57.6	15.5	6.4
Germany	1014.0	30.6	81.4	22.0	12.5
Greece	84.2	2.5	10.4	2.8	8.1
Ireland	30.6	0.9	3.6	1.0	8.5
Italy	438.0	13.2	57.2	15.4	7.6
Luxemburg	13.3	0.5	0.4	0.1	33.3
Netherlands	173.0	5.2	15.4	4.2	11.2
Portugal	42.3	1.3	9.9	2.7	4.3
Spain	226.2	6.8	39.1	10.6	5.8
Sweden	55.0	1.6	8.8	2.4	6.3
Un. Kingdom	583.0	17.6	58.4	15.8	10.0
EU Total	3318.5	100	370.6	100	9.0

Table 1.3: Burden sharing of greenhouse gas emissions reduction agreed upon at the EU Council of the Ministers of the Environment (March 1997)

Member States	Quantified objectives of greenhouse gas emission reduction* by 2010, in comparison with 1990 levels
Austria	25%
Belgium	- 10%
Denmark	- 25%
Finland	0%
France	0%
Germany	- 25%
Greece	+ 30%
Ireland	+ 15%
Italy	- 7%
Luxemburg	- 30%
Netherlands	- 10%
Portugal	+ 40%
Spain	+ 17%
Sweden	+ 5%
Un. Kingdom	- 10%
EU Total	- 10%

* CO_2, CN_4, N_2O

reduction of the European emissions within the year 2010, distributed amongst specific objectives for each Member State (table 1.3), with the purpose of supporting the EU negotiations at the Conference of the Parties, in Kyoto.

1.1.6. ITALIAN COMMITMENTS WITHIN THE FRAMEWORK CONVENTION ON CLIMATE CHANGE

Italian vulnerability to climate change

The global reduction objective of greenhouse gas emissions, and, therefore, national emissions, are in conformity with a specific national interest in Italy.

The IPCC Second Report, the scientific evaluations made by the Columbia University for the Ministry of the Environment, the most recent (August 1997) forecasts of the IPCC Working Group II about the regional effects of climate change, put in evidence a significant environment vulnerability linked to the climate forecasts of next decades - that are more and more precise - in relation to the rise of greenhouse gas concentrations in the atmosphere:

- a progressive increase of arid areas in the South and Central regions, with degradation of soils, saline infiltration of acquifiers and changes in agricultural productivity;
- an increase in the frequency of floods and in the erosion of shores, particularly in the Po delta and in the Lagoon of Venice;
- an increase in the frequency of "intense" precipitation, particularly in the Central and North regions, with unusual increases of rivers flow and consequent alluvial events.

These climatic forecasts will test Italy's capability to "stand", in prospective, a more consistent pressure on the land than the one to which we are already exposed, with seasonal floods, dry weather, the degradation of acquifers, and forest fires.

National emissions of carbon dioxide and other greenhouse gases to the year 2000

The National Program for the control of carbon dioxide emissions and the First National Communication to the Convention on Climate Change, approved by CIPE (24 Feb 1994 and 10 Jan 1995), define:

a) the emissions which refer to 1990;

b) the measures for reducing CO_2 emissions and the increase of energy-saving measures in sectors like that of energy production, industry and transport system;

c) the objective for the year 2000.

Particularly, the First National Communication extends the inventory of emissions to all greenhouse gases (carbon dioxide, methane, nitrogen oxide, carbon oxide and non methane volatile organic compounds) and to all sectors of emission and re-absorption.

According to the First Communication forecasts, Italy can bring back to the same values of 1990 its equivalent greenhouse emissions within the year 2000, even if it could be possible to increase lightly emissions of carbon dioxide, a gas which for 92-93% come from the energy sector.

The trend of carbon dioxide emissions

The actual growth of CO_2 emissions coming from the energy sector in more recent year has been limited. The monitoring of carbon dioxide emissions from the energy sector between 1990 and 1996 shows a trend which is to place between a 3.1% reduction in 1994 and a 2.1% growth in 1995. On the ground of the more up-to-date forecasts, the estimated emissions for the year 2000 should increase of 4-5%, and this growth is compatible with the objective of stabilising the European Union global emissions (table 1.4 and 1.5). It will be possible to reduce these emissions thanks to the adoption of energy-saving measures, that have to be effective in the short period, and so good that they should give results already in the year 2000.

Objectives of reduction of the national emissions within the year 2010

The objective of a 7% reduction by year 2010, in comparison with 1990 levels, decided by EU on March 3, 1997, drives Italy to the engagement of reducing the national greenhouse gas emissions from a value of circa 618 equivalent millions tons of CO_2 (annual), which has been forecast for the year 2010, to a value of 509 equivalent millions tons of CO_2 (annual).

Table 1.4: Trend in CO_2 emissions from the energy sector from 1990 to 1996 and estimates for the year 2000 (a)

Year	1990	1991	1992	1993	1994	1995	1996	2000 EU(b)	2000 (c)
Oil (Mt C/y)	69.1	68.4	71.7	70.0	68.6	70.6	69.4	70.1	67.3
Coal (Mt C/y)	15.8	14.9	13.1	11.5	12.1	13.1	12.6	13.1	13.0
Methane (Mt C/y)	24.6	26.2	25.9	26.4	25.5	28.1	29.0	35.5	34.6
Tot. energy emissions									
in Mt C/year	109.5	109.5	110.7	107.9	106.2	111.8	111.0	118.6	114.9
in Mt CO_2/year	401.6	401.5	405.7	395.6	389.4	409.9	406.9	435.0	421.3
index	100.0	100.0	101.0	98.5	96.9	102.1	101.3	108.3	104.9
Indicators									
Population in Millions	56.95	57.11	57.19	57.11	57.11	57.33	57.35	57.50	57.50
Per capita emissions									
(t CO_2/inhabitant)	7.05	7.03	7.10	6.93	6.82	7.15	7.10	7.56	7.33
GDP (TLit'90)	1311	1326	1333	1318	1346	1386	1399	1531	1531
Carbon intensity of									
GDP kg CO_2/MLit90	0.307	0.303	0.305	0.300	0.290	0.296	0.291	0.284	0.274

Table 1.5: Trend of national CO_2 emissions

Year	1990	1995	2000 (c)
Energy emissions	401.6	411.8	421.3
Emissions from industrial processing, use of solvents, change in the use of land and forests, waste	40.6	37.4	37.7
TOTAL	442.2	449.2	459.0

a) equal to 90% of National gross emissions of CO_2; excluding petrochemicals and international bunkering; some of the figures are slightly different from those in the next chapters due to the need to be consistent with the historical series
b) figure forwarded in January 1997 to the EC monitoring mechanism
c) estimated figure in September 1997 during this Second National Communication

So, the national objective could require, as regards the trend, a progressive reduction of greenhouse gas emission up to 109 millions tons within the year 2010
This is a very ambitious goal, if considering Italy starting-data, but it is technically feasible through the implementation of a series of interventions in different sectors, within an European policy which aims to reduce greenhouse gases.

Obviously, the national strategy has to be considered in conformity to a global point of view, because in Italy greenhouse gas emissions are about 2% of all the emissions in the world, and 13% of the whole European Union.

Moreover, the economic costs and effects of these measures need an harmonisation, at least:

- at an European level, because this is the "institutional" dimension of the inland market and some measures at a national level would lead just to market distortions and penalising effects, without valuable environmental results;

- at an international level, in the context of the developed countries, in order to guarantee the environmental effectiveness of these measures and safeguard the competitiveness on international markets.

1.1.7 OBJECTIVES OF THE SECOND NATIONAL COMMUNICATION

The Second National Communication (2 NC) to the Framework Convention on Climate Change offers a reference frame for the identification of the objectives and reduction measures of domestic emissions, along with the fulfilment of the commitments and the methodologies established by the Convention and the Secretariat.

The processing of the basic data, the assessing and the reduction scenarios is aimed at providing the elements and the argues to allow reasoned choices and to support the decisions Italy is going to assume in the frame of the Convention.

At the same time, the Second National Communication is a tool of information for the experts and the public on the complex matter of the climate change.
For the above reasons, the text has been written in a simple way, with clarification notes for terms abbreviations and units used in the framework of the Convention on Climate Change.

1.2. NATIONAL PROGRAM FOR THE REDUCTION OF EMISSIONS BY THE YEAR 2010

1.2.1 SPECIFIC NATIONAL CIRCUMSTANCES

At International and EC level Italy has proposed that National Objectives for Mitigation be fixed according to the national circumstances, both in terms of per-capita emissions and in terms of mitigation costs. It however supports methods which imply adoption of common policies and measures.

In 1990, the reference year of the Framework Convention on Climate Change, Italy emitted 442 Mt of carbon dioxide, which represent 13.5% and 2.2% of EU and global emissions respectively. It also emitted 548 Mt of the three main greenhouse gases (carbon dioxide CO_2, methane CH_4 and nitrous oxide N_2O), which measured in terms of CO_2 over a 100 years represent respectively 13.4% and 1.6% of EU and global emissions. Italy's influence on global greenhouse gas emission and, to a greater extent, on EC levels is so little that any further mitigation effort would be negligible unless part of wider action.

Carbon dioxide emissions by the 15 EU Member States have been reduced overall by 10% compared to the maximum levels of the 1970s. Over the same period per-capita emissions have fallen 13% and carbon intensity of income more than 40%. To reduce energy costs, the energy systems dependance on petroleum and risks of supply interruptions following the 1973 and 1981 crises, all European countries have implemented solutions which have reduced emissions and have invested in different technological options (energy efficiency, use of methane, nuclear energy)

At present the specific emissions of the more developed countries are very different, although standards of well being are the same. In other countries none of the above-mentioned investments were made and therefore over time there has been no significant fall in emissions. Considering population and income Italy's emissions are less than those of other developed countries: 7 tons per year compared to an average 9 tons in Europe, 12 in OECD countries and over 20 in the US. However it is not always clear to international analysts that countries which have already invested in reduction options are obliged to use more costly options for further mitigation while those countries which in the past have not strongly reduced emissions still have those options available.

1.2.2 INVENTORY OF EMISSIONS AND REMOVALS OF GREENHOUSE GASES

Using the methodology of the European Environment Agency, emission sources have been divided in detail by using an increased geographical distribution of data, calculation of emissions per single sources and calculation of emissions from widespread sources by means of average coefficients (table 1.6 shows the data summary of the 1995 inventory for the main greenhouse gases).

The energy sector is the main responsible for greenhouse gas emissions with 78.5% of total gross emissions of which 73.3% is due to carbon dioxide, 2.1% to methane and 3.1% to nitrous oxide. The latter is by far the most relevant greenhouse gas.

If emissions from the energy sector are measured per emission point, 30.9% come from the energy production and transformation sectors, 14.8% from industry, 17.8% from the transport system, 15.0% from agriculture, fishing and the military consumption. In sectors other than energy industrial processing accounts for 6.2% of emissions (4.9% CO_2, mainly from the production of cement), solvent related cycles for 0.4%, Agriculture and forestry sector for 11.6% (of which 4.2% from methane and 5.4% from nitrous oxide) and the waste sector for 3.3% (of which 3.2% methane).

If emissions are measured according to source activities, that is according to the demand for goods and services which cause emissions, then 27% of emissions of the three main greenhouse gases may be traced directly to end user demand while the remaining 73% is released due to the demand from the production sector.

Families emit about 18% in the residential sector (of which 3% from solid urban waste and about 10% for domestic heating) and the remaining 9% in the passenger transport system for transport directly by end users.

In the production sector, industry is responsible for about 36% of greenhouse gas emissions (29% for direct and indirect energy uses and the remaining 7% for process emissions). Emissions related to the service sector, more difficult to estimate, may be classified around 10%, with a relevant proportion due to indirect emission related to the production of the electricity consumed therein. If emissions due to transport of goods (approx. 11%) and to the proportion of passenger transport used for production services (approx. 3%) are included then emissions attributed to the service sector strongly increase. The remaining 13% of emissions comes from the agricultural and forestry sector and is equally accounted for by carbon dioxide, methane and nitrous oxide.

1.2.3 MITIGATION POLICIES AND MEASURES AND THEIR EFFECTS

The Program of Measures to Implement a National Program for Mitigation of Climate Change is a rational and consistent design of strategies, measures and interventions which, in relation to increasing knowledge on the issue of global climate, the Government plans to apply to ensure: national contribution to achieve the international objectives regarding mitigation of climate change, integration of environmental policies with those regarding each sector, balance between social needs and the companies' objectives, implementation of mechanisms to ensure convergence of objectives at European, National and local levels.

The program aims to further support the one approved by the CIPE on 25.02.1994 (National Program for the Containment of carbon dioxide emissions by 2000 at 1990 levels) extending its time frame to 2010 and including the three main greenhouse gases (carbon dioxide, methane and nitrous oxide from now on abbreviated as greenhouse gases).

The policies and measures regard in general the initiatives required to modernise Italy and protect the environment and they refer to two main fields of action:

1) Development programming and management and use of resources by the administrations:
- regulations, standards, incentives and restraints, voluntary agreements for a rational use of energy, energy saving, development of renewable sources;
- promotional action, information and environmental education;
- national plan to safeguard air quality
- regional plans to safeguard air quality, regional energy plans, regional transport plans, city energy plans
- urban traffic plans

Table 1.6: National Inventory of Greenhouse gas emissions: 1995 data summary (Gg/y) (a)

CATEGORIES OF EMISSION AND ABSORPTION OF GREENHOUSE GAS	CO_2 emissions	CO_2 absorption	CH_4	N_2O	NO_X	CO	NMVOC
Total National Emissions and absorption	449159	36199	2515.6	161.8	1848.6	7785.7	2374.7
1 Energy Sector	411793	—	467.2	44.0	1827.0	7154.9	1489.4
A Combustion processes: refer. method	412554						
sectorial method	409116		115	44.0	1821.3	7146.5	1335.0
1. Energy Industries	139180		4.9	20.0	375.6	30.1	4.9
2. Manufacturing and building	83043		7.3	7.9	252.9	519.7	15.2
3. Transport	108842		77.1	5.5	990.7	5894.2	1217.3
4. Other sectors (civil, agriculture and fishing)	76481		25.4	10.6	190.8	685.8	93.5
5. Other (military consumption)	1569		0.1	0.1	11.3	16.7	4.1
B Emissions from fuel leakage	2677.7		352.2	0.0	5.7	8.4	154.4
1. Fossil fuels			3.4				2.7
2. Oil and Methane	1163		348.8		5.7	8.4	151.7
3. Other (geothermal)	1515						
2 Industrial processing	22985	—	4.6	20.4	4.8	290.8	71.1
A Mineral products	19077						
B Chemicals	2335		2.32	20.4	1.4	11.4	48.0
C Metals	1034		2.26		3.3	279.3	2.9
D Other (paper and food industry)	539				0.0		20.2
E Prod. halogenated hydrocarbons and SF_6							
F Consumption of halogenated hydrocarbons and SF_6							
3 Use of solvents	1962	—	—	—	—	—	629.5
4 Agriculture	—		871.7	75.9	0.9	25.2	1.9
A Enteric fermentation			607.2				
B Excreta			181.9	12.4			0.6
C Rice cultivation			81.4				
D Crop Lands			0.0	63.5			
E Savannah fires							
F Agricultural waste burning			1.2	0.0	0.9	25.2	1.2
5 Changes in the use of land and forest	11692	36199	183.3	20.9	1.0	34.2	156.1
A Changes in forests and in other wood biomass areas	10344	35947					
B Conversion of forests and meadowlands	1348		3.9	0.0	1.0	34.2	3.9
C Abandoned cultivated areas		157					
D CO_2 emissions from and absorption by land		95					
E Other (managed forests)			179.4	20.9			152.2
6 Waste	727	—	988.8	0.5	14.9	280.5	26.8
A Landfills and dumps	0		464.0				8.2
B Wastewater processing	0		511.4				1.3
C Incineration of waste	727		13.4	0.5	14.9	280.5	17.3
D Other	0		39.9				
Additional information, extra-inventory emissions							
International bunkering	13099		1.1	0.7	193.0	23.0	8.8
- - Air	5447		0.4	0.2	17.5	5.0	3.7
- - Marine	7651		0.7	0.5	175.5	18.0	5.1
Biomass emissions	4279		15.3	0.7	7.6	270.5	22.2

(a) This unit of measurement is used to guarantee uniformity with the IPCC/OECD; it is equal to 1000 tons of CO_2/year or to 1/1000 Mt CO_2/year

2) Economic and Industrial initiatives towards technological innovation and minimising energy consumption supported by private investments and joint public funding (National and European) in the following sectors:
- electric power production
- industrial production
- production of motor vehicles and other means of transport
- infrastructures for public transport
- transportation of goods
- heating and cooling systems
- recycling and energy recovery from waste

As far as policies and measures are concerned three main types of intervention to reduce national emissions have been identified (table 1.3 shows a summary)

A) Intervention required to update Italian economy and protect the environment regard mainly:

a) increase in energy efficiency in the industrial and energy production sectors;
b) increase in energy production by renewable sources biomass and waste;
c) adoption of measures to control urban traffic;
d) replacement of about 50% of currently running vehicles with more efficient models;
e) construction of a rapid rail and tramline transport network in metropolitan areas and development of intercity rail networks;
g) widespread use of low emission biofuels;
h) increase in the use of methane in the industrial, residential and service sectors;
i) promotion and diffusion of appliances and systems to reduce consumption of electricity in the residential and service sectors.

Interventions will have reduced the greenhouse gas emission trend by 77 milion tons by the year 2010. This corresponds to a 1.3% reduction of the 1990 levels of emission. Investments required for intervention are estimated in 71,000 billion liras only partly due to the objective of reducing greenhouse gas emissions. The current net value of equivalent primary energy saving, evaluated at the crude oil price of 20$ a barrel and a discount rate of 5% in real terms is around 44,000 bilion 1997 liras minus the extra operating costs.

B) Additional intervention to reduce greenhouse gas emission to achieve the EU objective regard mainly:

a) increase in the use of renewable sources for electricity generation and heating for domestic use;
b) increase in the proportion of natural gas used in industry;
c) improvement in efficiency of industrial processing;
d) reduction in electric and heating consumptions in the residential and service sectors;
e) greater efficiency in the livestock sector;
f) increase in waste differentiation and recycling of alluminium, paper and glass.

The interventions will further reduce emissions by 32 milion tons which corresponds to an overall 7.1% reduction of 1990 emission levels. The investments required for these interventions have been estimated in 20,000 billion liras not entirely attributed to the objective of reducing greenhouse gas emissions. The current net value of equivalent primary energy saving, evaluated at the crude oil price of 20$ per barrel and at a discount rate of 5% in real terms is 32,000 billion 1997 liras minus the extra operating costs.

According to a maximum estimate of the extra operating costs and of the proportion of investments, the intervention package will need overall State subsidies for 2-3000 billion liras over 12 years.

C) Further interventions to reduce emissions are more troublesome both to implement, since it would mean sectoral agreements at EC level, and from the point of view of overall economic efficiency. They are:

a) further increase in efficiency of the industrial and animal breeding sectors;
b) further reduction of residential consumption due to heating;
c) promotion of low-consumption cars.

These interventions could yet further reduce emissions by 30 milion tons correspondin to anoverall 12.5% reduction of 1990 emission levels. Investments required for the interventions are estimated in approximately 27,000 billion liras. The current net value of equivalent primary energy saving at the crude oil price of 20$ a barrel and at a discount rate of 5% in real terms is about the same minus the extra operating costs. According to a maximim estimate of the extra operating costs and of the proportion of investments, this intervention package would require state subsidies of about 20-30,000 billion liras over 12 years mainly for the production of biofuels and high efficiency vehicles.

Table 1.3: Objectives and measures to implement a National Program to face climatic changes

Greenhouse gas (in Mt/yr CO_2 equiv. 100 years)	CO_2 emiss.	CO_2 absorp.	CH_4	N_2O	Gross Total
FCCC REFERENCE EMISSIONS (1990)	443.1	35.9	48.9	51.0	543.0
Energy sector: prod. process. distrib.	150.8		6.6	6.2	163.6
Industry sector	107.6		0.3	10.2	118.1
Mobility and transport sector	95.1		1.3	1.1	97.5
Residential, commercial and service sectors	78.0		0.4	3.6	82.0
Agriculture, animal breeding and forest sector	10.9	35.9	23.0	29.8	63.7
Waste processing sector	0.7		17.3	0.1	18.1
EMISSIONS IN 2010: trend scenario	509.7	36.2	55.8	59.6	615.0
A - Modernisation and local environment protection	453.5	36.2	39.1	45.1	537.6
B - European Union Objectives	425.4	36.2	35.5	45.1	505.9
C - Further interventions	396.6	36.2	34.5	45.1	476.1
MITIGATION AND REDUCTION OF EMISSIONS		A	B	C	
Emission reduction objectives in the year 2010		77	109	139	
Energy sector: prod. process. distrib.		18	23	23	
Industrial sector		13	20	24	
Mobility and transport sector		23	25	29	
Residential, commercial and service sectors		5	18	29	
Agriculture, livestock, and forest sector (incl. biofuels)		2	3	12	
Waste processing sector		16	20	21	
Measures to carry out interventions and technical potential		77	109	139	
Sectoral reorganisation, general policy laws, plans etc.		18	20	24	
Investments and direct action		10	10	12	
Incentives for voluntary measures		24	35	42	
Economic measures (taxes, tariffs, subsidies, etc.)		7	9	15	
Regulatory measures (standards, controls, etc)		18	35	46	

Inter sectorial measures: fully involve local authorities, enhance common European measures and policies, integrate global environment in the fiscal system, increase R&D activities regarding mitigation technology, spread technological innovation, permanent monitoring, studies and analyses of strategies to face climatic changes.

ADAPTATION: Measures to safeguard river environments, hydrologic security, flood forecasting, subsidence control on behalf of the watershed authorities.

TECHNOLOGY TRANSFER: Supporting competitiveness of the National industry of mitigation technology, establishment of an Italian fund for the Global environment, technology transfer through joint implementation

RESEARCH ON THE CLIMATE: Adoption/initiation of the National Program for Climatic Changes to co-ordinate national activities and act as reference for international co-operation (see art.5 FCCC)

REPORTS, INFORMATION, TRAINING: Promote public awareness on the issue of climate change, promote public participation in the discussions regarding mitigation policies and create a consensus in accepting the measures for greenhouse gas emissions reduction.

In order to protect global climate the program coordinates sectoral measures either already implemented or under discussion, aimed at modernising the country. Besides being time consuming to implement, coordination and completion of sectoral policies require large scale information campaigns and high transaction costs (organization, behaviour and financial), although single technological actions may be economically worthwhile. If necessary commitments will be enhanced in the long term by defining new sectoral objectives, further measures and eventual additional interventions. The program will have the simultaneous effect of updating some of the countries infrastructures and some of the operating and organizational aspects of the sectors involved such as to ensure economic advantages in the long term.

It seems that interventions can be implemented only by a common effort.

At European level, because an increasing number of policies and measures cannot be implemented at national level.
At international level, at least for the countries of Annex I, to avoid penalizing national productive systems in terms of competitiveness on the international markets.
Since there is no international agreement within the Convention, it would be useful to implement those

interventions which provide economic advantages besides reducing net greenhouse gas emissions. This would start up a process, which postponed, will require greater effort if called for later on due to the evolution of global climate.

This second policy, which however requires a great administrative and organizational effort, can achieve only limited goals compared to the first since it lacks the international perspective as well as common European measures and policies.

1.3 NATIONAL ACTIVITIES REGARDING GLOBAL CLIMATE

1.3.1 ASSESSMENT OF VULNERABILITY

According to experts, over the next decades climate variation in Italy may bring about a rise in temperature and a fall in humidity at ground level with negative effects on land, ecosystems and agriculture; in Central and Southern Italy, drought will be more severe although no quantified evaluation may be made at present. If, according to the possible scenarios, the sea level rises it will mainly affect the Po delta and the Venetian lagoon. It is no chance that the risks involving these two areas had already been considered in the First National Communication.

According to data collected by the Italian Hydrographic Service on sea level variations since the 1970s, in the upper Adriatic sea the real sea level is stable or has risen very little compared to the previous period.

This seems to contrast with the global trend in sea level rise over the last 100 years. Perhaps in the last 20-25 years local and regional factors have been able to mitigate the impact of the rise in sea level in one of the most critical areas in Italy. Another hypotheses may be that the rise in sea level does not follow a straight trend and may remain stable for decades.

Comparison between the past and a hypothetical future should be taken with a grain of salt: past and future scenarios deriving from paleoclimatic research and use of the same models are to various degrees uncertain; besides, anthropic impact, nowadays eextremely important, was irrelevant before the industrial revolution. However, convergence of results provided by paleoclimatic studies and scenarios showing a future rise in temperature may suggest these are the most likely scenarios for the next future.

Climatic changes in our macro-region may have an impact on the hydrogeologic situation, forest ecosystems, protected areas, glaciers, marine biodiversity and human health.

1.3.2 MEASURES FOR ADAPTATION

As far as policies related to territorial defense are concerned reducing vulnerability to the effects of climate change will call for a better planning of interventions and more rigorous project conditions than those adopted so far.

Law 183 of May 18, 1989 containing the "Regulations for organizational and functional restructuring of land defense" is the main legal measure so far adopted to ensure organic planning of interventions to safeguard the territory and redress hydrogeological balance. With this law new programs and plans have been introduced to ensure defense of territory, water recovery and use of water resources for a rational social and economic growth at the same time safeguarding the related environmental aspects.

The law has remodelled the institutional and organizational structure of territorial defense. The territory is divided into hydrographic watersheds of National, interregional and regional importance. For each watershed of national importance a "Basin Authority" shall be established which shall draw up a watershed plan containing forecasts and plans regarding the basic lines of territorial structure. Moreover the authority shall implement and monitor implementation of the watershed plan.

While waiting for the approval of the watershed plans, referring to Law n. 493 and regulations following the 1993 and 1994 floods in the Po region, the watershed authorities may draw up and approve plans related to specific functional sectors and the most important sub-watersheds and adopt immediately binding legal measures to safeguard them.

In particular, almost all national watershed authorities have adopted or are about to adopt measures to safeguard river environments as well as plans in the sector of hydrologic security. These plans together with laws and regulations regarding areas with mining activity, and regulation of water concessions have produced specific risk-prevention measures and guidelines regarding land use and construction projects.

In view of an increase in extreme meteorological phenomena, floods and decline in land quality, the government is setting up combined action on behalf of local and national authorities to enhance "natural infrastructures" to defend and safeguard the territory. To this aim a mixed State-regional committee will be established to monitor exceptional climatic events and to coordinate yearly prevention programs.

There are specific laws for the Venetian lagoon, the most vulnerable Italian site to sea level rise. Considering the great national interest these laws define the general objectives for intervention and the most suitable implementation procedures.

According to the September 1991 General Plan of Interventions, protection from exceptional tides is provided by a set of mobile barriers situated on the three openings between the lagoon and the sea. When tides are exceptionally high these barriers are able to isolate the lagoon from the sea in the shortest time possible (the project has been submitted to the Ministry of the Environment to verify environmental compatibility). To reduce frequency in the use of the barriers, local interventions such as raising the pavement levels and banks shall be carried out to safeguard inhabitants in case of tides up to a minimum of 1 meter above sea level. Thus the barriers would be used only 7-8 times a year for tides equal or greater than 100 cm. The plan is made up of other interventions such as reinforcement of the coastline to limit decline in the lagoon's natural and articial means of defense, restructuring the offshore breakwaters, morphological recovery of the lagoon, reopening the fishing areas to improve local environmental conditions, bans on crude oil and fuel oil transport within the lagoon, halting and reversing decline.

Considering a natural subsidence of 4 cm per century and a 50 cm rise by 2010 in sea level due to climate change on the basis of the IPCC best estimate, before the end of the 21st century Venice may experience a land altitude loss of 54 cm. If this occurred, Venice, Chioggia and the minor islands would be daily subject to overflows. Wave movements would increase and cyclical pressures caused by rapid submersions would compact the sand and therefore produce landslides.
Consequent social and economical damage is easy to imagine although difficult to quantify. The combined effect of water and waves would cause permanent and progressive damage to historical and urban heritage with an increasing risk of abandon accompanied by a exponential increase in costs which above a certain limit could no more be faced.

1.3.3 FINANCIAL RESOURCES AND TECHNOLOGY TRANSFER

In 1994 and 1995, Italy allocated respectively 0.27% and 0.14% of GDP to bilateral and multilateral Public Aid to Development (PAD). Bilateral PAD in 1994 and 1995 was overall 1834.38 and 805.70 milion US$, respectively. Albeit reduction in funds allocated to technology transfer, Italy has tried to place priority on environmental aspects in agreement with the general commitments to promote sustainable growth: to enhance Agenda 21 guidelines, in 1994 and 1995 Italy distributed respectively 6.59 milion US$ and 21.33 million US$ to bilateral environmental programs and projects according to its declarations at the DAC (Development Assistance Committee) of the OECD.

Moreover, several project identification activities have been carried out by the fund established in 1992 by Italy for bilateral aid to Central East European Countries and the Comunity of Independent States. In 1996 a series of programs were initiated for an overall 10.36 million US$. In particular activities to safeguard and recover the environment have been implemented in cooperation with Bulgaria and Slovenia for a total 0.57 milion US$. Further inter-sector environmental activities are financed by technical-scientific and vocational-technical training programs carried out jointly with CEEC and CIS countries.

In 1994 and 1995 Italy provided respectively 870.24 and 816.96 million US$ in funding to Multilateral Organizations including the European Union and undersigned capitals to banks and International funds, many of which finance projects and programs aimed at achieving the objectives of the Convention on Climate Change. Besides, after its contribution to the pilot stage, Italy has also taken on the commitment to contribute to restablishing GEF and in 1996 it deposited 25.89 million US$ as a first instalment of the Italian contribution to an organism acting as ad interim financial body of the Convention.

As far as technology transfer is concerned Italy supports several activities through public and private bodies which promote, aid and finance access to environment-friendly tecnology and to the know-how required to reduce greenhouse gas emissions by developing countries. The aim is to enable these countries to comply with the provisions set forth by Convention.

Many Italian industries and service companies are actively involved in technology transfer with positive environmental effects. This has been possible thanks also to promotional action carried out by the Institute for Foreign Commerce which organizes several activities in developing countries interested in joint ventures with Italian partners.

As in other countries, in Italy it may be convenient to establish an ad hoc fund to aid growth in the environmental sector thus providing a more integrated approach among the various sectors and as far as bilateral and multilateral initiatives are concerned.

1.3.4. RESEARCH ON CLIMATE CHANGE AND ITS EFFECTS

Research in Italy is carried out to assess the effects of human activity on climate, climate variability, environmental impact and climate changes in the past (paleoclimate). Research is carried out mainly in universities and National research institutes but research by other groups is increasing.

Activity regards mainly monitoring, observation and measurements. Several oceanographic ships are used for research to collect very important data regarding climate change in the Mediterranean Sea.

Another important research sector concerns the numeric simulation of climate by means of detailed general circulation models. This activity is based on global scale simulations with atmospheric models on a decade or interdecade scale with established surrounding conditions. Oceanic circulation models are used for research on data assimilation and for basic studies on equatorial ocean dynamics. Models developed in our country especially at regional level and for the Mediterranean area are disseminated internationally.

As far as impact studies are concerned, Italy has undertaken a series of initiatives which focus mainly on the effects of sea level variations stemming from climate change, a particular interesting issue for damp coastal areas.

Desertification is another research sector in which Italy is deeply involved at international level. Research is being carried out on how to address the issue and implement mitigation strategies to manage water and agricultural resources in situations where social, economical and environmental pressure increases.

National research activity in the field is carried out within the European Commission Framework Programs and especially in the "Environmental" sector. Italian groups have been quite successful in their applications: in 1994 and 1995 Italian researchers have taken part in about a hundred EU Projects on environmental issues financed by the EC.

1.3.5 INFORMATION TO THE PUBLIC AND TRAINING

Art. 6 of the Convention on Climate Change, Education training and public awareness, contains a series of obligations for the signatory parties as far as education and public participation are concerned.

In this Second National Comunication 6 sectors are stated as being able to contribute to education and information on the issue of climate change:

1. Central Goverment, especially Ministry for the Environment
2. National Research Institutions
3. Local Administrations: mainly city councils
4. Non-governmental Environmental Organizations
5. Mass media
6. All schools

For each sector the second communication states the action to be taken to promote information and achieve public awareness. At present various activities exist but they are not linked and efficacy is thus reduced. One of the objectives shall therefore be coordination of current activities to enhance public participation even when it comes to the choices the government must make to reduce greenhouse gas emissions.

2. Introduction: Italy's commitments

2.1 THE FRAMEWORK CONVENTION ON CLIMATE CHANGE

During the years of negotiation carried out at the UN within the Intergovernmental Negotiating Committee (INC) and the preparation of the UN Framework Convention on Climate Change (UNFCCC), undersigned by Italy at Rio de Janeiro during the "Earth Summit" in June 1992, Italy has taken a leading position among the developed countries and has pulled along other European Union Member States. In the joint declaration of October 29, 1990, drawn up and adopted by the European Union Council of Ministers for Energy and the Environment under Italian Presidency, Member States have recognised the objective and the common effort to prevent climate change and reduce greenhouse gas emissions starting with CO_2.

In particular, the commitment to stabilise carbon dioxide emissions by the year 2000 at 1990 levels, calls for all Member States to implement programs and initiatives regarding environmental reconversion, energy efficiency in the industry sector, in energy production, in transport, and in activities in the service and civil sectors. Moreover, the declaration commits Member States to protect forest and to increase carbon dioxide sinks. Contents and commitments of the declaration were a great part of the basis of the negotiations in the frame of the UNFCCC.

During negotiations and in order to clarify the complex environmental and energy problems which arose among the parties, at the United Nation's request, in October 1991, Italy organised and hosted an International symposium on promotion and transfer of the best environment-friendly and energy-efficient technology to East European and Developing Countries (ESETT '91). Forty-five countries from all over the world took part and the results are a basic part of the final contents of the Framework Convention on Climate Change undersigned at Rio de Janeiro.

The following joint European Councils of 13.12.1991 and 23.4.1993 confirmed the previous decisions and the Rio policy-calling Member States to:

- formulate and publish a National Program for the Reduction of CO_2 Emissions.

- draw up a report on the emissions of other greenhouse gasses not subject to the Montreal Protocol and the corresponding measures for limitation.

2.2 RATIFICATION OF THE CONVENTION AND NATIONAL PROGRAM FOR THE REDUCTION OF CO_2 EMISSIONS

Art 4. comma 2 of the Convention obliges OECD countries and those with economies in transition (countries included in FCCC Annex I) to take the lead in changing the current long term emission trend by returning emissions to 1990 levels, by the year 2000. This commitment is approximately consistent with the equity criteria at the heart of the Convention and especially with the principle of "common, but differentiated responsibilities".

With Law 65 of 15.1.1994 the Italian Parliament ratified the UN Framework Convention on Climate Change and allocated 1500 billion liras in 1994 and 1995 to monitor greenhouse gas emissions, to update national programs for mitigation, for Italian co-operation in the Intergovernmental Panel on Climate Change (IPCC) and to financially contribute to the functioning of the Convention Secretariat. By ratifying the UNFCCC, Italy has committed itself to:

- contribute to achieving the ultimate objective of the Convention i.e. "achieve stabilisation of atmospheric concentrations of greenhouse gasses at a level as to prevent dangerous anthropogenic interference on the climate; this level should be reached in a period of time which would allow ecosystems to naturally adapt to climate change ensuring food production is not endangered and allowing sustainable economic growth;

- develop, periodically update and publish inventories of anthropogenic emissions from the different sources and sinks for all greenhouse gas not controlled by the Montreal Protocol;

- use standard methodologies to draw up the inventories of greenhouse gas emission and removals.

A first acknowledgement concerning the commitments stemming from adhesion to the Convention is contained in the National Program for the Containment of Carbon Dioxide Emissions by the year 2000 at 1990 levels jointly presented by the Ministry for the Environment and the Ministry for Industry, Trade and Crafts (MICA), approved by the Comitato Interministeriale per la Programmazione Ecomomica (CIPE-Interministerial Committee for Economic Planning) in the session of 25.2.1994. Among other things the Program approved by the CIPE plans to limit within 430 Mt CO_2/year carbon dioxide emissions from the energy sector in the year 2000 compared to the 1990 level of 421 Mt CO_2/year 6, that is 40-60 Mt CO_2/year less than forecasted emissions if national energy consumption had followed its normal trend; this is feasible if the total primary energy demand in the year 2000 is less than 178 Mtoe. Moreover, the program indicates which technological, regulatory and fiscal measures must be taken to return emissions to 1990 levels by the year 2000.

2.3 THE FIRST NATIONAL COMMUNICATION

The first National Communication (1stNC) under the Framework Convention on Climate Change prepared by ENEA for the Ministry for the Environment was forwarded to the United Nations on January 16th 1995. It extends the inventory of emissions to all emission and removal sectors and to all greenhouse gasses: carbon dioxide, methane, nitrous oxide (N_2O), nitrogen oxides (NO and N_2O), carbon oxide and volatile organic compounds other than methane.
According to the 1st NC the Italian system can return its equivalent emission of greenhouse gas in the year 2000 back to 1990 levels even if the national objectives to limit CO_2 emissions are more costly than in other countries due to the low energy intensity. The 1990 primary energy consumption of 163.5 Mtoe (million of tons oil equivalent) released 400.4 Mt CO_2 of which 34.5% came from energy processing and production industries, 23.9% from transport, 22.6% from industry, 10.3% from the residential sector and 6.6% from the commercial and institutional sector. In the scenario trend, with an average increase in GDP of 2% per year in international currency, the primary energy demand in the year 2000 has been forecasted at 190 Mtoe/year with an emission of approximately 463 Mt CO_2/year.

Enhancing energy efficiency as stated in the programs of intervention to modify or update processes and products, however necessary due to market requirements or to the wearing out of plants, an increase in primary energy demand between an average 0.9% and 1.3% per year was forecasted for the year 2000 with a corresponding increase in CO_2 emissions between 0.4 and 0.9%. The lower figures and their stability after the year 2010 were linked to implementation in of a wide range of policies and measures such as rules and regulations, voluntary agreements, financial incentives, and training and information, in each sector responsible for greenhouse gas emissions.

Analysis of national emissions in carbon dioxide equivalent units[1] points out the possibility to achieve the objective of limiting national contribution to global radiative forcing in the year 2000 in a time frame of 20 years by implementing all planned interventions on the energy offer and on a 100 year time frame considering also the interventions on the demand side.

As far as the specific objective of stabilising CO_2 emissions is concerned, a particularly important issue in stabilising long term climatic forcing, the Italian government has considered national efforts in the wider perspective of international co-operation.

2.4. ASSESSMENT BY THE CONVENTION SECRETARIAT

The group of experts appointed by the Convention Secretariat to assess (in depth study) the 1st Italian NC to the UNFCCC has verified that the requirements contained in articles 4 and 12 of the Convention have been met. In the assessment process carried out from November 1997 to February 1998, by meeting representatives of various Ministries and the authors from ENEA, assessors have been able to analyse in depth some of the critical issues of the communication such as inventories, scenario consistency and the related methodologies, assessment of the effects of mitigation measures, information campaigns to improve energy efficiency by end users. Moreover, the assessors were updated on future developments regarding the Italian economy, energy programs and programs related to other sectors involved in climate change as well on the setting up of a Gas and Electricity Authority.

Assessors could see that the Italian energy system still has a good efficiency with a consequent low energy consumption and CO_2 emission per capita as well as per unit of GDP. These positive effects are not only due to reduced economic growth in the early 1990s but also to specific energy policies such as the progressive price structuring of electricity for domestic use and incentives to produce electricity from renewable sources or by cogeneration.

The assessors however pointed out that Italy still lacks a national objective in the sector of greenhouse gas emissions and a co-ordinating and monitoring mechanism to ensure implementation of policies and measures stated in the 1stNC. In their opinion replacing coal and fuel oil with methane will therefore be the main means of limiting national emissions of greenhouse gases because many of the measures described in the 1st NC are either too general and insufficiently subsidised or lack information concerning the specific amounts of financial and fiscal incentives.

As far as the formulation of the 2ndNC is concerned the group of assessors has recommended Italian experts to improve clarity and detail regarding the inventories and the effects of policies and measures[2]. To follow this recommendation evidently requires availability of information on already approved sectorial programs with details on the investments and the financial and fiscal measures to implement them including the mechanisms.

1 Greenhouse gases other than CO_2 are converted to equivalent CO_2 by means of their so called Global Warming Potential over a period of 100 years.

2 On the basis of indications contained in the guidelines for inventories prepared by IPCC/OECD and in those approved by the Conference of the Parties for drawing up national communications.

2.5 THE EUROPEAN MONITORING MECHANISM

The European Union[3] has set up a "Mechanism for Monitoring the emissions of CO_2 and other greenhouse gases"[4], to assess implementation of the EC commitment to stabilise emissions in 2000 at 1990 levels and implementation of commitments taken by the EC as party of the Framework Convention on Climate Change relating to CO_2 and other greenhouse gas emissions. This mechanism includes yearly reports by all Member States containing data and information as well as an assessment report by the European Commission.

In the first assessment report (November 1993), the Commission acknowledged the information contained in the "National Program to limit CO_2 emissions by the year 2000 at 1990 levels" and the fact that concrete measures to reduce CO_2 emissions had already been adopted or planned. However it pointed out the lack of further action and means to achieve stabilisation.

In the second assessment report (September 1995) the Commission underlined that according to assessment criteria established by experts, the effect of reduction measures listed in the First National Communication was particularly high. Given a average annual GDP increase of 2% and higher prices per barrel of crude oil (14.8 $) than those estimated in the First National Communication, the EC considered likely a 6% increase on 1990 levels of CO_2 emission in the year 2000 compared to the 2.9% figure officially forwarded (referring both to emissions from the energy sector and those from industrial processing and without considering forest sinks).

In January 1997, Italy reported the estimated CO_2 emissions from the energy sector for the year 2000 to the European Union. The estimate had been obtained considering a average annual 2.3% increase of GDP and complete implementation of measures and policies contained in the 1st NC (see table 2.1).

2.6. TOWARDS THE THIRD CONFERENCE OF THE PARTIES

Italy's commitment on the issues related to climate change and strategies of mitigation was confirmed during the plenary session of the Intergovernmental Panel for Climate Change (IPCC) which finalised the Second Assessment Report (SAR) on Global Climate in the conference organised and hosted by Italy in December 1995 in Rome. According to the SAR and to the following "Ministerial Declaration" approved by almost all undersigning countries in the second Conference of Parties (COP-2 July 1996):

- "anthropogenic influence on global climate is more and more evident"
- "without specific policies and measures to mitigate climate change, the 1990 average global temperature shall increase by about 2% °C (between 1.5 and 3.5 °C) by 2100; average sea level by 2100 shall rise by about 50 cm (between 15 and 95 cm) compared to 1990 levels";
- "stabilisation of atmospheric concentrations of CO_2 at double pre-industrial age levels shall require global emissions to be less than half those at present."

During its Presidency of the European Union in the first semester of 1996, Italy stated its objectives:

1. establishment of Quantified Emission Limitation and Reduction Objectives (QELROs) for greenhouse gas emissions for the years 2005, 2010, 2020 for the European Union and burden sharing of Member States.

2. the definition of policies and measures to be commonly implemented and co-ordinated by all Member States to achieve the above stated objectives for emission reduction.

3. formulation of a first draft protocol to be presented at UN negotiations.

3 The European Union has signed the UNFCCC as an independent body and has enhanced adhesion to the Convention of each Member State.

4 In the Decision 93/389 of the European Union Council of Ministers for the Environment of 22.3.1993.

5 "Quantified emission limitation and reduction objectives within specific time frames" presented in Rome on 8 June 1996. The main principles have recently been published (Tosato et at, 1997).

Table 2.1: Data and indicators concerning CO_2 emission from the energy system from 1990 to 1996 and estimates for the year 2000 (a)

Year	1990	1991	1992	1993	1994	1995	1996	2000 EU(b)	2000 (c)
Oil (Mt C/y)	69.1	68.4	71.7	70.0	68.6	70.6	69.4	70.1	67.3
Coal (Mt C/y)	15.8	14.9	13.1	11.5	12.1	13.1	12.6	13.1	13.0
Methane (Mt C/y)	24.6	26.2	25.9	26.4	25.5	28.1	29.0	35.5	34.6
Total energy emissions									
in Mt C/year	109.5	109.5	110.7	107.9	106.2	111.8	111.0	118.6	114.9
in Mt CO_2/yr	401.6	401.5	405.7	395.6	389.4	409.9	406.9	435.0	421.3
index	100.0	100.0	101.0	98.5	96.9	102.1	101.3	108.3	104.9
Indicators									
Population in millions	56.95	57.11	57.19	57.11	57.11	57.33	57.35	57.50	57.50
Per capita emissions									
(t CO_2/inhabitant)	7.05	7.03	7.10	6.93	6.82	7.15	7.10	7.56	7.33
GDP (TLit'90)	1311	1326	1333	1318	1346	1386	1399	1531	1531
Carbon intensity of									
GDP kg CO_2/MLit90	0.307	0.303	0.305	0.300	0.290	0.296	0.291	0.284	0.274

a) equal to 90% of National gross emissions of CO_2; excluding petrochemicals and international bunkering; some of the figures are slightly different from those in the next chapters due to the need to be consistent with the historical series
b) figure reported to the EC monitoring mechanism in January 1997
c) figure estimated in September 1997 and contained in the present Second National Communication

As far as the first issue is concerned, Italian experts have collected and formulated in a document[5] the informal elements presented to the Italian Presidency by experts of Member States regarding mitigation policies and measures and their possible effects on greenhouse gas emissions. According to this preliminary analysis, if all planned measures were implemented, in 2010 greenhouse gas emissions would be 5% less than in 1990; the related cost had not been at the time assessed. The Italian Presidency's document has been the basis for the following formulations by the Irish and Dutch Presidencies which led to the European Union's negotiating position and to burden sharing for each Member State decided at the European Member Council of Ministers on March 3,1997.

The Italian Presidency's document has moreover contributed to a better definition of policies and measures for mitigation of greenhouse gas emissions that Italy considers a priority and introductory in defining quantified reduction objectives. Eleven potential areas for intervention with common policies and measures have been identified:

- renewable energy;
- energy efficiency standards, labelling and other product related measures;
- CO_2 emission from the transport sector;
- financial means;
- energy policies;
- emission from the industrial sectors (including voluntary agreements);
- emissions from the agriculture sector;
- forests;
- waste management;
- HFC and PFC;
- action at local urban level.

Preparation of documents stating conditions, perspectives or possible common action was commenced under the Italian Presidency (four documents approved and presented to the Convention Secretariat) and finished during the Dutch Presidency (first semester 1997).

Participation in these activities, which cover both scientific and social-economical and political aspects related to climate change, enhances capacity to intervene consistently with the ongoing international and community process.

2.7 PARTICIPATION IN INTERNATIONAL ACTIVITIES

Italy participates in international activities on climate change placing priority on action by the European Commission, the Intergovernmental Panel for Climate Change (IPCC), the Organisation for Economic Co-operation and Development (OECD), the International Energy Agency and the Convention Secretariat (Bonn), and agreeing on negotiating positions common to other Member States of the European Union.

The Italian representatives at the Convention Secreatariat[6] come from different parts of the public administration. The Ministry for Foreign Affairs leads delegations during the Conference of the Parties by means of an Ambassador or an official of the same level or through the different representatives (especially at Geneva); the Ministry for the Environment (Atmospheric and Acoustic Pollution and Industrial Risk Service), with the collaboration of the Ministry for Industry (General Direction Energy Sources), co-ordinates participation in meetings of auxiliary bodies and in those at EU level fulfilling technical and administrative duties; the Ministry for Treasury takes care of financial aspects. To carry out activities related to the Convention's technical and administrative procedures, the Ministry for the Environment together with the Ministry for Industry have set up an interministerial working group which includes experts from ENEA.[7]

The European Union is involved in climate change through various activities and bodies. The political focus of the Union's commitment is the Council of Ministers for the Environment supported by the EC General Direction XI for the Environment. Italy participates through the Ministry for the Environment, General Direction for Atmospheric and Acoustic Pollution and Industries at Risk (SIAR), supported by the General Direction of Energy Sources and Basic Industries of the Ministry for Industry, Trade and Crafts and by ENEA experts who are part of the above mentioned interministerial working group; the SIAR General Direction invites participation of all the General Directions of the Ministries involved in each specific sector. The Ad Hoc Group for Climate[8], the Monitoring Mechanism and the CORINAIR[9] project have been especially important in recent years. Through ENEA, Italy also takes part in activities of the European Thematic Centre on Emissions (ETCIAEM)[10].

Italian researchers' participation in IPCC[11] is co-ordinated by the Ministry for the Environment that proposes possible co-authors of the document and appoints assessors of the final document. ENEA is the focus for the IPCC's activities, spreading information at national level and providing technical support to the Ministry for the Environment for final assessment by the Government.
Albeit efforts on behalf of the Ministry for the Environment, Italian research institutions are weakly involved due also to the fact that many of the initiatives proposed by the government regarding co-ordination and promotion of climate change research have never been approved by the Parliament.

6 The main bodies of the Convention are: Secretariat in Bonn; Conference of the Parties, (COP); Subsidiary Body for Scientific and Technological Advice, SUBSTA; Subsidiary Body for Implementation, SBI; Ad Hoc Group for the Berline Mandate (AGBM), set up by COP1 for adoption of a protocol; Ad Hoc Group on Article 13 (AG13) set up by COP1 regarding issues for implementation of the Convention.

7 Set up during the semester of Italian Presidency of the EU, the interministerial group was confirmed and is partly responsible for this communication.

8 The Ad Hoc Group for Climate has been and is the privileged seat of discussion and preparation of common actions in view of the European Councils of Ministers for the Environment; meeting are held once a month; when necessary the more technical issues are discussed by groups of experts which for Italy have also come from the production sector.

9 CORINAIR (Co-ordination Informal AIR) is the project promoted by the EC since 1985 and aimed at collecting and organising data on emission of air pollutants in the EU.

10 Functioning within the European Environmental Agency. Italy is represented by the General Direction of Environmental Impact Assessment of the Ministry of the Environment.

11 The IPCC was set up jointly by the World Meteorological Organisation (WMO) and the United Nations Environmental Program (UNEP) in 1988 to evaluate scientific, technical and socio-economical information related to climate change.

2.8. OBJECTIVES OF THE SECOND NATIONAL COMMUNICATION

This Second National Communication (2ndNC) to the Framework Convention on Climate Change is needed to meet obligation deriving from undersigning the Convention. Therefore it follows the methodologies suggested by the Convention Secretariat and includes the issues stated in the guidelines[12].

The elements which distinguish Italy from the other undersigning parties, presented in Chapter 3, are fundamental to understand the reasons for the national differences in emissions, in objectives and in actions. The inventory of emissions presented in Chapter 4 summarises data and calculation details reported in the annex according to the methodologies set forth by the Secretariat. Policies and measures for mitigation and emission scenarios for the year 2010, although separately described in Chapters 5, and 6, should be jointly assessed since they are two aspects of the same assessment.
The following thematic chapters summarise the current knowledge of national vulnerability to climate change (Chapter 7), suggest some actions to adapt to possible changes (Chapter 8), present Italy's international commitment both in terms of financial resources and technology transfer (Chapter 9), provide some indications on the state of Italian research on global climate (Chapter 10) and describe national and local activities regarding information to the public and training on the issue of climate change mitigation options (Chapter 11).

However, the report has three aims at national level linked to the necessity to simultaneously approve a Program of Measures to Implement a National Policy for Mitigation of Climate Change which indicates time and means of achieving the desired reductions.

One of these aims is administrative, since this communication acts as an enlarged report to the Program proposal already approved by CIPE.

The second aim regards information and training since we have realised that issues on climate change are not well known to the public at large. Albeit the difficulty in describing technical concepts, the text has been written a simple language with explanations notes and a large glossary (in italian version of this publication) to explain concepts, terms, abbreviations, and less familiar units of measurement.

Another aim has been to provide information on techniques and data used to implement the scenarios to experts from various sectors, to workers in the field and to political decision makers in order to spread internal discussion with a view to international deadlines.

12 Besides improving methodologies for drawing up inventories, the main differences between the first and second communication derive from the different time frame 2000 for the 1st NC (a 6 year time frame), at least 2010 for the 2nd NC (+13 years) and the relatively different methods.

3. Specific national circumstances

In International and EU meetings Italy proposes to establish methods and objectives for mitigation of climate change that are trimmed to national circumstances both in terms of per capita emissions and even more in terms of replacement costs placing priority of course on implementation of common policies and measures. This chapter contains relevant national data on emissions and the factors that produce them, compares the national situation with that of some other countries and motivates the national demand as far as international equity is concerned.

3.1 NATIONAL TREND OF GREENHOUSE GAS EMISSIONS AND INTERNATIONAL COMPARISONS

3.1.1 SPECIFIC EMISSIONS

In 1990, reference year of the Framework Convention on Climate Change, Italy released 442 million tons of carbon dioxide (Mt CO_2), 2.47 Mt of methane (Mt CH_4) which had a radiative effect equal to 52 Mt CO_2, and 0.17 Mt of nitrous oxide (MtN_2O) which had a radiative effect of 54 Mt CO_2. The equivalent 548 Mt CO_2 emissions in Italy in 1990 due to the three main greenhouse gases were made up by carbon dioxide (80.6%) methane (9.5%) and nitrous oxide (9.9%).[1]

National emissions of CO_2 accounted for 2.2% of global emissions while emission of the three greenhouse gases totalled 1.6% (see table 3.1).

Italy's accounts for a very low proportion of the total world emission of greenhouse gases, negligible when compared to the United States. Europe's share of emissions is also lower than the United States (16.3% for CO_2 only; 12.2% for the three main greenhouse gases). Therefore EU and National efforts to reduce CO_2 emissions have a scarce influence on a world-wide scale if they are not part of a co-ordinated international effort which includes also developing countries (IPCC, TP4, 1997).

Considering population and income, Italy's emission share is lower than other developed countries (see table 3.2)

Italy accounts for 13.5% of total EU CO_2 emissions, 13.4% if all three main greenhouse gases are considered. Figures 3.1a and 3.1b show that the emission share is lower than population and income shares because the carbon intensity of income and the per capita emissions are lower than the average EU figures especially compared to those of important countries such as Germany and the United Kingdom.

3.1.2 HISTORICAL GROWTH OF CO_2 EMISSIONS WITHIN THE EUROPEAN UNION

Carbon dioxide emissions by the 15 Member States of the European Union have been reduced by an overall 10% compared to the maximum levels of the early 1970s. Per capita emissions have been reduced by 13% in the same period and carbon intensity of income by 40% (see figure 3.2) To reduce the cost of energy, dependence of energy systems on petroleum and risks of supply interruption following the 1973 and 1981 crises, all European countries have implemented measures which as a consequence have reduced emissions, and have invested in different technological options (efficient use of energy, use of methane, use of nuclear energy)

1 Absolute figures and emission percentages vary according to the source and to the calculation method: quite a few basic data are uncertain (see also paragraph 4.9).

Table 3.1: Burden of gross national anthropogenic emissions of the three main greenhouse gases in 1990

Greenhouse gas	CO_2 Tg/y	CH_4 Tg/y	N_2O Tg/y	TOTAL (a) (in Tg CO_2 eq.100)
National emissions (b)	442	2.5	0.17	548
EU-15 emissions (c)	3286	24.7	0.93	4091
Italy's proportion of EU-15 emissions (%)	13.5	10.0.8	18.7	13.4
Global emissions (d)	20167	375	17.91	33595
EU-15 proportion of global emissions (%)	16.3	6.6	5.2	12.2
Italy's proportion of global emissions (%)	2.2	0.6	1.0	1.6

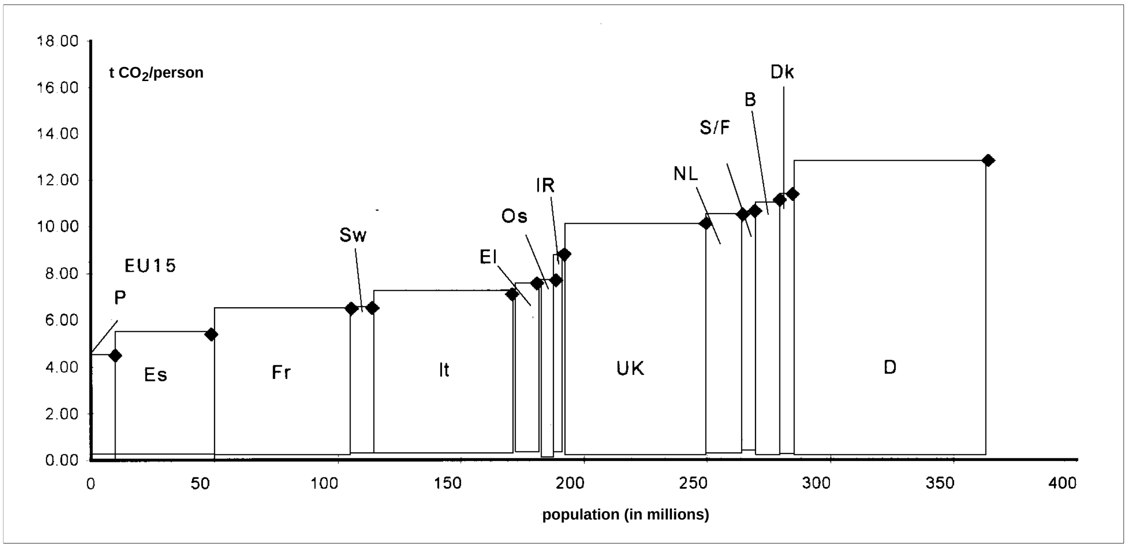
a) the conversion in equivalent tons of carbon dioxides made by multiplying the amount of each gas by the coefficient of global warming potential over a 100 years: CO_2=1, CH_4=21 and N_20=310;
b) see updated inventory in chapter 4, table 4.5;
c) the European Environment Agency, June 1995;
d) IPCC, Climate Change 1994 - Radiative Forcing of Climate Change and An Evaluation of the IPCC IS92 Emission Scenarios, 1995.

Table 3.2: Per capita emissions of CO_2 and per capita income in some countries (1990 and 1995)

Country	per capita GDP ($1990) 1990	per capita GDP ($1990) 1995	per capita CO_2 (kg) 1990	per capita CO_2 (kg) 1995
Austria	16,671	17,891	9,157	8,428
Belgium	16,298	17,091	11,113	11,819
Denmark	16,554	18,123	11,501	13,064
Finland	16,203	15,190	13,880	16,355
France	17,358	17,872	7,004	6,918
Germany	16,242	16,906	12,421	10,770
Greece	9,133	9,387	7,387	7,511
Ireland	11,248	14,245	9,305	9,598
Italy	16,257	17,023	7,041	7,351
Luxembourg	22,918	23,737	28,417	22,071
Netherlands	15,995	16,962	10,384	11,457
Portugal	9,371	9,764	4,690	5,607
Spain	11,787	12,474	5,709	6,612
Sweden	16,997	16,582	8,903	9,300
United Kingdom	15,882	16,516	10,296	9,567
EU 15	15,484	16,141	9,064	8,867
USA	21,966	23,370	20,662	20,948
Japan	17,623	18,544	8,808	9,587
OECD	16,029	16,808	11,626	11,823
China	na	488	1,983	2,490
India	na	409	195	882
Russia	na	2,179	25,438	16,175
World	4,056	4,247	4,112	3,906

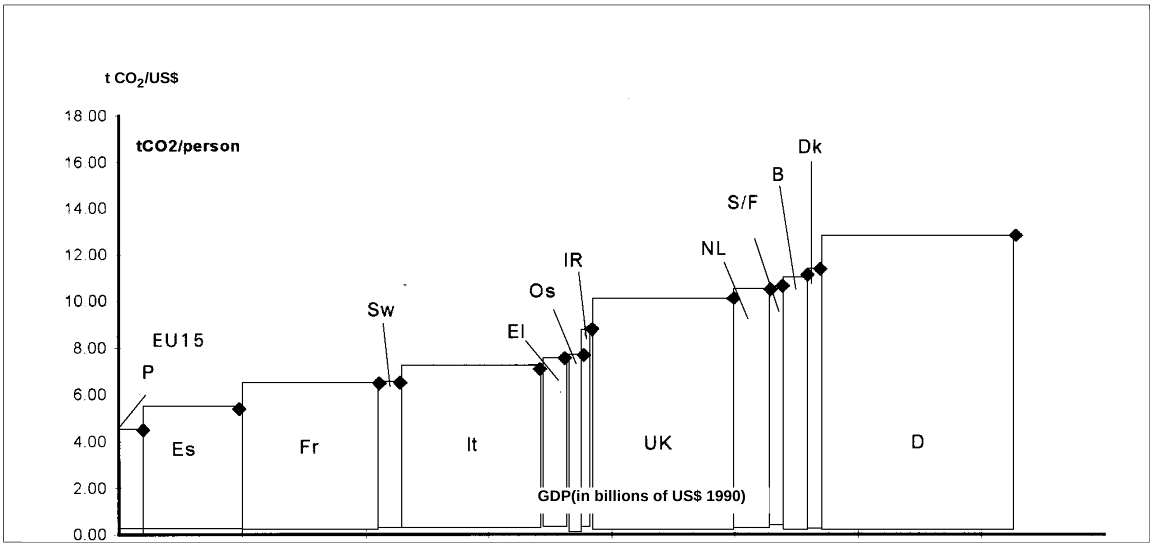
na = not avalaible
Source: OECD, UNFCCC Secretariat.

Figure 3.1a: Per capita CO_2 emission levels and share of Member States (EU-15,1990)



Note:
P = Portugal, Es = Spain, Fr = France, Sw = Sweden, It = Italy, El = Greece, Os = Austria, Ir = Ireland, UK = United Kingdomom, NL = Netherlands, S/F = Finland, B = Belgium, Dk = Denmark, D = Germany; emissions for Luxembourg are not indicated due to problems of scale.

Figure 3.1b: Share and level of carbon intensity of income (EU-15, 1990)



P = Portugal, Es = Spain, Fr = France, Sw = Sweden, It = Italy, El = Greece, Os = Austria, Ir = Ireland, UK = United Kingdomom, NL = Netherlands, S/F = Finland, B = Belgium, Dk = Denmark, D = Germany; L = Luxembourg.

Currently, the specific emissions of the more developed countries are very different because such investments have not been made in other countries and therefore over time their specific emissions have not been greatly reduced (see table 3.3).

It is not always clear to international negotiators and analysts that countries that have already invested in reduction options must apply other more costly mitigation measures to further reduce emissions.

3.1.3 SECTORIAL SHARES OF GREENHOUSE GAS EMISSIONS

The energy sector is the main responsible for greenhouse gas emission with 78.5% of total gross emissions (this percentage as well as the others appearing in this paragraph refer to 1990 and are taken from the revised inventory in table 4.5) of which 73.3% due to carbon dioxide, 2.1% to methane and 3.0% to nitrous oxide.

If greenhouse gas emissions are calculated by point of emission then 30.1% are released by energy production and processing, 15.6% from the industrial sector, 17.8% from transport, 15% from the civil and agricultural sectors. In sectors other than the energy 6.3% of emissions come from industrial processes (5% is CO_2 mainly from cement production), 0.4% from solvents, 11.6% from the agricultural and forest sector (of which 4.1% methane and 4.3% nitrous oxide), and finally 3.3.% from the waste sector (of which 3.1% methane)

If emissions are calculated according to the activity responsible for emission that is according to the the demand of goods and services which cause emis-

Figure 3.2a: CO_2 emissions: EU-15

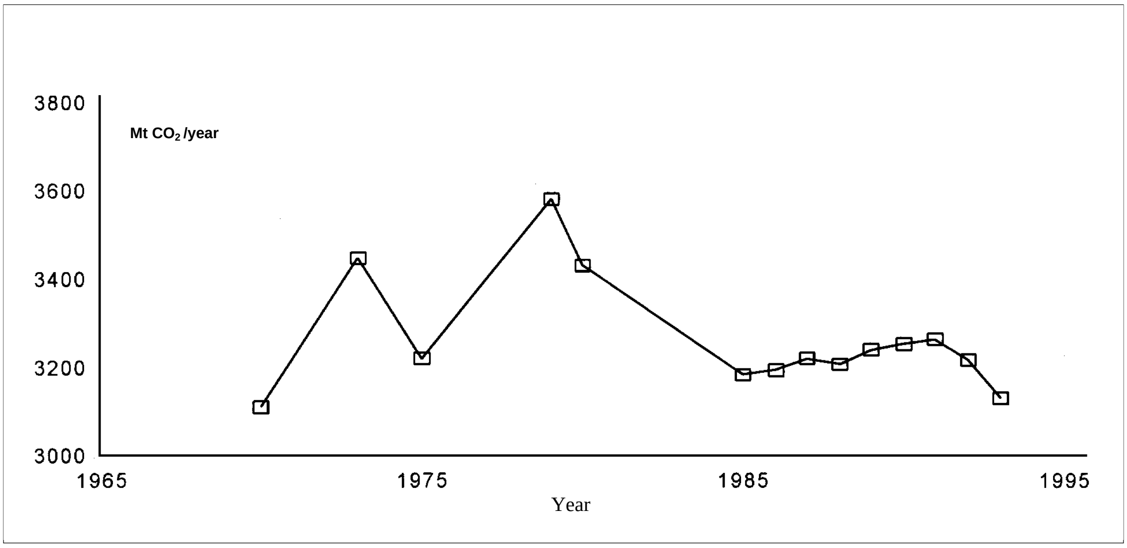


Figure 3.2b: Carbon intensity of income: average EU-15

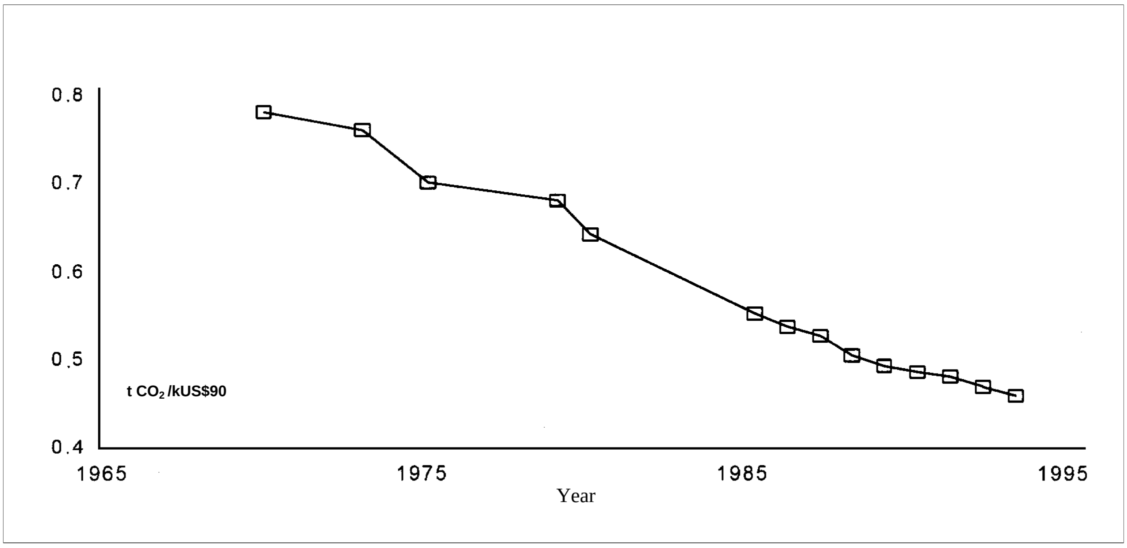


Table 3.3: CO_2 emissions by the energy systems of European Union countries (Mt CO_2/year)

	1970	1973	1975	1979	1980	1985	1990	1991	1992	1993
Belgique/België	155	168	146	142	134	105	111	116	116	118
Danmark	50	58	54	65	61	59	59	60	59	58
Deutschland	1038	1110	1036	1151	1115	1076	1016	978	928	911
Ellada	40	42	45	53	53	58	76	73	75	76
España	96	138	153	178	189	183	209	221	231	217
France	429	506	446	509	485	385	373	391	393	364
Ireland	21	23	23	28	28	26	31	31	31	32
Italia*	268	367	348	392	387	373	418	419	421	398
Luxembourg	20	18	16	15	14	12	13	13	13	13
Nederland	123	147	146	162	146	145	157	161	162	168
Österreich	53	61	56	62	61	57	59	64	59	57
Portugal	12	15	18	24	25	26	44	42	46	47
Suomi/Finland	40	42	44	57	54	50	53	53	54	55
Sverige	100	90	85	87	80	66	56	51	53	53
United Kingdom	664	660	601	656	598	561	580	585	570	555
EUR15	3108	3445	3218	3580	3430	3183	3255	3258	3209	3124

Source: Document of the Italian Presidency, June 1996

sions[2] then about 27% of emissions due to the three main greenhouse gases may be traced directly to end users while the remaining 73% is released to meet the demand of the production sector.

Families emit about 18% in the residential sector (3% from solid urban waste and about 10% from heating) and the remaining 9% in passenger transport of final users.

Among the production sectors, industry accounts for 36% of greenhouse gas emissions (about 29% for direct and indirect uses of energy and about 7% for emissions due to processing). Emissions from the service sector are more difficult to estimate and may be considered about 10% with a relevant proportion due to indirect emission by the production of electricity used therein. Service sector emissions greatly increase if emissions from freight (11%) and passenger transport for production of services (3%) are included. The agriculture and forest sector emits the remaining 13% divided equally among carbon dioxide, methane and nitrous oxide.

Considering the details in each of the above mentioned economic sectors it is possible to assess contribution to greenhouse gas emission by main sectoral factors as opposed to global factors such as population and income[3]. National emission figures, their past trend and possible future evolution are different from those in other countries due to the different figures related to factors which are directly or indirectly involved in emission.

Compared to other Member States, Italy's position may be appreciated more if two factors are separated: extensive (such as population and income) and intensive (emission intensity per capita and per income).

2 Technically speaking energy consumption is divided by category of end user (families and producers): emissions from the service sector are then attributed mainly those regarding pro-quota energy processing for end users.

3 Breakdown of emissions in relevant factors is made through an extension of Kaya's formula (IPCC, SAR, vol III, chapter 1, par. 1.3.3.1).

3.2 POPULATION

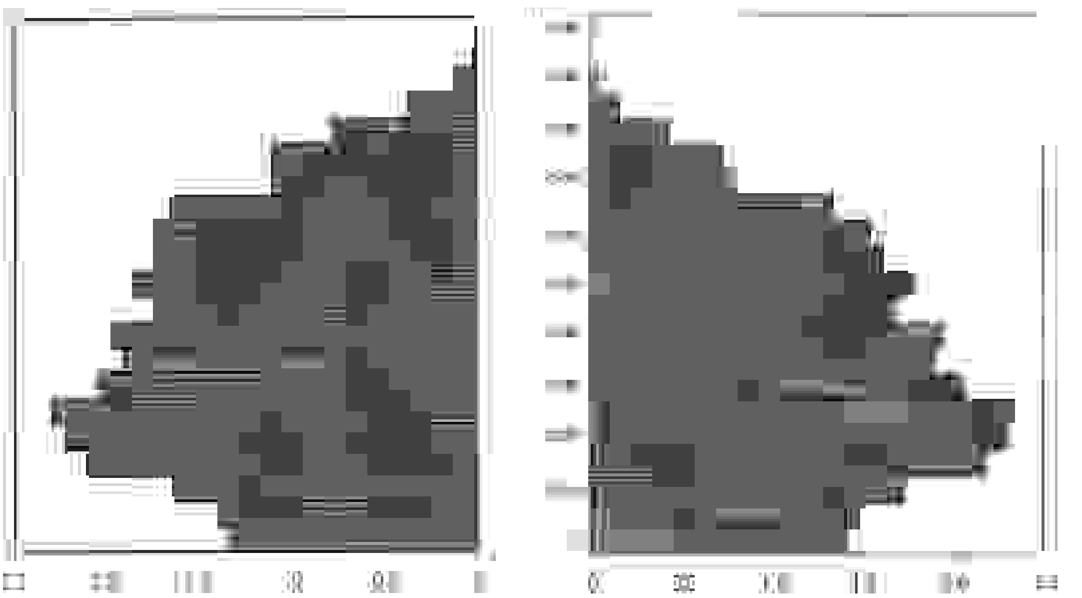
The first basic factor in the increasing emissions of greenhouse gases is population growth which has abruptly shot up: it took 123 years to increase from 1.000 to 2.000 million while the following 1.000 million increases took respectively 33, 14 and 12 years; 11 years will probably be enough to reach 6.000 million. Climate change has become a major issue since world population passed from 2.500 milion in 1950 to 5.500 milion in 1994. Population is therefore the first factor explaining greenhouse gas emission, regardless of which gas or which sector.

Italy has a completely different situation. After a period of growth which in 120 years doubled the residential population (even more evident considering the strong emigration trend in various periods over the last century), national population is now stable at 57 million. With a birth rate of one child per woman, Italy is currently the country with the lowest birth rate.

Table 3.4a: Comparison of some international population indicators

Country/Area	Population 1994, millions	Life expect. (years)	Rate (mean figures 90-95)		
			Annual growth (%)	Births per 1000 inhabit.	Fertility
Italy	57	77	0.3	10	1.2
Europe	512	75	0.3	13	1.7
Ex-USSR	285	70	0.5	16	2.3
Africa	682	53	2.9	43	6.0
North America	283	76	1.3	16	2.0
South America	458	68	1.8	26	3.1
Asia	3233	65	1.8	26	3.2
Oceania	28	73	1.5	19	2.5
TOTAL	5481	65	1.7	26	3.3

Figure 3.3: Age pyramid (1991 census)

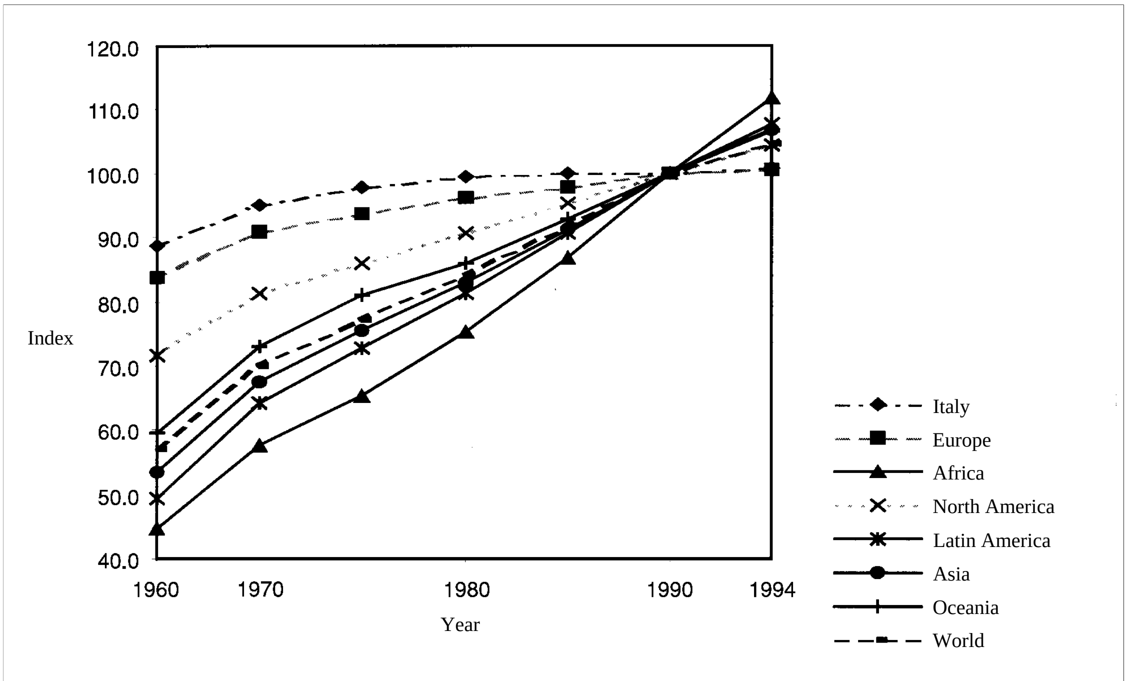


“y” coordinate: age group - “x” coordinate: the size of each cohort.

Table 3.4b: Population per geographical area (1994)

	millions	%		millions	%
World	5530	100.00	Europa	726	13.13
			Austria	8	0.14
Africa	708	12.80	Belgium	10	0.18
			Denmark	5	0.09
North America	290	5.24	Finland	5	0.09
Canada	29	0.52	France	58	1.05
United States	260	4.70	Germany	81	1.46
			Greece	10	0.18
South America	474	8.57	Ireland	3	0.05
			Italy	57	1.03
Asia	3403	61.54	Netherlands	15	0.27
China	1209	21.86	Portugal	10	0.18
India	919	16.62	Spain	39	0.71
Japan	125	2.26	Sweden	9	0.16
Oceania	28	0.51	United Kingdom	58	1.05

Figure 3.4: Population dynamics per region (index 1990=100)



Only a small part of the increase in greenhouse gas emissions over the past 40 years may be attributed to population dynamics. In this situation pressure on greenhouse gas emissions due to the population factor is almost nil; in perspective, population reduction shall contribute to reducing national emissions. Even a strong increase in immigration does not seem likely to contribute to population growth and therefore influence emissions.

A certain influence on per capita emissions may be due to "quality" of the population. For example the rate of urbanization and population distribution between warm and cold areas influences mobility for work and study reasons and the demand for domestic heating. Both these factors influence per capita emissions of greenhouse gases. Population ageing on one hand reduces the demand for mobility while on the other it increases the demand for climatization whether in winter or summer; an increase in age entails an increase in the demand for health services which may cause an increase in emissions due to energy consumption. Even extra-EU immigrates, responsible for the recent slight growth in population has a certain influence on greenhouse gas emissions. In the early stage of immigration, the average per capita emissions decrease since the immigrates consumption models are less intensive in terms of carbon emissions. At a later stage immigrates which tend to replace locals in lesser paid jobs adopt local consumption attitudes which usually lead to greater emissions than those existing in their native countries. On the other hand immigration reduces "carbon losses" from developed countries to others, slowing down if not blocking transfer abroad of industrial activities with greater carbon intensity.

Table 3.4c: Area, population and density in some countries 1992
(area in thousands of sqkm; population in thousands)

Country	Area	Population	Density
France	552	57379	104
Germany	357	80624	226
Italy	301	57203	190
United Kingdom	244	58190	237
Spain	505	39141	77
Canada	9976	28755	3
United States	9363	258233	28
Australia	7713	17661	2

Source: ISTAT

Table 3.4d: Towns and population per population size (a)

Number of inhabitants	North-Centre		South		Italy		Cumulative Italy	
	Towns	Inhabitants	Towns	Inhabitant	Towns	Inhabitants	Towns	Inhabitants
up to 5000	4,180	7,256,786	1,723	3,524,353	5,903	10,781,139	5,903	10,781,139 (19.0)
5.001-20.000	1,110	10,124,200	633	5,858,716	1,743	15,982,916	7,646	26,764,055 (47.1)
20.001-50.000	178	5,329,722	140	4,201,887	318	9,531,609	7,964	36,295,664 (63.9)
50.001-100.000	47	3,196,428	43	2,787,418	90	5,983,846	8,054	42,279,510 (74.5)
100.001-250.000	23	3,174,734	11	1,723,805	34	4,898,539	8,088	47,178,049 (83.1)
250.000-500.000	4	1,372,918	2	675,384	6	2,048,302	8,094	49,226,351 (86.7)
over 500.000	4	5,785,759	2	1,765,921	6	7,551,680	8,100	56,778,031 (100)
TOTAL	5,546	36,240,547	2,554	20,537,484	8,100	56,778,031	—-	—-

Source: ISTAT; (a) 31.12.1994.
The numbers in brackets are percentages.

Table 3.4e: Immigration estimates in 1996: comparison among the main European Union countries (in thousands)

Country	Population (1992)	Foreigners from EU Member States	Legal Non-EU immigrates	Illegal Non-EU immigrates
France	57379	1311	2284	500
Germany	80624	1507	4988	1500
Great Britain	58190	740	1278	100
Italy	57203	1640	827	700

3.3 ECONOMY

3.3.1 RESOURCES

The per capita Gross Domestic Product (GDP) is the second general factor which explains the trend in greenhouse gas emissions and the differences among various countries (see figure 3.5). GDP per inhabitant is higher than the European average but lower than Germany, France, USA and Japan (see table 3.5a).

In 1995, Gross Domestic Product in Italy amounted to 1.386.000 billion (in 1990 liras) compared to 1,311,000 billion in 1990 (see tables 3.5b-c) The mean annual growth rate is about 1.1.%, less than in the 1980s when it was approximately 2.4%. In 1996 the growth rate slowed down even more to 0.7% compared to 2.9% registered the previous year. The annual growth rate of GDP in Italy is generally less than in the other six more developed countries where it was 2.7% in the eighties and 1.5% in the ninenties (see table 3.5d).

In 1995 agriculture provided about 3.4% of the overall added value in the country compared to

Figure 3.5: Scatter graph of European Countries according to energy consumption and GDP

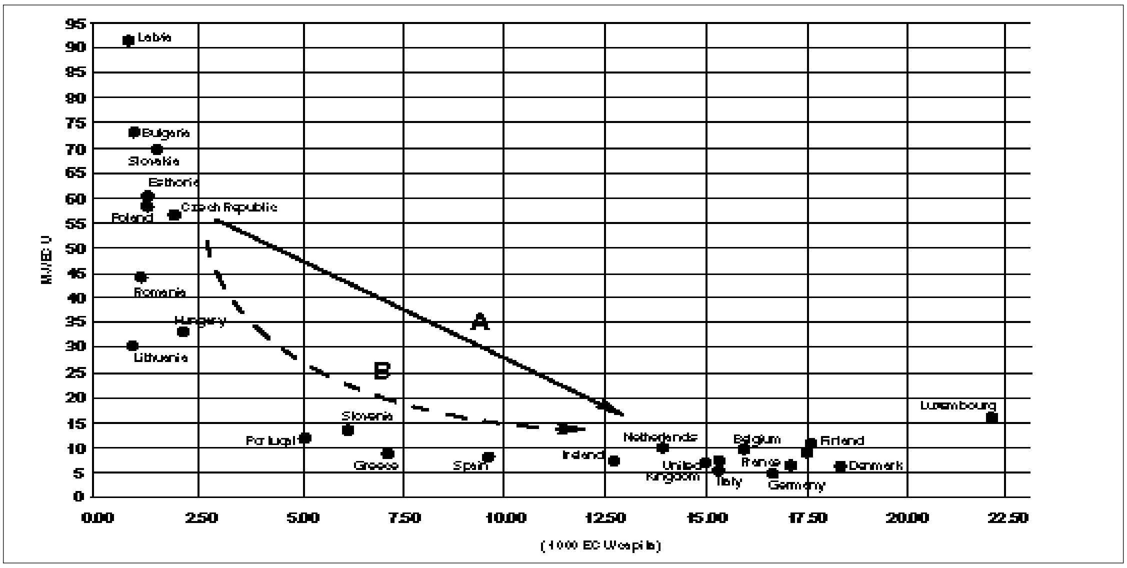


Table 3.5a: Gross Domestic Product per inhabitant at market prices for some countries
Figures at Current Prices in Purchase Power Standards ($ USA)

COUNTRY	1990	1992	1994	COUNTRY	1990	1992	1994
Austria	16,623	18,827	20,210	Netherlands	15,658	17,693	18,589
Belgium	16,318	18,953	20,166	Portugal	9,371	11,407	12,335
Denmark	16,548	18,241	20,546	Spain	11,787	13,374	13,581
Finland	16,193	15,083	16,208	Sweden	17,004	17,205	17,422
France	17,347	19,294	19,201	Switzerland	21,283	23,088	23,942
Germany	15,991	18,721	19,675	United Kingdom	15,874	16,890	17,650
Greece	9,133	10,537	11,315	USA	21,966	23,246	25,512
Ireland	11,245	13,416	15,212	Japan	17,596	19,986	20,756
Italy	16,274	18,377	18,681	EU 15	15,427	17,307	17,914
Luxembourg	22,929	26,752	29,454	OECD	16,003	17,604	18,646
Norway	17,497	20,612	21,968				

Source: OECD

Table 3.5b: National Resources 1995

	1990 Prices billions of liras	%	Index 1990=100
GDP at market prices	1,385,618	82.3	127.8
Importation of goods and services	297,180	17.7	132.4
TOTAL	1,682,798	100.0	128.6

Source: ISTAT

Table 3.5c: Trend in Gross Domestic Product

YEAR	1990 Liras in billions	% variation
1970	738,415	—
1980	1,051,042	—
1990	1,310,659	—
1991	1,325,582	+1.1
1992	1,333,072	+0.6
1993	1,317,668	-1,2
1994	1,345,674	+2.1
1995	1,385,618	+3.0

Source: Unione Petrolifera

Table 3.5d: Real Gross Domestic Product for some countries
Percentage variation compared to previous period

COUNTRY	1980	1985	1990	1991	1992	1993	1994	1995
Austria	2.9	2.5	4.2	2.8	2.0	0.4	3.0	1.8
Belgium	4.3	0.8	3.4	2.2	1.8	-1.6	2.2	1.9
Denmark	-0.4	4.3	1.4	1.3	0.2	1.5	4.4	2.6
Finland	5.3	3.3	0.0	-7.1	-3.6	-1.2	4.4	4.2
France	1.6	1.9	2.5	0.8	1.2	-1.3	2.8	2.2
Germany	1.0	2.0	5.7	5.0	2.2	-1.2	2.9	1.9
Greece	1.8	3.1	0.0	3.1	0.4	-1.0	1.5	2.0
Ireland	3.1	3.1	7.8	2.2	3.9	3.1	6.4	7.7
Italy	4.1	2.6	2.1	1.2	0.7	-1.2	2.2	3.0
Luxembourg	0.8	2.9	3.2	3.1	1.9	0.0	3.3	3.7
Netherlands	1.2	3.1	4.1	2.3	2.0	2.0	2.7	2.4
Portugal	4.6	2.8	4.3	2.1	1.1	-1.2	0.8	2.5
Spain	1.3	2.6	3.7	2.3	0.7	-1.2	2.1	3.0
Sweden	1.7	1.9	1.4	-1.1	-1.4	-2.2	2.6	3.0
United Kingdom	-2.2	3.8	0.4	-2.0	-0.5	2.3	3.8	2.4
EU	1.5	2.5	3.0	1.6	1.0	-0.5	2.8	2.5
USA	-0.3	3.7	1.3	-1.0	2.7	2.2	3.5	2.0
Japan	2.8	4.4	5.1	4.0	1.1	0.5	0.9	2.2
OECD	1.2	3.4	2.7	0.8	1.8	1.0	2.7	1.9

Source: OECD

33.2% from industry and 49.9% from the service sector (see tables 3.6). The latter is more dynamic than the overall economy (which in part explains the reduction in carbon intensity in recent years), while in industry, the energy products show a greater increase although they are a minimum part of the overall added value (5.3%).

In the early 1990s Italy acquired a growing share in international markets thanks to an increase in global demand and in competitiveness: up to 1995 exports rose substantially with a 35% increase in volume compared to 1992 (see table 3.7a). In 1996 exports did not vary compared to 1995 due to a weak foreign demand and the loss of competitivity of Italian economy. In 1995, 22% of exports came from the industrial and agricultural machines sector, while textile products and clothing accounted for about 11%.

In 1995, imports of goods and services corresponded to 17.7% of total national resources (in 1990 constant prices, see table 3.7b). Up to that year there had been an increasing trend (more than 8% in 1994 and more than 10% in 1995), which was interrupted in 1996 when the trend reverted (minus 3%).

Analysis of the different imported goods points out a greater average carbon intensity on imports than on exports. Although a more detailed analysis is necessary it seems that national income entails consumption of goods and services which correspond to a greater carbon dioxide emission per capita than reported in national inventories.

3.3.2 EMPLOYMENT

In general, there may be a considerable increasing trend in greenhouse gas emission over the next few years if production increases to levels allowed for by the available work force in a recovery phase of employment. At the moment in Italy there is high unemployment which differs strongly among regions. The average national unemployment rate is approximately 12% which rises to 21.7% in the South compared to 7.7% in the rest of the country. The unemployment crisis is similar in other European countries. Between 1990 and 1992 the unemployment rate rose from 10.3% of the total work force to 12.2%; the European mean rate went from 8.1% in 1990 to 11% in 1995. (see table 3.8b)

In 1995 the work force accounted for 40.1% of the Italian population; 35.3% were employed: 2.6% in agriculture, 11.5% in industry and 21.2% in the service sector (see table 3.9a). The sectors show different trends: a fall in the agricultural and industrial sector more than made up for by an increase in employment in the service sector.

Table 3.6a: Composition of added value to market prices and gross domestic product: Year 1995

Sectors and Branches	1990 Prices Composition %	Index numbers 1990=100
Goods and services for sale	86.5	128.0
Agriculture, forest and fishing	3.4	109.0
Industry	33.2	122.7
Energy products	5.3	141.2
Industrial processing goods	22.8	117.8
Building	5.1	125.5
Services	49.9	132.8
Trade, hotels and public commercial concerns	18.6	127.9
Transport and communications	6.6	127.1
Credit and insurance	5.4	118.5
Building rents	7.1	159.3
Various services	12.2	134.3
Services not for sale	13.5	122.0
VALUE ADDED TO GROSS MARKET PRICES	100.0	127.2
Bank services (-)	5.1	118.9
VALUE ADDED TO NET MARKET PRICES	94.9	127.6
VAT and indirect taxes on imports	5.8	130.5
GROSS DOMESTIC PRODUCT AT MARKET PRICES	100.8	127.8

Source :ISTAT

Table 3.6b: Investments - Year 1995

	1990 Prices (billions of liras)	%	index 1990=100
Domestic end consumption	1,083,967	64.4	129.2
-by families	844,161	77.9	131.2
of which: transport	88,825	10.5	132.5
fuels and electricity	28,992	3.4	135.9 (a)
-collective	239,806	22.1	122.0
of which: public administrations	236,410	98.6	122.0
private social institutions	3,396	1.4	122.5
Gross fixed investments	243,645	14.5	123.6
of which: building	118,640	48.7	125.4
machinery, equipment and other	102,468	42.1	119.4
means of transport	22,537	9.2	132.8
- net fixed investments	67,441	4.0	123.3
- amortization	176,204	10.5	123.6
Variation of stock	11,514	0.7	—
Export of goods and services	343,672	20.4	129.1
TOTAL	1,682,798	100.0	128.6

Source: ISTAT;
(a) This figure refers to the aggregate transport and communications

Table 3.7a: Italian Exports - percentage

Branch	1991	1992	1993	1994	1995
Agriculture, forestry and fishing products	2.9	2.6	2.5	2.7	2.6
Energy products	2.3	2.1	2.1	1.6	1.4
Ferrous and non-ferrous ore	4.3	4.1	4.5	4.4	4.6
Non-metallic minerals and products	4.1	4.2	4.1	4.2	4.1
Chemicals	7.4	7.9	7.9	8.0	8.4
Metal and mechanical engineering	34.3	34.3	35.0	34.7	35.0
Means of transport	10.6	10.0	9.0	9.4	10.0
Foodstuffs, drinks and tobacco	4.3	4.8	4.7	4.4	4.2
Textiles, leather and clothing	17.6	17.6	17.3	17.7	16.6
Wood, paper, rubber and other manufactures	12.2	12.4	12.9	12.9	13.1
TOTAL %	100.0	100.0	100.0	100.1	100.0
10^{12} current liras	226.7	232.1	233.0	272.4	332.4

Source: ISTAT

Table 3.7b: Italian Imports - percentage

Branch	1991	1992	1993	1994	1995
Agriculture, forestry and fishing products	7.1	6.4	6.5	6.4	6.0
Energy products	11.9	10.7	12.1	10.4	9.7
Ferrous and non ferrous ore	8.6	8.5	8.5	9.4	10.4
Nonmetallic minerals and products	1.9	1.9	2.0	1.9	1.8
Chemicals	12.2	12.5	13.5	14.0	14.1
Metal and mechanical engineering	22.9	22.7	22.1	22.5	23.5
Means of transport	12.8	14.0	11.0	10.4	10.5
Foodstuffs, drinks and tobacco	8.0	8.1	8.7	8.4	7.6
Textiles, leather and clothing	6.4	6.8	7.1	7.8	7.2
Wood, paper, rubber and other manufactures	8.2	8.4	8.5	8.8	9.2
TOTAL (%)	100.0	100.0	100.0	100.0	100.0
10^{12} current liras	209.7	219.4	266.2	308.0	376.8

Source: ISTAT

Table 3.8a: Work Force in some countries
Variation in percentage compared to the previous period

COUNTRY	1990	1991	1992	1993	1994	1995
Austria	2.3	2.3	1.6	0.5	0.0	-0.3
Belgium	0.8	0.8	0.7	0.9	0.4	0.3
Denmark						
Finland	-0.1	-0.9	-1.2	-0.7	-0.2	0.7
France	0.5	0.6	0.4	0.2	0.9	0.3
Germany	2.2	1.7	-0.7	-0.5	0.1	-0.4
Greece						
Ireland	1.7	1.5	1.4	2.0	1.9	1.3
Italy	0.0	0.1	-0.6	-1.0	-0.5	0.2
Luxembourg						
Netherlands	2.0	2.0	1.6	1.9	1.0	1.0
Portugal	1.8	2.4	-6.4	-0.5	1.3	-0.3
Spain	1.4	0.4	0.5	1.1	1.0	1.0
Sweden	1.1	-0.6	-1.9	-2.7	-1.2	1.3
United Kingdom	0.1	-0.6	-0.6	-0.4	-0.4	-0.5
EU	0.9	0.5	-0.3	-0.1	0.2	0.1
USA	1.6	0.4	1.4	0.8	1.4	1.0
Japan	1.8	1.9	1.1	0.6	0.4	0.3
OECD	1.4	0.8	0.8	0.6	0.9	0.7

Source: OECD

Table 3.8b: Standard unemployment rates in some countries (a)
Proportion of total work force

COUNTRY	1990	1991	1992	1993	1994	1995
Belgium	7.2	7.2	7.7	8.6	9.6	9.4
Finland	3.4	7.5	13.0	17.7	18.2	17.1
France	8.9	9.4	10.3	11.7	12.3	11.6
Germany (b)	4.8	4.2	4.6	7.9	8.4	8.2
Ireland	13.3	14.7	15.5	15.6	14.3	12.9
Italy	10.3	9.9	10.5	10.2	11.1	12.2
Netherlands	7.5	7.0	5.6	6.2	6.8	6.5
Portugal	4.6	4.1	4.1	5.5	6.8	7.1
Spain	15.9	16.0	18.1	22.4	23.8	22.7
Sweden	1.8	3.3	5.8	9.5	9.8	9.2
United Kingdom	6.9	8.8	10.1	10.4	9.6	8.7
EU (c)	8.1	8.5	9.4	10.9	11.4	11.0
USA	5.6	6.8	7.5	6.9	6.0	5.5
Japan	2.1	2.1	2.2	2.5	2.9	3.1
OECD	6.1	6.8	7.5	8.0	7.9	7.5

Source: OECD;
(a) The unemployed are defined as people of working age without work, available for work and actively looking for work; unemployment is expressed as percentage of the total work force including the armed forces.
(b) Figures for 1992 and before refer only to West Germany;
(c) EU refers only to the countries in the Table

Table 3.9a: Work Force in Italy

	1992		1994		1995	
	in thousands	%	in thousands	%	in thousands	%
Work Force	24,257	42.4	22,680	40.1	22,734	40.1
Employed	21,459	37.5	20,119	35.6	20,010	35.3
Agriculture	1,749	3.1	1,574	2.8	1,490	2.6
Industry	6,851	12.0	6,587	11.7	6,494	11.5
Other	12,859	22.5	11,959	21.2	12,025	21.2
People looking for work	2,799	4.9	2,561	4.5	2,725	4.8
Non Work Force	32,930	57.6	33,859	59.9	33,906	59.9
Total population	57,187	100.0	56,540	100.0	56,641	100.0

Source: ISTAT

3.3.3 INFLATION AND EXCHANGE RATES

Inflation and exchange rates in the last decade have been the sign of substantial difficulties of the Italian Economy which has to some extent strayed from the common trend of most developed countries (see table 3.10). In 1995 inflation was at 4.8% compared to an average 3% in Europe. The reduction of the cost of life started in 1996 with production prices slowing down and the steady reduction of the inflation rate.

The timely devaluation of the lira in early 1990 (table 3.11) contributed to the sharp inflation rise in 1995. When the liras re-entered the European Exchange agreements, exchange rates recovered from the exceptionally low 1995 levels. With its participation in the Euro, in the next future any inflation-driven problems in the economy will not differ from those occurring in the rest of Europe.

Table 3.9b: Population and Work Force (in thousands, in mid-year)

	Resident Population	Total Population	Work Force	Rate of activity (%)	Unemployment rate (%)
1992	56,960	57,187	24,257	42.4	11.5
1993	57,138	56,407	22,801	40.4	10.2
1994	57,269	56,538	22,680	40.1	11.3
1995	57,314	56,640	22,733	40.1	12.0

Source: Unione Petrolifera

Table 3.10a: GDP Deflator in some countries
Variation in percentage compared to the previous period

COUNTRY	1980	1985	1990	1991	1992	1993	1994	1995
Austria	5.2	3,1	3,3	4.0	4.2	3.4	3.4	2.1
Belgium	3.8	6.1	3.0	2.7	3.5	4.1	2.6	2.2
Denmark	8.2	4.3	2.7	2.2	3.2	0.7	1.7	1.7
Finland	9.8	5.4	5.9	2.5	0.7	2.4	1.1	3.7
France	11.4	5.8	3.1	3.3	2.1	2.5	1.5	1.6
Germany	5.0	2.1	3.2	3.9	5.5	3.8	2.3	2.2
Greece	17.7	17.6	20.6	20.2	14.5	14.0	10.8	9.3
Ireland	14.7	5.2	-0.8	1.7	2.0	4.1	1.2	1.4
Italy	20.2	8.8	7.6	7.7	4.5	4.3	3.6	4.8
Luxembourg	7.9	3.0	3.0	3.0	4.5	4.7	1.9	3.1
Netherlands	5.5	1.8	2.3	2.7	2.3	2.0	2.3	1.9
Portugal	20.9	21.7	12.9	14.2	13.5	7.4	5.6	5.8
Spain	13.4	7.7	7.3	7.1	6.9	4.3	3.9	4.8
Sweden	13.0	6.6	8.9	7.6	1.1	2.6	2.7	4.1
United Kingdom	19.5	5.7	6.4	6.5	4.4	3.3	1.9	2.4
EU	12.6	5.9	5.3	5.5	4.5	3.7	2.7	3.0
USA	9.1	3.3	4.3	4.0	2.7	2.6	2.3	2.4
Japan	5.4	2.1	2.3	2.7	1.7	0.6	0.3	-0.5

Source: OECD

Table 3.10b: Index of retail prices in some countries

COUNTRY	Index of retail prices base 1985 1994	1995
Austria	127.7	130.5
Belgium	123.4	125.3
Denmark	130.6	133.6
Finland	141.2	143.6
France	127.8	129.9
Germany	122.7	125.0
Greece	391.1	427.4
Ireland	129.8	133.2
Italy	160.0	168.3
Luxembourg	122.7	125.1
Netherlands	117.8	120.1
Portugal	231.5	241.1
Spain	168.1	176.0
Sweden	161.6	165.7
United Kingdom	152.4	157.6
EUR15	144.0	148.5
USA	137.8	141.7
Japan	114.6	114.4

Source: ISTAT

Table 3.10c: Index of production prices in some countries (1990=100)

COUNTRY	1994	1995
Belgium	99.5	101.7
Denmark	99.7	103.4
France	100.9	103.1
Finland	105.8	107.7
Germany	104.7	106.5
Greece	156.6	171.4
Ireland	107.7	—-
Italy	113.3	122.2
Luxembourg	107.2	110.8
Netherlands	101.1	103.9
Spain	109.8	116.8
Sweden	108.6	117.3
United Kingdom	114.4	118.7
EUR15	108.3	112.4
USA	103.6	107.2
Japan	96.8	96.1

Source: ISTAT

Table 3.11:
Exchange rates of Italian Liras (mean annual rates)

YEAR	$ USA	ECU	YEN
1990	1,198.1	1,521.9	8.292
1991	1,240.6	1,533.3	9.208
1992	1,232.4	1,587.5	9.743
1993	1,573.7	1,841.6	14.207
1994	1,612.4	1,913.9	15.783
1995	1,628.9	2,131.3	17.439
1996	1,542.9	1,958.6	14.197

Source: IMF, UIC e DRI

3.4 MACRO-SECTOR INDICATORS

3.4.1 INDUSTRY

The industrial sector provides 33% of national income and accounts directly for 36% of greenhouse gas emissions. Growth in the 1980s has been followed by an up and down trend during the 1990s (see table 3.12). The 1992 crisis was followed by recovery in 1994-95 which however was interrupted in 1996 by a 1.7% fall in industrial production.

The energy production sector which in 1995 provided 5.3% of the overall added value in the country (at 1990 constant prices) has experienced differential trends: mining related to energy minerals steadily increased regardless of the 1992 general fall in production while the industrial production index of cokeries and refineries incredibly show an opposite trend, an absolute fall between 1990 and 1995; the production and distribution of electricity, water and gas show a definitely positive trend. Products from industrial processing made up 22.8% of added value in 1995 and building accounted for another 5.1%. Manufacturing showed the same trend as general industrial production with a more evident trend in the field of plastics and rubber articles.

Emissions from the industrial sector are lower than in other countries. This is due both to the structure of Italian industry and to the efficiency of single sectors.

Table 3.12: Index of industrial production in some countries (1980 = 100)

COUNTRY	1990	1991	1992	1993	1994
Austria	132	134	132	130	136
Belgium	122	119	119	113	116
Denmark	131	133	136	132	—
France	114	114	114	111	115
Germany	123	100	98	90	94
Greece	110	109	108	105	106
Ireland	184	190	208	220	246
Italy	114	113	112	110	115
Luxembourg	143	143	142	138	146
Netherlands	117	119	118	117	119
Portugal	161	161	160	154	153
Spain	120	119	115	110	118
Sweden	121	114	113	114	127
United Kingdom	123	118	118	121	127
USA	126	124	128	132	140
Japan	148	150	141	135	130

Source: ISTAT

3.4.2 AGRICULTURE AND FORESTS

In 1990 the agricultural, forestry and fisheries sector provided about 4% of overall added value, but accounted for 13% of the overall emissions of greenhouse gas in Italy.
Thirty percent of the Italian Territory (approx 301.000 sqkm) is for farm crops, 9.4% for woody crops, 14.3 for livestock forage while woods and forests cover 22.5% of the land. Arable lands make up 41% of the territory, one of the highest percentages in Europe (average 36%) and among OECD countries (12%) (see tables 3.14).

Table 3.13a: Index of industrial production per economic activity (1990=100)

	1992	1994	1995
General index	98.9	101.5	106.9
Mining	95.2	106.1	113.2
Energy minerals	100.6	111.2	113.5
Non-energy minerals	87.3	98.6	112.7
Manufacturing	98.6	100.9	106.3
of which: coke and oil refineries	103.0	101.6	99.5
chemicals, artificial and synthetic fibres	99.7	100.5	102.6
rubber articles and plastics	102.9	107.5	111.3
transport	85.0	75.2	82.4
Electricity generation and distribution, gas and water	103.8	107.2	111.6

Source: ISTAT

Table 3.13b: Index of industrial production per end use (1990=100)

	1992	1994	1995
Consumables	101.2	104.1	107.4
Non durable goods	104.7	105.8	106.1
Semi durable	100.4	103.9	108.4
Durable	96.3	101.4	108.0
Investment goods	92.1	92.2	105.4
Machinery and equipment	93.6	98.1	114.1
Transport	84.8	70.0	79.6
Other	95.1	97.7	106.6
Intermediate goods	99.8	103.0	107.0

Source: ISTAT

Table 3.14a: Area and land use in some countries - 1993 - Percentages

COUNTRY	Farm crops	Woody crops	Livestock forage	Woods and forests	Other areas	Water	Total Area	thousands of sqkm
France	33.1	2.1	19.5	27.1	17.9	0.3	100.0	552
Germany	32.7	1.2	14.7	30.0	19.2	2.1	100.0	357
Italy	30.0	9.4	14.3	22.5	21.5	2.4	100.0	301
United Kingdom	24.8	0.2	45.1	10.0	18.6	1.3	100.0	245
Spain	29.7	9.3	20.4	32.0	7.6	1.1	100.0	505
Canada	4.6	0.0	2.8	49.5	35.6	7.6	100.0	9.976
USA	18.9	0.2	24.4	29.2	24.9	2.4	100.0	9.809
Australia	6.0	0.0	53.6	18.8	20.6	0.9	100.0	7.713

Source: ISTAT

Table 3.14b: Area per type of vegetation in some countries - 1990.

	Arable (% of total)	Pastures and meadows (% of total)	Forests (% of total)	Irrigated areas (a) (% of total)	Total (thousands of sqkm)
Austria	18	24	47	..	84
Belgium	25	20	20	..	31
Denmark	61	..	12	17	43
Finland	8	..	77	3	338
France	35	21	28	7	552
Germany	36	16	30	4	357
Greece	31	41	20	30	132
Ireland	14	68	..	..	70
Italy	41	17	23	25	301
Luxembourg	22	27	33	..	3
Norway	3	..	31	11	324
Netherlands	28	31	10	59	37
Portugal	35	9	35	17	92
Spain	41	20	31	16	505
Sweden	7	..	68	4	450
Switzerland	13	32	32	6	41
United Kingdom	28	44	10	2	245
USA	21	26	32	10	9,370
Japan	12		67	62	378
China	10	—	14	46	9,560
India	56	..	22	25	3,290
EU 15	36	24	26	14	2,370
OECD	12	37	34	10	31,400

Source: UNO;
(a) 1989 figures

Table 3.15a: Retailed fertilizers (in thousands of hundreds of kg)

	1990	1992	1994
Nitrogen	15,125	18,539	18,797
Nitrate	6,148	8,297	7,661
Phosphate	5,725	4,640	4,727
Superphosphate	5,495	4,486	4,631
Potassium	2,349	2,371	2,416
Binary compounds	6,805	7,212	6,487
Ternary compounds	11,726	11,892	9,338
Organominerals	—	2,188	2,405

Source: ISTAT

Table 3.15b: Retailed fertilizers per inhabitant (kg)

	1990	1992	1994
Nitrogen	26.6	32.7	33.1
Nitrate	10.8	14.6	13.5
Phosphate	10.1	8.2	8.3
Superphosphate	9.7	7.9	8.2
Potassium	4.1	4.2	4.3
Binary compounds	12.0	12.7	11.4
Ternary compounds	20.7	20.9	16.4
Organominerals	—	3.9	4.2

Source: ISTAT

Table 3.15c: Pesticide consumption in some countries (tons per 1000 inhabitants)

	1985-1991
Austria	0.8
Belgium	1.0
Denmark	0.9
Finland	0.3
France	1.7
Germany	0.4
Greece	..
Ireland	0.0
Italy	1.6
Luxembourg	..
Norway	0.3
Netherlands	1.3
Portugal	2.2
Spain	3.4
Sweden	0.2
United Kingdom	..
Switzerland	0.4
USA	1.5
Japan	0.7
EU	1.5
OECD	1.3

Source: UN

Table 3.16: Composition of livestock (in thousands)

	1992	1994	1995[(a)]
Cattle	7.704	7.272	7.128
Sheep	10.439	10.682	10.531
Goats	1.344	1.448	1.457
Pigs	8.244	8.023	7.964
Horses	373	367	353

Source: ISTAT;
(a) Temporary data

Between 1985 and 1991 1.6 tons of pesticides per 1000 inhabitants have been used in Italy compared to the 1.5 European average and to the 1.3 average for OECD countries. In 1994 33.1 kg of nitrogen fertilizers and 8.3 kg of potassium fertilizers per 1000 inhabitants were distributed to retailers.

Livestock composition has remained almost the same with 7,128,000 cattle and 10,531,000 sheep in 1995 (see table 3.16).

3.4.3 MOBILITY AND TRANSPORT

The overall 23% of greenhouse gas emission in the transport sector (9% for end user transport, 3% for transport of production system staff, 11% for freight) is greater in percentage than the turnover in the transport production sector (6.6% including communications) and than end consumption by families for transport expenses (10.5%).

Between 1970 and 1990, in the field of transport, Italy has more than doubled energy consumption and related greenhouse gas emission, from 16.9 to 34.3 Mtoe per year (table 3.25b). The main role has been taken by road transport with an increase from 14 to 31 Mtoe per year (table 3.25a).

Almost 74% of passengers (1995 data) move by car and 8% by motorcycle (table 3.17b). This means of transport is steadily rising compared to a gradual fall in collective urban transport (from 2.35% in 1990 to 1.98% in 1993). In 1993 there were 32 milion cars equal to 57 vehicles every 100 inhabitants and 106 vehicles for each kilometer of road (see table 3.17c). There is an increasing trend in the number of vehicles circulating. The main fuels used (table 3.21) are petrol for cars (84%) and diesel for lorries (85%) and buses (97%). In 1990 the average car sold in Italy released 165 g CO_2/km compared to figures of 180 in Germany and United Kingdom; the fact that in 1995 the average car sold has higher emissions, about 170 g CO_2, may cause some worry.

There has been a steady trend in air transport (table 3.25a) which has remained approximately around the 1990 figure of 2.1 Mtoe/year (versus 1.7% in 1971); the same may be said for rail transport which has never strayed far from 0.7 Mtoe/year (table 3.25b).

Seventy-two percent of internal transport of goods is carried out on roads (table 3.17a); a proportion which in the early 1990s has shown an increasing trend. Sea transport accounts for 14% of total transport while the remaining share is carried out on fixed facilities (8%) or by pipeline (almost 5%).

In 1995, the Italian railways covered 19,526 km, of which 11,499 run by electricity (table 3.24). Tramways covered 405 km in 1994, mostly in urban areas (365 km), while there were 307,046 km of roads of which 6,469 were motorways. With its 2.8 km of railway per 10,000 inhabitants and 53.2 km for each 10,000 sqkm Italy is below the European average (1994) of 3.9 km per 10,000 inhabitants and 57 km for each 10,000 sqkm (table 3.22).

There is a traffic of 34 million vehicle-km for 1,087 million passenger-km on urban tramways and 2 million-vehicle km and 46 million passenger-km on extraurban lines (table 3.23a). In both cases passenger traffic is falling. There is an increase in traffic on underground networks (table 3.23b) both in terms of vehicles (approx. 76 million vehicle km) and passengers (3,960 million passenger-km).

Table 3.17a: Total domestic freight per means of transport (in percentages)

MEANS OF TRANSPORT	1990	1991	1992	1993
Fixed networks	8.86	8.80	8.83	8.41
Navigation on lakes, rivers and canals	0.05	0.03	0.03	0.04
Coastal navigation	14.43	14.60	13.68	13.80
Air transport	0.01	0.01	0.01	0.01
Road transport	71.99	71.92	72.65	72.78
Pipelines	4.66	4.64	4.80	4.96
Total	100.00	100.00	100.00	100.00

Table 3.17b: Total domestic passenger traffic per means of transport (in percentages)

MEANS OF TRANSPORT	1990	1991	1992	1993
Fixed networks	6.66	6.65	6.29	6.16
Navigation on lakes, rivers and canals	0.01	0.01	0.01	0.01
Coastal navigation	0.33	0.33	0.30	0.27
Air transport	0.88	0.84	0.84	0.84
Road transport	71.71	72.26	73.62	73.97
Motor cycles	8.04	7.74	7.91	8.10
Collective urban transport	2.35	2.28	2.06	1.98
Other (*)	10.02	9.89	8.97	8.67
Total	100.00	100.00	100.00	100.00

(*) Coaches, tram-lines, coach rentals

Table 3.17c: Motor vehicles in circulation (a) per category

	MOTORCYCLES	MOTOR VEHICLES							TRAILERS and semi trailers
		Cars	Buses	Lorries	Road tractors + farm engines	Total			
						Absolute data	Per 100 inhabitants	Per km of road	
1990	6,003,505	27,415,828	77,731	2,348,992	67,780	29,910,331	51.8	98.3	670,116
1991	6,034,622	28,434,923	78,649	2,447,552	72,069	31,033,193	54.7	101.7	697,155
1992	5,853,648	29,429,628	78,179	2,531,813	74,135	32,113,755	56.4	104.9	713,402
1993	6,333,865	29,652,024	76,974	2,569,008	75,028	32,372,795	56.6	105.8	714,006
1994	6,545,534	29,665,308	76,076	2,637,884	75,564	32,454,832	56.6	106.1	754,980

Source: ACI;
(a) for which road tax has been paid

Table 3.18a: Total road traffic in some countries (billions of vehicle-km)

	1985	1990
Austria	38.3	58.5
Belgium	57.1	56.9
Denmark	29.7	36.5
Finland	31.2	39.8
France	328.0	394.0
Germany	391.6	511.0
Greece	28.6	38.3
Ireland	18.8	24.2
Italy	257.8	324.4
Luxembourg	2.5	3.4
Norway	19.5	21.9
Netherlands	74.4	90.2
Portugal	27.9	34.0
Spain	75.1	101.0
Sweden	48.0	63.9
Switzerland	42.3	48.9
United Kingdom	274.0	377.7
USA	2,840.0	3,439.9
Japan	447.0	614.0
EU	1,515.1	1,926.8
OECD	5,359.0	6,652.1

Source: OECD

Table 3.18b: Total road traffic: passenger transport in some countries (billions of vehicle-km)

	1985	1990
Austria	27.5	31.4
Belgium	42.1	50.5
Denmark	24.2	29.9
Finland	26.0	33.4
France	267.0	311.0
Germany	347.1	453.1
Greece	16.3	22.1
Ireland	13.5	19.3
Italy	213.5	272.3
Luxembourg	2.2	3.0
Norway	16.7	18.2
Netherlands	65.0	77.0
Portugal	22.5	26.3
Spain	56.3	81.3
Sweden	44.5	58.4
Switzerland	36.1	41.3
United Kingdom	228.0	311.7
USA	2,028.2	2,438.2
Japan	291.4	353.5
EU	1,264.0	1,606.0
OECD	4,009.6	4,892.8

Source: OECD

Table 3.18c: Total road traffic: freight in some countries (billions of vehicle-km)

	1985	1990
Austria	10.3	12.8
Belgium	4.6	6.4
Denmark	5.0	6.3
Finland	4.5	5.6
France	59.0	81.0
Germany	41.2	54.3
Greece	11.0	14.3
Ireland	3.9	4.7
Italy	40.5	47.0
Luxembourg	0.3	0.4
Norway	2.4	3.1
Netherlands	8.9	12.6
Portugal	5.2	5.7
Spain	17.6	22.4
Sweden	2.3	2.9
Switzerland	6.0	7.3
United Kingdom	43.0	60.0
USA	803.9	992.5
Japan	146.5	253.9
EU	233.3	301.6
OECD	1,309.3	1,702.4

Source: OECD

Table 3.19: Road network in some countries (thousands of km)

	1985	1990	1994
Austria	105	107	—
Belgium	128	141	137
Denmark	70	71	71
Finland	76	76	—
France	805	805	908
Germany	616	626	724
Greece	37	40	130
Ireland	92	92	92
Italy (a)	742	815	834
Luxembourg	5	5	5
Norway	86	89	—
Netherlands	113	117	104
Portugal	52	83	91
Spain	152	156	319
Sweden	131	135	—
Switzerland	71	71	—
United Kingdom	348	357	548
USA	6,242	6,243	—
Japan	1,128	1,115	—
EU	2,595	2,672	3,957
OECD	12,380	12,454	—

Source: OECD and Ministry of Transport; (a) The figures include urban and extraurban council roads and local roads which according to estimates by the National Transport Account were respectively 583, 653 e 669.

Table 3.20a: Motorvehicles circulating in some countries (thousands)

	1985	1990
Austria	3,153	3,692
Belgium	3,662	4,260
Denmark	1,768	1,893
Finland	1,747	2,233
France	25,168	28,290
Germany	30,944	37,223
Greece	1,883	2,523
Ireland	914	1,043
Italy	24,405	29,727
Luxembourg	161	195
Norway	1,764	1,943
Netherlands	5,277	6,028
Portugal	1,541	2,198
Spain	10,845	14,374
Sweden	3,383	3,925
Switzerland	2,938	3,297
United Kingdom	19,559	23,393
USA	171,654	188,655
Japan	46,157	57,698
EU	122,544	145,994
OECD	379,793	438,115

Source: OECD

Table 3.20b: Passenger vehicles circulating in some countries (thousands)

	1985	1990
Austria	2,531	2,991
Belgium	3,343	3,864
Denmark	1,501	1,591
Finland	1,546	1,939
France	21,325	23,550
Germany	29,405	35,512
Greece	1,263	1,730
Ireland	710	796
Italy	22,495	27,300
Luxembourg	152	183
Norway	1,514	1,613
Netherlands	4,901	5,509
Portugal	1,185	1,605
Spain	9,274	11,996
Sweden	3,151	3,601
Switzerland	2,617	3,012
United Kingdom	16,454	19,742
USA	131,864	143,550
Japan	27,845	34,924
EU	108,702	128,561
OECD	300,317	343,790

Source: OECD

Table 3.20c: Freight vehicles circulating in some Countries (thousands)

	1985	1990
Austria	207	253
Belgium	302	380
Denmark	259	294
Finland	180	264
France	3,779	4,670
Germany	1,413	1,567
Greece	601	772
Ireland	93	143
Italy	1,834	2,350
Luxembourg	9	11
Norway	233	308
Netherlands	364	507
Portugal	356	593
Spain	1,529	2,333
Sweden	218	310
Switzerland	201	272
United Kingdom	2,290	2,729
USA	39,196	44,479
Japan	17,140	21,321
EU	12,608	16,085
OECD	75,691	90,098

Source: OECD

Table 3.22: Rail network in some countries - 1994

	km	km per 10000 inhabit.	sqkm per 10000 inhabit.
Belgium	3,396	3.36	111.34
Denmark	2,349	4.52	54.50
France	32,275	5.58	59.33
Germany	41,401	5.09	115.97
Greece	2,474	2.38	18.74
Ireland	1,947	5.45	27.70
Italy	16,002	2.80	53.16
Luxembourg	275	6.71	105.77
Netherlands	2,757	1.80	67.24
Portugal	2,699	2.73	29.21
Spain	12,646	3.23	25.05
United Kingdom	16,564	2.84	67.88
EU	134,785	3.87	57.04

Source: Ministry for Transport and Navigation

Table 3.21: Motor vehicles in circulation per type of fuel used - Percentages

Year	Petrol	Diesel	Liquid gas	Methane	Total
			CARS		
1990	82.1	13.1	3.9	0.9	100.0
1991	83.1	12.3	3.7	0.9	100.0
1992	83.8	11.7	3.6	0.9	100.0
1993	84.2	11.7	3.3	0.8	100.0
			LORRIES		
1990	16.3	82.6	0.8	0.3	100.0
1991	15.5	83.5	0.7	0.3	100.0
1992	14.7	84.3	0.7	0.3	100.0
1993	14.4	84.6	0.7	0.3	100.0
			BUSES		
1990	4.2	95.6	0.2	..	100.0
1991	3.6	96.3	0.1	..	100.0
1992	3.3	96.6	0.1	..	100.0
1993	2.9	96.9	0.1	..	100.0

Source: ACI
(..) less than 0.05

Table 3.23a: Traffic on tram-lines (in thousands)

	URBAN		EXTRAURBAN	
	Vehicle-km	Passenger-km	Vehicle-km	Passenger-km
1990	40,337	1,575,558	1,922	53,502
1991	39,753	1,404,574	1,917	56,222
1992	37,999	1,117,016	1,906	51,063
1993	36,461	1,251,355	2,026	51,913
1994	34,656	1,087,885	2,004	46,378

Source: Ministry of Transport

Table 3.23b: Traffic on metroplitan rail networks (in thousands)

	Vehicle- km	Passenger-km	Network (km)
1990	60,022	2,579,591	96
1991	69,858	3,531,553	102
1992	74,723	3,755,326	104
1993	75,894	3,730,233	104
1994	75,473	3,960,816	104

Source: Ministry of Transport

Table 3.24: Length of transport networks (km)

	RAIL (a)		TRAM-LINE (a)		ROAD (b)	
	total	electric	total	urban	total	motorway
1990	19,576	10,793	449	402	303,907	6,185
1991	19,579	11,159	437	390	303,388	6,214
1992	19,465	11,325	428	388	306,043	6,289
1993	19,466	11,367	405	365	306,502	6,401
1994	19,528	11,444	405	365	307,046	6,469
1995	19,526	11,499				

(a) Ferrovie dello Stato (National Rail)
(b) Ministry of Transport - Conto Nazionale dei Trasporti (National Transport Account)

Table 3.25a: End consumption of energy in some countries: transport sector (in Mtoe/year)

	Air Transport				Road Transport			
	1970	1980	1985	1990	1970	1980	1985	1990
Austria	0.1	0.1	0.2	0.3	2.6	4.1	4.1	4.9
Belgium	0.4	0.5	0.6	1.0	3.4	5.1	5.2	6.6
Denmark	0.6	0.8	0.7	0.8	2.0	2.4	2.7	3.4
Finland	0.1	0.3	0.3	0.5	1.8	2.6	3.0	3.7
France	1.6	3.6	3.9	4.0	17.5	28.2	30.0	36.9
Germany	2.5	3.6	4.3	5.8	26.7	40.4	41.6	51.4
Greece	7.0	1.2	1.2	1.3	1.1	2.3	3.1	4.0
Ireland	0.3	0.2	0.2	0.4	0.8	1.5	1.5	1.6
Italy	1.7	2.0	2.0	2.1	14.0	22.3	25.0	31.1
Luxembourg	—	0.1	0.1	0.1	0.2	0.4	0.5	0.9
Norway	0.3	0.4	0.5	0.5	1.4	1.9	2.3	2.7
Netherlands	0.8	1.0	1.3	1.7	4.3	7.0	6.9	8.2
Portugal	0.4	0.5	0.5	0.6	0.8	1.9	2.1	3.1
Spain	1.0	2.1	2.0	2.6	5.2	10.7	12.1	18.1
Sweden	0.5	0.6	0.6	0.8	4.0	5.2	5.5	6.2
Switzerland	0.6	0.8	0.9	1.2	2.8	3.5	3.9	4.9
United Kingdom	3.7	5.0	5.4	7.0	20.4	26.5	29.2	37.0
USA	49.2	55.9	63.2	76.6	279.4	346.6	359.4	391.5
Japan	1.0	2.5	2.5	3.0	24.9	43.6	48.5	60.6
EU	13.4	20.1	21.6	27.0	93.4	144.1	155.4	195.9
OECD	69.0	87.0	96.3	118.2	445.0	607.4	636.6	732.7

Source: OECD

Table 3.25b: End consumption of energy in some countries: transport sector (in Mtoe/year)

	Rail Transport				Total			
	1970	1980	1985	1990	1970	1980	1985	1990
Austria	0.4	0.3	0.3	0.3	3.2	4.6	4.6	5.5
Belgium	0.2	0.2	0.2	0.2	4.4	5.9	6.2	7.9
Denmark	0.1	0.1	0.1	0.1	3.1	3.6	3.8	4.6
Finland	0.1	0.1	0.1	0.1	2.1	3.0	3.4	4.4
France	1.4	1.2	1.1	1.2	21.2	33.8	35.7	42.8
Germany	4.5	2.9	2.5	2.1	34.1	47.8	49.1	60.0
Greece	0.1	0.1	0.1	0.1	1.9	4.0	4.8	6.0
Ireland	—	—	—	0.1	1.2	1.8	1.7	2.0
Italy	0.7	0.6	0.7	0.7	16.9	25.4	28.3	34.3
Luxembourg	—	—	—	—	0.2	0.5	0.6	1.0
Norway	0.1	0.1	0.1	0.1	2.6	3.2	3.5	4.1
Netherlands	0.2	0.1	0.1	0.1	6.3	8.8	9.0	10.6
Portugal	0.1	0.1	0.1	0.1	1.4	2.6	2.7	3.8
Spain	0.8	0.4	0.4	0.5	8.4	16.2	16.0	22.8
Sweden	0.3	0.2	0.3	0.3	5.1	6.1	6.6	7.5
Switzerland	0.2	0.2	0.2	0.2	3.6	4.5	5.1	6.3
United Kingdom	1.6	1.2	1.0	1.1	26.9	33.9	36.8	46.5
USA	13.4	14.5	10.8	10.5	346.6	418.2	438.1	485.2
Japan	3.7	2.6	2.3	2.6	32.9	54.2	57.5	69.6
EU	7.7	5.7	5.4	5.6	120.7	178.2	188.8	235.1
OECD	29.4	27.0	22.6	22.9	562.7	741.0	774.9	895.0

Source: OECD

Table 3.26: Family consumptions - at 1990 prices; percentage variation

	1993	1994	1995	1996
Non durable goods	—-	-0.4	0.8	0.5
of which: foodstuffs	-0.2	-0.1	-0.5	-1.3
Semi-durable goods	-4.3	2.4	2.3	-1.6
Durable goods	-12.8	0.8	1.1	-0.4
of which: furniture, electrical and household appliances	-6.2	2.8	0.8	-0.5
transport	-28.3	1.0	0.7	1.3
Services	—-	2.7	2.6	2.6
TOTAL DOMESTIC CONSUMPTION	-2.4	1.4	1.8	0.7

Source: ISTAT

3.4.4 CIVIL SECTOR

Families consume approximately 60% of national wealth and account for 27% of greenhouse gas emissions (18% for residential use, 9% for transport). The service sector produces about 63% of GDP and was responsible for approximately 10% of greenhouse gas emissions in 1990.

Over the past four years family consumption has remained stable while changes have occured in consumption categories (see table 3.26). In 1991 foodstuffs accounted for 19% of the family budget and have decreased less than 1% over the last five years; the same has occurred with non-durable goods. Expense for services in 1992 accounted for about 32% of the family budget and increased by approx. 2% due to a rise in costs of housing, communication, hotel and public commercial concerns.

The proportion of durable goods is 11% of the total and during the 1990s has had a stable trend therefore slowing down growth in the stock of such goods. Among these, some domestic electrical appliances have pratically reached every home: refrigerator, television, washing machine are the most widespread and account for 37.2% of global energy consumption by household electrical appliances equal to 50 TWh (ENEL estimate 1993). Electricity consumption per capita is substantially less in Italy than in other developed countries because the system of tariffs and the 3 kW limit have prevented the use of electric heating and significantly reduced the use of electricity in cooking.

Among the energy aggregates, in 1995 transport expenses accounted for 10.5% of the family budget while fuel and electricity totaled 3.4% (see table 3.6b above). Heating is the major energy consuming sector: about 2/3 of civil energy consumption. A comparison with other European countries having the same consumptions shows that buildings in Italy are overall less insulated. In absolute terms heat loss per square metre is less in Italy than in France, Germany, Sweden, Denmark although in Italy the Degree.days of heating are a lot less. (SENSER, 1997). The average room per inhabitant is also less than in many other developed countries and therefore liable to increase.

Table 3.27: Electrical appliances: diffusion and electricity consumption per appliance and per end user -1993

Electrical appliance	Diffusion	Mean electricity consumption			
		per appliance	per end user	global	
	%	kWh/appliance	kWh/person	GWh/year	%
Refrigerator	96.3	370	356	7763	16.2
Freezer	22.4	480	107	2343	4.9
Television	91.2	230	210	4570	9.5
Videorecorder	34.2	120	41	894	1.9
Washing machine	84.1	300	252	5497	11.5
Dishwasher	16.2	450	73	1588	3.3
Air conditioner	1.9	300	6	124	0.3
Electric cooker	0.6	380	2	50	0.1
Mixed cooker	53.6	130	70	1518	3.2
Microwave oven	5.5	140	8	168	0.3
Water heater	39.9	1070	427	9302	19.4
Electric fire	15.9	150	24	520	1.1
Iron	96.0	80	77	1673	3.5
Lighting	100.0	300	300	6536	13.6
Other household appliances	—-	—-	150	3268	6.8
Other non-household appliances	—-	—-	97	2112	4.4
Total	—-	—-	2200	47926	100.0

Source: ENEL

3.5 VULNERABILITY AND SPECIFICITY OF THE NATIONAL ENERGY SYSTEM

The Italian energy system is responsible overall (including both combustion and fuel losses) for 80% of gross greenhouse gas emissions, for 85% of net emissions and 92% of CO_2 emissions. It is therefore of basic importance to compare the national situation with the situation in other industrialised countries and explain why Italy presents peculiar features which on the one hand are advantages but on the other increase vulnerability. The more evident factors are a fall in already low specific consumptions, the difficult differentiation of electricity production, the increasing dependence on imported fuels, the difficulty to adapt to environmental protection criteria, the insignificant contribution of new renewable energy sources.

3.5.1 THE SLOW IMPROVEMENT IN EFFICIENT USE OF ENERGY

The most comforting element in the Italian energy scenario is the low energy consumption/GDP ratio which in 1994 was 171 koe/MLit at 1985 prices. This figure is 40% less than the OECD average, 25% less than the EU Member States average and significantly less than figures for France and Japan. However, efficient use of energy in Italy is only partly due to policies for technological investments and rationalization in the use of energy. The major determinants of the low energy intensity in Italy are structural: the traditional lack of energy which has led to energy saving infrastructures and behaviour and the establishment of a less energy-greedy production structure; heavy taxation which has traditionally increased energy cost for end users well above the standard in other countries; lower per capita income, a relatively mild climate, high population density which tends to reduce average length of travel.

After a consistent growth in the 1950s and ‘60s and a peak in 1973 the fall in energy intensity in the years immediately following was greater than in other countries and enhanced by elimination of productive cycles of high energy intensity.
Subsequently, decrease was less evident than in other countries especially during the 1980s. Since 1985 energy intensity has remained almost stable (an under 2% fall) compared to a 7% fall in OECD countries and 8% in Europe. Compared to other major industrialised countries, Italy has infact lower margins in improving efficient use of energy. Besides, regulations have been difficult to apply and have met with a poorly receptive environment. Law 308 aimed at improving efficient use of energy and development of renewable energy sources was made only in 1982 and, considering the necessities, was applied with great delay. Thus results did not meet expectations. Law 10 of 1991 did not produce expected results due to the lack of funding.

Increase in road transport played a significant role in slowing down energy-intensity even though specific fuel consumption had greatly improved. Insufficient policies to promote development of infrastructures for rail and urban public transport have so far weakly affected the increasing use of motor vehicles. Hence the increase in consumption of petrol, diesel and other fuels to over 40 Mtoe at an average yearly rate of 2%.
Damage to the environment and overall costs in terms of national economy are more and more evident in the big towns and along the main interurban connection routes. Freight is particularly different compared to European Union countries where rail and internal navigation gain a growing share of the market. In 1990 in Italy, 10% of goods were carried by rail compared to 18% in Germany and 20% in France. Due to limits to heavy vehicle traffic imposed by Austria and Switzerland new railways across the Alps will have to be built. This fact together with the development of urban parking, infrastructures, underground railways and inter-urban rail networks will allow consumption to slow down although only just before 2010.

3.5.2. DIFFICULTIES IN DIFFERENTIATION OF ELECTRIC POWER

The main differentiation of primary sources in other countries regards nuclear energy and coal. Having met with particular difficulties in Italy they have been put aside and, on the basis of current technologies, are unlikely to be considered again in the near future. Risk and pollution reduction linked to nuclear energy and coal have led to an higher average and marginal costs in electricity production compared to other countries.

The unlucky fate of policies for the development of alternative sources and the low cost of imported electric power has significantly slowed down the

Table 3.28: Total end user energy consumption per unit of GDP

	Index 1985=100							Toe/1000 $USA
	1985	1986	1987	1988	1989	1990	1991	1985
Austria	100	100	100	95	92	91	94	0.22
Belgium	100	102	100	97	94	92	95	0.28
Denmark	100	99	99	96	93	97	101	0.21
Finland	100	103	106	101	99	99	105	0.34
France	100	99	98	95	92	91	95	0.19
West Germany	100	100	98	95	89	97	..	0.23
Greece	100	96	103	104	106	108	107	0.22
Ireland	100	108	106	98	96	93	92	0.27
Italy	100	98	100	99	99	97	98	0.16
Luxembourg	100	94	91	88	89	90	93	0.59
Norway	100	97	100	97	95	93	90	0.34
Netherlands	100	100	102	96	91	90	93	0.29
Portugal	100	102	102	107	107	107	106	0.17
Spain	100	97	95	100	98	97	100	0.16
Sweden	100	100	97	95	90	88	90	0.31
Switzerland	100	98	97	94	92	91	95	0.18
USA	100	98	98	99	97	95	96	0.32
Japan	100	98	97	97	96	94	93	0.17
EU	100	99	98	96	93	92	..	0.21

Source: OECD

elimination of fuel oil in the production of electricity in the early 1980s. Approximately 50% of electric power in Italy is still produced through fuel oil compared to a European average of 5%. No significant reduction may be forecasted in the medium term.
In the last decade use of fuel oil has increased considerably both in absolute and in relative terms reaching again 50% as far as primary input source for electric power production is concerned.
Consumption would have been even greater if not for methane which increased its share as primary input source from 7% in 1980 to 20% and more in recent years. Although on the one hand the slow reduction in the use of fuel oil has been an advantage for the refining industries slowing down the costly reconversion process required to produce medium and light products, on the other, problems arise due to an increasing demand for natural gas, estimated in 20 Mtoe in 2010, with an electricity primary input share of 30%. Despite the strong increase in methane input, the demand for crude oil products for electricity production may at the most become stable over the next ten years.

3.5.3 INCREASING DEPENDENCE ON IMPORTED FUELS

Among the main industrialised countries, Italy is the most dependant on crude oil and on its importation: over 80% of the energy demand is met through imported sources. The high dependence on imported energy sources, although mitigated by the low energy intensity, leads to an increase in the price of energy due to tensions on the international energy markets and amplifies the effects on the trade balance and on the country's economic stability. It will be difficult to reduce dependence on importation over the next 15 years, and even a strong growth of renewable sources and containment of electric power importation within limits common to other European countries does not seem sufficient to bring the level of dependence below 80% by 2010.

Crude oil, 95% of which imported, is still too prevalent especially considering the international tensions in demand and offer likely to arise after the year 2000. Replacement with methane and development of renewable sources will not reduce the crude oil share of national demand more than just below 50% by 2010 (55% in 1995). The role of crude oil will be even more critical if: there is strong economic growth due to a greater opening in international markets and increased global trade; poor policies are implemented concerning rational use of energy and diffusion of energy-efficient technology since the time required to increase supply of coal and natural gas would be longer.

3.5.4 INDIRECT BENEFITS FROM ENVIRONMENTAL PROTECTION

Until 2010, rigidity of the national energy system makes it difficult to limit CO_2 emissions. On the contrary the environmental externalities related to sulphur oxides and nitrogen emissions may be substantially limited and reduced if action taken over the last decade is carried on. Ninety percent of sulphur oxide emissions come from the energy sector. During the 1980s they were greatly reduced from 3800 kt in 1980 to 2000 in 1989. By signing the Oslo protocol in 1994[4], the Italian government commited itself to reduce the emissions to not more than 1330 kt in 2000 and 1040 in 2005. In 1990 in Italy sulphur oxide emissions were 2130 kt of which 1980 come from combustion of fossil energy sources: more than half in transport and a quarter in the so called Great plants. In the Sofia protocol in 1988, Italy commited itself to reduce emissions to not more than 1193 kt by 1998 a level which now seems unachievable. A new protocol is currently being discussed regarding reduction of sulphur oxide emissions in European countries in the next decade.

The great reduction in sulphur oxide emissions during the 1980s was due mainly to the spread of methane and cannot be repeated without a strong rise in costs. To meet commitments regarding these pollutants it is not necessary to install desulfurizers on thermoelectric plants if the average sulphur content of fuel oil is reduced to less than 0.8% (it fell from an average 2.8% in 1980 to 1.5% in 1990). Such a low figure however requires more investments in Hydrodesulfurization by refineries and/or purchase of high quality crude oil with a lower sulphur content. The cost of fuel oil with low sulphur content would rise significantly also due to a fall in refinery efficiency during the desulfurization phase. Likewise, a strong reduction in nitrogen oxide emissions calls for considerable investments and higher operating costs.

In the so-called “Great plants” sector, besides optimizing combustion through primary technologies it is necessary to install denitrogeners on the traditonal coal-fired plants thus leading to higher additional costs. Market conditions and updated regulations may enhance use of combined cycles or civil and industrial cogeneration systems based on gas turbines.
The plants may be fired with a hydro-treated heavy diesel oil which may be competitive compared to fuel oil without solphur content considering performance, investment costs and internal flexibility of the refining system. Finally, new options presented in recent years should not be underestimated: orimulsion and gasification of refinery residues which, with equal environmental emission, overall seem less expensive than gasification of coal.
Besides diffusion of catalytic converters (which leads to a slight loss in energy efficiency in the sector) and a quick introduction of the new diesel engines is necessary in the transport sector. In the long term a more intense use of rail transport and other means based on the use of electric power may have a decisive effect.

There is also an economic restraint in decisions regarding the energy issue. Although the Italian energy system is less inefficient than in other countries, the annual energy demand in our country has a high financial and economic cost both concerning foreign trade (6-8% of national imports in the 1990s, but almost 30% during the 1973 and 1981 petroleum crises) and GDP (GDP, currently 1-1.5% but over 6% in 1981) and internal resources however. Given the energy demand, economic restraint is linked to the international market price of the energy vectors which in turn is more or less strongly related to the price trend of crude oil.

3.5.5 DEVELOPMENT OF RENEWABLE SOURCES

Table 3.29 shows the contribution of renewable sources to the national energy budget in 1994 and

4 Second Protocol on sulphur emission reduction ratified under the Convention of Geneva on Transboundary Pollution.

1995. Contribution was evidently affected by reduced water resources in 1995 and thus fell to 7.4% of gross domestic consumption.
Over the last 30 years annual production of energy by hydroelectric sources has fluctuated between 40 and 50 TWh. Research carried out on residual hydrological resources estimate a further 15 TWh contribution through technically feasible plants. Special mention must be made of small hydroelectric plants, those up to 10 MW, which had previously been ignored because economically inconvenient. Interest in small-size plants has grown due also to the almost total lack of sites for medium or large power plants.
The 1996 situation in Italy provides the data breakdown regarding hydroelectric production from natural sources[5]. Only the latter are considered from now on. In 1994 there were 1843 hydroelectric plants (gross power efficiency: 15943 MW). In 1995 there was an increase in the number of plants (1870) and overall power (16054 MW) but a significant fall in production related to the low availability of water resources during that year. In 1996 the number of plants rose to 1875 with a further increase in power to 16068 MW and production reached again 42 TWh due to 1996 being an average hydrological year while 1995 had been dry.
Systems using solar energy for water heating generally made up of solar collectors and a water tank have been used for a long time all over the world. The main uses are:
- production of hot water for household use which accounts for most of the systems sold in Europe;
- solar energy systems for collective use used to heat or pre-heat water in hospitals, in hotels, in residential blocks;
- environmental climatization particularly interesting in areas requiring long periods of heating (in Austria, for example solar collectors are used to support centralised heating in private buildings);
- remote heating first experimented in Sweden which limits at 5% the share of demand met by solar heating;
- swimming pools, where installation is very simple since the system is included in the hydraulic circuit for water filtration;
- solar drying in agriculture where air heated in appropriate collectors is used to dry agricultural products; heat for industrial processes by using special solar collectors which heat a service fluid up to a temperature of 110 °C;
- high temperature applications generally for production of electricity.

At the end of 1995 there were an estimated 180,000 sqm of solar collectors installed (mostly used in water heating for household use) with a thermal energy production around 84,000 MWh[6]. The national market (following the peak in the 1980s when thanks to incentives, a figure of 50,000 sqm/year was achieved) has become stable at 12,000-13,000 sqm/year. This proportion is devoted entirely to renewal of existing systems and therefore the energy contribution has remained the same.
The national situation is completely atypical compared to the trend in Europe where since 1989 annual sales of solar collectors have steadily increased. In 1994 for the first time a sales figure of more than 500,000 sqm/year of collectors (with the glass covering) was reached. A recent study funded by the European Commission suggests strategies to overcome the significant delay in Italy[7]. The strategy is based essentially on selection of areas where plans of replacing current energy systems already exist. Moreover, to reduce payback time active and passive solar systems are combined: 3 million people involved and replacement of 10% of the energy demand in 10 years half through active and half through passive solar energy systems. Under these circumstances 225,000 sqm of solar collectors will be installed in 10 years of intervention with a production of approximately 145,000 MWh/year and a 38,000 t/year reduction in CO_2 emissions (84,000 if combined intervention is considered).

5 Electricity production and consumption in Italy in 1996, (ENEL, ROME (1997).

6 Pietro Menna: “Il contributo delle fonti rinnovabili in Italia”, in: Energia, Ambiente e Innovazione, n° 3/1997 (ENEA, ROME).

7 ESIF Sun in action Final Report EC/DGXVII Altener Programme (1996).

Table 3.29: Contribution of renewable energy sources to the national energy budget

(in Mtoe/year)	1994	1995
Hydroelectric	9.825	8.312
Wind	0.001	0.002
Solar for heating	0.007	0.007
Photovoltaic	0.002	0.003
Geothermal (electricity)	0.752	0.756
Geothermal (direct use)	0.213	0.213
Biomass	3.673	3.528
Total renewable sources	14.474	12.821
Gross domestic consumption (Mtoe)	165.2	172.6
Proportion of renewable sources (%)	8.8	7.4
Gross Domestic production (Mtoe)	34.2	33.1
Proportion of renewable sources (%)	42.3	38.7

• For electricity production from hydroelectric, wind, photovoltaic and geothermic sources the constant conversion factor of 2,200 kcal/kWh has been adopted. which corresponds to the specific average consumption of Italian thermoelectric plants. stated in the National Energy Budget.

Table 3.30: Number of hydroelectric plants, gross power, gross and net production of electricity in Italy in 1994-1995-1996 per class of power

	1994	1995	1996
Gross power over 10 MW			
Number of plants	280	281	281
Gross power (MW)	13,848	13,911	13,909
Gross production of electricity (MWh)	35,841,900	30,340,500	33,181,100
1 MW < Gross power ≤ 10 MW			
Number of plants	481	510	508
Gross power (MW)	1,737	1,787	1,779
Gross production of electricity (MWh)	7,182,900	6,029,100	7,205,000
Gross power up to 1 MW			
Number of plants	1,082	1,085	1,106
Gross power (MW)	367	357	380
Gross production of electricity (MWh)	1,633,300	1,411,200	1,649,500
TOTAL ITALY			
Number of plants	1,843	1,876	1,895
Gross power (MW)	15,953	16,054	16,068
Gross production of electricity (MWh)	44,658,100	37,780,800	42,036,000

7 ESIF Sun in action Final Report EC/DGXVII Altener Programme (1996)

Table 3.31a: National energy balance (in million tons of oil equivalent- Mtoe)
Years 1990 and 1991

Supply and consumption	YEAR 1990					YEAR 1991				
	Solid fuels	Natural gas	Oil	Electric energy	Total	Solid fuels	Natural gas	Oil	Electric energy	Total
1. Domestic produc.	1.270	14.044	4.668	8.426	28.408	1.342	14.129	4.332	10.733	30.536
2. Import	14.054	25.382	109.464	7.827	156.727	13.964	27.578	105.833	7.800	155.175
3. Export	0.141	0.015	19.454	0.203	19.813	0.121	0.021	20.875	0.082	21.099
4. Stock withdrawal	-0.613	0.340	2.139	—	1.866	0.126	0.170	-2.462	—	-2.166
5. Total energy supply (1+2-3-4)	15.796	39.071	92.539	16.050	163.456	15.059	41.516	91.752	18.451	166.778
6. Losses and consumption	-1.504	-0.332	-6.218	35.812	-43.866	-1.451	-0.661	-5.634	-36.695	-44.441
7. Thermoelectric energy production	-8.220	8.085	-21.905	38.210	0.000	-7.430	-7.461	-22.216	37.107	0.000
8. Total final consumption (5+6+7)	6.073	30.654	64.415	18.448	119.590	6.178	33.394	63.902	18.863	122.337
- Industry	5.133	12.993	8.795	9.532	36.453	5.109	13.134	7.763	9.541	35.549
- Transport	—	0.209	32.826	0.577	33.612	—	0.213	33.759	0.602	34.574
- Other energy uses	0.761	15.772	13.672	8.339	38.544	0.873	18.299	13.492	8.720	41.384
- No energy uses	0.179	1.680	6.435	—	8.294	0.196	1.748	6.344	—	8.288
- Marine bunkers	—	—	2.687	—	2.687	—	—	2.545	—	2.545

Table 3.31b: National energy balance (in million tons of oil equivalent- Mtoe)
Years 1992 and 1993

Supply and consumption	YEAR 1992					YEAR 1993				
	Solid fuels	Natural gas	Oil	Electric energy	Total	Solid fuels	Natural gas	Oil	Electric energy	Total
1. Domestic produc.	1.451	14.738	4.501	10.834	31.524	1.317	15.773	4.640	10.593	32.323
2. Import	12.350	28.316	111.622	7.908	160.196	10.107	26.842	110.371	8.824	156.144
3. Export	0.130	0.024	21.255	0.142	1.990	0.117	0.027	22.871	0.149	23.164
4. Stock withdrawal	1.906	-0.037		1.990	-0.658	0.485	-1.097	—	-1.270	
5. Total energy supply (1+2-3-4)	13.550	41.124	94.905	18.600	168.179	11.965	42.103	93.237	19.268	166.573
6. Losses and consumption	-1.330	-1.190	-5.908	-36.916	-45.344	-1.282	-0.695	-6.132	-36.822	-44.931
7. Thermoelectric energy production	-5.807	-7.224	-24.501	37.532	0.000	-4.711	-8.146	-23.987	36.844	0.000
8. Total final consumption (5+6+7)	6.413	32.710	64.496	19.216	122.835	5.972	33.262	63.118	19.290	121.642
- Industry	5.246	13.365	6.945	9.569	35.135	4.900	13.561	6.538	9.442	34.441
- Transport	—	0.215	35.249	0.619	36.083	—	0.126	36.008	0.615	36.839
- Other energy uses	0.959	17.646	12.445	9.028	40.078	0.900	18.529	11.943	9.233	40.605
- No energy uses	0.198	1.484	7.405	—	9.087	0.172	0.956	6.187	—	7.315
- Marine bunkers	—	—	2.452	—	2.452	—	—	2.442	—	2.442

Table 3.31c: National energy balance (in million tons of oil equivalent- Mtoe)
Years 1994 and 1995

Supply and comsumption	YEAR 1994					YEAR 1995				
	Solid fuels	Natural gas	Oil	Electric energy	Total	Solid fuels	Natural gas	Oil	Electric energy	Total
1. Domestic produc.	1.322	16.716	4.895	11.253	34.186	1.361	16.511	5.236	9.979	33.087
2. Import	11.132	24.258	108.486	8.513	152.389	13.333	28.584	106.621	8.506	157.044
3. Export	0.102	0.027	20.318	0.241	20.688	0.095	0.031	16.783	0.272	17.181
4. Stock withdrawal	-0.454	0.214	0.974	—	0.734	0.772	0.227	-0.638	—	0.361
5. Total energy supply (1+2-3-4)	12.806	40.733	92.089	19.525	165.153	13.827	44.837	95.712	18.213	172.589
6. Losses and consumption	-1.142	-0.398	-5.972	37.349	-44.861	-1.219	-0.448	-6.463	-38.891	-47.021
7. Thermoelectric energy production	-5.354	-7.979	-24.000	37.733	0.000	-6.412	-9.375	-25.372	41.159	0.000
8. Total final consumption (5+6+7)	6.196	35.014	63.877	20.481	125.568	6.310	32.356	61.717	19.909	120.292
- Industry	4.974	14.884	6.697	10.272	36.827	5.087	14.060	6.638	9.836	35.621
- Transport	—	0.244	36.944	0.651	37.839	—	0.230	36.083	0.631	36.944
- Other energy uses	1.056	18.924	11.018	9.558	40.556	1.055	17.108	10.184	9.442	37.789
- No energy uses	0.166	0.962	6.778	—	7.906	0.168	0.958	6.449	—	7.575
- Marine bunkers	—	—	2.440	—	—	2.363	—	2.363		

Table 3.31d: National energy balance (in million tons of oil equivalent- Mtoe) - Year 1996

Supply and comsumption	ANNO 1996				
	Solid fuels	Natural gas	Oil	Electric energy	Total
1 Domestic produc.	1.315	16.528	5.452	11.192	34.487
2 Import	11.767	30.596	107.591	8.393	158.347
3 Export	0.076	0.036	18.418	0.167	18.637
4 Stock withdrawal	0.256	0.737	0.314	—	1.307
5 Total energy supply (1+2-3-4)	12.750	46.351	94.311	19.418	172.830
6 Losses and consumption	-1.088	-0.403	-6.176	-39.185	-46.852
7 Thermoelectric energy production	-5.962	-9.854	-24.651	40.467	0.000
8 Total final consumption (5+4+7)	5.700	36.094	63.484	20.700	125.978
- Industry	4.514	15.036	6.372	10.240	36.162
- Transport	—	0.265	37.258	0.699	38.222
- Other energy uses	1.018	19.913	10.822	9.761	41.514
- No energy uses	0.164	0.880	6.725	—	7.769
- Marine bunkers	—	—	2.307	—	2.307

4. Inventory of emissions and removals of greenhouse gases

This chapter presents the inventory of emissions and removals of greenhouse gases for 1994 and 1995 (see table 4.1 and 4.2). 1994 was the last year for which it was possible to use the European Environment Agency's CORINAIR method in its entirety. This method uses a detailed nomenclature of emission sources[1], as well as being characterised by a high spatial dissagregation of data; this allows for individual reporting of point sources (a bottom-up approach) and calculation of emissions from area sources using average coefficients (a top-down approach)[2]. As the information on activity indicators and emission factors for point sources for 1995 is still incomplete, we have, instead, continued to update 1994 estimates taking into account variations in available statistical indicators, in particular for those regarding the energy system.

Tables are provided with summary data of emissions and of removals of the following greenhouse gases: natural gas, CH_4; nitrous oxide, N_2O; nitric oxides, $NO+NO_2$; carbon monoxide, CO; non-methane volatile organic compounds, NMVOC; sulphur dioxide, SO_2; hydrofluorocarbons, HFC; perfluorocarbons, PFC; sulphur hexafluoride, SF_6.

4.1 EMISSIONS FROM THE ENERGY SYSTEM

To estimate emissions from the energy system using the CORINAIR approach, we have used a detailed classification of activities, which takes into account the physical characteristics of the emission sources, such as their size and the technology used. We have used a bottom-up approach for point sources, and a top-down approach for area sources.
On the basis of the inventory for the base year 1990, reviewed in accordance with the 1996 IPCC Guidelines (see paragraph 4.8), the energy sector is responsible of: 90.74% of CO_2 emissions, 22.26% of CH_4, 31.01% of N_2O emissions, 98.96% of NO_X, 89.69% of CO, 59.74% of NMVOC emissions, 97.67% of SO_2. There were no emissions of HFC, PFC, SF_6.

4.1.1 FUEL COMBUSTION

The CORINAIR '94 methodology which has been used, is described in the Emission Inventory Guidebook of the European Environment Agency (Joint EMEP/CORINAIR, 1996); it has been chosen by the 1996 IPCC Guidelines as the most detailed option (Tier 3) for the estimation of emissions from this sector.

Regarding CO_2 emission factors, documented figures have been adapted - taking into account different methodologies - to the situation in Italy, on the basis of available data and information on the chemical composition and the energy content of fuels. The emission factor for natural gas, crude oil and steam coal has been changed from year to year depending on the chemical and energy characteristics of fuels, in relation to the source of the supply.

For the purposes of evaluating CO_2 emissions in the atmosphere, the amount of carbon which is not oxidised in the combustion process, has been esti-

1 The SNAP '94 nomenclature developed by the European Topic Centre for Air Emissions (ETC/AEM) ensures total consistency with IPCC emission categories; in this way it has been possible, for the purposes of reporting information, to transfer CORINAIR estimates directly in the format recently established by IPCC/OECD for the "Revised 1996 Guidelines".

2 Emissions from air transport, industrial processes (including HFC, PFC, and SF_6), land use change and forests, agriculture, waste, have been estimated proceeded on the basis of the indications in the "Revised 1996 Guidelines", approved by the 12th plenary session of the IPCC.

Table 4.1: Summary Report 1994 for National Greenhouse Gas Inventories (in Gg)

Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC
Total National Emissions and Removals	424972	-36396	2513.0	160.4	1795.4	7572.8	2354.1
1 Energy	387860		458.5	41.8	1774.0	6953.5	1458.8
A Fuel Combustion: Reference Approach	392205						
Sectorial Approach	385192		106.3	41.8	1768.3	6945.1	1304.4
1. Energy Industries	129069		4.6	18.7	346.6	27.9	4.6
2. Manufacturing Industries and Construction	81071		7.3	7.7	246.0	516.6	14.9
3. Transport	103742		70.6	5.5	973.8	5672.7	1184.3
4. Other Sectors (Residential, Agriculture and Fishing)	69717		23.7	9.8	189.5	711.5	96.6
5. Other (Military)	1593		0.1	0.1	12.4	16.4	4.0
B Fugitive Emissions from Fuels	2668		352.2		5.7	8.4	154.4
1. Solid Fuels			3.4				2.7
2. Oil and Natural Gas	1163		348.8		5.7	8.4	151.7
3. Other (Geothermal)	1505						
2 Industrial Processes	22852		4.5	20.6	4.8	290.4	70.5
A Mineral Products	19077						5.4
B Chemical Industry	2214		2.3	20.6	1.4	11.1	47.9
C Metal Production	1022		2.3		3.3	279.3	2.9
D Other Production (Pulp and Paper, Food and Drink)	539				0.0		14.3
E Production of Halocarbons and Sulphur Hexafluoride							
F Consumption of Halocarbons and Sulphur Hexafluoride							
G Other							
3 Solvent and Other Product Use	1976						634.1
4 Agriculture			870.5	75.9	0.9	25.2	1.9
A Enteric Fermentation			607.2				
B Manure Management			181.9	12.4			0.6
C Rice Cultivation			80.2				
D Agriculture Soils				63.5			
E Prescribed Burning of Savannas							
F Field Burning of Agricultural Residues			1.2	0.0	0.9	25.2	1.2
G Other							
5 Land-Use Change & Forestry	11565	-36396	192.4	21.6	0.7	23.1	163.9
A Changes in Forest and Other Woody Biomass Stocks	10488	-35947					
B Forest and Grassland Conversion	1077		2.6	0.0	0.7	23.1	2.6
C Abandonment of Managed Lands		-133					
D CO_2 Emissions and Removal from Soil		-316					
E Other (Managed Forests)			189.7	21.6			161.3
6 Waste	719		987.1	0.5	15.0	280.5	25.0
A Solid Waste Disposal on Land			426.5				7.7
B Wastewater Handling			511.4				
C Waste Incineration	719		13.4	0.5	15.0	280.5	17.3
D Other (Composting)			35.8				
7 Other, Memo Items:							
International Bunkers	12416		1.1	0.7	185.7	22.0	8.3
- Aviation	4926		0.4	0.2	15.6	4.5	3.3
- Marine	7491		0.7	0.5	170.1	17.5	5.0
CO_2 Emissions from Biomass	4178						

Table 4.1: Summary Report 1994 for National Greenhouse Gas Inventories (in Gg) (Continued)

SO_2	HFCs P	HFCs A	PFCs P	PFCs A	SF_6 P	SF_6 A	Greenhouse Gas Source and Sink Categories
1271.7	0.0000	0.6925	0.0000	0.0116	0.0000	0.0145	Total National Emissions and Removals
1240.7							1 Energy
							A Fuel Combustion: Reference Approach
1182.7							Sectorial Approach
776.1							1. Energy Industries
243.2							2. Manufacturing Industries and Construction
105.0							3. Transport
							4. Other Sectors
57.0							(Residential. Agriculture and Fishing)
1.3							5. Other (Military)
58.0							B Fugitive Emissions from Fuels
							1. Solid Fuels
58.0							2. Oil and Natural Gas
							3. Other (Geothermal)
29.9		0.6925		0.0116		0.0145	2 Industrial Processes
16.5							A Mineral Products
8.9							B Chemical Industry
3.3				0.0116			C Metal Production
							D Other Production
1.1							(Pulp and Paper, Food and Drink)
		0.1069				0.0036	E Production of Halocarbons and Sulphur Hexafluoride
		0.5856				0.0109	F Consumption of Halocarbons and Sulphur Hexafluoride
							G Other
							3 Solvent and Other Product Use
							4 Agriculture
							A Enteric Fermentation
							B Manure Management
							C Rice Cultivation
							D Agriculture Soils
							E Prescribed Burning of Savannas
							F Field Burning of Agricultural Residues
							G Other
							5 Land-Use Change & Forestry
							A Changes in Forest and Other Woody Biomass Stocks
							B Forest and Grassland Conversion
							C Abandonment of Managed Lands
							D CO_2 Emissions and Removal from Soil
							E Other (Managed Forests)
1.1							6 Waste
							A Solid Waste Disposal on Land
							B Wastewater Handling
1.1							C Waste Incineration
							D Other (Composting)
							7 Other. Memo Items:
113.6							International Bunkers
1.6							- Aviation
112.0							- Marine
							CO_2 Emissions from Biomass

Table 4.2: Summary Report 1995 for National Greenhouse Gas Inventories (in Gg)

Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC
Total National Emissions and Removals	450010	-36265	2555.5	161.8	1853.1	7787.2	2370.6
1 Energy	412818		467.2	44.1	1831.4	7156.4	1490.2
A Fuel Combustion: Reference Approach	412716						
Sectorial Approach	410140		115.0	44.1	1825.6	7148.0	1335.7
1. Energy Industries	139180		4.9	20.0	375.6	30.1	4.9
2. Manufacturing Industries and Construction	83043		7.3	7.9	252.9	519.7	15,2
3. Transport	109867		77.1	5.6	995.1	5895.7	1218.0
4. Other Sectors (Residential, Agriculture and Fishing)	76480		25.4	10.6	190.8	685.8	93.5
5. Other (Military)	1569		0.1	0.1	11.3	16.7	4.1
B Fugitive Emissions from Fuels	2678		352.2		5.7	8.4	154.4
1. Solid Fuels			3.4				2.7
2. Oil and Natural Gas	1163		348.8		5.7	8.4	151.7
3. Other (Geothermal)	1505						
2 Industrial Processes	22985		4.6	20.4	4.8	290.8	67.6
A Mineral Products	19077						6.0
B Chemical Industry	2335		2.3	20.4	1.4	11.4	44.4
C Metal Production	1034		2.3		3.3	279.3	2.9
D Other Production (Pulp and Paper, Food and Drink)	539				0.0		14.3
E Production of Halocarbons and Sulphur Hexafluoride							
F Consumption of Halocarbons and Sulphur Hexafluoride							
G Other							
3 Solvent and Other Product Use	1962						629.5
4 Agriculture			871.7	75.9	0.9	25.2	1.9
A Enteric Fermentation			607.2				
B Manure Management			181.9	12.4			0.6
C Rice Cultivation			81.4				
D Agriculture Soils				63.5			
E Prescribed Burning of Savannas							
F Field Burning of Agricultural Residues			1.2	0.0	0.9	25.2	1.2
G Other							
5 Land-Use Change & Forestry	11520	-36265	183.3	20.9	1.0	34.2	156.1
A Changes in Forest and Other Woody Biomass Stocks	10709	-36013					
B Forest and Grassland Conversion	811		3.9	0.0	1.0	34.2	3.9
C Abandonment of Managed Lands		-157					
D CO_2 Emissions and Removal from Soil		-95					
E Other (Managed Forests)			179.4	20.9			152.2
6 Waste	725		1028.7	0.5	15.1	280.5	25.5
A Solid Waste Disposal on Land			464.0				8.2
B Wastewater Handling			511.4				
C Waste Incineration	725		13.4	0.5	15.1	280.5	17.3
D Other (Composting)			39.9				
7 Other, Memo Items:							
International Bunkers	13099		1.1	0.7	193.0	23.0	8.8
- Aviation	5447		0.4	0.2	17.5	5.0	3.7
- Marine	7651		0.7	0.5	175.5	18.0	5.1
CO_2 Emissions from Biomass	4279						

Table 4.2: Summary Report 1995 for National Greenhouse Gas Inventories (in Gg)
(Continued)

SO_2	HFCs P	HFCs A	PFCs P	PFCs A	SF_6 P	SF_6 A	Greenhouse Gas Source and Sink Categories
1321.8	0.0000	0.6956	0.0000	0.0117	0.0000	0.0144	Total Emissions and Removals
1290.7							1 Energy
							A Fuel Combustion: Reference Approach
1232.7							Sectorial Approach
823.1							1. Energy Industries
243.9							2. Manufacturing Industries and Construction
105.2							3. Transport
							4. Other Sectors
59.3							(Residential, Agriculture and Fishing)
1.2							5. Other (Military)
58.0							B Fugitive Emissions from Fuels
							1. Solid Fuels
58.0							2. Oil and Natural Gas
							3. Other (Geothermal)
29.9		0.6956		0.0117		0.0144	2 Industrial Processes
16.5							A Mineral Products
9.0							B Chemical Industry
3.3				0.0117			C Metal Production
							D Other Production
1.1							(Pulp and Paper, Food and Drink)
							E Production of Halocarbons
		0.1100		0.0000		0.0033	and Sulphur Hexafluoride
							F Consumption of Halocarbons
		0.5856				0.0111	and Sulphur Hexafluoride
							G Other
							3 Solvent and Other Product Use
							4 Agriculture
							A Enteric Fermentation
							B Manure Management
							C Rice Cultivation
							D Agriculture Soils
							E Prescribed Burning of Savannas
							F Field Burning of Agricultural Residues
							G Other
							5 Land-Use Change & Forestry
							A Changes in Forest and Other Woody Biomass Stocks
							B Forest and Grassland Conversion
							C Abandonment of Managed Lands
							D CO_2 Emissions and Removal from Soil
							E Other (Managed Forests)
1.2							6 Waste
							A Solid Waste Disposal on Land
							B Wastewater Handling
1.2							C Waste Incineration
							D Other (Composting)
							7 Other. Memo Items:
117.5							International Bunkers
1.8							- Aviation
115.7							- Marine
							CO_2 Emissions from Biomass

mated using the figures suggested in table 1-6 of the IPCC Reference Manual and subtracted from the carbon contained in the fuel. Taking slight variations in emission factors into account, the trend in emissions from energy production is closely linked to trends in energy consumption, and to the mix of the various energy sources and to the relevant technologies.

Apart from the sectoral method, which has used the bottom-up approach of the CORINAIR inventory, CO_2 emissions have also been calculated using the IPCC reference method, which uses a top-down methodology and aggregated energy consumption data relevant to the entire economic system. Differences, negligible in 1990, and slight in the other years (2% in 1994 and 0.9% in 1995), could be reduced by a close examination of trends in energy consumption and of emission factors relating to energy production transformation (refineries, production of coke).

In line with the CORINAIR inventory, emissions of other gases (CH_4, N_2O, NO_x, CO, NMVOC, and SO_2) have been calculated using individual reporting of emissions from point sources and a calculation of emissions from area sources. A very detailed nomenclature of activities (SNAP'94) has been used, which permits the use of different emission factors for the different activities of the combustion process sector, depending on the fuel used, the type of combustion, the technology used and emission reduction measures (EEA-TF, 1992).

Estimates for emissions from road transport are based on the COPERT model (Eggleston et al., 1996) used in the context of the CORINAIR project, which employs basic information regarding fuel consumption, type of vehicle, driving conditions, age of vehicles and climatic conditions.

A simplified methodology (Tier 1) has been used for other transport (rail, marine), while emissions from air transport have been estimated using the detailed methodology (Tier 2) created for the CORINAIR project, and included in the Reference Manual of the 1996 Guidelines. Some adaptation was necessary to estimate emissions from international marine and air transport.

On the basis of Decision 9/2 of the Intergovernmental Negotiating Committee (INC-FCCC), emissions due to international marine and air bunkers have not been included in the national total, although evaluated and shown separately.

The amounts of fuel oil and gas oil relating to international marine bunkers are shown as a specific item in the National Energy Production Accounts. Major difficulties arise when evaluating air bunkers, which are grouped together with national air transport consumption under the same item in the NEPA. To calculate the consumption of jet fuel used in international transport, consumptions during Landing and Take Off (LTO) for national flights and international flights were calculated separately. This was done on the basis of the number of national and international flights (CNT, 1990-1996) and of the specific consumption of M-80, used as the average aircraft type representative of the fleet operating in Italy, both on national and international flights (De Lauretis et al., 1996). These amounts have then been subtracted from total consumptions. The remaining amount has been subdivided into cruising consumption for national and international flights on the basis of data available on consumption relating to 1995, and taking into account the number of national and international flights in 1990 and 1994. It has been assumed that the consumption of jet kerosene for civil commercial flights and that of aviation gasoline for military flights refers entirely to national flights; in these cases there is no distinction between consumption and emissions for LTO cycles and cruising phases.

Emission factors for maritime transport are provided by the Joint EMEP - CORINAIR Guidebook; for aviation gasoline used for civil commercial aviation and for military flights default emission factors of the IPCC simplified methodology are used (Tier 1). Emission factors for jet kerosene used by civil commercial aviation (FAA, 1991; Olivier, 1991) are those specified for the M-80 (taken as the average national aircraft type).

Emissions from fuel consumption by the Armed Forces are shown in a separate category of the inventory (IA5, Other). Consumption of oil products shown in the "Bollettino Petrolifero" (Italian Oil Industry Report) and the consumption of natural gas reported by the Armed Forces have been used; estimates include emissions from heating plants, from off-road vehicles and Aviation. It has not been possible to distinguish between military and civil commercial consumption in the marine sector.

4.1.2 FUGITIVE EMISSIONS FROM FUELS

All emissions originating from the production, refining, transport, storage and use of fuels have been included in IPCC category IB (Fugitive emissions from fuels). Also included are those from combustion processes not linked to production (such as flaring of natural gas at oil and gas production plants).

Emissions (mainly of CO_2) from geothermal plants are included in the same category.

Emissions of natural gas of significant size are due to the extraction and primary compression of the gas, to the infrastructures for the import, storage and distribution of the gas under high pressure over the whole country. Emissions may also be attributed to the distribution network of low-pressure distribution network to the end users; these emissions are obviously proportionate to the quantities of gas transported.

As already stated in the First National Report, estimates for emissions for 1990 and 1995 were made using the most recent CORINAIR methodology (1995). The estimate gives a figure for total losses of around 304/321.8 kt for 1990/1995. Distribution alone would release around 250 kt. These estimates are in agreement with the average coefficients for leakages for the European networks and are reliable. The evaluations carried out by the Battelle-Institut for the Federal Republic of Germany (included in the "First report of the Government of the Federal Republic of Germany pursuant to the UN Framework Convention on Climate Change", Annex 1, September 1994) are very interesting in that they refer to a situation which is very similar to that in Italy in relation to the technology used. In this study the emission coefficients are related to the type of construction of the networks and their length in km, especially those for urban distribution. Emissions from old cast iron networks, in particular, are around one order of magnitude greater than those from modern networks in steel and two orders of magnitude greater than those in PVC. Cast iron networks refer to technology, which was in use roughly until the second half of the sixties, especially in urban networks for city and natural gas distribution.

Applying the leakage coefficients of the above-mentioned study to our networks, a value of 222 kt per year is obtained. This confirms estimates from various sources for the primary network and assigns more than 70% of losses to the cast iron network, even though it only represents 10-12% of the length of the entire distribution network.[3] It should also be noted that CORINAIR's data for network emissions, which is slightly higher than the preceding figure, includes a maximum figure for leakages during distribution to metered users, or in the network within dwellings, which is not analysed in the aforementioned study. At this time it is not possible to evaluate whether the difference of around 35 kt in emissions (271-236) can be attributed to leakages from metres. So as to obtain a solid scientific methodology for estimating emissions from infrastructures for which it has responsibility, SNAM, which manages a large part of the network, has launched an experimental study on infrastructures for import and distribution of natural gas over the whole country.[4] According to this study, total losses for the entire SNAM system for 1993 were estimated to be equivalent to 0.1% of the total natural gas content in the natural gas imported or produced in Italy in 1993, with a statistical margin of error of 18%[5].

Geothermal

CO_2 emissions from geothermal fluid plants for electricity generation have also been included in the losses from fuels category (1B3, Other). The only data available is that measured by ENEL in 1996, equivalent to 1669 Gg. Yearly variations have been determined on the basis of annual electricity production from geothermal sources[6].

3 The greatest leakages occur in low pressure town distribution networks with cast iron piping; until extensive experimental studies are carried out in this sector, repair/replacement of the old cast iron network responsible for most of the losses is proceeding.

4 The activity has been carried out in cooperation with the "Gas Research Institute" and Radian. Both of them have a consolidated experience in the field coming from studies developed in the US. The results of this activity were presented at the 20th World Conference on Gas, held in Copenhagen in June 1997, and will be published.

5 The system studied comprises about 27,000 km of lines, 22 compression stations, 8 of which are also for storage, three gas importation ducts and a plant for the conversion of liquefied natural gas into gas. The study has included both field measurements and estimates using emission factors from EPA sources.

6 3058 GWh in1990, 3198 GWh in 1994, 3219 GWh in 1995, 3547 GWh in 1996.

4.2 EMISSIONS FROM INDUSTRIAL PROCESSES

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.

Estimates shown for CO_2, CH_4, NO_x, CO, NMVOC, SO_2 emissions are substantially consistent with those given in the First National Communication. Emissions of N_2O from nitric acid production have been added to these, while data relating to emissions of HFC, PFC, and SF_6 have been revised on the basis of indications in the 1996 IPCC Guidelines.

On the basis of the revised 1990 inventory, industrial processes account for 6.15% of CO_2 emissions, 0.15% of CH_4, 13.52% of N_2O, 0.37% of NO_x, 6.6% of CO, 3.11% of NMVOC, 2.28% of SO_2, 100% of PFCs; there are no emissions of HFCs or SF_6.

Nitrous oxide (N_2O)

With regard to N_2O emissions resulting from nitric acid production (IPCC category 2B2), we have taken into account the fact that, in Italy, HNO_3 is produced, mainly, by plants which use a medium-high removals process, characterised by higher values of emission factors.

Emissions of N_2O from adipic acid production (IPCC category 2B3) have been estimated using an emission factor provided by the national industry (0.33 kg N_2O/kg adipic acid produced).

Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6)

Regarding emissions of these gases from metal production, PFCs (CF_4 and C_2F_6) resulting from the primary fusion of aluminium (IPCC category 2C3) have been included. Emission estimates are based on annual production figures, and make use of a documented emission factor, in accordance with the approach designated as Tier 1C by the 1996 IPCC Guidelines. Specific emissions of CF_4 and C_2F_6 are extremely uncertain, and depend to a large extent on the exact technology being used. Italian plants, which have recently been renovated (1992), use a "prebake" technology with feeder points to add the aluminium. This technology is characterised by the lowest emission factors. For this type of plant, some recent measurements relating to French and Norwegian plants, provide a figure of 0.06 kg CF_4 per ton of aluminium produced. Emissions of C_2F_6 are usually lower, and the relevant emission factor can be assumed to be equivalent to 0.006 kg C_2F_6 per ton of aluminium produced.

Assumed leakage rates for estimating amounts of HFC, PFC and SF_6 released during the production of halogenated hydrocarbons and of sulphur hexafluoride (IPCC category 2E) are very low, since emissions from both by-products and from leaks are almost entirely contained and incinerated. Substances emitted as by-products are HFC-23 (or R-23, according to the ASHRAE nomenclature), CF_4, C_2F_6, SF_6.

Emissions of HFC and SF_6 from the use of halogenated hydrocarbons and sulphur hexafluoride (IPCC category 2F) have been calculated using 1995 as reference. The hypothesis has been made that the use of HFC's started in 1994. Where specific data was not available consumption was assumed to be the same for 1994 as for 1995. The estimates shown here consider, in a simplified way, the diverse phases of the life cycle of devices and plants that use these substances; the approach suggested by the IPCC for the estimation of actual emissions has been applied to the different steps. On the other hand it has not been possible to calculate potential emissions in the absence of reliable data relating to the production, import, export and destruction of these substances. To simplify the presentation of the data, in tables 4.1, 4.2 and 4.5 columns relating to potential emissions, which are included in the IPCC Reporting Instructions for National Greenhouse Gas Inventories, have been omitted. Data relating to emissions from products and plants at the end of their life span have been neglected, since all appliances in Italy are relatively new.

Data for consumption and for emission factors provided by the relevant associations has been used for domestic refrigeration and small commercial appliances. Estimates relating to other final uses were made using data on presumed consumption supplied by distributors' marketing services and emission factors taken from the Reference Manual of the 1996 IPCC Guidelines. Regarding air conditioning in new cars, FIAT has provided average data for air conditioned home produced cars; this information has also been used for cars of foreign production registered in Italy. An aftermarket share has been assumed on the basis of information supplied by DIAVIA. The data relating to the refrigeration of large commercial plants by conventional means includes industrial refrigeration, cold stores and other refrigeration uses, which represent a small proportion of consumption in this category. Information relating to air conditioning of buses or lorries is not available at present.

Emissions of HFC's from fire prevention systems have not been estimated, given the complete absence of information in this area. In any case, there is reason to believe that in Italy, the share of the market that uses HFC's as a fire extinguisher is very small.

Emissions from the use of HFCs as a solvent are assumed to be equivalent to zero, since these substances are not used for this purpose in Italy.

With regard to total HFC emissions, it can be assumed that 80% consists of R-134a, 10% of R-404, 5% of R-407 and another 5% of R-507.

Emissions of SF_6 included in the inventory relate to the use of this gas in electrical appliances. According to the ANIE, which is the umbrella group of the sector, only 30% of sulphur hexafluoride comes from this type of use. According to the same source, there is significant use of this gas in Al and Mg foundries, for sound proofing in double glazing, as an inflating gas for use in sport (tennis, motor racing etc.). At the present time, however, no information is available to allowing the relevant estimates to be made.

A summary of HFC, PFC, SF_6 emissions, expressed in Gg of the different substances and Gg of CO_2 equivalents, is shown in table 6.17, together with related projections for 2000, 2005 and 2010.

4.3 EMISSIONS FROM SOLVENTS

On the basis of the revised 1990 inventory, solvent use is responsible for 0.46% of CO_2 emissions and 28.95% of NMVOC emissions. There are no emissions of CH_4, N_2O, NO_x, CO, SO_2, HFC, PFC, and SF_6. Emissions of non-methane volatile organic compounds from the use of solvents have been estimated according to the CORINAIR method, using numerous emission factors which are typical of the national productivity situation (in particular for solvent use in dry cleaning and the production of polypropylene and the tanning industry).
In accordance with indications in the IPCC Guidelines, carbon contained in oil-based solvents, or released from these products, has been considered both in the form of NMVOC emissions and in the form of CO_2 emissions. The conversion of NMVOC emissions into CO_2 emissions has been made on the basis of factors suggested by ETC/AEM for the CORINAIR project.

4.4 EMISSIONS FROM AGRICULTURE

On the basis of the 1990 revised inventory, agriculture is responsible for 36.75% of CH_4 emissions, 43.27% of N_2O, 0.05% of NO_x, 31.55% of CO, and 0.07% of NMVOC. There are no CO_2, SO_2, HFC, PFC, and SF_6 emissions.

4.4.1 ENTERIC METHANE EMISSIONS

Estimation of enteric emissions has been made by defining an emission factor for every livestock category that has been multiplied by the population of each livestock category. Enteric emissions for 1990 were quantified using the following information:

- population of each livestock category by province, gathered from the 1990 data from the general agricultural census (ISTAT, 1991) relating to the numbers and different categories of animal species, sorted according to the age of the animal and the type of production.

- emission factors 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 calculated using the aforementioned criteria.

In order to quantify emissions in line with the method contained in the IPCC Guidelines, a detailed procedure for bovines was used. Estimates were made taking into account Italy's specific conditions, considering the availability of specific data for this situation (for example milk productivity per head, type of diet). However, a simplified procedure was used for pigs, sheep, goats and horses[7].

In relation to animal productivity, a single figure was used at the national level for animals for meat production. 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.

Total enteric emissions thus estimated for 1990 were approximately 642.5 kt/year, 1.76% less than the figure in the First National Communication.

4.4.2 EMISSIONS OF METHANE FROM MANURE MANAGEMENT

Estimates of emissions from manure management, made on a regional basis, take account of the fact that these emissions depend on the specific manure management practices and on environmental conditions (Safley et al., 1992; Steed and Hashimoto, 1995; Husted, 1994), and in particular 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 cows and pigs has been used. This takes account of specific national features regarding rearing methods (feeding, rates of production, breeds reared, etc.) and of manure management.[8] 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 of them to be made.

7 For the latter, the amount of methane has been calculated as multiplication of the number of animals for the emission factor suggested by the Guidelines.

8 Emission factors proposed by the Guidelines in relation to the climatic region (cold or temperate) to which some Italian regions belong have been used for the remaining categories of relevant livestock, as follows:
- sheep; 0.19-0.28.
- goats: 0.12-0.18.
- horses: 1.4-2.08.
- donkeys and mules: 0.76-1.14.
- poultry (hens, broilers, ducks, geese, and turkeys) and rabbits: 0.078-0.117.

Total CH_4 emissions for 1990 from slurry are approximately 191.4 kt/year, 21.58% of the figure shown in the First National Report. This last figure was overestimated in that an incorrect emission factor was used due to an error in calculations.

4.4.3 NITROUS OXIDE EMISSIONS

The new methodology (1997) proposed by the IPCC for estimating N_2O emissions from the agricultural sector points out two principal emission sources:

- management systems for livestock manure;
- agricultural soils

Regarding livestock manure management systems, 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, an estimate of 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.

Estimate of emissions from manure management systems was made on the basis of the methodology and emission factors suggested by the IPCC Guidelines. The data on livestock populations, 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 and solid waste were studied, since these are the only systems relevant in Italy.

With regard to the other main source of emission, emissions from soils, the 1997 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. the amount of nitrogen from synthetic fertilisers;
2. the amount of nitrogen from animal waste (excluding quantities excreted while grazing);
3. the amount of nitrogen (or rather the nitrogen which remains in the soil) as a result of nitrogen fixation from nitrogen-fixing crops;
4. the amount of nitrogen (or rather nitrogen which remains in the soil) following the incorporation of crop residues from non nitrogen-fixing crops.

Emissions resulting from the cultivation of organic soils (Histosoils), should also be quantified, always as direct N_2O emissions. They should be calculated 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 calculated starting at 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 supply of nitrogen; emissions are calculated from the estimates of the supply using appropriate emission factors (kg N_2O/kg N supplied by atmospheric deposition and surface runoff respectively).

Regarding soil emissions, some modifications have been made to the IPCC methodology, to take account of 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 too approximate in the calculation of the total biomass produced. Instead, the data for cultivated areas (FAO database) and the quantities of N fixed per hectare (Erdman, 1959 in Agronomia Generale, page 205, Giardini) 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 (Uses of Agricultural and Agri-industrial By products, Vol. 1). The N content is obtained by dividing the quantity of proteins present 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 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). Finally, regarding nitrogen from cultivation of organic soils, the data for surface area supplied by the ISSD of Florence (Source: Carta Pedologica Mancini, 1961) has been used. This data has 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.

4.5 EMISSIONS AND REMOVALS FROM LAND-USE CHANGE AND FROM FORESTS

On the basis of the revised 1990 inventory, the following emissions occur as a result of changes in land-use and from forests: 2.50% of CO_2 emissions, 7.57% of CH_4 emissions, 12.03% of N_2O emissions, 0.10% of NO_x, 0.86% of CO. There are no NMVOC, SO_2, HFC, PFC, and SF_6 emissions. The sector is also responsible for 100% of CO_2 removals from the atmosphere.

Estimates of emissions and removals relating to this sector presented in the First National Communication have been completely revised. 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).

4.5.1. CHANGES IN FOREST AND OTHER WOODY BIOMASS STOCKS

All steps suggested in the IPCC Guidelines have been followed for this category. The removals of C due to the annual biomass increase in Italian forests for the years 1990-1995 has been calculated. To do this the annual increase per hectare of coppice and high forest was examined. This increase is 3 m^3/ha/year for coppice (source: Forest Inventory for Umbria region) and 7.8 m^3/ha/year for high forest (this figure is an average taken from the figures given by the National Forest Inventory for areas of broad leaved high forest and coniferous high forest - Isafa, 1985). This increase was then multiplied by the biomass density, which, was taken as equal to 643 g/m^3 for coppices, and as 550.5 kg/m^3 for high forests (1993, average values, taking into account the diversity of species found in Italian forests, Pettenella) to obtain the annual increase expressed in tonnes/ha. This increase 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 1990-1995. In this way the annual increase in woody biomass was obtained for the whole country. The figure obtained for 1990 (9768.3 Gg C/per year) is much lower than the figure given in the First National Communication (13854.5 Gg C/per year), which was the result of research carried out by the Ministry for Agriculture, Food and Fisheries.

The C content of removed biomass (timber use) was subtracted from this figure. Timber use within forests (timber for construction and energy purposes) and timber use outside forests was estimated, expressed in m^3 shown in national statistics. These figures, as suggested by the IPCC method, were multiplied by a figure for biomass density of 0.5965, an average for the figures for coppices and high forests, which allows the data for m^3 to be converted into dry matter.

4.5.2 GREENHOUSE GAS EMISSIONS CAUSED BY FIRES (FOREST AND GRASSLAND CONVERSION)

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 therefore 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. However, CO_2 emissions from biomass used for fuel are not considered (this use is negligible).

To calculate biomass which has been burnt in the years 1990-1995, national statistics relating to 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 present in these areas, reference was made to a detailed research (Bovio, 1996), which sets out the different types of vegetation in Italian regions with the 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 1995. 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 1995.

The IPCC method was followed for CH_4, CO, N_2O, NO_x emissions, multiplying the amount of C released in 1990-1995 by the emission factors suggested by the method. The emissions calculated in this way were attributed to category 5B2 (others) of category 5B (forest and grassland conversion/temperate forests).

4.5.3 ABANDONMENT OF MANAGED LANDS

With regard to this emission category (abandonment of managed lands), the decline in areas cultivated for permanent forage crops (fields and pastures) since1970 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 and could be used as a basis for evaluating the proportion of these lands that could regrow into forest.

In the twenty years between 1975 and 1995 the phenomenon of abandonment related to around 15% 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 regrow. The IPCC method has been strictly followed and national statistics have been used in the estimations. In accordance with the IPCC Guidelines, the abandonment of managed lands has been quantified considering twenty years periods ending with the inventory year (1970-1990, 1974-1994, 1975-1995) and calculating differences in areas cultivated for permanent forage crops. This data was then smoothed using the moving average method.
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 regrows 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 0.5 Mton 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 from them would then be included in the relevant category (Changes in forests and other accumulations from wood biomass).

4.5.4 CO_2 EMISSIONS AND REMOVALS FROM AGRICULTURAL SOILS

To estimate emissions or removals in relation to 1990, 1994 and 1995 we have considered the changes in areas by type of agricultural practices in terms of surface area in the periods 1970-1990, 1974-1994 and 1975-1995 was taken into account (steps 1, 2 and 3 relating to IPCC category 5D).

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 (1990). 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 66+/- 10 tons. The carbon content of forest soils has not been taken into consideration, because of the very many types of forest in the country. For every type of soil (seed sowing, wood for farm use, 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 -5.15 Tg CO_2 for 1990, -0.316 Tg CO_2 for 1994 and -0.095 Tg CO_2. The minus figures refer to CO_2 removal, illustrating the importance of the phenomenon of abandonment of cultivated land.[9]

9 The IPCC method takes account of CO_2 emissions from organic soils (step 4), 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, which deals with the addition of carbonates to acid soils, relates to practises that are uncommon in our country.

4.6 EMISSIONS FROM WASTE MANAGEMENT

On the basis of the 1990 revised inventory, waste management sector is responsable of 0.16% of CO_2 emissions, 33.26% of CH_4 emissions, 0.17% of N_20, 0.53% of NO_x, 2.45% of CO, 0.04% of NMVOC emissions, 0.05% of SO_2 emissions. There are no emissions of HFC, PFC, and SF_6.

4.6.1 SOLID WASTE DISPOSAL ON LANDS

In relation to waste disposal, 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). Apart from solid urban waste, industrial waste which is landfilled and sludge from wastewater handling plants have also been considered.

On the basis of data available on the characteristic composition of waste, a figure for the percentage of organic biodegradable carbon of 11% has been obtained. The dissimilated fraction of organic biodegradable carbon was assumed to be 0.1. Methane correction factors of 1.0 for managed landfills and 0.4 for unmanaged sites have been assumed.

4.6.2 WASTEWATER HANDLING

The IPCC method was used only for CH_4 emissions from industrial wastewater treatment plants, after the organic load of the effluent from every industrial sector using BOD5 (average figure 7.89 g/litre) was determined. It was assumed, in the absence of more precise indications, that the anaerobically treated fraction is equivalent to 15%.

In Italy sewage is treated using aerobic treatment plants. It is assumed that there are no CH_4 emissions from water treatment, while emissions from sludge disposal have been considered according to the manner of disposal (landfilling, spreading on agricultural land, incineration).

4.6.3 INCINERATION

Existing incinerators in Italy are used for the disposal of solid urban waste, together with industrial waste, hospital waste, sewage sludge and used oil. On the basis of indications in the IPCC Revised Reporting Instructions, emissions from plants without energy recovery systems have been reported under category 6C (Waste incineration), while emissions from plants with an energy recovery system are reported under category 1A4a (Combustion activity, commercial/institutional sector). Specifically, all emissions from the incineration of industrial, hospital, sewage sludge and used oil waste have been included in 6C, together with a percentage of emissions from solid urban waste and assimilated waste equivalent to 29.6% in 1990, 29% in 1994 and 28% in 1995.

To quantify the amount of waste incinerated, various available sources relating to the period 1990-1995 were used. (RSA 1992; RSA 1997; Assoambiente 1995; ENEA 1995; ENEA 1996; Di Marzio 1994), using deductions for the years for which there was no available data.

Different procedures were used to estimate emission factors, according to the data available for each type of waste. Specifically:

- for solid urban 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 solid urban 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 solid urban 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, 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. Emissions from removable residues from agricultural production were included in the same IPCC category.

4.6.4 OTHERS

In addition to emissions relating to disposal methods indicated above, those from composting were also studied (CH_4 emission factor = 0.05 kg/t).

4.7 OTHER EMISSIONS

4.7.1 EMISSIONS FROM VOLCANOES

Although not required by the Framework Convention (articles 4.1 and 12.1) the evaluation of the most important natural emissions, like those from volcanoes, and the study of their trends is important for the study of increases in radiative forcing, which is characteristic of the changes in the greenhouse effect caused by human activity. Of particular interest are volcanic emissions that may reduce radiative forcing, as happened during the eruption of Piñatubo in 1991 that had obvious cooling effects.

In fact, volcanoes are responsible for the release of various gases into the atmosphere (H_2O, CO_2, SO_2, HCl, and HF), some of which (H_2O, CO_2, and SO_2) are of interest from a radiative point of view. The IPCC is particularly interested in sulphur compounds, which are changed into aerosols in the stratosphere. Aerosols can determine important negative radiative forcings, even if this is transient (for a few years), which tend to cool the earth's surface and the lower atmosphere for a few years. For example the average global forcing as a result of the Piñatubo eruption reached a figure of -3/-4 W/m^2 (compared to a figure of 2.45 W/m^2 from the increase in the concentration of atmosphere gases with long lifetime). The spatial distribution of this forcing is, however, very variable.

Although imprecise by default, available estimates indicate that volcanoes release between 10% and 20% of all anthropogenic sulphur emissions yearly and between 1 and 2% of all anthropogenic carbon dioxide emissions (Barberi and Carapezza, 1996).

In Italy, which is home to much volcanic activity, data is available on emissions from monitoring geochemical activity relating particularly to Etna and to Vulcano (undertaken by different Institutes of the National Research Council and some Universities). More sporadic information is available for Stromboli and the Campi Flegrei area, while there is an absence of data for the dormant volcanoes like Vesuvius and volcanic areas that are no longer active.

The figures given in table 4.3 are certainly underestimated due to the relatively small number of direct measurements of gas flows from volcanic eruption or from dormant volcanoes which have fumarole activity only. However, it is noted that SO_2 emissions from Etna account for 7.8% of all volcanic emissions of this gas in the world.

Table 4.3: Average annual emissions of greenhouse gases from active italian volcanoes (Gg/y)

Gas	Etna	Stromboli	Vulcano	Solfatara di Pozzuoli (Campi Flegrei)
H_2O	13870	1168		
CO_2	12775 (10585-43800)	1058.5-2117	76.65	85.17 (47.45-127.75)
SO_2	1460 (401.5-3577)	146-292	19.20 (2.56-43.80)	

Sources: Barberi and Carapezza, 1996; Baubron et al., 1990; Bruno et al., 1993; Caltabiano et al., 1996; Chiodini et al., 1996

4.8 REVISION OF THE BASE INVENTORY FOR 1990 IN ACCORDANCE WITH THE NEW IPCC METHODOLOGY

The inventory for the base year 1990, contained in the First National Communication (table 1.3, shown here as table 4.4), has been revised (see table 4.5), principally as a result of the adoption of the "Revised 1996 IPCC Guidelines" so as to take account of the following:

- The introduction of new gases (SO_2, HFC, PFC, SF_6).
- New methodologies for emissions from air transport, industry, changes in land-use and forestry, agriculture, waste.

In particular, new estimates, or revisions of previous estimates, have been made, for the following:

- CO_2 emissions from fossil fuel combustion (1A);
- CO_2 emissions from the burning of waste for energy production (1A);
- emissions of CO_2, CH_4, N_2O, NO_x, CO, NMVOC, SO_2 from air transport (1A3ai,1A3aii);
- emissions of CO_2, CH_4, N_2O, NO_x, CO, NMVOC, SO_2 from marine transport (1A3di, 1A3dii);
- emissions of CH_4 from natural gas distribution (1B2ii);
- emissions of N_2O from nitric acid production (2B2);
- CO_2 emissions from the solvent and other product use (3);
- CH_4 and N_2O emissions from agriculture (4);
- CO_2 removals from changes in forest and other woody biomass stocks (5A);
- CO_2 emissions from fires (5B);
- CO_2 removals by abandonment of managed lands (5C);
- CO_2 removals from agricultural soils (5D);
- CH_4 emissions from solid waste disposal on lands (6A);
- CH_4 emissions from wastewater handling (6B);
- CO_2 emissions from waste incineration (6C);
- CH_4 emissions from composting (6D).

Table 4.4: Summary of the national inventory of greenhouse gas emissions 1990 and removals (Gg)*

Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
Total net national emissions	392213	3901.3	120.2	2127.8	9332.9	2400.6
Total greenhouse gas emissions	432613	3901.3	120.2	2127.8	9332.9	2400.6
Total greenhouse gas removals	-40400	0.0	0.0	0.0	0.0	0.0
1 All energy (fuel combustion and fugitive)	401350	413.4	41.7	1981.4	7155.0	1276.3
A Fuel combustion	400350	66.0	41.7	1981.2	7154.9	1136.8
Energy industries & transformation	138291	8.2	19.5	462.2	40.6	27.1
Industry (ISIC)	91345	9.7	10.0	377.5	656.1	19.4
Transport	95624	27.4	3.5	966.8	5645.6	994.8
Commercial/institutional	26331	2.5	3.1	21.9	27.3	2.2
Residential	41142	4.5	4.8	34.0	54.6	8.2
Agriculture/forestry	8112	3.4	0.4	108.7	534.8	68.4
Other	505	0.1		8.0	3.2	1.3
Biomass burned for energy	2525	10.3	0.4	2.2	192.7	15.4
B Fugitive fuel emissions		347.5		0.2	0.1	139.6
Oil and natural gas system		337.1		0.2	0.1	139.6
Coal mining		10.4				
2 Industrial processes	27593	4.4	14.8	7.2	370.9	73.4
A Iron and steel	386	2.1		3.3	172.5	2.7
B Non-ferrous metals	1460				182.9	0.4
C Inorganic chemicals	2296	1.8		3.4	1.7	9.0
D Organic chemicals	1	0.4	14.8	0.4	13.8	41.2
E Non metallic mineral products	22959					
F Other	489			0.1		20.1
3 Use of solvents						537.6
A Paint application						238.3
B Degreasing and dry cleaning						48.7
C Chemical products manufacture/processing						63.5
D Other						187.1
4 Agriculture		1860.1	58.7	31.6	1703.5	491.5
A Enteric fermentation		654.0				
B Animal waste		887.0				380.1
C Rice cultivation		64.2	0.6			
D Agricultural soils		157.5	56.6			14.0
E Field burning of agricultural residues		97.4	1.5	31.6	1703.5	97.4
F Savannah fires						
5 Land-use change and forestry	-36730	12.0	5.0	94.0	75.0	
A Forest clearing & on-site burning of cleared forests	3670	12.0	5.0	94.0	75.0	
B Grassland conversion						
C Abandonment of managed lands						
D Managed forests	-40400					
6 Waste	7282	1611.3	0.1	13.5	28.6	21.8
A Solid waste disposal on lands	5096	1526.4				21.7
B Wastewater		33.6				
C Other	2185	51.4	0.1	13.5	28.6	0.1

* CO_2 emissions relating to the production of biomass and to waste have not been included in the national total, in accordance with the IPCC/OECD instructions (IPCC/OECD, 1994)

4.9 RELIABILITY

The general revision of the inventory to take account of the "Revised 1996 IPCC Guidelines" and of the instructions in the "In depth review" of the First National Communication has increased the reliability of the data by the following means:

- the availability of estimation methodologies with different levels of complexity and detail, the simplest of which can be used to verify results obtained using other methods;
- the availability of data and results of national studies relating to both activity indicators and emission factors.

Emphasis is placed, in particular, on the consistency between the two estimates relating to CO_2 emissions from combustion processes. The first, obtained using the IPCC reference method, uses data from the National Energy Accounts relating to the whole energy system. The second was obtained using the CORINAIR methodology which makes use of a detailed classification of activities and makes provision for individual reporting of the most important sources of emission.

By means of this type of verification, but without proceeding with a quantitative evaluation of data uncertainty, it has been possible to state how relative estimates for some sectors (in particular agriculture, forestry and change of land use, waste) continue to be extremely sensitive to the interpretation of the calculation methodology and to the values of the parameters assumed (see table 4.6). Emphasis is placed, for example, on how the use of a methodology for estimating emissions from waste disposal, which includes variations in time of methane emissions, can modify the actual emission trends.

The absence of data relating to the production, importation, export and destruction of halogenated hydrocarbons and sulphur hexaflouride has made it impossible to evaluate potential emissions of HFC and SF_6 from the consumption of these substances (IPCC category 2F). Evaluation of actual emissions is characterised by a marked uncertainty, since it has not been possible to obtain information on any of the uses of these substances.

Considerable work has been carried out by the IPCC in collaboration with the OECD and the IEA on the development of estimation methodologies and emission factors for the sectors listed above, and the new gases included in the inventory, in particular. Further developments in this area, including the exchange of technical information, should take place between the different Parties to the Convention.

Legenda

ABBREVIATION	MEANING
EVALUATION	
PART	Partial estimate
ALL	Total estimate of all sources
NE	Non estimated
IE	Estimated but included elsewhere
NO	Non existing
NA	Non applicable
QUALITY	
H	Very reliable estimate
M	Middling reliability of estimate
L	Not very reliable estimate
DOCUMENTATION	
H	High
M	Middling
L	Low
DISAGGREGATION	
1	Total emissions estimate
2	Sectorial subdivision
3	Sub-sectorial subdivision

Table 4.5: Summary Report for National Greenhouse Gas Inventories (1990) (in Gg)

Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC
Total National Emissions and Removals	443550	-35891	2348.5	164.4	1944.7	7894.4	2221.1
1 Energy	402400		405.4	44.6	1924.4	7080.8	1326.3
A Fuel Combustion: Reference Approach	399611						
Sectorial Approach	400047		96.5	44.6	1919.3	7072.0	1179.8
1. Energy Industries	148445		5.0	19.9	458.6	30.9	5.2
2. Manufacturing Industries and Construction	78117		8.1	9.5	295.5	522.7	15.4
3. Transport	95521		61.7	3.6	967.9	5687.9	1049.2
4. Other Sectors (Residential, Agriculture and Fishing)	76805		21.4	11.6	186.0	806.6	105.3
5. Other (Military)	1159		0.2	0.0	11.4	23.9	4.7
B Fugitive Emissions from Fuels	2353		309.0	0.0	5.1	8.8	146.5
1. Solid Fuels			5.0				3.0
2. Oil and Natural Gas	914		304.0		5.1	8.8	143.5
3. Other (Geothermal)	1439						
2 Industrial Processes	27520		4.4	23.5	7.2	527.5	72.5
A Mineral Products	22715						6.0
B Chemical Industry	2350		2.3	23.5	3.8	15.5	49.6
C Metal Production	1977		2.1		3.3	512.0	2.8
D Other Production (Pulp and Paper, Food and Drink)	478				0.1		14.1
E Production of Halocarbons and Sulphur Hexafluoride							
F Consumption of Halocarbons and Sulphur Hexafluoride							
G Other							
3 Solvent and Other Product Use	1999						641.5
4 Agriculture			909.1	75.0	0.9	24.9	1.9
A Enteric Fermentation			643.1				
B Manure Management			191.5	12.9			0.7
C Rice Cultivation			73.3				
D Agriculture Soils				62.1			
E Prescribed Burning of Savannas							
F Field Burning of Agricultural Residues			1.2	0.0	0.9	24.9	1.2
G Other							
5 Land-Use Change & Forestry	10942	-35891	187.2	20.9	1.9	67.7	159.9
A Changes in Forest and Other Woody Biomass Stocks	8736	-35817					
B Forest and Grassland Conversion	2154		7.7	0.1	1.9	67.7	7.7
C Abandonment of Managed Lands		-74					
D CO_2 Emissions and Removal from Soil	52						
E Other (Managed Forests)			179.4	20.9			152.2
6 Waste	688		842.5	0.3	10.2	193.4	19.1
A Solid Waste Disposal on Land			302.1				6.1
B Wastewater Handling			511.4				
C Waste Incineration	688		9.2	0.3	10.2	193.4	13.0
D Other (Composting)			19.8				
7 Other, Memo Items:							
International Bunkers	12204		1.1	0.6	206.3	23.5	8.2
- Aviation	3737		0.3	0.1	12.0	3.5	2.5
- Marine	8467		0.8	0.5	194.3	20.0	5.7
CO_2 Emissions from Biomass	3100						

Table 4.5 Summary Report for National Greenhouse Gas Inventories (1990) (Continued)

SO_2	HFCs P	HFCs A	PFCs P	PFCs A	SF_6 P	SF_6 A	Greenhouse Gas Source and Sink Categories
1650.3	0.0000	0.0897	0.0000	0.0153	0.0000	0.0092	Total Emissions and Removals
1610.3							1 Energy
							A Fuel Combustion: Reference Approach
1541.7							Sectorial Approach
999.8							1. Energy Industries
323.0							2. Manufacturing Industries and Construction
106.1							3. Transport
111.6							4. Other Sectors (Residential, Agriculture and Fishing)
1.2							5. Other (Military)
68.6							B Fugitive Emissions from Fuels
							1. Solid Fuels
68.6							2. Oil and Natural Gas
							3. Other (Geothermal)
39.1		0.0897		0.0153		0.0092	2 Industrial Processes
20.4							A Mineral Products
11.6							B Chemical Industry
3.8				0.0153			C Metal Production
3.4							D Other Production (Pulp and Paper, Food and Drink)
		0.0897				0.0026	E Production of Halocarbons and Sulphur Hexafluoride
						0.0066	F Consumption of Halocarbons and Sulphur Hexafluoride
							G Other
							3 Solvent and Other Product Use
							4 Agriculture
							A Enteric Fermentation
							B Manure Management
							C Rice Cultivation
							D Agriculture Soils
							E Prescribed Burning of Savannas
							F Field Burning of Agricultural Residues
							G Other
							5 Land-Use Change & Forestry
							A Changes in Forest and Other Woody Biomass Stocks
							B Forest and Grassland Conversion
							C Abandonment of Managed Lands
							D CO_2 Emissions and Removal from Soil
							E Other (Managed Forests)
0.8							6 Waste
							A Solid Waste Disposal on Land
0.8							B Wastewater Handling
							C Waste Incineration
							D Other (Composting)
							7 Other, Memo Items:
132.4							International Bunkers
1.2							- Aviation
131.2							- Marine
							CO_2 Emissions from Biomass

Table 4.6: Explanatory table of National Greenhouse Gas Inventories

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions		CO_2 removals		CH_4		N_2O		NO_x		CO		COVNM	
	Evaluation	Quality	Evaluation	Quality	Evaluation	Quality	Evaluation	Quality	Evaluation	Quality	Evaluation	Quality	Evaluation	Quality
Total National emissions and removals														
1 Energy														
1. Energy industries	ALL	H	NO		ALL	L	ALL	L	ALL	H	ALL	M	ALL	M
2. Manufacturing industries and construction	ALL	M	NO		ALL	L	ALL	L	ALL	M	ALL	M	ALL	M
3. Transport	ALL	H	NO		ALL	L	ALL	L	ALL	H	ALL	M	ALL	M
4. Other sectors (residential, agric. and fish.)	ALL	H	NO		ALL	L	ALL	L	ALL	H	ALL	M	ALL	M
5. Other (military)	PART	H	NO		PART	L	PART	L	PART	H	PART	M	PART	M
B Fugitive emissions from fuels														
1. Solid fuels	NO		NO		ALL	M	NO		NO		NO		ALL	M
2. Oil and natural gas	ALL	M	NO		ALL	M	NE		ALL	M	ALL	M	ALL	M
3. Other (geothermal)	ALL	M	NO		NO		NO		NO		NO		NO	
2 Industrial processes														
A Mineral production	ALL	M	NO		NO		NO		NO		NO		NO	
B Chemical industry	ALL	M	NO		ALL	M	ALL	M	ALL	M	ALL	M	ALL	M
C Metal production	ALL	M	NO		ALL	M	NO		ALL	M	ALL	M	ALL	M
D Other production (pulp and paper, food and drink)	ALL	M	NO		NO		NO		ALL	M	NO		ALL	M
E Prod. of halocarbons and sulphur hexafluoride	NO		NO		NO		NO		NO		NO		NO	
F Cons. of halocarbons and sulp. hexafluoride	NO		NO		NO		NO		NO		NO		NO	
3 Solvent and other product use	**ALL**	**L**	**NO**		**NO**		**NO**		**NO**		**NO**		**ALL**	**H**
4 Agriculture														
A Enteric fermentation	NO		NO		ALL	M	NO		NO		NO		NE	
B Manure management	NO		NO		ALL	M	NO		NO		NO		NE	
C Rice cultivation	NO		NO		ALL	M	NO		NO		NO		NO	
D Agriculture soils	NO		NO		NO		ALL	L	NO		NO		NO	
E Prescribed burning of savannas	NO		NO		NO		NO		NO		NO		NO	
F Field burning and agricultural residues	NO		NO		ALL	M	ALL	M	ALL	M	ALL	M	NE	
5 Land-use change & foresty														
A Changes in forest and other woody biomass stocks	ALL	M	ALL	M	NO		NO		NO		NO		NO	
B Forest and grassland conversion	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	NO	
C Abandonment of managed lands	PART	L	PART	L	NO		NO		NO		NO		NO	
D CO_2 emissions and removal from soil	ALL	L	ALL	L	NO		NO		NO		NO		NO	
E Other (managed forests)	NO		NO		ALL	L	ALL	L	NO		NO		ALL	L
6 Waste														
A Solid waste disposal on land	NO		NO		ALL	M	NO		NO		NO		ALL	M
B Wastewater handling	NO		NO		PART	M	NE		NO		NO		NE	
C Waste incineration	ALL	M	NO		PART	L	ALL	L	ALL	M	ALL	M	ALL	M
D Other (composting)	NO		NO		ALL	L	NO		NO		NO		NO	
Other, memo items														
International bunkers														
- - Aviation	ALL	H	NO		ALL	L	ALL	L	ALL	M	ALL	M	ALL	M
- - Marine	ALL	H	NO		ALL	L	ALL	L	ALL	M	ALL	M	ALL	M
CO_2 emissions from biomass	ALL	M	NO		ALL	L	ALL	L	ALL	M	ALL	M	ALL	M

Table 4.6: Explanatory table of National Greenhouse Gas Inventories (continued)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	SO_2		HFCs real		PFCs real		SF_6 real		Documentation	Disaggregation
	Evaluation	Quality	Evaluation	Quality	Evaluation	Quality	Evaluation	Quality		
Total National emissions and removals										
1 Energy										
1. Energy industries	ALL	H	NO		NO		NO		H	3
2. Manufacturing industries and construction	ALL	H	NO		NO		NO		H	3
3. Transport	ALL	H	NO		NO		NO		H	3
4. Other sectors (residential, agric. and fish.)	ALL	H	NO		NO		NO		H	3
5. Other (military)	PART	H	NO		NO		NO		H	3
B Fugitive emissions from fuels										
1. Solid fuels	NO		NO		NO		NO		M	2
2. Oil and natural gas	ALL	M	NO		NO		NO		M	2
3. Other (geothermal)	NO		NO		NO		NO		L	2
2 Industrial processes										
A Mineral production	NO		NO		NO		NO		M	3
B Chemical industry	ALL	M	NO		NO		NO		M	3
C Metal production	ALL	M	NO		ALL	M	NE		M	3
D Other production (pulp and paper, food and drink)	ALL	M	NO		NO		NO		M	3
E Prod. of halocarbons and sulphur hexafluoride	NO	ALL	M	ALL	M	PART	M		L	3
F Cons. of halocarbons and sulphur hexafluoride	NO	PART	M	NE		PART	M		L	3
3 Solvent and other product use	**NO**		**NO**		**NO**		**NO**		**M**	**2**
4 Agriculture										
A Enteric fermentation	NO		NO		NO		NO		M	3
B Manure managemen	NO		NO		NO		NO		M	3
C Rice cultivation	NO		NO		NO		NO		M	1
D Agriculture soils	NO		NO		NO		NO		M	1
E Prescribed burning of savannas	NO		NO		NO		NO			
F Field burning and agricultural residues	NO		NO		NO		NO		M	1
5 Land-use change & foresty										
A Changes in forest and other woody biomass stocks	NO		NO		NO		NO		H	3
B Forest and grassland conversion	NO		NO		NO		NO		H	3
C Abandonment of managed lands	NO		NO		NO		NO		H	3
D CO_2 emissions and removal from soil	NO		NO		NO		NO		H	2
E Other (managed forests)	NO		NO		NO		NO			
6 Waste										
A Solid waste disposal on land	NO		NO		NO		NO		H	3
B Wastewater handling	NO		NO		NO		NO		M	2
C Waste incineration	ALL	M	NO		NO		NO		H	3
D Other (composting)	NO		NO		NO		NO		L	2
Other, memo items										
International bunkers									M	
- - Aviation	ALL	H	NO		NO		NO		M	
- - Marine	ALL	H	NO		NO		NO		M	
CO_2 emissions from biomass	NO		NO		NO		NO		M	

5. Mitigation Policies and Measures

The present chapter intends to provide a rational and consistent picture of provisions and interventions which, according to growing awareness and knowledge on the issue of global climate, the government plans to implement order to ensure: integration of environmental and sectoral policies, national contribution to international objectives regarding mitigation of climate change, compensating collective needs and company objectives, implementation of mechanisms which ensure convergence of objectives among the different decision making levels, European, national, local.

A brief presentation of the reasons leading to action will be followed by a detailed report on probable objectives of national policies by 2010, current measures, commitments to be reviewed or to be taken ex-novo, and the process required to achieve mitigation objectives. Since provisions are decided by sectoral administrations, objectives, options, mitigation strategies and measures required to implement, political decisions will be described per sector: production, processing and distribution of energy, manufacturing, residential, commercial and civil, transport, agriculture and forests, solid waste and wastewater disposal.[1]

5.1 NATIONAL PROGRAM FOR MITIGATION OF CLIMATE CHANGE

The "Program of measures to implement a national policy for mitigation of climate change" intends to support the current provisions on the matter approved by the Interministerial Committee for Economic Planning on 25.2.1994 (National Program for Containment of CO_2 emissions by the year 2000 to 1990 levels). It also aims at extending its scope to the year 2010 and to the three major greenhouse gases (carbon dioxide, methane and nitrous oxide from now on abbreviated as greenhouse gases).

5.1.1 MOTIVATIONS

The international community has steadily become aware of the risks related to climate changes. The 1992 Framework Convention on Climate Change has identified objectives and commitments to prevent and mitigate risks related to climatic changes. For an even greater national commitment which has already been substantial (see chapter 2) the government has planned further initiatives and a national policy for mitigation. According to international studies (Second Assessment Report of the Intergovernmental Panel for Climate Change, SAR-IPCC, 1996), there is urgent need for measures to prevent risks related to climatic changes (which may be very approximately summarised in a rise in mean temperatures of about 2 °C and a rise in sea level of about 50 cm over the next 100 years) and to reduce annual global greenhouse gas emission by 50% over the next 100 years. The eventual additional costs stemming from prevention measures may by considered as a kind of insurance policy against possible damages due to climate change which would have disastrous effects on communities and economies situated in risk areas. Only timely interventions may ensure international equity and avoid damage to less developed areas and inter-generation equity to avoid damages falling on future generations.

1 Adaptation policies and measures , international promotion, research on climate, communication, information and training are described in the following chapters.

At the moment it is not simple to draw up a strategy of response which requires implementation of a great deal of measures in various economic and technological sectors. Scientific research and technological development have not yet identified economically valid and globally applicable systems capable of meeting the economic system's demand for goods and services without emitting greenhouse gases. Similarly, so far it appears impossible to separate economic growth from the production of greenhouse gases. Neither can it be said that technological research and development will be able to provide radical solutions in the short or medium term although sustainable growth is the objective of the United Nations Agenda 21 and of the EU program V for environmental action.

However, immediate implementation of a national policy for mitigation has many domestic benefits besides contributing to international efforts. Each reduction in carbon dioxide emissions from the use of energy produces a "double gain" in the sense that it automatically entails reduction of emissions due to all other atmospheric pollutants related to combustion. Another benefit would come from the commitment to improve infrastructures in order to reduce emissions in the transport and mobility sector, underdeveloped when compared to other countries. Although substantial investment is initially required, the direct and indirect benefits in the long run will be great. Finally, modernisation of systems of production and consumption through better technologies and techniques will stimulate the national productive system to offer more and more innovative products and promote state-of-the-art efficiency in technologically driven systems.

5.1.2 APPROACHES

The National program for mitigation plans to follow these guidelines:

- act jointly with other Member States of the European Union which has the responsibility on environmental matters but not disjointed from other developed countries considering the initial conditions;

- to adopt no/low regret options;

- minimum cost combination, also in terms of time (which among other things implies reducing intermediate objectives that do not allow implementation of optimal combinations that by definition increase costs;

- sectoral strategies integrated in a single program;

- gradual improvement of efficiency and reduction of pollutants as to follow step by step the improvements in the technological system and only occasional interventions to accelerate renewal of capital stock;

- to preferably adopt voluntary and program agreements accompanied by economic means instead of regulatory, "command and control" approaches;

- periodical assessment of the gap between objectives and results.

5.1.3 COMMITMENTS FOR THE YEAR 2000

The current low Italian level of greenhouse gas emissions per capita and per unit of Gross Domestic Product (GDP) is due to sectoral policies implemented far back in time. The lack of coal delayed industrialisation compared to England, France, Germany and the United States, and the industrial system in Italy developed in the low energy intensity sectors and through more efficient technologies. The trend was further supported when crude oil became the main energy source and national governments encouraged efficient use of transport fuel through heavy taxation; the average capacity of cars circulating in Italy is still lower than in all the other G7 countries.

In a time of increasing globalisation of markets and standards, the fact that emissions are still lower than in almost all the more developed countries means that Italy is deeply committed in this field[2]. In the last three years new provisions have been added to the already long list reported in the First National Communication; the most significant seem the interventions to free the market for gas and electric energy also by establishing an Authority to regulate energy services for public use, privatisation of once State owned energy firms and revision of regulations in the field of waste disposal.

2 See list of provisions in the Annexe 2.

Greenhouse gas emissions have not been stable after 1990, as Italy had planned since it becomes a very ambitious goal when the international price of fossil fuels is low and when the national economy budget is having a hard time. Besides, in this stage the EU policies to reduce average European emissions still have to show their effect due to:

- the below average Italian figures of emissions;
- the minimum energy prices imposed by the European Commission being lower than the domestic prices;
- the new European standards of energy efficiency which often entail consumption above the average lower-sized but less efficient;
- demand Side Management of the electricity market has practically applied the 3 kW threshold for domestic use long before it had been invented;
- the objective of emission stabilisation which require a set of additional management measures such as urban traffic control, campaigns to promote the diffusion of more efficient appliances and intervention on electric power production.

5.1.4 NATIONAL OBJECTIVES BEYOND THE YEAR 2000

Within the framework of the "Berlin Mandate" Italy has performed studies and sectoral analyses to evaluate commitments for the years after 2000[3]. Due to these studies, the government has approved the negotiating position of reducing national emissions in 2010 by 7% compared to 1990 levels. This will be possible if at COP-3 the European Union jointly commits itself to a 10% reduction in the overall emissions of the three main greenhouse gases (carbon dioxide, methane and nitrous oxide using as measure the global radiative power at 100 years)[4].
By adopting a Program of Measures for Implementation of a National Policy for Mitigation of Climate Change, described in the present and following chapters, Italy may fulfil the reduction commitments which will be agreed on during the ongoing international negotiations (see table 5.1 and figure 5.1)

5.1.5 FORMALISING OBJECTIVES AND STRATEGIES

To implement this very painstaking policy, through the CIPE the government has approved the general lines of the program of measures for the mitigation of climate change (see Annexe 3). With the aim of protecting global climate, the program co-ordinates a set of sectoral provisions already implemented or under discussion in each sector. If necessary the commitments may be increased in the long term by defining new sectoral objectives and further means of intervention. The program will simultaneously update some of the country's infrastructures and some of the operating and organisational processes in the sectors involved; in other words the program may bring economic advantages in the long term.
Following approval by CIPE sectorial administrations draw up measures to implement the program to obtain approval by the appropriate decision-makers.
Moreover, to co-ordinate sectoral programs the government has appointed a working group (which when necessary may be extended to include representatives of local authorities). With the following duties:

- monitor the trend of emissions;
- monitor implementation of sectorial provisions;
- where necessary, propose integration of sectoral provisions with general provisions concerning the global environment;
- provide eventual annual budgets for extra costs;
- promote analyses and research to gain increasing knowledge on the issues;

The setting up of a permanent technical secretariat made up of inter-sectoral experts is also being considered. It will be charged with providing support to interministerial bodies with a view to fulfilling domestic and international commitments, updating statistics, carrying out research and analyses and above all facilitating operation of the program.

3 See Pinchera et al 1992; Tosato, 1993; Tosato, 1994; Contaldi et al., 1994a, 1994b; Macchiato et al., 1993; ENEA, 1995; Cosmi et al., 1996; Tosato et al., 1997.

4 In March 1997 the European Council approved a negotiating mandate for a 15% reduction in overall emissions without specifying the 10-15% burden sharing among Member States but stating that the objective will be achieved by common (and co-ordinated) policies and measures. If this becomes a binding commitment then both the European Union and other developed countries are involved.

Figure 5.1: Possible national trends in carbon dioxide and greenhouse gas emissions

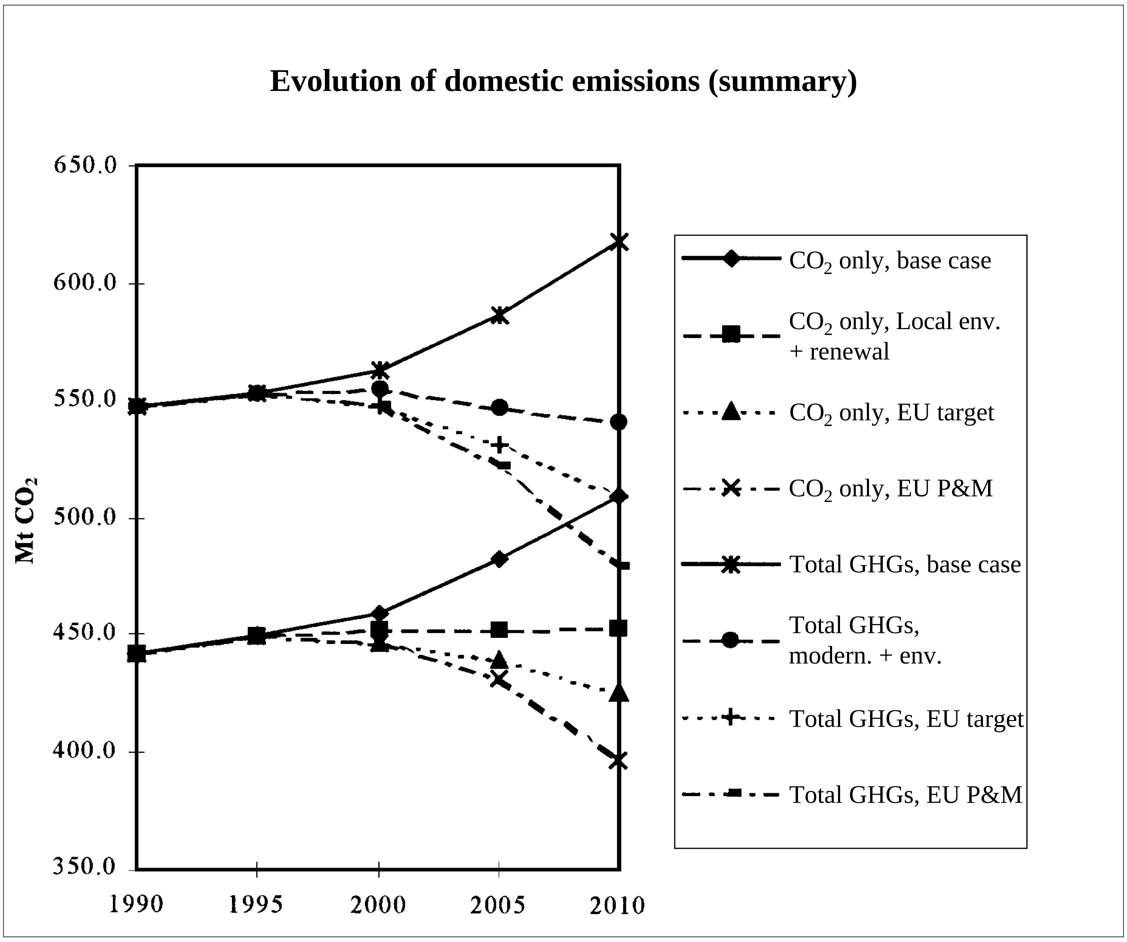


Table 5.1: Objectives and measures for implementation of a national programme in response to climate change

GREENHOUSE GAS (in Mt/y CO_2 equiv 100 years)	CO_2 emiss.	CO_2 removal	CH_4	N_2O	Total gross
FCCC REFERENCE EMISSIONS CQCC (1990)	443.1	35.9	48.9	51.0	543.0
Energy sector: prod. processing and distribution	150.8		6.6	6.2	163.6
Industry sector	107.6		0.3	10.2	118.1
Transport and mobility sector	95.1		1.3	1.1	97.5
Residential, commercial and service sector	78.0		0.4	3.6	82.0
Agriculture, livestock and forestry sector	10.9	35.9	23.0	29.8	63.7
Waste processing	0.7		17.3	0.1	18.1
EMISSIONS IN 2010: scenario trend	509.7	36.2	55.8	59.6	615.0
A – modernisation and local environmental protection	453.5	36.2	39.1	45.1	537.6
B - European Union Objectives	425.4	36.2	35.5	45.1	505.9
C - Further interventions	396.6	36.2	34.5	45.1	476.1

MITIGATION AND REDUCTION OF EMISSIONS	A	B	C
Reduction objective for the year 2010 (a)	77	109	139
Energy sector: production, processing distribution	18	23	23
Industry sector	13	20	24
Transport and mobility sector	23	25	29
Residential, commercial and service sectors	5	18	29
Agricultural, livestock and forestry sector (incl. biofuels)	2	3	12
Waste processing sector	16	20	21
Intervention measures and potential	77	109	139
Sectoral restructuring, general policy laws, plans, etc	18	20	24
Investments and direct action	10	10	12
Stimulating voluntary agreements	24	35	42
Economic measures (taxes, tariffs, subsidies, etc.)	7	9	15
Regulatory measures (standards, controls, etc)	18	35	46

Inter sectorial measures: fully involve local authorities, enhance common European measures and policies, integrate global environment in the fiscal system, increase R&D activities regarding mitigation technology, spread technological innovation, permanent monitoring, studies and analyses of strategies to face climatic changes

ADAPTMENT: measures to safeguard river environments, hydrologic security, flood forecasting, subsidence control on behalf of the watershed authorities

TECHNOLOGY TRANSFER: Supporting competitiveness of the National industry of mitigation technology, establishment of an Italian fund for the Global environment, technology transfer through joint implementation

RESEARCH ON THE CLIMATE: Adoption/initiation of the National Program for Climate Change to co-ordinate national activities and act as reference for international co-operation (see art.5 FCCC)

REPORTS, INFORMATION, TRAINING: promote public awareness on the issue of climate change, promote public participation in the discussions regarding mitigation policies and create a consensus in accepting the measures for greenhouse gas emission reduction

(a) Sum of figures shown in the following tables is greater than the total shown here because some interventions may have been assigned to more than one sector.

5.2 ENERGY SECTOR: PRODUCTION, PROCESSING AND DISTRIBUTION

5.2.1 MITIGATION OBJECTIVES AND IMPLEMENTATION PROSPECTS

In 1990 the sector concerning electric power production, processing of crude oil products and transport and distribution of energy has accounted directly for 33% of carbon dioxide emissions and 31% of emissions of the three main greenhouse gases (GHGs-measured in units of equivalent carbon dioxide). The whole national energy system, including the end use sectors released 91% of carbon dioxide and 73% of the three main GHGs. The growth of emissions from the final energy supply sector (see graph 5.2) and the possible reduction of emissions through mitigation measures (see table 5.2) depend on the trend of the end demand for energy. Mitigation policies in the energy supply sector (described in this paragraph) are linked to measures and interventions in the end use sectors (described in paragraphs 5.3-5).

The energy market cannot be considered as any other sector where the balance between demand and offer depends solely on interaction of the operators. Due to its strategic importance in the economic system in order to reduce emissions the national energy policy must be directed:

- the time frame regarding investments is too long for a financial market to guarantee national interests in terms of secure energy supply;
- monopolies and concentration of the offer limit market competitiveness and may hinder diffusion of increasingly energy efficient production and consumption technologies;
- an open and competitive energy market tends to transfer costs outside thus damaging consumers, environment and national economy.

The functions of energy policy are currently more complex than in the past and include also: balance with other national priorities; the search for mechanisms of integration among institutional bodies and among sectoral policies; links with European, regio-

Table 5.2: Objectives and measures for implementation of a national program in response to climate change: mitigation in the energy sector: production, processing and distribution

Emission reduction objectives for CO_2 in 2010 (in Mt CO_2/year)	20-36
Rationalisation and development of sources without carbon: renewable sources (a)	6-22
Shift to fossil fuels with low carbon-content	6-6
Technological innovation and improvement of conversion efficiency and efficient use of fuels (b)	8-8
Rationalisation of the energy services market and efficient use of energy	(c)
Decarbonisation of flue, storage and carbon dioxide sequestering	0

Main intervention measures and tools

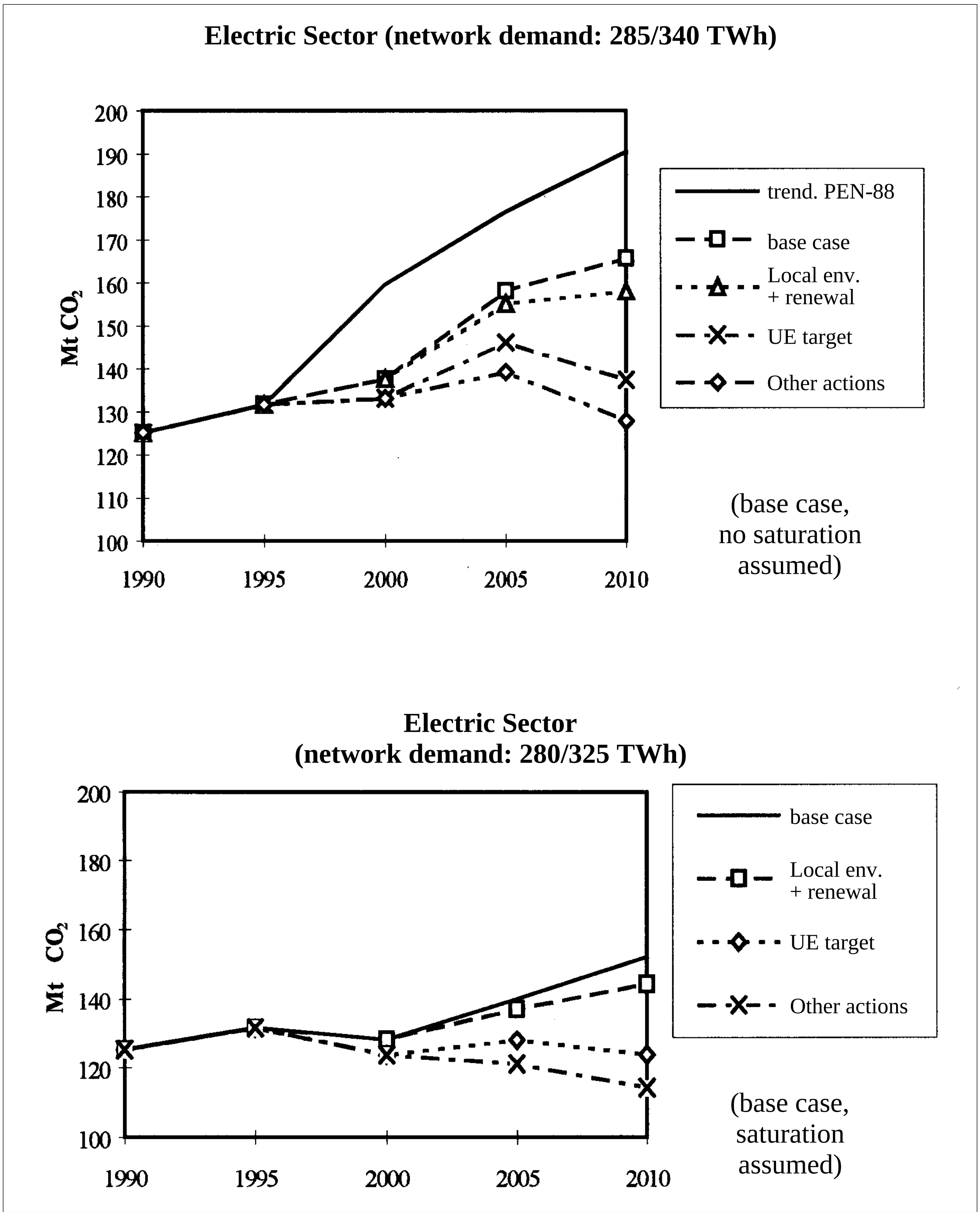
Free market and competitiveness in the methane and electric power sectors, extending the market to energy services
Legislation pro- agencies and firms providing energy and environmental services
Voluntary and program agreements for technological innovation and energy efficiency, capital stock turnover
Revision and reformulation of subsidising policies, incentives, taxes regarding interventions for mitigation
Integrated resource planning, minimum cost planning and integrated demand-offer management
EC and National standards for integrated environmental policies at local and macro-regional level

(a) Besides renewable sources for electricity production (such as additional hydroelectricity, wind power and additional geothermal) includes also bio-fuels (which in other tables are included in the transport sector) solar heating and biofuels (which in other tables are included in the residential and civil sector).
(b) Cogeneration by independent producers is included in the industry sector for the sake of consistency with criteria suggested by IPCC.
(c) The objective has been included here since it may be achieved only if energy suppliers are fully involved. The amounts are indicated in the tables related to each sector.

nal and local policies; promotion of the market as the most suitable instrument to ensure efficient allocation of resources; setting the standards which rule action of the operators in safeguarding the environment and consumers.

The need to reduce negative impacts on the environment is a new means to improve energy efficiency and stimulate technological innovation even when basic energy sources are available at low prices. Some of the leading environment-

Figure 5.2: Possible trends in national carbon dioxide emissions in the energy sector: production, processing and distribution



oriented countries have recently established laws and regulations to safeguard the environment through measures which call for a significant reconversion of energy technology (see national communications of other EU countries). In Italy, too, over the last decade there has been an increasing trend of trimming energy options to environmental goals.

The objective is to promote voluntary and program agreements with the major energy firms operating in Italy and their associations: a greater commitment in the several possible activities for mitigation of climate change will ensure the best solution to local, international and innovation problems. The government shall promote this policy at European level.

Finally, according to its power to guide and co-ordinate action of other bodies to achieve goals of general national interest, co-operation of the different bodies shall be promoted to implement mitigation options and to monitor reception of these objectives in the each body's independent action in its sector.

5.2.2 DEVELOPMENT OF RENEWABLE SOURCES

Current technology provides a set of options that use renewable energy sources, the only really sustainable, to produce electric power, heat, fuel and fuel oils[5]. The considerations mentioned below related to promotion of electric technologies are mostly applicable to other renewable sources that will be treated in the paragraphs regarding the institutional and agriculture and forest sectors. An important contribution to emission reduction may be provided by biomasses (6 Mt CO_2/year, see paragraph 5.6.4) and by solar heating (about 1.5 Mt CO_2/year, see paragraph 5.5.7) in the residential sector.

Exploitation of water resources for electric power production can only marginally be improved due to the lack of great falls (jumps) of interest for the big producers and the often high costs of smaller plants. Small producers are also discouraged by administrative difficulties in obtaining a licence and by the lack of those incentives which law n. 10 was supposed to provide.[6]

Technology for electric power production by windpower is already widespread as far as 500 kW installations are concerned with a total 6 GW world-wide and production costs around 100-200 Lire/kWh in fairly windy sites. Perspectives of increasing electric power production by windpower have rapidly improved in Italy following introduction of the free market for renewable sources by law n. 9 and the recent opening of the market for the supply of aerogenerators to all EU producers (DL n. 158 of 17.05.1995 receptive of EU regulations). A strong stimulus to the growth of production by windpower was the low-cost site detection service provided by ENEA and the financial contributions to set up the installations provided by local administrations. In 1996 the Italian network was below 60 MW but projects have been approved for installation of 740 MW by the year 2002 on sites where besides the production subsidies offered by the CIP 6 provision (170 Lit/kWh for 8 years) an additional contribution in capital of around 30-40% is offered by European structural funds.[7]

Solar heating is not far from being competitive. In 1995 there were 6.5 million square metres installed in Europe while the figure for Italy is still relatively low (0.2 million m^2). According to the National program on Solar Energy[8] by public intervention to stimulate the demand, by programmed and subsidised maintenance, by low instalment payments 3 million m^2 of sunlight collectors may be installed by 2010 replacing 0.5

5 More significant contributions and technological results would probably be achieved if the EU funded the renewable energy sector with the same 15 billion dollars with which since 1990 it has subsidised research in the crude oil and nuclear energy sectors.

6 According to the Association of hydroelectric energy producers a 2000 MW potential may be achieved by making the water concession process simpler (implementing law 9/91), by establishing a 10 MW threshold for "great derivations" and by reutilizing multiple use water power (see report at the Conference on Climate Change, Energy and Transport, November 1997).

7 In especially favourable conditions, windpower may significantly contribute to overall production. In Denmark windpower has reached a 6-7% peak of national electric power with a 1-2% contribution to overall production.

8 Agreed on in principle between the Ministry for the Environment and the Ministry for Industry in summer 1997 and awaiting validation, preparation of executive plans and funding.

Mtep/year of primary energy and reducing carbon dioxide emissions by 1.5 Mt/year at a net public cost of 1000 million liras.

Technologies regarding photovoltaic conversion of sunlight in electric power still require a lot of R&D to make them competitive compared to fossil conversion technologies. Moreover, they need a strong market promotion to reach levels of production which would initiate scale economies in production and create the conditions leading to greater research by firms and public bodies.[9]

Interventions on electric power production to be completed immediately after the year 2000 regard all those in convention with ENEL: 750 MW of new hydroelectric plants, the same for windpower, 7 MW of sunlight energy, about 1200 MW of biomasses/municipal solid waste and biogas and 330 MW of geothermal energy. In the tentative agreement Ministry of Industry - Ministry for the Environment[10] installation of other plants has been considered: 2500 MW of windpower and 1800 MW between biomasses and municipal solid waste, a further 800 MW of small hydroelectric plants and 300 MW of geothermal energy; with incentives these and other renewable energy plants may significantly contribute to emissions abatement by the year 2010.

The development of renewable energy sources plays a strategic role in mitigation of climate change and in sustainable economic growth. Although the overall economic potential of renewable energy sources with current technologies by 2010 shall be well below expected and far from the long term objectives, nonetheless international, national and EU actions shall be taken to promote the more economically valid technologies, research and development and market penetration.

To promote market penetration of renewable sources, yearly contracts shall be awarded to install significant quotas of renewable energy-fired electric power plants. Moreover, economic payback of the more convenient technologies shall be ensured. The possibility of establishing a different market for green energy (already being studied in other countries) is also being examined.

Further action includes:

- simplification of administrative procedures, by establishing priority and fast bureaucratic processes, to set up small size energy installations;
- improving certification of products for exploitation of national energy sources;
- providing special financial credit tools for development of more competitive renewable sources, incentives and contributions to set up infrastructures required prior to installation, production and regular use of renewable energy plants.

5.2.3 ELECTRIC POWER SECTOR

Mitigation options in the sector related to production, transmission and distribution of electric power are basically:[11]

- improvement in conversion efficiency of thermoelectric power stations and in part of the transport and distribution systems;
- production by non-fossil sources;
- production by fossil sources with low carbon content but same heating power such as natural gas.

Except for the first option the other mitigation interventions must be implemented jointly with those in many other sectors.

Considering the current Italian electric power sector, the government's commitments (CIP 6/92 already approved), plans and indications by ENEL and other national producers, construction and financial applications forwarded, reasonable esti-

9 According to the National Program for Solar Energy 10.000 photovoltaic roofs may be installed in 5 years with an overall power of 50 MW at the cost of 500,000 million liras, 70% made up of public funding; also this part of the program is awaiting validation, preparation of executive plans and funding.

10 The draft program for Promotion and Development of Renewable Sources was jointly formulated by Ministry of Industry and the Ministry for the Environment in summer 1997.

11 In his study on mitigation potential in the Electric power production and consumption sectors, Florentin Kraus (IPSEP, California) has made some very significant suggestions although some of the final figures regarding quantity and cost seem optimistic. See also Silvestrini's report at the Conference for Climate Change, Energy and Transport, Rome, November 1997.

mates of demand and proportion of fossil sources, an improvement in production efficiency and reduction of emissions are feasible with implementation of new plants and use of more efficient technologies.

The average net efficiency of fossil-fired plants has passed from 37.8% in 1990 to 38.6% in 1995 and is estimated to increase to 39.4% in 2000 and 40.5% in 2010. The 1995 figure is due to old plants being closed down and traditional power stations with a 38% efficiency entering service, increase in cogeneration and reduction in the use of coal.

Over the next years ENEL has planned new power stations with a 40-41% efficiency (4000 MWe, repowering and the Montalto plant going into operation), new combined cycle stations (about 4000 MWe and a 46% efficiency) and gasification of residues, about 700 MWe. It is likely that by 2010 another 700 MWe of gasification of residues and further combined cycles will be in use with a net efficiency over 50%.

As far as improvement in thermoelectric production is concerned the following technologies are likely to be implemented:

- high efficiency combined cycles, over 55% net, should be commercially available and even greater efficiency has been forecasted after the year 2000. These shall account for most of the new plants although they are not currently included in plans drawn up by energy producers;
- the use of gasification plants for solid fossil fuels, emulsions or heavy crude oil by-products associated with combined cycles is the most efficient technological solution in the use of environmentally sound primary sources other than natural gas and light petroleum by-products;
- the great potential of industrial cogeneration.[12]

Electricity import, which is in theory a mitigation option for Italy and the EU since it replaces national thermoelectric power with French nuclear energy, shall not be considered for general economic reasons. Import shall therefore remain stable at the current mean figure of 37 TWh/year until 2000 and then shall be steadily reduced to 25 TWh/year by 2010. Network losses have been updated to 1995 and are estimated to remain substantially the same in percentage on transmission in the period at issue.

If the use of solid fossil sources remains substantially at 1995 levels and there is a slight reduction in the use of crude oil (ENEL, Programmes and perspectives for the electricity sector, 1/97) and an increase in the use of natural gas, emissions per kWh used would fall from 154 grams of Carbon in 1990 to 146 in 1995 to about 135 (-12%) in 2000. In 2010 emissions would either fall to about 130 g C/kWh by increasing use of methane and independent production of electricity and heat or remain at 2000 levels.[13]

By setting up the Electric Power and Gas Authority steps have been taken to promote competition and efficiency in the energy services sector both in terms of convenience and income. This is achieved through a system of tariffs based on predefined criteria for recovery of costs faced to ensure quality, efficiency and adequate nation-wide distribution including Demand Side Management (DSM) investments which are to be made both for electric power and methane demand.

Taking into account the evolution in the electric power (and gas) sector - regulation of the market by an independent Authority, free production market, privatisation of ENEL, a more and more open European market for electric power -

12 19 TWh was produced by cogeneration in 1990 and a figure between 36 and 52 TWh has been forecasted by 2010. Estimates regarding its technical potential in a long-term scenario have been made: overall it provides high production efficiency (over 50% at present, over 60% in the short term) of 100-130 TWh/year of electric power considering the current consumption of fossil fuels in the industrial sector. This remarkable potential however requires substantial modifications in the current industrial processes, it does not seem feasible before 2005-2015 and must be within a consistent international context.

13 In calculations of average carbon emissions per kWh used emissions due to imported electric power are considered nil. Electricity is imported mainly form France (nuclear energy) and Switzerland (hydroelectric energy). In the hypothesis that contracts for supply expire in 2002, it is likely that Italy shall meet its overall demand for electric power totally through national production with the current power stations and primary fossil sources. In this case, in 1990 Italy should have used additional fossil sources uniformly distributed among those used which would have emitted overall 25 Mton of additional CO_2. With the thermoelectric stations forecasted for 2010 and specific emissions of 165 g C/kWh produced, a further 16 Mton of CO_2 must be added to the scenarios which include a 25 TWh/year import.

growth of the system shall be guided towards technological options, a system of tariffs and an administrative system which promote reduction of GHGs emissions. Moreover, studies, minimum cost analysis and integrated resource planning shall be carried out to provide long-term trends which may aid energy market operators in their independent choices.

5.2.4 OIL SECTOR

Although the 1970s energy crises have reduced internal consumption of oil by-products and Italy has given up its role as supplier for the Mediterranean area, the Italian refining industry is one of the biggest both at European and at world level. The amount of refined products is established on the basis of domestic demand (more fuel oil is consumed compared to European average) and product prices on the international market.

Changes in the refining sector are due to:

- evolution in environmental regulations which calls for products with low and very low sulphur contents;

- reduction in aromatic hydrocarbon contents in petrol;

- a fall in the barrel demand which requires continuous investments to restructure production capacity;

- increasing competition in market supply mainly due to Middle-East refineries;

Estimates for the refining sector are difficult to make since it is tightly linked to the transport sector and the current uncertainties regarding type (petrol/diesel) and environmental quality of fuels required in 2000/2010. The UP (Unione Petrolifera, Petroleum Union) has estimated (Energy demand estimates, Feb. 1997) that overall petrol and diesel consumption should rise slightly (+6%) from 1995 through 2000 followed by a fall in petrol consumption (-6%) by 2010 and a rise in diesel consumption.
Refinery emissions are estimated to increase due to the need to produce cleaner fuels (sulphur content must fall to 200 parts per million after 2000 and probably to 50 ppm by 2010) and at least partially change composition (aromatic hydrocarbon content must not exceed 35%) and simultaneously reduce the percentage of fuel oil. According to a first estimate by national producers this means emissions shall increase between 30 and 50% by 2010 (UP/Confindustria document, May 1997). Further technical research has suggested 15-30% as a more feasible figure. Complete implementation of available technological innovations (as in the industry sector) may reduce the increase although these innovations must be normally adopted when restructuring plants.

In the oil sector program agreements with the refining industries are being assessed to establish a long-range picture of activities and where possible stimulate renewal of plants and adoption of the best available technology.

Optimal use of resources, emission reduction and end user convenience shall be pursued through promotion at European level and implementation at national level of the program agreements which extend the Commission’s auto-oil program to other end uses of energy; through studies, analyses and joint negotiations between refineries and producers of fuel consuming devices.

5.2.5 THE NATURAL GAS SECTOR

Replacement of liquid and solid fossil fuels with methane represents an option for mitigation of CO_2 and overall greenhouse gas emissions.[14]

Considering the increase in the transport and distribution of gas and the increased network extension, a first assessment made on current data points to a rise in emissions from primary network and distribution. The older urban networks are being replaced or restructured to reduce those portions in cast iron responsible for leakages which should thus remain

14 The increase in methane leakage from the distribution network and end users is insignificant. Replacement of 1 Mtoe of oil products with the equivalent amount of methane (1.21 Gm^3) reduces emissions by about 0.73 Mt CO_2 but with the current network increases methane leakage by 6.42 kt CH_4 equivalent to 0.135 Mt CO_2. The distribution network accounts for 60% of methane leakage but losses will be reduced to 2.42 kt CH_4 when over the next years when plastic or steel pipes shall replace the current cast-iron. Considering methane boilers are slightly more efficient than diesel or fuel oil each Mtoe increase in the use of methane entails a net reduction in greenhouse gas emission of an equivalent 0.68 Mt CO_2 at 100 years.

approximately the same until 2000. All the cast iron tubes will then be replaced or modified and leakages will be reduced to under 0.18 Mt CH_4/year. These data are subject to revision since experimental research on leakages from the distribution network is in progress.

Natural gas shall play a more and more significant role in Italy's energy demand sector and the country shall have to increase its supply from the current 50 GM^3/year to 80 Gm^3/year over the next 15 years. This increase must be implemented in the period when many supply contracts expire and when competition on the international market is on the rise due to the strong demand in all developed countries for this more environmentally sound source. Additional problems stem from long distance transport especially from extracontinental suppliers where pipelines are inconvenient and from the free market which will privilege supply of liquid natural gas by minor importers.

The Authority that regulates energy services is responsible also for the methane sector and therefore all the regulations as well as the free market will be applied to this sector too. In an increasingly free market, industrial initiatives will be promoted to involve qualified operators and further develop the natural gas market in the supply phase: production, transport and storage.

In particular Italy intends to:

- promote synergy in European initiatives for the development and integration of transport networks and support a wider presence of Liquid Natural Gas in Italy besides concluding the ongoing initiatives;
- reassess storage capacity of natural gas in Italy and the ability to face increase in demand and eventual interruption of supply and make appropriate amendments.

As far as methane emissions from transport and distribution are concerned, cast iron pipes will be replaced and other action shall be assessed such as recovery of gas during maintenance operations and installation of better quality components.

5.2.6 EFFICIENT USE OF ENERGY

Since the Energy Offer sector depends on energy demand the energy industry must participate in development of the short-medium term national market, the most important for mitigation of climate change.

The importance of tackling energy demand to achieve convenience, supply security and reduce of environmental impact has been realised only during the last ten years. However whereas producers tend to minimise costs to increase profits, the end user are far from choosing low cost options. Market forces alone are unable to direct consumers and producers choices towards optimal balance and amount; consumers either do not have information relating price, quality and efficiency which is necessary to recognise the best technologies and products or cannot understand them.
The high transaction costs which the end user must face to use more energy efficient appliances strongly limit the market's role and call for action by the Public Administration aimed at improving efficient use of energy.

The main problem on the consumption side is the fragmentation of sectoral markets that coincide with all production and consumption sectors of the national economy. Information circulated through campaigns, product qualification, consumer advice, self-ascertainment of energy performance and other actions are essential in directing the market towards an efficient use of energy. However this alone cannot turnabout consumers' choices and must therefore be supported by economic and regulatory measures.[15]

Setting up minimum efficiency standards may decisively influence both the energy market directly or indirectly through its products. Efficiency standards limit market freedom and deny access to products whose price or amount is too far from standards. The latter must therefore be established well in advance and, above all, must involve producers.
This kind of action is useful only in the case of widely consumed products that substantially influence energy consumption.

15 Great potential is provided by the “Energy manager” in manufacturing industries with consumption over 10 ktoe/year and in any service enterprise with consumption over 1 ktoe/year; so far 2500 have been appointed (of an estimated 10.000) who cover 60% of consumption in the industrial and services sector (see FIRE report at the Conference on Climate Change, Energy and Transport, Rome, November 1997): if appointees start operating through certified initiatives to improve energy services eventually associated with the use of ESCO (see next paragraph) then remarkable improvements in energy efficiency may be achieved.

National commitment on programmes for efficient use of energy is summed up in Law 10 of 1991. If wider objectives are set, implementation is carried out at regional level, too, procedures are simplified and follow faster routes, if all implementation provisions are issued and above all if the law receives new funding then it may become one of the main tools in national policy for mitigation of climate change. Joint participation of energy firms to profit must be included through least cost planning and its implementation by means of Demand Side Management (DSM which provides profit for electricity companies although their market share is reduced) and the setting up of companies for the supply of energy services (ESCO, which allows firms to expand their market adding the supply of energy services to the sole energy sale and provides new entrepreneurs with the advantages of an expanding market).

Generation, transformation and distribution sectors will receive more and more responsibility in achieving significant mitigation results by promoting energy efficiency to end-users. All actions entailing a reduction in domestic demand by means of new energy efficient technologies and systems shall therefore be supported. Sectorial provisions shall be defined according to the following guidelines:

- circulation of information (information campaigns, product qualification, consultancy to end users, self-assessment of energy performance, specialist training in the energy sector);
- support to voluntary measures (agreements, integrated resources planning, DSM, ESCO, energy diagnoses, certification);
- regulatory measures (technical regulations, efficiency standards for processes and products, periodic control of efficiency, mandatory reporting, energy managers);
- financial tools (taxes and tariffs, subsidies, setting up, markets, incentives in the capital account);[16]
- direct investments (regulations regarding purchase and public tenders, territorial planning, R&D and demonstrations, investment in new technologies);

Detailed and exhaustive analyses of the results due to application of law 10/91 will be carried out to assess efficiency, energy saving, technological innovation, territorial diffusion and other significant parameters. According to these analyses the law shall be refunded and extended to include other objectives or it shall be replaced by a new one more suitable to the new energy and institutional situation).

16 The involvement of banks to reduce financial burden of sectoral investments in a no-risk scenario seems particularly interesting; see also ABI (Associazione Bancaria Italiana, Italian Banking Association) report at the Conference for Climate Change, Energy and Transport, Rome, November 1997.

5.3 INDUSTRY SECTOR

5.3.1 OBJECTIVES, OPTIONS AND SECTORIAL PROSPECTS

In 1990 the manufacturing industry accounted for approximately 180 Mt CO_2 (end use), 15 kt CH_4 and 35 kt N_20 direct (from combustion, processing) and indirect (electricity used) emissions.

As shown in the tables in chapter 4, overall the industry has significantly reduced energy and processing emissions in 1990-1995. Thus further reduction in the manufacturing sector is limited (fig. 5.3) although implementation of several measures has been planned (table 5.3).

Policies to reduce greenhouse gas emissions in the industrial sector are part of sectoral policies: measures to improve energy efficiency are part of the national energy policy since they improve supply security while measures which improve competitiveness and promote new processes and technologies are part of the industrial policy.

5.3.1.1 Mitigation options in the high-energy intensity sector

The steel, building materials, petrochemical, chemical, glass, ceramics and paper industries are all high energy intensity industrial sectors and have many technological options to reduce specific consumption of energy per unit of goods produced and therefore CO_2 emission.

Studies performed by the industrial associations[17] show that a good level of energy efficiency in production have been reached compared to other countries. A further increase in efficiency is possible but must be assessed case by case. Only in the glass sector an increase in process efficiency seems likely and action in this respect has already been partially planned.

The circulation of information regarding more energy efficient technological options is already quite good in the case of high-energy intensity industries since energy costs account for a significant percentage of operating costs. However, the failure to adopt new technologies on a larger scale is due to industrial policy and lack of capital.

Political measures which promote adoption of these technologies may be divided into three groups: processing technologies with payback in less than three years, those with payback over three years and within this second group a third group regarding technologies for efficient use of electricity.

Due to their economic and financial convenience technologies belonging to the first group should be adopted spontaneously when restructuring current plants.

Without a co-ordinated agreement at European, OECD and WTO levels an increase in energy duties is not possible due to the effect on production and on international competitiveness. It is therefore necessary to stipulate voluntary agreements with the Association categories. This would be an advantage in terms of competitiveness since the introduction of new technologies to cut down costs would avoid industries becoming rapidly outdated.

The second group of measures is financially less convenient and requires incentives and/or risk being taken by third parties (holdings and investment banks).

The sub-group of technologies aimed at a more efficient use of electricity (high efficiency light bulbs, high efficiency and/or variable speed engines) have a longer payback time but are virtually free of risk. Regulatory measures and third party funding will be required to promote a market for these more efficient components and also the market for their replacement.

According to the category associations further reduction of emissions through the use of methane is difficult to achieve due to the high levels of use reached in 1995. In the cement sector reduction of

17 Sectorial analysis on mitigation potential and measures was carried out by experts from the Ministry for Industry, General Direction for Energy Sources and Basic Industries, and by experts of the Industrial associations which are part of the Confindustria; a document regarding evolution of technologies and consumption in the years 1990-2010 prepared by the associations of each sector, co-ordinated by Confindustria and delivered to Ministry of Industry in May 1997 was also considered.

emissions may be achieved by replacing coal or oil coke with selected municipal solid waste.

Various sectors (paper and mainly chemicals) plan to increase cogeneration to reduce emissions. This solution is particularly advantageous in terms of electricity generation but cogeneration provides only limited improvements in industrial processing efficiency.

5.3.1.2 Mitigation options in low-medium energy intensity industrial sectors

In these sectors energy costs do not significantly influence production costs. Energy saving options are also quite unknown. Analysis of consumption however points out the importance of adopting technologies aimed at an efficient use of energy, above all electricity (high efficiency light bulbs, high efficiency and/or variable speed engines)

Energy diagnoses and circulation of information are required to promote energy saving policies. An agreement with the associations seems the best way to promote adoption of technologies with a payback of less than three years. For those technologies with longer payback times the only feasible means seem to be incentives and/or significant changes in energy prices.

Horizontal electrical technologies are especially important in this sector: their saving potential in terms of equivalent primary energy is comparable to that of process improvement, new efficient electrotechnologies (such as microwave and infrared ovens, thermocompression of vapour). They may replace fuel-driven industrial processes wherever primary energy reduction is demonstrated and wherever local environments, staff health and security are improved. Regulatory measures to improve product standards (engines, equipment, etc...) together with a rise in the price of energy and Demand Side Management to increase efficiency seem the best tools to promote adoption of these technologies.

5.3.1.3 Carbon dioxide emissions from industrial processes

In production of cement clinker, lime and glass, carbon dioxide is generated in unit amounts which depend on the chemical reaction which produces the material from the raw products.

In clinker production, emissions have fallen from 20 Mt in 1990 to around 16 Mt in 1995 and due to stability in production are expected to remain the same over the next years. In preparation of lime, emissions have increased from about 1.34 Mt in 1990 to 1.46 Mt in 1995 and are expected to increase by 2010 due to a rise in production.

The only way to reduce emissions from clinker and lime production is to limit production levels promoting the use of reformulated cements.[18]

Glass industry emissions may be significantly reduced by recycling. Considering that in 1990, substantial amounts of old material were being used and there is a limit in its use for producing high quality glass, measures to enhance recycling (described in paragraph 5.7.5) will reduce emissions by about 20-40%.

5.3.2 INTEGRATED ENVIRONMENTAL DIAGNOSES BY COMPANIES

Since the 1970s energy crises, Italian manufacturers have significantly improved energy efficiency investing in equipment and technologies capable of reducing energy costs. Energy audits were carried out to establish amounts and features of the energy used, costs, kind of end-use, consumption per unit of product. Statistics drawn up by ENEA from hundreds of energy audits carried out over the last 15 years show that firms implement almost 40% of energy conservation opportunities detected through energy audits.

National regulations call for the presence of an energy manager in the major industries. He is charged with drawing up the firm's energy budget according to economic parameters and end uses (law 10/91, art. 19). Reporting the firm's energy budget and other information to Ministry of Industry allows access to subsidies to improve energy efficiency although these subsidies have never been handed out due to the lack of funds. Greater advantages may be obtained by voluntary participation in the EC ecomanagement and environmental diagnosis system (so called Ecoaudit) which extends the principle of energy diagnosis to all resources, including environmental ones.

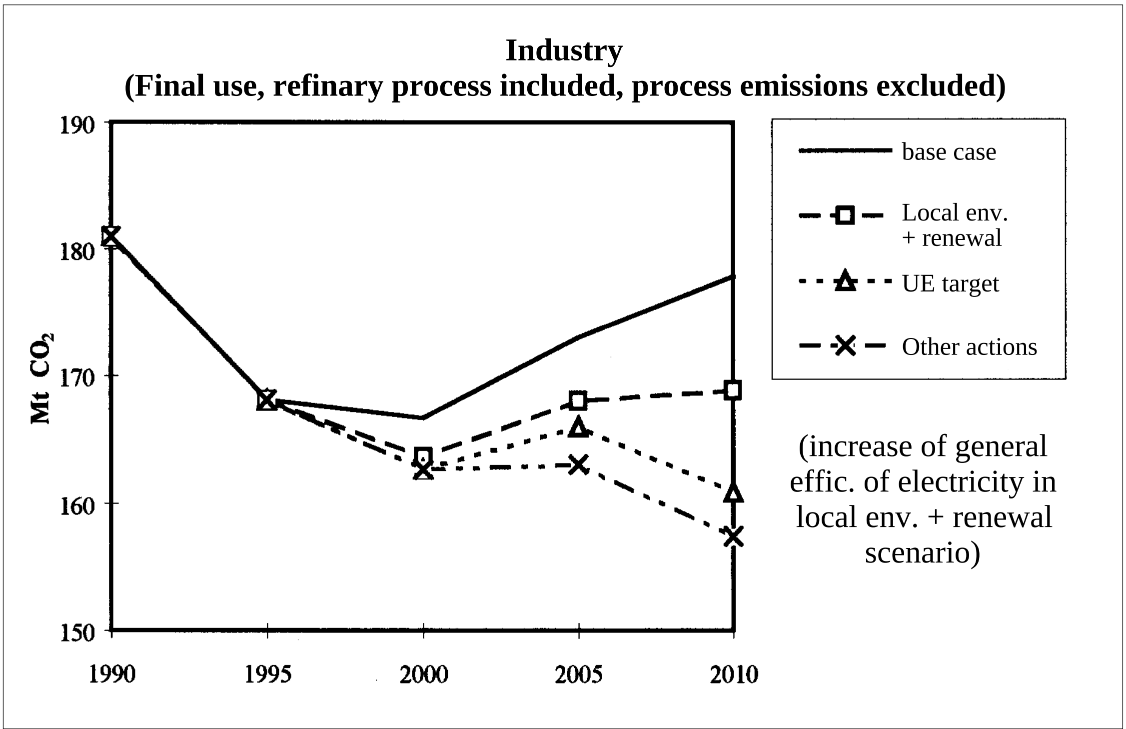
18 As far as lime is concerned the share of product used for plaster, less than 30% reabsorbs all emitted carbon dioxide by forming $CaCO_3$ during maturation. On the contrary maturation and hardening of cement involves water molecules.

Table 5.3: Objectives and measures for implementation of a national program in response to climate change: mitigation in the manufacturing sector

Emission reduction objectives for CO_2 by 2010 (in Mt CO_2/year) (a)	19-31
Reduction in the use of material whose production causes greenhouse gas emission (a)	0-1
Use of low carbon fuels and biomass	3-4
Improvement in energy efficiency of processes	6-15
Optimising the use of heat (cogeneration, optimal thermal cycles, etc.) (b)	6-6
Reduction of emissions from processing	4-5
Main intervention measures and tools	
Voluntary agreements, EC, national and local program agreements	
Environmental and energy diagnoses of production, feasibility studies	
Fiscal and regulatory benefits to firms to innovate products, processes and technology	
Process and product regulations and standards concerning the emissions from the entire life cycle	
Revision of pro-sector subsidies, incentives and taxes, low carbon intensity production and products	

(a) includes recycling of waste which in table 5.1 is included in provisions for the waste sector;
(b) interventions already included in table 5.2 on energy

Figure 5.3: Trend in carbon dioxide emissions from the manufacturing sector



Following the approval of European regulation n. 1836 on June 29, 1993, of Italian implementation regulations (law 70, January 25th, 1994) and the issue of implementation regulations through decree 413 of August 2 1995 by the Ministry for the Environment, the Government has set up the Ecoaudit system by appointing 12 members of the Ecolabel and Ecoaudit Committee. The Ecolabel and Ecoaudit Committee will start operating as soon as possible; the government also plans to extend Ecoaudit regulations to provide all major firms with a diagnosis of greenhouse gas emissions in order to detect mitigation options for emissions, carry out feasibility studies and physically intervene.

5.3.3 VOLUNTARY AND PROGRAMME AGREEMENTS

Agreements between the public administration and industries, and/or sectorial industrial associations are halfway between information campaigns and imposition of standards. They have met increasing success in reducing emissions from industrial production and processing. Agreements may concern the definition of specific environmental objectives such as application of current regulations, action to be taken or intermediate objectives that a firm must achieve to reach an already fixed final objective. Voluntary agreements are the best way to mediate environmental issues with the industries' need to maintain competitiveness by promoting common efforts to develop and adopt cleaner technologies. The agreements also seem the most suitable means to promote process technology with a payback of less than three years. They require limited institutional support but a trustful relationship between industry and public administration.[19]

An increase in voluntary agreements with an environmental feedback is therefore being pursued by improving relationships between central and local government and industries through a regular and transparent assessment of really feasible improvements. A link between public subsidising and participation in voluntary agreements is also being established.

5.3.4 DEMAND SIDE MANAGEMENT

Improvements in efficient use of energy can be widely applied and are economically very advantageous for the minor energy intensity sectors and in general for small and medium firms.

Implementation is however hindered by the lack of information and the difficulties in investing in more efficient equipment when economic advantages are spread out over time. Government incentives in the capital account have had little success because they entail complex procedures and refunds are either unsure or diluted over time. Experience has shown that firms become energy efficient when regulations are certain and information is clear and incentivating. Demand Side Management carried out through incentives in operating accounts resulted in a good success. In Italy the Authority for Energy Regulation has issued a law establishing DSM (Art. 2 comma 18c, according to which DSM costs may be included in establishing production performance and therefore tariffs).

DSM shall be introduced in agreement with the European plans. Since DSM is important in reducing consumption with no global cost and with great advantages for everybody, mechanisms will be studied to offer greater opportunities to electricity producers who employ DSM techniques.

5.3.5 REGULATIONS AND MINIMUM LEVELS OF ENERGY EFFICIENCY

Surveys conducted in the manufacturing sector show that the use of electrical equipment and machines in mechanical processing or in other stages of production are not always optimised in terms of energy efficiency because they are outdated, they lack maintenance or because of improper use. According to some cautionary estimates, it is possible to cut electrical consumption by 5-13% (6-15 TWh/year) by maximum exploitation of available technologies. These technologies have long-term paybacks but are virtually free of risk.

Together with other European Union Member States, minimum levels of efficiency will be established for electrical equipment, such as electric motors, widely used in manufacturing, when voluntary agreements with producers are not possible. Incentives to industries, mainly small and medium size, to replace electrical equipment with more efficient models are also being considered.

19 In Italy, voluntary agreements based on energy efficiency are still too few and too scarcely applied: of 75 agreements reported in an OECD study (OECD, 1995) only two referred to Italy and only four regarded energy efficiency: home gas, home electricity, motor vehicles and local energy planning. In 1997 voluntary agreements were stipulated with FIAT, Assovetro, AGIP Gela; agreements with ENEL and ANIE are under discussion.

In agreement with regulations and ongoing studies at European level the BAT (Best Available Technique) principle will be promoted in the energy, metal mineral products, chemicals and waste management sectors and then extended to include all the industrial sectors.

5.3.6 COGENERATION

Italy is one of the leading countries in the application of cogeneration and the Italian plant industry supplied even Northern European markets. After a fall in the early and mid eighties, industrial cogeneration rose again in 1988 with the implementation of remote heating projects. It received the main forward impulse only in 1991 due to partially setting free production and sale of electricity introduced by Law 91 and the strong incentives from the sale price in the following CIP provisions. In an increasingly free electricity market, and with appropriate external conditions: funding, methane (the main source), remunerative tariffs, technology should be able to develop further.

Cogeneration has a fundamental and increasingly important role in Italy's supply of electricity: it is highly efficient and less polluting.

5.3.7 GROWTH OF PRODUCTION SECTORS WITH LOW GREENHOUSE GAS EMISSION

Changes in the production structure have been one of the reasons behind reduction of greenhouse gas emissions. The added value of companies with low emissions has grown more compared to high emission firms. In the latter, sub-sectors and compartments with low emissions have developed more than others have.

Growth of low emission production activities will be promoted by controlling government incentives and providing advantages in setting up activities according to free market rules and needs of the national economy.

5.3.8 MEASURES AND POLICIES TO LIMIT HFC, PFC AND SF_6 EMISSIONS

Data provided by companies regarding consumption in 1994 and 1995 and forecasts for the year 2000 show that HFC play a significant role in replacing fluids ruled by the Montreal Protocol especially in production of isolating foams, in refrigeration and in aerosol production for pharmaceutical use.[20]

Most users of electrical equipment isolated with SF_6 already recover and reuse the gas according to the technical directives CEI-IEC 1634, CIGRE' WG23.10 TF01 and IEEE-EI-S32.

Experience gained through implementing the Montreal Protocol has shown that reduction of these emissions is possible provided interventions are timely and simultaneous.

Action by a single government is useless unless within a global action; the European Union has drawn up its own strategy to limit HFC, PFC and SF_6 emissions which includes common and co-ordinated efforts at European level and actions to be included in a protocol at the Framework Convention on Climate Change.

While waiting for new EC regulations, at national level, Law 179 of June 16 1997 forbids use of HFC and perfluorcarbons (PFC) in the fire extinguisher sector from December 31st 1998. The prohibition had already been applied to HCFCs. Besides this deadline, while waiting for new technologies the national industry has increased use of conventional fire extinguishing techniques (foams, powders, nebulised water) and those linked to halon technology.

In refrigeration, research is in progress on the security and health problems related to HFC alternatives. Hydrocarbon mixtures are increasingly employed in home refrigeration because of the low amounts required and special attentions (protection of light bulb in the refrigerator) have reduced risks of explosion almost to nil. Feasibility studies are being carried out on centralised ammonium plants which employ intermediate fluids for transport to end users; the main obstacle is the high viscosity which these fluids achieve at the temperatures of end use and therefore the greater pumping power required.

In the sector of isolating foam expanders, hydrocarbon technology has already established itself in Italy except in some types of processing where security

20 Knowledge concerning these greenhouse gases is still limited both regarding emission inventories and efficient and less polluting alternatives; the information contained in the present paragraph shall therefore be improved by results obtained in ongoing studies.

problems still need to be solved (panels with continuous metallic coating, spray applications).

Finally in order to limit use of HFC as a propellant in aerosols for medical use, the Ministry of Health, National Health Service, doctors' associations and those for Asthma patients should provide guidelines to inform and direct doctors and patients towards alternative therapies which do not employ gas propellants or employ propellants without HFC. These alternatives are currently on the market.

Emissions produced at end of the life cycle of products, plants and durable goods containing HFC, PFC and SF_6 are regulated by law 549 of December 28 1993 "Measures to safeguard stratospheric ozone and the Environment", law 179 of June 16 1997 which modifies the previous law and Law 22 of February 5 1997 which applies various EC directives concerning waste.

The above mentioned regulations also establish a deposit on durable goods containing harmful substances, oblige used plants and equipment to be handed in at authorised centres, and compel retailers of such goods to accept used equipment.
The Ministry for the Environment and all companies involved in the life cycle of harmful substances are discussing program agreements for collection, processing, recovery and recycling. These operations must be carried out according to specific regulations issued by the Ministry for the Environment and Ministry for Industry. Law 549/93 and law 179/93 apply only to substances which damage stratospheric ozone; another law is required to include HFC, PFC and SF_6.

To pursue the above mentioned commitments and those stemming from D.L. 22/97 on waste, the Ministry for the Environment has recently signed a protocol of intent with CISPEL-Federambiente (which groups all local institutional waste processing firms) aimed at setting up eco-environmental platforms for waste storage and processing to recover recyclable and harmful materials contained in used electrical appliances. The activity will take place in 12 regions and will employ 756 long-term unemployed persons who shall receive an unemployment benefit.
Three gathering centres are already operational. One established by a group of firms from the refrigeration sector, foodstuffs, logistics and private and public waste collection, and the other two managed by private firms.

5.4 TRANSPORT AND MOBILITY SECTOR

5.4.1 SECTORIAL PERSPECTIVES

The growing demand for mobility of people and goods is one of the features of modern society, which in Italy as in other countries means a dynamic increase in energy consumption, and therefore emissions in the transport sector. According to the more reliable sectoral analyses[21], the expected increase in mobility of passengers and goods shall cause energy consumption to rise from 35/39 Mtep/year in 1990/1995 to approximately 48 in 2010 (international air bunkering included). There is also a strict link with the strong increase in consumption in the refinery sector from 6/6.5 Mtep/year in 1990/1995 to 8 in 2010. Direct emissions from transport were 96/110 Mt CO_2 in 1990/1995 and are expected to rise to 130 in 2010 (excluding international air bunkering). Overall mobility of passengers shall increase from 710/810 billion passenger-km in 1990/1995 to 860 in 2000 and to approximately 970 in 2010; mobility of goods should rise from 247/265 billion tons-km to about 290 in 2000 and over 350 in 2010.

European and national provisions and policies more and more influence the sector. European policy is changing from drawing up provisions to overcome regulatory obstacles to formulating a framework programme of sustainable mobility. The programme aims to ensure greater mobility considering the environmental and cost limits linked to the growth of European economy[22]. The policy program for transport includes:

- pursuance and promotion of real competition among companies who operate in the various transport sectors;
- integration of national infrastructures in the trans-European network.

Studies and projections for the year 2010 provided by the Ministry for Transport[23] and related to the Italian situation in a European network perspective posits three scenarios:

- low GDP growth with a growth in the mobility demand between 1% and 2%;
- high GDP growth with a growth in the mobility demand between 2 and 4%;
- transfer of demand from road to rail and sea to reduce energy consumption and environmental consequences.

The scenario considered in this study (see beginning of paragraph) regards an estimated growth in freight with a 1% flexibility compared to GDP growth and provides two estimates for passenger traffic, respectively 1% flexibility and flexibility reduced to about 0.6% to account for recent falls in demand and its saturation due to congested networks. Besides of course an increase in the use of rail and sea transport.

Overall emissions from the transport sector in 2010 (see graph 5.4) are those most influenced by interventions, mitigation policies and measures (see table 5.4). The mentioned figures show the possible trends of sectoral emissions after implementation of measures in a demand scenario consistent with a national policy of modernisation by the year 2010, achievement of EU objectives and further possible interventions.[24]

21 Analysis of the transport and mobility sector was coordinated by the General Direction for Planning, Organization and Coordination which provided the basic data of the National Transport Account for 1994 concerning rail, road, air and sea passenger and freight mobility as well as forecast scenarios of consumption. Moreover it provided a picture of the planned National and EU transport networks (CNT, 1996).

22 See white book Dec. 1992 “Development of a common policy of transport”; Delors plan “Growth, Competition, Employment”, 1993; white book Kinnock com. 1996 “Strategy to revive European rail”.

23 Mobility scenarios drawn up recently by the Ministry for Transport’s VII General Direction for planning, organisation and co-ordination and particularly interesting in the choice of infrastructures (roads and motorways) for the director plan for transeuropean networks.

24 Interesting scenarios of emissions from the transport sector are contained in the study carried out by the Friends of the Earth on behalf of the Ministry for the Environment; the study also suggest measures capable of containing and reducing sectorial emissions by 2010.

These objectives are consistent with the aim to reduce greenhouse gas emissions since in the transport sector options concerning organisation have equal or greater potential compared to technological options. Intermodality is aimed at creating a balanced transport system i.e. integration of different means of transport and definition of their technical-economical, energy efficient, eco-compatible features; integrated mobility management balances intervention on supply with control policies regarding demand. Only a few pilot studies are currently available to assess the latter potential.

5.4.2 TECHNOLOGICAL OPTIONS FOR MITIGATION

To promote low consumption cars (about 12 million cars from 1998 to 2005 and about 8 million from 2006 to 2010) a protocol will be stipulated with the national manufacturer which anticipates eventual European agreements. Average consumption of new cars should thus fall from the current 7.4 lt/100 to 5.9 lt/100 in 2005 (145 g CO_2/km, with 35% of diesel cars). National car industries have a market share of 50% and therefore this agreement should produce a 8 Mt reduction in CO_2 emissions since other manufacturers should also be drawn to do the same. A European agreement would provide greater potential estimated at 12 Mt CO_2 in 2010 with a car population at 1995 levels.

The reduction potential of the measure is of course even greater, 20 Mt, and should be fully implemented by 2015. Production cost should increase by an average 0.3 million liras per vehicle.[25]

A framework of co-ordinated European policies would allow for voluntary agreements to produce and sell low consumption (120 g CO_2) petrol-driven cars with a 5-10% increase in costs compared to low-consumption cars. Emissions may be reduced by a further 8 Mt by 2010 and by over 20 Mt by 2020.

Combined methane-petrol cars allow a significant reduction in emissions (-19%). Methane-fuelled cars, more efficient than combined combustion cars and therefore with less emissions, have not yet been planned. The current number of methane cars accounts for 0.15 Mt CO_2 saving per year. An eventual growth of up to 1 million vehicles (50% of current GPL total) would further reduce emissions by 0.5 Mt.

GPL and in part diesel cars provide a limited reduction in CO_2 emissions. Maintaining current levels of GPL consumption, through tax benefits reduces emissions by about 0.4 Mt CO_2. The maximum foreseeable growth would further reduce emissions by 0.3-0.5 Mt CO_2. As far as diesel cars are concerned the option is already contained in the current agreement with producers of low-consumption cars: increase in market share from 15% to 35-40% by 2005. Further growth would be a risky forecast.

An estimated 0.1 million electric cars will be circulating in 2010, given the benefits due to absence of other emissions. This option is overall less energy efficient in terms of CO_2 emissions unless the average composition of electricity generated in Italy changes. A positive effect is obtained if recharge occurs at night but this option cannot be assessed due to lack of data.

Non-fossil fuels have no emissions; in the case of ethanol, besides the strong tax incentives, the overall production cycle is scarcely efficient. National production would therefore cancel any energy and emission advantages thus requiring import.

Biodiesel is instead energetically convenient; production in Italy is currently little and distributed extra-network. Strong tax incentives are necessary with an equivalent cost of 350 kLit/t CO_2. This option is actively pursued in France where it is planned to mix all fuels with up to 5% of biodiesel; the emission reduction potential is very high and a 1 Mt production of biodiesel (5% of current transport consumption) would allow a 3 Mt CO_2 saving.[26]

Methane buses are preferable for the very low emissions of other pollutants available by installing catalytic converters. With an estimated 50% 0.1 Mt CO_2 would reduce replacement of current vehicles emissions.

25 For these aspects and further improvements see the FIAT report at the Conference on Climate change, Energy and Transport, Rome, November 1997.

26 An additional 1 Mt of biodiesel may be produced if necessary. This may be implemented only if circumstances change: contrasts with the EC and among Politicians in charge of National foreign, agricultural and fiscal policies practically prevent production of the 0.1 Mt planned so far.

In the commercial vehicle sector (vans, lorries and buses) replacement of vehicles with new models has been planned. This provides a 15% potential to improve efficiency. No further options have been considered.

Finally, vans and small lorries running on methane would be welcome in urban areas since they may install catalytic converters with a very low emission of other pollutants. If 15% of current vehicles were replaced with combined petrol/methane combustion vehicles it would save 0.25 Mt CO_2.

5.4.3 STRUCTURAL OPTIONS AND ORGANISATION: INTERMODAL TRANSPORT

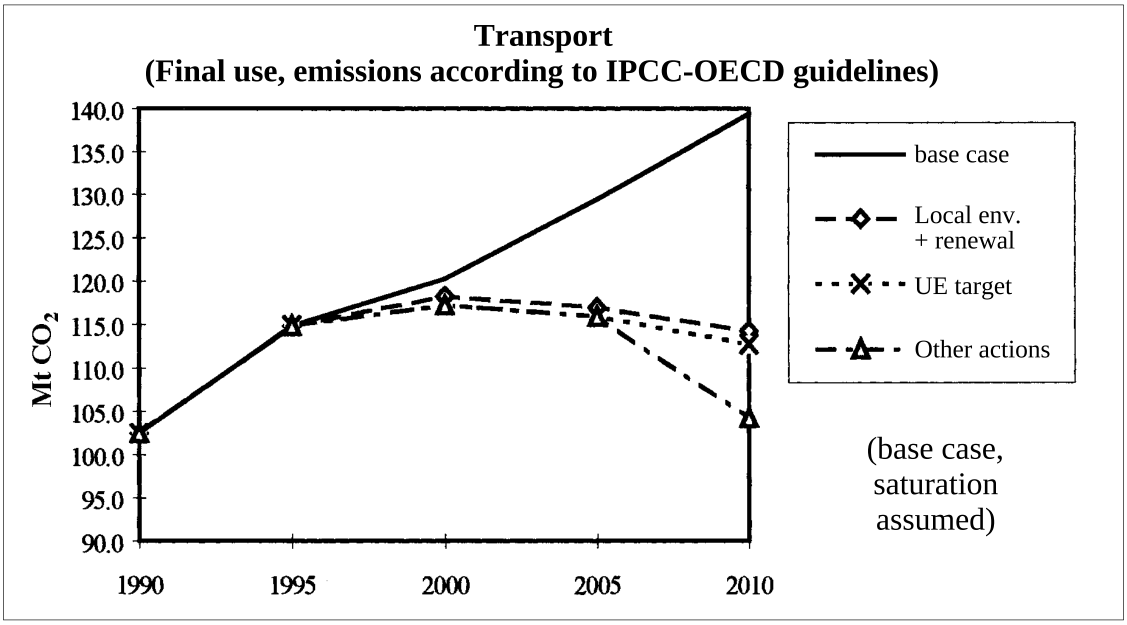
Consistent with the European concept of sustainable mobility and with special reference to balance in

Table 5.4: Objectives and measures for implementation of a National programme in response to climate change: interventions for mitigation in the transport and mobility sector

Objectives for reduction of CO_2 emissions by 2010 (in Mt CO_2/year) (a)	25-35
Use of low fossil-carbon fuels (a)	1-7
Improvement in efficiency of currently circulating motor vehicles	12-16
Increase in the demand for collective and intermode transport	10-10
Improvement in mobility management	2-2
Main measures and tools to implement interventions	
International voluntary agreements (mandatory) to improve minimum efficiency standards of new vehicle	
Controls, incentives to phasing out and maintenance of infrastructures to improve average efficiency of currently running cars	
Reformulation of road freight taxes to enhance low-emissions methods and technologies (including an increase in road tax according to the vehicles age)	
Implementation of traffic plans and integrated urban mobility (including tolls on local circulation)	
Investments in transport infrastructures, telecommunications to rationalise mobility demand and offer	

a) includes biofuels which in table 5.1 are included in the agricultural sector

Figure 5.4: Trend of Carbon Dioxide emissions from the transport and mobility sector



the means of transport the objectives for 2010 are:

- passengers, 15% by rail compared to current 6% and 78% by road (buses) compared to present 88%;

- increase in rail freight from 16% to 25% and reduction of road freight from 76% to 68%.

In 1990 the rail traffic share was 7.5% of passenger-km on rail and underground, in 1995 7.3% and following ongoing interventions in 2010 it is estimated at 8.5%. Rail transport of good accounted for 12.5% in 1990, 13.5% in 1995 and should increase to 15-19% by 2010.[27]

In order to achieve EC objectives: increase rail freight and passengers and develop all infrastructure by 2010, the Strategy set up by the General Transport Plan (PGT) may be summarised as:

- strong development of the rail network with priority on the Alps crossing routes;

- high speed rail service;

- combined freight;

- southern Italy rail network;

- completion of motorway network;

- implementation of motorway traffic management and control technologies;

- port and airport modal system.

5.4.3.1 Medium-long distance traffic

As far as passenger traffic is concerned the ongoing program to update some of the most important railway connections and make them faster will produce an increase of about 6 billion passenger-km (Gp*km) keeping the current market share. By 2010 a fourfold increase in the main railway connections for about 1300 km of extra railway (high-speed) will provide a further 13 Gp*km with a recovery in the market share (50% in the basic case). With additional restructuring, increase in trains and employment, a further 10 Gp*km may be moved thus increasing number of passengers on medium-long distances.

Overall, long-medium distance traffic should increase by 120% compared to 1990 levels. Strong investments are estimated, over 70,000 billion liras, of which 38,000 already funded. The main tool is the funding of the program contract between Ministry of Transport and the FS (FS, Ferrovie dello Stato, National Rail)

Emissions due to passenger road traffic may also be reduced through speed limits. An average 10 km/h reduction in maximum speed may reduce emissions from this sector by 5%.

Combined transport of goods is mandatory for various reasons: roads are too congested, environmental impact would be significantly reduced, life standards for lorry drivers would improve and there would be fewer accidents. It is well known that even with the current costs and tariffs, it is convenient to carry goods by rail at distances of 400-500 km and over.

Together with the plans initiated by FS program contract, completion of current plans for combined transport (DDL 3270, 1800 billion liras) should allow at least 10 Gt*km of goods to be moved from road to rail by 2005. This would mean a 40% increase on 1995 levels and a saving of 1-1.5 Mt CO_2

With appropriate computer and information technology support the mean filling coefficient may be increased by 10% while emissions from road freight should fall by about the same amount.

High speed railway will provide considerable room for traffic and if combined transport is adequately promoted it will be possible to move at least another 12 Gt*km from road to rail by 2010. If new infrastructures for transborder traffic were completed (Brennero pass and the pass to France) there may be still further increase in rail freight transported by rail (at least 12 Gt*km).

Even with these developments the percentage of goods carried by rail would be 20-25% and therefore the EC objective may be achieved only through strong intervention. This activity would be justified under every point of view (according to the new ISTAT estimates, the percentage would be even lower and farther away from the objectives).

27 Percentage of freight on distances over 50 km according to current statistical data; a new ISTAT survey, in press, reports an increase in overall road traffic with a significant fall in the rail share.

Port development plans may bring benefits in terms of increase in sea traffic in the Tyrrhenian and Adriatic seas. By 2010 an estimated 10 Gt*km will be moved from road to the Adriatic Sea with a 30% increase and a emissions saving of about 1 $MtCO_2$

5.4.3.2 Urban and short-distance traffic

Between 1975 and 1993 use of personal means of transport has greatly increased due also to the crisis in local public transport. Recently there have been bans on personal private transport in some hours due to traffic congestion and the high levels of urban pollution. By 2005 infrastructures and investments will be made to:

- achieve a 3-5 Gp*km increase on urban buses (45% increase on p*km transported in 1990), reduce emissions by 0.7 Mt, purchase new buses, have high operating costs, absorb traffic increase, use trams as a partial alternative;

- achieve a 6-10 Gp*km increase on interurban buses (a 30% increase for commuters compared to 1990 levels), reduce emissions by 0.8 Mt, purchase new buses, have high operating costs, absorb traffic increase and provide intermodal transport through use of car plus tram;

- implement urban traffic plans: 3-5% reduction in consumption and emissions, 0.6-1 Mt;

- achieve a 6 Gp*km increase of urban traffic on underground/tram and local rail by doubling and speeding up the current networks and building a few new lines; basic projections;

- achieve a total 20-26 Gp*km increase on traffic on underground/tram, local and regional rail by building 160 km of new network and updating another 350 km with 21,000 billion liras of investments (most already issued) in network and trains.

By 2010 infrastructures and investments will be made to

- achieve 16 Gp*km increase in in-town urban traffic; build 160 km of new tram/underground network, investments for about 10,000 billion liras

- achieve a 4 Gp*km increase on local and regional trains by restructuring a further 500 km of the network and investing 10,000 billion liras; intermodal transport with cars.

- additional measures such as car parks and tolls for access to some town areas would be convenient to promote public transport.

These measures and those described in the previous paragraph on medium-long distance rail will increase rail passenger transport from the projected 8.5% in 2010 to a figure between 11 and 14%. The EC objective of 15% does not seem achievable. To provide a better idea of the impact of these measures one must consider that there shall be a 40% increase (1990 to 2010) in passenger-km carried by in-town transport. The figure would increase to 150% in co-ordinated European policy scenario. Only in the latter case significant proportions of traffic would be shifted from road to other networks.

Moreover greenhouse gas emissions from road traffic in urban areas may by reduced by improving driving habits. Information campaigns are the best tool to promote awareness on the matter. A 5% reduction potential has been estimated.

Intervention aimed at cutting the demand for physical mobility by incentivating communications.

5.4.4 IMPLEMENTATION MEASURES

Management of mobility is a crucial modern issue where sometimes opposite objectives need to be balanced: containing energy consumption; minimising environmental impact; economic convenience of solutions in terms of diffusion, speed efficacy and security. In Italy there are some particularly difficult aspects: insufficient use of rail/tram/underground transport, scarce growth of coastal and inland waterway navigation; the predominance of road transport especially for goods; the legacy of urban policies based on building speculations responsible for the lack of infrastructures or services in the suburbs; historical town centres which do not allow implementation of those infrastructures required for intense traffic.

More than elsewhere, reduction of emissions in Italy requires national and European sectoral policies to modernise the sector and reduce pollution at national and local level. Measures and action in the sector provide financial benefits such as energy saving, direct and indirect economical benefits such as lower costs of services and reduction of environmental externalities.

Besides the measures described below, voluntary agreements and incentives are necessary and are described further on in this chapter. Voluntary agreements with the motor vehicle industry to produce very efficient or maximum efficiency vehicles have been described in the paragraph on mitigation measures in the industrial sector. EC measures, mainly concerning production and use of biofuels will be presented in the paragraph on mitigation measures in the agricultural sector.

5.4.4.1. Statistical surveys on mobility of goods and passengers

Considering there are missing pieces in the picture of mobility pointed out by the relevant organisms[28] and considering the importance of promoting intermodal transport to significantly reduce emissions the following surveys will be carried out:

- quantified in-depth study of current analyses on freight, in particular by considering the international component and all Italian and foreign vectors;
- survey on urban transport especially private passenger and freight to separately quantify overall mobility in large cities and smaller town where urban traffic plans exist.

5.4.4.2. Programme agreements

Collaboration is underway among the industrial, environmental and transport administrations to stimulate industries involved in production of motor vehicles to adapt to new demands of the European motor vehicle market and to ensure a rapid marketing in Italy of the more efficient models.[29]

The main tools will be programme agreements with industries to develop especially efficient vehicles and previous regulations for the use of eco-friendly vehicles as in other countries.

5.4.4.3 Adjustment of regulations regarding type-testing and control of vehicles

Regulations will be proposed regarding periodical control of vehicle efficiency and to provide the authorities involved with the necessary means.

5.4.4.4 Incentives to modernise the current fleet

With specific reference to road transport technology, only recently have interventions been carried out to renew the fleet of vehicles and exploit the increasing gap between old and new models as far as technical performance, environmental features and fall in performance are concerned.

Incentives will be provided for purchasing new cars. Owners of old cars will be penalised according to fuel consumption and emissions of pollutants.

5.4.4.5 Direct investments in infrastru c t u re for passenger transport and freight

Service infrastructures will be developed: interurban and urban rail networks, urban car-parks and roads, ports and berths for sea and river vessels, integrated logistic centres to manage intermodal transport.

Investment policies will be implemented to: develop collective transport of passengers and goods at urban and interurban level and integrate management of mobility with the aim of reducing overall energy consumption and emission of pollutants. The National Transport Plan will be redesigned to include rationalisation of energy consumption as one of its prime objectives.

5.4.4.6. Regulating urban traffic

More power will be given to local authorities to regulate urban traffic: tolls, payment for, directing transport modes by means of fiscal measures or solutions such as car sharing, collective taxis and mobility managers.

28 The Ministry of Transport General Direction for Organisation, Planning and Control.

29 The protocol agreement Ministry for the Environment-FIAT signed on 16.4.1997 follows this direction.

5.5 RESIDENTIAL, COMMERCIAL AND SERVICE SECTORS

5.5.1 SECTORIAL PROSPECTS

In 1990 the Civil and Agriculture sectors released 130 Mt CO_2. Part was due to use of fuel and part to the use of electricity[30]; most of the emissions were due to heating or air conditioning. Graph 5.5. shows the possible trend of emissions in 2010 following application of measures related to a co-ordinated European mitigation policy. Interventions and proposed mitigation measures are summarised in table 5.5.

Current consumption of electricity will increase up to 50% in line with the current trend; Italy will however have a slightly lower per capita consumption compared to the other main European countries. Increase in prices will only scarcely affect consumption while reduction or changes in the price structure would stimulate electric heating and greatly increase demand.[31]

As in the case of industry, most of the technological options, electrical appliances and high efficiency light bulbs are convenient for end-users while only the really best technological options have increasing costs to reduce CO_2 emissions. Consumers do not seem very interested at the moment and the regulatory option, voluntary agreements (with producers) seems the most effective in directing the market towards more advantageous solutions.

The following measures are therefore proposed:

- keeping the current price structure for energy supply contracts with strongly progressive costs, or fixing new prices to stimulate energy saving without penalising the poor parts of the population;

- keeping current price incentives at the 3 kW limit for the residential sector due to the measure's great potential regarding demand side management of family consumption;

- promotion of low consumption electrical appliances through voluntary agreements (at European level) with producers and importers of electrical appliances, labelling measures, information campaigns and progressive ousting from the market of less efficient models;

- support to low consumption light bulbs, and in general to all technologies reducing primary equivalent energy consumption. This action will be developed by all electric energy producing companies, also through strong information campaigns;

- revision of all norms on the use of surface and well waters as sources of heating for civilian use.

As far as fuel consumption for heating is concerned after a rise in 1995-2000 it may return to 1990 figures due to the spread of more efficient technologies and to some energy saving options although demand shall increase. There shall be a strong increase in the use of methane in line with the current trend and minor environmental externalities (atmospheric acidification). Oil fuels should maintain a market niche competing with biofuels, due to differences in costs compared to oil by-products, in those areas without methane.

If publicly subsidised, remote heating, so far limited by the high investment requirements, may increase and lead to a significant reduction (around 5-10% in 2010-2020) as well as a strong reduction (around 10-25%) in 2010-2020 of direct fossil sources.

The following measures are therefore proposed:

- keeping current tax on fossil fuels to stimulate saving;

- stimulate energy saving technologies by revitalising and updating law 10/91;

30 Methane emissions from waste and leakages during use of energy will be dealt with in the appropriate paragraphs.

31 Heating and hot water produced by heat pumps instead of conventional methods may reduce primary energy consumption and improve security and local environments. The use of air to air pumps for heating should rise significantly when users find out that with only 10% additional cost (to add a valve and the related controls) they may use summer air conditioners as heating appliances (currently only 30% of the air-conditioner market is made up of reversible models). Other condition which stimulate diffusion of heat pumps are the permission to use well water as source of heat (as in other countries), development of a network of authorised and qualified installers, standards, removal of the generalised 3 kW threshold in the residential sector.

- adjust insulating potential in new or restructured buildings;
- energy certification of buildings;
- progressive tariff/tax on the use of methane according to degree.day;

5.5.2 ENERGY DIAGNOSIS OF BUILDINGS, CERTIFICATION AND CONTROL

Energy consumption and greenhouse gas emissions in the civil sector is due mainly to heating and air conditioning of buildings. Following the 1973-74 oil crisis, provisions and laws have been made which all over the country strictly regulate maximum volume dispersion. Albeit increasing severity, the laws in force are less restrictive than in other European countries. New materials and convenient high quality industrial components allow further reduction of dispersion coefficients with no rise in production costs. It is more difficult to reduce energy consumption for heating and air conditioning in buildings where demand over the next twenty years shall be concentrated. Effects of current voluntary agreements or regulations aimed at reducing consumption in buildings are insignificant. The lack of funds has hindered reduction of thermal leakage in current buildings (art.8 law 10/91) while regulations concerning energy certification of buildings (art. 30) have not yet been practically implemented. The reduction potential for energy consumption in this category of buildings is particularly great (even 50% per unit) and may be achieved at relatively low costs and short-term payback especially if intervention occurs when periodic maintenance, restructuring and improvement is due.[32]

Certification of energy performance cannot be delayed any more. Information and incentives should be balanced by standards for components and systems. Although climate is good dispersion coefficients for new buildings will be lowered even more in order to reduce acoustic pollution, too. A revision of classification by climate zones will also take place and new criteria to quantify degree.days will be established to account for the increasing demand for air conditioning in the hotter areas in summer.

5.5.3. INFORMATION TO END-USERS AND ENERGY LABELLING OF ELECTRICAL APPLIANCES

Energy labelling of electrical appliances means informing the public on absolute and relative energy consumption. It has been implemented by the European Commission within the SAVE program and following the directive for reduction of carbon dioxide emissions.[33] The commission has established the main principles of labelling in the general policy directive (CEE75/92) and in a set of directives for application that set up operating details for each electrical appliance considered. The Italian industry, which has a leading position in Europe, has been very active in this field and has co-operated in drawing up the directives through its association ANIE. Besides reception of the general policy directive and issuing decrees for its implementation an information campaign on energy labelling will be promoted.

Information to consumers is part of voluntary agreements between the government and the EC and producers/importers to renew industries and market more efficient electrical appliances that will reduce bills and safeguard the environment. Apart from refrigerators where labelling has already been agreed on and old models will be taken off the market by Autumn 1999, the EC and the European Association of washing-machine producers are about to sign an agreement to reduce by average consumption of models sold by 20%.

5.5.4. MINIMUM LEVELS OF ENERGY EFFICIENCY

To improve energy efficiency for electrical appliances the EC has started sectoral studies on the performance of the main appliances. The studies point out the lack of correlation between price and efficiency i.e. even cheap models may be very efficient. On the other hand, production costs of electricity in Italy

32 Of great importance in this respect, the proposal contained in art. 31 of the law connected to the law for the 1998 financial budget. The proposal establishes a deduction from income tax (IRPEF) of 41% of expenses for restructuring buildings including renewable energy sources; by reducing black market restructuring there is increasing potential for thermal efficiency of buildings.

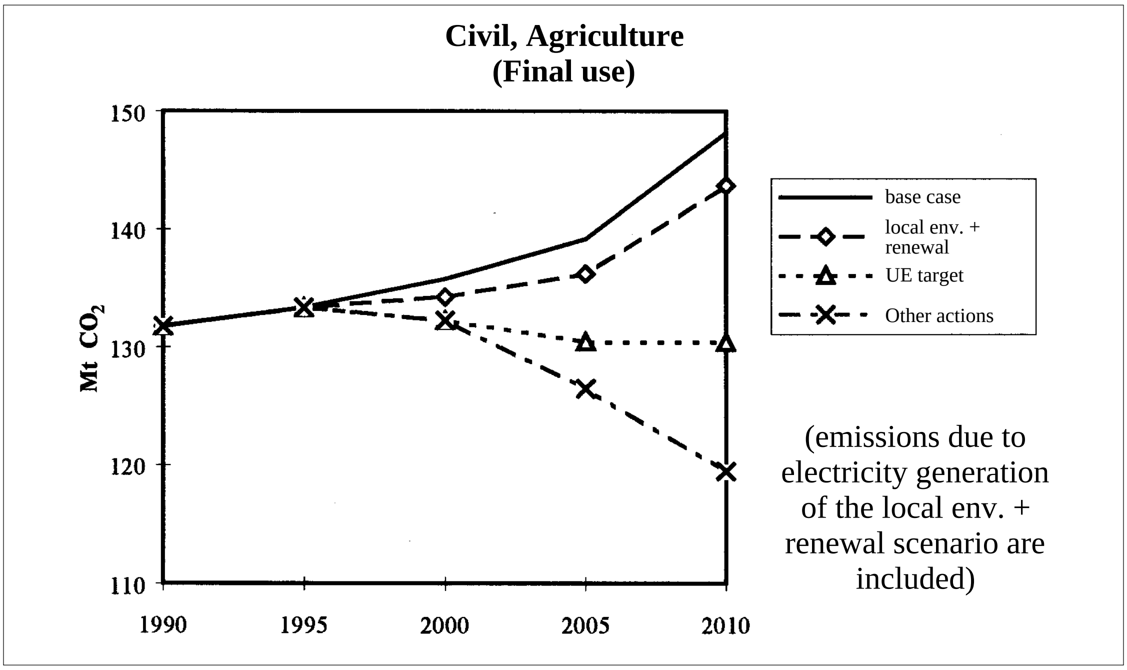
33 In defining the directive on labelling, Ministry of Industry and ENEA have actively collaborated with the EC and among other things have contributed to changing the formula regarding equivalent volume.

Table 5.5: Objectives and measures to implement a national programme in response to climate change: interventions for mitigation in the residential and services sectors

Objectives for reduction of CO_2 emissions by 2010 (in Mt CO_2/year)	5-29
Use of energy sources with low fossil carbon content (a)	2-5
Improvement in energy efficiency of electrical appliances	3-10
Reduction of thermal loss in buildings	0-11
Improvement in efficiency of heating and cooling systems	0-3
Main measures of intervention	
Policies to update public tenders, awards and programs for excellent purchase in Public Administrations	
Fiscal measures to stimulate restructuring of buildings, incentives for thermal isolation	
Local territorial programming (implementation of energy, recovery and safeguard plans)	
Environmental energy diagnosis of buildings and mandatory control of heating systems	
Programmes based on action by market forces (demand management, support to energy service firms)	
Information campaigns for end users, energy- labelling and ecolabelling of products	
Minimum energy efficiency standards of appliances through voluntary agreements with the industry (or through regulations)	

(a) includes 1 Mt emissions avoided by using solar energy; the figure is also included in the sum in table 5.2

Figure 5.5: Growth of carbon dioxide emissions from the residential and services sector



are so high than even expensive appliances are worthwhile if they are adequately efficient.

In 1996 the European Parliament approved directive 95/57/EC which provides minimum quality thresholds for refrigerators and freezers on the market from September 1999.[34] The best way to improve efficiency is through voluntary agreements between

34 Just over 70% of current models will be taken off the market at that date according to the 1994 reference data bank (with a percentage variation between 70 and 82% for the different categories except for horizontal freezers where percentage is 43%), fifty three percent of those produced in 1995 and 40% produced in 1996. The expected energy saving in EU is 20% on the basis of the 1994 reference data bank calculated according to the method set up by the Dutch TNO Institute.

the EU and manufacturers to establish the minimum energy efficiency thresholds for marketed products. This self-regulatory measure has produced good results: recently, in October 1997, the main European washing machine manufacturers have agreed to reduce average energy consumption on their models by 20%. In Europe and within the World Trade Organisation it is best to establish minimum levels of energy efficiency without hindering international trade. Close co-operation with ANIE is also necessary to improve methods to define minimum European levels of energy efficiency and then apply them to all electrical appliances; reinforce the presence of national manufacturers on the market by gradually ousting less efficient models and avoid penalising the cheaper ones.

5.5.5 ECOLOGICAL QUALITY LABEL ON PRODUCTS

The European Commission has established an ecological quality label (ecolabel) to be applied to the more eco-friendly products (Reg. 880/92). For energy consuming products one of the most important elements considered in awarding the label is energy efficiency through the whole life span; thus labels regarding energy efficiency and environmental quality partly coincide. The criteria leading to ecolabelling ensures that products have a significantly lower cost over their life span even when their purchase price is higher. The Italian government has also passed a regulation for ecolabelling (law 70/94 and decree n. 413 of 02.08.95 by the Ministry for the Environment) and has set up an Ecolabel and Ecoaudit Committee with ANPA in the role of technical support. Introduction of ecolabelling in Italy allows manufacturers to compete on European markets and provides information to end-users on energy and environmental costs of products thus stimulating reduction in consumption. Development of ecolabelling in Europe has to face two main problems. It is always difficult to establish criteria for ecolabelling of products from different categories and for all the sectors involved (environment, energy, industry, transport). Within the WTO, ecolabelling is strongly opposed even by countries such as the United States that consider it a hindrance to free trade.

Ecolabels enhance environmental safeguard, reduces energy consumption and improves quality and competitiveness of firms: it is necessary to promote its application at international level. At the same time a clear and resolute position on criteria is required and adequate importance must be given to the energy issue. At national level the Ecolabel and Ecoaudit Committee will be more active.

5.5.6. DEMAND SIDE MANAGEMENT

Improvement in the efficient use of energy in the residential sector is strongly limited by the lack of information and the difficulties met by families in investing in more efficient appliances whose economic advantages are spread over time. Government incentives in capital account have had little success because procedures are complex and reimbursements are not always sure or occur over time. Experience shows that end users "purchase" energy efficiency when regulations are certain and information is clear and stimulating although there is still indifference to eco- or energy labels. One of the most successful mechanisms is Demand Side Management carried out mainly through incentives in operating accounts. The great popularity of this approach has been demonstrated by ENEA's recent experience regarding efficient light-bulbs[35] and by the program for diffusion of solar energy modules implemented by ENEL in the late 1980s. Application of DSM in Italy, established by the Regulation Authority[36], is limited compared to other developed countries where per capita electricity consumption is greater and where networks provide unlimited power compared to the current 3 kW threshold in Italy.

It would be useful to introduce DSM, currently only a proposal, at European level. Since DSM reduces consumption at global costs nil and provides significant economic advantages to the public, EC mechanisms will be identified to offer the best advantages to energy suppliers who apply DSM techniques.

5.5.7 DIRECT USE OF SOLAR ENERGY

Water heating and building heating may be partly supplied by solar energy especially in one - or two - family buildings. By yearly installing 100.000 sqm of flat solar collectors for water in buildings where electric water heaters are used families could reduce

35 Success was ensured by a mechanism unforeseen when planning: instead of waiting months to get paid retailers offered a strong discount if clients paid immediately (ACEA had offered payment in six instalments together with the electricity bills).

36 Art.2 comma 18c states that DSM costs may be included in determination of productivity and therefore tariffs.

their energy consumption by 70 GWh/year; over 10 years annual emissions of CO_2 would be reduced by 0.5 Mt CO_2/yr. Further reduction may be achieved through the use of renewable sources in heating (heat pumps, biomass passive solar energy).

Achievement of this objective is linked to two kinds of measures[37]. On one hand the small solar energy market for residential use must be enlarged through information campaigns, introduction in public tenders and subsidised building, personnel training and project standards. On the other hand, offer of plants and systems must be incentivated by direct and indirect subsidies to producers and by implementing public utility programs.

5.6. AGRICULTURE, LIVESTOCK AND FORESTRY SECTOR

5.6.1 CARBON DIOXIDE EMISSIONS FROM ENERGY CONSUMPTION IN AGRICULTURE

5.6.1.1 Biological agriculture

Production systems related to organic agriculture provide a net reduction in direct and indirect energy consumption and in the release of carbon and N_2O compared to traditional agriculture. This is due to the reduced use of chemical fertilisers, to returning organic material to the soil, to the greater use of winter and perennial crops and to reduction in surface tillage. IPCC has estimated a 10-50% reduction of energy consumption compared to traditional agriculture.

Thanks to incentives provided through Regulation 2078/92 of the European Union the sector is rapidly growing in Italy although there are difficulties in applying Regulation 2092/91 regarding methods of organic production; as of June 1995, applications concerned an area of 16,700 ha. Overall agricultural areas biologically cultivated passed from 250,000 ha in December 1995 to 325,000 in December 1996; the concerns involved cover 0.2% of the total with an average 18 ha.

5.6.1.2 Emissions related to the use of fertilisers

In the early 1990s in Italy there was a rise in the use of chemical fertilisers in agriculture. 1994 showed a slightly reverse trend; overall use of nitrogen fertilisers totalled 66.6 kg/ha (referring to fertilisable area) compared to 59.9 kg/ha in 1990 and 74.7 kg/ha in 1993 (ISTAT 1996).

Unfortunately due to the widespread use of this source of pollution legal provisions based on the level of pollutants at the point of discharge cannot be applied. The only possible measures are therefore economic restraints to the use of fertilisers and promoting awareness among farmers for a more rational use of nitrogen fertilisers.

As far as the first option is concerned, the 1997 Document for Economic and Financial Planning (DPEF) harmonised VAT rates with those currently existing in the EU and raised the rate for fertilisers and plant protection products from 4 to 10%.

However this measure alone cannot affect much the use of fertilisers unless accompanied by a continuous information campaign for rational use. In this respect Italy has been one of the first European Union countries to have drawn up a "Code of Good Agricultural Practice to protect water from nitrates" which shall be adopted through the EU Directive 676/91. The code for good agricultural practice provides the means to achieve high efficacy in rationalising the use of fertilisers. It defines methods for the preparation of plans for nitrogen fertilising. Knowledge of specific crop demands, assessment of the nitrogen content of soil - which changes in time as a consequence of several (mainly climatic) factors - it is possible to define the amount of fertiliser to be used and when and how to use it. Optimisation of performance of the unit of nitrogen provided to crops is the most environmental correct way to use nitrogen fertilisers.

Integrating these instructions with others specifically aimed at safeguarding the atmosphere and climate (such as the use of products with controlled release) may slightly reduce fertiliser consumption by 5% in 2010 compared to 1990 levels.

37 See previous paragraph on renewable energy and related programmes.

Reduction in the use of nitrogen fertilisers reduces CO_2 emissions related to their very energy intensive production and reduces other emissions (especially N_2O) due to production of Nitric Acid, an intermediate product in the production of fertilisers.

5.6.2 METHANE EMISSIONS FROM LIVESTOCK

Evolution in the sector is influenced by two main factors. The first has do to with quantity restraints on livestock in the EC; the second regards evolution of the dairy cattle sector. Thanks to genetic improvement and large size breeding structures the sector should increase the yield per unit of cattle and thus make up for production losses due to the decrease in number.

5.6.2.1 Reduction of enteric emissions

As far as methane production from feed digestion by ruminant animals is concerned, studies are being carried out to assess reduction through the animal's diet and ensuring optimal bacterial conditions in the rumen. Mincing and pelleting forage, use of mixed forage and concentrate instead of gross forage, the use of additive for silos-stored feed, integration of straw with digestible cellulose or hemicellulose or other additives (energy sources) to optimise "cell wall degradation". All the above are factors which may all lead to a decrease in methane production although no experimental results in this respect are yet available.

While in developing countries great improvements in efficiency of ingested energy (and therefore reduced waste including methane emissions) may be achieved, the same may not be said of countries with a highly developed livestock sector, such as Italy, where cattle feeding has already reached high levels of efficiency. In the case of dairy cattle for example there has been a rising trend in productivity and thus the conversion factor of net ingested energy to methane is estimated to fall from 5.5% in 1990 to 5% in 2000 and 2010. This would mean achieving the best level proposed for example by the 1995 IPCC guidelines. Other interventions do not seem feasible at the moment since they require further study to assess their application at a business level.

As far as meat livestock and remount animals are concerned there is no sign of a change in the short-medium term in the conversion factor of ingested energy into methane compared to 1990. In the former case the high diet efficiency does not allow much for further reductions. In the latter case (remount animals) there are economic and physiological drawbacks.

5.6.2.2 Reduction of emissions from manure management

To further reduce CH_4 emissions from the livestock sector it is best to concentrate on technological innovations to abate emissions and recover energy from gases released by storage of wastes.

For cattle and pigs, intervention would involve covering storage tanks for liquid wastes and sending the biogas to combustion or cogeneration plants. This measure may provide up to 100% efficiency in abatement but in the Italian situation it is difficult to apply due to problems in building appropriate lids for wide and low storage lagoons. This technology may be applied to the larger sized plants provided incentives are handed out as stated in the CIP deliberation 6/92. Moreover, it is important to continuously promote awareness on the issue of emissions by enhancing adoption of the codes of good agricultural practice.

Avicultural sites - usually big enough for this kind of technology - are already being restructured with air circulating systems which pre-dry excrements before transport to an aerobic composting plant (some projects, in Emilia Romagna for example, have been funded by the Ministry for the Environment's three-year Plan for environmental protection). Other sites are instead provided with a combustion plant for energy recovery (in the latter cases incentives of CIP 6/92 have been applied for).

5.6.3 CARBON DIOXIDE SEQUESTRATION THROUGH LAND USE CHANGE AND FORESTS

5.6.3.1 Policies, plans and sectorial measures

This paragraph deals with the main intervention options to reduce carbon dioxide emissions and increase sinks in the agriculture and forestry sector and through land use change.

In most of the developed countries, the agricultural sector has long been subsidised. On one hand this has meant an increase in production due mainly to intensive farming and breeding. On the other it has produced an increasing environmental decline (land erosion and nitrate pollution), made even worse by a substantial abandonment of land.

These policies are currently being revised on the basis of the agreement reached in December 1993 during the Uruguay Round of GATT which in short calls for a reduction of agriculture support policies when they may distort international trade.

In the EU increase in surpluses and therefore in Community expenses to support prices during the 1980s led to the need to reform Common Agricultural Policy. The CAP reform, known as the McSharry reform, features the following main aspects:

- reduction of "institutional prices" for some surplus products, made up for by direct aid linked to the area of the concern but disjointed from produced amounts;
- measures to contain the offer of surplus products and to support small and medium size concerns;
- measures to improve quality production;
- supplementary measures for environmental protection and forestation;
- supplementary measures for pre-retirement.

The main intervention options in this sector, only partially linked to reduction of current subsidies, are set-aside and forestry policies, quantity restraints on livestock production, abatement of emissions from the livestock sector, restraints to the use of fertilisers, development and use of biofuels. Promotion of organic agriculture may contribute to reduction of emissions in the atmosphere and increase sinks.

5.6.3.2 Forestry policies

Forest areas in Italy are slowly expanding due mainly to reconversion of arable land in woods. This is a common trend in all developed countries due to four main reasons:

- the reduced increase in the demand for agricultural products compared to the rise in income;
- stability of the population and therefore stability in food consumption;
- increase in productivity of farm lands;
- a rise in the demand for public services offered by woods and forests (spare time and recreational activities, improving the countryside, environmental protection).

The increase in forest areas recorded by the National Institute for Statistics stems from three main issues:

- reforestation which after some years has really contributed to the growth of new forests;
- natural revegetation of abandoned land;
- modifications in the system for classification of forest areas or surveying and in general in the organisation of sectoral statistics.

The Piano Forestale Nazionale (National Forestry Plan) is the most important set of guidelines for forestry policy in Italy and was approved by a CIP deliberation on 2.12.1987; some of the interventions such as maintenance and development of degraded woody areas and reforestation with broadleaf trees may enhance CO_2 sequestration. Unfortunately funding was issued only for the 1988-1992 period and the funds were inadequately used due to technical shortcomings and poor management, priority on employment issues and poor involvement of private owners.

5.6.3.3 The effects of the Community Agricultural Policy

The recent reform of the Community Agriculture Policy is especially relevant as far as use of farmland is concerned and thus carbon sequestration. The reform's objective is to significantly modify criteria for distribution of funds to the agricultural sector in order to:

- reduce surplus but ensure the same income levels for farmers;

- increase production of those goods whose amount in Europe is very low (such as wood);

- safeguard the environment.

Concerning land use and carbon sequestration by biomass and organic substances in soil there are two important measures linked to the CAP reform:

- Reg. 2080/92, which replaces the previous set-aside measures in forestry (Reg. 1760/87 and later modifications up to Reg. 232/91), has established EC aid to enhance reforestation and improvement of forest areas;
- Reg. 2078/92, which provides additional funding

and extends intervention mentioned in the previous Reg. 2328/91 through a set of incentives to farmers who employ eco-compatible methods of production and take care of natural areas;

- Reg. 2080/92 is the only specific financial provision for the forestry sector and it meets the need to reorganise the EU market by replacing surplus products with woody crops and by improving current forest resources.

The potential for intervention is very flexible: the regions have drawn up multi-year plans and have thus established amount, time-frame and funding conditions for EC aid. Practically, they have preferred the establishment of new farm woodlands to the amelioration on improvement of existing forests.

The EU provides substantial funding for afforestation. This has enhanced afforestation of marginal areas such as pastures and meadows but also of fertile plains, which are particularly eco-sensitive. In both areas intervention has privileged wood growing by planting slow-growing broadleaf trees (walnut, cherry, maple etc) or, mainly on plains, fast growing trees such as poplars.

Placing priority on establishment of new farm woodlands and especially on wood growing greatly increases capacity for carbon sequestration compared to reforestation implemented with traditional techniques and species.

Reg. 2078/92 plans to limit risks of pollution from the agriculture sector, to adapt production sectors to market needs, to reduce production intensity and to stimulate care for land subject to abandon, erosion, flooding or fire. Incentives vary according to the areas, divided in ordinary and preferential, and to the type of crop. They are reduction in the use of chemicals; support to organic agriculture, increasing the range of agricultural products, reduction of breeding density; employment of eco-compatible methods and care for natural areas; breeding threatened species; care for abandoned farm lands and forests; managing lands for entertainment and spare time activities.

The regulation has had a general positive effect and has increased fixation capacity of soil used by the primary sector although estimates are quite difficult to make. The number of measures and different application according to the region make it difficult to assess how much the funds affect the capacity for carbon sequestration.

5.6.4 BIOFUELS

The main study areas regarding biomass energy are:

- bioelectricity from residual biomass and cultivated biomass;

- biofuels (biodiesel from oil-seed plants and bioethanol/ETBE from starch or sugar plants).

In Italy electric power from biomass waste and cultivated biomass may reach 5000-9000 MWe with 25-50 TWh/year of energy produced[38]. However development of technologies based on biomass exploitation is hindered by several factors: high investment costs, uncertainties in EU Agriculture Policy, lack of organisation and social consensus due mainly to lack of information. Mechanisms contained in CIP deliberation 6/92 have been quite successful here as in other sectors: by June 1995 the Ministry for Industry had received applications for production of overall 483 MWe of energy from agricultural biomass.

The most developed area of study regards biodiesel, which IEA has recently identified as the liquid fuel allowing the greatest reduction in CO_2 emissions per litre of fuel replaced. In Italy there are incentives to produce biofuels such as total relief of excise duty within an annual production of 120.000 t. However only 0.076 Mt of biofuel was produced in 1994 (of which 95% was used for residential heating compared to a national diesel demand of 22.35 million tons).

ETBE is an ether used as a knock suppresser additive in petrol and substitutes cancerogenous substances such as benzene. Ten to fifteen percent of ETBE is allowed as an additive: with a total 16 million ton consumption of petrol (1994 data), the market limit for this product varies between 1.6 and 2.5 Mt/year. About 150-200,000 ha of sugar plantations are required to produce such amounts. At the moment only Ecofuel in Ravenna produces ETBE and in 1994 produced 90,000 tons. The Ravenna plant operates in dual fuel and can produce also MTBE from methanol according to market prices for raw materials.

According to estimates based on local sample sur-

38 ENEA estimates.

veys, there is greater use of wood than reported in official energy statistics. Consumption however, has already reached the limit of sustainability and no further significant development may be forecasted. Increase in energy uses seems possible only for biomass that cannot be economically employed for processing or through afforestation and exploitation of waste from maintenance of forest areas. There is instead great technical economical and energy-environmental potential in cultivation of specific lignocellulose plants. The new generation of electricity plants has costs close to competitiveness if they include cogeneration while abatement of greenhouse gas emissions is quite positive (15-20 toe of renewable sources produced for each tep of fossil source used in the production cycle). The optimal small size of plants (20-50 MWe) makes it easy to find appropriate sites. Lignocellulose crops also provide benefits as far as hydrogeological structure and land recovery are concerned as well as having a positive effect on the microclimate.

The use of sugary/starchy crops to produce ethanol is limited by the petrol's capacity to absorb ethanol as ETBE. There are significant drawbacks to mixing ethanol with conventional fuels that rule out production. The trend is towards a limited coproduction of ethanol rather than specific plants and crops that have quite a low energy budget. Only in the use of waste to produce electricity there is just over 1 toe of renewable energy per each toe of fossil source employed. The option of oil-seed crops has recently appeared in Europe and in Italy. They may be used for the production of biodiesel (by synthesis from fatty acids and methanol) which may be used as a surrogate for heating and motor diesel. This sector has a better energy budget (2 toe of renewable source per each toe of fossil source) but costs are still too high and the product is not competitive unless aided by costly incentives and tax relief.

To overcome these difficulties the following provisions are being examined:

- a more effective distribution of production quotas for biodiesel at least to meet production capacity (1 Mt/year);
- regulations for mandatory use of biodiesel instead of motor diesel in some circumstances such as internal navigation;
- mandatory replacement of a fixed proportion of diesel for heating or motor vehicles (for example urban buses) in towns or local council transport concerns where problems regarding distribution to private end-users can be overcome;
- simplification of administrative procedures to collect and process forestry or agroindustrial wastes.

Moreover, there is an ongoing study whose objective is production of at least 8 Mtoe/year with a possible 250,000 ha investment and 12,500 new jobs in agriculture besides jobs in induced activities.

In EU common agricultural policies, modifications of current agricultural subsidies will be proposed in order to make biodiesel and other biofuels competitive.

5.7 WASTE PROCESSING

5.7.1 POLITICS, PROGRAMS AND SECTORIAL MEASURES

Among the planned national interventions for waste processing the most important for reduction of greenhouse gas emissions are:

- limiting the production of waste, especially of the biodegradable portion;
- reduction of landfill waste;
- capture and use of biogas from landfills;
- recovery and recycling of waste materials.

The main law concerning waste processing is the legislative decree n. 22 of 5th February 1997. Free market of waste materials will be promoted in order to enhance their economic value as secondary raw materials but at the same time safeguarding health.

5.7.2 LIMITING THE PRODUCTION OF WASTE, ESPECIALLY OF THE BIODEGRADABLE PORTION

The EU objective stated in the 5th EU Environmental Action program to safeguard the Environment is to stabilise annual production of waste at around 300 kg per capita. In Italy this objective is pursued through intervention in industrial production, on consumption and in the sector concerning urban hygiene services.

National programs concerning industrial waste consist in introducing cleaner technologies in each stage of production. The legislative decree promotes negotiation between the public administration and the economic operators involved in order to discover and implement means to reduce quantity and danger of waste materials, and draw up sectoral plans to reduce, recover and optimise the waste stream.

A significant contribution will be provided also by the simplified procedures for waste recovery contained in D.L. 22/97.

The waste tax on municipal solid waste disposed into landfills will be gradually transformed into a tax on the production of waste and fully implemented in 1999. It will be made up of a quota related to actual cost of the service and a quota related to amount of waste produced by each user.

The main interventions will be carried out on packaging material, which in 1990 accounted for 37% of total urban solid waste. The legislative decree has the following recovery and recycling objectives to be achieved within 5 years by the national consortium of producers and users:

- from 50 to 65% recovery of packing materials as material or energy source;
- from 50 to 65% recycling of packing materials;
- at least 15% recycling for each packaging material.

5.7.3 REDUCTION OF LANDFILL WASTE

Italy still depends strongly on landfills compared to most developed countries; currently 81% of waste ends up directly in landfills. The percentage is however decreasing due to the establishment of new installations thanks to funds issued by the First and Second Three-year Programme for Environmental Protection respectively 1989-91 and 1994-96.

With the 1996 financial law, a tax on landfill waste was introduced with different rates according to type of waste; the tax is collected by the regional governments and may be used to fund programs for environmental recovery and especially those related to waste.

The new legislative decree has established objectives for differentiated recycling (15% of total waste within two years, 25% within four and 35% within six); paper, moist urban solid waste and dry urban solid waste are collected separately as stated in DM 29.05.1991. The moist portion may thus be processed in composting plants.

The DM also states that from January 1st 2000 only moist waste, materials responding to specific technical provisions and materials obtained by recycling, recovery and processing may be discharged in landfills.

As far as industrial waste processing is concerned, the decree tends to facilitate the building of plants by simplifying procedures for authorization and building. Law 10/91 implementing the National Energy plan is especially important in enhancing the value of waste. The law encourages energy recovery from waste and provides funding aimed at rational use of energy, reducing energy consumption in production and use of manufactured goods, reduction of specific consumption in production processes and the use of renewable sources. By June 1995, on the basis of the CIP deliberation 6/92, the Ministry of Industry had received applications to build electricity generation plants from waste for overall 744 MWe.

5.7.4 CAPTURE AND USE OF BIOGAS FROM LANDFILLS TO PRODUCE ENERGY

According to national regulations on solid urban waste (starting from D.P.R. 915/82), all landfills must be equipped with systems to capture and burn the biogas produced therein. The percentage of captured gas, is increasing thanks to the new plants built with funds from the agreements signed between the Ministry for the Environment and the regional governments and from the Three-year Plan for Environmental Protection 1989-1991.

Use of biogas energy may speed up the building of systems to capture landill gases; the current availability of funds through the CIP deliberation 6/92 will allow the building of biogas-fired plants for an overall 100 MWe. This would mean a 300,000-ton cut in annual methane emissions. Further incentives would allow up to 80% capture of methane. Intervention would consist in making impermeable the surface layer and improvement of capture systems in old and new landfills.

5.7.5 PROMOTING RECOVERY AND RECYCLING OF WASTE MATERIALS

A significant contribution to sustainable growth may be obtained by reusing materials disposed of at the end of their normal production or consumption cycles. Besides reducing use of primary raw materials and depletion of resources, recovery of materials with direct or indirect high-energy contents (plastics, paper, glass, aluminium, iron etc.) may significantly reduce energy demand in the specific industrial sectors and general pollution. Selected waste collection of materials with high-energy contents is currently carried out only in some urban areas of Italy. Only 10-20% of primary consumption materials is recovered (up to 50% for glass); thus recycled materials only slightly affect the market of primary raw materials. Selling industrial waste to third parties increases the percentage of recycled materials, around 50% excluding dangerous materials or sludge. Recycling is hindered by administrative, only partially by regulatory and economic reasons while no technological problems exist.

Considering the importance in improving overall energy efficiency and in reducing energy intensity of the economy, all activities that encourage recovery and recycling of waste will be promoted by simplifying administrative procedures as stated in the legislative decree 22/97. In the short term, information shall be collected, diagnoses will be carried out, information campaigns will be promoted, managers and technicians will be trained and energy planning at local and regional level will be implemented together with central and local governments. Controls regarding application of current regulations will be extended to include waste recycling. Discussion with local administration will regard the most efficient methods to rapidly disseminate selected collection of waste in all urban and rural areas. The same process will be repeated for the main categories of products (paper, glass, plastics, cans and other metallic containers, organic and other kinds of waste) according also to the kind of processing chosen. Waste tax will be applied according to the end destination (recycling, energy recovery, incineration, landfills) to encourage operators as consistent as possible with issues regarding rational use of energy and environmental protection. Incentive policies regarding electricity generation from waste are being revised and all alternatives are being considered such as solid urban waste combustion and refuse derived fuel.

Eight percent of solid urban waste currently produced in Italy (about 20 Mt/year) is used for energy purposes by either by incineration or by recovery of landfill gas. The electricity generating capacity of the 20 incineration plants is about 50 MWe with a 350 GWh/year production. The planned increase in the proportion of incinerated waste up to 30% would allow an overall increase in electric power of about 500 MWe. This seems feasible since technologies to achieve the objective are already commercially available and financial-economic performance has been widely demonstrated. Opposition by environmental associations seems to have fallen since it is increasingly difficult to find new landfills and alternatives strongly contribute to local pollution. To speed up the process, the legislative decree 22/97 (art. 22, sub-section 11), states that by special programme agreements with the Ministry for the Environment and the Ministry for Industry and together with regional administrations it is possible to build waste recovery plants within currently existing industrial sites even in those cases where this will contrast existing regional plans.

5.8. INTERSECTORIAL STRATEGIES

Measures and commitments in each sector are mostly efficient if co-ordinated and supported by actions, which involve more than one economic sector. This paragraph suggests measures for those sectors that have not been directly discussed in previous paragraphs.

5.8.1 CO-OPERATION WITH LOCAL AUTHORITIES

Action by local authorities has a great impact on climate change since in OECD between 60 and 80% of energy is used in cities. Intervention potential is particularly great in the following areas:

- integration of policies: energy may be the starting and collection point to improve management in key areas such as pollution, industrial growth, urban and transport planning;

- demand management: at urban level it is possible to draw up and implement wide ranging plans for demand management which may act as an alternative to traditional policies based on management of the energy offer;

- renewable energy: some cities have already set up pilot markets for technologies related to renewable sources and have thus reduced economic drawbacks to their diffusion;

- combined production and urban heating: combined production of electricity and heat is one of the most effective means of using primary energy of fossil fuels; the use of heat for urban remote heating systems produces great environmental advantages by eliminating emissions from traditional heating systems;

- transport: the most rapid increase in energy consumption and in emissions occurs in the transport sector; congestion and pollution in most urban areas may encourage radical change in management of mobility;

- education and training: information is a fundamental tool in providing the end user with knowledge of environmental effects stemming from energy production and consumption and thus direct his/her choices; at urban level it is possible to set up specialised administrative and training centres.

So far, regional authorities have had a limited role in decisions regarding energy planning although through law 10/91 they have been officially charged with energy management. Regional authorities are obliged to prepare energy budgets, draw up regional energy plans, prepare and draw up inventories of hydroelectric resources, waste, and remote heating sites. Moreover Art. 5 states that all towns with over 50,000 inhabitants must draw up a local plan on use of renewable energy sources.

Five years after law 10/91 was issued the objective of co-responsibility and co-ordination has only in part been achieved: the implementation stage of plans differs significantly from region to region (see table 5.9).
The scarce technical-administrative ability of some regions as well as the lack of technical-economical training for managers is particularly worrying.

Table 5.9 does not provide an overall picture of the degree of implementation of other regional obligations on the energy issue, which are often not part of the plans. However, although there are great differences, one may notice that there is a widespread difficulty in implementing actually operative Plans i.e a system with objectives, priority issues, projects, time-frames, costs, funding, enterprises, beneficiaries and drawbacks.

This is due to various reasons:

1) difficulty in finding one's way in the elaborate system of national, regional, provincial and local responsibilities;

2) limited possibility of affecting decisions of the main national energy concerns (ENEL, ENI, SNAM) and impose solutions on private enterprises which operate on the territory;

3) the lack of human, technical and scientific resources at regional level;

4) limited financial resources to implement projects related to the Plans.

As far as town councils are concerned, just over ten of them (compared to 134 involved by Art. 5 subsection 5 of Law 10/91) have drawn up Local Council Energy Plans; they are Torino, Rivoli, Moncalieri, Milan, Sesto San Giovanni, Padua, Rovigo, Bologna, Florence, Livorno, Grosseto, Rome, Caserta, Potenza, Palermo. The plans mostly consist in studies to identify intervention options with special attention to environmental impact related to production and use of energy.

Town councils have also specific responsibility in implementing general guidelines of the National Energy Policy such as control of central heating systems, control of standards in thermal isolation of buildings and in sometimes control of electricity production by Council concerns.

As far as responsibility for management of mobility and traffic are concerned, all towns with over 30,000 inhabitants should have adopted the Urban traffic Plan by June 24th 1996. The plan is considered "the short term administrative -technical tool to improve circulation and road safety, to reduce atmospheric and acoustic pollution and to limit energy consumption respecting environmental values".

No detailed report on the stage of implementation is available even for these further measures that contribute to a reduction of greenhouse gases. A recent sample survey (Klima Bundnis/Alleanza del Clima, Ökoinstitut SudTirol/Alto Adige, Osterreichisches Ökologie-Institut, 1995) has found out that the more frequent measures are those related to traffic and mobility (50% of adopted measures) while only 15-30% regard the energy sector. The main reason is reportedly the lack of institutional responsibility in the sector on behalf of town councils. Finally, very few councils relate the above mentioned interventions to national and international policies for climate protection.

There are many international activities and networks that operate to make people change to a more environmental-conscious and sustainable lifestyle. (International Council for Local Environmental Initiatives (ICLEI), Eurocities, Car Free Cities Club, Energie-cities, Ecomed, Città sane, Ecowatt).

At Geneva the European Union presented its proposal for local intervention which acknowledges the importance of greenhouse gas emissions reduction as reference target for action by local administrations.

In the 1994 Aalborg Conference organised by ICLEI and jointly sponsored by the European Commission, the Campaign for Sustainable Cities was born. The Aalborg Charter has been undersigned by more than 200 European towns and one of the commitments is to implement urban strategies to reduce emissions from fossil fuels. In 1995 in Berlin during the First Conference of Parties, the Second City Summit against the greenhouse effect was held. At the end of the meeting local administrations committed themselves to contribute to climate protection by asking governments to include local administrations in their programs for climate change.

The First Italian National Communication under the Framework Convention on Climate Change strongly pointed out the role of local administrations in reduction of greenhouse gases.

The Local Council Energy Plan is one of the main tools in reducing CO_2 emissions at town level. Stated in law 10 of September 10th 1991 it regards 134 towns with over 50,000 inhabitants and intends to encourage energy saving and development of renewable sources. Little more than ten towns have so far executed this law or started studies to draw up the Plan. They are Rovigo, Padova, Livorno, Sesto San Giovanni, Turin, Palermo, Bologna and Rome.

There are many reasons for this delay among which lack of financial support to local initiatives. Despite this, local environmental and economical benefits due to intervention on saving - including invested capital return - have convinced some Councils to promote their own environmental energy plans by setting drawing up energy policies within a more wider policy to reduce local carbon dioxide emissions. This is definitely the direction Italian town councils must take not only to improve the quality of life of residents but also their economic accounts.

The most widespread measures concern management of car parks and limitation of traffic, an absolute must in historical centres of Italian towns. As far as the energy sector is concerned, 80% of the councils interviewed have replaced light bulbs for urban lighting with more efficient ones, while one-third of the councils has appointed an energy manager.

The government has recognised that granting responsibility to regions, provinces and town councils to limit and reduce greenhouse gas emissions and integrating measures for management of the territory is a basic element in Italy's commitment to implement the Framework Convention on Climate Change. In accordance with OECD suggestions, action will be taken to ensure that policies and tools to implement joint national, regional and local responsibility will have the following prerequisites:

- definition of clear objectives to support action by local administrations and stimulate public interest on environmental issues;
- special attention to participation and support by the local public which is a must to achieve environmental and energy objectives;
- interventions to improve energy performance, such as demand side management in order to achieve sustainable growth of the energy system;
- participation of town councils in energy production and distribution as to facilitate implementation of new energy programs and co-ordinate and integrate sectoral policies;
- national energy policy objectives and the institutional and financial measures to achieve them so that local innovative experiences may not remain isolated;
- implementation of a system, which although prices in fossil fuels are low, points out to decision-makers the social and environmental impact and costs of energy production and consumption.

Table 5.9: Indicators of Regional Emissions Indicators and degree of implementation of Regional Energy Plans (PER) and Urban Traffic Plans (PUT)

Region/Independent Province	Territory (%)	Resident Population 1991 (%)	GDP/ 1992 consump. 1992 (%)	Primary energy demand 1995 (%) (a)	CO_2 emissions from the energy sector 1995 (%) (a)	State of the PERs: S=under study R=implemented D=deliberated (b)(c)	State of the PUTs P=forecasted A=adopted Drawn up, drafted (d)
Piedmont	8.43	7.58	8.7/7.9	8.50	6.18	R (1)	18P, 7A,4R, 2I
Valle d'Aosta	1.08	0.20	0.3/0.3	(6)	(6)		6P, 0A,0R, 0I
Lombardia	7.92	15.60	19.6/17.2	18.01	15.93	S	157, 28, 17, 24
Bolzano	2.46	0.78	(7)	(7)	(7)		(7)
Trento	2.06	0.79	1.9/2.0	1.68	1.23	S	42P. 2A, 1R, 0
Veneto	6.09	7.72	8.8/8.4	9.12	10.51	D	55P, 8, 11, 11
Friuli Venezia Giulia	2.60	2.11	2.4/2.4	2.57	2.82	S	4P, 2A, 0R, 1I
Liguria	1.80	2.95	3.4/3.4	4.33	6.59	D (5)	29, 10,2,5
Emilia-Romagna	7.34	6.88	8.4/8.0	8.61	7.48	S	73, 9, 7, 14
Toscana	7.63	6.22	6.6/6.6	6.37	6.36	S	38, 10, 4, 8
Umbria	2.81	1.43	1.3/1.5	1.69	1.32	S (2)	10, 4, 1, 2
Marche	3.22	2.52	2.6/2.7	2.17	1.65	D	42, 5, 0, 7
Lazio	5.72	9.05	10.5/9.2	7.47	9.27	S	47, 1, 2, 2
Abruzzo	3.58	2.20	1.9/2.1	2.16	1.58	S	13, 3, 1, 0
Molise	1.47	0.58	0.4/0.5	(8)	(8)		3, 0, 0, 0
Campania	4.51	9.92	6.9/8.0	4.83	3.69		36, 4, 3, 7
Puglia	6.43	7.10	5.1/5.8	6.79	8.91	S (3)	59, 3, 4, 2
Basilicata	3.32	1.08	0.7/0.8	0.67	0.46	S (4)	2, 1, 0, 0
Calabria	5.00	3.65	2.1/3.0	1.59	1.91	D (2)	26, 1, 0, 1
Sicily	8.53	8.75	6.1/7.6	9.29	8.97	S	29, 1, 4, 8
Sardinia	7.99	2.90	2.2/2.6	4.15	5.12	D (2)	8, 0, 1, 0
Italy	301.3 km^2	56,78 millions	1,5-1,22 10^{15} Lit	171,8 Mtoe	427,4 $MtCO_2$	PEN'88	697P, 91A, 62R, 94I

(1) implemented before law 10/91 and later updated; (2) Implemented before law 10/91; (3) A draft P.E.R. drawn up in 1983; (4) Only B.E.R. (Regional Energy Budget) implemented; (5) Deliberated and forwarded to the Government Commissioner for approval; (6) included in the figure for Piemonte; (7) included in the figure for Trentino; (8) included in the figure for Abruzzo.
(a) Grandoni, personal communication, 1997; the first regional energy budgets by ENEL (Grandoni) were drawn up in 1958 al 1958; (b) D'Angelo, personal communication, 1997; (c) the first studies on regional energy plans range back to the 1970s (IEFE); In the 1980s some studies were carried out on local energy plans. They were very significant as far as range, in-depth analyses and results were concerned and were consistent with the methods used in this communication to implement scenarios (BEST, 1985; Regione Sardegna, 1988); (d) data provided by Ministry of Transport.

With the approval of the "Proxy to the Government to confer responsibilities and duties to regions and local administrations, to reform Public Administration and to simplify administrative procedures", most of the responsibility regarding the energy issue should be transferred to the regions and local administrations except for those issues which have a specific national relevance. Moreover, as far as funds to finance energy policies are concerned regions have been authorised to introduce a further tax on methane and electricity.

After issue of the legislative decrees implementing the Proxy-law, the State-Regions conference may decide the reduction objectives for each region that will then be responsible for reduction objectives at local level. By December 31st 1999 these objectives must be included in the Regional and Town Energy Plans as stated in art. 5 of Law 10/91.

The principle of co-operation will be adopted also in implementation of policies and measures to mitigate climate change. Within the Conference State-Regions, studies will be carried out on the feasibility of programme agreements between the Ministry for the Environment and or sectoral Ministries and each region to optimise local mitigation actions.

5.8.2 DEVELOPMENT OF COMMON EUROPEAN POLICIES AND MEASURES

The general indicators of carbon intensity - i.e. ton of carbon released per capita and per unit of GDP - may explain the different national circumstances and historical development of each country. However these indicators cannot provide a full picture of the current state of technology and development potential. They can neither provide guidelines for common action nor monitor progress in achievement of common objectives. The indicators must therefore be integrated when implementing burden sharing among Member States.

More specific indicators help to understand differences in the general indicators. They may also point to objectives to be achieved and help to monitor progress in achievement of common objectives.

Since mitigation burdens will tend to more and more equal among EU Member States, burden sharing should be decided on the basis of common policies and measures for each specific sector and subsector and assessment should be carried out according to specific sectoral indicators regarding technical efficiency and costs.

The government intends to promote discussion among EU Member States on the issues regarding global climate and mitigation policies.

As far as reduction of carbon dioxide emissions within a specified time frame is concerned, the government shall continue to support burden sharing among EU Member States according to the energy intensity, the degree of economic development, climate differences, type of industrial growth. So no country would be penalised and it would ensure that per capita emissions in each country would over time converge on the most significant socio-economic indicators and real energy efficiency.

5.8.3 INTEGRATION OF THE GLOBAL ENVIRONMENT IN TAXATION

High taxation on energy products in Italy is historically due to the need to contain liabilities in the trade balance. Over the last ten years taxation has further increased (in the early 90s overall revenue from indirect taxation was almost 2.5 times the amount spent to purchase crude oil) due to the need to increase State revenue to face Public deficit. Although some industrial sectors have been penalised compared to other countries, this policy has slowed down consumption also through adoption of more energy efficient technologies and as a result there has been a reduction in emissions of environmental pollutants.

Over the last years almost all European countries have increased taxes on most crude oil by-products and have reached Italian levels (in some cases even higher) with a view to reducing emissions and protecting the environment and according to the different pollution potential of each energy source. Moreover, in almost all countries the environmental rationale has lead to an urban parking tax, which in Italy is practically unapplied. In the long term the government intends to implement all the directives currently under discussion in the EU.

Some production activities that contribute to greenhouse gas emission receive subsidies, which may stimulate an increase in these emissions. For example until recently the adjustment fund for electricity production was ruled by mechanisms which were opposed to reduction of thermoelectric production and improvement of efficiency reimbursing all the costs.

With expert co-operation these subsidies will be replaced by mechanisms aimed at achieving the same goals but consistent with the national policy for mitigation options and measures. Environmental externalities capable of reducing environmental risk will be progressively integrated in taxation.

Restructuring and rationalising taxation in the energy sector and in those responsible for greenhouse gas emissions is a critical issue on the government's agenda. The key element in this respect would be to redirect taxation and link it to environmental impact. Thus taxation on energy products and on other goods and services related to emission of greenhouse gas should follow the European guidelines on environmental issues. With this precise objective prices will be revised in order to account for indirect environmental costs in the short and long term without of course hindering economic growth. Considering global burden, a first analysis could regard heavier taxation on goods and services responsible for the release of greenhouse gas than on employment.

A proportion of these taxes would be devoted to mitigation options instead of increasing State revenue. As far as the transport sector is concerned there will be a more equal burden share between use of public ground (parking) and fuel consumption and local councils will be encouraged to implement taxation and use the subsequent revenue.

5.8.4 DEVELOPMENT OF R&D ON MITIGATION TECHNOLOGIES

Research and Development in the field of mitigation technology must take into account the increasing role played by European research; an adequate share of national resources must therefore provide joint funding of European sectoral projects.

Few but substantial and strategic R&D projects will be funded and will focus on a limited number of scientific and technological objectives regarding energy demand, energy consumption and greenhouse gas production in the industrial, mobility and transport, civil and residential, agriculture, forestry and waste sectors. Funding measures must be implemented to ensure flexibility, co-ordination and operation of research activities. To optimise national efforts, opportunities and synergies at EU level will be fully exploited. Research and resources will be concentrated on few priority issues where results on emissions reduction are likely to be achieved and where the competitiveness of national industry in the medium-long term will be ensured.

Joint public and private enterprise will be encouraged in the field of Research and Development (such as for example the Electric Power Research Institute, EPRI, USA).

Competitiveness induced by the European common market requires much technological R&D. Due to the limits in the National budget, only a small proportion of R&D may be publicly funded. It would mainly involve basic research or high-risk research with little or no prospect of paybacks in the short or medium term. On the other hand energy concerns, energy plants and component firms may only devote part of their own funds to technological R&D. New funding mechanisms must therefore be identified such as those adopted in Industry for experimental stations or in the field of Public Health (for instance Art. 12 of Law 502 devotes 1% of the Public Health Fund to research).

Since it is a very important issue the government plans to increase resources to train young graduates and experts in the field of applied research. The reform of Research institutions will also take into account the need for research on technologies to face climate change.

5.8.5 DISSEMINATION OF TECHNOLOGICAL INNOVATION

Appropriate measures are being studied in order to create markets for R&D products such as to reduce production costs and encourage competitiveness. There shall be further development in the future of those incentive measures agreed on within the EU common market and based on: tax relief, relief on investment costs, discounts on purchase prices of production factors. These incentives for diffusion and use of new technologies should only speed up reduction of costs of new environmental and energy technologies by increasing their market and the demand for technological know-how without affecting competition.

5.8.6 PERMANENT ENVIRONMENTAL WATCH

Over the last years there has been a steady decline in information regarding the national energy system which has complicated and reduced accurateness in introductory analyses required to formulate an energy policy. In other key sectors for assessment of emissions and impact of measures for mitigation and adaptation there is the same lack of information and statistics.
One of the most urgent priorities is the establishment of an Environmental Watch which co-ordina-

tes and manages all the information required to properly monitor greenhouse gas emissions, assesses phenomena related to climate change and plans measures for mitigation and adaptation by the national energy system. The main activities will regard:

- quality and price of energy services including those regulated by the Authority;
- development of national energy regulations and their effect compared to other EU Member States;
- Replacement of energy sources;
- trend in end-use energy efficiency;
- development of renewable sources.

These activities require setting up, developing and maintaining national statistics in an all-encompassing, reliable and timely manner. Local statistics should also be similarly developed as to allow homogenous and consistent action all over the territory. Collection and organisation of data will carry out through current networks in order to contain the amount of resources required.

5.8.7 STUDIES AND ANALYSES ON STRATEGIES TO FACE CLIMATE CHANGE

On the basis of climate observations and models regarding the Mediterranean area it will be necessary to study the impacts of current climate change on development and on the various sectors of national economy. Analyses of the potential scenarios require economic growth, technological and climate factors to be combined in more and more complex long-term economic models.

Since it is necessary to be aware of the impact of political decisions and laws before they are passed, research in the sector will be developed in co-operation with similar analyses in other countries. By encouraging multi-disciplinary groups constituted by experts from the single sectors, it will be possible to provide political pre-legislative analyses of the sectors.

5.8.8 CO-ORDINATION AND PROMOTION OF SECTORIAL POLICIES

In formulating global environmental policies the government shall try its best to mediate among global environmental objectives, national economic growth competition and security in energy supply. The Ministry for the Environment's role as guideline provider for national environmental policies will be effective only if its role will be to co-ordinate and link policies in other sectors affecting climate change. These sectors must include European and international policies, fiscal policies, energy policies, transport policies, policies regarding agriculture, forestry and Public Works, policies concerning devolution of responsibility to local government, policies regarding university and technical training and research. A relevant role in this respect will be carried out by the interministerial commission and the secretariat.

The government shall jointly encourage reception and integration of environmental objectives in sectoral policies. This includes also regional and local environmental policies so that priority is always placed on options that contribute to mitigation of negative environmental impacts.[39]

39 In some cases, devices introduced to improve the local environment (catalytic converters for example) reduce energy performance or increase indirect consumption of energy and further studies are required to establish overall environmental impact.

6. Projections and effects of policies and measures

This chapter presents a possible scenario of the emissions of greenhouse gases in the year 2010. This scenario assumes the complete success of all the reduction policies and measures described in the previous chapter, within a favourable international and EU context. Assuming that the third Kyoto Conference of Parties (COP-3, December 1-10, 1997) approves a legally binding protocol and that in it the European Union undertakes to reduce its emissions by 15% in comparison to 1990 figures[1], total national emissions of CO_2, CH_4 and N_2O in 2010, should be 7% less than those of 1990 (-4% for the emissions of CO_2 alone).

Since the results of negotiations, to continue also after COP-3, could have different results, two alternative scenarios are illustrated. The first, which could be viewed as maximum reduction with known technologies, examines the possibility of reducing greenhouse gases in 2010 by 12.5%, in comparison to those of 1990. The second scenario is valid should no agreement be reached in Kyoto. It is believed to be equally useful to undertake a similar national reduction policy, both for its positive consequences and also to start what will be a long a process of change, which must be initiated sooner or later. This latter policy, which involves a great deal of administrative and organisational effort, will achieve more limited results than the former, since the necessary international conditions and the support of common and co-ordinated European policies and measures will be lacking.

6.1 THE INTERNATIONAL AND EUROPEAN CONTEXT

When drawing up a national strategy for the reduction of climate changes it is essential to consider the possible development of emissions in other countries: the emissions of greenhouse gases in Italy are about 2% of total world emissions and 13% of the emissions of E.U.. The most important elements of international and E.U. scenarios, useful for the assessment of the possible scenarios of national emissions, emerge from an examination of the emissions of the energy sector alone, which is the most important, the most documented and the easiest scenario to analyse.

6.1.1 THE INTERNATIONAL CONTEXT

According to projections made by experts, world emissions of CO_2 from the energy sector will tend to increase over the next 13 years by 30-50% due to economic development and to a trend towards an increasing demand for energy (see table 6.1).

Emissions from more developed countries as a proportion of world emissions will tend to decrease: from 50% in 1990, to 42-46% in 2010. For this reason the agreements for the reduction of emissions being discussed by the developed countries must also be accompanied, without delay, by measures for the transfer of technology and agreements to control the emissions of the developing countries.

As a result of their particular economic structure, given present technology, more developed countries have an average elasticity of emissions in respect of

1 During the meeting held in March 97, the European Council on the Environment, together with a negotiating mandate providing for a 15% reduction of total emissions of CO_2 CH_4 and N_2O, expressed in CO_2 equivalent terms, employing the power of global warming in 100 years, respectively equal to 1, 21, and 310. Also approved was a subdivision of the burden of reduction (burden sharing) amongst Member States, which refers to a reduction of 10%. The Italian delegation has requested that it be minuted that for further reductions Italy will refer only to common and co-ordinated measures and policies.

GNP[2] for the period 1990–2010 which is much lower than that of developing countries (in the interval 0.2–0.5 in comparison to the interval 0.45–0.75). This means they can pursue their economic development in sectors and with technology which emit less carbon dioxide.

In particular, it is foreseen that the trend of emissions for the European Union may vary between +2% (estimate of the Conventional Wisdom scenario of the European Commission), to +19% (reference scenario of the American DOE), which are more moderate than those of the other developed countries are.

6.1.2 THE EVOLUTION IN THE EUROPEAN UNION

While at global level the study of alternative scenarios, with a moderate or reduced growth of emissions, is still at a theoretical level, at E.U. level there is a growing urgency to build scenarios with limited or reduced emissions.

With this aim, estimates of emissions in the Member States have been prepared, during the Italian Presidency (first semester of '96) using a starting point consistent with traditional type scenarios prepared by the European Commission (DG XVII Energy, see table 6.2). A trend of increased CO_2 emissions from the energy systems of the Member States of the European Union of up to 26% when compared with 1990 figures (with values higher than the Hypermarket scenario of the EC) emerges from these estimates. Should all measures and expert proposals be implemented, it has been hypothesised that emissions could be reduced to 95% of 1990 levels. These estimates for 2010, prepared by experts in the individual States, were consistent with the "Forum" scenario of the European Commission in particular (see figure 6.1).

From the point of view of implementation of policies and reduction measures, it is estimated that about two thirds of potential reduction may be achieved by employing measures to improve the overall efficiency of final use technology: 26% in industry, 18% in the service and private sector, 16% in transport. Further reductions are possible in the energy sectors: 19% with a change of fuels, 12% by improving the efficiency of production systems, and 7% through a more widespread use of nuclear and renewable energy.

Most experts have suggested actions without (or with low) added costs (no/low regret options), to be implemented by strengthening both common[3] and co-ordinated measures[4] at European level. This should unite international reduction strategies with the EU policy of making the indicators of emissions converge in the middle term (see figures 6.2-3). At the same time this will ensure that the cost of EU policies will not be borne mainly by countries, such as Italy, which have a century old tradition of containing energy consumption. These countries have already made huge investments in the sector and will presumably have the highest unit costs for new interventions.

In support of the decision of the Council of Ministries of the Environment of the European Union of March 1997, which assumed as a negotiating aim a 15% reduction of emissions, the European Commission has re-worked its strategies, with a new scenario for the development of energy consumption until 2010 (pre-Kyoto scenario[5], see table 6.3), and with a new quantification of the economic potential of emission reduction[6]. This new scenario includes an evolution of GNP from the ´90s to 2000 and of the main indicators of energy intensity and of carbon similar to that of the Hypermarket scenario. However, it hypothesises that emissions will grow only by 8% when compared with 1990, rather than by 12% as foreseen in December 1995. In short, the reduction of 800 Mt is obtained by a reduction of around 300 Mt in the generation of electricity, mostly renewable and cogeneration, reductions from technological initiatives in the tran-

2 Defined as the relationship between percentage variations of the first value (in this case emissions) and the percentage variations of the second value (in this case GNP).

3 Such as the improvement of the efficiency of vehicles, regulations and standards for final use, environment taxes and subsidies.

4 Such as voluntary agreements to define the technical potential in industry, the internationalisation of the externalities of road, maritime, and air transport, promotion of alternative transport and high speed trains, improvement of heating/insulation standards in the public and private sector, planning of integrated resources, promotion of the market for renewable resources, combining energy and heat, recyclable materials, promoting consumer preference for low energy.

5 Articulated in the Commission document of May '97 (Com (97) 96, final).

6 The relevant document is still in draft form (July 1997).

Table 6.1: 2010 scenarios of the emission of CO_2 from the energy sector in the main regions of the world

	Historical Data 1990	%90	1995	Projections 2010 (variations in respect of 1990 values normalised at 100) US/EIA ref.	IEA cc	IEA es	EU/EC cw
Global total							
emissions	22.04	100	104	146	149	136	130
energy	8647	100	106	149	155	143	134
GNP	18990	100		169	188	188	179
population	5450	100			132		
Developed Countries					(a)	(a)	(a)
emissions	10.95	49.7	105	129	127	113	120
energy	4633	53.6	108	135	132	120	125
GNP	16077	84.7		159	164	164	157
population	1210	22.2			113		
of which: United States					(b)	(b)	
emissions	4.90	22.2	106	129	130	117	118
energy	2106	24.4	108	128	131	120	123
GNP	5490	28.9		164	167	167	152
population	255	4.7			124		
EU				(c)	(c)	(c)	
emissions	3.32	14.9	100	119	115	102	110
energy	1324	15.3	104	128	125	113	119
GNP	5620	29.6		156	164	164	155
population	371	6.7			106		
of which: ITALY							
emissions	0.44	1.8					
energy	163	1.8					
GNP	1098	5.8					
population	57	1.1					
Japan					(d)	(d)	
emissions	1.13	5.1	117	151	143	124	121
energy	452	5.2	119	148	154	142	124
GNP	3141	16.5		165	164	164	159
population	125	2.3			106		
CEEC/CSI							
emissions	4.91	22.3	66	88	94	82	88
energy	1847	21.4	71	96	119	104	93
GNP	945	5.0		102	160	160	134
population	390	7.2			104		
Develping Countries							
emissions	6.19	28.0	130	223	229	216	181
energy	2169	25.1	130	225	246	232	180
GNP	2899	15.3		260	286	286	279
population	3850	70.6			137		
Of which: China							
emissions	2.29	10.4	131	244	214	210	167
energy	677	7.8	132	256	238	234	168
GNP	327	1.7		525	449	449	463
population	1187	21.8			120		
India							
emissions	0.58	2.6	140	266	290	274	
energy	193	2.2	136	280	316	300	
GNP	204	1.1			297	297	
population	880	16.1			140		

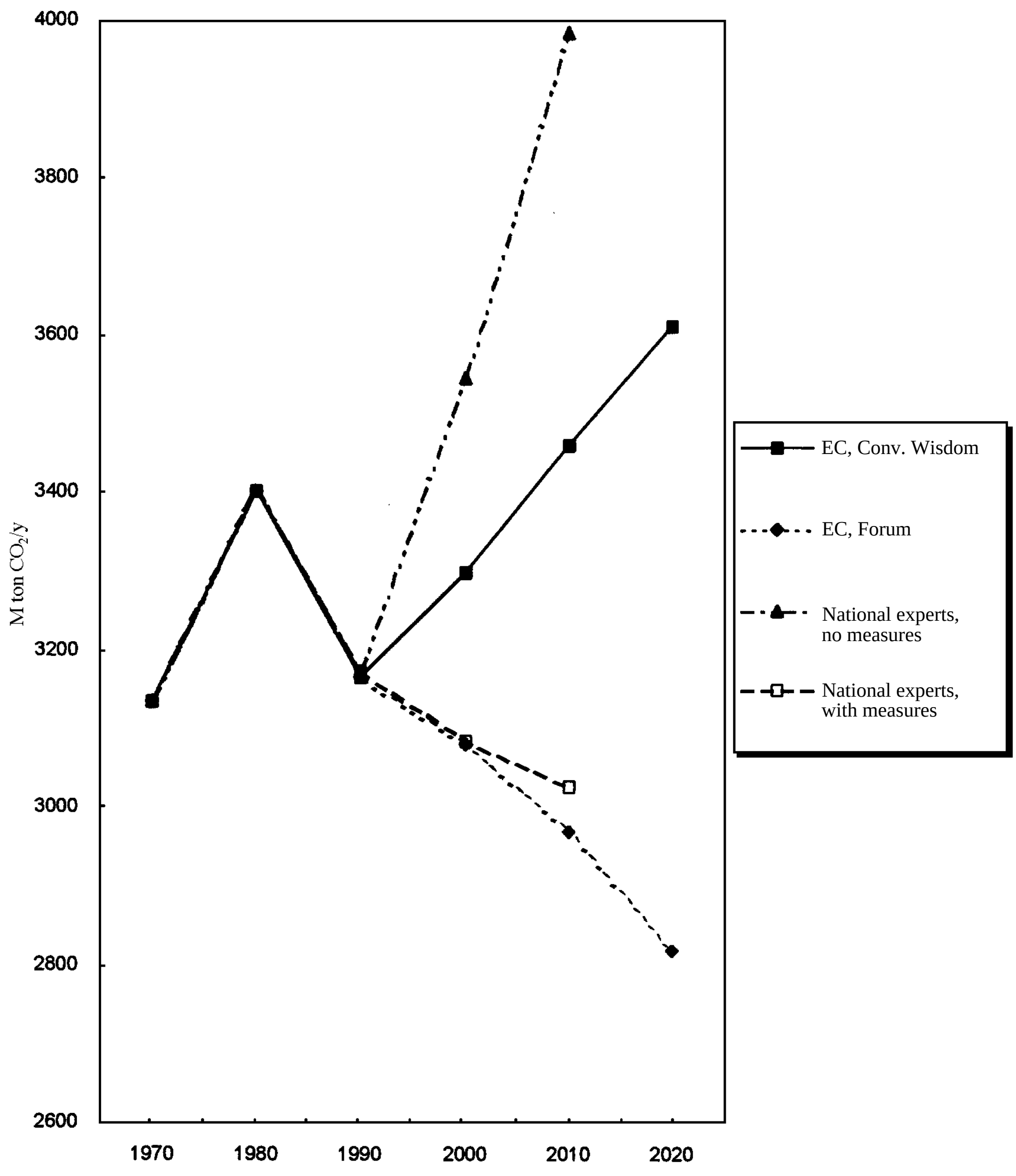
Unit of measure: emissions (Gt CO_2); energy (Mtoe); GNP (G$ 90); population (millions)

Notes: CEEC= Countries of Central Eastern Europe
(a) OECD countries; (b) North America; (c) OECD European area; (d) OECD Pacific area

sport sector (excluding inter-modality) of 200 Mt, and reductions of 100 Mt each from increased efficiency in industry and in the private sector.

The economic potential from emission reduction (800 Mt CO_2/y), with rather limited costs of between 16 and 30 ECU/t CO_2, would make it possible to reduce emissions by more than 15%, without compromising development. Impact on GNP is estimated at a yearly average of about 0.15%. Considering that the reduction of consumption will contribute significantly to achieving the goal of improved air quality and the reduction of acidification, this cost is reduced to a mere 0.1% of GNP.[7]

Figura 6.1: EU - 15 Total CO_2 emissions.

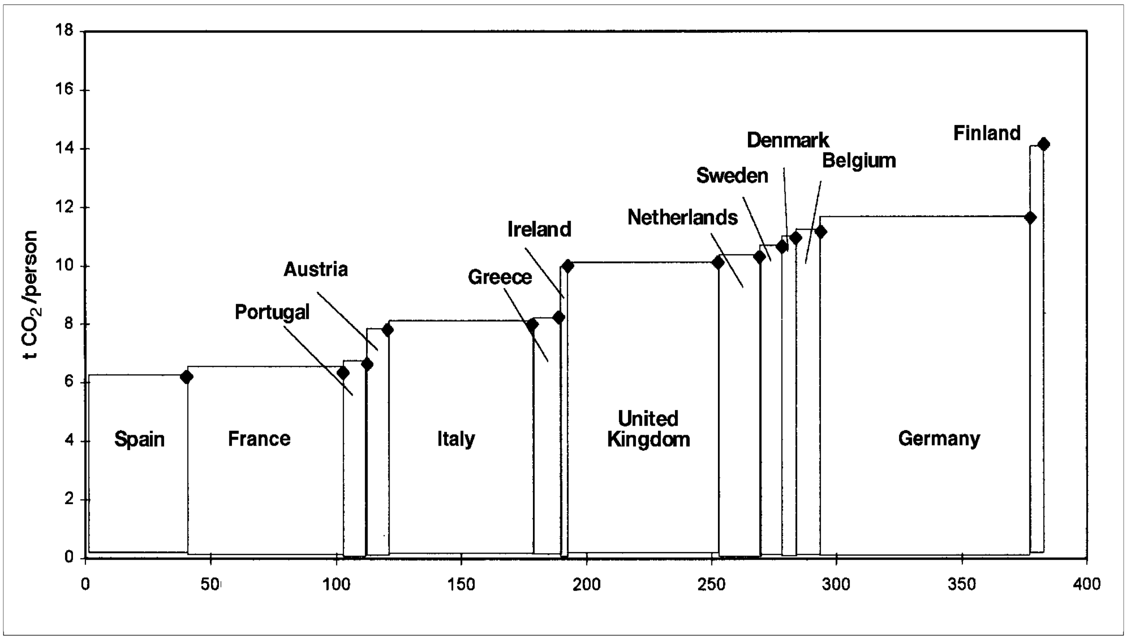


7 This estimate does not consider any contributions for Joint Implementation activities with other countries and the positive impact on the GNP (in redistributive sense) of tax policies.

Table 6.2: Energy system CO_2 emissions scenarios (Mt CO_2/y)

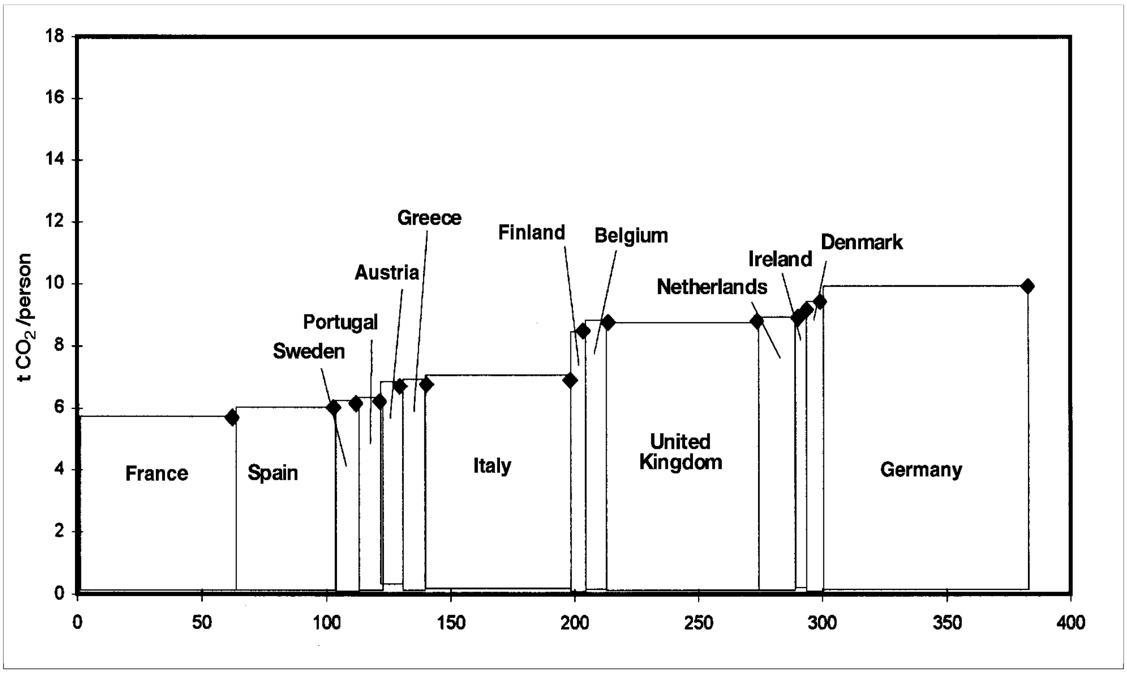
SOURCE	Format					European Commission						
SCENARIO		Without Measures		With Measures			Conventional Wisdom			Forum		
YEAR	1990	2000	2010	2000	2010	1990	2000	2010	2020	2000	2010	2020
EUR 15	3174.7	3545.6	3985.2	3086.0	3029.4	3167.0	3299.0	3462.0	3613.0	3082.0	2971.0	2819.0
Index	*100*	*11*	*12*	*97*	*95*	*10*	*10*	*10*	*11*	*97*	*94*	*89*
Belgium	103.7	115.3	122.4	105.0	82.0	111.0	113.0	112.0	125.0	102.0	88.0	83.0
Index	*10*	*11*	*11*	*10*	*79*	*10*	*10*	*10*	*11*	*92*	*79*	*75*
Denmark	59.0	64.8	71.1	50.9	42.4	53.0	62.0	58.0	51.0	60.0	50.0	43.0
Index	*10*	*11*	*12*	*86*	*72*	*10*	*11*	*10*	*96*	*11*	*94*	*8*
Germany	986.6	1122.0	1262.0	889.0	869.0	978.0	953.0	972.0	995.0	870.0	830.0	728.0
Index	*10*	*11*	*12*	*90*	*88*	*10*	*97*	*99*	*10*	*89*	*85*	*74*
Greece	76.3	98.9	120.	89.2	101.0	72.0	81.0	89.0	96.0	74.0	73.0	72.0
Index	*10*	*13*	*15*	*11*	*13*	*10*	*11*	*12*	*13*	*10*	*10*	*10*
Spain	208.0	247.0	260.3	239.2	249.6	208.0	218.0	251.0	292.0	213.0	244.0	246.0
Index	*10*	*11*	*12*	*11*	*12*	*10*	*10*	*12*	*14*	*10*	*11*	*11*
France	362.9	366.5	423.4	355.6	348.4	368.0	392.0	394.0	445.0	360.0	354.0	357.0
Index	*10*	*10*	*11*	*98*	*96*	*10*	*10*	*10*	*12*	*98*	*96*	*97*
Ireland	29.0	36.6	42.7	31.0	31.9	30.0	34.0	36.0	37.0	32.0	33.0	31.0
Index	*10*	*12*	*14*	*10*	*11*	*10*	*11*	*12*	*12*	*10*	*11*	*10*
Italy	401.0	426.0	457.0	402.0	383.0	402.0	439.0	461.0	480.0	425.0	399.0	412.0
Index	*10*	*10*	*11*	*10*	*96*	*10*	*10*	*11*	*11*	*10*	*99*	*10*
Luxembourg	10.4	8.0	10.0	5.9	8.0	12.0	8.0	10.0	9.0	8.0	8.0	10.0
Index	*10*	*77*	*96*	*56*	*77*	*10*	*67*	*83*	*75*	*67*	*67*	*83*
Netherlands	171.4	175.0	185.0	163.0	160.0	156.0	160.0	170.0	167.0	148.0	147.0	143.0
Index	*10*	*10*	*10*	*95*	*93*	*10*	*10*	*10*	*10*	*95*	*94*	*92*
Austria	56.4	51.4	52.4	46.2	36.2	57.0	62.0	64.0	62.0	59.0	55.0	50
Index	*10*	*9*	*93*	*82*	*64*	*10*	*10*	*11*	*10*	*10*	*96*	*88*
Portugal	37.3	52.0	71.0	50.0	62.5	39.0	50.0	63.0	78.0	48.0	59.0	71.0
Index	*10*	*14*	*19*	*13*	*16*	*10*	*12*	*16*	*200*	*12*	*15*	*18*
Finland	53.0	60.0	70.0	63.0	47.4	52.0	68.0	75.0	79.0	63.0	45.0	41.0
Index	*10*	*11*	*13*	*11*	*89*	*10*	*13*	*14*	*15*	*12*	*87*	*79*
Sweden	50.6	60.0	92.8	56.0	58.0	50.0	59.0	97.0	89.0	54.0	56.0	49.0
Index	*10*	*11*	*18*	*11*	*11*	*10*	*11*	*19*	*17*	*10*	*11*	*98*
United Kingdom	569.0	662.0	745.0	540.0	550.0	579.0	600.0	610.0	608.0	566.0	530.0	483.0
Index	*10*	*11*	*13*	*95*	*97*	*10*	*10*	*10*	*10*	*98*	*92*	*83*

Figure 6.2: Emission per capita EC “Conventional Wisdom” scenario, 2010



Note: The per capita emissions of Luxembourg are not included for scaling problems.

Figure 6.3: Emission per capita EC “Forum” scenario, 2010



Note: The per capita emissions of Luxembourg are not included for scaling problems.

6.2 SCENARIO OF GREENHOUSE GAS EMISSIONS TO 2000

Since 1990 the European Union has undertaken to stabilise carbon dioxide emissions at 1990 levels by the year 2000.[8] According to the most recent estimates, the stabilising of emissions at 1990 levels is likely, although not guaranteed (see table 6.3). According to the conclusions of the EU monitoring body, which has expressed a similar opinion, the hypothetical increase of emissions in Italy (up to 3-4%) is compatible with the EU aim of stabilising emissions.

The estimate of national emissions to 2000 from the energy sector has been modified from a figure of 435 Mt CO_2/year, which was communicated to the Monitoring Body of the EU at the end of 1996. In the meantime energy consumption in 1996 has not grown compared to that of 1995. The rate of methane consumption has increased more quickly than expected, while coal consumption has decreased. Furthermore, in the first five months of 1997, energy consumption has slightly decreased when compared with the same period of the previous year due to a slowing down of the economy. Even if the GNP should increase by a yearly average (y.a.) of more than 2% over the next three years, it is unlikely that energy consumption will increase by more than 1% y.a. and electric consumption by more than 1.6%, to a requirement of 280 TWh in 2000 from the power grid.

Extrapolating to 2000 the trend of emissions in the most recent years and hypothesising an average economic growth over the next three years in line with government guide-lines, it is foreseeable that in 2000 total man-produced emissions (IPCC-OCSE methodology) will reach 445 Mt CO_2/year, +1.5% compared to 1990, 420 of which will be from combustion[9] . It is foreseeable that there will be a 5% growth of these compared to total emissions in 1990, but only 3% more compared to emissions corrected in temperature. The estimated growth of gross emissions for the three most important greenhouse gases (CO_2, CH_4, and N_2O; compare table 6.4a with table 6.4b) is 2.3%.

It does not appear that structural action could change the natural evolution of emissions associated with the expected growth of GNP over a mere three year period. However, given the slight variance of estimates for 1990, economic events[10] and management-type measures (table 6.5a) may contribute to reducing emissions in 2000 and to reducing them to 1990 levels (table 6.5b).

Table 6.3: Emissions of CO_2 from the energy system of the European Union: recent trends and comparison of scenarios to 2010 (Mt CO_2/year)

CO_2 emissions	EURO-STAT 1990(a)	1995	COM / 196 pre - Kyoto 2000	2010	DG XI reduction strategy, 2010	
Industry	626	-10%	-14%	-15%	432	-31%
Transport	743	9%	22%	39%	833	12%
Civil. and agric.	654	-3%	-1%	4%	480	-27%
Prod. of heat & elec..	1036	-5%	-2%	2%	807	-22%
Energy	141	7%	9%	12%	158	12%
Total:	3200	-2%	+2%	+8%	2710	-15%
Indicators			1990/2000	2000/2010		
GNP			+2.1%	+2.4%		
Energy intensity			-1.0%	-1.6%		
Carbon intensity			-0.9%	-0.2%		
CO_2 emissions			+0.2%	+0.6%		

8 Italy has approved the Community position at national level. It has set the same target, without, however, making it a formal undertaking, in consideration of initial low level of specific emissions and of the intrinsic difficulty in attaining stabilisation (see CIPE resolution on the plan for the limitation of carbon dioxide emissions, February 1994)

9 Regarding CO_2 emissions from sectors other than burning of fossil fuels and of other greenhouse gases it is not posible to forsee any significant changes to 2000.

Table 6.4a: National inventories of green-house gases emissions, summary data for 1990 (1997 revision, Gg of CO_2 emissions, GWP in 100 years) (a)

CATEGORY OF EMISSIONS AND ABSORPTION OF GREEN-HOUSE GASES	CO_2 emissions	CO_2 absorp.	CH_4	N_2O	TOTAL gross em.	TOTAL net em.
Total national emissions and absorption	443092	35891	48903	50989	542984	507093
1 Energy sector	401943	0	8514	13824	424282	424282
A Comb. Processes: ref. Method						
sect. method.	399590	0	2026	13824	415440	415440
1. Energy industries	148445	0	105	6169	154719	154719
2. Manufac., building industry	78117	0	170	2939	81227	81227
3. Transport	95063	0	1296	1105	97464	97464
4. Other sectors (civil., agric., fish.)	76805	0	450	3599	80855	80855
5. Other (military consumption)	1159	0	4	12	1176	1176
B Emissions through loss of fuel	2353	0	6488	0	8841	8841
1. Solid fuel	0	0	105	0	105	105
2. Oil and methane	914	0	6383	0	7297	7297
3. Other (geothermic)	1439		0	0	1439	1439
2 Industrial processes	27520	0	92	7289	34900	34900
A Mineral products	22715	0	0	0	22715	22715
B Chemical industry	2350	0	47	7289	9686	9686
C Manufacturing of metals	1977	0	44	0	2021	2021
D Other man. (paper & food)	478	0	0	0	478	478
E Manufact. of halog. hydroc. & SF_6	0	0	0	0	0	0
F Use of halog. hydroc. & SF_6	0	0	0	0	0	0
3 Use of solvents	1999	0	0	0	1999	1999
4 Agriculture	0	0	19090	23303	42393	42393
A Enteric fermentation	0	0	13505	0	13505	13505
B Faeces	0	0	4022	3999	8021	8021
C Cultivation of rice	0	0	1539	0	1539	1539
D Agricultural land	0	0	0	19296	19296	19296
E Brush fires	0	0	0	0		0
F Burning of agricultural waste	0	0	25	8	33	33
5 Changes in soil and forest use	10942	35891	3930	6481	21354	-14537
A Changes in forest and in other						
accumulation of wood biomass	8736	35817	0	0	8736	-27081
B Conver. of forests and grassland (+fires)	2154	0	162	16	2333	2333
C Aband. of cultiv. land	0	74	0	0	0	-74
D Emiss. and removal of CO_2 from the soil	52	0	0	0	52	52
E Other (managed forests)	0	0	3768	6465	10233	10233
6 Waste	688	0	17277	91	18057	18057
A Landfills	0	0	6344	0	6344	6344
B Treatment of waste water	0	0	10739	0	10739	10739
C Burning of waste	688	0	194	91	974	974
D Other	0	0	415	0	415	415

(a) This table corrects or updates some figures contained in the introduction to the CIPE resolution and shown in table 6.5b which follows; the figures in this table are consistent with the tables in chapter 4.

Table 6.4b: Forecast of green-house gases emissions: summary data for 2000 (base scenario, Gg of CO_2 equivalent, GWP in 100 years) (a)

CATEGORY OF GREEN-HOUSE EMISSIONS	CO_2 emiss.	CO_2 absop.	CH_4	N_2O	TOTAL gross em.	TOTAL net emiss
Total national emissions	459038	36199	51848	49899	560786	524587
1 Energy sector	421272	0	7939	13402	442613	442613
A Combustion processes:	418202	0	1156	13402	432760	432760
1. Energy industries	147768		193	4608	152569	152569
2.Manuf. & build. industry	79934		71	2170	82175	82175
3. Transport	111000		672	4053	115725	115725
4. Other sectors: civil., agric., fish.	77900		219	2571	80690	80690
5. Other (milit. consump.)	1600		0	0	1600	1600
B Emissions due to loss of fuel	3070		6783	0	9853	9853
1. Solid fuels	0		105	0	105	105
2. Oil and methane	1163		6678	0	7841	7841
3. Other (geothermic)	1907		0	0	1907	1907
2 Industrial processes	23385	0	153	6324	29862	29862
A Mineral products	19721		0	0	19721	19721
B Chemical industry	2090		49	6324	8463	8463
C Production of metals	1035		104	0	1139	1139
D Other production	539		0	0	539	539
E Prod. of halog. hydroc. and SF_6	0		0	0	0	0
F Use of halog. hydroc. and SF_6	0		0	0	0	0
3 Use of solvents	1962	0	0	0	1962	1962
4 Agriculture	0	0	18305	23544	41849	41849
A Enteric fermentation	0		12750	0	12750	12750
B Faeces	0		3820	3848	7669	7669
C Cultivation of rice	0		1709	0	1709	1709
D Agricultural land	0		0	19688	19688	19688
E Brush fires	0		0	0	0	0
F Burning of agricultural waste	0		26	8	34	34
5 Changes in soil and forest use	11692	36199	3850	6474	22016	-14183
A Changes in forests and in the other accumulations of the wood biomass	10344	35947	0	0	10344	-25603
B Convers. of forests and grassland (+fires)	1348	0	82	8	1438	1438
C Abandonment of cultivated land	0	157	0	0	0	-157
D Emis. and removal of CO_2 from the soil	0	95	0	0	0	-95
E Other (managed fires)	0	0	3768	6465	10233	10233
6 Waste	727	0	21602	155	22484	22484
A Landfills		0	9744	0	9744	9744
B Treatment of wastewaters		0	10739	0	10739	10739
C Burning of waste	727	0	281	155	1163	1163
D Other		0	837	0	837	837

(a) the emissions of N_2O from the energy sector are correct in respect of CIPE projections.

Table 6.5a: Programme for the reduction of green-house emissions to 2000: management type interventions (million tons equivalent CO_2/year)

1.REDUCTION OF EMISSIONS FROM ENERGY USE	CO_2	CH_4	N_2O
1.1. Reduction of losses from the power grid	0.1		
1.2. Reduction of losses from the methane network and of emissions from methane use		0.2	
1.3. Measures for monitoring urban traffic	1.0		
1.4. Increase in the use of natural gas in industry and in civil use	0.5		
1.5. Heating systems: monitoring campaigns	3.0		
1.6. Promotion of fuels with low green-house emissions	1.0		
1.7. Activities involving electricity generation	2.0		
1.8. Labelling, information campaigns and voluntary agreements by manufacturers of household appliances	1.0		
1.9. Upgrading of energy efficiency in the residential building sector	1.0		
1.10. Increases in the efficiency of electric appliances	2.0		
1.11. Low consumption vehicles	0.5		
1.12. Fuels with lower emission of green-house gases in electricity generation	0.7		
TOTAL	12.8	0.2	0
2. REDUCTION OF EMISSIONS FROM NON-ENERGY USES	CO_2	CH_4	N_2O
2.1. Reduction of emissions from industrial processes			1.5
TOTAL: UPDATING AND ENVIRONMENT PROTECTION PROGRAMME	12.8	0.2	1.5

Table 6.5b: Reduction of national emissions of greenhouse gases to 2000: summary table (million tons equivalent CO_2/year) (a, b) (CIPE table)

REDUCTION SCENARIO GREEN-HOUSE GASES	CO_2	CO_2		CH_4		N_2O		TOTAL (Mt) EMISSIONS		NET EMISSIO.
	TOT.	Energy	Absorp.	TOT.	Energy	TOT.	Energy	TOT.	Energy	
1990 EMISSION	442.2	401.6	35.9	52.0	11.6	53.9	16.7	548.0	429.9	512.1
2000 EMISSION BASIC SCENARIO TRENDS.	459.0	421.3	36.2	51.8	7.9	51.5	15.0	562.4	444.2	526.2
% - 1990	+ 3.8	+ 4.9	+ 0.8	- 0.4	- 31.9	- 4.5	- 10.2	+ 2.6	+ 3.3	
2000 EMISSIONS WITH MANAGEMENT INTERVENTION	446.2	408.5	36.2	51.6	7.7	50.0	15.0	547.9	431.4	511.7
% diff. - 1990	+0.9	+ 1.7	+ 0.8	- 0.8	- 33.6	- 7.2	- 10.2	- 0.0	+ 0.3	

a) conversion coefficient from methane Gg to CO_2 Gg equivalent = 21
b) conversion coefficient from N_2O Gg CO_2 Gg equivalent = 310

10 Among the economic type events relevant to the reduction of greenhouse gases are the following: an undesired reduction in economic development; an increase in the internal price of energy as a result of international factors; an increase in average winter temperatures and a decrease in the number of days when heating use is most pronounced in comparison with 1990; an increase in rainfall and related hydro electric power production; an increase in the amount of electricity imported from France; a slight shift to coal over fuel oil, emulsions and methane in particular, in thermoelectric generation; a trend towards reduced cement production.

6.3 EMISSIONS OF CARBON DIOXIDE TO 2000

6.3.1 METHODS FOR CREATING AN ENERGY SCENARIO

To assess the effects of the policies and measures described in the previous chapter a basis for calculation is used which does not modify the tendency to use technological and organisational emission reduction options. Since there is no documentation on possible national economic development in the international context in the middle-long term, and since similarly there are no official projections to the year 2000 of the energy sector alone, a basis for calculation has been created independently. Two methods have been employed, producing a coherent picture:

- a very detailed technological approach, based upon the MARKAL technology (the MARKet ALocation model of the Project for the Analysis of Energy Technologies Systems of the International Energy Agency, IEA, Paris, a typical bottom-up model), described in IPCC in its second assessment report (IPCC, SAR, 1995) as a recommended model for the assessment and the cost of middle long term reduction strategies. This model has been used to build a model of the Italian energy system[11] and any possible scenarios to 2030 have been analysed;

- subsequently, starting with detailed interventions and scenarios built using the MARKAL-Italy model, the macro-economic aggregates from the technological model are reinterpreted according to the most frequently used patterns of econometric models (top-down methodology).

Emission reductions from the calculation basis have then been worked out: with the first approach the method specific to the technological model of minimum cost of MARKAL long term has been employed. Using the second model emissions to 2010 have been calculated by removing emission reductions which are achievable with the technological options encouraged by hypothesised policies. These polices were in general chosen from the optimisation model, using sectoral simulation models and electronic spreadsheets.

Since the choices and indications of the technological model have a clear rational explanation, possible action indicated by the technological method for the launch of a suitable reduction strategy and the ensuing scenarios of evolution of the energy system and emissions are presented here within a framework of macro-economic coherence and with the appropriate terminology. Consequently, emissions are studied as if they were the result of econometric projections based on the development trend of the main economic and energy indicators. An explanation of the complex technique required to set up basis for calculation and the activity scenario with the MARKAL methodology, as well as possible scenarios and the main elements of the technological database, is contained in the bibliography and in the notes in the Enclosure.

6.3.2 BASIS FOR CALCULATION

To a certain extent the calculation basis reproduces the projections which may be obtained from current hypotheses on the development of demand, prices, and economic and administrative system (see tables 6.6 and 6.9). The calculation basis is initially created using the technological model which chooses actions hypothesising the permanence of the present differences in discount rates as estimated by the various participants in the national energy system. It can be reconstructed through the econometric method hypothesising a continuous intrinsic improvement of energy efficiency (about 1% y.a.).[12]
The higher values for emissions are obtained by

11 The MARKAL methodology was chosen for the analysis of reduction strategies anticipating the expiry of the Second National Communication, for many reasons: the international character of the method (it was created by the International Energy Agency, Paris); the availability of ample documentation; its use by around 100 international, national and local groups to analyse the development of environmental energy systems; its use for the analysis of reduction strategies in view of COP-3, Kyoto, in around 10 countries; the continual development and improvement of the method; the availability of a national model, the construction of which employed many resources.

12 In other words, it is hypothesised that average elasticity for primary energy demand compared to income (defined as the relationship between percentage variations for primary energy and percentage variations for income) should be around 0.5 for the entire period and that the energy intensity of income should fall correspondingly.

extrapolating to 2010 the most recent figures for elasticity compared to income from electricity and from energy consumption for transport. In this way the demand for electricity to 2010 from the power grid is calculated as 240 TWh and the demand for fuels as 48 Mtoe. The ensuing energy demand in 2010 is 196 Mtoe, with yearly carbon dioxide emissions in the energy sector equal to about 485 Mt CO_2/year. (Should the quantity of coal remain the same, methane increases to 71 Mtoe and electricity imports reduce to 25 TWh). This scenario also considers the effects of PEN 1988 policies and implementation and decisions taken after 1990 increasing the use of methane over coal and of combined cycles for thermoelectric generation.
Primary energy demand may be reduced to 193 Mtoe/year and emissions to 470 Mt CO_2/year in 2010. This outcome depends on a group of variables: a mid-long term time span (13 years), the relative maturity of the energy market and possible saturation in the transport sector (elasticity equal to 0.6, with a consequent demand of 46.5 Mtoe/year of fuels), and in the electricity sector (elasticity equal to 0.9, demand on the network of 325 Mtoe). This calculation basis is on mid-low figures compared to energy scenarios recently prepared by other analysts (see table 6.7).

The calculation basis includes many well defined sectoral measures, in other words those which are already financed or approved (see table 6.8).
Some assumptions have been made in the production, transformation and distribution of energy sectors: that plants which opened or which began construction between 1990 and 1995 are now operative (including 5500 MW of combined cycle plants); that the use of methane for thermoelectric production increases according to projections; that obsolete electric plants be decommissioned; and that existing plants be restructured according to previous ENEL decisions, increasing the use of methane up to 14.5 Mtoe (-6 Mt CO_2). In the independent manufacturing sector, it is assumed that planned increases in capacity (6 GW), including cogeneration and a greater use of methane have taken place. In the refining sector an increase of 15-25% have been assumed due to desulfurisation activities, reduction of aromatics in petrols, and more generally to further lightening of the barrel. In the methane sector, a further extension of the gas pipelines from Algeria, and the construction of at least one of the two other methane pipelines (Norway or Russia) have been included. On the other hand, imports by sea have not been included, due to the difficulty of building ports suitable for methane-carriers and plants for re-gassing (750 MW). In the renewable energy sector new plants for small hydroelectric power[a] (750 MW), for pressurised gas, wind energy (750 MW), photovoltaic (7 MW), for biomasses (1150 MW), for biogas (90 MW), and geothermal energy (330 MW), have been included. All of these plants have already been included in the ENEL agreement, assuming that general interest will lead to a rapid solution of the present contentious situation. All these actions are in progress, have already been financed and are economically valid within the present regulatory framework.

It is assumed that in the manufacturing industry the present levels of efficiency, operative since 1990 will be maintained, with the increased manufacturing levels hypothesised by the industry (Confindustria document of May 1997).

Table 6.6: Main hypotheses of development to 2010

	1990	1995	2000	2010
Population (millions)	56.7	57.3	57.3	56.5
GNP (in thousand billions of liras 1990)	1311	1386	1530	1865
Average yearly growth rate		1.1	2.0	2.0
Industrial production (index)	100.0	106.9	118	145
Family use (in thousand billions liras 1990)	1041	1093	1207	1471
Passenger km (in thousand billions of pass. km)	717	824	878	994
Tons km (in thousand billions t/km)	230	244	272	331

Source: Enea processing from ENI data

a Translator's note. The Italian word used here is "hydraulic" but given the context " hydroelectric" has been substituted.

Table 6.7: Comparison between CO_2 emission scenarios from the national energy system, 2010 (energy in Mtoely, emissions in Mt CO_2/y)

	1990 NEB	'90(a) EUROST	1995 NEB	CE-DG XVII (a) CW	BF	FO (c)	HM	ENI Sept '96	PU	DRI	E 2/96 Case B	IT Presid. June 96	Calculus basis	Scenario -7%(estim.)
Solids	15.8	17.5	13.8	26.0	23.5	16.8	27.2	15.0	14.7	27.2	15.6	16.0	16.6	10
Oil and derivatives	92.5	89.8	95.7	85.6	85.8	82.4	93.1	98.5	97.1	108.5	88.9	84.0	89.9	65
Methane	39.1	39.0	44.9	71.0	67.7	68.7	73.9	69.9	70.0	58.6	68.5	70.5	71.5	79
Primary electricity	16.1	7.2	18.2	9.4	9.4	12.4	9.4	20.0	16.9	18.2	23.1	22.1	15.0	21
TPER	**163.5**	**153.5**	**172.6**	**192.0**	**186.4**	**180.3**	**203.6**	**203.4**	**198.7**	**212.5**	**196.1**	**192.6**	**193.0**	**175**
Final consumption	**119.6**	**110.0**	**125.6**	**135.2**	**129.9**	**132.0**	**143.4**	**148.3**	**na**	**na**	**141.3**	**141.3**	**141.7**	**125**
Industry	36.5	37.0	36.8	45.3	43.7	41.7	46.3	44.6	na	na	36.0	40.0	39.0	35
Transport	36.3	33.4	40.3	43.9	41.2	45.0	47.9	47.3	na	na	57.6	50.5	49.5	42
Civ. and agric. use	38.5	39.6	40.6	46.0	45.1	45.2	49.3	47.6	na	na	40.0	44.5	44.5	39
Net non-energy use	8.3	8.3	7.9	8.8	8.8	8.8	8.8	8.8	na	na	7.8	7.4	8.7	9
CO_2 emissions:														
Not correct. figures	411	402	426	461	446	400	493	502	514	572	467	474	482	na
IPCC normalis. figures	399	399	413	455	440	394	487	496	508	566	461	462	469	385
Memo														
Biomass	1.1	2.9	1.5	8.0	7.3	10.4	8.9	na	2.0	2.0	1.8	1.0	1.0	3,0
Naval bunkering	2.7	na	2.4	na	na	na	na	2.4	na	na	na	na	na	na
Air bunkering	1.1	na	1.5	na	na	na	na	na	na	na	na	na	na	na
Indicators														
Population (millions)	56.7	57.7	57.3	57.8	57.8	57.8	57.8	55.8	na	na	na	na	56,5	56,5
t CO_2/person														
GNP	1311	650	1386	948	878	954	1005	1861	na	na	na	1958	1865	1865
unit of measure	TLit'90	Becu85	TLit'90	Becu85	Becu85	Becu85	Becu85	TLit'90				TLit'90	TLit'90	TLit'90
Mt CO_2/GNP units														

Acronyms: na = not available; TPER = Total Primary Energy Requirements; NEB = National Energy Balance; CE-DG XVII = Directorate General for Energy of the European Commission; CW = Conventional Wisdom Scenario; BF = Battlefield Scenario; FO = Forum Scenario; HM = Hypermarket Scenario; PU = Unione Petrolifera; E 2/96 = article by O. Bernardini "Il Futuro Energetico dell'Italia.." pubblished by *Energia* n. 2, 1996; IT Pres. (June 96) see Tosato et al., 1996;

(a) does not include naval bunking; the value of non-energy use is an estimate;

(b) the value of air bunking is in IPCC normalised emissions; not included

(c) an hyhothesis based on national production of 10 Mtoe of electro-nuclear energy;

(d) this is scenario B described by O. Bernardini on *Energia* 2/96; two other alternative scenarios are described, according to which the primary demand in 2010 is between 178.8 and 216.4 Mtoe/year and normalised emissions are 392 and 516 Mt CO_2/year.

Table 6.8: Interventions and options included in the calculation basis for the scenario for CO_2 emissions from combustion to 2010

Sector Type	Quantity	Red. of CO_2 emiss. to 2010 (Mt CO_2/y)	Total expenditure (billion Lit'96)
Energy industry (b)		(32.75)	>53685 unchang
New lines and doubling of methane pipe-lines in Algeria	12 Mtoe	(8.4) (c)	12000, unchang
New gas-pipeline from Norway	12 Mtoe	(8.4) (c)	to be estimated
New ENEL plants, operative between '90 and '95 or being completed; methane instead of coal (PEN'88), shutting down of old plants, environment. update of existing plants		15	18000 unchang (to be updated)
Completion of new ENEL plants, as from CIPE del. of 1994 (660 MW *2 polyfuel, Gioia Tauro, + 400 fluidised bed + 5500 MW of combined cycles), methane 14.5 Mtoe		6	to be estimated
Planned increase of elect. production, of cogen., of use of methane up to a 6.5 Mtoe by independent producers	6000 MW	4.7	8000 unchang
Small scale hydro., being converted (4530 hours/year)	750 MW	2.2	3750 unchang
Pressurised gas, methane pipe-lines, being converted	120 MW	0.5	60 unchang
Wind (ENEL)	30 MW	0.04	60 unchang
Wind plants (CIP 6/92 agreement)	720 MW	0.9	1440 unchang
Photovoltaic plants (ENEL)	3.7 MW	0.003	>40 unchang
Other photovoltaic plants (CIP 6/92 agreement)	3.3 MW	0.002	>35 unchang
Municipal solid waste-Refuse derivated fuel plants from biomass (in agreement)	1150 MW	1.8	8050 unchang
Biogas plants (CIP 6/92 agreement)	90 MW	0.2	270 unchang
New geothermoelectric ENEL plants	330 MW	1.4	1650 unchang
Manufacturing industry (b)		(12)	
Increase in use of natural gas, from 1990, in high energy industries		3.0	
Activities in progress, increase in efficiency in comparison to 1990, voluntary agreements to maintain levels reached in high intensity		6	210 year (a)
Increased efficiency in the production of glass		(0.4)	
Increased use of natural gas, from 1990, in industries with mid-low energy intensity		3	
Mobility and transport (b)		(4)	
Use of fuels with lower greenhouse emission: existing, liquefied oil gas		0.4	
Use of fuels with lower greenhouse emission: existing, bio-diesel		0.003	
Local railways	1 Gp.km	0.1	carrried out
Metro-tram	3 Gp.km	0.2	carried out
Passenger railways, regional	2 Gp.km	0.2	5000 unchang
Passenger railways, mid long distance	8 Gp.km	1.2	20-25000 unchang
Goods, from road to railway	10 Gt.km	1.5	4000 unchang
Commuter traffic, from car to town buses	3-5 Gp.km	0.4-0.7	
Housing and services (b)		(19.4)	
Use of methane		6	0
Reduction of use for heating		2.7	to be estimated
Retention of present progressive structure of rates for electricity for domestic use		10	
Reduction of electricity use		0.7	to be estimated
Accounting total of interventions in calculation basis (b)		(68.2)	

(a) total expenses for implementing interventions, with the exception of actions in progress to increase the energy efficiency in industry with high energy intensity, which must be viewed as an average yearly cost. (b) total and subtotals are included to aid accounting verification. Actually the individual reductions of primary energy demand and emissions are not exactly additions, in that there are some figures noted twice and a certain degree of overlapping; (c) figures noted here, but totalled in the final use sectors

Table 6.9: Projection of national emissions of greenhouse gases; summary data for 2010 (basic scenario/trend in Gg of CO_2 equivalent, GWP to 100 years) (a)

CATEGORY OF GREENHOUSE EMISSIONS	CO_2 emiss.	CO_2 absorp.	CH_4	N_2O	TOTAL gross em.	TOTAL net em.
Total national emissions	509696	36199	55759	49580	615035	578836
1 Energy sector	470969	0	7762	13083	491814	491814
A Combustion processes:	466836	0	1055	13083	480974	480974
1. Energy industries	174168		214	3092	177474	177474
2. Manufac., building industry	85067		76	1860	87003	87003
3. Transport	129000		546	5560	135106	135106
4. Other sectors (civil., agric., fish)	76900		219	2571	79690	79690
5.Other (military consumption)	1700		0	0	1700	1700
B Emissions through loss of fuel	4133		6707	0	10840	10840
1. Solid fuel	0		105	0	105	105
2. Oil and methane	1163		6602	0	7765	7765
3. Other (geothermic))	2970		0	0	2970	2970
2 Industrial processes	24346	0	153	6324	30823	30823
A Mineral	20535		0	0	20535	20535
B Chemical industry	2237		49	6324	8609	8609
C Manufacturing of metals	1035		104	0	1139	1139
D Other man. (paper & food)	539		0	0	539	539
E Manufact . of halog. hydroc. & SF_6	0		0	0	0	0
F Use of halog. hydroc. & SF_6	0		0	0	0	0
3 Use of solvents	1962	0	0	0	1962	1962
4 Agriculture	0	0	18305	23544	41849	41849
A Enteric fermentation	0		12750	0	12750	12750
B Faeces	0		3820	3848	7669	7669
C Cultivation of rice	0		1709	0	1709	1709
D Agricultural land	0		0	19688	19688	19688
E Brush fires	0		0	0		0
F Burning of agricultural waste	0		26	8	34	34
5 Changes in soil and forest use	11692	36199	3850	6474	22016	-14183
A Changes in forest and in other accumulation of wood biomass	10344	35947	0	0	10344	-25603
B Convers.of forest and grassland (+fires)	1348	0	82	8	1438	1438
C Aband. of cultiv. land	0	157	0	0	0	-157
D Emiss. and removal of CO_2 from the soil	0	95	0	0	0	-95
E Other (managed forests)	0	0	3768	6465	10233	10233
6 Waste	727	0	25688	155	26570	26570
A Landfills		0	13020	0	13020	13020
B Treatment of waste water		0	11550	0	11550	11550
C Burning of waste	727	0	281	155	1163	1163
D Other		0	837	0	837	837

(a) emissions of N_2O from the energy sector are correct in comparison with CIPE projections

With regard to final users, it is assumed that the demand for energy will not grow as in the past, even in presence of stable nominal prices and increased expenditure, such as GNP. This should come about due to the saturation effect of appliances (housing, vehicles, household appliances) and to a reduced growth in their use, since the marginal usefulness of energy services appears to be reduced in comparison with other sectors. In the commercial and private residential sectors, it is assumed that the marked increase in the use of methane will continue, by about 6 Mtoe compared to 1990, with an equivalent reduction of emissions of about 6 Mt CO_2 (partly due to the displacement of oil products, and partly due to a corresponding improvement in efficiency). With regard to electricity, it is assumed that electricity rates will remain unchanged and will not be lowered, and that space heating using electricity will remain uneconomical. In the mobility and transport sectors, it is assumed that the planned increase in the use of GLP and bio-diesel will take place. It is also assumed that the plans for building infrastructures for the mobility of passengers and goods (subway, high-speed trains, interports) already in progress will be completed (-3,4 Mt CO_2).

6.3.3 SCENARIO OF NATIONAL ACTIVITIES FOR A CO-ORDINATED EUROPEAN POLICY

The aim of reducing CO_2 emissions from the energy system consistent with a global reduction of 7% appears to be possible only by means of a united effort:

- at European level, since a growing number of policies and measures may no longer be taken at national level;[13]
- at international level, at least for the countries in Annex I, in order not to penalise the national production system in terms of competitiveness on international markets.[14]

In a less favourable international situation, the potential of each policy or measure could vary. The level of reduction implementation would vary as a result. In both cases, in order to initiate the programme, a huge organisational effort at national level is required, even before any financial commitment is made.

6.3.3.1 Motivation and feasibility of interventions

The programme includes many reduction measures, indicating for each option the reduction potential, the cost, and an approximate figure for unit cost. This makes it possible to develop sectorial comparisons, and a quality indicator, which provides an indication of the main reason for which the measure is suggested (see tables 6.10 and 6.11). Table 6.10 identifies these measures and the national options within a co-ordinated European policy for reduction in climate changes. Measures and options are divided according to sector (energy industry, manufacturing industry, mobility and transport, housing and service industry), and according to the main reason for the action (improvement of the environment on local and regional level (AL); reduction of climate change (CC); validity from an economic point of view, although sometimes not from a financial point of view (EC); sectoral policies (S); reduction of energy dependency and improvement in the security of supply (SA); protection of public health (SP).

Some measures have priority, since they support the introduction of technology and organisational methods, which are more efficient from an economic, and energy point of view (no-regret actions). They also improve market functions bringing it closer to an optimal balance. The cost of these measures is mainly organisational (transaction costs) and are geared towards improving infrastructures, and improving the environment at local and regional level. Their costs should not be attributed to the programme for the reduction of climate change. The last two types of measures are often not implemented more as a result of co-ordination difficulties rather than cost.

Other measures presuppose the use of the best available technology[15], which is influenced by an international situation consistent with the aims of this programme, or the replacement of some plants and

13 As in the case of national subsidies for the sale of 0.1 Mt of biodiesel and the subsequent infringement procedures which have not yet been completely resolved.

14 Annex 1 nations are OECD countries (Austria, Australia, Belgium, Canada, Denmark, Finland, France, Germany, Japan, Greece Ireland, Iceland, Italy, Luxemburg, Norway, New Zealand, Holland, Portugal, United Kingdom, Russia, Spain, Sweden, Switzerland, USA, Turkey), Central and Eastern European countries associated with the EU (Bulgaria, Czech Republic, Estonia, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia and Hungary) and the countries of the Community of Independent States (Belorussia, Russia and the Ukraine).

15 However, the use of technology which captures carbon dioxide produced by combustion before it is released into the atmosphere is not envisaged, since such technology has not yet been proven, nor is the re-introduction of nuclear power envisaged.

appliances before they have reached the end of their technical life. In both cases the preferred method is action through Community regulations and directives, backed up by national regulations and incentives.
Table 6.11 groups more expensive measures per ton of non-emitted CO_2, both in terms of investment and operational costs.

6.3.3.2 Measures in the energy industry sector

In the sector producing, transforming and distributing energy it is predicted that the use of central polyfuels will be discontinued and that they will be replaced by combined cycles at very high efficiency. These are associated with gas conversion processes (converting residues or emulsions) with a power of 2700 MW (ENEL, -3 Mt CO_2), increasing cogeneration by 1200 MW and the use of methane by 1 Mtoe (-1.3 Mt CO_2). A further reduction of emissions of about 0.7 Mt CO_2 equivalent will result from the increased efficiency in the transmission and distribution of electricity.

A further reduction in emissions of greenhouse gases from the energy production, transformation and distribution sector will be the implementation of plants which have been proposed on the basis of the CIP classification 6/92 but which have not been assigned to the network. These are new renewable sources for the generation of electricity, through the installation of another 1500 MW of wind power (around 3 thousand billion of unchanged estimate to boost production by 20-30%), 600 MW from biomass (3-4 thousand billion of unchanged estimate to boost production by around 50%) and 700 MW from solid urban waste (around 5 thousand billion of unchanged estimate, to boost production with suitable changes in collection rates), 150 MW of geothermal power and 600 MW of small hydraulic power. Taken as a whole these measures reduce emissions by around 6.3 Mt CO_2. If necessary, a further reduction in emissions is possible by limiting the use of coal and fuel oil for generating electricity (-11.5 Mt CO_2, even if this entails annual costs of more than one thousand billion) and to increase the use of renewable sources for generating electricity by 2000 MW (-3 Mt CO_2).

6.3.3.3 Measures in the manufacturing industry sector

In the manufacturing industry sector it is proposed to increase the use of methane by 6 Mtoe to the maximum limit, replacing oil products (-4 Mt CO_2), making use of potential provided by a gas conversion terminal using imported methane. Moreover, the recycling of solid urban waste in the cement industry is proposed (-4.4 Mt CO_2, with total unchanged estimate costs of around 700 billion) and to increase the proportion of recycled scrap (aluminium, glass, metals etc., -1 Mt CO_2 and reductions in CF_4 and CF_6 emissions).

Further reductions in the manufacturing industry sector are possible by eliminating electrical appliances which do not have optimum efficiency by using a mixture of European standards, checks and incentives. Further reduction may be obtained through an increase in the availability of highly efficient electrical appliances (-7 Mt CO_2, with additional unchanged estimates of around 2600 billion liras, to be backed up with appropriate production standards and economic incentives).

6.3.3.4 Measures in the mobility and transport sector

In the mobility and transport sector it is proposed to leave tax on fuel unchanged in real terms, together with other Member States in accordance with recent Ecofin proposals (-6 Mt CO_2). It is also proposed to adhere to the E.U. directives on average emissions in the region of 150-140 g CO_2/km to 2005 and 2010 (-12 Mt CO_2, as already partly agreed by the protocol of intent between the Ministry for the Environment and FIAT). Promotion of cars using methane (-0.5 Mt CO_2), initiation of programmes for the intermodality of goods by road and by ship along the Italian coast (-2.5 Mt CO_2), increasing the availability of urban public transport on trains (increasing the infrastructure measures for metropolitan, regional and high speed transport), with a reduction of around 4 Mt CO_2 to 2010 is also proposed It is further proposed to increase the shift in commuting traffic from private means to buses and to improve urban traffic management (-1.4 Mt CO_2).[16]

Within a consistent E.U. framework, further reductions in the transport sector are possible by levelling taxes which are central to the E.U.'s proposals of increases on fuels in the long term, with a reduction in consumption and emissions in the order of 8 Mt CO_2, by increasing by 1 Mt the amount of biodiesel (-3 Mt CO_2) and by further increasing the fleet of cars

16 See also the study prepared by the Friends of the Earth for the Ministry of the Environment (November 1997), which has a particularly detailed transport section.

Table 6.10: National interventions and options within the framework of a co-ordinated European policy of reduction in climate change to 2010

Sector Type of intervention and option	Quantity	Specific cost	Emission annually reduction CO_2 in 2010 Mt CO_2/year	Total expenses for investment Billion Lit'96	Probability of success (a)	Reason for the measure (b)
Emissions from energy use: total interventions, within the framework of a co-ordinated European policy			**(87.5-93.1)**	**>140000 invest.**		
Energy industry			**(22.6)**	**>40000- invest.**		
Increased efficiency, specifically in refineries (d)			(0.5)*	350 invest.	++	EC
Gas reconversion plants liquefied natural gas (e)	8 Mtoe		(5.6)	6-8000 invest.	++	EC/SA
New gas pipelines from Russia/Middle East (e)	12 Mtoe		(8.4)	To be estimated	++	EC/SA
Gas conversion of emulsions and residues/combined cycles at very high efficiency, abandoning 660*2 poly-fuel, decommissioning (ENEL)	2700 MW		3	3600 invest.	++	EC
Further cogeneration and increase in methane use 1 Mtoe (independent producers)	1200 MW		1.3	1800 invest.	++	EC
Reduction of losses by around 6% up to a total value of 6.5% in the power grid			0.7	operat.	++	S/CC
A further 1300 MW of conversion of emulsions and residues into gas + 2640 MW of combined cycles at very high efficiency, decommissioning (ENEL)	~4000 MW		5.1	6600 invest.	++	EC
Further combined cycles, decommissioning of existing plants (indep. prod.)	3000 MW		3.5	4000 invest.	++	EC
Additional wind power 2010	1500 MW	2 GLit/MW	1.9	3000 invest.	++	CC/SA
Additional biomass plants and urban solid waste - refuse derivated fuel to 2010	1300 MW	~4 GLit/MW	2.1	5200 invest.	++	CC/SA
Additional renewable resources plants, to a large extent urban solid waste	1300 MW	>4 GLit/MW	1.6	>5000 invest.	+	CC/SA
Additional small hydraulics	800 MW	5 GLit/MW	2.1	4000 invest.	+	CC/SA
Additional geothermal	300 MW	5 GLit/MW	1.4	1500 invest.	+	CC/SA
Manufacturing industry			**(17.3-18.8)**	**>3000 invest**		
Further increases in the use of nat. gas after 2000, energy intense industries			2-3		++	AL
Recycling of aluminium			1	50 invest	++	EC
Recycling of glass			0.3	50 invest.	++	EC
Further increases in the use of natural gas after 2000, industries with medium-low energy requirements			2.5-3		++	AL
Volontary agreements and energy diagnosis in industries with medium-low energy requirements			4.5	250 invest.	++	EC
Standards and volontary agreements for high efficiency electric components for the industry			7	2600 invest.	+	EC

Table 6.10: (continued)

Sector Type of intervention and option	Quantity	Specific cost	Emission annually reduction CO_2 in 2010 Mt CO_2/year	Total expenses for investment Billion Lit'96	Probability of success (a)	Reason for the measure (b)
Mobility and transport			**(29.6-32.7)**	**>90000 invest.**		
Promotion of cars/vans run on methane: existing + phase I			0.5		++	EC/AL
Evaluation of the environmental/energy performance of vehicles			1		++	EC/AL
Low consumption cars, national and European agreement, by 2005 145 g CO_2/km, and then constant	12 M cars	+0.3 MLit/car	12	3600 invest.	++	EC/AL
Local railways, planned campaigns	4 Gpas-km		0.5	4000 invest.	++	S/AL
Metro - tram, planned campaigns	12/18 Gp-km		1-1.5	12200 invest.	++	S/AL
Metro - tram, further measures	16 Gp-km		2	~10000 invest.	++	S/AL
Passenger trains, regional	4 Gpas-km		0.5	10000 invest.	++	S/AL
Passenger trains, medium - long distance	13 Gp-km		1.5-2	45000 invest.	++	S/AL
Goods by road and train, planned interventions	10 Gton-km		1.5	1800 invest.	++	EC/S/AL
Goods by road and rail, further interventions	20 Gton-km		3	~4000 invest.	++	EC
Goods by road/by ship along the Italian coast	10 Gton-km		1		++	EC/S/AL
Commuting traffic from car to suburban bus	6-10 Gp.km		0.4-0.8		++	S/AL
Urban traffic plans, 13 major urban areas			0.4-0,6		++	S/AL
Urban traffic plans, other urban areas			0.2-0.4		++	S/AL
Promotion of fuels with low greenhouse emissions (> 2000), liquefied oil gas			0.2-0.5		++	AL
Promotion of fuels with low greenhouse emissions (>2000) bio-diesel	0.5 Mt	1000 Lit/l	1.5	650 oper.	+	AL/SA
Promotion of cars/vans using methane, phase II			1-2		++	EC/AL
Speed limits (-10 km/hr)			0.9		++	SP
Reduction of journeys without goods (road)			0.5		++	EC
Residential and tertiary sectors			**(18-19)**	**>8000 invest.**		
Further conversion to methane			2-3		++	AL
Most efficient measures for reducing electricity consumption			1.5		++	EC
Reduction of heating consumption with certification			3		++	EC
More efficient measures for the reduction of electricity consumption			7		++	EC
Reduction in heating consumption through renovations (increase in building insulation)			3	3500	+	EC
Active and passive solar energy			1.5	4500	-	EC/SA

(a) ++ denotes measures which are thought to be attainable even within an unfavourable international /E.U. framework; the symbol - denotes measures which are thought to be less attainable.
(b) Meaning of symbols which denote the principal motivation for the measures: AL= improvement of the environment on a local and regional scale; CC=reduction in climate change; EC=economically valid, even if not always financially valid; S=sectorial policies; SA=reduction of energy dependence and improvement In the security of supply; SP=defense of public health (c) the total and subtotals are shown to facilitate verification of the figures; actually, individual reductions in primary energy needs and in emissions are not strictly additions in that some figures are given twice and there is a certain amount of overlapping.; the lower figure in the space corresponds to the total contributions for measures with the symbol +, which are likely to succeed, even in a less favourable international context.
(d) increased efficiency absorbed by increased production; (e) real estimate of effect on end use, here estimate for replacement of fuel oil

Table 6.11: Final national measures and options for additional reductions above 7% by 2010

Sector Type of measures and options	Quantity	Exact cost	Reduction CO_2 annual emissions tot. 2010 $MtCO_2$/year	Cost of total invest. Billion Lit'96	Probability of success (a)	Reason for measure (b)
Energy sector			**(60)**	**to be estimated**		
Energy industry			**(17)**	**>8800 invest. +a**		
Replacement of all coal and 40% fuel oil with natural gas (to be verified)	4+4 Mtoe/y		11.5	1100 year	-	CC
Production of electricity from biomass	2200 MW	4 GLit/MW	5.5	8800 invest.	+	CC/SA
Manufacturing industry			**(7.9)**	**2700 invest.**		
Use of waste (DM 16/1/95) in the production of cement	50%		4.4	700 invest.	+	EC/AL/S
Voluntary standards/agreements for lighting and for electric components in the industry			3.5	2000 invest..	+	EC
Mobility and transport			**(23.5)**	**to be estimated**		
Cars with very low consumption, period 2005-2010 (120 g CO_2/km by 2010)	7 M car	+2 MLit/car	4	14000 invest.	+	EC/AL
Passenger trains, medium-long distance	10 Gp-km		2	to be estimated	+	S/AL
Promotion of fuels with lower greenhouse emissions (>2000) bio-diesel	1.5 Mt	1000 Lit/l	4.5	financial year 2000	+	AL/SA
Awareness of environmental effects: phase I (to be verified)			6		++	AL/CC
Awareness of environmental effects: phase II (increase of prices in real terms) (to be verified)			7		+	AL/CC
Residential and tertiary sector			**(11.3)**	**to be estimated**		
More efficient measures for the reduction of electricity consumption			3		+	EC
Photovoltaic solar power	500 MWp	<5 MLit/kWp	0.3	2500	-	CC/SA
reduction in heating consumption (maintenance of real taxation levels 1992)			8		+	EC

(a) ++ denotes measures which are thought to be attainable even within an unfavourable international /E.U. framework; the symbol - denotes measures which are thought to be less attainable.
(b) see corresponding note of table 6.10
(c) the total and subtotals are shown for book keeping purposes. Actually the individual reductions in the primary energy needs and in emissions are not strictly additions in that some figures are noted twice. There is also a certain amount of overlapping; the lower figure in the space/margin corresponds to the total contributions for measures with the symbol + which will probably succeed even in a less favourable international context.
(d) increased efficiency absorbed by increased production.
(e) real estimates of the effects in end use, here the estimate for replacement of fuel oil

and vans run on methane (-2 Mt CO_2). The possibility of promoting, together with other Member States of the EU, the production of cars which emit 120 g CO_2/km is considered very useful, although with little prospect of succeeding for technical and economic reasons, but with quite high emission reduction potential, especially if coupled with measures which provide an incentive to renew the fleet (up to -10 Mt CO_2). Moreover, further infrastructural measures to increase mobility using environmentally appropriate means, and further investments in subway and trams together with improvements in traffic management are possible. All this would lead to reductions of 2 Mt of CO_2, a decisive move towards the intermodality of goods would lead to reductions of 3 Mt of CO_2, reduction of journeys with empty lorries, speed limits and improvement in driving styles would lead to reductions of 1.4 Mt CO_2.

6.3.3.5 Interventions in the residential and tertiary sector

In the commercial and private residential sectors it is proposed to push for the maximum use of methane with a reduction equivalent to 2 Mt CO_2, to carry out examinations and checks on consumption for central heating and to put in place regulations which have already been envisaged for building certification (-8 Mt CO_2). A last proposal is to achieve an improvement in the efficiency of electrical appliances and electrical equipment in offices by means of an information campaign and community regulations for the product market (-1.5 Mt CO_2).

For further reductions in the commercial and private residential sector involvement in the area of heating buildings is proposed. The criteria for the energy certification of buildings would be lowered and regulation at local level would be increased (by means of agreement on plans with regional provincial and municipal authorities), with a further reduction of 6-8 Mt $CO_2$of emissions of greenhouse gases equivalent. Another 5-8 Mt CO_2 of emissions equivalent to carbon dioxide can be reduced by further improving the average efficiency of the electric appliance stock using measures effecting the producers (and importers) of electrical appliances and electricity rates. Moreover, by providing incentives for the use of solar power and by displacing fossil fuels, reductions equivalent to 4.5 Mt CO_2 can be obtained.

6.3.3.6 Interventions in other sectors

In the agricultural sector, bearing in mind the increasing trend of the last few years and the availability of the incentives provided by EC Regulation 2078/92, it is possible to assume that 900,000 additional ha will be involved in organic agriculture, between now and 2010. On the basis of an assessment reported in the IPCC Technical Paper I, it can be assumed that reductions in the consumption of direct energy on conventional farms, will be around 30%. Emissions of CO_2 thus avoided would be equal to 0.044 Mt CO_2 in 2000, 0.088 Mt CO_2 in 2005 and 0.132 Mt in 2010.

6.3.4 OTHER EMISSIONS AND REMOVALS OF CARBON DIOXIDE

It is foreseen that, in the short term, CO_2 emissions from waste incineration will increase further with the full implementation of D.L. 22/97.[17]

As a result of reforestation measures and improvements in forested areas, brought about by the implementation of EC regulation 2080/92, which provided 926 billion liras in the four years 1994-1997 (one third from State funds, the rest financed by the European Union), removal of CO_2 from the atmosphere by forests of around 2-3 Mt of CO_2 for 2002-2002 and of 4-6 Mt for 2010- 2012[18] can be predicted.

17 According to optimistic estimates almost 10 Mt of solid urban waste and assimilables would be incinerated in 2010.

18 This data does not include the contribution of poplar cultivation, relevant only in the short term, since the wood is used mainly for the production of woodpulp for paper and therefore its carbon content is not stored for long.

Table 6.12: National interventions and options within the framework of a co-ordinated European policy for reduction in climate changes to 2010

Sector Type of intervention and option	Emission reduction	Exact cost	Emission reduction, CO_2 equiv. in 2010 Mt CO_2/year	Total cost invest. Billion Lit'96	Probability of success (a)	Reason for measure (b)
Reduction of emissions from other sectors: total interventions, within the framework of a co-ordinated European policy			**(10.7-11.5)**			
Increased removal: total interventions			**(3.5-6.2)**			
Carbon dioxide						
Agricultural sector, organic agriculture	0.13 (CO_2)		0.1		++	EC
Waste, emissions from landfills, included in the base scenario	-				++	EC/SA
Reafforestation, removal by forests	3.5-6.2 (CO_2)		3.5 - 6.2		++	EC/SA
Methane:						
From the energy sector, included in the base scenario	-				++	S/CC
Emissions from stock farming	8.6 - 47.8 kt		0.18-1	150-780 invest.	+	EC
Emissions from landfills and treatment of wastewater, the treatment and incineration of 50% of solid urban waste	300 kt		6.3	(included in electricity)	++	CC
					++	EC
N_2O:						
Emissions from industrial processes (nitric acid and adipic acid)	12 kt		4	to be estimated	++	

(a) ++ denotes interventions which are considered attainable even in a less favourable international/community context; the symbol - denotes interventions which are considered less attainable
(b)Acronyms denoting the principal motivation behind the interventions: AL=improvement of the local and regional environment; CC=reduction in climate change; EC=economically valid even if not always financially valid; S=sectorial policies; SA=reduction of energy dependence and improvement in the security of supply; SP=protection of public health.
(c) the total and subtotals are shown to facilitate book keeping verification; actually the individual reductions on primary energy demand and emissions are not strictly additions in that some figures are shown twice and there is a certain degree of overlapping; the lower figure in the space corresponds to total intervention contributions marked with the symbol +,which will probably succeed even in a less favourable international context.
(d) increased efficiency absorbed by increased production; (e) real estimate of final use effects, here an estimate of fuel oil replacement.

6.4 METHANE EMISSION SCENARIO

6.4.1 EMISSIONS FROM ENERGY SECTOR

The total figure for losses in 1995 is in the order of 270 thousand tons of methane per year (kt CH_4/year), of which at least 60% can be attributed to the cast iron network, even though this only represents around 10-12% of the total length of the distribution network.

According to an initial evaluation of the situation to 2000 with the available data, allowing for the consistent increases in the quantities of gas transported and distributed and of extensions of the network, emissions from the primary network and from the distribution will increase. At the same time, work is in progress renovating and restructuring the oldest urban networks that should significantly reduce those sections of the cast iron network responsible for the biggest part of total losses. However, these are assumed to be ongoing until approximately 2000.

Projections of methane emissions from the energy sector to 2010 have been obtained by elaborating the data from available statistical sources. Emissions have been estimated according to the approach suggested by the Joint EMEP-CORINAIR Handbook, using estimated consumption figures and leakage coefficients provided by the international literature for the type of installations which can be found in the Italian network. Since all cast iron pipes will be replaced or modified in this period, a reduction in losses to a figure of less than 180 kt CH_4/year is forecast. Given that experimental verification of leakages from the low pressure distribution network are on-going these figures are subject to revision.

6.4.2 EMISSIONS FROM THE LIVESTOCK

The basic information for quantifying the projections of emissions from livestock are the following:

- variations in livestock populations (ISMEA, 1996; IIASA, 1996);
- increased productivity in dairy cows (13.69 kg milk/head* in 1990, 16.96 in 1994, 18.8 in 2000 and 22 in 2010);
- increased efficiency in the transformation of ingested food, which brings the rate of conversion of food transformed into methane from 5.5% in 1990 to 5% in 2000;
- practically no influence of the increase in manure retention time due to the implementation of new environmental regulations, considering that the effect of such an increase refers mainly to colder periods, when spreading waste is problematic, but when the production of methane is low or non-existent;
- very low implementation, limited to swine manure, of covered storage systems equipped with recovery of biogas fuel.

The reduction of total methane emissions which can be assumed to the year 2000 (of 16% compared to 1990) relate almost exclusively to the reduction in the population of cattle and diary cows in particular, to increased efficiency in the utilisation of ingested energy, while the effect of other factors is negligible. Increased productivity per head of diary cows leads to greater unit emissions per head, so that the reduction in enteric emissions is less pronounced than could be expected in relation to the reduction in population. The scenario for methane emissions to 2010, apart from development of densities in accordance with the indications in table 6.13a, refers to potential interventions for the reduction of emissions from manure management, under the conditions shown in table 6.13b.

The results of plans drawn up for the two time scales of 2000 and 2010 are detailed in table 6.14. This shows total CH_4 emissions from livestock and manure management systems for 2000 and for 2010 and reductions that can be obtained on the basis of the assumed hypotheses. The table also shows the total annual cost of possible interventions and the specific cost of total hypothetical interventions, relating to the reduction of emissions achieved by applying the emission abatement techniques of reduction from stock (MLit/t of reduced CH_4).

Reductions in methane emissions (enteric emissions and emissions from manure management) which can be attained as a result of the different intervention scenarios to 2010 (94-126 kt of CH_4/year, equivalent to 4.5-6.0 Mt CO_2/year) relate mainly to the reduction in the number of head, particularly of dairy cows, and to the increased efficiency in food utilisation. Regarding reductions in methane emissions from manure management, as a result of the growth in abatement technology, it is assumed that these could vary considerably, between 7 and 39 kt of CH_4/year (equivalent to 0.15-0.8 Mt CO_2 per year). Interventions could involve mainly swines (between 10% and 40% of all animals) and cattle to a lesser extent. As already emphasised, the cost of measures would require subsidies in any case, which could vary from simple incentives for the production of electricity from biogas (as planned in CIP resolution 6/92) to the availability of funding for the creation of plants. Intercepting emissions from the manure management allows the reduction of emissions from other gases, such as ammonia or volatile organic compounds, thus contributing to the improvement of air quality and to the reduction of acid deposition.

6.4.3 EMISSIONS FROM WASTE RECYCLING

The start up of thermodistribution plants from waste, at present in the construction and inspection phase, would bring the amount of municipal solid waste and other similar burned from 1.17 Mt/year in 1990 and 1.71 Mt/year in 1995 to 3.4 Mt/year by 2000 and would cause an increase in emissions of 2.3 Mt CO_2/year. If time variations in the quantity of waste dumped every year are taken into account, it is estimated that related methane emissions will reach a value of 0.511 Mt/year[19], with a significant increase compared to 1990 (+65%) and much less significant compared to 1995 (+8%).

Estimates of emissions from the burning of solid municipal waste and other similar until 2010 are based on legislative decree of 5 February 1997, no. 22. Estimates are in particular based on arrangements relating to the programme for carrying out differentiated collection (art.24) and on those which restrict the use of landfills to disposal of inert waste or to activities determined by specific technical regulations or to waste which is left over from recycling, recovery or from some specific incineration procedure (art. 5 subsection 6). Being cautious it is thought that the final objectives of the legislative decree will be achieved in 2010.

More particularly, it is assumed that the proportion of differentiated collection could reach a figure of 10%. For treatment and recovery plants (incineration with energy recovery, decision finalised on the production of non conventional fuel and/or composting of the organic fraction) it is assumed that the increase in treatment capacity will be derived exclusively from the start-up of plants which are in the construction and inspection phase at present.

For 2005 and 2010 it is thought that further interventions could already be put in place relating to the provision of incineration plants with energy retrieval and of selection where undifferentiated material associated with differentiated collection objectives of 25% for 2005 and 35% for 2010 respectively, would flow together in an equal manner. The total proportion of municipal solid waste and other similar burned using various methods in 2000, 2005 and 2010 are shown in table 6.15. Table 6.16 summarises data relating to methane emissions from landfills for 1990, 1995, 2000, 2005 and 2010.

A further reduction in methane emissions, compared to that of the base scenario, could be achieved by specific interventions aimed at reducing the per-capita production of waste. These interventions anticipate the introduction of measures similar to those already in place in other EU Member States. It is therefore assumed that it will be possible to achieve net waste reductions in line with the Fifth environmental action programme of the European Union. This a result of the gradual changing of tax on landfilled waste into a rate proportionate to the amount of refuse produced, and as a result of the introduction of disincentives for packaging and the launching of information and awareness campaigns. With regard to increased trends in the production of municipal solid waste hypothesised in the base scenario, it is assumed that this reduction could be in the region of 5% in 2005 and of 10% in 2010.

A similar hypothesis has been considered for industrial waste, as a result of simplified procedures anticipated by D.L. 22/97 for specific material/energy recovery from manufacturing by-products and as a result of the implementation of regulations regarding certification and environmental management.

19 It should also be borne in mind that, during this period there have been variations in the quantity of waste dumped each year. In the meantime methods for calculating emissions have become more precise, providing different values.

Table 6.13a: Hypothetical development of animal populations

Category	Density1990 (1)	Density 2000 (2)	Density 2010 (3)
Other bovines	5,195,972	5,090,855	6,235,641
Dairy cows	2,641,755	1,697,524	1,469,866
Swine	8,406,521	7,982,247	9,177,517
Sheep	8,739,253	8,501,912	8,501,912
Goats	1,258,962	1,433,131	1,433,131
Horses	225,673	221,605	221,605
Broilers + other poultry	129,044,806	134,413,858	150,577,931
Egg layers	44,296,756	44,616,636	48,145,277
Rabbits	14,893,771	17,645,406	17,645,406
Fur animals	325,121	56,806	56,806

(1) Source: ISTAT, 1990 (4th General agricultural census)
(2) CRPA processing of ISMEA data, 1996
(3) CRPA processing of IIASA sources, 1996

Table 6.13b: Summary of abatement techniques for methane emissions and related investments

Animal category	Abatement technique	No. of head involved	Investment MLit/y
Year 2000 - Covering of tanks for swine only			
Pigs	Covers on tanks	69669	495
Year 2010 - Average level of intervention: Tank covers for all relevant categories			
Other bovines	Covers on tanks	24660	147
	Replacmt. of lagoons with covered tanks		
Diary cows	Covers on tanks	4506	62
	Replacement. of lagoons with covered tanks		
Swine	Covered tanks	710624	10485
	Replacement of lagoons with covered tanks		
Year 2010 - Maximum level of intervention: Covered tanks for all relevant categories with maximum take-up capacity			
Other bovines	Covers on tanks	147960	1013
	Replacement of lagoons with covered tanks		
Diary cows	Covers on tanks	31986	551
	Replacement of lagoons with covered tanks		
Swine	Covered tanks	3789996	55917
	Replacement of lagoons with covered tanks		

Table 6.14: Projected methane emissions from livestock

	2000	Intermediate intervention, 2010	Maximum intervention, 2010
Reference scenario			
Enteric emissions (t)	535808	563403	563403
Emissions from manure management (t)	167073	185226	185226
Total (t)	702881	748629	748629
Scenario with interventions			
Reduction (t)	558	7131	39371
Total (t)	702323	741498	709258
Total cost (GLit/y)	0.49	10.7	57.5
Exact cost (MLit/t CH_4)	0.89	1.50	1.46

The effect of this type of intervention, negligible in 2005 and 2010, given that estimates for emissions from landfills takes account of the amount of waste dumped in previous years, is set to increase with the passage of time.

Table 6.16 illustrates the effect of interventions aimed at increasing the efficiency of biogas retrieval from landfills, to a level of 80% by 2010. Higher investments that will be necessary can be justified only if adequate incentives exist for biogas use.

Table 6.15: Primary treatment type for municipal solid waste and assimilables in 2000, 2005, 2010 (%)

	2000	2005	2010
Differentiated collection	10.0	25	35
Energy recovery	12.2	25	32.5[20]
Selection	11.0	25	32.5
Landfill	66.8	25	0
Total	100.0	100	100

Table 6.16: Emissions of methane from landfills in 1990, 1995, 2000, 2005 e 2010 (t)

	1990	1995	2000	2005	2010
Base scenario					
Emissions (t)	304134	466071	503983	349012	140038
Scenario with reduction in waste production					
Emissions (t)				345301	134177
Reduction (t)				3711	5861
Scenario with increased percentage retrieval of methane					
Emissions (t)				309418	86332
Further reduction (t)				35883	47845

6.5 EMISSIONS OF NITROUS OXIDE

Emissions of N_2O (nitrous oxide) from nitric acid production (IPCC category 2 B 2), have already been reduced by around 44% between 1990 and 1995, relating to a drop in production and they seem likely to reduce further to 2.7 kt/year in 2010 following further potential reductions in production. When evaluating emissions to 2000, 2005 and 2010 it is assumed that production of HNO_3, equivalent to 1,040,509 t in 1990 and 588,370 t in 1995, will be reduced to 400,000 t in 2010.

Further reductions in emissions could be achieved with specific abatement measures in adipic acid and nitric acid production plants. The extent and nature of these measures will be defined in appropriate voluntary agreements between the Environment Ministry and industries in the sector.

On the basis of changes in animal populations to 2010 and of the hypothetical stabilisation of nitrogenous fertiliser use by that date to 1990 levels, substantial changes to N_2O emissions by the agricultural sector are not anticipated. Slight reductions could be achieved by means of information and awareness campaigns aimed at a more intelligent use of fertilisers.

For projected emissions of N_2O from agriculture and animals to 2000, 2005 and 2010 data on animal densities already used for estimates of CH_4 emissions have been referred to, and Assofertilizzanti predictions were used to estimate nitrogenous fertiliser use. It is also hypothesised that:

- as a result of the spread of systems for drying poultry manure from laying hens, some of the cor-

20 Taking account of energy recovery on the dry matter fraction from selected treatments, this could be as high as 52%

responding emissions can be evaluated with the emission factor relevant to "other systems" rather than with the emission factor relevant to slurry management;

- the use of nitrogenous fertilisers to 2010 could be reduced by 5% by means of persistent campaigns regarding more intelligent use of fertiliser.

6.6 OTHER GREENHOUSE GAS EMISSIONS

With regard to greenhouse gases other than carbon dioxide, it is assumed that policies and measures for the reduction of emissions from industrial processes will also have a marked effect in the trend scenario, in such a way as to have emissions shown in the reference scenario.

Specific emissions of PFC (CF_4, and C_2F_6) from Italian plants for primary aluminium fusion are very low. This is because these plants, which have been renovated recently (1992), use prebake technology with point feeders for the aluminium additing, which has lowest emission factors (see chapter 4). National emissions should further reduce due to a tendency to production characterised by high electricity consumptions to developing countries. On the basis of this trend primary fusion aluminium production has already fallen in the last few years in Italy. According to producers' estimates, it should remain at the same level until 1997-1998, and then start to fall. In 2000 it should be at around 140,000 t. After 2000 it is estimated that production will fall still further, as a consequence of the recovery and recycling of packaging objectives anticipated by D.L. 22/97, and that it could fall to a figure of 100,000 t in 2010.

The evaluation of HFC emissions from the production and use of halogenated hydrocarbons for the 2000, 2005 and 2010 time scales are guidelines only. This is due to the extreme uncertainty of the national and international reference framework relating to fluids that are damaging the ozone layer, and to the lack of available information on the relevant emission estimates.

Bearing in mind the role which HFCs, together with hydrocarbon mixtures, will play in the replacement of first, CFCs and then HCFCs, it is possible to predict that total emissions will be 2000 t in 2000, 2400 t in 2005 and 2700 t in 2010. 80% by weight of these substances will consist of R-134a, 10% of R-404, 5% of R-407 and another 5% of R-507.

Lastly, estimates have been made of emissions of SF_6 for 2000, 2005 and 2010 linked to the production phase of this compound and to the installation and filling of equipment and to leaks from installed equipment. A hypothetical reduction in the leakage rate of equipment installed from 1% to 0.5% of the amount of SF_6 contained in installed equipment has been taken into consideration, as a result of voluntary agreements with companies in the sector starting in 2000.

The summary framework of emissions of HFC, PFC, SF_6 in 1990, 1994, 1995, 2000, 2005 and 2010, expressed both in Gg of the different substances and in Gg of CO_2, equivalent is shown in table 6.17.

Table 6.17: Present emissions of HFC, PFC, SF_6 and projections to 2010

Year / Unit of measurement (a)	1990 Gg	1990 Gg CO_2	1994 Gg	1994 Gg CO_2	1995 Gg	1995 Gg CO_2	2000 Gg	2000 Gg CO_2	2005 Gg	2005 Gg CO_2	2010 Gg	2010 Gg CO_2
Metal production (2C)												
CF_4 (without intervention)	0.0139	90.4	0.0105	68.5	0.0107	69.3	0.0084	54.6	0.0084	54.6	0.0084	54.6
C_2F_6 (without intervention)	0.0014	12.8	0.0011	9.7	0.0011	9.8	0.0008	7.7	0.0008	7.7	0.0008	7.7
CF_4 (with recycl. Alum. waste									0.0072	46.8	0.0060	39.0
C_2F_6 (with recycl. Alum. waste)									0.0007	6.6	0.0006	5.5
Production of halogenated hydrocarbons and sulphur hexaflouride (2E)												
HFC 23 (by-product)	0.0300	351.	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
HFC 125	0.0000	0.0	0.0080	22.4	0.0080	22.4	0.0080	22.4	0.0040	11.2	0.0030	8.4
HFC 134a	0.0000	0.0	0.0320	41.6	0.0320	41.6	0.0320	41.6	0.0160	20.8	0.0090	11.7
HFC 32	0.0000	0.0	0.0020	1.3	0.0020	1.3	0.0020	1.3	0.0010	0.7	0.0010	0.7
HFC 227ea	0.0000	0.0	0.0020	5.8	0.0020	5.8	0.0020	5.8	0.0010	2.9	0.0010	2.9
HFC 236ea	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0010	6.3	0.0010	6.3
HFC 236fa	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0010	6.3	0.0010	6.3
HFC 245fa	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0010	0.6	0.0010	0.6
CF_4 (by-product)	0.0150	97.5	0.0050	32.5	0.0050	32.5	0.0050	32.5	0.0060	39.0	0.0060	39.0
$C_2F_6 + C_3F_8$	0.0040	36.8	0.0010	9.2	0.0010	9.2	0.0010	9.2	0.0010	9.2	0.0010	9.2
C3, C4 (high-boiling pyrolisis by-products)	0.0010	7.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
SF_6	0.0050	119.5	0.0020	47.8	0.0020	47.8	0.0030	71.7	0.0030	71.7	0.0030	71.7
Use of halogenated hydrocarbons and sulphur hexaflouride (2F)												
R-134a	0.0000	0.0	0.4684	608.9	0.4684	608.9	1.6000	2080.	1.9200	2496.	2.1600	2808.
R-404	0.0000	0.0	0.0586	193.2	0.0586	193.2	0.2000	660.0	0.2400	792.0	0.2700	891.0
R-407	0.0000	0.0	0.0293	43.9	0.0293	43.9	0.1000	150.0	0.1200	180.0	0.1350	202.5
R-507	0.0000	0.0	0.0293	96.6	0.0293	96.6	0.1000	330.0	0.1200	396.0	0.1350	445.5
SF_6 (without intervention)	0.0066	156.8	0.0109	261.6	0.0111	264.1	0.0127	302.9	0.0147	351.3	0.0166	397.4
SF_6 (with reduction of leakages from installed equipment)									0.0120	287.4	0.0103	246.5
Total (without intervention)	0.0769	871.8	0.6600	1443.	0.6603	1447	2.0749	3770	2.4589	4446	2.7529	4963
Total (with intervention)									2.4549	4373	2.7439	4795

(a) Gg= Billions of g; Gg CO_2= Billions of CO_2 equivalent.

6.7 EMISSIONS TO 2005

The effects of the programme for emission reduction will already begin to be felt in 2005, when it will be possible to obtain consistent reductions in emissions (see table 6.18).

Table 6.18: Emission scenarios for greenhouse gases to 2005 (in millions of tons equivalent CO_2/year) (table CIPE)

	CO_2 tot.	CO_2 energ	CO_2 absor	CH_4 (a) tot.	CH_4 (a) energ	N_2O (b) tot.	N_2O (b) energ	emission totals tot.	emission totals energy	emiss. net
Emissions 1990	442.2	401.6	35.9	52.0	11.6	53.9	16.7	548.0	429.9	512.1
Emissions in 2005										
Trend	482.8	445.8	36.2	52.2	8.3	52.8	14.7	587.8	478.8	542.6
diff. % - 1990	+ 9.2	11.0	+ 0.8	+ 0.4	-28.4	- 2.0	- 12.0	+ 7.3	+ 11.4	
Modern/Environ. protection	452.1	415.1	36.2	42.7	7.8	49.8	14.7	544.6	447.6	499.4
diff. % - 1990	+ 2.2	+ 3.4	+0.8	-17.9	-32.8	- 7.6	- 12.0	- 0.6	+ 4.1	
EU objective	440.0	403.0	36.2	38.9	7.8	49.8	14.7	528.7	435.5	483.5
diff.% - 1990	- 0.5	+ 0.3	+0.8	-25.7	-32.8	- 7.6	- 12.0	- 3.5	+ 1.3	
Further measures	432.0	395.7	36.2	38.4	7.8	49.5	16.3	519.9	427.5	474.7
diff. % - 1990	-2.3	- 1.5	+0.8	-26.2	-32.8	- 8.2	- 12.0	-5.1	- 0.6	
Emissions in 2010										
Trend	509.7	471.0	36.2	55.8	7.8	53.1	16.6	618.5	495.3	582.3
diff. % - 1990	+15.2	17.2	+ 0.9	+ 7.3	-32.9	- 1.5	- 0.7	+12.8	+15.1	
Modern Environ. protection	453.5	414.8	36.2	39.1	7.1	48.6	16.6	541.1	438.4	504.9
diff. % - 1990	+ 2.5	+ 3.2	—	-24.8	-38.9	- 9.8	- 0.7	- 1.3	+1.9	
EU objective	425.4	386.7	36.2	35.5	7.1	48.6	16.6	509.4	410.3	473.2
diff.% - 1990	- 3.9	- 3.8	—	- 31.7	-38.9	- 9.8	- 0.7	-7.1	-4.6	
Further measures	396.6	357.9	36.2	34.5	7.1	48.6	16.6	479.6	381.5	443.4
diff. % - 1990	-10.4	-11.0	—	-33.7	-38.9	- 9.8	- 0.7	-12.5	-11.3	

a) Conversion coefficient Gg methane in Gg CO_2 = 21
b) Conversion coefficient Gg N_2O in Gg CO_2 = 310

7.Vulnerability assessment

The floods in Piedmont in November 1994, the extraordinary persistence of high water in Venice in the winter of 1996/97, the intensification of erosion and desertification in Southern Italy and the main Islands all highlight Italy's great vulnerability to climatic events which seem to have become more frequent and serious over recent years. It is not certain whether the effects of human action on the climate are the causes of the recent disastrous phenomena, since the climatic phenomena affecting Italy today also occurred in previous periods not subject to global changes and can therefore still be ascribed to natural climatic variability.

The intensive and inappropriate exploitation of environmental resources is however adversely affecting the natural equilibrium of the territory, and its capacity to regenerate resources and to mitigate the effects of extreme climatic events.

7.1 ITALY'S TERRITORY

Italy's territory has a widely differing and fragmented geographical structure (see table 7.1). On mainland Italy, over 50% of the country consists of flat areas (four million hectares, 64% of the country's total flat areas) and hilly areas in the Alpine and Apennine foothills (2.3 million hectares), with the great Alpine water resources. Continental Italy is characterised by a series of unstable mountains exposed to serious erosion, thus creating difficulties for communications and widely differing regional situations. The length of the coastline also causes difficulties.

A significant part of the country is protected for archaeological, historical or landscape reasons. This sometimes makes it difficult to install the infrastructures necessary to rationalise urban settlements, the transport and productive activities.

Table 7.1: Area of Italy by altitude zones (percentage composition on 31/12/1994)

	MOUNTAINS (b)			HILLS (c)			PLAINS	TOTAL	
	Inland	Coastal	Total	Inland	Coastal	Total	(d)	km^2	%
North-Central Italy	23.33	0.26	39.90	16.66	3.24	33.60	26.50	176247	100
Southern Italy	10.33	1.30	28.50	13.65	8.08	53.20	18.30	123061	100
Italy	33.65	1.56	35.21	30.31	11.32	41.63	23.15	301308	100

Source: ISTAT; In italics: total percentage of Italy;
(b) Area characterised by significant mountains, usually with altitudes not less than 600 metres in Southern Italy and 700 metres in Central-Southern Italy and the islands.
c) Areas which, despite significant mountains higher than 300 metres, cannot be defined as mountain areas;
(d) Low-lying land and plains characterised by the absence of mountains.

7.2 CLIMATE

The climate and above all the precipitation pattern are largely responsible for the physical decline of some zones of the country. The precipitation pattern is not uniform: in continental Italy, precipitation is nearly evenly divided into four quarters, while in the peninsular part patterns are irregular, with torrential rainfall with sometimes-disastrous effects. In the southern zones there is a significant coinciding of warm and dry seasons, with negative effects on agriculture.

7.2.1 THE ITALIAN CLIMATE

The Italian climate has been studied and described in great detail by various authors including Mennella (1967) and Pinna (1969) who have used a vast weather and climate data survey network, which has been expanded and improved over the years.

The sources of climate data for Italy are as follows[1]:
1. Air Force Meteorological Service
2. National Hydrographic and Oceanographic Service
3. Central Office for Agrarian Ecology, National Agricultural Information Service

Italy's geographical and morphological characteristics, though falling within the so-called "Mediterranean" and "temperate" climate, lead to different local climatic conditions, thus enhancing the country's vulnerability to the combined action of human and climatic agents. On the basis of the dynamic and static characteristics of the climate, various authors have identified classifications as a basis for the subdivision of Italian territory into districts. The climatology of the average annual temperatures and rainfall calculated by the National Agricultural Information Service (SIAN) shown in figures 7.1 and 7.2 gives an idea of how much Italian climatic conditions vary[2].

The South and the islands are characterised by a warm, dry climate while the North is colder and wetter. The main factors affecting temperature and rainfall patterns are the distance from the sea and orography,

1 Despite excellent quality standards, other regional and watershed area weather and climatic data survey networks are not taken into account here since they have been set up only recently.

2 The SIAN weather and climatic data archive refers to all the sources available in Italy and is currently the only climatic data resource with a structure useful for research on vulnerability and other environment-related topics. Access to the archive currently involves logistic and organisational problems which limit its use.

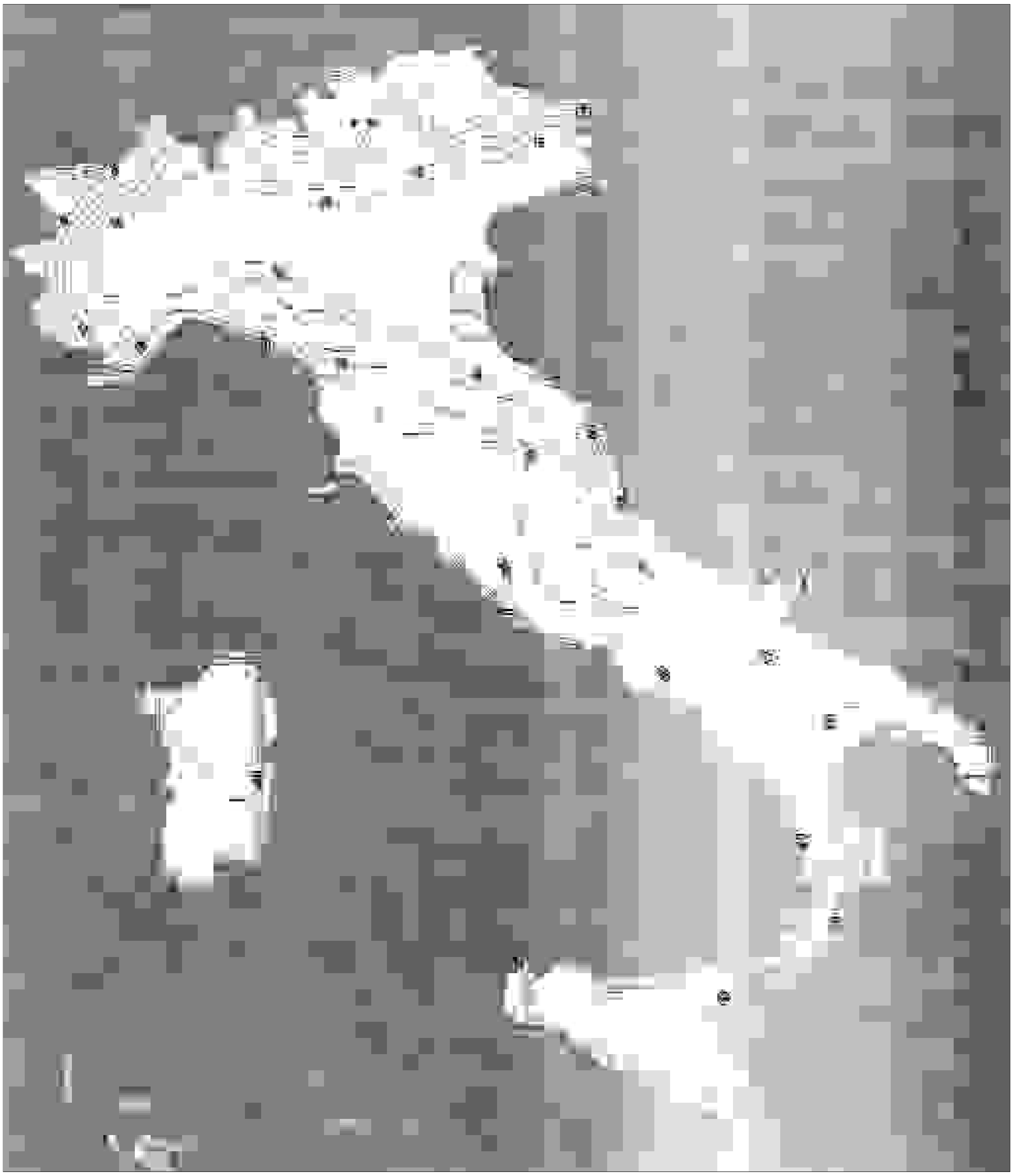
Figure 7.1a: Yearly Average of Average Temperature (1951- 1995)

Source: Ministry for Agricultural Policies

Figure 7.1b: Yearly Average of Minimum Temperatures (1951-1995)

Source: Ministry for Agricultural Policies

Figure 7.1c: Yearly Average of Maximum Temperature (1951-1995)



Source: Ministry for Agricultural Policies

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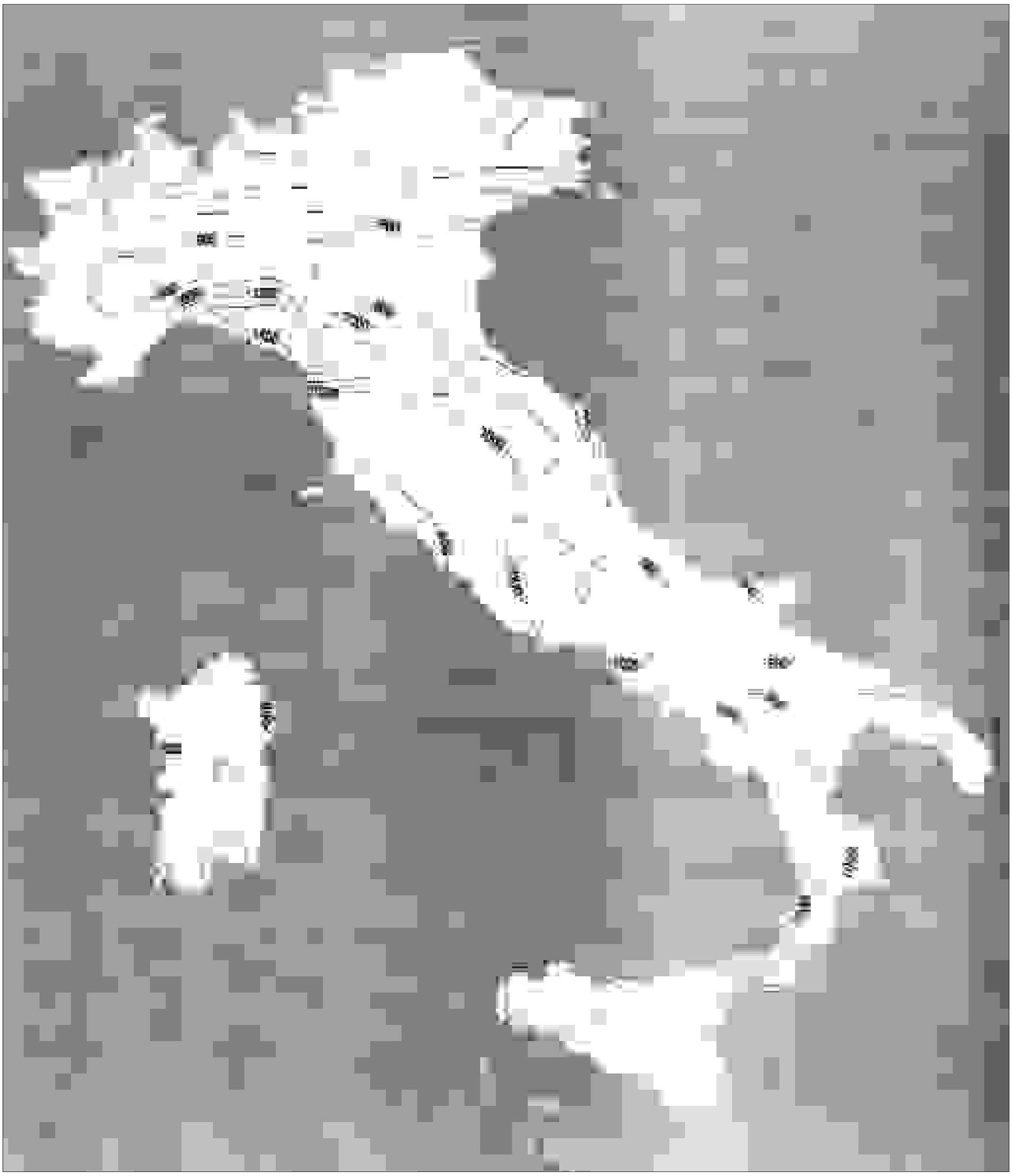
Figure 7.2: Yearly Average Rainfall (1951-1995)



Source: Ministry for Agricultural Policies

Table 7.2a: Average maximum and minimum temperatures for some stations (a) (data in C°)

Stations	1993		1994		1995	
	Max.	Min.	Max.	Min.	Max.	Min.
Cagliari-Elmas	21.7	11.9	22.9	12.6	22.4	11.8
Milano-Malpensa	16.6	4.3	19.3	7.6	17.3	5.3
Catania	22.9	10.9	25.3	12.8	23.0	10.6
Reggio Calabria	23.1	14.8	24.3	15.8	22.7	14.5
Roma Urbe	22.2	10.5	23.1	9.9	21.3	7.9
Torino-Caselle	16.9	7.3	17.7	7.6	17.7	6.9

Source: ISTAT;
(a) The data refer to the “weather year” which begins in December of the previous calendar year and ends in November of the stated year.

Table 7.2b: Precipitation for some stations (a) (b) (quantity data in millimetres; frequency in days)

Stations	1993		1994		1995	
	Quantity	Frequency	Quantity	Frequency	Quantity	Frequency
Cagliari-Elmas	455.8	53.0	260.2	51.0	288.6	46.0
Milano-Malpensa	—	—	783.1	52.0	1072.4	73.0
Catania	234.2	27.0	—	—	222.0	23.0
Reggio Calabria	510.2	62.0	404.9	50.0	303.5	46.0
Torino-Caselle	790.6	69.0	1379.2	71.0	814.2	45.0

Source: ISTAT;
(a) The data refer to the “weather year” which begins in December of the previous calendar year and ends in November of the stated year.
(b) The quantity indicates overall precipitation (snow, rain, snow, hail, etc.) reduced to water. Frequency indicates the number of days in which the amount reached a height of one millimetre.

Table 7.2c: Sunshine for some stations (a)

Stations	1993		1994		1995	
	Hours of sunshine detected	% on total maximum	Hours of sunshine detected	% on total maximum	Hours of sunshine detected	% on total maximum
Cagliari-Elmas	2575.3	57.9	2749.5	61.8	2830.7	63.6
Messina	2478.0	55.4	2649.7	59.3	2569.4	57.5
Roma-Ciampino	2555.0	57.4	2571.4	57.7	2566.1	57.6
Torino-Brick d.Croce	1852.5	41.5	1979.5	44.4	2009.3	45.1

Source: ISTAT;
(a) The data refer to the “weather year” which begins in December of the previous calendar year and ends in November of the stated year.

7.3 CLIMATE CHANGES IN ITALY

The climate is a continuously evolving system. In order to quantify the changes, we need a long series of historical data enabling us to identify both local, short-term changes and longer-term changes characterising global changes.

The recent report of the Intergovernmental Panel on Climate Change (IPCC 1995) confirms that the average global temperature has increased by 0.3-0.6 °C during the last century and by approximately 0.2-0.3 °C over the last 40 years. This global trend does not imply uniform warming but rather large area of reduction alternating with areas showing temperature increases. Italy and the Mediterranean basin, for example, have recorded a decrease of 0.5 °C in the average annual temperature in the 20-year period 1975-1994, compared to the 20-year period 1955-1974 (IPCC 95).

7.3.1 CLIMATE CHANGES IN THE PAST

Records extending over the last century can be used to measure the extent of the climatic trends. Studies on monthly precipitation and temperature data for the period 1870-1970 in 27 stations (S. Palmieri et al., 1991) have highlighted the following aspects for that period:

- the average annual temperature mainly tends to rise;
- annual precipitation does not show statistically significant changes;
- the average monthly temperature has risen in November;
- the average temperature has generally risen in Sicily, Sardinia and Southern Italy in spring and early summer;
- rainfall has decreased in April.

The analysis of this data archive does no quantify the changes and above all has not been updated since 1970.

Figure 7.3 shows the series of the UCEA Observatory at the Collegio Romano in Rome, which date back to 1782. Anomalies in average annual temperature (compared to the average value for the 30-year period 1961-90) show a rising trend of about 0.43 °C/100 years. This increase can be wholly attributed to trends in the minimum temperature. The irregularities in average temperature have different stages:

- negative anomaly patterns between 1840 and 1860;
- stationary values between 1869 and 1910;
- positive anomalies from 1920 to 1940, followed by a stationary period up to 1960;
- a cold phase from 1960 to 1980, followed by the current warm phase recording the maximum anomalous figures of the series.

The analysis of the Rome series (Todaro and Migliardi, 1992) has highlighted:

- an increase in the minimum temperature in all the months of the year with maximum increase in September (+2.3 °C) and minimum in November (+0.9 °C);
- stationary maximum monthly temperature;
- stationary total monthly precipitation rates[3];
- stationary variability for daily precipitation and temperature, except for the minimum temperature in May, showing a decrease in variability.

The rise in minimum temperature recorded in Rome and Milan (see figure 7.4) is confirmed by the IPCC results indicating that this is a worldwide trend, especially evident in the Northern Hemisphere. This change has been attributed to an increase in the cloud cover and since the same change has been observed in both urban and rural areas, it cannot be attributed sole to an increase of the urban "heat island" effect[4].

3 Although the series of precipitation anomalies and variability do not show statistically significant trends, it should be pointed out that over the past 50 years the amount of precipitation in Rome has decreased as part of the natural climate variability.

4 Other analyses based on data from several centuries in urban areas (Colacino and Conte, 1992) attribute a 1°C temperature increase in one hundred years to local environment changes.

Other studies on climate data for Milan and Padua (Buffoni, 1996; Camuffo, 1996) have highlighted the need for more in-depth analysis of the homogeneity of the historical data, often affected by systematic errors that can have a negative effect on the scientific validity of the results.

7.3.2 INDICATIONS OF CHANGES FROM 1950 UP TO TODAY

Various authors (Colacino et al, 1997, Bacci et al., 1997) have made detailed analyses of the historical series for precipitation and temperature available starting from 1950. A selection was made in Italy of 60 stations for the temperature and 40 for precipitation on the basis of criteria of completeness and reliability. The temperature data analyses indicate that:

- the temperature trend in Italy in the period 1952-1992 is mainly rising and can be attributed to the trends of the last decade.

- precipitation is stationary in 31 stations on 40, rising in 5 stations, and decreasing in 4 (in Puglia and Calabria).

The analysis of precipitation data in the period 1951-1995 (Colacino et al., 1997) extended to other measurement stations in the Mediterranean countries, shows that:

- in the Central-Western Mediterranean basin, rainfall is tending to decrease as an annual average and in the winter months, above all in January;

- the most marked reduction in rainfall is in the most southerly area of the basin;

- in Italy, precipitation shows the same trends as the entire basin.

A more general analysis of the climate data for the same period (Colacino et al., 1997a) also suggest that:

- there is an increase in anticyclone patterns in the Mediterranean basin;

- the surface air temperature in the Mediterranean is rising at rates above global averages;

- sea-level rise is no different from data observed elsewhere;

- with regard to extreme events, there is a tendency of the frequency of severe cyclones to decrease and an increase in the frequency of heatwaves.

7.3.3 SCENARIOS IN REGIONAL CLIMATE TRENDS IN THE NEXT CENTURY

The assessment of the possible impact of climate change in the next century requires the availability of a coherent data framework. The general atmospheric and ocean circulation models (AOGCM) are currently the best tool for studying the global climate and assessing the possible effects of changes in the chemical composition of the atmosphere due to human activity. The state of the art models foresee, in the long term and at the global scale, a climate change caused by the increase in the atmospheric concentration of greenhouse gases. Recently, climate simulations have been made taking into account the combined effect of greenhouse gases and man-made aerosols[5]. Incorporating the effect of aerosols, modelling projections for the year 2100 reduced the estimate average global warming to 1-3.5 °C, confirming that warming will be greater at the poles and at high latitudes. All the climate change scenarios made up to now provide for an increase of precipitation at the global level.

The models basically agree on the high latitudes, while they vary with regard to trends in the tropics. The scenarios for the years 2030-2050 (IPCC 1995) taking into account only the greenhouse gases give the following possible changes in the Mediterranean area:

- in winter a temperature increase of between 3.5 and 4.5 °C and no change in precipitation;

- in summer a temperature increase of between 3 and 4.5 °C and a decrease in precipitation of between 0.2 and 0.5 mm/day.

5 Aerosols are small suspended liquid or solid particles in the atmosphere. Aerosols are emitted by both natural sources (including dust storms and volcanic activity) and by human activity (including the burning of fossil fuels and biomass), but also spread as the product of other pollutants. Aerosols contribute to smog and can causes a decrease of the intensity of sunlight at ground level. Aerosols, as a net effect, unlike greenhouse gases, shield the earth from solar rays, thus leading to a cooling effect. According to the most recent theories, the relative stability of the climate over the last 100 years is mainly due to the high concentration of aerosols in the atmosphere.

Figura 7.3: Rome 1782-1996; temperatures, precipitations and 30 year averages

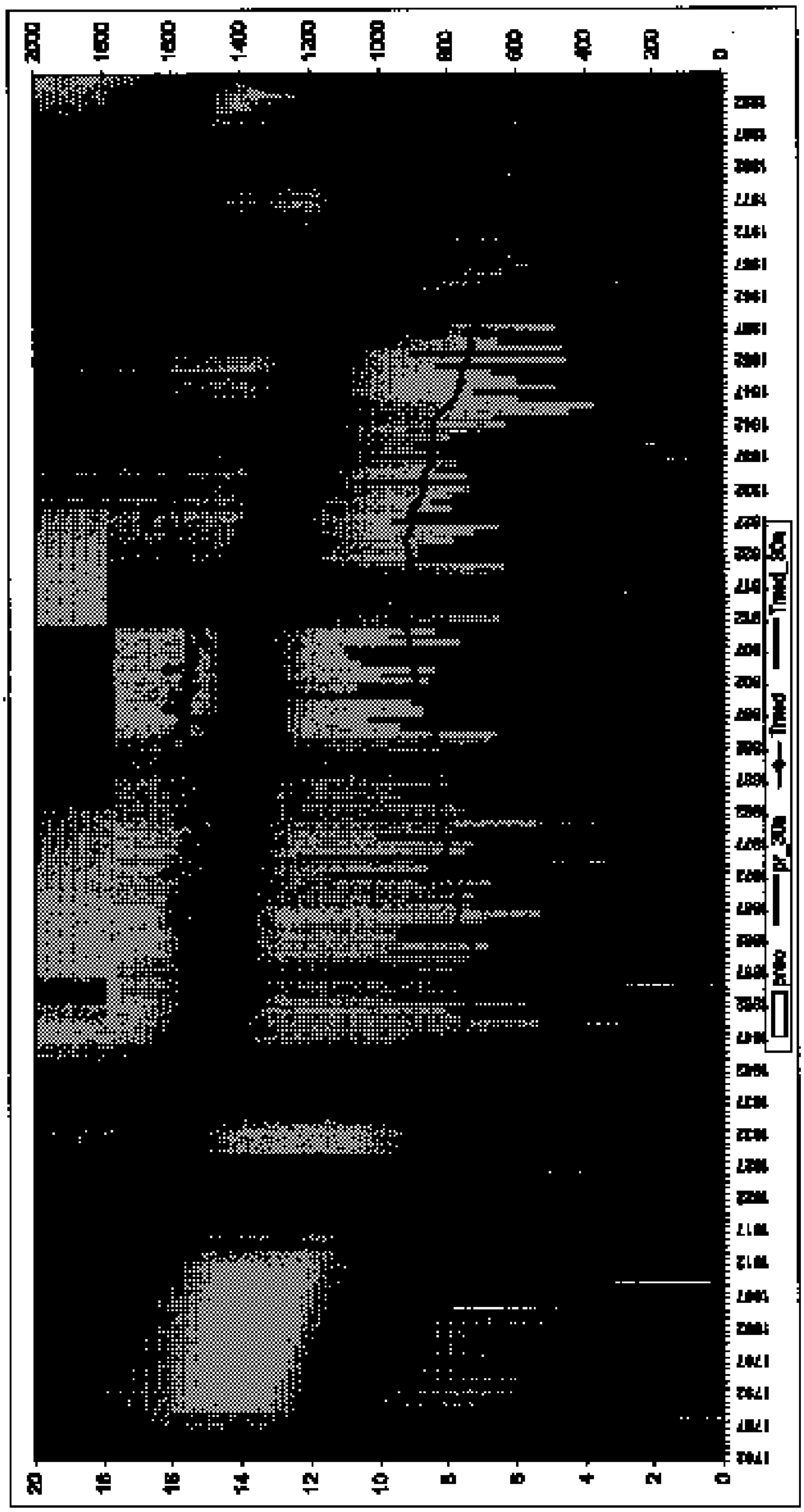
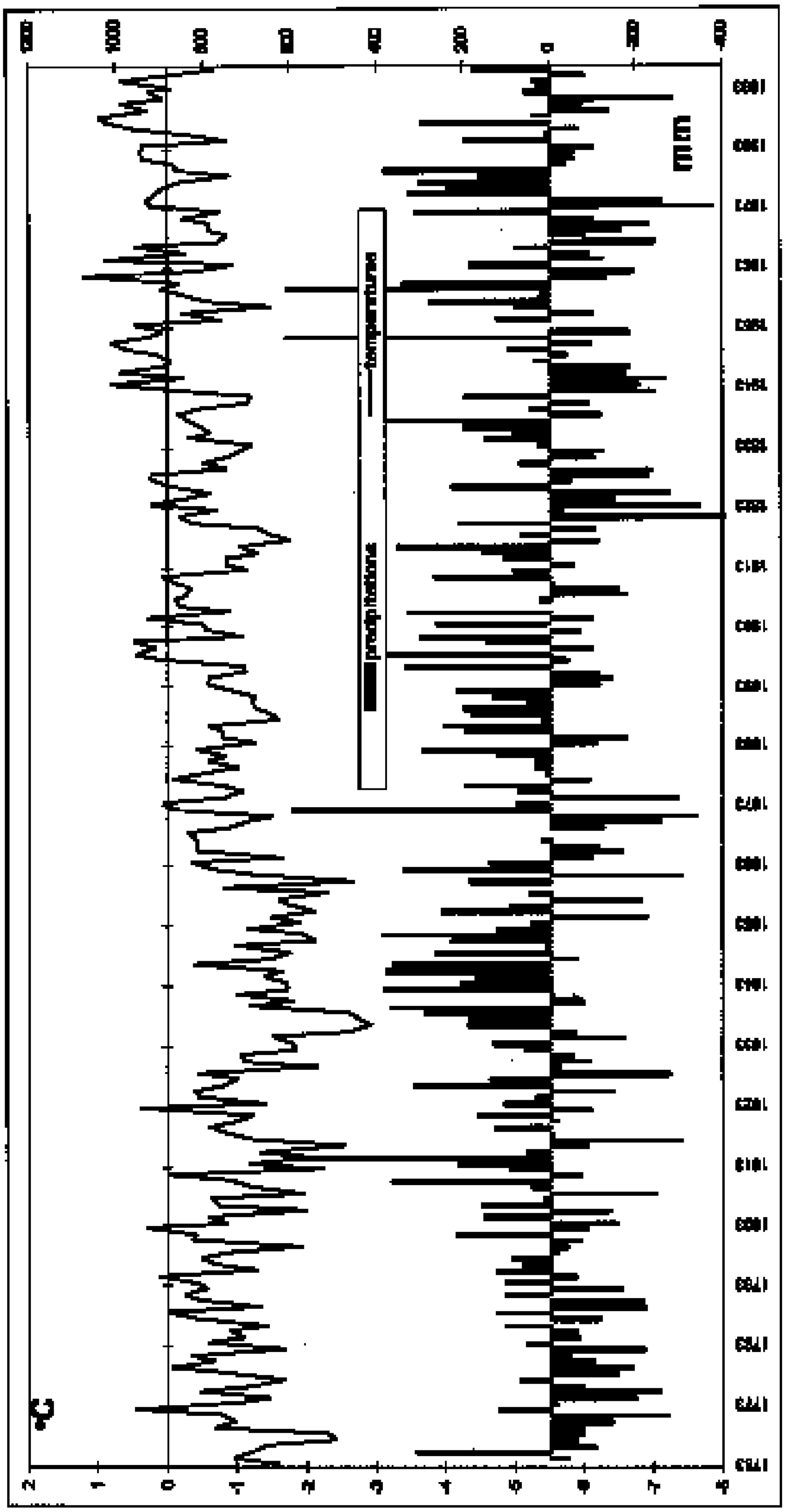


Figura 7.4: Milan 1763-1996; anomalies compared to the average value in the period 1961-1990



The scenarios that besides greenhouse gases also take aerosols into account give the following possible changes in the Mediterranean area:

- in winter a temperature increase of between 1.5 and 3.5 °C and change in precipitation of between -0.2 and +0.4 mm/day;

- in summer a temperature increase of between 0.6 and 1 °C and an increase in the precipitation of between 0.1 and 0.3 mm/day.

The results of the simulations highlight aerosols can have a very strong effect on the climate, particularly at medium latitudes of the Northern Hemisphere.

Although the most recent results confirm the trend towards global warming, it is not yet possible to formulate with confidence climatic scenarios up to 2050 on the scale of the Mediterranean basin. This is due to the fact that the contribution of man-made aerosols has not yet been sufficiently studied and the results gained up to now do not agree, above all on precipitation trends.

7.4 VULNERABILITY OF THE TERRITORY

The assessment of the implications of any climate change does not just involve climate or environment researchers. A climate change, by modifying local weather phenomena, would disturb the systems and processes upon underlying innumerable economic and social activities. Every nation or region, according to its environmental and social characteristics, has a particular type of vulnerability. The assessment of this vulnerability can be made only on the basis of current empirical knowledge correlating a wide range of variables. The forecasting of impact requires working hypotheses and reference scenarios with margins of tolerance that are hard to evaluate in advance. Although the methodology for impact assessment has been widely discussed, its application is still in the early stages.

The assessment of Italy's vulnerability to climate change, shown below, is based on the results of research activity conducted in Italy within European Union projects, as well as the results of a study conducted for the Ministry for the Environment (SIAR) by Columbia University (Rosenzweig, Tubiello, Gornitz, 1995). The assessments currently available do not take into account any considerations linked with the speed with which the changes will take place over the next 50-100 years. If, as the IPCC believes possible, the changes will occur much more rapidly than has been the case over the last 10000 years of life on the planet Earth, there will be a further vulnerability factor which cannot currently be taken into account.

7.4.1 COASTAL AREAS

In Italy, the trend of rising sea levels over the last century has been within the global average of 1-2 mm/year (Gornitz, 1995), if we exclude the areas subject to heavy subsidence, tectonic effects or bradysism.

A sea-level rise is a result of the temperature increase: it is thought that over the next 30-40 years the sea-level will rise between 8 and 29 cm (5-20, if we consider the results derived from models taking aerosol effects into consideration) (Warrick & Oerlemans, 1990).

The estimated sea level rise is higher than for the ones measured over the last decades. About half the rise will be due to the thermal expansion of the ocean, while the rest will be mainly due to the melting of continental glaciers and perhaps the ice caps (Wigley & Raper, 1993).

The sea-level rise will therefore have effects on the coastal areas. The sea-level rise scenarios for the period 2025-2030 allow us to forecast the flooding of very low coastal areas and coastal marshes, accelerated coastal erosion, the increase of salinity in estuary and delta areas due to salt water incursion, and a greater salt water infiltration into coastal groundwater. Low-lying coasts would also be more subject to flooding in case of exceptionally high waves; the outflow of rivers into the sea would be more difficult with a higher probability of flooding in case of heavy flows.

The consequences of these environmental changes can be summarised as follows:

- the incursion of seawater into coastal areas could lead to the loss of fresh water and brackish water marshes, of great importance for fishing, but also to the reduction of arable land. Considering that the lowest coastal areas are mainly located at river deltas and estuaries, the following parts of Italy will undergo greater impact: the lowest part of the Po and Veneto plain from Romagna to Friuli, the northern and southern coastline of Tuscany, the Tiber delta and the Pontine plain in Lazio, the lower Volturno plain in Campania;

- seawater infiltration into groundwater could affect all the coastal area where fresh groundwater interacts with salty and brackish water;

- faster erosion of the coastline would lead to the loss of considerable beach areas for leisure purposes and damage to tourist and residential facilities constructed near or on the beaches;

- hydraulic works in the coastal and drained areas, near or under sea-level, will require modification and adaptation.

The impact on the coastline could be even more serious if at the same time a decrease in precipitation occurs: the flows of the streams would fall, and groundwater seepage in the coastal areas would increase. If more reservoirs had to be built for water storage, there would be a further fall in the amount of solid material carried by rivers, needed to consolidate the beaches, and the impact on the coastline would be even worse.

A sea-level rise of approximately 8-29 cm (5-20 cm) on the global scale, could, along certain coastal areas, be increased or reduced by interference with local effects. Some areas are subsiding, i.e. subject to sinking due to natural or human-induced causes, while others may rise due to tectonic and isostatic causes.
In the subsidence zones the relative increase in sea level could be much greater than the one estimated due to the simultaneous sinking of coastal areas. The subsiding areas generally include the low-lying coastal plains and in particular the lowest part of the Po and Veneto plain from Romagna to Friuli. In the rising areas, the increase in sea level could trigger much less serious consequences.

Special factors like exposure of the coastline to wave set-up, currents and different erosion rates of coastal sediments could also lead to local effects of magnification or mitigation of the impact of sea-level rise.

The historical data (last 100-120 years) on changes in sea-level, recorded by the Italian Hydrographic Service (Rusconi, Ferla & Filippi, 1993), show that starting from the 1970s, the Upper Adriatic (one of the most vulnerable zones) has shown a sea-level that is stable or rising by a rate much slower than the one previously observed. This appears to contradict the trend towards sea-level increase on the global scale for the last 100 years. It could therefore be hypothesised that over the last 20-25 years there have been local and regional factors capable of mitigating the impact of the increase of sea-level in one of Italy's most critical areas, or that the increase in sea-level is occurring in a non-linear manner with decades-long periods of stasis.

7.4.1.1 Vulnerability of the Upper Adriatic coastal areas due to the combined impact of the change in sea-level and subsidence

The study of coastal trend on the eastern Po plain due to the effects of average sea-level rise caused by climate changes, and natural and human-induced subsidence over the next 100 years has been conducted on the macro scale on the coastal area between Cattolica and Monfalcone, and on the local scale in three significant site along the Romagna coast (Ravenna, Cesenatico and Rimini)[6].

The macro scale analysis has been aimed at representing coastal trends in geometrical terms, considering the rise in sea-level and subsidence of the areas. Subsidence was the result of the fall in the deep substrata, natural compacting of more recent sediments and human activities (pumping of fluids – water and gas) from the subsoil. On the local scale, besides the above phenomena, factors observed included the shoreline morphodynamics, representing the sedimentary pattern of significant stretches

6 Study conducted by the Department of Mathematical Methods and Models of the University of Padua in the CENAS-Study project on the Coastline Evolution of the Eastern Po Plain Due To Sea Level Change Caused by Climate Variation and Natural and Anthropic Subsidence (1990-1994).

of the Romagna coast and making a quantity assessment of the impact on shoreline recession caused by the apparent loss of sediment due to the change in the relative sea-level.

In order to assess the vulnerability of coastal areas to marine incursion, some realistic scenarios have been considered for three return time periods (current, in 50 years and in 100 years) regarding the effects caused only by the inherent sea-level rise and those caused by marine weather effects for return times of 1, 10 and 100 years. Using the GIS method, a comparison was made between the digital model of the land and the digital model of the sea-level changes, taking into account only inherent rising, the high water phenomenon (storm surge) and of the coastal rise due to waves (wave set-up). The intersection between the two models ha led to the extension of the areas potentially subject to flooding and the vulnerability (understood as water depth in the flooded zones) of the coastal area.

In order to generate feasible scenarios for trends in the overall physical phenomena considered here, state of the art digital simulation models for natural subsidence, subsidence due to water and gas drilling, hydrodynamic circulation and the rise of the sea-level in the Adriatic, wave generation and wave set-up have been developed and applied. The models, validated by known situations and calibrated by observed data, have been used to forecast trends in these phenomena with the scenarios hypothesised. For the average forecast rise in sea level, reference is made to the 1992 forecasts by the IPCC, again confirmed in the EPOCH project (1993) and in recent studies (1996).

Some significant results are shown in the following figures (see figures 7.5a and b), highlighting the areas threatened by of marine incursion due to natural and human-induced subsidence over the next 100 years, together with an inherent rise in the sea-level only (a) and in relation to marine weather effects for return times of 1, 10 and 100 years (b). An analysis of figure (a) shows that for much of the Emilia-Romagna area between the Po Delta and the Ravenna area (approximately 900 km^2), the potential marine incursion is independent from the time scale of the marine weather events considered, especially with regard to possible trends in subsidence, shown here in the most pessimistic scenario. Reference is obviously made to potential marine incursion since part of the coastal areas is protected by artificial barriers or dune barriers blocking flooding. In any case, with regard to figure (b), in 100 years, for effect of the average expected rise in the sea-level and of subsidence, area potentially subject to flooding is rather large (over 2000 km^2) also in relation to frequent events (1 year time span).

In the areas potentially subject to marine incursion, besides the actual flooding hazard, we should consider all the problems related to the need to create artificial drainage, giving rise to the need to build drainage works or expand existing ones. In order to standardise information on a geographical basis, taking into account local land use and the different degree of vulnerability, a flood threat analysis method has been developed on the basis of top international methodologies, outlined in Chapter 8.

7.4.2 PROCESSES OF ENVIRONMENTAL DEGRADATION AND THE HYDROLOGICAL BALANCE

The effects of the hypothesised climate changes on processes of environmental degradation and on the hydrological balance can be estimated, though not on a sufficiently quantifiable basis. The scenarios based on models do not give unanimous answers for the extent and distribution of precipitation; it is not clear whether there will be an increase or decrease in precipitation. Furthermore is difficult to determine whether any increase would actually lead to an even light increase in soil humidity (as shown in Oljenik's 1988 simulation for Central-Northern Italy) or whether, despite the increase in precipitation, soil humidity would fall due to the greater evaporation triggered by the rise in temperature.

A slight increase of soil humidity should not significantly change the environment, and could lead to the improvement of the hydrological balance of the streams and groundwater, the dilution of pollutants transported by streams and, save for particular cases, benefits to agriculture. On the basis of current climate characteristics, the impact linked to the decrease of soil humidity would be much greater on Central-Southern Italy and the Islands than on Northern Italy. The seriousness of the consequences also depends on the geological and geomorphological context, the local characteristics, land use, etc.

A decrease in rainfall for Central-Southern Italy and the Islands, associated with a significant increase of

Figure 7.5a - Extension of the areas of potential marine incursion in the Upper Adriatic due to natural and human-induced subsidence over the next 100 years, considering only the average inherent rise in sea-level due to climate changes

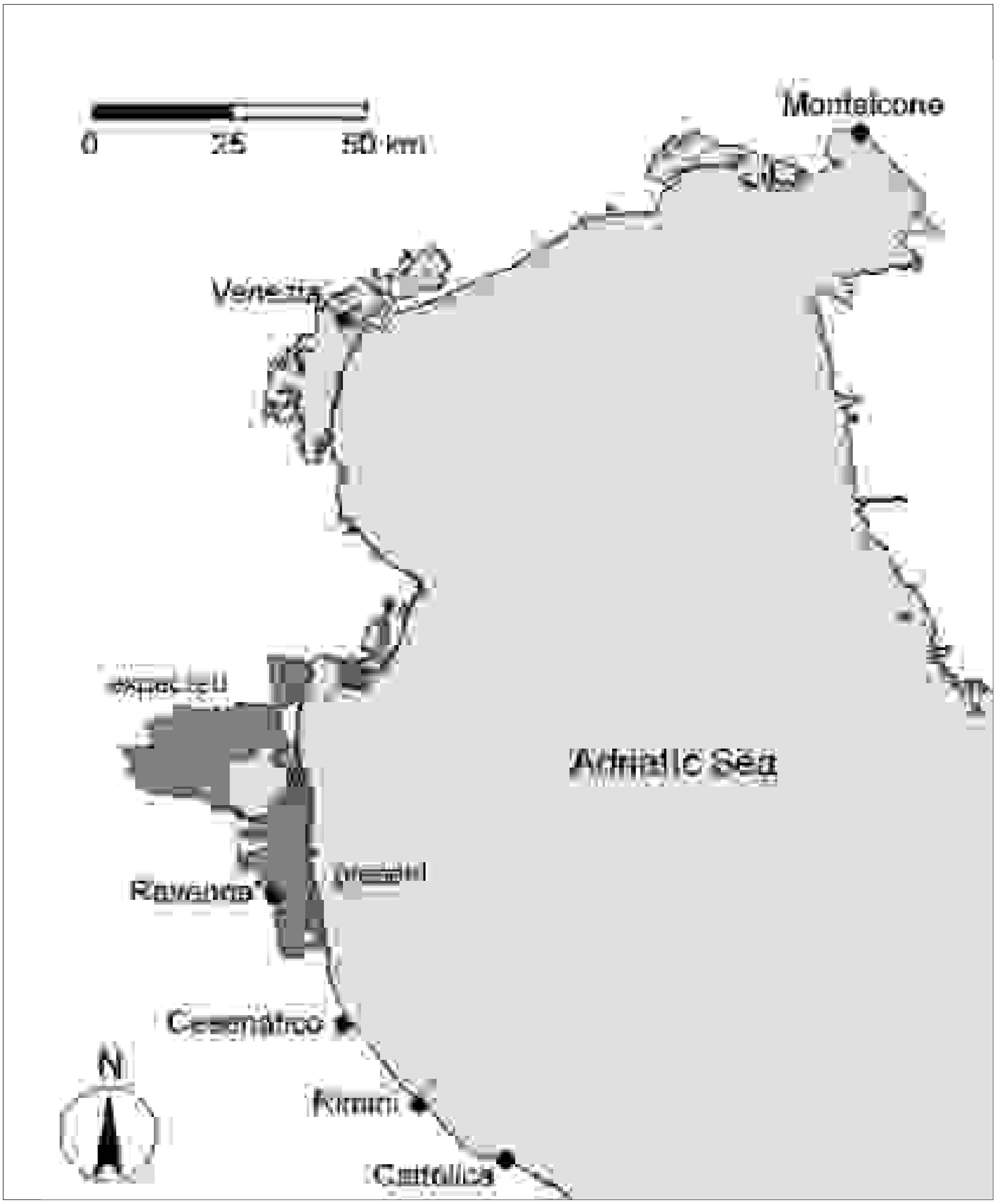


Figure 7.5b - Extension of the areas of potential marine incursion in the Upper Adriatic due to natural and human-induced subsidence over the next 100 years in relation to extreme marine weather events with a return time of 1 and 100 years rp

the average temperatures, seems likely to trigger aridification processes in the country. These processes, whose gravity cannot currently be estimated, will produce effects varying in severity from place to place, due to the morphological and geological differences. Aridification will basically have an impact on soil productivity and erosion rates, on the stability of slopes, the behaviour of streams and the sediment they transport, and on the feeding of groundwater supplies.

The range of effects on the soil and the hydrological balance of the areas affected by aridification show how serious the consequences could be on farm production, on hydraulic works and on the vulnerability of human settlements to flooding, on water resources, on energy production etc. The impact of the hypothesised changes could be mitigated in various ways by staking structural measures in advance and planning changes in the exploitation of the land and of water resources; nevertheless, the changes may cause damage which will be hard to contain.

With regard to Northern Italy, the impact could be more limited. Even if this situation did not lead to a fall in average annual precipitation, changes in the seasonal amounts and frequency of rainfall could trigger some similar effects; but if amounts were significantly lower, there would be aridification. In particular the climate changes hypothesised could trigger following effects: shrinking of glaciers (see paragraph below 7.4.5 and annexes), change in river characteristics, greater drainage of groundwater to watercourses, soil impoverishment. There would be problems due to the greater occurrence of serious flooding events, problems for agriculture, for energy production and effects on winter tourism. The hypothesised effects would in any case be felt to different extents according to the geological and morphological characteristics. River plan areas not subject to flooding could be less affected thanks to their geomorphological stability. Furthermore, since groundwater would also be fed by precipitation mainly concentrated in winter, the diminished availability of water in the irrigation canals, due to the fall of river flows in summer, could be partly compensated by seepage of groundwater.

On the whole, in Northern Italy the effects of the climate changes could be less serious than in Central-Southern Italy, and it can be assumed that these effects could be mitigated with suitable measures for agriculture and hydraulic works.

7.4.3 THE AGRICULTURAL SYSTEM

The Italian agricultural system is highly complex due to both physical and socio-economic conditions. From the physical point of view, the Italian environment ranges from mountainous and Alpine conditions in which low temperatures are the major limiting factor, to definitely sub-arid situations where the amount of rainfall is the main factor for the success of farming. One of the major threats for Italian agriculture is the frequency of extreme weather phenomena. There are many examples, also recent, of phenomena with a significant impact on the farming system, involving not only the producer, but also sometimes the whole social system. Very heavy autumn rains (from October to December) have often hampered ordinary sowing of autumn and winter wheat, undertaken in all the Italian regions; frequent, repeated cold spells in spring have often damaged many herbaceous and woody crops in both the southern and northern regions. Extensive winter drought has caused considerable falls in the winter and spring cycle crops. Event of this type occurred often in the 1996-97 season, when heavy autumn rains, extended winter drought the serious, late spring frosts caused serious damage to many sectors of agriculture in both the South and the North of the country. It follows that the vulnerability of agriculture to climate change will very much depend on a significant increase in the variability of the climate, i.e. on the possible greater frequency of extreme weather or climatic events. The analysis of the historical series for climate data of the last 50 or 100 years suggests that this frequency has actually increased significantly over the last decade (Maracchi et al., 1993), even if we cannot affirm that this is a definite manifestation of climate change under way. Therefore, only the analysis of future scenarios based on experiments using the so-called General Circulation Models (GCM) remain feasible (see § 7.3.3).

Studies also conducted in our country have shown that an average increase of the air temperature alone would not have had a negative impact on some crops typical to Italian agriculture (Bindi et al., 1995; Miglietta et al., 1995), although a non-uniform distribution f this average increase would be negative. As a matter of fact, an annual average temperature increase of 2 or 3 °C could also be very negative if it all occurred in spring and summer, with much less worrying consequence if it were uniformly distributed over the various seasons (Miglietta et al., 1995).

It should be stressed that the increase of atmospheric concentration of greenhouse gases may have major direct effects on vegetation, and consequently on forestry and farming systems. In particular, it is known that a rise in the atmospheric concentration of carbon dioxide (CO_2) has obvious effects on plant physiology and in particular on photosynthesis and transpiration mechanism. The doubling of the CO_2 concentration from 280 parts per million (ppm) of the pre-industrial era to the 560 ppm forecast for the middle of the next century could cause in most plant species an increase of up to 70% in the photosynthesis of leaves. This means that a square meter of vegetation would absorb much more carbon from the atmosphere in 50 years as compared to now or 50 years ago. Even if it would be unwise to claim that all the extra carbon assimilated through photosynthesis could be expressed as an increase in farm production, there is now definite proof that the doubling of the atmospheric concentrations of CO_2 alone could cause production increases of 10-15% for wheat (Kimball et al., 1995; Miglietta et al., 1996; Rosenzweig, Tubiello, Gornitz, 1995, see Figure 7.6), up to 15-20% in the grapevine (Bindi et al., 1995), 20-30% in potatoes (Miglietta et al., 1997). These data are the result of innovative experiments that have also been conducted also in our country, the only ones in Europe, using new technology (FACE, Free Air CO_2 Enrichment) that allow for the exposure of entire fields of crops to high concentrations of atmospheric CO_2. The results achieved in this and other experiments, besides showing that the rise in atmospheric CO_2 can stimulate growth, have also shown that the quantity of water in plant transpiration per unit of leaf area falls with exposure to high concentrations of atmospheric CO_2. This anti-transpiration effect of atmospheric CO_2 is well known to plant physiologists, but this is not enough to conclude that vegetation in the next century will "consume" less water than today. As a matter of fact, it is calculated that retroactive phenomena between plants and the atmosphere could, on a regional scale, balance out this effect observed in experiments (Miglietta and Amthor, 1996). Another important consequence of the rise in atmospheric CO_2 is a significant change in the quality of agricultural produce. Tests made up to now in FACE experiments have shown that the increase in production induced by the rise in CO_2 could be compensated by a quality reduction of the product, such as, for example, less protein in wheat (Kimball et al., 1996), less sugar in grapes (Bindi et al., 1995).

To conclude, the vulnerability of the Italian farming system or, more generally, of the Mediterranean area, will depend on the interaction between climate change factors that are hard to forecast, and the increase of greenhouse gases in the atmosphere, a factor that has now been proved. While the former could have highly negative effects on agriculture, a rise in atmospheric CO_2 could have basically positive effects. This conclusion coincides with the results published by Columbia University, using simulation models on the regional or global sustainability of the world farming system in relation to climate change (Rosenzweig, Tubiello, Gornitz, 1995).

7.4.4 FORESTRY ECOSYSTEMS AND PROTECTED AREAS

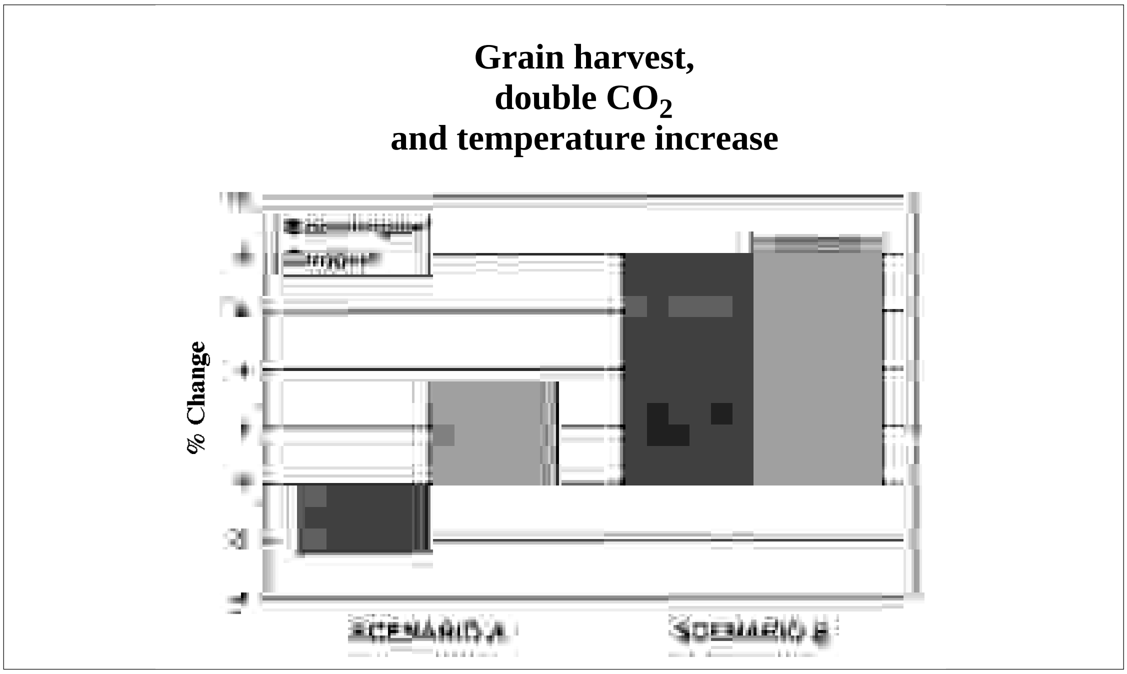
Italy has a number of ecosystems whose distribution, productivity and efficiency depend closely on the climate and are therefore particularly vulnerable to possible climate changes. From the general point of view, the Mediterranean and Mediterranean-mountain climate that characterises the whole country is already naturally characterised by periods of serious stress (water supply, temperature etc.) which make these ecosystems especially sensitive.

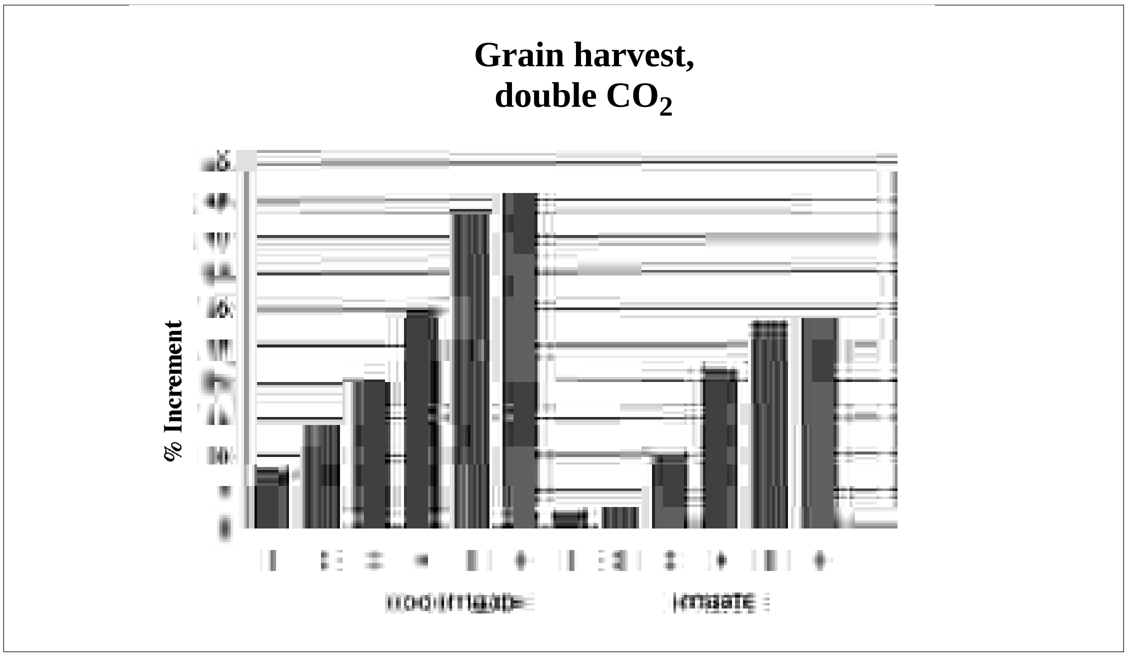
Moreover, the Italian forests also depend on the topographical and geomorphological characteristics of the various zones, given Italy's considerable variety, characterised largely by mountains with steep slopes and highly differentiated exposure and topography. This allows for the diffusion of trees and forest communities characterising both the Mediterranean environment and that of Central and Northern Europe (Bernetti, 1995).

Furthermore, the Italian forests, as in the rest of the world, not only reflect the current climatic situation but also past climatic events, in particular those of the glacial and post-glacial periods. Indeed many species of trees that now dominate and characterise the European forest landscape survived in those periods in Italy, and particularly in Central-Southern Italy. Therefore, the forest trees have adapted to climatic conditions different from the ones prevailing today, and some could also no longer be in balance with the present-day climate. The forest vegetation is distributed in phyto-climatic areas according to the latitude and altitude, from the coastal environment to the mountain and sub-Alpine ecosystems (Pignatti, 1979).

The climatic parameters that identify types of vegetation and enable the estimate of forest productivity

Figure 7.6: Simulation of the changes in spring wheat harvests for the combined effect of a doubling of CO_2 in the atmosphere and of an average daily temperature increase of 2 °C. Two possible warming scenarios are considered: scenario A shows an increase equally weighted between minimum and maximum temperature, while in scenario B the rise in the minimum temperature is greater than that of the maximum. The figure highlights interaction with irrigation techniques (Tubiello et al., 1994, in press)





correspond to the mean annual temperatures, the average and absolute minimum values, annual difference between maximum and minimum, the annual and summer precipitation and summer rainfall with evapo-transpiration (Pavari in Piussi 1994).

Approximately 50% of Italy is characterised by a climate corresponding to potential forest vegetation of the Mediterranean type, evergreen or deciduous and xerophylls (average temperature 16 °C ± 4 °C). 35% of Italy is potentially in the area occupied by sub-mountain forests of broadleaf shade intolerant trees flourishing in sunshine (average temperature 12.5 °C ± 2.5 °C) while only 16% of forest area in the mountain and sub-Alpine category, with forests of beech or fir (respective average temperature 9 °C ± 3 °C and 4.5 °C ± 1.5 °C). From these indications, inevitably simplified, we can already conclude that average annual temperature increases of 2-4 °C could lead to an upheaval in the geographical distribution of forest vegetation, with a northward and upward shift (in latitude and altitude) of the various phyto climatic areas.

However, vulnerability of forest vegetation to climate change will be reliable when climate forecasts become sufficiently significant and convincing.

With regard to the more recent scenarios produced by the IPCC and the latest studies on the historical data series of the Italian climate (§ 7.3), the following points can in any case be made (Kirschbaum and Fischlin, 1996):

- it is highly important to consider the interactions of the climate with other aspects of global changes such as the increase of the atmospheric concentration of CO_2, the increase of nitrogen depositions (Becker et al. 1994), changes of type and intensity forest management and the accumulation of biomass as well as dead organic matter in forest ecosystems;

- the phytoclimatic parameters seem to indicate on the whole a shift of the climate and therefore of the vegetation to a reduction of continentality;

- the change in the specific composition of our forests could occur in the mountain and sub-Alpine areas, with a probable reduction of the diffusion of typically continental species (e.g. spruce, larch and perhaps the white fir);

- there will probably be a greater occurrence of fungal and animal parasites favoured by higher winter temperatures (increase of the minimum temperature) and precipitation that could rise in the vegetative period. In this regard we can recall that important forest trees specifically need a winter cold period; if these needs were not satisfied, the forest community would be gradually weakened and more subject to attack by parasites.

- if a reduction in spring precipitation occurs, there will probably be weakening parasite attacks on Mediterranean oaks, especially the Quercus cerris L., associated with the impact of water supply stress;

- is it highly likely that there will be greater summer water stress on Mediterranean vegetation and the disappearance of the last portions of hygrophilous plains forests (deciduous oaks) currently growing in the alluvial plains, especially in coastal areas;

- there will be greater fire risks in summer for Mediterranean vegetation and of winter fires for Alpine forests; moreover we can forecast an increase of damage due to avalanches, flooding etc. Reforestation and natural forests, if well managed, could reduce the impact of these events on human activities.

Eight ecosystems particularly vulnerable to climate change have been identified in Italy [7]:
1) plains forests with Quercus robur and Carpinus betulus (Querco-Carpinetum boreoitalicum): azonal, closely depending on the area of the groundwater supplies;
2) coastal and river banks forests with Alnus glutinosa and Fraxinus oxycarpa (Populetalia albae): azonal, closely depending on temporary accumulation of water in the area;
3) marsh vegetation (Phragmitetea): azonal, closely depending on prolonged accumulation of water in the area;
4) peat vegetation (Scheuchzerio-Caricetea fuscae, Oxycocco-Sphagnetea): azonal, glacial residue, closely depending on prolonged accumulation of water in the area and low temperatures;
5) shrub vegetation with Pinus mugo of the Apennines (Vaccinio-Piceetalia): 1500 to 2300 m above sea-level, glacial residue, closely depending on cold continental climate with long-lasting snow cover;

7 On the basis of data and assessments provided by the Ministry for Agricultural Policy, Department of Forest, Mountain and Water Resources.

6) shrub vegetation with Vaccinium myrtillus of the Central Apennines (Vaccinio-Hypericetum richeri): 1500 to 2300 m above sea level, glacial residue, closely depending on long-lasting snow cover;
7) Mediterranean-mountain meadows with Sesleria tenuifolia (Pediculari elegantis-Seslerietum tenuifoliae): 2000 to 2300 m above sea-level, pre-glacial residue, depending on the Mediterranean climate and topography;
8) Alpine tundra with Silene acaulis and Kobresia myosuroides of the Central Apennines (Saxifrago speciosae-Silenetum cenisiae, Leontopodio-Elynetum): 2300 a 2800 m above sea level, glacial residue, closely depending on the cold continental climate of high altitudes.

For most of these ecosystems the predictable consequences of climate change are the decline and total disappearance of the populations of the original species, which are unlikely to be replaced by populations of other species, since the latter are not very adapted to the peculiar conditions of the ecosystem. This will lead to the total disappearance of the ecosystem in the area. Exceptions include high altitude meadows of Sesleria tenuifolia that could actually extend their area at the expense of other vegetation.

In particular, the replacement of the plain, coastal and river banks forests with ecologically similar vegetation is often made impossible by the fragmented nature of the areas concerned and the absence of suitable alternative vegetation in the area; it can therefore be expected that these ecosystems will undergo complete extinction. In the case of marsh vegetation, there is likely to occur a significant regression, with massive invasions by the community of flooded meadows (Molinio-Arrenatherea). In the peat areas, the regression process is almost imperceptible, since the soil conditions are to limiting for species that are not well adapted such as those typical of these habitats: the niches left empty by these species will therefore remain empty. With regard to Pinus mugo and Vaccinium myrtillus shrubs, there is a rapid regression towards high altitude xerophyll meadows with Sesleria tenuifolia that therefore will expand at the expense of other vegetation. It is only this ecosystem that will not suffer significant consequences. The decrease of stress due to the rise in temperature (that causes the disappearance of the plants adapted to cold) is actually compensated by the increase of stress related to greater aridity. The Alpine tundra, characterised by frequent occurrence of microthermal species (glacial residues), will also undergo rapid regression towards Sesleria[8] meadows.

The National and Regional Parks of the Central Apennines would be particularly affected by the disappearance of the original species of alpine tundra and the gradual decline in the Pinus mugo populations. In many State Reserves and WWF Oases we could expect the disappearance of the plains, hygrophilous forests and the regression of marsh vegetation.

The small animal populations living in colder areas (glacial residues) will undergo a decline. This process, however, will presumably be slower than for plant populations because of the relatively greater mobility of animals.

Conservation problems would be exacerbated by other phenomena in the ecosystems of the protected areas:

- easier propagation of fires linked to rainfall reduction and the lengthening of the dry periods;
- the worsening of slope stability due to irregular and more intense rainfall;
- the different effects (floods, erosion, saline intrusion) of the increase of the sea level, in particular on dune systems.

With regard to management strategies, we should recall that most of the Italian protected areas and in particular the National Parks, are subdivided into zones with various protection levels. The inclusion of particularly vulnerable ecosystems in completely protected areas would help prevent the impact of climate change from being exacerbated by man-made destruction. The creation of suitable ecological corridors would facilitate the adaptation of the ecosystems to changed climatic conditions, allowing for processes of species migration which would otherwise be impossible due to the highly fragmented nature of Italy's forest and natural vegetation cover.

8 On the basis of detailed information on the distribution in Italy of these ecosystems and all the areas where it is observed, WWF-Italy has identified protected areas most vulnerable to climate change.

7.4.5 THE ITALIAN GLACIERS

According to recent estimates, Italy has about a thousand glaciers covering a total area of approximately 600 km^2. Except for a small Apennine glacier - the Calderone Glacier, the most southerly one in Europe – they are located in the Alps, of which they represent 21% of the total glacial area (Smiraglia, 1992).

Some glaciers have an area of over 10 km^2 and are several km long, with tongues going down into the valleys to the timber line, but most of them are small mountain glaciers, hidden in hollows and gullies at high altitude. If we rule out the highest altitude portions, the Italian glaciers are wholly formed by ice at freezing temperature, and are therefore highly sensitive to temperature changes.

Forecasts on the future behaviour of the glaciers

The upward regression of the equilibrium front Italian glaciers in last century has been estimated at between 100 and 130 m. If we initially attribute this change entirely to an average annual temperature increase, we would have a value of 0.5 - 0.7 °C, i.e. the same size generally confirmed on the basis of processing of instrument data (Climate Change 1995).

Again from the initial point of view, it is therefore possible to forecast the future upward receding of the equilibrium front if current warming trends continue, on the basis of different hypothetical values. For each glacier we can estimate when the equilibrium line will recede to a higher altitude of the glacier, extending the ablation area to the entire glacier (this has already occurred for 15 years in the Careser Glacier), subsequently leading to its disappearance. If this trend were to continue, the small glaciers would be severely reduced or transformed into areas of dead ice covered by debris in about a century. The larger and higher altitude glaciers could still survive for centuries. The phenomenon would be obviously accelerated in case of an average annual temperature increase of over 1 °C.

Forecast consequences of a further contraction of the glaciers

The continuation of the current phase of receding in the alpine glaciers could have consequences on the high mountain environment. Besides the reduction of the water resources for the production of electric power and the loss of a tourist resource, we can expect more dangerous situations related to the instability of the ice masses and the surrounding slopes. For example, there could be more frequent collapses of glacier fronts (Coolidge Glacier, 1989; Grandes Jorasses, 1997), rockslides on glaciers possibly leading to avalanches (Brenva Glacier, January 1996), glacial breakages, i.e. sudden emptying of lakes within or under glaciers (Dutto & Mortara, 1993). Furthermore, a temperature increase would affect Alpine permafrost (permanent ice in the ground and cracks of the rocks) threatening the stability of the slopes and any buildings located there. In polythermal glaciers, an increase in temperature would produce the detaching of parts of the “cold ice” (temperature under 0 °C) bound to the substratum and would introduce changes in endoglacial water circulation, one of the factors controlling glacier dynamics

The slopes and deglaciated areas covered with debris, often with an ice core, would be exposed to collapse and sliding, and there would be an overall increase in solid material in watercourses with the filling of ponds attenuating stream flow.
Deglaciated rock slopes would be exposed to collapse and landslides (Climate Change 1995). In general there would be an increase and the expansion too higher altitudes of the areas exposed to the typical risks of the alpine environment, with consequences affecting valley areas below.

7.4.6 MARINE BIODIVERSITY

The Mediterranean ecosystem is characterised by a high degree of diversity, basically due to the biogeographical heterogeneity of the flora and of the fauna. Climate changes can have a significant effect on marine biological diversity (Reid & Miller, 1989). Various effects can be identified, such as, for example, the direct influence of the temperature on organisms, that causes alterations in survival capacity, reproduction success, dispersion patterns etc. These effects involve biotic interactions and indirect effects related to marine currents. The main consequences can be identified as change in population size and in species distribution, alteration of the specific composition, of geographical extension of habitats and ecosystems, and increase of extinction rate of species.

Many efforts have yet to be made to improve our understanding of the ecosystem responses to environmental alterations stemming from climate changes. As a matter of fact, it is not always easy to relate climate change with changes in population and of the community structure, also because there are often overlapping effects of human pressure (Bourcier, 1996). Furthermore, the resilience of ecosystems is largely determined by the degree of human impact to which they have already been subjected. Consequently, the changes related to climate changes cannot be considered as simply natural factors.

From the biogeographical point of view, the temperature in the Mediterranean has been shown to have great influence, determining either directly or indirectly the current composition of flora and fauna (Sarà, 1985). The biodiversity patterns are currently subject to changes that can be relayed to the temperature increase of the seawater; a number of biological indicators confirm this (Francour et al., 1994). For example, in the NW sector of the Mediterranean, an increased occurrence of southern species has been observed. An ENEA research programme has highlighted a latitude shift in the location of species and in the migration of the their limits of geographical distribution as a possible response to a temperature increase. This applies to a number of marine species such as algae, Enidaria, echinoderms, molluscs and fish reported in the Ligurian Sea (Bianchi & Morri, 1994). The northward expansion of these species over the last ten years has been related to the increase in temperature recorded in intermediate and deep waters of the Ligurian Sea, and of the air temperature.

Abundance and structure of plankton community, respond rapidly to environmental changes, and the effect of a slight temperature increase probably has a significant influence on plankton population. Long term historical data on plankton are of great value in highlighting the influence of climate changes on marine communities (Southward, 1995). Up to now, only partial use has been made of historical data on phytoplankton and zooplankton, available for a number of sites along the Italian coast (Adriatic, Ligurian and Tyrrhenian Sea). Some urgent questions are still without answers, such as the predictability of algae bloom and the change in the availability of food for fish stocks in relation climatic influence.

The combined action of human impact and climate change is showing a negative influence on many marine species. One of the research topics covered by ENEA researchers is the regression of the Posidonia oceanica meadows along the Italian coast. These meadows given the multifunctional role they play along the coasts (high rate of production, nursery for the youthful stages of many species, high biodiversity, etc.) have been included in the UNCED Action Paper (Agenda 21) as ecosystems requiring priority protection. The regression of Posidonia has accelerated over recent years and in the Ligurian Sea approximately the 30% of the original areas have been lost in the last 30 years (Bianchi & Peirano, 1995). The changes linked to the temperature, but above all urbanisation have been identified as possible causes of the regression.

Recently introduced species such as Caulerpa taxifolia are very successfully colonising the Italian coastal areas. In the 1992 the alga was reported in Leghorn and Imperia (Porto Maurizio) and subsequently in other ports of Liguria (Boudouresque et al., 1995). C. taxifolia is dominant compared to the indigenous seaweeds thanks to the high growth rate and to the capacity of occupation of the substratum, leading to a considerable decrease of the eco-diversity in coastal ecosystems. The growth of the tropical alga is closely related to the temperature of the water: it survives up to a temperature of 7° C, but does not grow until the temperature reaches 15° C. The purpose of some experimental studies under way is to verify the relationship between the colonisation processes and the climate changes[9].

The seasonal and year-to-year variability of the growth of some bioconstructor biocenoses is currently being studied (Cocito et al., 1997). The biological concretions play a fundamental role in many Mediterranean ecosystems. Thanks to their intrinsic value for biological diversity, they have enormous scientific and economic interest. Some of these, e.g. coral, are currently in danger (Bellan-Santini et al., 1994). The analysis and the assessment of the role of bioconstructor organisms are highly important since their activity is closely related to the carbon dioxide cycle. As a matter of fact, an increase of the atmospheric carbon dioxide in the atmosphere concentration due to the greenhouse effect may favour the dissolving of this gas in seawater. This, in turn, could affect the calcium carbonate deposition rates and, consequently, the activity of the bioconstructor organisms. The influence of the temperature and the carbon dioxide content on the

9 ENEA is defining measures for location and mapping some areas on the sounding-depth of the Ligurian Sea.

metabolism and turnover rates of the organisms must be assessed in detail.

While climate changes have been shown to affect long term marine production, it is not easy to achieve a precise correlation between the trends observed in marine ecosystems and shorter-term climate changes (e.g. over a few years). Unfortunately, there are not many historical series for biological surveys. Long term biological historical data is available only in the fishing sector for the analysis of climate change, but not in the Mediterranean. Data are currently available for some fish species in the Adriatic. However, the studies need to be supported by long-term monitoring since the main changes in the ecosystems occur over decades.

7.4.7 HUMAN HEALTH

The possible impact of climate change on the health of the human population can be due to direct or indirect causes. The direct causes include those due to the increase of severe weather events such as tornadoes, heatwaves, floods and drought; the indirect ones include a number of pathologies related to the greater diffusion of infectious organisms. The health implications for Italy are undoubtedly less serious than for the developing countries, more vulnerable to infectious diseases (WHO, 1996).

Reference is made here to health problems that could be significantly affected by climate changes, such as the increase of temperatures and precipitation, together with a number of resulting demographic factors such as uncontrolled migration flows from non-European regions.

1) Diffusion of organisms acting as carriers of infectious diseases (malaria, dengue etc.). Malaria is caused by unicellular parasites (plasmodium) that propagate from a sick to a healthy individual by the bite of a mosquito of the genus Anopheles.
Approximately 50 of the over 400 species of Anopheles may propagate the four species of parasites causing malaria in man. The lifecycle of the parasite in man starts with the bite of the mosquito carrying plasmodium. With its saliva, the Anopheles transfers thousands of sporozoa that circulate in human blood reaching the liver. They mature here before returning to the blood and acting on the red blood cells. The correlation between climate and malaria is due to the fact that the development of the Anopheles depends on environmental parameters such as temperature and humidity. A higher air temperature and the presence of stagnant water favour the reproduction of the Anopheles. In Italy the malaria was endemic before the 1950s, and was widespread in all the marshy areas. It was subsequently eradicated from the whole country, so that in the 1970 Italy was included in the list of countries free from this disease. Since then in almost all the cases reported, the disease has been contracted in tropical and subtropical countries, only a few cases having been caused by blood transfusions, and only one case being suspected of having been transmitted by a carrier brought accidentally into Italy. Apart from the epidemiological considerations, the analysis of future climatic scenarios (Martin, 1995) indicate the possible extension of the area of endemic malarial diffusion, with Italy coming back into this area. If we add that due to environmental (desertification) or demographic (overpopulation) reasons, millions of people will abandon their homelands in developing countries where this disease is already endemic, we can see that the health risk due to the return of malaria is not to be ignored. Moreover, since 1990, the Aedes albopictus, a mosquito originating in Asia that can be a major carrier of dengue fever and filariasis, has been introduced into Italy through used clothing imports. Since then the Aedes has spread in Italy and in 1995, 10 regions and 19 provinces have reported the insect. Up to 1994, no cases of dengue have been reported, but the Aedes could play an important role in the transmission of canine filariasis.

2) Diffusion of infectious diseases not due to carriers (cholera, salmonellosis, etc.) following the proliferation of microorganisms due the increase in temperature. There are no specific studies on this topic. Many food-related infections are influenced by the temperature of the environment and have their annual peaks in the summer season; it is therefore logical to expect their increase following a rise in temperature. Furthermore, a greater diffusion of some infectious diseases is likely to occur due to the decrease in the availability and in quality of drinking water following increased floods or drought.

3) Changes in mortality and the occurrence of pathologies could take place due to changes in the frequency and severity of heatwaves and to less severe winter weather conditions. There are no European surveys on this topic, but extrapolating the data of an American study, an estimate has been made for the European Union of approximately 9,600 additional deaths (above all among persons at risk due to previous cardiovascular and respiratory diseases) from heatwaves due to an average temperature increase of 2.5 °C. The studies also

indicate approximately 800 cases of death avoided due to less severe winters.

4) An increase in respiratory disease related to the increase of spores, pollen and pollutants in the atmosphere. The temperature increase favours the spread and the persistence in the atmosphere of spores and pollen, leading to a rise in allergies such as asthma and hay fever. These conditions likewise favour the production of photochemical smog, a phenomenon already significant in our country, so that a definite increase of respiratory disease can be expected following climate changes.

5) An increase in mortality and the incidence of pathologies related to the greater severity of extreme events (floods, drought, storms etc.). There is no research able to quantify this effect in Italy or Europe, but the number of victims caused by extreme events is relatively low for the entire European continent. The high level of the infrastructures available should not make this factor particularly significant for Italy.

6) Indirect effects on health following changes in social and economic conditions due to climate changes. Only very marginal sectors of the Italian population would be involved in changes in economic and social conditions caused by climate changes; this could derive from effects of the climate changes on investments, on the distribution of wealth and population mobility.

7.5 CONCLUSIONS

The results of studies on climate trends, using data sources currently available, are insufficient to confirm the existence of climatic change of anthropogenic origin in Italy. The only statistically significant historical series analysed in detail is the one for Rome. The analysis of this series indicates stationary precipitation and maximum temperatures in the period 1830-1990. The increase of minimum temperature observed in this series, undoubtedly partly due to the urban heat island effect, is not necessarily attributable to a change on the global scale. Although there are other historical series comparable with the one for Rome, their reliability and validity is still being studied. Their analysis is indispensable for providing a scientifically valid response for Italy as a whole.

Other data series that are shorter, and therefore have less climatic significance, have been analysed to detect signs of climate change.

The data series for temperature analysed show significant increases, above all in the last decade; precipitation does not show significant trends, except for some series in Central and Southern Italy. The rise in the air temperature also observed in Italy in the last decade makes the theory that climate change is already under way in Italy plausible, although not scientifically ascertained. The assessment of the trend of the Italian climate has not made significant advances over recent years, despite the commitment of individual researches in various institutes.

Although the research agrees on future scenarios involving an increase of temperature in Italy, the amount and space-time framework of the possible changes of precipitation are still too uncertain to be able to quantify the possible impact. In terms of scenarios, it should therefore be hypothesised that together with a possible rise in temperature, on which all the studies currently seem to agree, there could also be an increase or a decrease of the precipitation.

- If precipitation and soil humidity remain stable or higher, the impact of climate change will above all concern coastal areas and ecosystems due to the rise in sea level, and the high mountain areas and ecosystems, where the glaciers will recede.

- The impact of the climate changes forecast in the scenarios that suggest, besides a temperature increase, a fall in precipitation and of soil humidity, would have much more serious effects on the land, ecosystems and agriculture in Italy. These effects would be more severe in Central-Southern Italy.

Paleoclimatic studies conducted in Italy could validate the scenarios developed by the use of models. During the recent geological past, in the part of the last interglacial period (Holocene), the period in which we live, and the previous one (Eemian), warmer periods than at present seem to have occurred. In the Holocene, before 5000 years from the present, the glaciers have been smaller than today (Baroni & Orombelli, 1996; Peretti & Charrier, 1964). In the Eemian, the sea-level was higher than now (Dai Prà, 1995). During these periods, soil humidity, estimated by examination of soil strata, the levels of the lakes and considerable extent of the forests, seem to have been greater than now (Follieri et al., 1988; Frezzotti & Giraudi, 1989; Giraudi, 1988). The comparison between the situation in the past and the hypothetical future scenario must be viewed with caution. The past and future scenarios formulated with paleoclimatology and with the use of models obviously have various degrees of uncertainty. Moreover, human impact, a basic factor in our time, was irrelevant in the Eemian and only slight in the prehistoric period. However, the convergence between the results derived from paleoclimatological studies and the scenarios showing future rises in temperatures and, partly, of soil humidity, could suggest that these scenarios may be more reliable for the near future.

The impact due to possible climate changes, are intrinsically more uncertain than the environmental scenarios on which they are based, since they involve the effect of social and economic factors. There is currently no comparative vulnerability analysis quantifying the risk of environmental changes and economic damage in Italy. The indications contained in this report, derived from research experience, are the necessary premise to conducting assessments for the whole country. The transition from the local/experimental dimension to the national level to face the problem of vulnerability in quantitative terms would require greater human and financial resources than the ones available to the research bodies that have contributed to this work.

In the light of current knowledge, we can say that among the ones examined, the agricultural and forestry sectors and the coastal areas are the ones most exposed to significant damage. The assessment of their vulnerability requires the development of an evaluation methodology on the national scale which will best exploit the existing resources and the new ones dedicated to this research.

8. Adaptation measures

Vulnerability to the consequences of climate change can be reduced by means of intervention concerning administration, technology and public opinion information and participation. In densely populated countries like Italy, many of the available technological options are well known and have often been used for centuries in order to protect the land from various natural phenomena. In some cases, climate change can be expected to require better planning of intervention and the enacting of stricter planning standards than the ones normally used. There are situations however, the most obvious example of which is the city of Venice, where the seeable environmental changes are so serious that strategies and interventions thus far never taken into consideration will become necessary. It is currently extremely difficult to estimate the financial commitment and the extent of the social and cultural acceptability.

This chapter will survey some of the most recent developments in Italian legislation on planning in environment planning and management and of the specific situations of the Venice Lagoon and the Po Delta.

8.1 THE INSTITUTIONAL FRAMEWORK FOR LAND PROTECTION IN ITALY

Law n. 183 of 18 May 1989 entitled "Regulations on the organisational and functional reform of land protection" is the major law currently in use for ensuring coherent planning of intervention for environment protection and the restoring of the hydrogeological balance. It has been used to introduce new planning models for protecting the land, cleaning the water, using and managing water resources for rational economic and social development and protecting related features of the environment.

The instruments for protection deriving from the law are implemented in homogeneous areas through "basin planning" regulations designed in art. 17 of Law n. 183/1989, considered as the regulatory, information and operational instrument for planning intervention and practical rules for the conservation, protection and improvement of the land and the direct use of resources. The "basin plan", applicable as the local planning instrument to which the other local planning and environmental measures must be adapted, lays down binding rules for the public administration and for the private individuals.

The institutional and organisational structure was reformed. The country is divided into watershed areas or basins on the national, inter-regional and regional scale. There is a Basin Authority for each national basin, with the main function of drawing up forecasts and plans for determining the main trends for environment protection and for planning and checking of the implementation of the basin plans and the corresponding measures for implementation. The Basin Authority provides for co-operation and co-ordination of intervention by the central and regional authorities. Decrees of the President of the Council of Ministers dated 10 August 1989 set up the national Basin Authorities for the Po, Adige, Arno, Tiber, Liri-Garigliano, Volturno, Isonzo, Tagliamento, Livenza, Piave and Brenta-Bracchiglione rivers. Law n. 183/1989 also calls for the setting up on an experimental basis of a pilot regional basin for the Serchio river. This was later assimilated from the institutional and organisational point of view with the basins of national importance, pursuant to Law n. 253 of 7 August 1990 ("Additional measures to Law n. 183 of 18 May 1989 with regulations on the organisational and functional reform of land protection").

The Basin Authority has the following internal structure:

- the Institutional Committee, for political decision making and co-ordination of the central and peripheral organisations having jurisdiction;
- the Technical Committee, a body of experts;
- the Secretary General as the organisational and operational point of reference for implementing the decisions of the Institutional Committee;
- an operational and technical Secretariat.

The Minister of Public Works chairs the Institutional Committee in basins of national importance, and the Minister of the Environment for matters under its jurisdiction.

Law n. 183 of 18 May 1989 also provides for the transfer to the regions of the operational functions in the water sector, planning for rivers in the regional and inter-regional basins. The Minister of Public Works has no jurisdiction there except for guideline powers exercised through the Committee of Ministers stated in art. 4 of the same law. In art. 10 point 7 the delegates jurisdiction to the regions, in compliance with the general guidelines and criteria laid down by the central government regarding the administrative functions of the central government in the defence of the coastline. Excluded from regional jurisdiction are the areas of basins of national importance and areas of major national interest for the security of the State and for maritime navigation. The main criterion for drawing up these guidelines is based on the defence of the coastline as such, as well as promoting organic, global protection of the land in terms of physical interaction (solid sediment from rivers) and of the social economic and environmental aspects. The guidelines involve the co-ordination of the needs of different branches of the administration and should also include technical rules for the execution of the measures.

The setting up of the regional and inter-regional Basin Authorities is a basic factor for implementing Law n. 183/1989. However, this is an area where significant, overall delays have occurred, particularly in the Southern regions. There has been a serious delay in the operation of the Technical Committees to assist in the planning of intervention and measures in the defence of the land.

Besides the local structure described up to now, Law n. 183 also calls for a central structure composed of the following:

- the National Committee for the Defence of the Land (art. 6, Law n. 183/1989) with task of making proposals and providing consultancy to the Ministry of Public Works;
- department for the Defence of the Land of the Ministry of Public Works, assigned with the task of providing basic guidelines and co-ordination for the implementation of the law;
- the National Technical Services (water resource and oceanographic service, seismic service, dams and the geological service) due to be reorganised at the Department of the President of the Council of Ministers. The services will have the task of re-organising, managing and co-ordinating a single information service and a national survey and supervisory network in the sector of the defence of the land.

Besides the need to plan intervention to protect the environment, taken into account by the laws described above, it is equally urgent to review the regulations on water resources management, fragmented into a number of laws and regulations. The fact that there were several legislative sources was also partly due to the concept of keeping the use, distribution, protection and re-use of water in distinct categories.

In 1994, Law n. 36 entitled "Regulations on water resources" was issued. The law provides an organic, overall framework for the management and protection of water resources. Some of the general principles inspiring Law n. 36/1994 are:

- acknowledgement of the public character of water resources;
- affirmation of the priority of drinking water over the various types of uses;
- conservation and renewal of water resources, which must be used without harming the environment;
- water supply charges ensuring that local utilities companies are economically efficient.

Law n. 36 further defines the sharing of tasks at various institutional levels.

The central government has the task of defining methodologies and guidelines concerning: inventories of water resources; regulation of water use and protection of water from pollution. Also defined by the central government are: planning, that includes the completion of works for the transfer of water between different regions; the revision of the General Plan for aqueducts; identification of areas risking a water crisis; management of the new water supply service.

Art. 21 of Law n. 36/1994 likewise calls for the central government to set up at the Ministry of Public Works a Committee for the supervision of water resources use. This body should enhance the efficiency, effectiveness and economic efficiency of the service, propose a standardised charging method and protect the interests of consumers. The Committee will make use of the Observatory for Water Services, which will collect and process statistical data and information after setting up and managing a database.

The regions likewise have greater responsibilities for water resources planning and management. The local authorities are assigned tasks regarding the organisation of the service. In the context of the functions set forth in Law. n. 183/1989 on the defence of the land, the regions have the task of identifying "suitable areas" in order to overcome the fragmentation of the current management system and to guarantee a suitable size of the utilities. They must likewise update the General Plan for aqueducts in the watershed basins where they have jurisdiction.

With regard to the organisation of water services, Law n. 36 adjusts the mechanisms for rationalising the existing utilities to the setting up a single water service (art. 4, par. 1, letter f). It is conceived of as the sum total of public services of acquisition, pumping and distribution of water for domestic use as well as for sewers and sewage treatment. In order to implement this, the law calls for the organisational and functional review of the bodies involved in water resources management so that they respond to criteria of efficiency and economic management.

8.2 INTERVENTION FOR LAND PROTECTION

These activities are mainly concentrated in the tasks of the river basin authorities, the Po Magistracy, the Venice Waters Magistracy, the regions, the National Forest Service and the park authorities.

Until the basin plans are approved, the basin authorities, according to Law n. 493 and subsequent laws of 1993 and 1994 on flooding in the Po basin, can draw up and approve plans for specific priority functions and sub-basins, as well as adopt protective measures which are immediately binding.

In particular, plans for protecting river areas and in the sector of water safety have been are being adopted by almost all the national basin authorities. These plans, together with protection rules and directives concerning overflow risk areas, well drilling and the regulation of authorisations to tap water sources, have produced specific measures for the prevention of risks and guidelines for land use and the planning of works.

The government intends to focus on prevention, which is certainly less costly than intervention after damage has occurred. Between 1949 and 1995 there were 45 State-financed projects for reconstruction due to flooding, with a cost of over Lit. 60,000 billion. In the last decade there has also been an increase in interventions and in government expenditure. The cost to public expenditure for the reconstruction and recovery of economic activities for the 1993 and 1994 floods in the western Po basin alone cost Lit. 9,016 billion, including interest payments on mortgage loans. This was 10 times the amount allocated for the whole of Italy to finance urgent preventive measures for the 1989-91 three-year period.

The fact that floods are unpredictable and exceptional does not justify the delays in prevention policy. The study of climatic, water resource and morphological features enables us to identify the high-risk areas, and measures can be taken to contain the disastrous consequences on people and goods.

To this end, the various basin authorities have started survey programmes in their area on the climatic and water resource features. The Ministry of the

Environment has proposed the organisation in each region of local control and monitoring facilities able to undertake prompt and effective preventive measures to safeguard the environment, until the basin plans come into effect.

Under the METEONET project funded by the Ministry of the Environment through the 1996-98 Three-Year Environment Protection Plan, the regional authorities in the Po basin have started interlinking of regional weather radar facilities with the addition of ground and satellite data. Thus the reliability of weather survey and forecasting, also by the use of limited area models (LAM) will be enhanced.

Finally, the European Union, in the Innovation Programme, has recently accepted a project designed to produce an advanced digital flood forecasting system using a decision-making support system based on a geographical information system. The project will assess the adoption of a forecasting and alarm system linked with the media in order to facilitate the providing of information to the public in emergency situations. The pilot areas for this study will be the Tagliamento basin in Italy and the southern Meuse basin in Belgium.

The increase in the frequency and intensity of extreme weather phenomena, and the likely increase of flooding and harm to the soil require the combined efforts of various local and national authorities to strengthen the "natural infrastructures" for defending and safeguarding the land. To this end, a joint committee will be set up between the central and regional authorities for monitoring exceptional climatic events and the co-ordination of annual prevention programmes.

8.3 THE SITUATION IN THE UPPER ADRIATIC AREA

Coastal areas characterised by natural and man-made subsidence are most vulnerable to rises in the sea level, and involve in particular the low coastal plains of the Upper Adriatic from Romagna to Friuli.

Considerable area of this region are just above sea level; in the past they were marshes, with various mixtures of water over time and according to the location, tidal patterns and the hydrological features of the rivers, which were not provided with embankments in the past. Considerable areas of the region are now below sea level, e.g. much of the Po Delta area, with depressions of over 3 m, and coastal areas to the north and south of the Venice Lagoon, with altitudes of up to one meter below sea level.

Over time, human settlement has led to the building of a dense network of drainage works and embankments around the lagoon and rivers, with water directed out of the lagoon and towards the sea. Areas of land have been drained (for over a century the mechanical lifting technique has been used). Basically, the water management of the plains and the lagoon has consisted in the centuries-long separation of seawater from the fresh river water. As for the latter, the "high" water flowing by gravity towards the sea from mountain watersheds has been separated from the "low" water drained in the plains, for which numerous pumping installations have been used.

The Venice plains area therefore has a particularly sophisticated hydraulic system (embankments, drains, drainage channels, water-scooping machines, siphons, sluices etc.), the regulation and management of which requires specialised personnel and high maintenance costs.

The gradual rise in the average sea level is gradually bringing about a number of problems, the extent and number of which is hardly ever identified in various interventions by man, since the time required for the various phenomena to mature is generally longer than the career of an individual (on average 40 years). The signs are not very obvious compared to other more spectacular ones such as high tides, high river levels, embankment erosion or flooding due to the breakdown of a water-scooping machine. The most obvious effect is the increase in management expenses of the hydraulic system described. The water-scooping machines have to work more hours and with a greater delivery head, the tops of the embankments are gradually raised, the fresh water inlets from rivers (for irrigation and drinking water) are moved due to saline water incursion etc. The continuous, gradual changes in the local water system that will be required, especially if subsidence should resume, would involve colossal expenditures.

8.3.1 ANALYSIS OF THE MARINE INCURSION RISK ON THE UPPER ADRIATIC COAST

In the context of the European project mentioned previously (Cf. Par. 7.4.1.1), developed with the coordination of the University of Padua, the analysis of possible incursion of sea water into coastal areas has been performed to define vulnerability (i.e. to identify zones particularly liable to flooding) and risks. The analysis combines vulnerability data with the economic value of land use and the probability of occurrence of the event.

Using the UNDRO (United Nations Disaster Relief Office) methodology, flooding risk R is calculated by the following formula:

$$R = H_t * E * V$$

where:

- H_t is the inundation hazard defined by the probability that the selected event, characterised by a return time T, will occur at least once in the period of time considered (t) ($Ht = 1 – (1-1/T)t$);

- E represents the economic value of the area potentially subject to flooding and can therefore be defined on the basis of the knowledge of land use;

- V is vulnerability, i.e. the potential expected damage for the economic resources assumed in this study to be proportional to the highest water level reached in the flooded area.

By adopting this methodology, greatly facilitated by computer techniques such as GIS used in the project, we have been able to generate risk maps for the entire Upper Adriatic coastal area and for some local areas on which a detailed study has been made. This has made it possible also to take into account the possible morphological changes of the shoreline.

For every single cell into which the area analysed has been subdivided (200x200 m on the macro scale and 10x10 m on the local scale), the vulnerability and hazard rate have been assessed using the results provided by digital forecasting models of sea level rise and subsidence, with the methodology described in the previous chapter. In order to determine the economic value of the land, reference is made to the Remote Survey Pilot Project for the Italian coastline (coastal strip atlas) produced by the Water, Waste and Soil Department of the Ministry of the Environment. Land use is simplified under the following categories: urban, industrial, agricultural, uncultivated and internal waters. Each type of land has been assigned between 0 and 100 points of economic value. The results of the risk analysis were then processed on a relative basis, giving maps of the type shown in the following figure for the entire Upper Adriatic coast (Figure 8.1).

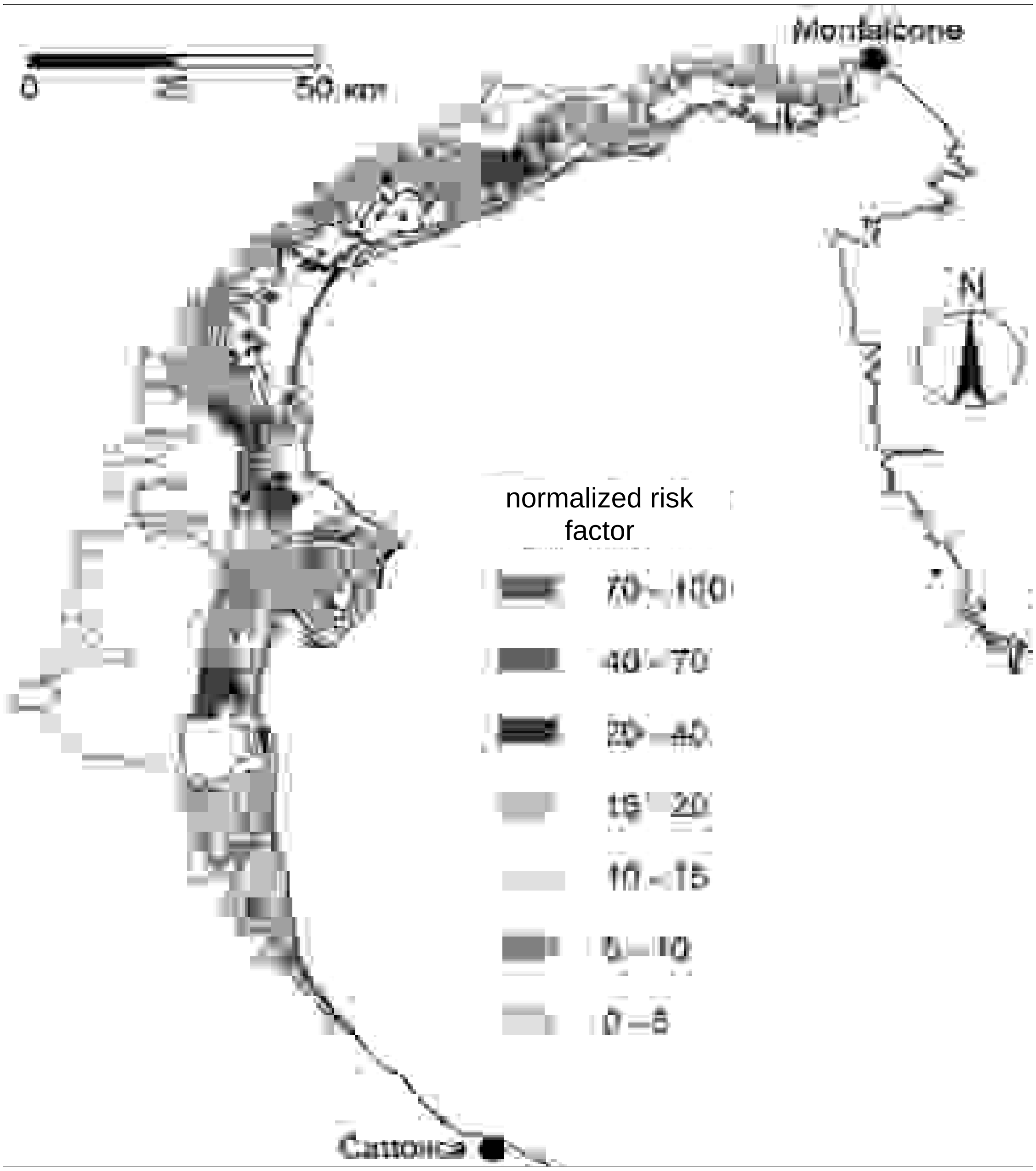
The effect of the reduction of vulnerability of an area cannot be take into account on the macro scale, related to the presence of natural or artificial protective structures blocking the penetration of sea water inland, such as embankments, dikes, dune barriers and roadbeds. On the local scale, however, a more in-depth analysis of the risk factor and the use of a tighter grid have allowed for the inclusion of this factor. The position/shape index I has been introduced in the definition of the risk factor, taking into account the position of the single sub-area with respect to the inundation source, the average altitude of the sub-area and the presence and height of earthworks surrounding the area. The calculation of the risk of marine incursion has been made more reliable thanks to this parameter. The following figures show the results of the analysis for a significant amount of the land in the municipality of Ravenna, one of the three sites for which a local scale study has been made (see Figure 8.2)

The results obtained and the future studies conducted with the methodology described can provide guidelines for the national and local authorities to chose the type and extent of protective intervention to be implemented in order to provide an effective barrier against marine incursion over the coming decades.

8.3.2 INTERVENTION FOR THE VENICE LAGOON

The Venice Lagoon is the largest lagoon in Italy, measuring approximately 550 km^2, and is the remainder of a larger lagoon, which until the not so distant past extended from Ravenna to Monfalcone. Its features and morphology are the results of continuous intervention by man, and since the first millennium have been modifying the natural tendency to silting in order to safeguard the economic activities conducted in the area.

Figure 8.1: Marine incursion risk factor map for the Upper Adriatic coast, adjusted on the basis of the vulnerability of the area and the economic value of the land



The deviation of rivers has prevented the lagoon from silting up, especially in the northern part. The reduction of sediment flow and the removal of materials have triggered a gradual erosion process, aggravated by the construction of quays at river moths, and more recently by the dredging of deep navigable canals. The pumping of groundwater has caused natural subsidence to accelerate a significant factor in the shrinking of the city. Systematic observations of marine patterns in the Venice Lagoon, which started in 1972 and continued without interruption since 1907, have shown that in the period 1890-1991 the difference between the soil of Venice and the average level of the sea has fallen by over 24 cm. According to recent estimates, subsidence of Venice was approximately 11 cm in this period, while the rise in sea level was about 13 cm (Rusconi et al., 1993). Other authors give different figures, while still confirming the substantial balance between the two factors.

Figure 8.2a: Local scale risk analysis in the municipality of Ravenna. Digital model of area

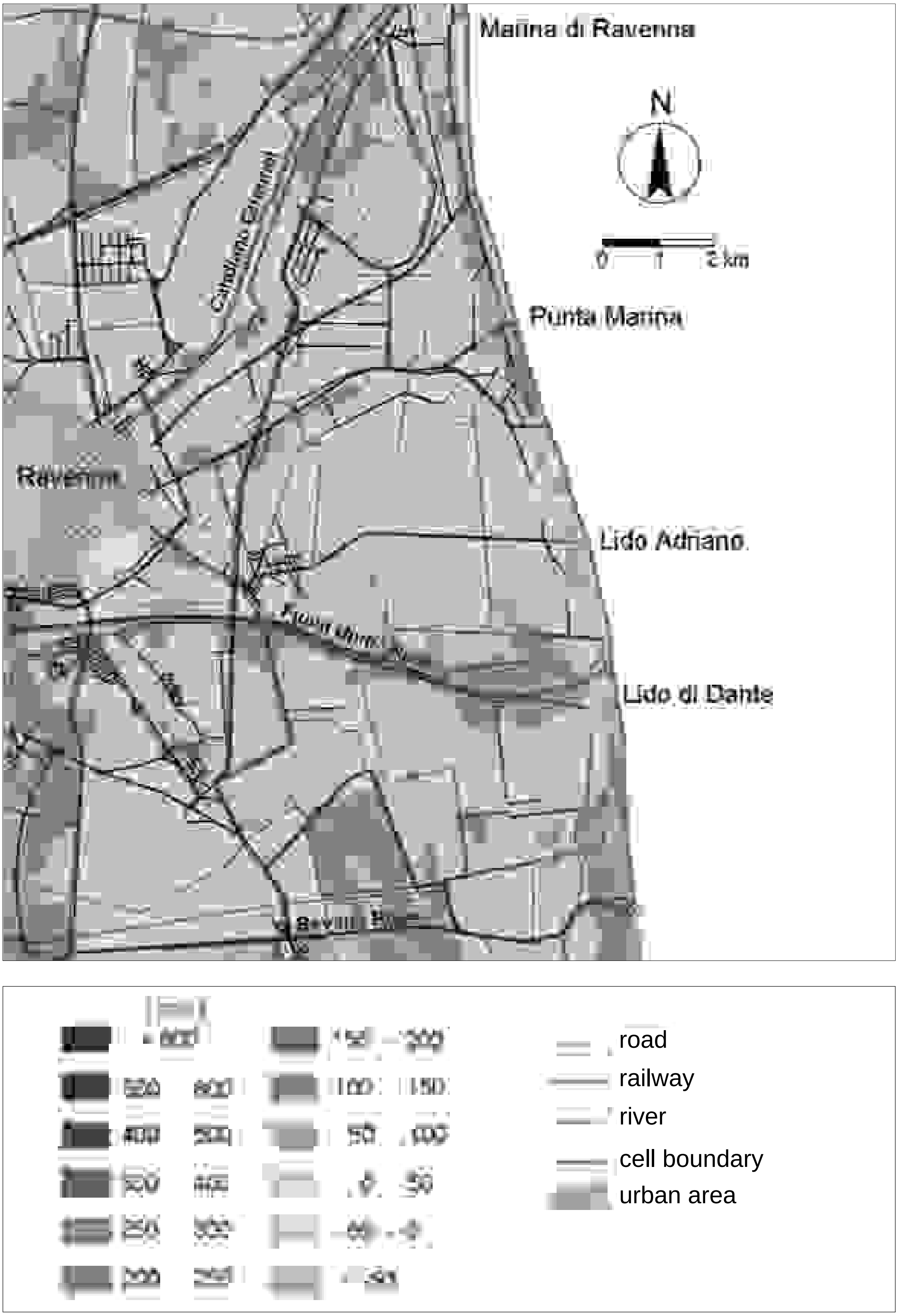


Figure 8.2b: Local scale risk analysis in the municipality of Ravenna. Distribution of “position/shape index”

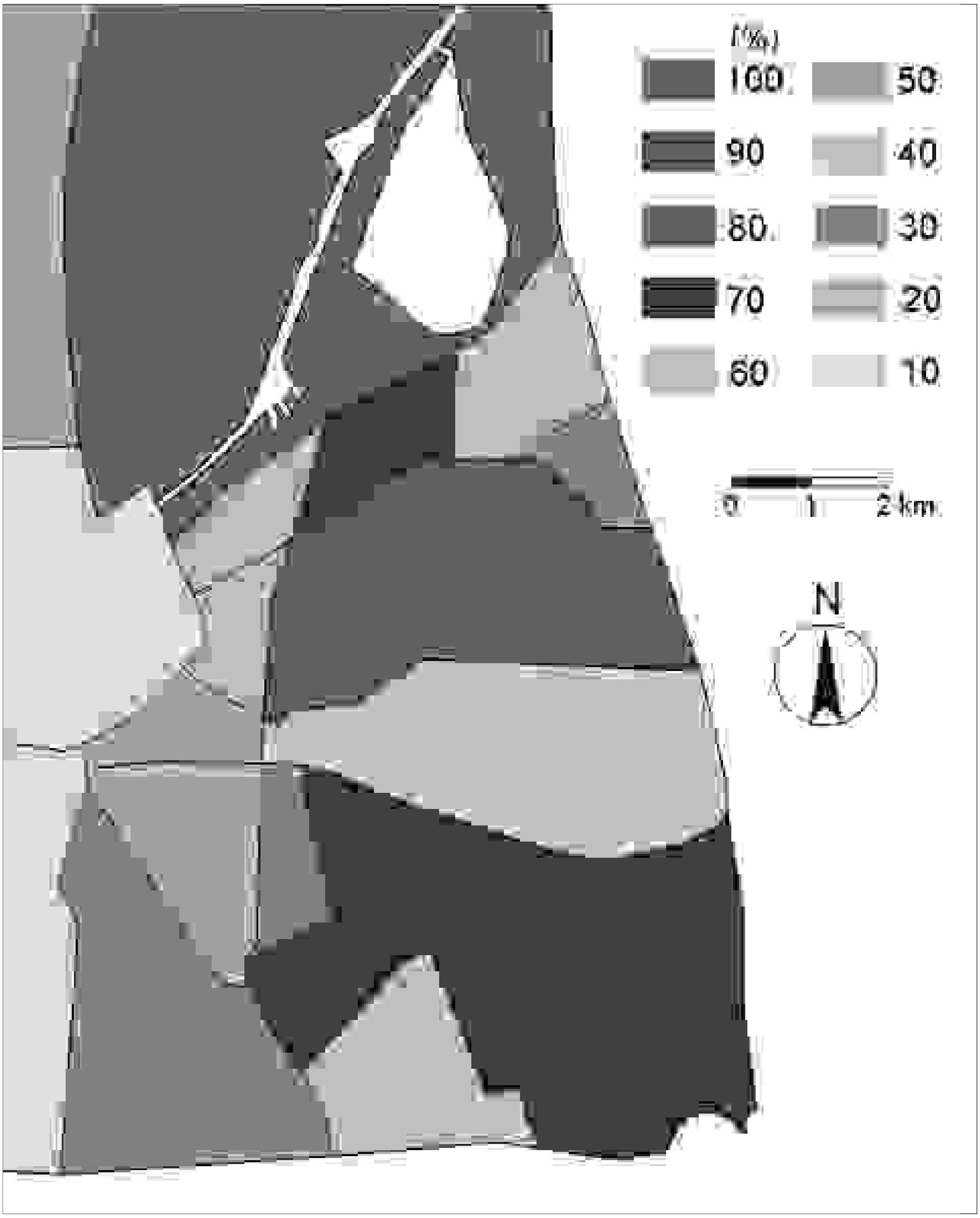


Figure 8.2c: Local scale risk analysis in the municipality of Ravenna. Adjusted risk

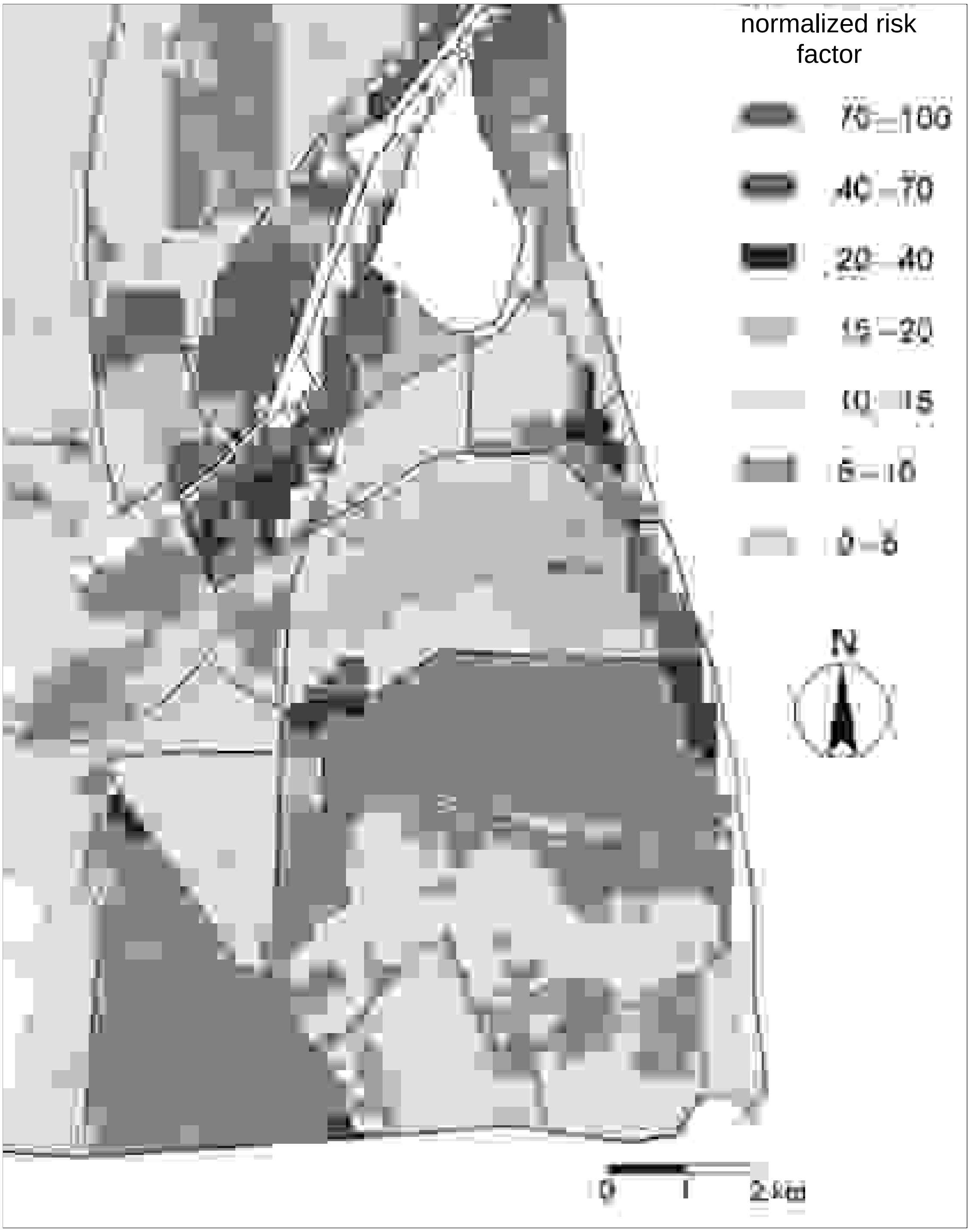


Table 8.1: Interventions to safeguard Venice: funding and expenses by type of intervention and managing body (million liras)

Description of activities and managing body	Amounts allocated and available	Amounts spent	%
DIRECT CENTRAL GOVERNMENT ADMINISTRATION	327,905	270,196	82
Hydrogeological measures	700	0	0
Anti-pollution	15,055	6,637	44
Lagoon embankments	3,842	2,461	61
Government buildings	150,981	130,565	86
Arsenal	23,917	21,354	89
Bridges, canals, foundations	96,122	78,973	82
Rivers	18,226	11,981	66
State owned real estate	9,026	6,595	23
Universities, Architecture	12,036	12,038	100
GOVERNMENT CONCESSION (CONSORZIO VENEZIA NUOVA)	1,714,873	1,314,518	77
Hydrogeological measures and blocking decline	1,295,855	989,873	76
Lagoon embankments	61,000	45,764	93
Maritime works	344,231	274,169	80
Exclusion of petroleum	13,781	9,312	66
VENETO REGION	1,161,300	208,512	18
Pollution elimination	1,094,300	194,510	18
SS. Giovanni e Paolo Hospital	27,000	11,439	42
Aqueducts	46,000	2,563	6
PROVINCE OF VENICE	27,933	18,400	66
Restoration of historical sites			
VENICE MUNICIPALITY	1,024,483	526,688	51
Refurbishing of buildings			
Primary urban facilities			
Subsidies to private parties			
Industry			
Integration project			
VENICE MUNICIPALITY WITH VENETO REGIONAL FUNDS	70,000	5,004	7
Integration project			
CHIOGGIA MUNICIPALITY	146,373	60,741	41
Refurbishing of buildings			
Urbanisation works, private parties			
Infrastructures			
TOTAL	4,475,119	2,404,059	54

Source: Ministry of Public Works

Table 8.2: Frequency of high water > 100 cm in Venice in the next century, in case of a gradual rise in the sea level of 50 cm

Year	Subsidence	Number of cases per year
2000	Current situation	7
2020	+ 10 cm	17
2040	+ 20 cm	46
2060	+ 30 cm	115
2080	+ 40 cm	238
2100	+ 50 cm	396

Source: Rusconi et al., 1993

All the municipal administrations have have had to deal with problems linked to the management and safeguarding of the lagoon environment. The current institutional framework is mainly defined in Law n. 366/1963 with "New rules on the Venice and Murano Lagoons". Protective measures have been increased since the flood of 3 November 1966, particularly with special laws n. 171/1973 and n. 798/1984. These laws, having ascertained that the problem is of "major national interest", define the overall goals of the interventions and the best procedures to implement them.

The central government has jurisdiction for the following types of intervention:

- "studies, projects, experiments and works aimed at restoring the hydrogeological balance of the lagoon, the stopping and reversal of the process of decline in the lagoon basin and the elimination of its causes, the attenuation of tidal levels in the lagoon, defence with specific measures of the island blocks of town centres and the protection of urban lagoon settlements from exceptionally high water, also through the use of levees with movable gates for tide regulation, pursuant to the characteristics of experimentation, reversibility and gradual nature set forth in resolution n. 209 of the Superior Council for Public Works";
- "lagoon embankments";
- "port and maritime works for coastal defence";
- "studies and projects for the works…required to avoid transport in the lagoon of petroleum and its derivatives, …as well as the opening of fishing areas."

The law establishes a Committee for guidelines, coordination and control (the "Big Committee", constituted of the President of the Council of Ministers, the Minister of Public Works, the Minister for Cultural and Environmental Heritage, the Minister of the Merchant Marine, the Minister of the Environment, the Minister of Scientific Research, The President of the Veneto Region, the Mayors of Venice and Chioggia, and two representatives of the other municipalities. The Minister of Public Works, through the Venice Waters Magistracy, assigns the Venezia Nuova Consortium the task of implementing the central government initiatives. Besides laying down the central government jurisdiction (for physical safeguarding), the law also sets for the tasks of the regional authorities (elimination of water pollution) and the municipalities of Venice and Chioggia (socio-economic measures and safeguarding of monuments), committing the central government to fund the latter. The flow of financing, virtually blocked in the 1988-1991 3-year period, resumed subsequently with Laws n. 139/92, 539/95 and 515/96.
According to the hypothesis of the General Intervention Plan of September 1991, the protection of the city of Venice from exceptionally high tides is to be undertaken by a series of mobile barriers at the three inlets from the sea into the lagoon. The barriers are designed to close the lagoon in a relatively short time in case of high tides. To reduce the number of times the barriers would have to be used, the plan calls for local interventions to defend the lagoon cities up to a minimum of a one-meter tidal level above the average sea level. These interventions consist of the raising of pavement and the revision of coastal works. It is therefore estimated that the tidal barriers would be used only 7-8 times a year for tides equal to or greater than 100 cm. The plan also includes other interventions such as the reinforcement of the shore works in order to prevent the weakening and decline of the lagoon's natural and artificial defences, the reopening of fishing areas in order to improve local environmental conditions, the abolition of crude and fuel oil transport in the lagoon and the blocking and reversal of environmental decline in the lagoon.

Table 8.1 shows the estimated expenses for the measures to safeguard Venice. The executive plan for the port inlets, approved by the Waters Magistracy and the Superior Council for Public Works, is now awaiting approval for environmental compatibility by the Ministry of the Environment.

Taking into account both natural subsidence of up to 4 cm per century (CNR-ISDGM, 1996) and the average increase in the sea level caused by climate change, which according to the best IPCC estimate is 50 cm up to 2100, Venice could suffer from a loss of altitude of 54 cm by the end of the 21st century. If this were the case, the populated areas of Venice, Chioggia and the minor islands (terraces alongside canals, streets, squares and houses) would be subjected to flooding on a daily basis due to normal rises in the tides. This flooding would be associated with an increase in wave action and cyclical overloading caused by rapid submersion, producing compacting in the sandy layer and therefore the sinking of the ground.
Under these conditions, it is easy to imagine (though hard to quantify) the socio-economic damage.

The combined effect of the water and the waves would cause gradual, permanent damage to the historical and urban heritage, with the growing risk of abandonment due to spiralling costs of maintenance, which in any case has its limits.
This scenario regarding the city would occur in a broader local situation regarding the low-lying plain areas, many of which, as we have seen, are under sea level and kept artificially dry by a drainage system. The effects of the rise in sea level would have a major impact on the frequency of flooding of submerged coastal areas, of the lagoon (city of Venice) and the river estuaries (Po, Adige, Piave etc.).
In 2060 an altitude loss of 30 cm is forecast, with 100 high water events per year, a frequency so high as to make the city uninhabitable. The high water, governed by the lunar tide cycle, would occur every day around the lunar phase. By 2100 Venice would be flooded every day of the year.
In order to safeguard human activities physically and historically associated with the city of Venice, strategic choices and interventions for which it is now hard to make a financial estimate would be required.

8.3.3 INTERVENTION FOR THE PO DELTA

The Po Delta in the strict sense includes an area with 5 active branches of the river system between the Po di Maistra to the north and the Po di Goro to the south. The zone has an area of approximately 3,900 km^2 and includes 57 towns in the provinces of Rovigo, Ferrara, Bologna and Venice.

From the hydrographic point of view, it is a complex of land and water formed by islands, marshes and streams produced by the interaction between the river, the sea and human activities; this interaction has taken place for over 3,000 years and has seen significant events such as:

- the construction of water-related defence works in the 12th-15th centuries together with the setting up of organisations for water management, like the Po Magistracy;

- the re-routing towards the south-east of the last stretch of the Po via the Porto Viro Cut, made in the early 17th century by the Republic of Venice to prevent the lagoon from being silted up;

- starting from 1870, the construction of drainage works – first by private parties and after 1882 with government support, in order to transform the damp delta land into an agricultural area.

The water situation in the area is characterised by serious flooding hazard, aggravated by subsidence due to natural and man-made causes. Subsidence has been considerably affected by drainage, water and gas wells from both shallow and deep deposits, the urbanisation of the coastal areas and the building of infrastructures. The closure of the methane gas wells ordered between 1961 and 1963 has considerably slowed down subsidence. Available data shows that the ground sank at speeds sometime exceeding 25 cm/year in the 1951-1957 period; between 1958-62, the average subsidence rate went down to 9.15 cm/year. The 1962-67 period saw a further reduction, down to 3.4 cm/year. The most recent data shows levels of under 2-3 mm/year.

The delta area is now mainly under sea level, with some depressions of over 3 m, leading to many serious consequences:

- damage to the entire rainwater drainage system due to the height to which the water has to be pumped;

- the need to raise embankments, which are no longer efficient due to the sinking of the ground;

- coastal erosion;

- general damage to embankments.

The consequences of subsidence, whether natural or man-made, have been exacerbated by other phenomena such as the reduction of the sediment deposits by river due to the barriers and the removal of gravel for building purposes. The situation is so serious that the Po Magistracy has ordered "the cessation of activity of all the fixed plant operating in the bed of the Po during low water" (circular n. 107). With regard to processes affecting the shoreline, there has been an overall advance of the sea since 1974 after a period of net land expansion from the first half of the century.

There are various types of coastal defence works according to the characteristics of the coastline involved. Flat, sandy beaches typical of the Adriatic coast are protected from the sea by artificial barriers consisting of embankments which both prevent waves from reaching the beach and foster the accumulation of sand behind them. The delta coastline with its lagoons, sandbanks and mud-banks creates greater problems. Heavy barriers are not feasible since they would ruin the landscape and natural resources; instead there is a series of dikes set back from the shore, going along the edge of the sea in the main lagoon inlets. These barriers are useful to defend the area from flooding, but not from erosion by waves. They have a low environmental impact (they are generally "fixed" dunes covered by vegetation) but have high maintenance costs, especially where there is heavy erosion of the sand. The only way to protect the area from the increase in sea level without changing the delicate balance ensuring the survival of the delta is to utilise environment-friendly engineering techniques.

The delta area has a complex of defence works used both for the prevention of flooding hazards, such as embankments and various types of barriers, and works for the expulsion and disposal of water filtering through the land and the barriers, such as water-scooping machines. With the continuing rise in the sea level, the currently high management costs of this system will increase.

All the improvement measures for against flooding and for the maintenance and completion of the water infrastructures in the Po Delta come under the jurisdiction of the Po Magistracy in Parma. Table 8.3 summarises the estimated investments by this institution up to the year 2000.

Table 8.4 also shows the estimated investment by the Consorzio di Bonifica Delta Po Adige in its "General Plan for the drainage and protection of rural areas" for works to improve embankments, restore canals and update water-scooping installations.

Due to the rise in sea levels, energy consumption by the water-scooping installations will rise because of the greater amount of water to handle and the higher levels involved. Over recent years, the volume of water pumped has varied considerably: 260 billion m^3 in 1994, 351 billion m^3 in 1995, 148 billion m^3 in 1996. The costs in 1995 were approximately Lit. 1–1.2 billion (table 8.5).

Table 8.3: Investment programmes for the Po Delta water management system

Investment programme	Total amount (liras)	Approval status of measures
General Plan 45 Recovery of water resources balance, elimination of hydrogeological damage, prevention of hydrogeological risks, recovery of areas subject to flood hazards (drawn up by the Po Basin authority, now being revised)	144,750,000,000	Measures to be wholly covered by funding
Chap. 7701 – Extraordinary maintenance Programme for building, restoring and repairing water-related works under central government jurisdiction financed	5,300,000,000	Measures reported but not yet
Chap. 7749 – Law for the defence of the land N.	308,863,000,000	Measures for which funding has been requested from the Po Basin Authority for the 1997-99 three-year period
Chap 7740 - Subsidence Expenditure for urgent measures for the defence from the sea of Po Delta area affected by subsidence and the defence of drainage water in the Ferrara and Rovigo provinces	22,801,200,000	Measures for which funding has been requested to the Ministry of Public Works for the 1997-99 three-year period

Source: Po Magistracy of Parma

Table 8.4: Amount of estimated investments in the "General Plan for the drainage and protection of rural areas" of the Consorzio di Bonifica Delta Po Adige (million liras)

Project	Estimated amount
S. Anna hydrographic area	15,500
Rosolina hydrographic area	26,500
Contarina-Donada hydrographic area	32,050
Ca' Venier island hydrographic area	17,200
Ariano island hydrographic area	33,900
Donzella island hydrographic area	27,500
Camerini island hydrographic area	8,200
TOTAL	160,850
General measures	170,724
TOTAL	331,574

Source: Consorzio di Bonifica Delta Po Adige

Table 8.5: Costs for the use of water-scooping installations in the Po Delta

Cost item	Cost (million liras)
Operation	
- Electricity (5,721,000 kWh)	998
- Sundry operational material	32
Maintenance	
- Machinery and buildings	133
- Verification and updating	13
Other	24
TOTAL	1,200

Source: Consorzio di Bonifica Delta Po Adige

9. Financial resources and technology transfer

9.1 INTRODUCTION

In hosting and financing the 11th Plenary Session of the UN Intergovernmental Commission on Climate Change, Italy has contributed to increasing national and international awareness of the importance of the measures required to implement the Convention on climate change, including the financial and technological instruments. Thanks to this initiative, among others, Italian co-operation for development has tried to highlight the environmental aspects in accordance with overall commitment to sustainable development.

Despite a significant reduction in government allocations leading to a reduction in Italian public development aid (PDA) from 0.27% of GNP in 1994 (US$ 2,705 million in total payments) to 0.14% in 1995 (US$ 1,623 million in total payments), Italian co-operation has focused on closer collaboration with multilateral institutions and international NGOs active in the environment sector. It has also subjected the development projects to analysis under the manual of environment impact assessment prepared by the ENEA (Ente per le Nuove Tecnologie, l'Energia e l'Ambiente). Italy has also been active in the environmental aspects of urban development such as water supply, waste management, the creation of green belts, the strengthening of the institutions and training; it also participated in the preparation process for the UN Conference on Human Settlements (Habitat II) in Istanbul.

Italy recently ratified the International Convention against Desertification, which involves an innovative, wide-ranging approach to international development co-operation. There has also been activity in the Development Co-operation Department to increase information on the application of the new convention. The continuation of a series of successful projects regarding the land protection and recovery has been approved until new programs have been developed according to the processes set forth in the convention, based on participation-oriented approaches and the attribution of primary responsibility to the beneficiaries. Italy will likewise host the first Conference of the Parties of the convention in Rome, together with the FAO.

9.2 BILATERAL CO-OPERATION WITH DEVELOPING COUNTRIES

In 1994 and 1995, bilateral PDA was respectively US$ 1,834.38 and 805.7 million. Italy has in any case tried to apply the guidelines set forth in Agenda 21 by including environmental problems in the bilateral programs and projects of Italian development co-operation. On the basis of the data of the OECD Development Assistance Committee (DAC), total PDS in the environment sector was US$ 6.59 million in 1994 and 21.33 million in 1995. Table 9.1 summarises the contribution paid out in 1994 and 1995 for projects with environmental components related to climate change.

Table 9.1: Bilateral financial aid in areas related to the implementation of the Convention (1994; million US$)

Sector Recipient country	Energy	Transport	Agriculture	Environment
1994				
Angola			2.02	
Argentina			0.27	
Bolivia			0.17	
Brazil			0.52	0.01
Burkina Faso			0.34	
Colombia			1.98	
Ecuador			1.00	
Egypt	0.42			
Ethiopia	5.52		0.12	
Djibouti	0.03			
Mozambique			2.86	
Nicaragua			0.17	
Niger			4.26	
Peru	0.73	6.23		
Dominican Republic	1.48			
Senegal			12.07	
Tanzania	0.07			
Tunisia			1.80	
Turkey				0.08
Not allocable			0.04	0.11
Total 1994	8.25	6.23	27.62	0.20
1995				
Angola			2.065	
Argentina			0.003	
Bolivia			0.059	
Brazil			0.199	
Ecuador			0.015	
Egypt			0.259	
Ethiopia	2.794		0.006	
Mozambique			0.420	
Niger			0.852	
Senegal			2.667	
Tunisia			0.160	
Dominican Republic	0.270			
Not allocable	0.353			0.10
Total 1995	3.417		6.705	0.10

Table 9.2: Bilateral co-operation activity for the development of energy relevant to climate change (million US$)

Country	Project	1994	1995
Egypt	EREDO project for the development of new renewable energy sources	0.42	
Ethiopia	Project on the Tendaho feasibility study for the production of electricity	5.52	2.794
Djibouti	Geothermal energy project	0.03	
Peru	Construction of mini hydroelectric plants at Chota and Tarabamba	0.59	
Peru	Plan for exploiting non conventional energy and developing local technology for building mini hydroelectric plants in the Chavin region	0.14	
Dominican Rep.	Study and construction design for the Rio Blanco hydroelectric plant and training of local personnel	1.48	0.270
Tanzania	Mini hydroelectric plant	0.07	
Not allocable	Courses on alternative energy sources, energy planning techniques and environment impact assessment for personnel of some LDCs		0.353
Total		8.25	3.417

9.2.1 ENERGY

Several projects on new and renewable energy have been financed in the sectors, as well as energy training targeted at the rational use of energy and the assessment of environment impact, thus contributing to achieving the UNFCCC objectives. Table 9.2 shows some examples of these activities.

9.2.2 AGRICULTURE AND FORESTRY

There are a number of activities in this sector which can affect the capacity of the developing countries to adapt to climate changes by a correct management of environmental resources, monitoring, developing and the recovery of the agricultural and rural environment. Table 9.3 shows some examples of these activities.

9.2.3 WASTE MANAGEMENT

In this sector, the importance of regional collaboration has been highlighted, with the organisation in Italy of a seminar on waste management in the Middle East. The seminar was organised in connection with the Environmental Working Group of the multilateral peace negotiations for the area. Specific projects to be implemented in the next three years have been identified.

9.2.4 TRANSPORT

An example of activity in this sector is the technical and economic advanced project concerning the Lima electric train to encourage the use of collective transport and contribute to the reduction of gas emissions (Peru).

9.2.5 OTHER

Other co-operation activity in sectors which could have long term effects on the mitigation and adaptation of climate change include the programmes for:

- a coastal pollution control system for Espirito Santo (Brazil);

- hydrogeological and hydrological improvement of the city of Cankiri (Turkey);

Numerous training activities have been conducted in sectors relevant to the global climate such as:

- scholarships at Perugia University in the hydrological sector in collaboration with the Water Resources Research and Documentation Centre (Ethiopia);

- co-operation with the Agostinho Neto University in Luanda for training in the sector of water resources research and assessment and the protection/management of the coastal strip (Angola);

- co-operation with the La Plata University for the creation of a school specialised in the environment and environmental pathology (Argentina);

- meetings, seminars and short visits for technical, scientific and cultural collaboration in the environmental field.

9.3 BILATERAL CO-OPERATION WITH THE COUNTRIES FOR CENTRAL AND EASTERN EUROPE AND THE COMMUNITY OF INDEPENDENT STATES

Under Law n. 212/92, Italy has set up a fund for bilateral aid to the countries of Central and Eastern Europe and the Community of Independent States (CIS). In 1994-95 activities for project identification were conducted and in 1996 a series of programmes were stated with a value of approximately 16 billion liras. In particular, for environmental protection and recovery, collaboration was started with Bulgaria and Slovenia for a total of approximately 889 million liras. Environmental sectors were also financed in the areas of technical and vocational training, scientific co-operation and technical assistance.

Italy has also continued to contribute to the funds of the European Bank for Reconstruction and Development, part of which are allocated to environmental and energy projects relevant to the global climate.

Finally, Italy also contributes to various trust funds of the World Bank and the IFC to provide technical assistance to the countries of Central and Eastern Europe and the CIS, including environment-related activity and the rational use of energy.

Table 9.3: Bilateral development co-operation activities regarding climate change in the agricultural and forestry sector (expenditure in US$ million)

Country	Project	1994	1995
Angola	Expansion of agricultural development programme of the Luanda green belt and improvement of rural population standards of living	2.02	2.065
Argentina	Agricultural and agro-food development for the Quena-Morillo area and creation of a farming-animal breeding pilot centre	0.27	0.003
Bolivia	Porvenir integrated rural development project in controlled agriculture, water infrastructures, reforestation and environmental recovery	0.17	0.059
Brazil	Guimaraes integrated agricultural development programme with intervention in the environmental impact of irrigation	0.52	0.199
Burkina Faso	Improvement of water resources	0.01	
Burkina Faso	Water and soil conservation programme	0.33	
Colombia	Farm mechanisation in Bucaramanga suited to local conditions for rational use of environmental resources	1.98	
Ecuador	Irrigation project to improve agriculture in Chambo Guano	1.00	0.015
Egypt	Integrated rural development project for the north Sinai highlands aimed at balanced environment management and improved social and economic integration with the rest of the country		0.259
Ethiopia	Multi-sector aid programme for the population resettled in the Beles valley, concerning diversified agricultural production systems and the support of activity for environmental improvement such as forestation and water resources	0.12	0.006
Mozambique	Agro-industrial and animal breeding development	1.03	0.021
Mozambique	Development of the N'Guri rural area using renewable energy sources, farm produce processing and reforestation measures		0.05
Nicaragua	Intervention in the agro-forestry sector in the area of the Cruz Verde, Mexico, Los Chiles, La Venada and Papaturro villages, with training activity on environment problems in humid tropical areas, farm produce diversification, reforestation and controlled exploitation of balsa wood; creation of an independent consultancy body for sustainable development	0.17	
Niger	Environment protection and development programme in the Keita valley with recovery and protection measures (protection of watersheds and diversification of agricultural production by the digging of 20 wells for vegetable gardens)	3.52	0.852
Niger	Scientific monitoring of measures for environmental conservation and recovery	0.73	
Niger	Ader Doutchi Maggia integrated rural development programme in the Keita valley based on overall recovery by control of erosion, reforestation and recovery of soil production capacity. In 1994, 1.375 billion trees were transplanted in a process of agro-forestation and reforestation	0.01	
Senegal	Rural development programme in the Seghiou district with measures for the creation of local infrastructures, the development of farm production and the protection of the environment and natural resources	11.92	2.667
Tunisia	Integrated programme for the improvement of the Sahara and Southern Tunisia for water and soil conservation	1.29	
Tunisia	Integration of development project for agriculture, animal breeding and forestry on public land	0.51	0.160
Not dividable	Specialisation course in economics, agro-forestry techniques and food supply	0.04	
Total		27.62	6.705

9.4 MULTILATERAL CO-OPERATION

Italy spent a total of US$ 870.24 million in 1994, and US$ 816.96 million in 1995, in contributions to multilateral organisations, including the European Union and capital subscriptions to international banks and funds. Many of these institutions finance programmes and projects contributing to the achievement of the objectives of the Convention on Climate Change (see table 9.4).

For 1996 data is available on payments for participation in Banks and Funds for regional development, which together with the GEF contributions total US$ 741.71 million as shown in Table 9.4. There are also data on contributions to the UNEP and the connected Conventions (table 9.5).

9.4.1 GLOBAL ENVIRONMENT FACILITY

Italy, after the contribution to the pilot phase, is also committed to contributing to again setting up the Global Environment Facility (GEF). In 1996 Italy paid US$ 25.89 million as its first instalment to the GEF1.

9.4.2 NEW AND ADDITIONAL CONTRIBUTIONS

These contributions should include so-called voluntary and targeted contributions already included in the PAD accounts. The planning of these contributions has favoured the organisations implementing programmes in sectors including the fight against draught, human and social development, training, industry and the environment. The latter include financing to activity fully or partly related to the implementation of the Framework Convention. There are also contributions to the following initiatives.

- Support programme to the co-ordination unit of the UNEP Mediterranean Action Plan for improving environment data processing: total US$ 0.16 million;
- Habitat – Outcome of Brazzaville Conference (Congo) for a total of US$ 0.14 million;
- Pan-African Habitat Conference in Johannesburg with a contribution of US$ 0.14 million;
- 11th Plenary Session of the IPCC Intergovernmental Commission on Climate Change, held in Rome in December 1995, organised by the Ministry of the Environment in collaboration with the ENEA for a total of US$ 0.33 million;
- Secretariat of the IPCC Intergovernmental Negotiating Commission on Climate Change (INC-FCCC) with a contribution of US$ 0.12 million to the Secretariat and 0.06 million to the fund for the participation of developing countries in the negotiating session for 1994 and 1995;
- IPCC Trust Fund, contribution of US$ 0.06 million with the participation of developing countries in the activities of the committee for 1994 and 1995.

There have been numerous voluntary Italian contributions to FAO, aimed at improving agricultural and forestry resources in many developing countries.

Table 9.4: National contributions to operational branches of financial mechanisms and other regional and multilateral institutions and programmes (in million US$; 1 US$ = Lit. 1,613 in 1994, 1,629 in 1995 and 1,543 in 1996).

	1994 Contribution	1994 Capital subscr.	1995 Contribution	1995 Capital subscr.	1996 Capital subscr.
Global Environment Facility I (first instalment)					25.90
A. Total United Nations (1-7)	190.45		147.52		
1) UNDP	27.90		18.42		
2) UNICEF	33.79		14.43		
3) UNRWA	9.30		7.37		
4) WFP	5.58		2.15		
5) UNHCR	9.92		10.44		
6) UNFPA	1.55		1.23		
7) United Nations, other (a+b)	102.41		93.48		
a) Main beneficiaries	72.76		60.21		
Capacity 21	0.62				
INSTRAW	0.19		0.18		
UNDCP	12.40		8.59		
UNICRI	0.99		0.86		
UNDRO	0.81				
UNEP	1.26		0.61		
UNESCO	1.55		3.74		
FAO	15.50		12.28		
UNIFEM	0.19		0.18		
HABITAT	0.62		0.58		
Human Rights	0.12		0.12		
ICCROM	0.22		0.31		
UNIDO	7.07		8.46		
Mozambique	13.33				
ILO	6.20		4.91		
UNOV	0.31		0.31		
UNDESD	7.44				
UNO	0.22		0.61		
WHO	3.72		3.69		
Desert Convention			0.09		
DHA			1.34		
DDSMS			9.21		
UNSO			0.09		
Sarajevo Fld. Fund			3.07		
UNETPSA			0.98		
b) UN contributions (partly ODA)	29.65		33.27		
WHO	12.73		12.73		
WIPO	0.19		0.21		
FAO	8.63		7.85		
WMO	0.05		0.06		
ILO	1.40		1.46		
UPU	0.06		0.07		
ITU	0.84		0.97		
UNESCO	0.93		4.01		
UNO	4.82		5.91		
B. Totale UE	613.03		634.2		
EDF	278.22		279.6		
CEC	334.81		350.3		
EIB			4.21		
C. Total World Bank Group	6.32	14.75	2.14	17.19	
IBRD	3.10				
IDA	1.98			10.18	368.10
IFC	1.24	14.75		7.01	7.20

(continues)

Tabella 9.4: (continuation)

	1994 Contribution	1994 Capital subscr.	1995 Contribution	1995 Capital subscr.	1996 Capital subscr.
D. Total Regional Banks	1.86	1.59		1.48	
Inter-American Development Bank	1.86	1.06		0.98	19.08
Caribbean Development Bank		0.53		0.50	
Caribbean Development Fund III					10.51
Caribbean Development Fund IV					3.76
Asian Development Bank					1.92
Asian Development Fund V					70.93
African Development Fund VI					213.45
E. Other Agencies	42.25		14.41		
IFAD	3.83		1.23		
IMF	2.68				
Total Other Multilateral (a-q)	35.74		13.18		
a) Genetics Eng. Centre	4.19		4.15		
b) CGIAR	2.48		1.53		
c) CIFT	12.40				
d) CIHEAM	3.67		3.95		
and) CIPPT	5.46				
a) Montreal Protocol	0.03				
b) Montreal Protocol and Ozone (includes back payments)					21.02
c) IARC	0.19		0.18		
d) ICAC			0.04		
and) IDLI	0.41		0.25		
f) IILA	4.54		0.31		
g) IPS	0.31		0.15		
h) ITC	0.31		0.31		
i) OECD	0.22		0.38		
j) IMO	1.34		1.55		
k) OUA	0.19		0.29		
l) SID			0.09		
F. Total	853.91	16.34	798.3	18.67	741.71
G. Multilateral + capital subscription: Total		870.25		816.96	741.71
Multilateral Training Programme					
ENEA scholarships for researchers from ICTP, LDCs, Eastern Europe and CIS (multilateral)		0.11		0.19	0.26

Table 9.5: Italian contributions to the UN Environment Programme (UNEP) and related conventions

Funds and conventions	1996 contributions (million US$)
Fund for the Environment	0.67
Fund for the protection of the Mediterranean against pollution	1.38
Fund for the Convention on the Conservation of Migratory Species (CMS)	0.09
Fund for the Bale Convention	71.21
Fund for the Convention on Biodiversity	0.49
CITES – Implementation activity	0.09
TOTAL	73.93

9.5 TECHNOLOGY TRANSFER

Italy provides support to numerous activities contributing, through public and private bodies, to promoting, facilitating and financing access by developing countries to environmentally compatible technologies. Italy also supports the acquisition of know-how to reduce the emission of greenhouse gas in order to enable these countries to comply with the rules of the Convention.

9.5.1 PUBLIC SECTOR

Various Italian research organisations, including CNR and ENEA, work with various technical and scientific institutions in the developing countries and in countries with transition economies. Collaboration is through specialised training activity in Italian laboratories, the organisation of seminars in Italy and the developing countries and technical assistance for preparing and implementing research, development and demonstration projects. These activities aim at improving the technological and scientific capacities of those countries, familiarising them with Italian environment technology including the field of greenhouse gas reduction (and the most promising technology for renewable resources and energy savings).
In order to foster the exchange of information on technology transfer, the Istituto Italiano per il Commercio con l'Estero (ICE) is continuing to allocate substantial amounts to the promotion of joint ventures in the sector of low impact technology among companies in Italy, developing countries and countries with transition economies. Numerous seminars have been organised annually in order to present the engineering and services capacity of the Italian enterprises in the field of technology, material and equipment for environment protection, both in individual countries and in the context of regional initiatives.

Other significant initiatives include:

- Participation in the GREENTIE programme (exchange of technologies for limiting greenhouse gas emission) of the OECD/IEA promoted by the Ministry of Industry, Commerce and Crafts to supply information to developing countries on greenhouse gases reduction technologies;

- Participation in the OECD/IEA Climate Technology Initiative;

- Participation of numerous Italian universities and research and development bodies in programmes of the European Commission in collaboration with developing countries and countries with transition economies. Particularly relevant examples for the implementation of the convention are:

- INTERSUDMED Programme with the goal of the diffusion of the use of new and renewable energy in the countries of the Southern Mediterranean;

- The Energy and Urban Environment Programme in the Mediterranean Countries, targeted at promoting the rational use of energy and improving the environment management of many cities on the southern shores of the Mediterranean.

9.5.2 PRIVATE SECTOR

It is thought that there are many Italian industries and service companies in the transfer of beneficial environment technology, as can be seen from the concrete participation in the promotional initiatives of the ICE and other organisations promoting international collaboration in the environmental sector. Table 9.6 shows an example of technology transfer in the desulphuration for a thermoelectric power plant in the Czech Republic and another example of technology transfer in the field of photovoltaic systems in India.
In an informal survey on the companies which consider themselves qualified to collaborate in the implementation of innovative projects fundable by the GEF in the climate change sector, many have reported the capacity to transfer technologies and know-how for the rational use of energy and for clean processes and product. They state they have acquired experience in various developing countries.

9.5.3 PRIVATE/PUBLIC SECTOR

ENEL SpA is participating with the E7 Group (formed by eight of the major power companies of the G7 countries) in various projects for transferring technology to developing countries. These projects can be considered as preliminary to future activities implemented jointly in the field of renewable energy and the efficiency of thermoelectric power plants. The projects improve the global environment by reducing greenhouse gas emissions, this demonstrating the feasibility of a common approach to environment protection and the promotion of economic and social development. In particular, the projects concern Jordan, Indonesia, Zimbabwe, the Czech Republic and India (see Table 9.6).

9.6 TECHNOLOGY TRANSFER AND JOINT IMPLEMENTATION MECHANISMS

Due to its low energy intensity, Italy's contribution to world CO_2 emissions was only 1.9% of the total in 1992, while the contribution of the whole of Europe was 15.2%. The goals of attenuating climate change are to be achieved by associating the developing countries (starting with China and India) and the countries with economies in transition (starting with Russia) in measures to change trends in rising global emissions. In order to ensure that this takes place according to the criteria of fairness laid down in the Convention, the IPCC stresses the need for developing countries to have:

- support of institutional capacity-building measures to enable them to participate actively in decision making on climate change;

- an effective international co-operation mechanism allowing for an appropriate redistribution of the cost of climate change.

Among the instruments for international co-operation targeted at the reduction of greenhouse gas emissions, the report mentions joint implementation, negotiable emission rates, taxes on CO_2 (national and international), non-negotiable emission quotas and international standards. These instruments are based on the attempt to take advantage of the fact that with resources being equal, the requalification of industrial systems in the developing countries and countries in transition could reduce emissions much more than could be achieved in countries such as Italy, Japan and the other developed countries which already have low emissions.
In order to achieve the maximum result with the capital available, provide incentives to investment by developed countries in the developing countries and countries in transition and facilitate technology transfer, the UN Framework Convention on Climate Change (UNFCCC) has provided for a joint implementation (JI) mechanism, later redefined in terms of Activities Implemented Jointly (AIJ). According to this mechanism two countries can agree to jointly reach emissions reduction goals, without the location of the territory where the reduction will take place being influential. This will enable an industrial country to invest in developing countries and countries in transition in order to reduce emissions in those countries. The mechanism has the advantage of being delegated directly to the industrial countries involved in executing the measures.
It is not easy for AIJ to find the ideal implementation formula in international climate negotiations, since agreement has not been reached on how to calculate emission reduction for the country supplying capital for investment. The AIJ are therefore under way on an experimental basis to study the possible solutions but not to supply emission credits. Formulas are currently being examined to allow for implementation at least in the transition countries without waiting for the end of the experimental stage.
On the international level, extension of the AIJ should be proposed, at least for the investor countries whose overall emission are less than 3% of global emissions, considering the objective difficulties and the need for heavy investment for countries such as Italy with a relatively efficient energy system.
The government is also following with great interest the current trials of environmental permits. It will decide whether to introduce them into Italy on a jointly agreed European basis, considering that practical application of this tool would require the widespread setting up of additional emission control system. For the moment this measure is not considered necessary for the domestic market, but studies are under way for the possible implementation of the European level should this prove necessary.

9.6.1 IMPROVEMENT OF COMPETITION OF NATIONAL INDUSTRY IN THE SECTOR

Italian industries may also gain considerable benefits from the opportunities for international co-operation in implementing measures related to climate change.

One of the sectors potentially most concerned is the supply of plants, goods and services. In the key sectors of energy and transport, the national production system can provide highly efficient services at competitive prices if it receives sufficient promotional support.

Particular attention should be given to the Italian industry for energy efficiency enhancement. Taken together, all the industries producing high yield boilers, co-generation systems, insulation, counter and control systems, heat pumps, heat recovery systems, non-conventional combustion devices, high yield light bulbs and other components and systems improving the final energy efficiency rate have total sales of over Lit. 4,500 billion. This sector is growing at an extremely dynamic rate of 13-14% per year. The companies in the sector need to upgrade the quality of their products and services to the new standards requested, and ensure that these standards are properly perceived by the end user by means of certification.

It is therefore necessary to develop the national market of energy-efficient products by substantial interventions in standards requiring compliance with rational criteria in the purchasing process as regards the environmental, economic and energy aspects. These regulations will provide transparent, reliable rules specifying the objectives to be achieved in terms of safety limits, energy efficiency and environmental quality, without going into the technologies used to achieve them; they will be harmonised with the rules to be defined on a European level. This type of national economic development is also an important factor for ensuring international competitiveness.

9.6.2 CREATION OF AN ITALIAN FUND FOR THE GLOBAL ENVIRONMENT

A review of the implementation status of the commitments agreed to under the Framework Convention on Climate Change has highlighted a lack of “new and additional” instruments to foster the transfer of financial and technological resources from Italy to the developing countries and countries in transition. The reduction of public development aid that has occurred in most other OECD countries has not been compensated in Italy by specific instruments for international co-operation for the global environment. These instruments are already applied in other countries like France in order ensure better quality in bilateral co-operation measures and to enhance the capacity to target and utilise the contributions paid to international environmental organisations. In 1994, for example, France decided to create a French Fund for the Global Environment in addition to the multilateral commitments connected with the Global Environment Facility (GEF). An additional amount of approximately FF 440 million (about Lit. 120 billion) was allocated to it for the 1994-1997 period in addition to the budget of the French public development aid.

A similar step would enable Italy to have the following advantages: better quality of its bilateral interventions for the global environment, greater chances to gain concrete returns from the multilateral organisations in which it is participating with compulsory and voluntary contributions. Another important advantage would be an improved national image with partners in the developing countries and countries in transition.

The government intends to foster the protection of the global environment in developing countries and countries in transition with priority importance for Italian co-operation, by creating an Italian Fund for the Global Environment (FIAG) providing additional financial resources for projects with a positive impact on the global environment. The Fund would also provide additional integration funds to the major existing sources. This fund will catalyse Italian development aid by providing a new instrument of intervention in the environmental area, while working with the existing financial instruments, in order to facilitate integration with other bilateral and multilateral international programmes, especially those in the GEF. In any case, the FIAG resources are additional, since compensate the cost of projects or parts of projects helpful to the global or regional (more than local) environment, providing the amount which would not otherwise be covered by international aid. A major priority of the FIAG will be to demonstrate the innovative character of the projects proposed, from the scientific, technological and institutional point of view as well as their reproducibility.

Table 9.6: Private Italian funding of activity abroad in the electric power sector

Jordan
Purpose: Improvement of the efficiency of the thermoelectric power stations of Aqaba and Hussein, of the Jordanian Electricity Authority (JEA), through the reduction of fuel consumption, yield optimisation of the various power stations (improvement of chemistry, reduction of drainage in water cycle, of key design parameters such as excess air and condenser pressure, air preheating regulation).
Total cost : 1.1 million US$, payable by the E7;
Start: February 1996
Planned end: June 1997
Advantages: (with reference to 650 MW; current yield; extra power)
- quantified gains: +2% yield; + 1,000 hours use;
- fuel savings: 50,000 toe/year;
- CO_2 emissions avoided: 150,000 t/year;
- creation of specialised skills and technology transfer with potential repetition by JEA and other utilities companies in the region.

Indonesia
Purpose: Supply of electricity for domestic use and for communities, with renewable energy plants with 1,000 photovoltaic solar systems (50 W each) in the province of Nusa Tenggara Timor.
Total cost: 4.4 million US$, of which 3.4 payable by the E7 and 1 by the Indonesian government.
Start: December 1996
Planned end: Start 1999
Advantages:
- One million kWh/year produced with renewable energy (of which 50,000 with photovoltaic; substantially less than 1% of fuel integration for supply reliability);
- 1,500 tons of CO_2 saved every year, compared to a similar service with diesel engines;
- extensive technology transfer and full development of local capacities.

Zimbabwe
Purpose: Supply of electricity from renewable energy in a remote rural area in the south of the country (350 km from Harare at the Manyuchi dam) with the electrification of an existing dam with a 140 kW turbine.
Total cost: 1.2 million US$, all payable by the E7
Start: July 1996
Planned end: June 1998
Advantages:
- 700.000 kWh/year con renewable energy;
- 900.000 kg CO_2/year saved with respect to the same service using a diesel engine;
- technology transfer, training for technical skills, cost recovery, maintenance;
- local social and economic development.

Czech Republic
Purpose: Desulphuration of thermoelectric power station smoke
Total cost: 17 million US$
Start: 12/5/1995
Planned end: 30/11/1997
Advantages:
- supply of a turnkey plant by Ansaldo Energia Spa, designed to produce smoke desulphuration (water system) for the Detmarovice thermo-electric power plant.

India
Purpose: Manufacture of photovoltaic cells
Total cost: 2.3 million US$
Start: 1994
Planned end: 1994
Advantages:
- supply of machinery, know-how and technical assistance by Helios Techology Srl, for the manufacturing of photovoltaic cells, modules, components and photovoltaic systems for the city of Calcutta.

Bianca

10. Research on climate change and its effects

The national research system is carrying out investigation, studies and research on the anthropogenic influence on the climate system, its variability, impact on the environment and climate changes in the past. Research is mainly carried out by universities and national research organisations, though there are some cases in which research is conducted outside traditional channels through consortia.

10.1 MONITORING AND SYSTEMATIC OBSERVATION

There is considerable activity regarding the measurement of atmospheric components, with the development of innovative data analysis instruments and techniques, both for the major and the trace components. National observation networks, starting with the Weather Service, now supported by the expertise of other bodies and organisations, provide excellent coverage throughout the country (Figure 10.1), and in many cases very long historical series are available (from 1700 onwards).

There are two stations – at Monte Cimone and Lampedusa - monitoring greenhouse gases (CO_2, CH_4, N_2O, and CFC). Their data contribute to the World Data Centre for Greenhouse Gases run by the WMO (World Meteorological Organisation of the United Nations). Another greenhouse gas sampling and observation station is managed by ENEL at Plateau Rosa.

Daily monitoring of the ozone content of the atmosphere is carried out by various national organisations in Italy, Antarctica and Argentina using Dobson, Brewer and DOAS spectrometers. Vertical atmospheric ozone sampling is made on a weekly basis at San Pietro Capofiume and Vigna di Valle. Numerous research groups are active in programmes for studying stratospheric processes using LIDAR instruments.

Monitoring of forest system physiology in relation to climatic parameters and the carbon storage capacity in the biomass is performed at three sites with climatic and environmental characteristics typical of the coastal zone (Castel Porziano), Apennine zone (Collelongo) and Alpine zone (Trento).

Italy also has a number of oceanographic vessels used for research tours, collecting important data on the Mediterranean climate system.

Italy is likewise involved in national research programmes on Antarctica including major research and studies on climate issues. Italy has a high altitude station in the Himalayas in the K2 area, and is currently organising an Arctic base for monitoring Arctic ozone.

Figure 10.1: Distribution of weather stations in Italy

10.2 DIGITAL CLIMATE SIMULATION

Italy has groups which are active and internationally acknowledged in the field of digital climate simulation. Much of the global simulation activity using detailed general circulation models focuses on global scale models with atmospheric models on a decadal and multi-decadal basis with the required boundary conditions. Oceanic circulation models are also used in research programmes on oceanic assimilation and/or for basic studies on equatorial ocean patterns.

Regional simulation models are more widespread and are now available to many groups for both atmospheric and oceanic research. Regional atmospheric models are used for dynamic downscaling variability studies on climate, short-term forecasts and studies on processes.

A Mediterranean oceanic circulation model, developed in Italy and then divulged on the international level, has been highly successful. It provides a realistic and detailed simulation of inter-annual variability in the Mediterranean. There are also oceanic models on a reduced scale for the Adriatic Sea and other areas. The development in Italy of a marine ecosystem simulation model is also interesting. It contains a detailed description of the population dynamics, and will be highly significant in the study of the influences of climate change on the ecosystems.

There is also a strong tradition of theoretical studies focusing on the basic characteristics of climate dynamics, the predictability and reproducibility of climate changes and on the nature and origin of climate fluctuation statistics.

Other groups are working on stratosphere simulation and in particular on the complex chain of chemical reactions regulating the trace components of the atmosphere.

10.3 IMPACT STUDIES

The impact studies sector is active with a series of initiatives focusing mainly on the effects of sea level variations as a consequence of climate change, of special concern for wetlands. These studies investigate not only local effects, but also the possibility of using the Mediterranean as a gauge to monitor global changes.

Experimental studies and models on the effects of an increase in atmospheric CO_2 on natural vegetation and agricultural crops are being carried out in universities and research institutes.

A number of studies have been investigating the effect of climate change on the land and on environmental risks. Italian researchers are working on the assessment of slope instability risks, coastal erosion and the identification of hydrogeological areas at risk because of changes in rainfall characteristics.

10.4 DESERTIFICATION

Italy is active in this sector with international research projects on the reconstruction of the history of desertification in the Mediterranean through the study of proxy data for reconstructing the development over time and the mechanisms of desertification in the Mediterranean.

Research is also under way in Southern Italy and in particular in the Agri valley in Basilicata and Sardinia regarding areas affected by soil degradation and for the study of strategies for prevention and attenuation of erosion. Italy recently ratified the Convention to Combat Desertification (CCD), and this has provided a stimulus for the spreading of information on topics related to the fight against desertification. Italy is actively participating in European Union research projects on desertification in the Mediterranean (MEDALUS) and is a member of the study group currently including Spain, Greece, Portugal and Turkey (Annexe IV of the CCD) aimed at defining a common strategy to fight desertification.

10.5 PALEOCLIMATE

Italy is working towards several goals in the field of paleoclimatic research:

- understanding of the phenomena involved in global climate changes in the past by studying Arctic and Antarctic ice cores in international programmes (GRIP in Greenland and EPICA in Antarctica);
- ascertaining of past climate changes in the Mediterranean area by marine sediment cores, as an active part of international and national programmes, and by the geological and geo-archaeological studies in national programmes and ones in collaboration with the countries on the southern shores of the Mediterranean;
- comprehension of the impact on Italian territory of global climate changes in the past by geological and stratographic studies on coastal and continental areas, also by drilling and coring of lake sediment, in international and national programmes.

10.6 INTERNATIONAL PROGRAMMES

Since there is no national plan on climate change, much of the research previously mentioned is carried out under funding for the Framework Programmes of the European Commission, especially the Environment Programme. The Italian groups have achieved considerable success in competing for European funding programmes. In 1994, they were participating in about a hundred EU programmes on climate-related topics. In 1995, they were participating in about a hundred programmes financed by the various thematic areas.

Among these 100 projects, Italy has the scientific and financial co-ordination of 13 projects, which are in the areas of climate variability (4), the impact of climate change (6) and desertification (3).

Italy is also participating in experimental research and international networks for the study of especially significant problems such as the gradual depletion of stratospheric ozone. In the winter of 1996-97, the CNR, ENEA, PNRA (National Research Program in Antarctica) and university institutes, in collaboration with Russian scientific institutes, completed the Air-borne Polar Experiment (APE) project. Their work included measurements taken from by aircraft on chemical and physical phenomena in the polar stratosphere in relation to the formation of stratospheric clouds and their role in ozone phenomena.

10.7 PROPOSAL FOR A NATIONAL RESEARCH PLAN ON CLIMATE CHANGE

National research on climate change and its effects is characterised by high quality, but it is not yet sufficiently supported by a national infrastructure network. In order to compensate for the weakness, fragmentary nature and improvisation that characterises research in this sector, a National Research Programme on Climate Change is now being set up in order to strengthen Italy's role and to undertake targeted structural interventions.

The role of the Programme is to co-ordinate national research and provide a point of reference for international collaboration regarding the reaching of the goals set in Article 5 of the Convention.

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Annexe 1: Emission inventory
Sectorial and summary report tables

YEAR 1990

Table 1 Sectorial Report for Energy (1990)

(Sheet 1 of 3)

Sectorial Report for National Greenhouse Gas Inventories (Gg)								
Greenhouse Gas Source and Sink Categories		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total Energy		402400	405,4	44,6	1924,4	7080,8	1326,3	1610,3
A Fuel Combustion Activities	Reference Approach							
	Sectoral Approach	400047	96,5	44,6	1919,3	7072,0	1179,8	1541,7
1 Energy Industries		148445	5,0	19,9	458,6	30,9	5,2	999,8
a Public Electricity and Heat Production		107178	4,0	16,8	408,6	24,1	4,1	767,2
b Petroleum Refining		26460	0,9	2,7	41,5	2,8	0,9	194,5
c Manufacture of Solid Fuels and Other Energy Industries		14806	0,1	0,9	8,5	4,1	0,1	38,2
2 Manufacturing Industries and Construction		78117	8,1	9,5	295,5	522,7	15,4	323,0
a Iron and Steel		15380	4,5	1,9	35,7	483,1	2,4	48,5
b Non-Ferrous Metals		803	0,1	0,1	2,1	0,0	1,9	12,1
c Chemicals		15594	0,8	2,0	64,1	10,6	5,8	63,0
d Pulp, Paper and Print		3116	0,1	0,3	6,5	0,6	0,2	12,9
e Food Processing, Beverages and Tobacco		3830	0,2	0,4	8,2	0,8	0,3	17,4
f Other (Mineral, Glass)		24080	1,6	3,7	139,6	3,9	1,5	102,1
g Other (Mechanic, Textile, Manufacture, Extraction, Building)		15313	0,9	1,6	39,4	23,6	3,3	67,1

(*) Emission from autoproducers are assigned to the sectors where they were generated and not under 1A1a

Table 1 Sectorial Report for Energy (1990)

(Sheet 2 of 3)

Sectorial Report for National Greenhouse Gas Inventories (Gg)							
Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
3 Transport	95521	61,7	3,6	967,9	5687,9	1049,2	106,1
a Civil Aviation	1875	0,2	0,0	6,4	4,7	2,0	0,5
b Road Transportation	91871	25,1	3,1	944,6	5515,9	950,7	103,0
c Railways	614	0,0	0,2	7,8	2,1	0,9	1,2
d Navigation	1162	1,0	0,3	8,8	165,2	93,2	1,4
e Other(Pipeline)		35,5		0,2		2,5	
4 Other Sectors	76805	21,4	11,6	186,0	806,6	105,3	111,6
a Commercial/Institutional	24055	7,6	3,0	29,6	91,7	8,1	31,7
b Residential	44019	10,9	5,4	38,6	162,6	13,6	58,4
c Agriculture/Forestry/Fishing	8730	2,9	3,2	117,7	552,3	83,5	21,4
5 Other (Military)	1159	0,2	0,0	11,4	23,9	4,7	1,2
B Fugitive Emissions from Fuels	2353	309,0		5,1	8,8	146,5	68,6
1 Solid Fuels		5,0				3,0	
a Coal Mining		2,0					
b Solid Fuel Transformation		3,0				3,0	
c Other ()							
2 Oil and Natural Gas	914	304,0		5,1	8,8	143,5	68,6
a Oil	914	2,3		5,1	8,8	124,5	67,3
b Natural Gas		301,6				19,0	
c Venting and Flaring				0,0			1,3
3 Other (Geothermal Energy Extraction)	1439						

Table 1 Sectorial Report for Energy (1990)

(Sheet 3 of 3)

Sectorial Report for National Greenhouse Gas Inventories (Gg)							
Greenhouse Gas Source and Sink Categorie	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Memo Items	15304	1,1	0,6	206,3	23,5	8,2	132,4
International Bunkers	12204	1,1	0,6	206,3	23,5	8,2	132,4
Aviation	3737	0,3	0,1	12,0	3,5	2,5	1,2
Marine	8467	0,8	0,5	194,3	20,0	5,7	131,2
CO2 Emissions from Biomass	3100						

Table 2 Sectorial Report for Industrial Processes (1990)

(Sheet 1 of 2)

Sectorial Report for National Greenhouse Gas Inventories (Gg)

Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
								P	A	P	A	P	A
Total Industrial Processes	27520	4,4	23,5	7,2	527,5	72,5	39,1		0,0897		0,0153		0,0092
A Mineral Products	22715					6,0	20,4						
1 Cement Production	20375						20,4						
2 Lime Production	677												
3 Limestone and Dolomite Use													
4 Soda Ash Production and Use													
5 Asphalt Roofing						1,0							
6 Road Paving with Asphalt						5,0							
7 Other (Glass Decarbonizing)	1662												
B Chemical Industry	2350	2,3	23,5	3,8	15,5	49,6	11,6						
1 Ammonia Production	2275				1,5	1,6							
2 Nitric Acid Production			7,1	3,4									
3 Adipic Acid Production	1		16,4	0,4									
4 Carbide Production	21						0,0						
5 Other (Sulfuric Acid, Titanium Dioxide,Carbon Black, Organic Chemical)	53	2,3			14,0	48,0	11,6						
C Metal Production	1977	2,1		3,3	512,0	2,8	3,8				0,0153		
1 Iron and Steel Production	927	2,1		3,3	329,1	2,3	1,4						
2 Ferroalloys Production	566				138,8								
3 Aluminium Production	429				44,1	0,1	2,3				0,0153		
4 SF_6 Used in Aluminium and Magnesium Foundries													
5 Other (Silicium Production)	55					0,3							

Table 2 Sectorial Report for Industrial Processes (1990)

(Sheet 2 of 2)

Sectorial Report for National Greenhouse Gas Inventories
(Gg)

Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
								P	A	P	A	P	A
D Other Production	478			0,1		14,1	3,4						
1 Pulp and Paper				0,1		0,2	3,4						
2 Food and Drink	478					13,9							
E Production of Halocarbons and Sulphur Hexafluoride									0,0897				0,0026
1 By-product Emissions									0,0897				
2 Fugitive Emissions													0,0026
3 Other ()													
F Consumption of Halocarbons and Sulphur Hexafluoride Metal Production													0,0066
1 Refrigeration and Air Conditioning Equipment													
2 Foam Blowing													
3 Fire Extinguishers													
4 Aerosols													
5 Solvents													
6 Other (Electrical power equipment)													0,0066
G Other()													

Table 3 Sectorial Report for Solvent And Other Product Use (1990)

(Sheet 1 of 1)

Sectorial Report for National Greenhouse Gas Inventories (Gg)			
Greenhouse Gas Source and Sink Categories	CO_2	N_2O	NMVOC
Total Solvent And Other Product Use	1999		641,5
A Paint Application	821		263,4
B Degreasing and Dry Cleaning	218		70,0
C Chemical Products, Manufacture and Processing	201		64,5
D Other (Printing Industry, Application of glues, Domestic S	760		243,7

Table 4 Sectorial Report for Agriculture (1990)

(Sheet 1 of 2)

Sectorial Report for National Greenhouse Gas Inventories (Gg)					
Greenhouse Gas Source and Sink Categories	CH_4	N_2O	NO_x	CO	NMVOC
Total Agriculture	909,1	75,0	0,9	24,9	1,9
A Enteric Fermentation	643,1				
1 Cattle (including buffalo)	244,2				
2 Dairy cows	306,4				
3 Sheep	69,9				
4 Goats	6,3				
5 Horses	2,9				
6 Mules and asses	0,7				
7 Swine	12,6				
B Manure Management	191,5				0,7
1 Cattle (including buffalo)	54,0				0,3
2 Dairy cows	52,8				0,2
3 Sheep	1,8				0,0
4 Goats	0,3				0,0
5 Horses	0,2				0,0
6 Mules and asses	0,1				0,0
7 Fattening pigs	53,5				0,1
8 Sows (including piglets)	13,5				0,0
9 Broilers	7,7				
10 Laying hens	3,6				
11 Other poultry	2,5				
12 Other (rabbits)	1,2				
13 Other (fur animals)	0,1				

Table 4 Sectorial Report for Agriculture (1990)

(Sheet 2 of 2)

Sectorial Report for National Greenhouse Gas Inventories (Gg)					
Greenhouse Gas Source and Sink Categories	CH_4	N_2O	NO_x	CO	NMVOC
B Manure Management (continued)		12,9			
10 Anaerobic					
11 Liquid Systems		0,5			
12 Solid Storage and Dry Lot		12,4			
13 Other (please specify)					
C Rice Cultivation	73,3				
1 Irrigated	73,3				
2 Rainfed					
3 Deep Water					
4 Other (please specify)					
D Agricultural Soils		62,1			
E Prescribed Burning of Savannas					
F Field Burning of Agricultural Residues	1,2	0,0	0,9	24,9	1,2
1 Cereals					
2 Pulse					
3 Tuber and Root					
4 Sugar Cane					
5 Other (please specify)					
G Other (please specify)					

Table 5 Sectorial Report for Land-Use Change and Forestry (1990)

(Sheet 1 of 1)

Sectorial Report for National Greenhouse Gas Inventories (Gg)							
Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC
Total Land-Use Change and Forestry		-24948,9	187,2	20,9	1,9	67,7	159,9
A Changes in Forest and Other Woody Biomass Stocks		-27080,7					
1 Tropical Forests							
2 Temperate Forests	8736	-35817,0					
3 Boreal Forests							
4 Grasslands/Tundra							
5 Other (please specify)							
B Forest and Grassland Conversion	2154		7,7	0,1	1,9	67,7	7,7
1 Tropical Forests							
2 Temperate Forests	2154		7,7	0,1	1,9	67,7	7,7
3 Boreal Forests							
4 Grasslands/Tundra							
5 Other (please specify)							
C Abandonment of Managed Lands		-74,2					
1 Tropical Forests							
2 Temperate Forests		-74,2					
3 Boreal Forests							
4 Grasslands/Tundra							
5 Other (please specify)							
D CO_2 Emissions and Removals from Soil	52						
E Other (Managed Forests)			179,4	20,9			152,2

Table 6 Sectorial Report for Waste (1990)

(Sheet 1 of 1)

Sectorial Report for National Greenhouse Gas Inventories (Gg)							
Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total Waste	688	842,5	0,3	10,2	193,4	19,1	0,8
A Solid Waste Disposal on Land		302,1				6,1	
1 Managed Waste Disposal on Land		192,0				4,6	
2 Unmanaged Waste Disposal on Land		110,1				1,5	
3 Other (please specify)							
B Wastewater Handling		511,4					
1 Industrial Wastewater		511,4					
2 Domestic and Commercial Wastewater							
3 Other (please specify)							
C Waste Incineration	688	9,2	0,3	10,2	193,4	13,0	0,8
D Other (Composting)		19,8					

Table 7A Summary Report for National Greenhouse Gas Inventories (1990)

(Sheet 1 of 2)

Summary Report for National Greenhouse Gas Inventories (Gg)														
Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF6	
									P	A	P	A	P	A
Total National Emissions and Removals	**443550**	**-35891**	**2348,5**	**164,4**	**1944,7**	**7894,4**	**2221,1**	**1650,3**	**0,0000**	**0,0897**	**0,0000**	**0,0153**	**0,0000**	**0,0092**
1 Energy	**402400**		**405,4**	**44,6**	**1924,4**	**7080,8**	**1326,3**	**1610,3**						
A Fuel Combustion: Reference Approach	*399611*													
Sectoral Approach	*400047*		*96,5*	*44,6*	*1919,3*	*7072,0*	*1179,8*	*1541,7*						
1. Energy Industries	148445		5,0	19,9	458,6	30,9	5,2	999,8						
2. Manufacturing Industries and Construction	78117		8,1	9,5	295,5	522,7	15,4	323,0						
3. Transport	95521		61,7	3,6	967,9	5687,9	1049,2	106,1						
4. Other Sectors (Residential, Agriculture and Fishing)	76805		21,4	11,6	186,0	806,6	105,3	111,6						
5. Other (Military)	1159		0,2	0,0	11,4	23,9	4,7	1,2						
B Fugitive Emissions from Fuels	*2353*		*309,0*	*0,0*	*5,1*	*8,8*	*146,5*	*68,6*						
1. Solid Fuels			5,0				3,0							
2. Oil and Natural Gas	914		304,0		5,1	8,8	143,5	68,6						
3. Other (Geothermal)	1439													
2 Industrial Processes	**27520**		**4,4**	**23,5**	**7,2**	**527,5**	**72,5**	**39,1**		**0,0897**		**0,0153**		**0,0092**
A Mineral Products	22715						6,0	20,4						
B Chemical Industry	2350		2,3	23,5	3,8	15,5	49,6	11,6						
C Metal Production	1977		2,1		3,3	512,0	2,8	3,8				0,0153		
D Other Production (Pulp and Paper, Food and Drink)	478				0,1		14,1	3,4						
E Production of Halocarbons and Sulphur Hexafluoride										0,0897				0,0026
F Consumption of Halocarbons and Sulphur Hexafluoride														0,0066
G Other														

Table 7A Summary Report for National Greenhouse Gas Inventories (1990)

(Sheet 2 of 2)

Sectoral Report for National Greenhouse Gas Inventories (Gg)

Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs P	HFCs A	PFCs P	PFCs A	SF6 P	SF6 A
3 Solvent and Other Product Use	**1999**						**641,5**							
4 Agriculture			**909,1**	**75,0**	**0,9**	**24,9**	**1,9**							
A Enteric Fermentation			643,1											
B Manure Management			191,5	12,9			0,7							
C Rice Cultivation			73,3											
D Agriculture Soils				62,1										
E Prescribed Burning of Savannas														
F Field Burning of Agricultural Residues			1,2	0,0	0,9	24,9	1,2							
G Other														
5 Land-Use Change & Forestry	**10942**	**-35891**	**187,2**	**20,9**	**1,9**	**67,7**	**159,9**							
A Changes in Forest and Other Woody Biomass Stocks	8736	-35817												
B Forest and Grassland Conversion	2154		7,7	0,1	1,9	67,7	7,7							
C Abandonment of Managed Lands		-74												
D CO2 Emissions and Removal from Soil	52													
E Other (Managed Forests)			179,4	20,9			152,2							
6 Waste	**688**		**842,5**	**0,3**	**10,2**	**193,4**	**19,1**	**0,8**						
A Solid Waste Disposal on Land			302,1				6,1							
B Wastewater Handling			511,4											
C Waste Incineration	688		9,2	0,3	10,2	193,4	13,0	0,8						
D Other (Composting)			19,8											
7 Other														
Memo Items:														
International Bunkers	**12204**		**1,1**	**0,6**	**206,3**	**23,5**	**8,2**	**132,4**						
- Aviation	3737		0,3	0,1	12,0	3,5	2,5	1,2						
- Marine	8467		0,8	0,5	194,3	20,0	5,7	131,2						
CO2 Emissions from Biomass	**3100**													

Table 7B Short Summary Report for National Greenhouse Gas Inventories (1990)

(Sheet 1 of 1)

Summary Report for National Greenhouse Gas Inventories (Gg)

Greenhouse Gas Source and Sink Categorie	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF6	
									P	A	P	A	P	A
Total National Emissions and Removals	***443550***	***-35891***	***2348,5***	***164,4***	***1944,7***	***7894,4***	***2221,1***	***1650,3***	***0,0000***	***0,0897***	***0,0000***	***0,0153***	***0,0000***	***0,0092***
1 Energy	***402400***		***405,4***	***44,6***	***1924,4***	***7080,8***	***1326,3***	***1610,3***						
A Fuel Combustion (Sectoral Approach)	400047		96,5	44,6	1919,3	7072,0	1179,8	1541,7						
B Fugitive Emissions from Fuels	2353		309,0	0,0	5,1	8,8	146,5	68,6						
2 Industrial Processes	***27520***		***4,4***	***23,5***	***7,2***	***527,5***	***72,5***	***39,1***	***0,0000***	***0,0897***	***0,0000***	***0,0153***	***0,0000***	***0,0092***
3 Solvent and Other Product Use	***1999***						***641,5***							
4 Agriculture			***909,1***	***75,0***	***0,9***	***24,9***	***1,9***							
5 Land-Use Change & Forestry	***10942***	***-35891***	***187,2***	***20,9***	***1,9***	***67,7***	***159,9***							
6 Waste	***688***		***842,5***	***0,3***	***10,2***	***193,4***	***19,1***	***0,8***						

1A5 Other (Military) (DETAILED INFORMATION 1990)

IPCC category	Included in (SNAP '94):	Activity data		Emission estimates							Emission factors						
		Type of fuel (NAPFUE '94)	Total fuel quantity	CO2	CH4	N2O	NOx	CO	NMVOC	SO2	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
			(t)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(kg/t)	(kg/t)	(kg/t)	(kg/t)	(kg/t)	(kg/t)	(kg/t)
IA5a Other (stationary)	20201 Commercial and institutional plants	Gas oil (204)	13339	41,771	0,004	0,008	0,028	0,011	0,002	0,080	3131,5	0,3	0,6	2,1	0,9	0,1	6,0
IA5a Other (stationary)	20201 Commercial and institutional plants	Natural Gas (301)	1050	2,025	0,000	0,000	0,000	0,001	0,000	0,000	1928,4	0,2	0,1	0,2	0,9	0,2	0,0
IA5a Other (stationary)				43,796	0,004	0,008	0,029	0,012	0,002	0,080							
1A5b Other (mobile) - offroad	80801 Other mobile sources and machinery (military)	Motor gasoline - (208)	48693	155,433	0,108	0,003	1,427	18,456	3,034	0,037	3192,1	2,2	0,1	29,3	379,0	62,3	0,8
1A5b Other (mobile) - offroad	80801 Other mobile sources and machinery (military)	Diesel oil for road transport (205)	159943	500,860	0,064	0,014	7,999	3,197	1,278	0,963	3131,5	0,40	0,1	50,0	20,0	8,0	6,0
1A5b Other (mobile) - offroad				656,293	0,172	0,018	9,426	21,653	4,312	1,000							
1A5b Other (mobile) - aviatio	80801 Other mobile sources and machinery (military)	Jet fuel (207)	143187	451,942	0,003	0,013	1,915	0,638	0,319	0,143	3156,3	0,02	0,1	13,4	4,5	2,2	1,0
1A5b Other (mobile) - aviatio	80801 Other mobile sources and machinery (military)	Aviation gasoline (209)	2347	7,214	0,000	0,000	0,032	1,577	0,032	0,002	3073,6	0,02	0,1	13,4	672,0	13,4	1,0
1A5b Other (mobile) - aviatio	80801 Other mobile sources and machinery (military)			459,155	0,003	0,013	1,947	2,216	0,351	0,146							
1A5b Other (mobile)				1115,449	0,175	0,031	11,373	23,869	4,663	1,145							
IA5 Other(Military)				1159,245	0,179	0,039	11,401	23,881	4,665	1,226							

INTERNATIONAL BUNKERS (DETAILED INFORMATION 1998)

Source and sink categories	Activity data			Emission estimates							Emission factors								Type of Fuel
	Number of LTO-cycles	Type of fuel	Total fuel quantity	CO2	CH4	N2O	NOx	CO	NMVOC	SO2	Fuel consumption	CO2	CH4	N2O	NOx	CO	NMVOC	SO2	
			(t)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(kg/LTO)	(kg/LTO or kg/t)	(kg/LTO or kg/t)	(kg/LTO or kg/t)	(kg/LTO or kg/t)	(kg/LTO or kg/t)	(kg/LTO or kg/t)	(kg/LTO or kg/t)	
Civil aviation international airport traffic	147874,0	Jet fuel (207)	147874,0	458,1	0,0	0,0	1,7	0,8	0,2	0,1	1000,0	3142,3	0,10	0,1	11,8	8,4	1,8	1,0	Jet fuel (207)
Civil aviation international cruise traffic		Jet fuel (207)	1080761,0	3301,7	0,3	0,1	10,3	2,5	2,3	1,1	1000,0	3118,7	0,24	0,1	9,7	2,4	2,2	1,0	
Total international aviation (Bunkers)				3730,8	0,3	0,1	12,0	3,6	2,8	1,2									
International marine (Bunkers)		Gas oil (204)	800000,0	1768,7	0,2	0,1	41,0	4,2	1,3	3,4		3188,3	0,29	0,2	72,0	7,4	2,1	6,0	Gas oil (204)
International marine (Bunkers)		Bunker oil (205)	2120000,0	6681,4	0,5	0,4	153,3	15,8	4,6	127,7		3150,3	0,29	0,2	72,8	7,4	2,1	60,0	Bunker oil (205)
Total international marine (Bunkers)				8457,1	0,6	0,5	194,3	20,0	5,7	131,3									

6 WASTE (DETAILED INFORMATION [illegible])

SOURCE AND SINK CATEGORIES		EMISSION ESTIMATES (Gg)						
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
6 Waste		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WASTE: 6A Solid waste disposal on land

SOURCE/SINK CATEGORIES	ACTIVITY DATA Gg	EMISSION ESTIMATES (Gg)							AGGREGATE EMISSION FACTORS (kg/t)							CH4 RECOVERED Gg
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	
6A Solid waste disposal on land (net)	[illegible]	[illegible]	[illegible]	NO	NO	NO	[illegible]	NO	[illegible]	[illegible]	NO	NO	NO	[illegible]	NO	
6A Solid waste disposal on land (gross)	[illegible]	[illegible]	[illegible]	NO	NO	NO	[illegible]	NO	[illegible]	[illegible]	NO	NO	NO	[illegible]	NO	
6A1 Managed waste disposal on land	[illegible]	[illegible]	[illegible]	NO	NO	NO	[illegible]	NO	NO	[illegible]	NO	NO	NO	[illegible]	NO	[illegible]
6A2 Unmanaged waste disposal sites	[illegible]	[illegible]	[illegible]	NO	NO	NO	[illegible]	NO	[illegible]	[illegible]	NO	NO	NO	[illegible]	NO	[illegible]

Emissions from landfill gas reported under 1A

SOURCE/SINK CATEGORIES	ACTIVITY DATA Gg	EMISSION ESTIMATES (Gg)							AGGREGATE EMISSION FACTORS (kg/t)						
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1A4a Commercial/Institutional	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WASTE: 6B Wastewater handling

SOURCE/SINK CATEGORIES	ACTIVITY DATA [illegible]	EMISSION ESTIMATES (Gg)							AGGREGATE EMISSION FACTORS ([illegible])						
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
6B Wastewater handling	[illegible]	[illegible]	[illegible]	NE	NO	NO	NE	NO	[illegible]	[illegible]	NE	NO	NO	NE	NO
6B1 Industrial wastewater	[illegible]	[illegible]	[illegible]	NE	NO	NO	NE	NO	[illegible]	[illegible]	NE	NO	NO	NE	NO
6B2 Domestic and commercial wastewater		reported under [illegible]													

WASTE: 6C Waste incineration

SOURCE/SINK CATEGORIES	ACTIVITY DATA Gg	EMISSION ESTIMATES Gg							AGGREGATE EMISSION FACTORS kg/t						
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
6C Waste incineration		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]							
Municipal	[illegible]	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Industrial	[illegible]	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sewage sludge	[illegible]	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hospital	[illegible]	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Waste oil	[illegible]	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Open burning of agricultural wastes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Emissions from MSW incineration reported under 1A

SOURCE/SINK CATEGORIES	ACTIVITY DATA Gg	EMISSION ESTIMATES Gg							AGGREGATE EMISSION FACTORS kg/t						
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
1A4, Commercial/Institutional	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

6D Other

SOURCE/SINK CATEGORIES	ACTIVITY DATA Gg	EMISSION ESTIMATES Gg							AGGREGATE EMISSION FACTORS kg/t						
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_x
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

YEAR 1994

Table 1 Sectorial Report for Energy (1994)

(Sheet 1 of 3)

Sectorial Report for National Greenhouse Gas Inventories (Gg)

Greenhouse Gas Source and Sink Categories		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total Energy		387860	458,5	41,8	1774,0	6953,5	1458,8	1240,7
A Fuel Combustion Activities	Reference Approach	391958						
	Sectorial Approach	385192	106,3	41,8	1768,3	6945,1	1304,4	1182,7
1 Energy Industries		129069	4,6	18,7	346,6	27,9	4,6	776,1
a Public Electricity and Heat Production		99191	3,8	16,2	299,4	21,2	3,7	571,6
b Petroleum Refining		16201	0,7	2,1	38,6	3,1	0,8	160,4
c Manufacture of Solid Fuels and Other Energy Industries		13677	0,1	0,3	8,6	3,6	0,1	44,1
2 Manufacturing Industries and Construction		81071	7,3	7,7	246,0	516,6	14,9	243,2
a Iron and Steel		22749	4,2	1,0	31,2	451,2	2,3	39,2
b Non-Ferrous Metals		1201	0,0	0,0	1,9	0,4	2,1	12,8
c Chemicals		11893	0,6	1,5	48,7	25,1	5,5	44,3
d Pulp, Paper and Print		5419	0,1	0,2	3,0	1,6	0,2	4,3
e Food Processing, Beverages and Tobacco		4777	0,2	0,4	9,3	1,5	0,3	14,1
f Other (Mineral, Glass)		21444	1,5	3,0	117,5	9,5	1,4	75,6
g Other (Mechanic,Textile, Manufacture, Extraction, Building)		13588	0,7	1,5	34,3	27,5	3,2	58,8

(*) Emission from autoproducers are assigned to the sectors where they were generated and not under 1A1a

Table 1 Sectorial Report for Energy (1994)

(Sheet 2 of 3)

Sectorial Report for National Greenhouse Gas Inventories (Gg)

Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
3 Transport	103742	70,6	5,5	973,8	5672,7	1184,3	105,0
a Civil Aviation	1916	0,1	0,0	6,6	2,6	1,0	0,5
b Road Transportation	99966	39,2	4,9	946,2	5496,0	1083,4	101,9
c Railways	595	0,0	0,2	7,5	2,0	0,9	1,1
d Navigation	1265	1,0	0,3	13,2	172,1	96,9	1,5
e Other(Pipeline)		30,3		0,2		2,1	
4 Other Sectors	69717	23,7	9,8	189,5	711,5	96,6	57,0
a Commercial/Institutional	15122	7,6	2,0	22,3	119,5	9,9	14,1
b Residential	45900	14,0	4,5	41,1	221,1	18,3	25,5
c Agriculture/Forestry/Fishing	8695	2,1	3,3	126,1	370,9	68,3	17,4
5 Other (Military)	1593	0,1	0,1	12,4	16,4	4,0	1,3
B Fugitive Emissions from Fuels	2668	352,2		5,7	8,4	154,4	58,0
1 Solid Fuels		3,4				2,7	
a Coal Mining		0,7					
b Solid Fuel Transformation		2,7				2,7	
c Other ()							
2 Oil and Natural Gas	1163	348,8		5,7	8,4	151,7	58,0
a Oil	926	2,0		5,4	8,3	129,9	45,6
b Natural Gas		346,8				21,8	
c Venting and Flaring	236			0,4	0,1		12,4
3 Other (Geothermal Energy Extraction)	1505						

Table 1 Sectorial Report for Energy (1994)

(Sheet 3 of 3)

Sectorial Report for National Greenhouse Gas Inventories (Gg)							
Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Memo Items	16594	1,1	0,7	185,7	22,0	8,3	113,6
International Bunkers	12416	1,1	0,7	185,7	22,0	8,3	113,6
Aviation	4926	0,4	0,2	15,6	4,5	3,3	1,6
Marine	7491	0,7	0,5	170,1	17,5	5,0	112,0
CO2 Emissions from Biomass	4178						

Table 2 Sectorial Report for Industrial Processes (1994)

(Sheet 1 of 2)

Sectorial Report for National Greenhouse Gas Inventories (Gg)													
Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
								P	A	P	A	P	A
Total Industrial Processes	22852	4,5	20,6	4,8	290,4	70,5	29,9	0,0000	0,6925	0,0000	0,0116	0,0000	0,0145
A Mineral Products	19077					5,4	16,5						
1 Cement Production	16542						16,5						
2 Lime Production	656												
3 Limestone and Dolomite Use													
4 Soda Ash Production and Use													
5 Asphalt Roofing						1,1							
6 Road Paving with Asphalt						4,3							
7 Other (Glass Decarbonizing)	1879												
B Chemical Industry	2214	2,3	20,6	1,4	11,1	47,9	8,9						
1 Ammonia Production	2157				1,4	1,5							
2 Nitric Acid Production			4,0	1,0									
3 Adipic Acid Production	1		16,6	0,4									
4 Carbide Production	18						0,0						
5 Other (Sulfuric Acid, Titanium Dioxide,Carbon Bl	38	2,3			9,7	46,3	8,9						
C Metal Production	1022	2,3		3,3	279,3	2,9	3,3				0,0116		
1 Iron and Steel Production	402	2,3		3,3	184,0	2,5	1,5						
2 Ferroalloys Production	252				62,0								
3 Aluminium Production	325				33,4	0,1	1,8				0,0116		
4 SF6 Used in Aluminium and Magnesium Foundries													
5 Other (Silicium Production)	42					0,3							

Table 2 Sectorial Report for Industrial Processes (1994)

(Sheet 2 of 2)

Sectorial Report for National Greenhouse Gas Inventories (Gg)													
Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
								P	A	P	A	P	A
D Other Production	539			0,0		14,3	1,1						
1 Pulp and Paper				0,0		0,2	1,1						
2 Food and Drink	539					14,1							
E Production of Halocarbons and Sulphur Hexafluoride									0,1089				0,0036
1 By-product Emissions									0,1089				
2 Fugitive Emissions													0,0036
3 Other ()													
F Consumption of Halocarbons and Sulphur Hexafluoride&Metal Production									0,5856				0,0109
1 Refrigeration and Air Conditioning Equipment									0,3688				
2 Foam Blowing									0,0150				
3 Fire Extinguishers													
4 Aerosols									0,2018				
5 Solvents													
6 Other (Electrical power equipment)													0,0109
G Other()													

Table 3 Sectorial Report for Solvent And Other Product Use (1994)

(Sheet 1 of 1)

Sectorial Report for National Greenhouse Gas Inventories (Gg)			
Greenhouse Gas Source and Sink Categories	CO_2	N_2O	NMVOC
Total Solvent And Other Product Use	1976		634,1
A Paint Application	915		293,6
B Degreasing and Dry Cleaning	167		53,6
C Chemical Products, Manufacture and Processing	210		67,5
D Other (Printing Industry, Application of glues, Domestic Solvent Use)	684		219,5

Table 4 Sectorial Report for Agriculture (1994)

(Sheet 1 of 2)

Sectorial Report for National Greenhouse Gas Inventories (Gg)					
Greenhouse Gas Source and Sink Categories	CH_4	N_2O	NO_x	CO	NMVOC
Total Agriculture	870,5	75,9	0,9	25,2	1,9
A Enteric Fermentation	607,2				
1 Cattle (including buffalo)	269,1				
2 Dairy cows	237,4				
3 Sheep	79,7				
4 Goats	8,3				
5 Horses	3,5				
6 Mules and asses	0,5				
7 Swine	8,7				
B Manure Management	181,9				0,6
1 Cattle (including buffalo)	62,0				0,3
2 Dairy cows	99,8				0,1
3 Sheep	2,1				0,0
4 Goats	0,3				0,0
5 Horses	0,3				0,0
6 Mules and asses	0,0				0,0
7 Fattening pigs	48,9				0,1
8 Sows (including piglets)	12,9				0,0
9 Broilers	7,8				
10 Laying hens	3,8				
11 Other poultry	2,5				
12 Other (rabbits)	1,3				
13 Other (fur animals)	0,1				

Table 4 Sectorial Report for Agriculture (1994)

(Sheet 2 of 2)

Sectorial Report for National Greenhouse Gas Inventories (Gg)					
Greenhouse Gas Source and Sink Categories	CH_4	N_2O	NO_x	CO	NMVOC
B Manure Management (continued)		12,4			
10 Anaerobic					
11 Liquid Systems		0,5			
12 Solid Storage and Dry Lot		11,9			
13 Other (please specify)					
C Rice Cultivation	80,2				
1 Irrigated	80,2				
2 Rainfed					
3 Deep Water					
4 Other (please specify)					
D Agricultural Soils		63,5			
E Prescribed Burning of Savannas					
F Field Burning of Agricultural Residues	1,2	0,0	0,9	25,2	1,2
1 Cereals					
2 Pulse					
3 Tuber and Root					
4 Sugar Cane					
5 Other (please specify)					
G Other (please specify)					

Table 5 Sectorial Report for Land-Use Change and Forestry (1994)

(Sheet 1 of 1)

Sectorial Report for National Greenhouse Gas Inventories (Gg)							
Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC
Total Land-Use Change and Forestry		-24830,2	192,4	21,6	0,7	23,1	163,9
A Changes in Forest and Other Woody Biomass Stocks		-25458,6					
1 Tropical Forests							
2 Temperate Forests	10488	-35947,1					
3 Boreal Forests							
4 Grasslands/Tundra							
5 Other (please specify)							
B Forest and Grassland Conversion	1077		2,6	0,0	0,7	23,1	2,6
1 Tropical Forests							
2 Temperate Forests	1077		2,6	0,0	0,7	23,1	2,6
3 Boreal Forests							
4 Grasslands/Tundra							
5 Other (please specify)							
C Abandonment of Managed Lands		-132,8					
1 Tropical Forests							
2 Temperate Forests		-132,8					
3 Boreal Forests							
4 Grasslands/Tundra							
5 Other (please specify)							
D CO_2 Emissions and Removals from Soil		-315,6					
E Other (Managed Forests)			189,7	21,6			161,3

Table 6 Sectorial Report for Waste (1994)

(Sheet 1 of 1)

Sectorial Report for National Greenhouse Gas Inventories (Gg)

Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total Waste	719	987,1	0,5	15,0	280,5	25,0	1,1
A Solid Waste Disposal on Land		426,5				7,7	
1 Managed Waste Disposal on Land		344,0				6,6	
2 Unmanaged Waste Disposal on Land		82,5				1,1	
3 Other (please specify)							
B Wastewater Handling		511,4					
1 Industrial Wastewater		511,4					
2 Domestic and Commercial Wastewater							
3 Other (please specify)							
C Waste Incineration	719	13,4	0,5	15,0	280,5	17,3	1,1
D Other (composting)		35,8					

Table 7A Summary Report for National Greenhouse Gas Inventories (1994)

(Sheet 1 of 2)

Summary Report for National Greenhouse Gas Inventories (Gg)

Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF6	
									P	A	P	A	P	A
Total National Emissions and Removals	424972	-36396	2512,0	168,4	1795,4	7572,8	2254,1	1271,7	0,0000	0,6725	0,0000	0,0116	0,0000	0,0145
1 Energy	[illegible]		480,5	41,8	1774,8	[illegible]	1458,8	1240,7						
A Fuel Combustion: Reference Approach	402205													
Sectoral Approach	395192		166,3	41,8	1788,1	6843,7	1304,4	1182,7						
1. Energy Industries	[illegible]		4,0	14,7	340,0	27,9	4,6	776,1						
2. Manufacturing Industries and Construction	81971		7,3	7,7	240,0	336,0	14,9	243,2						
3. Transport	107742		70,8	3,3	973,8	5672,7	1104,3	105,0						
4. Other Sectors (Residential, Agriculture and Fishing)	69717		23,7	9,0	180,5	711,5	96,6	57,8						
5. Other (Military)	1998		0,1	0,1	12,4	18,4	4,0	1,2						
B Fugitive Emissions from Fuels	2607		352,2		2,7	8,4	154,4	58,0						
1. Solid Fuels			3,4				2,7							
2. Oil and Natural Gas	1062		348,8		2,7	8,4	151,7	58,0						
3. Other (Geothermal)	1306													
2 Industrial Processes	22858		4,6	20,6	4,0	290,4	78,5	20,9		0,6725		0,0116		0,0145
A Mineral Products	16077						5,4	14,5						
B Chemical Industry	2214		2,3	20,6	1,4	11,1	47,8	6,0						
C Metal Production	1822		2,3		3,3	279,3	2,9	0,5				0,0116		
D Other Production (Pulp and Paper, Food and Drink)	599				0,6		14,5	1,1						
E Production of Halocarbons and Sulphur Hexafluoride										0,3069		0,0000		0,0036
F Consumption of Halocarbons and Sulphur Hexafluoride										0,3656				0,0109
G Other														

Table 7A Summary Report for National Greenhouse Gas Inventories (1994)

(Sheet 2 of 2)

Sectorial Report for National Greenhouse Gas Inventories (Gg)

Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVO	SO_2	HFCs		PFCs		SF6	
									P	A	P	A	P	A
3 Solvent and Other Product Use	**1976**						**634,1**							
4 Agriculture			**870,5**	**75,9**	**0,9**	**25,2**	**1,9**							
A Enteric Fermentation			607,2											
B Manure Management			181,9	12,4			0,6							
C Rice Cultivation			80,2											
D Agriculture Soils				63,5										
E Prescribed Burning of Savannas														
F Field Burning of Agricultural Residues			1,2	0,0	0,9	25,2	1,2							
G Other														
5 Land-Use Change & Forestry	**11565**	**-36396**	**192,4**	**21,6**	**0,7**	**23,1**	**163,9**							
A Changes in Forest and Other Woody Biomass Stocks	10488	-35947												
B Forest and Grassland Conversion	1077		2,6	0,0	0,7	23,1	2,6							
C Abandonment of Managed Lands		-133												
D CO2 Emissions and Removal from Soil		-316												
E Other (Managed Forests)			189,7	21,6			161,3							
6 Waste	**719**		**987,1**	**0,5**	**15,0**	**280,5**	**25,0**	**1,1**						
A Solid Waste Disposal on Land			426,5				7,7							
B Wastewater Handling			511,4											
C Waste Incineration	719		13,4	0,5	15,0	280,5	17,3	1,1						
D Other (Composting)			35,8											
7 Other														
Memo Items:														
International Bunkers	**12416**		**1,1**	**0,7**	**185,7**	**22,0**	**8,3**	**113,6**						
- Aviation	4926		0,4	0,2	15,6	4,5	3,3	1,6						
- Marine	7491		0,7	0,5	170,1	17,5	5,0	112,0						
CO2 Emissions from Biomass	**4178**													

Table 7B Short Summary Report for National Greenhouse Gas Inventories (1994)

(Sheet 1 of 1)

Summary Report for National Greenhouse Gas Inventories (Gg)														
Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVO	SO_2	HFCs		PFCs		SF6	
									P	A	P	A	P	A
Total National Emissions and Removals	*424972*	*-36396*	*2513,0*	*160,4*	*1795,4*	*7572,8*	*2354,1*	*1271,7*	*0,0000*	*0,6925*	*0,0000*	*0,0116*	*0,0000*	*0,0145*
1 Energy	*387860*		*458,5*	*41,8*	*1774,0*	*6953,5*	*1458,8*	*1240,7*						
A Fuel Combustion (Sectoral Approach)	385192		106,3	41,8	1768,3	6945,1	1304,4	1182,7						
B Fugitive Emissions from Fuels	2668		352,2	0,0	5,7	8,4	154,4	58,0						
2 Industrial Processes	*22852*		*4,5*	*20,6*	*4,8*	*290,4*	*70,5*	*29,9*	*0,0000*	*0,6925*	*0,0000*	*0,0116*	*0,0000*	*0,0145*
3 Solvent and Other Product Use	*1976*						*634,1*							
4 Agriculture			*870,5*	*75,9*	*0,9*	*25,2*	*1,9*							
5 Land-Use Change & Forestry	*11565*	*-36396*	*192,4*	*21,6*	*0,7*	*23,1*	*163,9*							
6 Waste	*719*		*987,1*	*0,5*	*15,0*	*280,5*	*25,0*	*1,1*						

1A5 Other (Military) (DETAILED INFORMATION 1994)

IPCC category	Included in (SNAP '94)	Activity data: Type of fuel (NAPFUE '94)	Activity data: Total fuel quantity	Emission estimates: CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	Emission factors: CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
			(t)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(kg/t)	(kg/t)	(kg/t)	(kg/t)	(kg/t)	(kg/t)	(kg/t)
1A5a Other (stationary)	020103 Commercial and institutional plants	Gas oil (204)	21482	67,[illegible]	0,003	0,013	0,048	0,018	0,003	0,128	3131,5	0,3	0,6	2,1	0,9	0,1	6,0
1A5a Other (stationary)	020103 Commercial and institutional plants	Natural Gas (301)	2770	5,357	0,000	0,000	0,000	0,002	0,000	0,000	1928,4	0,2	0,1	0,2	0,8	0,2	0,0
1A5a Other (stationary)				72,[illegible]	0,007	0,013	0,048	0,021	0,003	0,12[illegible]							
1A5b Other (mobile) - offroad	07 Road Transport	Motor gasoline (208)	[illegible]	107,341	0,076	0,003	1,076	11,274	2,135	0,03[illegible]	[illegible]	2,1	0,2	30,8	310,8	58,0	0,3
1A5b Other (mobile) - offroad	0801 Other mobile sources and machinery	Diesel oil for road transport (205)	144486	453,436	0,056	0,019	7,229	2,[illegible]	1,184	0,870	3131,5	0,40	0,1	50,8	20,8	8,0	6,0
1A5b Other (mobile) - offroad				560,418	0,132	0,019	8,305	14,107	3,330	[illegible]							
1A5b Other (mobile) - aviation	0805 Air Traffic	Jet fuel (207)	[illegible]	[illegible]	0,007	0,027	4,051	1,356	0,075	0,303	3150,5	0,02	0,1	13,4	4,6	2,2	1,0
1A5b Other (mobile) - aviation	0805 Air Traffic	Aviation gasoline (208)	1266	3,857	0,000	0,000	0,017	0,849	0,017	0,001	3073,0	0,07	0,1	13,4	872,0	13,4	1,0
1A5b Other (mobile) - aviation	0805 Air Traffic			[illegible],701	0,007	0,027	4,068	2,104	[illegible]	0,304							
1A5b Other (mobile)				[illegible],210	[illegible]	0,046	12,373	[illegible]	[illegible]	1,[illegible]							
1A5 Other (Military)				[illegible],775	0,146	0,059	12,[illegible]	[illegible]	[illegible]	1,[illegible]							

INTERNATIONAL BUNKERS (DETAILED INFORMATION 1994)

Source and sink categories	Activity data			Emission estimates							Emission factors								
	Number of LTO-cycles	Type of fuel	Total fuel quantity	CO2	CH4	N2O	NOx	CO	NMVOC	SO2	Fuel consumption	CO2	CH4	N2O	NOx	CO	NMVOC	SO2	Type of Fuel
			(t)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(kg/LTO)	(kg/LTO or kg/t)	(kg/LTO or kg/t)	(kg/LTO or kg/t)	(kg/LTO or kg/t)	(kg/LTO or kg/t)	(kg/LTO or kg/t)	(kg/LTO or kg/t)	
Civil aviation International airport traffic	177240,0	Jet fuel (207)	177240,0	526,8	0,0	0,0	2,1	1,1	0,3	0,2	1000,0	2972,0	0,18	0,1	11,8	6,4	1,6	1,0	Jet fuel (207)
Civil aviation International cruise traffic		Jet fuel (207)	1396461,1	4398,9	0,3	0,1	13,5	3,4	3,0	1,4	1000,0	3150,0	0,24	0,1	9,7	2,4	2,2	1,0	Jet fuel (207)
Total international aviation (Bunkers)				4925,6	0,4	0,2	15,6	4,5	3,3	1,6									
International marine (Bunkers)		Gas oil (204)	552000,0	1749,8	0,2	0,1	39,7	4,1	1,2	3,3		3170,0	0,29	0,2	72,0	7,4	2,1	6,0	Gas oil (204)
International marine (Bunkers)		Bunker oil (202)	1811000,0	5740,9	0,5	0,4	130,4	13,4	3,8	108,7		3170,0	0,29	0,2	72,0	7,4	2,1	60,0	Bunker oil (202)
Total international marine (Bunkers)				7490,7	0,7	0,5	170,1	17,5	5,0	112,0									

6 WASTE (DETAILED INFORMATION 1994)

SOURCE/SINK CATEGORIES		EMISSION ESTIMATES Gg						
		CO2	CH4	N2O	NOx	CO	NMVOC	SO2
6 Waste		719,2	987,1	0,5	15,0	280,5	25,0	1,1

WASTE: 6A Solid waste disposal on land

SOURCE/SINK CATEGORIES	ACTIVITY DATA Gg	EMISSION ESTIMATES Gg							AGGREGATE EMISSION FACTORS kg/t							CH4 RECOVERED Gg
		CO2	CH4	N2O	NOx	CO	NMVOC	SO2	CO2	CH4	N2O	NOx	CO	NMVOC	SO2	
6A Solid waste disposal on land (net)	26541,990	0,0	426,5	NO	NO	NO	7,7	NO	0,0	16,07	NO	NO	NO	0,29	NO	
6A Solid waste disposal on land (gross)	26541,990	0,0	583,5	NO	NO	NO	7,7	NO	0,0	21,98	NO	NO	NO	0,29	NO	
6A1 Managed waste disposal on land	26509,697	0,0	501,0	NO	NO	NO	6,6	NO	0,0	18,90	NO	NO	NO	0,25	NO	156,997
6A2 Unmanaged waste disposal sites	32,293	0,0	82,5	NO	NO	NO	1,1	NO	0,0	2554,12	NO	NO	NO	33,84	NO	0,0

Emissions from landfill gas reported under IA

SOURCE/SINK CATEGORIES	ACTIVITY DATA Gg	EMISSION ESTIMATES Gg							AGGREGATE EMISSION FACTORS kg/t						
		CO2	CH4	N2O	NOx	CO	NMVOC	SO2	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
1A4a, Commercial/Institutional	156,997	0,0	1,2	0,02	7,86	2,36	0,37	0,00	0,0	7,66	0,15	50,06	15,02	2,35	0,00

WASTE: 6B Wastewater handling

SOURCE/SINK CATEGORIES	ACTIVITY DATA m3	EMISSION ESTIMATES Gg							AGGREGATE EMISSION FACTORS kg/m3						
		CO2	CH4	N2O	NOx	CO	NMVOC	SO2	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
6B Wastewater handling	1,96E+09	0	511,38	NE	NO	NO	NE	NO	0,0	0,26	NE	NO	NO	NE	NO
6B1 Industrial wastewater	1,96E+09	0	511,38	NE	NO	NO	NE	NO	0,0	0,26	NE	NO	NO	NE	NO
6B2 Domestic and commercial wastewater		reported under 6A, 6C, 6D													

WASTE: 6C Waste Incineration

SOURCE/SINK CATEGORIES	ACTIVITY DATA Gg	EMISSION ESTIMATES Gg							AGGREGATE EMISSION FACTORS kg/t						
		CO2	CH4	N2O	NOx	CO	NMVOC	SO2	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
6C Waste incineration		719,2	13,40	0,49	15,00	280,52	17,28	1,13							
Municipal	457,306	132,2	NE	0,05	0,53	0,03	0,21	0,18	289,1	NE	0,10	1,15	0,07	0,46	0,39
Industrial	380,450	456,5	NE	0,04	0,76	0,21	2,82	0,49	1200,0	NE	0,10	2,00	0,56	7,40	1,28
Sewage sludge	181,849	0,0	NE	0,04	0,55	0,11	0,05	0,33	0,0	NE	0,23	3,00	0,60	0,25	1,80
Hospital	107,274	128,7	NE	0,01	0,21	0,06	0,79	0,14	1200,0	NE	0,10	2,00	0,56	7,40	1,28
Waste oil	1,448	1,7	NE	0,00	0,00	0,00	0,01	0,00	1200,0	NE	0,10	2,00	0,56	7,40	1,28
Open burning of agricultural wastes	3,579	0,0	13,40	0,36	12,95	280,11	13,40	NO	0,0	3,74	0,10	3,62	78,26	3,74	NO

Emissions from MSW Incineration reported under IA

SOURCE/SINK CATEGORIES	ACTIVITY DATA Gg	EMISSION ESTIMATES Gg							AGGREGATE EMISSION FACTORS kg/t						
		CO2	CH4	N2O	NOx	CO	NMVOC	SO2	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
1A4a, Commercial/Institutional	822,105	237,6	NE	0,08	0,95	0,06	0,38	0,32	289,1	NE	0,10	1,15	0,07	0,46	0,39

6D Other

SOURCE/SINK CATEGORIES	ACTIVITY DATA Gg	EMISSION ESTIMATES Gg							AGGREGATE EMISSION FACTORS kg/t						
		CO2	CH4	N2O	NOx	CO	NMVOC	SO2	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
Compost production	705,558	0,0	35,84	NO	NO	NO	NE	NO	0,0	0,05	NO	NO	NO	NE	NO

YEAR 1995

Table 1 Sectorial Report for Energy (1995)

(Sheet 1 of 3)

Sectorial Report for National Greenhouse Gas Inventories (Gg)								
Greenhouse Gas Source and Sink Categories		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total Energy		412818	467,2	44,1	1831,4	7156,4	1490,2	1290,7
A Fuel Combustion Activities	Reference Approach							
	Sectoral Approach	410140	115,0	44,1	1825,6	7148,0	1330,7	1232,7
1 Energy Industries		139180	4,9	20,0	375,6	30,1	4,9	823,1
a Public Electricity and Heat Production (*)		107702	4,1	17,4	326,3	23,2	4,0	608,9
b Petroleum Refining		16965	0,7	2,2	40,4	3,3	0,8	169,6
c Manufacture of Solid Fuels and Other Energy Industries		14513	0,1	0,4	8,8	3,6	0,1	44,6
2 Manufacturing Industries and Construction		83043	7,3	7,5	252,9	519,7	15,2	243,9
a Iron and Steel		23641	4,1	1,0	29,4	447,5	2,3	30,4
b Non-Ferrous Metals		1302	0,0	0,0	1,9	13,4	2,2	13,2
c Chemicals		13019	0,6	1,7	52,8	26,5	5,8	53,0
d Pulp, Paper and Print		4217	0,2	0,4	8,4	1,2	0,3	11,6
e Food Processing, Beverages and Tobacco		4964	0,2	0,4	9,6	1,5	0,9	13,9
f Other (Mineral, Glass)		22951	1,5	3,0	119,3	3,6	1,5	74,4
g Other (Mechanic,Textile, Manufacture, Extraction, Building)		12950	0,7	1,3	31,5	26,0	2,9	48,1

(*) Emission from autoproducers are assigned to the sectors where they were generated and not under 1A1a

Table 1 Sectorial Report for Energy (1995)

(Sheet 2 of 3)

Sectorial Report for National Greenhouse Gas Inventories (Gg)							
Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
3 Transport	**109867**	**77,1**	**5,6**	**995,1**	**5895,7**	**1218,0**	**105,2**
a Civil Aviation	2036	0,1	0,0	7,0	2,8	1,0	0,5
b Road Transportation	105954	40,6	5,0	967,1	5712,0	1112,9	101,9
c Railways	592	0,0	0,2	7,5	2,0	0,9	1,1
d Navigation	1285	1,1	0,3	13,2	178,9	100,8	1,6
e Other(Pipeline)		35,3		0,3		2,5	
4 Other Sectors	**76480**	**25,4**	**10,6**	**190,8**	**685,8**	**93,5**	**59,3**
a Commercial/Institutional	16784	9,0	2,2	16,9	121,0	10,1	15,1
b Residential	50851	14,5	5,0	45,2	224,4	18,7	27,3
c Agriculture/Forestry/Fishing	8845	2,0	3,3	128,7	340,4	64,6	17,0
5 Other (Military)	**1569**	**0,1**	**0,1**	**11,3**	**16,7**	**4,1**	**1,2**
B Fugitive Emissions from Fuels	**2678**	**352,2**	**0,0**	**5,7**	**8,4**	**154,4**	**58,0**
1 Solid Fuels		**3,4**				**2,7**	
a Coal Mining		0,7					
b Solid Fuel Transformation		2,7				2,7	
c Other ()							
2 Oil and Natural Gas	**1163**	**348,8**		**5,7**	**8,4**	**151,7**	**58,0**
a Oil	926	2,0		5,4	8,3	129,9	45,6
b Natural Gas		346,8				21,8	
c Venting and Flaring	236			0,4	0,1		12,4
3 Other (Geothermal Energy Extraction)	**1515**						

Table 1 Sectorial Report for Energy (1995)

(Sheet 3 of 3)

Sectorial Report for National Greenhouse Gas Inventories (Gg)							
Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Memo Items	17378	1,1	0,7	193,0	23,0	8,8	117,5
International Bunkers	13099	1,1	0,7	193,0	23,0	8,8	117,5
Aviation	5447	0,4	0,2	17,5	5,0	3,7	1,8
Marine	7651	0,7	0,5	175,5	18,0	5,1	115,7
CO2 Emissions from Biomass	4279						

Table 2 Sectorial Report for Industrial Processes (1995)

(Sheet 1 of 2)

Sectorial Report for National Greenhouse Gas Inventories (Gg)													
Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVO	SO_2	HFCs		PFCs		SF_6	
								P	A	P	A	P	A
Total Industrial Processes	**22985**	**4,6**	**20,4**	**4,8**	**290,8**	**67,6**	**29,9**	**0,0000**	**0,6956**	**0,0000**	**0,0117**	**0,0000**	**0,0144**
A Mineral Products	**19077**					**6,0**	**16,5**						
1 Cement Production	16542						16,5						
2 Lime Production	656												
3 Limestone and Dolomite Use													
4 Soda Ash Production and Use													
5 Asphalt Roofing						1,0							
6 Road Paving with Asphalt						5,0							
7 Other (Glass Decarbonizing)	1879												
B Chemical Industry	**2335**	**2,3**	**20,4**	**1,4**	**11,4**	**44,4**	**9,0**						
1 Ammonia Production	2275				1,5	1,6							
2 Nitric Acid Production			4,0	1,0									
3 Adipic Acid Production	1		16,4	0,4									
4 Carbide Production	21						0,0						
5 Other (Sulfuric Acid, Titanium Dioxide,Carbo	38	2,3			10,0	42,8	8,9						
C Metal Production	**1034**	**2,3**		**3,3**	**279,3**	**2,9**	**3,3**				0,0117		
1 Iron and Steel Production	402	2,3		3,3	184,0	2,5	1,5						
2 Ferroalloys Production	252				62,0								
3 Aluminium Production	325				33,4	0,1	1,8				0,0117		
4 SF6 Used in Aluminium and Magnesium Foundries													
5 Other (Silicium Production)	55					0,3							

Table 2 Sectorial Report for Industrial Processes (1995)

(Sheet 2 of 2)

Sectorial Report for National Greenhouse Gas Inventories (Gg)													
Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVO	SO_2	HFCs		PFCs		SF_6	
								P	A	P	A	P	A
D Other Production	539			0,0		14,3	1,1						
1 Pulp and Paper				0,0		0,2	1,1						
2 Food and Drink	539					14,1							
E Production of Halocarbons and Sulphur Hexafluoride									0,1100				0,0033
1 By-product Emissions									0,1100				
2 Fugitive Emissions													0,0033
3 Other ()													
F Consumption of Halocarbons and Sulphur HexafluorideMetal Production									0,5856				0,0111
1 Refrigeration and Air Conditioning Equipment									0,3688				
2 Foam Blowing									0,0150				
3 Fire Extinguishers													
4 Aerosols									0,2018				
5 Solvents													
6 Other (Electrical power equipment)													0,0111
G Other()													

Table 3 Sectorial Report for Solvent And Other Product Use (1995)

(Sheet 1 of 1)

Sectorial Report for National Greenhouse Gas Inventories (Gg)			
Greenhouse Gas Source and Sink Categories	CO_2	N_2O	NMVOC
Total Solvent And Other Product Use	1962		629,5
A Paint Application	915		293,6
B Degreasing and Dry Cleaning	167		53,6
C Chemical Products, Manufacture and Processing	198		63,5
D Other (Printing Industry, Application of glues, Domestic Solvent Use)	682		218,8

Table 4 Sectorial Report for Agriculture (1995)

(Sheet 1 of 2)

Sectorial Report for National Greenhouse Gas Inventories (Gg)					
Greenhouse Gas Source and Sink Categories	CH_4	N_2O	NO_x	CO	NMVOC
Total Agriculture	871,7	75,9	0,9	28,2	1,9
A Enteric Fermentation	607,2				
1 Cattle (including buffalo)	269,1				
2 Dairy cows	237,4				
3 Sheep	79,7				
4 Goats	8,9				
5 Horses	3,5				
6 Mules and asses	0,5				
7 Swine	8,7				
B Manure Management	181,9				0,6
1 Cattle (including buffalo)	62,0				0,3
2 Dairy cows	39,8				0,1
3 Sheep	2,1				0,0
4 Goats	0,3				0,0
5 Horses	0,9				0,0
6 Mules and asses	0,0				0,0
7 Fattening pigs	48,9				0,1
8 Sows (including piglets)	12,9				0,0
9 Broilers	7,8				
10 Laying hens	3,8				
11 Other poultry	2,5				
12 Other (rabbits)	1,3				
13 Other (fur animals)	0,1				

Table 4 Sectorial Report for Agriculture (1995)

(Sheet 2 of 2)

Sectorial Report for National Greenhouse Gas Inventories (Gg)					
Greenhouse Gas Source and Sink Categories	CH_4	N_2O	NO_x	CO	NMVOC
B Manure Management (continued)		12,4			
10 Anaerobic					
11 Liquid Systems		0,5			
12 Solid Storage and Dry Lot		11,9			
13 Other (please specify)					
C Rice Cultivation	81,4				
1 Irrigated	81,4				
2 Rainfed					
3 Deep Water					
4 Other (please specify)					
D Agricultural Soils		63,5			
E Prescribed Burning of Savannas					
F Field Burning of Agricultural Residues	1,2	0,0	0,9	25,2	1,2
1 Cereals					
2 Pulse					
3 Tuber and Root					
4 Sugar Cane					
5 Other (please specify)					
G Other (please specify)					

Table 5 Sectorial Report for Land-Use Change and Forestry (1995)

(Sheet 1 of 1)

Sectorial Report for National Greenhouse Gas Inventories (Gg)							
Greenhouse Gas Source and Sink Categories	CO_2 Emission	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC
Total Land-Use Change and Forestry		**-24744,6**	**183,3**	**20,9**	**1,0**	**34,2**	**156,1**
A Changes in Forest and Other Woody Biomass Stocks		**-25304,0**					
1 Tropical Forests							
2 Temperate Forests	10709	-36012,6					
3 Boreal Forests							
4 Grasslands/Tundra							
5 Other (please specify)							
B Forest and Grassland Conversion	**811**		**3,9**	**0,0**	**1,0**	**34,2**	**3,9**
1 Tropical Forests							
2 Temperate Forests	811		3,9	0,0	1,0	34,2	3,9
3 Boreal Forests							
4 Grasslands/Tundra							
5 Other (please specify)							
C Abandonment of Managed Lands		**-157,1**					
1 Tropical Forests							
2 Temperate Forests		-157,1					
3 Boreal Forests							
4 Grasslands/Tundra							
5 Other (please specify)							
D CO_2 Emissions and Removals from Soil		**-95,0**					
E Other (Managed Forests)			**179,4**	**20,9**			**152,2**

Table 6 Sectorial Report for Waste (1995)

(Sheet 1 of 1)

Sectorial Report for National Greenhouse Gas Inventories (Gg)							
Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total Waste	**725**	**1028,7**	**0,5**	**15,1**	**280,5**	**25,5**	**1,2**
A Solid Waste Disposal on Land		**464,0**				**8,2**	
1 Managed Waste Disposal on Land		407,6				7,5	
2 Unmanaged Waste Disposal on Land		56,4				0,7	
3 Other (please specify)							
B Wastewater Handling		**511,4**					
1 Industrial Wastewater		511,4					
2 Domestic and Commercial Wastewater							
3 Other (please specify)							
C Waste Incineration	**725**	**13,4**	**0,5**	**15,1**	**280,5**	**17,3**	**1,2**
D Other (composting)		**39,9**					

Table 7A Summary Report for National Greenhouse Gas Inventories (1998)

(Sheet 1 of 2)

Summary Report for National Greenhouse Gas Inventories (Gg)														
Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removal	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF6	
									P	A	P	A	P	A
Total National Emissions and Removals	[illegible]	[illegible]	2535,5	161,8	1863,1	7787,2	2370,6	1321,6	0,0000	[illegible]	0,0000	0,0117	0,0000	0,0144
1 Energy	[illegible]		[illegible]	44,3	[illegible]	7186,4	[illegible]	[illegible]						
A Fuel Combustion: Reference Approach	417216													
Sectoral Approach	[illegible]		114,0	44,1	[illegible]	[illegible]	1535,7	1252,7						
1. Energy Industries	[illegible]		4,9	[illegible]	[illegible]	30,1	4,9	[illegible]						
2. Manufacturing Industries and Construction	[illegible]		[illegible]	7,9	[illegible]	319,7	33,2	[illegible]						
3. Transport	[illegible]		72,1	3,6	[illegible]	[illegible]	[illegible]	[illegible]						
4. Other Sectors (Residential, Agriculture and Fishing)	[illegible]		25,4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
5. Other (Military)	[illegible]		0,1	0,1	11,3	16,7	4,1	[illegible]						
B Fugitive Emissions from Fuels	[illegible]		[illegible]		4,7	8,4	134,4	[illegible]						
1. Solid Fuels			3,4				2,7							
2. Oil and Natural Gas	[illegible]		[illegible]		4,7	8,4	131,7	[illegible]						
3. Other (Geothermal)	1513													
2 Industrial Processes	[illegible]		4,6	[illegible]	4,8	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]
A Mineral Products	16077						6,0	14,5						
B Chemical Industry	[illegible]		[illegible]	[illegible]	1,6	[illegible]	44,6	[illegible]						
C Metal Production	[illegible]		[illegible]		3,1	270,2	2,9	3,5				[illegible]		
D Other Production (Pulp and Paper, Food and Drink)	[illegible]				0,9		14,5	1,1						
E Production of Halocarbons and Sulphur Hexafluoride										0,1140		[illegible]		[illegible]
F Consumption of Halocarbons and Sulphur Hexafluoride										[illegible]				0,0111
G Other														

Table 7A Summary Report for National Greenhouse Gas Inventories (1995)

(Sheet 2 of 2)

Sectorial Report for National Greenhouse Gas Inventories (Gg)

Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF6	
									P	A	P	A	P	A
3 Solvent and Other Product Use	1562						629,5							
4 Agriculture			871,7	75,9	0,9	25,2	1,9							
A Enteric Fermentation			607,2											
B Manure Management			181,9	12,4			0,6							
C Rice Cultivation			81,4											
D Agriculture Soils				63,5										
E Prescribed Burning of Savannas														
F Field Burning of Agricultural Residues			1,2	0,0	0,9	25,2	1,2							
G Other														
5 Land-Use Change & Forestry	11520	-36265	183,3	20,9	1,0	94,2	156,1							
A Changes in Forest and Other Woody Biomass Stocks	10709	-36013												
B Forest and Grassland Conversion	811		3,9	0,0	1,0	94,2	3,9							
C Abandonment of Managed Lands		-157												
D CO2 Emissions and Removal from Soil		-95												
E Other (Managed Forests)			179,4	20,9			152,2							
6 Waste	725		1028,7	0,5	15,1	280,5	25,5	1,2						
A Solid Waste Disposal on Land			464,0				8,2							
B Wastewater Handling			511,4											
C Waste Incineration	725		13,4	0,5	15,1	280,5	17,3	1,2						
D Other (Composting)			39,9											
7 Other														
Memo Items:														
International Bunkers	13099		1,1	0,7	193,0	23,0	8,8	117,5						
- Aviation	5447		0,4	0,2	17,5	5,0	3,7	1,8						
- Marine	7651		0,7	0,5	175,5	18,0	5,1	115,7						
CO2 Emissions from Biomass	4279													

Table 7B Short Summary Report for National Greenhouse Gas Inventories (1995)

(Sheet 1 of 1)

Summary Report for National Greenhouse Gas Inventories (Gg)														
Greenhouse Gas Source and Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF6	
									P	A	P	A	P	A
Total National Emissions and Removals	450018	-36265	3155,5	161,0	1853,1	7787,2	2378,6	1321,8	0,0000	0,6956	0,0000	0,0117	0,0000	0,0144
1 Energy	412818		467,2	44,1	1831,4	7156,4	1490,1	1290,7						
A Fuel Combustion (Sectoral Approach)	410140		115,0	44,1	1825,6	7148,0	1335,7	1232,7						
B Fugitive Emissions from Fuels	2678		352,2	0,0	5,7	8,4	154,4	58,0						
2 Industrial Processes	22985		4,6	28,4	4,8	290,8	67,6	28,9	0,0000	0,6956	0,0000	0,0117	0,0000	0,0144
3 Solvent and Other Product Use	1962						639,5							
4 Agriculture			871,7	73,9	6,0	25,2	1,9							
5 Land-Use Change & Forestry	11528	-36265	183,3	30,9	1,0	34,2	156,1							
6 Waste	725		1628,7	0,5	15,1	284,5	25,5	1,2						

1A5 Other (Military) (DETAILED INFORMATION 1995)

IPCC category	Included in (SNAP '94):	Activity data		Emission estimates							Emission factors						
		Type of fuel (NAPFUE '94)	Total fuel quantity	CO2	CH4	N2O	NOx	CO	NMVOC	SO2	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
			(t)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(kg/t)	(kg/t)	(kg/t)	(kg/t)	(kg/t)	(kg/t)	(kg/t)
IA5a Other (stationary)	20201 Commercial and institutional plants	Gas oil (204)	18478	57,864	0,006	0,011	0,039	0,016	0,002	0,111	3131,5	0,3	0,6	2,1	0,9	0,1	6,0
IA5a Other (stationary)	20201 Commercial and institutional plants	Natural Gas (301)	3449	6,651	0,001	0,000	0,001	0,003	0,001	0,000	1928,4	0,2	0,1	0,2	0,9	0,2	0,0
IA5a Other (stationary)				64,515	0,006	0,011	0,040	0,019	0,003	0,111							
1A5b Other (mobile) - offroad	80801 Other mobile sources and machinery (military)	Motor gasoline - (208)	41359	123,912	0,086	0,007	1,239	12,947	2,440	0,033	2996,0	2,1	0,2	30,0	313,0	59,0	0,8
1A5b Other (mobile) - offroad	80801 Other mobile sources and machinery (military)	Diesel oil for road transport (205)	113559	355,609	0,045	0,010	5,679	2,270	0,907	0,684	3131,5	0,40	0,1	50,0	20,0	8,0	6,0
1A5b Other (mobile) - offroad				479,521	0,131	0,017	6,918	15,217	3,348	0,716							
1A5b Other (mobile) - aviation	80801 Other mobile sources and machinery (military)	Jet fuel (207)	324826	1025,249	0,007	0,029	4,345	1,448	0,724	0,325	3156,3	0,02	0,1	13,4	4,5	2,2	1,0
1A5b Other (mobile) - aviation	80801 Other mobile sources and machinery (military)	Aviation gasoline (209)	55	0,169	0,000	0,000	0,001	0,037	0,001	0,000	3073,6	0,02	0,1	13,4	672,0	13,4	1,0
1A5b Other (mobile) - aviation	80801 Other mobile sources and machinery (military)			1025,418	0,007	0,029	4,346	1,485	0,725	0,325							
1A5b Other (mobile)				1504,940	0,138	0,046	11,264	16,702	4,072	1,041							
IA5 Other (Military)				1569,454	0,144	0,057	11,304	16,721	4,075	1,152							

INTERNATIONAL BUNKERS (DETAILED INFORMATION 1995)

Source and sink categories	Activity data			Emission estimates							Emission factors								
	Number of LTO-cycles	Type of fuel	Total fuel quantity	CO2	CH4	N2O	NOx	CO	NMVOC	SO2	Fuel consumption	CO2	CH4	N2O	NOx	CO	NMVOC	SO2	Type of Fuel
			(t)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	kg/LTO	(kg/LTO or kg/t)	(kg/LTO or kg/t)	(kg/LTO or kg/t)	(kg/LTO or kg/t)	(kg/LTO or kg/t)	(kg/LTO or kg/t)	(kg/LTO or kg/t)	
Civil aviation International airport traffic	199179,0	Jet fuel (207)	199179,0	586,0	0,0	0,0	2,4	1,3	0,3	0,2	1000,0	2942,3	0,18	0,1	11,8	6,4	1,6	1,0	Jet fuel (207)
Civil aviation International cruise traffic		Jet fuel (207)	1558861,7	4861,3	0,4	0,2	15,1	3,7	3,4	1,6	1000,0	3118,5	0,24	0,1	9,7	2,4	2,2	1,0	
Total international aviation (Bunkers)				5447,4	0,4	0,2	17,5	5,0	3,7	1,8									
International marine (Bunkers)		Gas oil (204)	566000,0	1776,3	0,2	0,1	40,8	4,2	1,2	3,4		3138,3	0,29	0,2	72,0	7,4	2,1	6,0	Gas oil (204)
International marine (Bunkers)		Bunker oil (202)	1872000,0	5874,9	0,5	0,4	134,8	13,9	4,0	112,3		3138,3	0,29	0,2	72,0	7,4	2,1	60,0	Bunker oil (202)
Total international marine (Bunkers)				7651,2	0,7	0,5	175,5	18,0	5,1	115,7									

6 WASTE (DETAILED INFORMATION [illegible])

SOURCE/SINK CATEGORIES		EMISSION ESTIMATES (Gg)						
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WASTE: 6A Solid waste disposal on land

SOURCE/SINK CATEGORIES	ACTIVITY DATA Gg	EMISSION ESTIMATES (Gg)							AGGREGATE EMISSION FACTORS							[illegible]
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	Gg
[illegible]	[illegible]	[illegible]	[illegible]	NO	NO	NO	[illegible]	NO	[illegible]	[illegible]	NO	NO	NO	[illegible]	NO	
[illegible]	[illegible]	[illegible]	[illegible]	NO	NO	NO	[illegible]	NO	[illegible]	[illegible]	NO	NO	NO	[illegible]	NO	
6A1 [illegible]	[illegible]	[illegible]	[illegible]	NO	NO	NO	7,8	NO	[illegible]	[illegible]	NO	[illegible]	NO	[illegible]	NO	[illegible]
6A2 [illegible]	[illegible]	[illegible]	[illegible]	NO	NO	NO	[illegible]	NO	[illegible]	[illegible]	NO	NO	NO	[illegible]	NO	[illegible]

[illegible]

SOURCE/SINK CATEGORIES	ACTIVITY DATA Gg	EMISSION ESTIMATES (Gg)							AGGREGATE EMISSION FACTORS						
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WASTE: 6B Wastewater handling

SOURCE/SINK CATEGORIES	ACTIVITY DATA [illegible]	EMISSION ESTIMATES (Gg)							AGGREGATE EMISSION FACTORS						
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
6B Wastewater handling	[illegible]	[illegible]	[illegible]	NE	NO	NO	NE	NO	[illegible]	[illegible]	NE	NO	NO	NE	NO
6B1 Industrial wastewater	[illegible]	[illegible]	[illegible]	NE	NO	NO	NE	NO	[illegible]	[illegible]	NE	NO	NO	NE	NO
6B2 [illegible]		[illegible]													

WASTE: 6C Waste incineration

SOURCE/SINK CATEGORIES	ACTIVITY DATA Gg	EMISSION ESTIMATES Gg							AGGREGATE EMISSION FACTORS kg/t						
		CO2	CH4	N2O	NOx	CO	NMVOC	SO2	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
6C Waste incineration		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1,17							
Municipal	[illegible]	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Industrial	[illegible]	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sewage sludge	[illegible]	[illegible]	NE	[illegible]	[illegible]	4,12	[illegible]	[illegible]	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hospital	[illegible]	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	0,14	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Waste oil	[illegible]	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Open burning of agricultural wastes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	NO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	NO

[illegible]

SOURCE/SINK CATEGORIES	ACTIVITY DATA Gg	EMISSION ESTIMATES Gg							AGGREGATE EMISSION FACTORS kg/t						
		CO2	CH4	N2O	NOx	CO	NMVOC	SO2	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

6D Other

SOURCE/SINK CATEGORIES	ACTIVITY DATA Gg	EMISSION ESTIMATES Gg							AGGREGATE EMISSION FACTORS kg/t						
		CO2	CH4	N2O	NOx	CO	NMVOC	SO2	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	NO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 8A Overview Table for National Greenhouse Gas Inventories

(Sheet 1 of 1)

Overview Table																								
Greenhouse Gas Source and Sink Categories	CO2 emissions		CO2 removals		CH4		N2O		NOx		CO		NMVOC		SO2		HFCs emissions		PFCs emissions		SF6 emissions		Documentation	Disaggregation
	Estimate	Quality	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																								
Sectoral Approach																								
1. Energy Industries	ALL	H	NO		ALL	L	ALL	L	ALL	M	ALL	M	ALL	M	ALL	H	NO		NO		NO		H	[illegible]
2. Manufacturing Industries and Construction	ALL	H	NO		ALL	L	ALL	L	ALL	M	ALL	M	ALL	M	ALL	M	NO		NO		NO		H	[illegible]
3. Transport	ALL	H	NO		ALL	L	ALL	L	ALL	M	ALL	M	ALL	M	ALL	M	NO		NO		NO		H	[illegible]
4. Other Sectors (Commercial, Institutional and Residential)	ALL	H	NO		ALL	L	ALL	L	ALL	M	ALL	M	ALL	M	ALL	M	NO		NO		NO		H	[illegible]
5. Other (Not elsewhere specified)	PART	H	NO		PART	L	PART	L	PART	M	PART	M	PART	M	PART	M	NO		NO		NO		H	[illegible]
B Fugitive Emissions from Fuels																								
1. Solid Fuels																	NO		NO		NO		M	[illegible]
2. Oil and Natural Gas																	NO		NO		NO		M	[illegible]
3. Other (Geothermal)	ALL	M	NO		NO		NO		NO		NO		NO		NO		NO		NO		NO		L	[illegible]
2 Industrial Processes																								
A Mineral Products	ALL	M	NO		NO		NO		NO		NO		NO		NO		NO		NO		NO		M	[illegible]
B Chemical Industry	ALL	M	NO		ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	NO		NO		NO		M	[illegible]
C Metal Production	ALL	M	NO		ALL	M	NO		ALL	M	ALL	M	ALL	M	ALL	M	NO		ALL	M	NE		M	[illegible]
D Other Production (Pulp and Paper, Food and Drink)	ALL	M	NO		NO		NO		ALL	M	NO		ALL	M	ALL	M	NO		NO		NO		M	[illegible]
E Production of Halocarbons and Sulphur Hexafluoride	NO		NO		NO		NO		NO		NO		NO		NO		ALL	M	ALL	M	ALL	M	L	[illegible]
F Consumption of Halocarbons and Sulphur Hexafluoride	NO		NO		NO		NO		NO		NO		NO		NO		PART	M	NE		PART	M	L	[illegible]
3 Solvent and Other Product Use	ALL	L	NO		NO		NO		NO		NO		ALL	M	NO		NO		NO		NO		M	[illegible]
4 Agriculture																								
A Enteric Fermentation	NO		NO		ALL		NO		NO		NO		NE		NO		NO		NO		NO		M	[illegible]
B Manure Management	NO		NO		ALL		NO		NO		NO		NE		NO		NO		NO		NO		M	[illegible]
C Rice Cultivation	NO		NO		ALL	M	NO		NO		NO		NO		NO		NO		NO		NO		M	[illegible]
D Agricultural Soils	NO		NO		NO		ALL	M	NO		NO		NO		NO		NO		NO		NO		M	[illegible]
E Prescribed Burning of Savannas	NO		NO		NO		NO		NO		NO		NO		NO		NO		NO		NO			
F Field Burning of Agricultural Residues	NO		NO		ALL	M	ALL	M	ALL	M	ALL	M	NE		NO		NO		NO		NO		M	[illegible]
5 Land-Use Change & Forestry																								
A Changes in Forest and Other Woody Biomass Stocks	ALL	M	ALL	M	NO		NO		NO		NO		NO		NO		NO		NO		NO		M	[illegible]
B Forest and Grassland Conversion	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	NO		NO		NO		NO		NO		M	[illegible]
C Abandonment of Managed Lands	PART	L	PART	L	NO		NO		NO		NO		NO		NO		NO		NO		NO		M	[illegible]
D CO2 Emissions and Removals from Soil	ALL	L	ALL	L	NO		NO		NO		NO		NO		NO		NO		NO		NO		M	[illegible]
6 Waste																								
A Solid Waste Disposal on Land	NO		NO		ALL		NO		NO		NO		ALL	M	NO		NO		NO		NO		M	[illegible]
B Wastewater Handling	NO		NO		PART	M	NO		NO		NO		NE		NO		NO		NO		NO		M	[illegible]
C Waste Incineration	ALL	M	NO		PART	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	NO		NO		NO		M	[illegible]
D Other (Composting)	NO		NO		ALL	L	NO		NO		NO		NO		NO		NO		NO		NO		L	[illegible]
Memo Items																								
International Bunkers																							H	
- Aviation																							H	
- Marine																							M	
CO2 Emissions from Biomass																								

NOTATION KEY FOR OVERVIEW TABLE							
Estimates		Quality		Documentation		Disaggregation	
Code	Meaning	Code	Meaning	Code	Meaning	Code	Meaning
PART	Partly estimated	H	High Confidence in Estimation	H	High (all background information included)	1	Total emissions estimated
ALL	Full estimate of all possible sources	M	Medium Confidence in Estimation	M	Medium (some background information included)	2	Sectoral split
NE	Not estimated	L	Low Confidence in Estimation	L	Low (only emission estimates included)	3	Subsectoral split
IE	Estimated but included elsewhere						
NO	Not occurring						
NA	Not applicable						

Annexe 2: Existing laws, rules, regulations and administrative instruments for emission mitigation measures

Table 1 – Existing laws, rules, regulations and administrative instruments for intersectorial mitigation measures

Art. 130 (R, S) of the EU treaty for a community environment policy	This is the basis of the EU right to establish rules in the environment sector valid for all Member States and based on the principle of prevention, with the aim of reducing pollution at the source. Furthermore, in the Maastricht Treaty for the approval of most of the laws on the environment, the principle of the qualified majority has been introduced, with the right of veto being suspended.
5th EU Environment Action Programme "For lasting and sustainable development", DG XI Environment of the EC	Political and practical programme of the European Union to help the environment and sustainable development; the latter is linked with a number of principles in the interpretation of laws, with institutional and functional aspects for fostering concrete actions in the various environment-related sectors.
CIPE resolution of 28.12.93: National Plan for Sustainable Development, implementing Agenda 21	Besides implementing the principle of long-term sustainable development in Agenda 21, prepared by the UN Environment conference held in Rio in 1992, it also identifies the goals and some procedures for starting up sustainable development in some sectors of the national economy. These include transport, industry, energy, agriculture and tourism; it also sets up the Interministerial Committee for Agenda 21.
CIPE resolution of 25.2.1994	National Plan for the Limitation of Carbon Dioxide emissions in 2000 to the level of 1990.
Reg. CE 880 of 23.3.92 to assign the ecological quality to products (Ecolabel)	Defines a Community system aimed at the design, promotion, marketing and use of products with lower environmental impact during the entire life cycle of the product and better information for consumers on the environmental impact of these products.
Law N. 70 of 25.1.1994 and DM Environment 413 of 2.8.1995 to implement Reg. EEC 1836/93 (EMAS) of the Council	Start-up of Ecoaudit, appointment of the Committee for Ecolabel and Ecoaudit, self-certification for voluntary membership by industrial enterprises in a Community system for ecological management and auditing. It sets up a voluntary system for the introduction and implementation by the enterprises of policies, programmes and environment management systems in relation to their location, for systematic, objective, periodical assessment of the efficiency of these elements, and for providing information to the public on environmental efficiency.
Framework Programme for Community Research	The Community research programmes also orient the allocation of national funds and resources for achieving technical and scientific improvement with the aim of sustainability, limitation of climate change and adaptation.
Law N. 46 of 17.2.92	Provides incentives for technological innovation in enterprises (including the energy sector) providing subsidies to enterprises which renew their plants with the most recent technology.
Programme Agreement ENEA-Ministry of Industry Art. 30 Law N. 9/91; Law N. 282 of 25.8.91 for reforming the ENEA	Sets guidelines for research and development activities and technological innovation in the energy sector and provides the instruments for a more in-depth analysis of national strategy for the development and diffusion of more efficient energy technology.
Law N. 9/91, Art. 30 for information campaigns on energy efficiency	Provides for the signature of agreements and contracts between the Ministry of Industry, Commerce and Crafts, producer and consumer associations, the Department of the President of the Council, ENEA and the major media organisations (RAI, FIEG) for the promotion and diffusion of energy efficiency.
DL 158 of 17.5.1995	Implementation of Community regulations for opening tenders within the EU; this will lead to better competition as well as making some climate change reduction technology more competitive (for example aerogenerators).
DPR 203/88 "Implementation of EC Directives 80/779, 82/884, 84/360, 85/203 rules on air quality, pollutants and pollution produced by industrial plants" (DM 9 and 10 of August 1994)	Introduces into Italian law an overall system for safeguarding the quality of the air in order to protect health and the environment throughout the country. The important aspects include greater responsibility for the regions for checking industrial plants, new authorisation procedures, the creation of a system of sanctions under administrative and criminal law. As for greenhouse gas emissions, the emission limitation regulations have favoured the use of primary sources with lower sulphur content, thus allowing greater efficiency.

Table 2 – Existing laws, rules, regulations and administrative instruments for mitigation measures in the national energy system

National Energy Plan (PEN), August 1988	Lays down five priority goals in energy policy for 2000: - energy saving, understood as efficiency in use, not just the reduction of use; - protection of the environment, not considered as a limitation in conflict with development; - development of national resources and diversification in the use of imported sources; - geographical and political diversification of supply source areas; - competitiveness of the production system, a pre-condition for economic survival.
Law N. 9 of 9.1.91: implements the PEN '88 for institutional aspects, hydroelectric power plants, power lines, hydrocarbons, geothermal energy, self-production	The main innovations concern the liberalisation of electricity production from non-traditional sources, providing incentives above all to production from renewable sources, very high efficiency plants and the combined production electricity and heat. Provision was also made for the "independent producer", previously absent in legislation.
Law N. 10 of 9.1.91 implements the PEN '88 for the rational use of energy, energy saving and development of renewable energy sources	This complex law innovated Italian legislation by introducing a framework for sectorial regulations aimed at the efficient use of conventional energy sources in all end user sectors, including the reduction of specific energy consumption in production processes and with particular reference to buildings and heating plants. Furthermore, the achieving of the rational use of energy is adopted as a criterion for awarding tenders for the supply of goods. The law likewise provides tax reduction and the payment by local authorities of incentives to foster the adopting of more efficient technology.
Law N. 9/91, Art.20 and 22, CIP resolution 6 of 29.4.92 and related laws, (DM of 19.7.96 and of 4.8.94, Law N. 577 of 14.11.96, DPR of 24.1.97)	Start of the liberalisation of electricity production by parties other than ENEL and the providing of incentives, through the setting of minimum guaranteed prices, for electricity production from renewable sources and "assimilated" sources such as the high efficiency co-generation of electricity and heat. Up to 1994, over 6000 MWe of new plants were authorised. With the DM of 4.8.94, the burning of waste is allowed to reach the energy index (measurement of plant efficiency) needed to have access to incentives on energy sold for main distribution.
DM of 28.12.1995 (pursuant to Law N. 359/92)	Granting to ENEL SpA of the right to provide the public service of electric power supply in Italy.
Law N. 481 of 14.11.95 "Rules for competition and the regulation of services of public utility"	With the setting up of the Electricity and Gas Authority, fully operational towards the end of 1996 (DPCM of 22.10.96 and Resolution of 4.12.96 of the Authority itself), the regulation and control of the electricity and gas market no longer depends on the Government but on an independent organisation responding directly to Parliament. The Authority sets electricity tariffs, and any "price-caps", also taking into account any investments for handling demand.
DPR of 18.9.95	General outlines for the services charter in the electricity and gas sectors.
DPCM of 2.10.95	This is a regulation of the marketing categories of fuels relevant for purposes of air pollution as well as the technological characteristics of the combustion plants, including those for residential and non-industrial use (see also local level).
DPCM of 14.11.95: implements Directive 93/12/EEC on the sulphur content of some liquid fuels	This prohibits, among other things, the marketing for heating purposes of fuel oil with sulphur contents over 0.2% weight, and of over 0.05% for vehicles and agricultural use (and increasing refinery carbon dioxide emissions).
Ministry of Industry Resolution of 7.2.95	Setting up of an observatory for the rational use of energy.

Table 3 – Existing laws, rules, regulations and administrative instruments for mitigation measures in the energy sector: production, processing, and distribution

Law N. 9/91, Art. 1, Law N. 36 of 5.1.94	Simplification of the administrative procedures for hydroelectric plants, tariff setting and rules for integrated use.
Law N. 9/91, Art. 15, DPR 485 of 18.4.94	Prospecting and exploitations of geothermal energy of national interest standards.
Law N. 9/91, Art. 20	Rules for the self-producers from conventional energy sources.
Law N. 9/91, Art. 22 and DM of 24.1.1997	Legal status of plants for electricity production using renewable sources and similar and rules for the sale of electricity produced by these plants.
Law N. 10/91, Art. 11 and implementation decrees	Rules for granting of subsidies for feasibility studies for energy saving and the use of renewable energy sources or similar.
Law N. 10/91, Art. 12 and implementation decrees	Granting of capital account subsidies for pilot projects for energy saving and the use of renewable energy sources and/or non-traditional fuels.
Law N. 10/91, Art. 14 and implementation decrees	Granting of subsidies for the reactivation or expansion of already existing hydroelectric plants and for the building of new plants.
Law N. 10/91, Art. 24, DM 209 of 11.6.91, CIPE resolutions of 30.7.91, 12.8.92 and 7.4.93, DL 487 of 20.9.96 and subsequent	Decrees and resolutions to regulate national and European support for the installation of methane gas in areas not previously served by the network, especially in Central and Southern Italy. The overall length of the transport and distribution network has increased from approximately 100,000 km in 1985 to approximately 140,000 km in 1990 and over 155,000 km in 1993.
DM Environment dell'8.5.89 "Limitation of atmospheric emission of some pollutants originating from major combustion installations": implements Directive 88/609/EEC	This is applicable to all the plants with thermal power di 50 MW or more: for the existing plants, ceilings or goals for reducing mixed sulphur and nitrous oxide emissions are set; for the new plants, the decree sets ceiling values for emissions of mixed oxides and dust. The decree implies costs of 8-10 thousand billion liras for the purchase of desulphuration and denitrification technology from Germany and Japan. As to the effects on CO_2 emissions, these increase, per kWh produced, in the case of the installation of desulphuration plants but are significantly reduced if emission reduction is obtained using another fuel (for example methane instead of coal or fuel oil), or improving the conversion efficiency from thermal energy to electricity.
DM of 12.7.90 "Guidelines for the emission limitation of pollutants in industrial plants" (existing)	This lays down guidelines for emission limitation, maximum and minimum emission values, general methods for sampling, analysis and assessment of emissions, criteria for the use of available technologies for emission control and general criteria for the gradual updating of plants.
Revision of guidelines for new plants (drafts)	The rules for pollutant emission limitation by new plants have been postpones for the moment until the available technologies have been identified.
Bills	Outline Convention between ENEL and independent producers for plants that are conventional but with high efficiency.

Table 4 – Existing laws, rules, regulations and administrative instruments for mitigation measures in the industrial sector (DPR 203/88 and DM 12.7.90, also applied to the industrial sector, are mentioned in the table on the energy sector)

Law N. 10/91, Art. 19, Circular of the Ministry of Industry 219/f of 2.3.92 and 226/f of 3.3.93, Law N. 162 of 27.5.93	Rules have been issued on the obligation of appointment and annual reporting to the Ministry of Industry and FIRE of the expert in charge of conservation and the rational use of energy. This person must be appointed in manufacturing industries with energy consumption above 10000 toe/year and in the services sector energy consumption above 1000 toe/year.
Law N. 10/91, Art. 10 (on the local level)	This grants in the industrial, crafts and services sector for building or modifying fixed plants, systems or components, including river transport, for the improvement of the efficiency of energy use.
DM Environment of 29.9.94 "Technical rules for the re-use of production or consumption cycle residues as energy sources"	This classifies the recoverable products with energy value, defines the general characteristics of treatment cycles, the technologies to be used and the ceiling values of pollution emissions in the air.
Law N. 10/91 Art. 12 and DM Ministry of Industry of 7.5.92 and of 22.11.93	Pursuant to the article according to which subsidies can be granted to particularly efficient and innovative pilot projects regarding the rational use of energy, the first decree lays down the procedures for sending applications. The second decree publishes "list in order of merit of applications eligible for assessment for the granting of subsidies for the design and construction of plants with innovative characteristics in the sector of the rational use of energy and renewable sources".
DM Environment of 16.1.95	Use of waste to replace fossil fuels in the production of cement.
DL 619 of 7.11.94 (not converted) and subsequent decrees up to Law N. 575 dell'11.11.96	Re-use of residue from production or consumption in general in combustion cycles for energy production.

Table 5 – Existing laws, rules, regulations and administrative instruments for mitigation measures in the transport sector

General Transportation Plan	
DDL 3720 and other expenditure laws to improve the railway network and build high speed stretches	Implementation of a complex investment plan per railway network improvement by 2000 for a total of approximately 88,000 billion liras, of which approximately 39,000 already funded up to 1998.
Law N. 651/96 and other expenditure laws	Promotion of railway use over medium and long distances, modernisation of existing lines and new high-speed passenger lines.
Integration with European transport infrastructures	Participation in the European programme for major infrastructure networks, with the following goals: interconnection of infrastructure networks, modal interoperability of services and systems, modal rebalancing of road and rail/passenger and goods demand, goods intermodal system with development of combined rail transport. The building of new Alpine tunnels is especially important for Italy.
Law N. 910/86	Financing for local railway modernisation.
Law N. 211/92	Financing of extension of underground and urban tramways with respect to railway subsidies.
Law N. 341/95	Financing of infrastructures (also transport) in Southern Italy.
Expansion of urban underground network	Building of new underground lines for approximately 25 km, to expand the existing ones, and the building of 1250 km of light urban railway lines.
DM of 16.5.96 new limits	Urban environment management for protection of health and vegetation.
Definition and development of a policy in the fuel sector	As for policy aimed at using alternative fuels such as methane gas or vegetable origin substances in urban areas for environmental reasons, a pilot programme is being developed on the industrial scale to provide limited amounts of fuel to urban transportation. The product is made economically feasible by a tax exemption policy. Promotion of fuels reformulated with low aromatic hydrocarbon and benzene contents in particular.
Laws 662-4 of 23.12.96 (1997 budget)	Incentives for auto demolition; postponement and extension to motorcycles and mopeds is being considered.
Five-Year Interport Plan, adopted by the CIPET on 7.04.93, awaiting final approval	With the subsequent interport financing measures (Law N. 240/1990, "Interventions by the State to build interports for goods transport and to favour intermodality") should encourage the start-up of interport infrastructures designed to transfer significant amounts of goods from road to rail.
Laws for public financing of interports	Before construction, the projects must pass environmental impact assessment
Regulations EEC 15/02, 15/03, 15/04, 47; Directives EEC 77/102, 78/665, 83/351, 88/76, 88/77, 91/441, 91/542, 93/59, 94/12, 96/160	This set of European regulations sets increasingly restrictive limitations on emissions of nitrous oxides, non-combusted hydrocarbons, carbon monoxide and total solid particles by new cars, light and heavy commercial vehicles, mopeds and motorcycles placed on the market up to 1999. The AUTO-OIL study commission is making proposals (EURO III and IV) to limit emissions for the subsequent years, up to 2005.
1997 budget, DDL July 97	Subsidies for car demolition over 10 years olds; extended to mopeds, stabilised for low consumption cars.

Table 6 – Existing laws, rules, regulations and administrative instruments for mitigation measures in the residential and commercial sector

Law N. 9/91, Art. 28	Reduction to 4% of VAT rates payable by users for connection to remote heating systems produced in compliance with existing regulations on energy saving.
Law N. 9/91, Art. 29 and DM of 15.2.1992	Introduction of tax concessions (deductions) for investments contributing to the reduction of energy consumption in buildings.
Law N. 9/91, Art. 31	Creation of the "Energy Saving" seal for home appliances and light bulbs.
Law N. 10/91, Title II and Art. 4 (Ministry of Industry Circular 231/f of 13.12.93)	Definition of the general technical and construction criteria and categories for subsidised building and building under conventions, as well as for public and private building. It also includes refurbishing of existing buildings for reducing energy consumption and improving environmental compatibility of energy use.
Law N. 10/91, Art. 8 (on the local level))	Grants subsidies for insulation of buildings; installation of high yield heat pumps, cogenerator, heat meters and high yield outdoor lighting; one-family gas processing plants; use of renewable energy sources in building. Revision of minimum energy efficiency standards of the shell of newly built buildings, residential and commercial; rules and calculation methods are introduced to determine and limit seasonal energy consumption in buildings.
Law N. 10/91, Art. 36	This states that non-compliance with the rules of the law observed by the purchaser or tenant of the premises shall be reported within the required deadline.
Law N. 10/91, Art. 30	Sets rules for the energy certification of buildings.
Law N. 10/91, Art. 32	This states that the energy characteristics and performance of building components and plants shall be certified according to procedures set forth for marketing purposes.
Law N. 10/91, Art. 4, DPR 412 of 26.8.93, Circ. of 12.4.94, DM of 6.8.94 and of 16.5.95, Law N. 25 of 5.1.96, DPR 660 of 15.11.96 (implements Directive 92/42/EEC)	Rules for energy consumption reduction, regarding the design, installation, running and maintenance of heating plants and the following aspects: determination of climatic zones, daily running time and operational periods of heating plants, maximum air temperature inside buildings during heating plants operation, yield of new boilers and hot water heaters powered by liquid fuel and gas, distribution logistics of energy sources. At the end of 1997, approximately 90 provincial and municipal administrations had passed resolutions on the control of heating plants.
Law N. 10/91, Art. 27	This states the heat energy and electricity consumption rates must be limited according to the official use of the buildings, the plants installed and the corresponding climatic zone.
Law N. 10/91, Art. 28, DM of 13.12.93, Circ. Ministry of Industry 231/f of 13.12.93	This states that compliance with energy rules in the construction of buildings and plants is to be certified by a technical report attached to the design of the work.
Law N. 10/91, Art. 31 and 33	The rules are laid down for the running and maintenance of plants and checking of the plants by municipal authorities.
DPCM of 2.10.95, regarding regional plans for the improvement and protection of the quality of the air	Title III provides for stricter characteristics of fuels and combustion plants in particularly vulnerable areas identified on the basis of regional plans for the improvement and protection of the quality of the air.

Table 7 – Existing laws, rules, regulations and administrative instruments for mitigation measures in the agricultural, forestry and land use change sector

National Forestry Plant, approved with resolution CIPE of 2.12.1987	The measures set forth in the Forestry plan, for which 500 billion liras was allocated for 5 years (1988/1992) by Law N. 752/86, provide for the maintenance and improvement of existing forests, incentives for reforestation, the consolidation and development of an efficient forestry industry, the improvement of enterprise management. Further financed measures include the development of forestry mechanisation, vocational training, research, the promotion of Italian wood and derived products, the relaunching of forestry and shrub products, the development and improvement of urban and suburban parks.
Directive EEC 676/91	Protection of water from pollution due to nitrates from agricultural sources by reducing the use of nitrogen in fertilisers.
Common Agricultural Policy, 1992 reform	Reform of the role of farmers in the protection of the environment by the promotion of less intensive, more sustainable farming and breeding practices.
EEC Regulation 2078/92	Grants financial and income aid in case of safeguarding the environment by extension, introduction of biological agriculture, reduction of the use of fertilisers and insecticides, reduction of livestock, care for abandoned farm and forestland, withdrawal of farmland from production, management of land for public access.
EEC Regulation 2092/91	This regards biological production methods, eligible for support under Regulation 2078/92.
EEC Regulation 2080/92	Regulation of activities connected with the protection of forestry resources and financial aid (Reg. 2078/92) for reforestation in the agricultural sector.
EEC Regulations 1765/92, 2293/92, 762/94	These regard the withdrawal of land from cultivation and extension, recalling the procedures for granting subsidies under Reg. EEC 2078/92.
Directive 91/676/EEC	This introduces measures to limit the use in agriculture of all the fertilisers containing nitrogen and reducing the use of organic mineral fertilisers.
DM of 20.5.91 and of 12.7.90, Directive 96/61/CE of 24.9.96	Reference made, in an irregular and inconsistent way, to emission ceilings for livestock enterprises.
Directive of the Po Basin Authority of 15.4.1996	This anticipates the implementation of Directive EEC 676/91, setting common rules for all the Po Valley regions for the storage time of livestock waste, time limits on spreading and maximum levels of nitrogen for spreading.
Implementation Decree DPR 203/88	Reduction of CH_4 emissions by manure stocks.
EC Structural Funds (PIM POP, ob. 5b regulation EU 2052/88 and 2328/91)	Reforestation, maintenance and forestry improvement.
Law N. 10/91, Art. 13 (on the local level)	Granting of incentives for the production of energy from renewable sources in the agricultural sector.

Table 8 – Existing laws, rules, regulations and administrative instruments for mitigation measures in the waste management sector

DPR 915/82	States that waste tips be equipped with systems for the capture (and combustion) of the gas produced.
Agreements between the Min. for the Environment and the regions (1991) 3-year Environment Protection Progr. 89-91/94-97	These provide for financing to build solid waste disposal plants and for the differentiated collection of waste.
Laws 9 and 10/91, CIP 6/92 and related	Thanks to the incentives of the CIP resolution, the installation of plants powered by waste tip biogas is planned.
DL 438 of 8.7.94 (implements la Directive EEC 91/156), DM of 5.9.94, 29.9.94 and 16.1.95	Provides regulations for the productive re-use of residues from production or consumption cycles or in a production process or combustion, as well as waste disposal, with obvious benefits in terms of replacing primary fossil fuel sources and reducing their use; favours the energy exploitation of waste.
DM Environment of 5.9.94 "Implementation of articles 2 and 5 of DL 438 of 8.7.94,", integrated by DM of 16.1.95	This classifies the recoverable products with energy value (for example in the replacement of fossil fuels in cement production), defines the general characteristics of treatment cycles, the technologies to be used and the air pollution emission ceilings.
Legislative Decree N. 22 of 5.2.97 "Implementation of Directives 91/156/EEC on waste, 91/689/EEC on dangerous waste and 94/62/CE on packaging and packaging waste"	This implements the main European directives on waste and unifies four national rules previously covered in general terms (Law N. 366/1941, DPR 915/1982, Law N. 441/1987, Law N. 475/1988), which are abrogated. The new rules include strong encouragement for reduction of waste production by the use of clean technologies, adopting of simplified administrative procedures and the use of economic instruments guaranteeing more efficient use of natural resources. The differentiated collection of solid urban waste must total at least 15% in 1999, 25% in 2001, 35% in 2003. After 2000, only inert and equivalent waste can be dumped in tips.
Agreement Protocol between the Ministry for the Environment and FIAT (April 1997)	Defines guidelines and goals for ecological car demolition and recycling; the recovery of plastics and metals reduces the primary production of materials and the corresponding energy requirements.

Table 9 – Existing laws, rules, regulations and administrative instruments for mitigation measures on the decentralised on the regional and local level

'Bassanini Law' and Legislative Decrees for implementation	
DPCM of 28.3.83 "Maximum limits for concentration and exposure acceptability for air pollutants in the external environment"	This states than within 10 years the regions should draw up plans for the gradual improvement of the quality of the air. Subsequently the Government issued DPCM of 21.7.89 ("Guidelines and co-ordination to the regions") and subsequent amendments with DPR of 25.7.91 and DM Environment of 20.5.91 which sets the criteria for the drawing up of regional plans for the improvement and protection of the quality of the air, and regional and provincial emissions inventories. At the end of 1996 16 regional projects for drawing up the plan were funded by the Ministry for the Environment.
Law N. 9/91, Art.21, DM of 10.4.92 and Law N. 36/94, DM of 11.7.96	This extends permission for electricity production to commercial enterprises and local authority power companies
Law N. 10/91, Art. 5	Regional Energy Plans (PER) for the feasibility of measures for the rational use of energy and the use of renewable energy sources for the regions and autonomous provinces. The PER has been approved in 6 regions and studied in 11.
Law N. 10/91, Art. 6	Deadlines and criteria for the identification of areas suited to the installation of remote heating plants for the regions and autonomous provinces.
Law N. 10/91, Art. 31 and 33	This provides rules for the running and maintenance of the plants and controls and on the plants by the municipal authorities.
Circular of the Ministry of Public Works 2575 of 8.8.86 for the drawing up of urban traffic plans	The management of urban mobility and traffic flow improvement, also for energy saving purposes, has considerable reduction potential. Not many cities have implemented an urban traffic plan yet.
Law N. 10/91 Art. 9, annual budget laws, laws and regional resolutions	The regions and autonomous provinces have jurisdiction for the payment of subsidies for: - support for the use of renewable energy sources in building; - limitation of energy consumption in the industrial, crafts and services sectors; - production of energy from renewable sources in the agricultural sector.
Budget laws 96-97	The regions are authorised to apply an additional tax on the consumption of energy sources (methane gas and petrol for vehicles).
Regional plans for water improvement	Water treatment leads to methane emission reductions. DM of 15.4.94 and of 25.11.95 per la quality of the air in urban areas (DM of 16.5.96) Contains technical rules on concentration limits and alert and danger levels for air pollution in urban areas. Mayors are authorised to intervene in urban traffic, heating in buildings and local industrial activity if the concentration of air pollution exceeds the alarm threshold.
DL 22 of 5.2.97 (see table in waste sector)	This provides for integrated waste management, to consist of regional waste management plans, other divisions that could coincide with the provinces, sectoral plans and programme agreements.

Table 10 - Ratification and signature of international Conventions and Treaties

Convention between the 25 UNECE Member States on Long Distance Transboundary Air Pollution, Geneva, of 13.11.79 ratified with Law N. 289 of 27.04.1982, implemented with protocols and commitments	- Environmental Monitoring and Evaluation Programme (EMEP, Geneva, 28.9.84; ratified with Law N. 488 of 27.10.88); - Protocol on sulphur emission reductions or of transboundary flows (Helsinki, 8.7.85; ratified with Law N. 488 of 27.10.88); - Protocol on nitrous oxide reductions or of transboundary flows (Sofia, 31.10.88; ratified with Law N. 39 of 7.1.92); - VOC Protocol (Geneva, 19.11.91; ratified with Law N. 146 of 12.4.95); - II Protocol on sulphur emission reductions (Oslo, 14.6.94, signed, to be ratified); - Protocols per nitrous oxide emission reductions (II), heavy metals, persistent organic compounds (being drawn up).
Vienna Convention (1985) for the protection of the stratospheric ozone layer, ratified with Law N. 277 of 4.7.88	Montreal Protocol (September 1987, on the limitation of substances harming stratospheric ozone) and subsequent amendments, ratified with Law N. 393 of 23.8.88; the implementation rule is contained in EEC Regulation 594/91 of 4 March 1991, by EEC Regulation 3952/92 of 30 December 1992, by EEC Regulation 3093/94 of 15 December 1994, by Law N. 549 of 28 December 1993 and by Law N. 179 of 16 June.
Framework Convention on Climate Change (Rio, 1992)	Ratified with Law N. 65 of 15.1.1994.
Convention for the fight against desertification (Paris, 1995)	Ratified with Law N. 170 of 23.6.1997.

Bianca

Annexe 3: Deliberation of the Interministerial Committee for Economic Planning (3.12.97)

APPROVAL OF THE GENERAL GUIDELINES OF THE "SECOND NATIONAL COMMUNICATION TO THE CONVENTION ON CLIMATIC CHANGES"

C.I.P.E.[1]

CONSIDERED the March 1992 Convention on Climate Changes held in New York;

CONSIDERED the C.I.P.E. deliberation of 24 February 1994 on the national plan for the reduction of carbon dioxide emissions;

CONSIDERED the First National Communication to the Convention on Climate Changes which the C.I.P.E has acknowledged the 10 January 1995;

CONSIDERED the decision taken by the EU Council of Ministers of the Environment the 3 March 1997;

CONSIDERED the note of the Minister of the Environment (314B/12, 28 November 1997) disseminating the outline of the "Second National Communication on Climate Changes";

Waiting for the commitments that will be taken at the Kyoto Conference (6-10 December 1997) and for resulting measures that may be taken by the EU Council of Ministers of the Environment in the session scheduled for march 1998, the general guidelines of the above mentioned Communication are shared by us, both in terms of carrying out our international commitments and implementing all actions that may help to achieve the objective of improving the quality of the environment at a national level.

Taken into account the additional positive effects that may result from the envisaged measures in terms of energy policies and support to employment;

CONSIDERED that it is advisable to define the procedures required for the approval of the implementation plans by C.I.P.E, in order to launch from the very beginning, preliminary measures consistent with the above mentioned international decisions;

DECREES

1. The Italian Government shall present to all relevant international bodies the Second National Communication on the Convention on Climatic Changes prepared, as stated above, by the Ministry of the Environment.

2. Within 30 April 1998, the specific plans – prepared by all relevant administrations - shall be submitted to C.I.P.E; they shall implement the above mentioned international commitments;
More specifically these plans will concern policies and measures that:
- Develop renewable energy sources;
- Reduce greenhouse gasses in the generation, transport and distribution of energy.
- Increase energy efficiency in the productive sector and among consumers;
- Reduce greenhouse gasses in the sector of transports;

1 Note of the translator: C.I.P.E. = Interministerial Committee for Economic Planning (in Italian: Comitato Interministeriale per la Programmazione Economica)

- Reduce emissions in other sectors different from the energy one;
- Promote international cooperation for the reduction of global emissions;
- Promote research and monitoring to prevent and reduce the negative effects that climate change can have on the territory;
- Develop training and education plans on the topic of global climatic changes.

1. In preparing the plans aimed at reducing emissions of greenhouse gasses, precedence shall be given to those measures that:
- resources being equal bring about the best results;
- fall in line with the general objectives of economic policies, reduce emissions and at the same time, contribute to:
• develop and promote employment
• improve the balance of payments
• strengthen the productive system
• foster territorial balance
• reduce dependency on energy
- envisage a significant financial involvement of private operators;
- give precedence to the use of EU resources.

1. These plans shall identify the financial resources required for their implementation and shall indicate the sources and methods of funding (public, private, tariff measures, project financing). Any measure undertaken before the definition of these plans will require financial coverage by each relevant Administration.

2. To achieve a higher level of integration in the planning of the above mentioned plans an Intergovernmental Workgroup is created, chaired by the Minister for the Environment and whose members are representatives of the Ministry of Industry, of Public Works, of Agricultural Policies, of the Treasury, of Balance and Economic Planning, of Transport, of the University, Scientific and Technological Research and representatives of the regions.

Rome, 3 December 1997

The Appointed President of C.I.P.E.
Carlo Azeglio Ciampi

1. PREFACE TO THE DELIBERATION

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

The first IPCC report in 1990, even if pointing out the borders of scientific uncertainties still present in the evaluation of climate change, put in evidence the risk of a global warming, with terrible effects on climate balance, because of the increase of greenhouse gas anthropogenic emissions, caused by industrial development, since the end of nineteen century, and the greater and greater use of fossil fuel.

The IPCC report, while indicating the need to go further with scientific researches on a national and global level, pointed out with strength the urgency of reducing greenhouse gas anthropogenic emissions, beginning from carbon dioxide.

Particularly, the most industrialised countries were called to undertake the commitment of reducing emissions: in 1990 49,7% of carbon dioxide emissions from the energy sector originated from the OECD countries, 22,3% from east and central Europe countries, 28,1% from developing countries (table 1).

The first answer given to the IPCC report was that of the European Union already at the end of 1990. With the joined statement from the EC Councils of Environment and Energy, on 29th October 1990, that was planned and adopted under the Italian Presidency, the Member States acknowledged the common aim and engagement for the prevention of climate change and the reduction of greenhouse gas emissions. Action should start from carbon dioxide produced by the use of fossil fuel for energy production, in industrial activities and in transport. Particularly, the commitment adopted by the Community for the stabilisation of carbon dioxide emissions by the year 2000 at the levels of 1990, requests Member States to plan and assume initiatives for the environment reconversion and the energy efficiency of industry, of energy production, of transport, of public services, of civil field. Moreover, this statement binds the Member States to protect and expand the absorption of carbon dioxide, referring to forests in particular.

The contents and the engagements of the European Union statement have largely formed the base for the negotiation for the Framework Convention on Climate Change.

2. THE FRAMEWORK CONVENTION ON CLIMATE CHANGE

The Framework Convention on Climate Change, adopted in Rio de Janeiro during the "Summit of the Earth" in June 1992, after a long and complex negotiation, established that:

"the ultimate objective of the Convention is to achieve, ..., stabilization of greenhouse gas[1] concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and enable economic development to proceed in a sustainable manner.

....

The Parties should protect the climate system for the benefit of the present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities, and respective capabilities. Accordingly, the developed countries Parties should take the lead in combating climate change and the adverse effects thereof".

1 The most important greenhouse gases are (warming potential equivalent in terms of carbon dioxide, in the time horizon of 100 years,/with a concentration - in 1990 - in parts per million): carbon dioxide (1/350ppm), methane (21/1,7ppmv), nitrogen protoxide (310/0.31), halogenated compounds (chlorofluorocarbons, hydrochlorofluorocarbons, bromides, and so on), controlled by the Montreal Protocol, fluorocarbons, ozone (stratospheric and tropospheric), aerosol.

Table 1: CO_2 global emissions in 1990

			Year 1990	%
World total		Emissions	22.04	100
		Energy	8647	100
		GDP	18990	100
		Population	5450	100
Developed Countries		Emissions	10.95	49.7
		Energy	4633	53.6
		GDP	16077	84.7
		Population	1210	22.2
from which:	USA	Emissions	4.90	22.2
		Energy	2106	24.4
		GDP	5490	28.9
		Population	255	4.7
	European Union	Emissions	3.32	14.9
		Energy	1324	15.3
		GDP	5620	29.6
		Population	371	6.7
	Italy	Emissions	0.44	1.8
		Energy	163	1.8
		GDP	1098	5.8
		Population	57	1.1
	Japan	Emissions	1.13	5.1
		Energy	452	5.2
		GDP	3141	16.5
		Population	125	2.3
CEEC/CIS		Emissions	4.91	22.3
		Energy	1847	21.2
		GDP	945	5.0
		Population	390	7.2
Developing Countries		Emissions	6.19	28.0
		Energy	2169	25.1
		GDP	2899	15.3
		Population	3850	70.6
of which:	China	Emissions	2.29	10.4
		Energy	677	7.8
		GDP	327	1.7
		Population	1187	21.8
	India	Emissions	0.58	2.6
		Energy	193	2.2
		GDP	204	1.1
		Population	880	16.1

Units of measure: emissions (Gt CO_2); energy (Mtoe); GDP (G$ 90, purchase parity); population (millions); CECC= Central and East European Countries; CIS= Community of Independent States.

The Convention has defined the commitments of the Signatories, and, particularly, the article 4 establishes that:

- each Party has to adopt programmes and measures that aim to prevent, control and mitigate climate change, through the establishment of national programs and, in case, regional ones;
- the more developed countries, that are included in Annex 1 (OECD countries and countries with economies in transition[2]) has to single out and adopt policies and measures in order to return, individually or jointly, in the year 2000, to 1990 levels of anthropogenic emissions of carbon dioxide or other greenhouse gases that are not controlled by the Montreal Protocol.

2 The so-called nations in Annex 1 include OECD countries (Austria, Australia, Belgium, Canada, Finland, France, Germany, Japan, Greece, Ireland, Iceland, Italy, Luxemburg, Norway, New Zealand, Holland, Portugal, United Kingdom, Russia, Spain, Sweden, Switzerland, United States of America, Turkey), the Central East European Countries associated to the European Union ("CEEC": Bulgaria, Czech Republic, Esthonia, Latvia, Lithuania, Poland, Rumania, Slovakia, Slovenia and Hungary) and three counties of the Community of Independet States (Belorussia, Russia and Ukraine).

3. THE SECOND ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL OF CLIMATE CHANGE (IPCC)

In December 1995 the Italian Ministry of the Environment organised and gave hospitality to the IPCC plenary session in Rome, which was attended by the representatives of more than 80 countries.
The plenary session approved the "Second Assessment Report" on global climate, that is the result of a long analysis and evaluation process of available information and forecasts, developed during four years of work, between 1991 and 1995.

The Report asserts, among other things, that:

- there is a discerned anthropogenic influence on global climate, caused by the greenhouse gas emissions which are produced during human activities;
- without specific policies and measures to mitigate climate changes, the global, superficial, average temperature of 1990, is expected to rise of about 2 °C (among 1.5 and 3.5 °C) in 2100;
- the average level of seas is doomed to rise of about 50 cm (among 15 and 95 cm) in 2100, in comparison with the level of 1990, compromising vast expanses of coastal lands that are intensively peopled;
- global warming will be able to determine important changes in climatic cycles, causing the intensification of extreme meteors (strong precipitation with alluvial events, which leave place to long periods of dry weather), alterations of earthly and aquatic ecosystems (effects on the degradation and drying of soils, modifications of agricultural productions);
- the rising of temperature will have effect on health, that will be direct (increase in the number of deaths and diseases, because of the so-called "heat-waves") and indirect (increase and spreading, even in the temperate zones, of contagious diseases that are typical of the tropical zones);
- in order to assure that, in 2100, the greenhouse gas concentrations are restrained within "compatible" levels, that is to say, in order to achieve the aim of stabilising atmospheric CO_2 concentration at twice pre-industrial levels, global emissions shall correspond to the half of the present ones.

According to the Panel forecasts, CO_2 world emissions coming from the energy sector, that are more than 95% among total emissions, without mitigation efforts, tend to rise of 30-50% in 2010, because of the rising of energy needs, that are essential for the world economic development.
Particularly, it is to expect that developing countries will be responsible, in 2010, for more than 50% of the global energy consumption, in comparison with 27% during 1990.

The scenarios and forecasts of the Second Assessment Report reminds the governments of all the signatory countries of the Convention, the need of renewing and making more efficient the international strategy for the prevention of climate change.

4. THE CONFERENCES OF THE SIGNATORY PARTIES OF THE CONVENTION ON CLIMATE CHANGE IN BERLIN (1995) AND GENEVA (1996): TOWARDS THE KYOTO PROTOCOL FOR THE REDUCTION OF GREENHOUSE GAS EMISSIONS

The First Conference of the Signatories of the Convention, that was held in Berlin in April 1995, established that, within the end of 1997, on the occasion of the Third Conference of the Parties, it should be adopted a protocol – that is to say a legally binding treaty – that would fix the time - frames and the size of the reduction of greenhouse gas emissions, produced by developed countries, beginning from 2000.

The Second Conference of the Parties, in Berlin in 1996, confirmed the Protocol objective, even if it had to take note of the difficulties of the negotiation process.

Moreover, such difficulties have been well emphasised even during the G8 Summit in Denver in June 1997, and in the following Special Session of the General Assembly of the United Nations "five years later Rio de Janeiro": notwithstanding the scientific evidence about the serious dangers for the global environment, that are linked with climate change, the developed countries are still not able to agree upon a common strategy and upon the industrial and energy measures which are really necessary to achieve the goal of the reduction of emissions.

Mainly, these difficulties come from two elements:

- the reduction of greenhouse gases requires a change in the national policies about energy and transport; a changing which will be much more difficult if there is a very high consumption, that is to say, if the industrial and economic system of the developed countries has very high energy consumption;

- it might not be enough to reduce the emissions of the developed countries for preventing climate changes, if it will continue the increase of the emissions in the developing countries (particularly China, India, south-east Asia, Brazil): that is to say, the programmes of reducing emissions should allow the developed countries to achieve the national goals in this field even through investments which should be realised in the developing countries, thanks to the supplying and the installation of industrial or energy plants and systems, or in the transport field, highly efficient equipment and with low emissions ("joint implementation" and "trade emissions").

The Conference of the Parties in Kyoto (in December 1997) provided a first answer, adopting a Protocol that can define, at the same time, effective (considerably reducing emissions) and possible (flexible rules) engagements: anyway, this is the trend that has been fixed in the conclusive paper of the G8 Summit in Denver, confirmed by the Special Session of the General Assembly of the United Nations (22-27 June 1997).

5. THE EUROPEAN UNION COMMITMENT

5.1 THE STABILISATION OF CO_2 EMISSIONS FOR THE YEAR 2000

The objective of the stabilisation of carbon dioxide emissions to the year 2000 to 1990 levels, fixed by the European Union on 29nth of October 1990, should be achieved by the European Union as a whole: this is the forecast given by the Management Committee of the European Monitoring System in regard to CO_2 emissions.

The single Member States contribute in different ways to the achievement of this goal, according to their respective starting points about emissions, too (absolute quantities and per capita emissions, table 2).

5.2 THE EUROPEAN UNION OBJECTIVE FOR THE REDUCTION TO THE YEAR 2010

The European Union Environment Council on 3rd of March 1997 has fixed a first objective of 10% reduction of the European emissions within the year 2010, distributed amongst specific objectives for each Member State (table 3), and that is preliminary to a 15% reduction, chosen as final goal.

The Council decision represent the European Union negotiating position for the Conference of the Parties in Kyoto in December 1997, which shall define the objectives of the developed countries emissions reduction: the EU proposes that all the developed countries undertake a reduction objective of 15% by the year 2010.

Table 2: CO_2 emission in 1990 of the European Union and of Member States

Member States	Emissions 1990 Mton CO_2	Emissions 1990 %	Population Millions	Population %	ton CO_2/capita
Austria	59.1	1.8	8.0	2.2	7.4
Belgium	115.5	3.5	10.1	2.7	11.4
Denmark	58.1	1.7	5.2	1.4	11.2
Finland	60.0	1.8	5.1	1.4	11.8
France	366.3	11.0	57.6	15.5	6.4
Germany	1014.0	30.6	81.4	22.0	12.5
Greece	84.2	2.5	10.4	2.8	8.1
Ireland	30.6	0.9	3.6	1.0	8.5
Italy	438.0	13.2	57.2	15.4	7.6
Luxemburg	13.3	0.5	0.4	0.1	33.3
Netherlands	173.0	5.2	15.4	4.2	11.2
Portugal	42.3	1.3	9.9	2.7	4.3
Spain	226.2	6.8	39.1	10.6	5.8
Sweden	55.0	1.6	8.8	2.4	6.3
Un. Kingdom	583.0	17.6	58.4	15.8	10.0
EU Total	3318.5	100	370.6	100	9.0

Table 3: Burden sharing of greenhouse gas emissions reduction agreed upon at the EU Council of the Ministers of the Environment (March 1997)

Member States	Quantified objectives of greenhouse gas emission reduction* by 2010, in comparison with 1990 levels
Austria	- 10 %
Belgium	- 25 %
Denmark	- 25 %
Finland	+ 30 %
France	+ 17 %
Germany	0 %
Greece	+ 15 %
Ireland	- 7 %
Italy	- 30 %
Luxembourg	- 10 %
Netherlands	- 25 %
Portugal	+ 40 %
Spain	0 %
Sweden	+ 5 %
United Kingdom	- 10 %
European Union	- 10 %

* CO_2, CN_4, N_2O

6. ITALIAN COMMITMENTS WITHIN THE FRAMEWORK CONVENTION ON CLIMATE CHANGE

6.1 ITALIAN VULNERABILITY TO CLIMATE CHANGE

The global reduction objective of greenhouse gas emissions, and, therefore, national emissions, are in conformity with a specific national interest in Italy.

The IPCC Second Report, the scientific evaluations made by the Columbia University for the Ministry of the Environment, the most recent (August 1997) forecasts of the IPCC Working Group II about the regional effects of climate change, put in evidence a significant environment vulnerability linked to the climate forecasts of next decades - that are more and more precise - in relation to the rise of greenhouse gas concentrations in the atmosphere:

- a progressive increase of arid areas in the South and Central regions, with degradation of soils, saline infiltration of acquifiers and changes in agricultural productivity;
- an increase in the frequency of floods and in the erosion of shores, particularly in the Po delta and in the Lagoon of Venice;
- an increase in the frequency of "intense" precipitation, particularly in the Central and North regions, with unusual increases of rivers flow and consequent alluvial events.

These climatic forecasts will test Italy's capability to "stand", in prospective, a more consistent pressure on the land than the one to which we are already exposed, with seasonal floods, dry weather, the degradation of acquifiers, and forest fires.

6.2 NATIONAL EMISSIONS OF CARBON DIOXIDE AND OTHER GREENHOUSE GASES TO THE YEAR 2000

The National Program for the control of carbon dioxide emissions and the First National Communication to the Convention on Climate Change, approved by CIPE (24 Feb 1994 and 10 Jan 1995), define:

a) the emissions which refer to 1990;

b) the measures for reducing CO_2 emissions and the increase of energy-saving measures in sectors like that of energy production, industry and transport system;

c) the objective for the year 2000.

Particularly, the First National Communication extends the inventory of emissions to all greenhouse gases (carbon dioxide, methane, nitrogen oxide, carbon oxide and non methane volatile organic compounds) and to all sectors of emission and re-absorption.

According to the First Communication forecasts, Italy can bring back to the same values of 1990 its equivalent greenhouse emissions within the year 2000, even if it could be possible to increase lightly emissions of carbon dioxide, a gas which for 92-93% come from the energy sector.

6.2.1 THE TREND OF CARBON DIOXIDE EMISSIONS

The actual growth of CO_2 emissions coming from the energy sector in more recent year has been limited. The monitoring of carbon dioxide emissions from the energy sector between 1990 and 1996 shows a trend which is to place between a 3.1% reduction in 1994 and a 2.1% growth in 1995. On the ground of the more up-to-date forecasts, the estimated emissions for the year 2000 should increase of 4-5%, and this growth is compatible with the objective of stabilising the European Union global emissions (table 4a and 4b). It will be possible to reduce these emissions thanks to the adoption of energy-saving measures, that have to be effective in the short period, and so good that they should give results already in the year 2000.

6.2.2. POLICIES AND MEASURES FOR STABILISING GREENHOUSE GAS EMISSIONS TO THE YEAR 2000

Reducing the growth of carbon dioxide national emissions (below the trend of 4%) which come from the energy sector within the year 2000 requiser bunding measures, that are yet feasible in the short period.

Considering that Italy has got, among the more developed countries, the lowest per capita energy consumption (2.7 toe/capita, against OECD figures, that have averaged 4.8%), if one wants to reduce strongly energy consumption, has to apply structural changes, able to reduce the marginal amounts of emission, that are just in part consistent with the

Table 4a: Trend in CO_2 emissions from the energy sector from 1990 to 1996 and estimates for the year 2000 (a)

Year	1990	1991	1992	1993	1994	1995	1996	2000 EU(b)	2000 (c)
Oil (Mt C/y)	69.2	68.5	71.7	70.0	68.6	70.9	69.4	70.1	67.3
Coal (Mt C/y)	15.8	14.9	13.1	11.5	12.1	13.2	12.6	13.1	13.0
Methane (Mt C/y)	24.6	26.2	25.9	26.4	25.5	28.2	29.0	35.5	34.6
Tot. energy emissions									
in Mt C/year	109.6	109.6	110.7	107.9	106.2	112.3	111.0	118.6	114.9
in Mt CO_2/year	401.9	401.8	405.7	395.6	389.4	411.8	406.9	435.0	421.3
index	100.0	100.0	100.9	98.4	96.8	102.4	101.2	108.5	104.3
Indicators									
Population in Millions	56.95	57.11	57.19	57.11	57.11	57.33	57.35	57.50	57.50
Per capita emissions									
(t CO_2/inhabitant)	7.05	7.03	7.10	6.93	6.82	7.15	7.10	7.56	7.33
GDP (TLit'90)	1311	1326	1333	1318	1346	1386	1399	1531	1531
Carbon intensity of									
GDP $kgCO_2$/MLit90	0.307	0.303	0.305	0.300	0.290	0.296	0.291	0.284	0.274

a) equal to 90% of CO_2 gross emissions; petrochemicals and international air and marine bunkers are excluded;
b) value pointed out to the monitoring system of the European Commission in Jan 1997;
c) forecast of 9/1997

Table 4b: Trend of national CO_2 emissions

Year	1990	1995	2000 (c)
Emissions from the energy sector	401.9	411.8	421.3
Emissions from Industrial proc., solvents usage, change in the exploitation of soils, woods and waste	40.6	37.4	37.7
TOTAL	442.2	449.2	459.0

c) forecast of 9/1997

time horizon of 2000, because they require longer times and are, moreover, still very conditioned by uncertainties on future arrangements of the industrial system and on transport's infrastructure.

Yet, some interventions in the short period are possible, which could be effective within the year 2000, and which should aim to improve the energy efficiency and to increase the use of renewable sources, with regard to a modernisation strategy in Italy and a better protection of the environment:

- efficiency improvement of electric power production and increase of renewable sources;
- large scale diffusion of more efficient electrical equipment;
- reduction of losses in the electricity grid and in the methane network;
- increased use of methane in industry and private sectors;
- traffic control and rationalisation of urban mobility;
- promotion of low greenhouse gas emission fuels energy efficiency improvements of the buildings;
- check of the heating system.

These interventions could allow to reduce further within the year 2000 carbon dioxide emissions by circa 13 Mt/y, getting closer to the objective of stabilisation and to a low rise of emissions, just 0.3% in comparison with 1990.

In order to achieve the stabilisation of greenhouse emissions within the year 2000, these energy-saving measures will have to be integrated by interventions in other sectors.

The realisation of some preliminary interventions in industrial processes which produce nitrogen protoxide, could allow a further decrease in greenhouse gas emissions by 1.5 Mt CO_2 equivalent.
Whit this intervention package it should be possible to achieve within the year 2000 the objective of the stabilisation of greenhouse gasses emissions.

6.3. OBJECTIVES OF REDUCTION OF THE NATIONAL EMISSION WITHIN THE YEAR 2010

6.3.1 QUANTIFIED OBJECTIVES OF REDUCTION

The objective of a 7% reduction by year 2010, in comparison with 1990 levels, drives Italy to the engagement of reducing the national greenhouse gas emissions from a value of circa 618 equivalent millions tons of CO_2 (annual), which has been forecast for the year 2010, to a value of 509 equivalent millions tons of CO_2 (annual).

So, the national objective could require, as regards the trend, a progressive reduction of greenhouse gas emission up to 109 millions tons within the year 2010.

This is a very ambitious goal, if considering Italy starting-data, but it is technically feasible through the implemention of a series of interventions in different sectors, within an European policy aims to reduce greenhouse gases.

Obviously, the national strategy has to be considered in conformity to a global point of view, because in Italy greehouse gas emissions are about 2% of all the emissions in the world, and 13% of the whole European Union.

Moreover, the economic costs and effects of these measures need an harmoniosation, at least:

- at an European level, because this is the "institutional" dimension of the inland market and some measures at a national level would lead just to market distortions and penalising effects, without valuable environmental results;
- at an international level, in the context of developed countries, in order to guarantee the environmental effectiveness of these measures and safeguard the competitiveness on international markets.

6.3.2. POLICIES AND MEASURES FOR REDUCING THE NATIONAL GREENHOUSE GAS EMISSIONS WITHIN THE YEAR 2010

To reduce greenhouse emissions of 7%, at least, within the year 2010, Italy has to adopt intersectoral policies and measures over the years, and organise them inside a common strategy which tends to the best energy-saving options. ENEA, the governmental agency for new technologies, energy and environmetn, which has among its institutional objectives the mission of promoting, among others, the efficient use of energy and the use of renewable energy sources, will supply the necessary technical support in order to co-ordinate the action on policies and measures. In general, such policies and measures are in conformity with the necessary initiatives for a modernisation strategy in Italy and a better environmental safeguard, and refer to two main fields:

a) the planning and control of the development and use of resources by Administrations

- regulations, standards, economic and restraints, voluntary arrangements for a rational use of energy, energy-saving measures, the development of renewable source;

- promotional actions, information and education about environmental safeguard;

- a national plan for safeguarding the quality of the air;

- regional plans for safeguarding the quality of the air, regional plans on energy-saving measures, regional plans on transport, city plans on energy-saving mesaures;

- urban plans on traffic;

b) the economic and industrial initiative for technological innovations and saving of energy consumption, supported by private investments and pubblic funding (national and European), in the following fields

- electric power production;
- industrial production;
- production of motor-vehicles and other means of transport;
- public transport's infrastructure;
- transportation of goods;
- heating and cooling systems;
- recycling and energy recovering from waste

THE REDUCTION OF NATIONAL EMISSIONS WILL BE IMPLEMENTED BY MEANS OF THREE INTERVENTION LEVELS.

A - Interventions that are anyhow necessary to the modernisation of Italian economy and to the safeguard of environment (table 6)

These interventions are mainly connected with:
a) the increase of energy-saving measures in industrial field and wherever energy is produced;
b) the increase of energy production from renewable sources, biomass and waste;
c) the adoption of control measures for urban traffic;
d) the replacement of about an half of circulating cars with more efficient cars;
e) the realisation of a fast mass transport system in city areas, and the development of the railway intercity connections;
f) the increase of percentage of total freight carried by trains;
g) the diffusion of low-emission biofuels;
h) the further use of methane in industrial sector, housing and in the tertiary sector;
i) the promotion and diffusion of devices and system to reduce electricity consumption in housing and in the tertiary sector.

The fulfilment of these interventions could allow a reduction of greenhouse emissions equal to about 77 millions tons within the year 2010, that is to say a reduction of 1.3% in comparison with 1990 emissions. The necessary investments for the realisation of interventions are estimated at 71,000 bn of liras; just a share of the whole can be assigned to the objective of reducing greenhouse gases. The present net value of the equivalent primary energy saving, valued at the price of oil (20$ a barrel) and at a discount rate of 5% in real terms, is of about 44,000 bn (in liras 1997), a figure from which the additional running costs have to be deducted.

B - Further interventions in reducing greenhouse gas emissions in order to achieve the EU objective (table 7)

These interventions are mainly connected with:

a) the increase in the use of renewable sources in order to produce electric power and generate heat for civilian use;
b) the increase in the use of biogas in the industrial field;
c) a further rise in efficiency of industrial processes;
d) reduction in electricity consumption and better heating systems in housing and in the tertiary sector;
e) a better efficiency in zootechnics;
f) the increase of selective waste collection and recycling of aluminium, paper and glass.

The fulfilment of these interventions could allow a further reduction of greenhouse emissions equal to about 32 millions tons, that is to say a total reduction of 7.1% in comparison with 1990 emissions. The necessary investments for the realisation of interventions are estimated at almost 20,000 bn; just a share of the whole can be assigned to the objective of reducing greenhouse gases. The present net value of the equivalent primary energy saving, valued at the price of oil (20$ a barrel) and at a discount rate of 5% in real terms, is of about 32,000 bn of liras 1997, a figure from which the additional running costs have to be deducted.

C - Further interventions in reducing emissions (table 8)

These interventions are more difficult to realise in comparison with the previous ones, both from an actual point of view, because they need sectoral agreements on a Community level, and from the general economic efficiency point of view, and refer to:

a) further efficiency in industry and zootechnics;
b) further decrease of heating consumption in buildings;
c) promotion of very low-consumption cars.

The fulfilment of these interventions could allow a further reduction of emissions equal to 30 millions tons, that is to say a total reduction of 12.5% in comparison with 1990 emissions. The necessary investments for the realisation of interventions are estimated at 27,000 bn. The present net value of the equivalent primary energy saving, valued at the price of oil (20$ a barrel) and at a discount rate of 5% in real terms, is of the same quantity, a figure from which the additional running costs have to be deducted.

The combined result of this kind of interventions in reducing emissions for the year 2010 is summarised in table 9.

Table 6: Programme to reduce greenhouse gas emissions by the year 2010: modernisation interventions

1 RIDUCTION OF EMISSIONS FROM THE ENERGY SECTOR (Millions tons of CO_2/annual equivalent)	CO_2 Mt/y	CH_4 (a)	N_2O (b)
1.1. Gasification of emulsions and residual products, very high-efficiency combined cycles (2700 MW)	3		
1.2. Further cogenerations (1200 MW)	1.3		
1.3. Six per cent reduction of leaks in the electricity grid	0.7		
1.4. Further gasification of emulsion and residual products + methane combined cycles	5.1		
1.5. Further combined cycles, dismissal of plants in existence (3000 MW)	3.5		
1.6. Electric power production from wind turbines (1500 MW)	1.9		
1.7. Further biomass system + solid waste (1300 MW)	2.1		
1.8. Reduction of leaks and emissions from methane system		0.7	
1.9. Measures for city public transport	2.1		
1.10. Replacement of 12 millions circulating cars with 12 millions low-emissions cars (145 g CO_2/km)	12		
1.11. Realization of new underground, tram, local railway system, modernisation/increase of speed of 1100 km	4		
1.12. Transfer of freight from road to railway and coastal navigation for about 40 Mton*km for the year 2010	5.5		
1.13. Promotion of biofuels and biodiesel	1.5		
1.14. Increase in the use of natural gas in industry	3		
1.15. Further use of methane in housing and in the tertiary sector	2		
1.16. Voluntary agreements and energy diagnosis in industries with medium-low energy consumption, new technologies	4.5		
1.17. Standards and voluntary agreements for high-efficiency equipment in industry	1.5		
1.18. More efficient equipment for reducing electricity consumption in housing and in the tertiary sector, new technologies	2.5		
TOTAL	56.2	0.7	
2. REDUCTION OF EMISSIONS FROM THE ENERGY SECTOR	CO_2	CH_4	N_2O
2.1. Energy-saving measures (recycling of solid waste), reclamation of landfills, incineration of industrial sludge		16	
2.2. Reduction N_2O emissions in industrial processes (nitric acid and fatty acid)			4.5
TOTAL: MODERNIZATION PROGRAMME/ENVIRONMENT SAFEGUARD	56.2	16.7	4.5

Notes: see table 8.

Table 7: Further interventions of reduction of greenhouse gas emissions to achieve E.U. objectives: -7% to the year 2010

1 RIDUCTION OF EMISSIONS FROM THE ENERGY SECTOR (Millions tons of CO_2/annual equivalent)	CO_2 Mt/y	CH_4 (a)	N_2O (b)
1.1. Energy production from renewable sources, biomasses included + solid waste (1300 MW) (c)	1.6		
1.2. Increase in the use of natural gas in industry and private sectors	2.5		
1.3. Promotion of methane cars/vans	1.7		
1.4. Reduction of heating consumption in housing/tertiary sector (new) and new technologies	3.0		
1.5. More efficient equipment for reducing electricity consumption in housing and in the tertiary sector (2nd phase)	4.5		
1.6. Standards and voluntary agreements for high-efficiency electric equipment in industry (2nd phase)	5.5		
1.7. Recycling of aluminium waste	1.0		
1.8. Recycling of paper (d)	—		
1.9. Recycling of glass	0.3		
1.10. New hydroelectric power plants (800 MW) and geothermal plants (8300 MW)	3.5		
1.11. Reduction of heating consumption in the reconstruction of buildings	3		
1.12. Active and passive solar heating in housing/tertiary sector	1.5		
2. REDUCTION OF EMISSIONS FROM THE NON-ENERGY SECTOR	CO_2	CH_4	N_2O
2.1. Emissions from cattle-breeding in farms		0.8	
2.2. Reduction of waste and increase in incinerating processes		2.8	
TOTAL: FURTHER INTERVENTIONS OF REDUCTION TO ACHIEVE E.U. AIMS	28.1	3.6	

Notes: see table 8

Table 8: Further interventions of reduction of greenhouse gas emissions for the year 2010

1 RIDUCTION OF EMISSIONS FROM THE ENERGY SECTOR (Millions tons of CO_2/annual equivalent)	CO_2 Mt/y	CH_4 (a)	N_2O (b)
1.1. Standards and voluntary agreements for high-efficiency electric	3.5		
1.2. More efficient equipment for reducinf electricity consumption in housing and in the tertiary sector	3.0		
1.3. Replacement of 7 millions circulating cars with 7 millions very low-consumption car (120 g CO_2/km)	4.0		
1.4. Promotion of biofuels	4.5		
1.5. Electric power production from biomass cultivation (2200 MW)	5.5		
1.6. Reduction of heating consumption in buildings	8.0		
1.7. Photovoltaic solar energy (500 MW) (e)	0.3		
TOTAL	28.8		
2. REDUCTION OF EMISSIONS FROM THE NON-ENERGY SECTOR	CO_2	CH_4	N_2O
2.1. Increase of methane exploitation in landfills		1	
TOTAL: FURTHER INTERVENTIONS	28.8	1	

a) the decrease of methane emissions (CH_4) is expressed in millions tons of CO_2 equivalent; in order to calculate the rigt values in millions tons of CH_4, one has to divide by 21, which is the coefficient of CH_4 global warming potential;
b) the decrease of nitrogen protoxide emissions (N_2O) is expressed in millions tons of CO_2 equivalent: in order to calculate the right values in millions tons of N_2O, one has to divide by 310, which is the coefficient of N_2O global warming potential;
c) the production of electric power from renewable sources is additional to the 2600 MW forecasted by CIP 6-92;
d) the process of recycling half the paper used in Italy allows to replace a higher cut of imported pulp in the national production cycles and to reduce, by overseas pulp producers, the energy consumption of circa 0.2 Mtoe/y and the emission of circa 0.6 Mt CO_2/y, if the pulp is produced thanks to process which use the by-products as a fuels;
e) if the investment cost falls below per Wp 5000; in the opposite case, the object has to be redefined.

Table 9: Reduction programme of national greenhouse gas emissions summary table (Millions tons of CO_2/y equivalent) (a,b)

REDUCTION SCENARIOS OF GREENHOUSE GAS EMISSIONS	CO_2 tot.	CO_2 energy	CO_2 absorption	CH_4 tot.	CH_4 energy	N_2O tot.	N_2O energy	global emissions (Mt) tot.	global emissions (Mt) energy	net emissions
EMISSIONS 1990	442.5	402.0	35.9	52.0	11.6	53.9	16.6	548.3	430.2	512.4
EMISSIONS 2010 MAIN SCENARIO/TREND	509.7	471.0	36.2	55.8	7.8	53.1	16.6	618.5	495.3	582.3
Diff. % - 1990	+15.2	+ 17.2	+ 0.9	+ 7.3	-32.9	- 1.5	- 0.7	+12.8	+15.1	
EMISSIONS 2010 (table 6) MODERNIZATION/ ENVIRONMENT SAFEGUARD	453.5	414.8	36.2	39.1	7.1	48.6	16.6	541.1	438.4	504.9
Diff. % - 1990	+ 2.5	+ 3.2	—	-24.8	-38.9	- 9.8	- 0.7	- 1.3	+1.9	
EMISSIONS 2010 (table 7) U.E. AIMS (c)	425.4	386.7	36.2	35.5	7.1	48.6	16.6	509.4	410.3	473.2
Diff. % - 1990	- 3.9	- 3.8	—	- 31.7	-38.9	- 9.8	- 0.7	-7.1	-4.6	
EMISSIONS 2010 (table 8) FURTHER INTERVENTIONS	396.6	357.9	36.2	34.5	7.1	48.6	16.6	479.6	381.5	443.4
Diff. % - 1990	-10.4	-11.0	—	-33.7	-38.9	- 9.8	- 0.7	-12.5	-11.3	

a) conversion coefficient of Gg methane into equivalent Gg CO_2 = 21
b) conversion coefficient of Gg N_2O into equivalent Gg CO_2 = 310
c) the seven per cent reduction object of national greenhouse gas emissions for 2010 is calculated on gross emissions, and is equal to a 7.6 reduction object, if considering net emissions.

6.4. REDUCTION INTERMEDIATE OBJECT OF NATIONAL EMISSIONS IN 2005

The modernisation interventions and the environmental safeguard, and all that is needed to achieve the European Union object will already allow in 2005 a decrease in emissions equal to 59 millions tons greenhouse gas equivalent (see table 10-12 for the precise evaluation of interventions and table 13 for a summary of reduction effects).

Table 10: Reduction programme of greenhouse gas emissions to the year 2005 - Modernization interventions and environment safeguard (millions tons of CO_2/y equivalent)

RIDUCTION OF EMISSIONS FROM THE ENERGY SECTOR	CO_2	CH_4	N_2O
1.1. Gasification of emulsions and residual products, very high-efficiency combined cycles	1.7		
1.2. Further cogenerations	0.8		
1.3. Four per cent reduction of leaks in the electricity grid	0.45		
1.4. Further gasification of emulsion and residual products + methane combined cycles	3.0		
1.5. Further combined cycles, dismissal of plants in existence	2.0		
1.6. Electric power production from wind turbines	1.0		
1.7. Further biomass system + solid waste	1.2		
1.8. Reduction of leaks and emissions from methane system		0.5	
1.9. Measures for city public transport	1.5		
1.10. Replacement of 4 millions circulating cars with 4 millions medium-emission cars (145 g CO_2/km) since 2002	4		
1.11. Realization of new underground, tram, local railway system, modernisation/increase of speed of 500 km	2		
1.12. Transfer of freight from road to railway and coastal navigation for about 20 Mton*Km for the year 2010	3		
1.13. Promotion of low greenhouse gas emissions fuel (0.7 Mt bio-diesel)	2		
1.14. Increase in the use of natural gas in industry	2		
1.15. Further use of methane in housing and in the tertiary sector	1.5		
1.16. Voluntary agreements and energy diagnosis in industries with medium-low energy consumption	3		
1.17. More efficient equipment for reducing electricity consumption in housing and in the tertiary sector	1.5		
TOTAL	30.7	0.5	
2. REDUCTION OF EMISSIONS FROM THE NON-ENERGY SECTOR	CO_2	CH_4	N_2O
2.1. Energy-saving measures in recycling of solid wastes, reclamation of landfills, incineration of industrial sludge		9	
2.2. Reduction N_2O emissions in industrial processes (nitric acid and fatty acid)			3
TOTAL: MODERNIZATION PROGRAMME/ENVIRONMENT SAFEGUARD	30.7	9.5	3

Table 11: Further interventions programme for reducing greenhouse gas emissions within the year 2005 (millions tons of CO_2/y equivalent)

REDUCTION OF EMISSIONS FROM THE ENERGY SECTOR	CO_2	CH_4	N_2O
1.1. Energy production from renewable sources biomasses included + solid waste (1000 MW)	1.5		
1.2. Increase in the use of natural gas in industry and private sectors	1.5		
1.3. Promotion of methane cars/vans	1.0		
1.4. Reduction of heating consumption in housing/tertiary sector	1.5		
1.5. More efficient equipment for reducing electricity consumption in housing and in the tertiary sector (2nd phase)	3		
1.6. Recycling of aluminium waste	1.0		
1.7. Recycling of paper	0.6		
1.8. Recycling of glass	0.3		
1.10. New hydroelectric power plants (300 MW) and geothermal plants (100 MW)	1.2		
1.11. Active and passive solar heating in housing/tertiary sector	0.5		
TOTAL	12.1		
2. REDUCTION OF EMISSIONS FROM THE NON-ENERGY SECTOR	CO_2	CH_4	N_2O
2.1. Emissions from cattle-breeding in farms		0.8	
2.2. Reduction of waste and increase of industrial sludge incineratin		2.8	
TOTAL: FURTHER INTERVENTIONS OF REDUCTION TO ACHIEVE E.U. AIMS	12.1	3.6	

Table 12: Further interventions of reduction of greenhouse gas emissions to 2005 (millions tons CO_2 of equivalent)

RIDUCTION OF EMISSIONS FROM THE ENERGY SECTOR	CO_2	CH_4	N_2O
1.1. Standards and voluntary agreements for high-efficiency electric equipment in industry	4		
1.2. Replacement of 7 millions circulating cars with 7 millions very low-consumption car (120 g CO_2/km)	0		
1.3. Reduction of heating consumption in buildings	3		
1.4. Reduction of heating consumption in the reconstruction of buildings	1		
TOTAL	8		
2. REDUCTION OF EMISSIONS FROM THE NON-ENERGY SECTOR	CO_2	CH_4	N_2O
2.1. Increase of methane exploitation in landfills		0.5	
2.2. Reduction of the use of fertilisers			0.3

Table 13: Reduction programme of national greenhouse gas emissions to2005

REDUCTION SCENARIOS OF GREENHOUSE GAS EMISSIONS	CO_2		CO_2	CH_4		N_2O		global emissions (MT)		net emissions
	tot.	energy	absorption	tot.	energy	tot.	energy	tot.	energy	
EMISSIONS 1990	442.2	401.6	35.9	52.0	11.6	53.9	16.7	548.0	429.9	512.1
EMISSIONS 2005 MAIN SCENARIO TREND	482.8	445.8	36.2	52.2	8.3	52.8	14.7	587.8	478.8	542.6
Diff. % - 1990	+ 9.2	+ 11.0	+ 0.8	+ 0.4	-28.4	- 2.0	- 12.0	+ 7.3	+ 11.4	
EMISSIONS 2005 (table 10) MODERNIZATION/ ENVIRONMENT SAFEGUARD	452.1	415.1	36.2	42.7	7.8	49.8	14.7	544.6	447.6	499.4
Diff. % - 1990	+ 2.2	+ 3.4	+0.8	-17.9	-32.8	- 7.6	- 12.0	- 0.6	+ 4.1	
EMISSIONS 2005 (table 11) E.U. AIMS	440.0	403.0	36.2	38.9	7.8	49.8	14.7	528.7	435.5	483.5
Diff. % - 1990	- 0.5	+ 0.3	+0.8	-25.7	-32.8	- 7.6	- 12.0	- 3.5	+ 1.3	
EMISSIONS 2005 (table 12) FURTHER INTERVENTIONS	432.0	395.7	36.2	38.4	7.8	49.5	16.3	519.9	427.5	474.7
Diff. % - 1990	-2.3	- 1.5	+0.8	-26.2	-32.8	- 8.2	- 12.0	-5.1	- 0.6	

a) conversion coefficient of Gg methane into Gg CO_2 = 21
b) conversion coefficient of Gg N_2O into Gg CO_2 = 310

6.5. INTERNATIONAL CO-OPERATION AND POLICIES FOR THE REDUCTION OF GLOBAL GREENHOUSE GAS EMISSIONS

Both the global dimension of greenhouse gas emissions and the foreseen increase in energy consumption from the developing countries and transition countries, with the connected growth in emissions, require technological co-operation programs to be outlined, on a bilateral and a multilateral basis.

Italy can give a substantial contribution to the diffusion of higly effective energy technologies, that can find application in the majority of industrial and civilian applications.

Moreover, though bilateral and multilateral co-operation program, Italy can play a major role in the war against desertification, one of the global effects of climatic alteration having the most relevant social and economic impact.

To this purpose, by 1998 a fund for the protection of the environment will be estabilished, of 20 billion/year, to support technological co-operation projects and private enterprises, in the frame of multilateral (Global Environmental Facility, World Bank) and bilateral programs, particularly with Mediterranean countries.
The fund will have to support those enterprises whose aim is the mitigation of climate change, and those actions linked to the fight against desertification and protection of biodiversity.

6.6. POLICIES AND MEASURES FOR THE PREVENTION AND THE REDUCTION OF EFFECTS

Policies and measures for the prevention and mitigation of the effects of climate change on a national basis base themselves on two major guidelines:

a) research and monitoring

Research and monitoring receive the support of the Ministry of the Environment, of Commerce Industry and Arts and Crafts, of University and Technological and Scientific Research, of Transports, of Agricultural and Forestry Policies, and have been accomplished by CNR, ENEA, Universities, pubblic bodies, private enterprises. They need a programmatic and operating co-ordination, also to make the position of Italy stronger inside the several International programs of research about climate.

To this purpose, a national fund of 10 billion/year will be estabilished for research on climate.

b) Protection and defence of territory

Growth in frequency and intensity of extreme meteorological phenomenon, and the foreseen raise of alluvial events and degradation of soils, call for a combined action of the several local and national bodies, for strengthening the "natural infrastructures" for the protection and the defence of territory.

To that purpose a mixed Committee Government-Regional Bodies will be established, with the co-ordination of the Ministry of the Environment, to monitor the unusual climate episodes and to co-ordinate the annual programs of prevention.

6.7. MEASURES AND POLICIES FOR ENVIRONMENTAL EDUCATION, TRAINING AND INFORMATION

Art. 4 of the Framework Convention on Climate Changes, item 1, engages all parties to “promote and co-operate in education, training and pubblic awareness related to climate change and encourage the widest participation in this process, including that of non governmental organizations”.

Environmental education, traininf and information on climate changes, will also have to be developed also with reference to the objective of the Conventions on desertification and to protect biodiversity.

A general program of environmental education, training and formation, therefore, will be outlined about global environmental protection, which will see the participation of:

- central government administrations, with particular reference to the Environment Minister,
- national research bodies,
- local administration bodies, with particular reference to city councils,
- non-governmental environmental associations,
- mass media,
- schools.

To this purpose, by 1998 a fund of 2 billion/year will be established.

Annexe 4: Guidelines of domestic policies and measures for the reduction of greenhouse gas emissions

DELIBERATION OF NOVEMBER 19, 1998 (# 137/98)

GUIDELINES OF DOMESTIC POLICIES AND MEASURES FOR THE REDUCTION OF GREENHOUSE GAS EMISSIONS

THE INTERMINISTERIAL COMMITTEE FOR ECONOMIC PLANNING
(CIPE)

HAVING SEEN the law # 65 of January 15, 1994, on the ratification of the United Nation Framework Convention on Climate Change, issued in New York in 1992, concerning the "stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system".

HAVING SEEN the decree-law # 112 of March 31, 1998, which moves further functions and competencies to the local Administrations and Institutions on environment and energy issues and taking into account the functions assigned to Unified Conference for the relationships among the State and Regional Districts, the County Authorities and the Local Authorities, by the article 8 of the decree-law # 281 of August 29, 1997;

HAVING SEEN the Protocol adopted in Kyoto on December 10, 1997, by the 3rd Conference of the Parties to the Framework Convention on Climate Change, which makes the Member States of the European Union committed to reduce the greenhouse gas emissions by 8% with respect to the levels of the reference year 1990, within the time period 2008-2012;

HAVING SEEN the Communication of the European Commission, Com (98) 353, "Climate Change - Towards an EU post-Kyoto strategy", which describes the strategies of policies and measures to be implemented for complying the Kyoto Protocol provisions, with special reference to the energy, transport, agriculture and industry sectors, the fiscal measures, the scientific research and the development of new technologies, as well as the implementation of flexibility mechanisms;

HAVING SEEN the decision of the Council of the EU Ministers of the Environment, taken on June 17, 1998, by which Italy is committed – in the frame of the EU commitments established by the Kyoto Protocol – to reduce its own greenhouse gas emissions by 6.5% with respect to the levels of 1990 (corresponding to an actual emissions reduction of a hundred million tons of carbon dioxide equivalent) within the time period 2008 to 2012, on the basis of a reduction plan to be implemented starting from 2002 and annually revised by EU;

HAVING SEEN the directives recalled by the above EU decision of June 17, 1998:
• 96/61/CE concerning the use the best available techniques for the protection of the environment and the energy efficiency, for the licensing of new industrial plants and the re-licensing of the existing ones
• 96192/CE concerning the liberalisation of the electric energy market and the efficient use of the electric power, as well as the directive approved on May 11, 1998, concerning the transport and distribution of natural gas;

HAVING SEEN the White Book issued by the European Commission on the Renewable Sources of November 26, 1997, and the decisions of the EU Ministers of Energy, taken on December 8, 1997 and May 11, 1998, both recalled by the decision taken on June 17, 1998, which underlines the need to support renewable sources, natural gas combined cycles power plants and energy efficiency in all the Member States through the introduction of suitable technical and fiscal regimes;

HAVING SEEN the Communication of the European Commission on "Transport and CO_2" (COM(98)204), which indicates the measure to be taken for emission reduction in the transport sector, related to technologies for car manufacturing, the application of the best available techniques for planning the different transport ways, the use of fiscal measures for cost internalisation and the promotion of low emission transport solutions;

HAVING SEEN the 5th Framework Plan of the European Union for the research and technology development, and demonstrative actions in the time period 1998-2002;

HAVING SEEN the National Plan for Renewable Sources from biomass, prepared by the Ministry of Agriculture, in October 1998;

HAVING SEEN the "Green Book on Renewable Sources of Energy", prepared by ENEA in co-operation with the Ministry of Industry, the Ministry of the Environment, the Ministry of University and Scientific and Technological Research, in July 1998;

HAVING SEEN the Document for the Economic and Financial Planning 1999-2001, and especially the chapter 5 on the policies for employment and development, which recalls the need for developing policies and measures to protect the environment and to reduce greenhouse gas emissions in the different sectors;

HAVING SEEN the CIPE deliberation of December 3, 1997, concerning the "2nd National Communication to the UN Framework Convention on Climate Change", which describes plans to control greenhouse gas emissions, to be implemented by the entitled Authorities in a co-ordinated manner and according to cost effective environmental and economic criteria;

HAVING SEEN the Prime Minister Decree (DPCM) of March 20, 1998, which establishes an Inter-ministerial Working Group (created to ensure a high degree of co-ordination among the Authorities' Plans for the sectors indicated in the CIPE deliberation of December 3, 1997);

HAVING SEEN the CIPE deliberation of August 5, 1998 concerning its own internal rules and especially article 2, paragraph 1, which establishes, among others, the Committee for Sustainable Development as CIPE activities supporting board;

HAVING SEEN the outcomes of the first meeting of the Committee for Sustainable Development, held on September 9, 1998, which includes in its own frame the activities of the above mentioned Inter-ministerial Working Group;

HAVING SEEN the structure of the decree-law, approved by the Council of the Ministers on July 10, 1998, which establishes the functions of ENEA as National Agency for Energy and the Environment, with the special task of "providing specialised technical support to the entitled Authorities on public actions, both at national and international levels";

CONSIDERING that the Kyoto Protocol, agreed upon by COP3 on December 10, 1997:

a) has decided that the emissions of the main six greenhouse gases not controlled by the Montreal Protocol for the protection of the ozone layer – namely Carbon Dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF_6) – have to be reduced;

b) has identified the following actions to be implemented by Annex I Countries (Developed Countries and Countries with Economy in transition) for the reduction of emissions:

- promotion of energy efficiency in all sectors;
- development of energy production from renewable sources and of innovative technologies for emissions reduction;
- protection and extension of forests for carbon removal;
- promotion of sustainable agriculture;
- limitation and reduction of methane emissions from landfills and other energy sectors;
- fiscal measures to discourage greenhouse gas emissions, as appropriate;

c) has created three flexible mechanisms, supplemental to the domestic actions, to contribute to the implementation of the commitments through joint actions among several Annex I Countries (Joint Implementation) or co-operation with non-Annex I Countries (Developing Countries or New Industrialised Countries) for clean development (Clean Development Mechanism), or through the international trade of emission permits (Emission Trading);

d) has indicated the carbon removal by afforestation and reforestation, accomplished since 1990, as supplemental measure for emissions reduction;

CONSIDERING the programs indicated by the above mentioned CIPE deliberation of December 3, 1997, and their consistency with the actions recommended by the Kyoto Protocol and the policies and measures recalled by the decision of the Council of the EU Ministers of the Environment on June 17, 1998;

CONSIDERING the domestic energy market, which is ought to implement significant changes as result of the European directives on market liberalisation and efficient use of electric energy, as well as distribution and vectoring of natural gas, and that with this purpose the National Conference on Energy and Environment has been convened for November 25-28, 1998;

HAVING CONSIDERED the programs for the reduction of the greenhouse gas emissions, indicated by the CIPE deliberation of December 3, 1997, prepared in agreement with the provisions of the Kyoto Protocol and in the frame of the EU guidelines, which will be an opportunity for modernisation of Italy, according to environmental and energy efficiency criteria, and will open new perspectives toward the international co-operation with the developing Countries and the Eastern and Central Europe Countries with economy in transition;

HAVING TAKEN note of the document "Guidelines for domestic policies and measures for the reduction of the greenhouse gas emissions", prepared by the Inter-ministerial Working Group;

HAVING SEEN the proposal by the Ministry of the Environment, # 3782/98/SIAR, of September 29, 1998.

DELIBERATES

1. The emission reduction targets reported in table 1 are approved; they include reduction achievable through the flexible mechanisms established by the Kyoto Protocol. The domestic interventions listed in the document "Guidelines for domestic policies and measures for the reduction of the greenhouse gas emissions", mentioned in the premise, are approved as well.

1.1 Till a specific fund to prevent climate changes is established, the expenses for the promotion and the development of domestic actions will be covered both by the ordinary budget of each entitled Authority and the financial resources allocated by the annex to the '99 financial law (House of the Representatives' act, # 5267 – article 8 – par. e, according to which the Government will devote part of the carbon tax yield to sectoral compensating measures and subsidies to reduce polluting emissions, to promote energy efficiency and to develop renewable sources).

1.2 The Committee for Sustainable Development prepares the policies and measures prescribed by this deliberation, monitors their implementation and assesses the consistence of public programmes and investments with the emissions reduction targets indicated in this deliberation, taking into account as well the degree of implementation achieved by the other EU Member States, in compliance with EU decisions.

1.3 The technical support to the work of the Committee for Sustainable Development is provided by the Inter-ministerial Working Group, mentioned in the premise – completed by representatives of the Ministry of Foreign Affairs, the Ministry of Finance and the Ministry of Foreign Trade - with the assistance of ENEA, in the framework of the General Agreements between ENEA and the Ministry of Industry and the Ministry of the Environment. The criteria and the operating modalities of the Inter-ministerial Working Group, as well as changes in its future composition, will be decided by an act of the Committee for Sustainable Development.

1.4 The Committee will promote the creation of an observatory for monitoring the implementation of the policies and measures indicated in this deliberation in co-operation with ENEA, ANPA, the Central Public Administrations, the Autonomous Regional Districts and Counties.

Table 1: Greenhouse gas emissions reduction targets by sector (in Mt CO_2 equivalent)

Actions	2002	2006	2008-2012 average
1. Efficiency improvement in the thermo-electric sector	-4/5	-10/12	-20/23
2. Reduction of energy consumption in the transport sector	-4/6	-9/11	-18/21
3. Production of energy by renewable sources	-4/5	-7/9	-18/20
4. Reduction of energy consumption in the industry / residential/ tertiary sectors	-6/7	-12/14	-24/29
5. Emissions reduction in non-energy sectors	-2	-7/9	-15/19
6. CO_2 removal by afforestation and reforestation			(-0,7)
TOTAL	-20/25	-45/55	-95/112

2. On the basis of the work of the Committee for Sustainable Development and taking into account the outcomes of the National Conference on Energy and Environment, mentioned in the premise.

2.1 Within April 30, 1999, the Minister of the Environment, in agreement with the Ministers of Education, University and Scientific and Technological Research, Public Works, Industry, and Agriculture, having heard the Unified Conference, submits for approval by CIPE the "The National Program for information on Climate Change", mainly dealing with:

a) development of information programs to the public at large, under the responsibility of the Public Administration;
b) promotion of information by public and private enterprises and associations, through the achievement of agreements with the Public Administrations.

2.2 Within April 30, 1999, the Minister of the Environment, in agreement with the Ministers of University and Scientific and Technological Research, Public Works and Agriculture, having heard the Unified Conference, submits for approval by CIPE the "National Program for the Research on Climate", on the basis of the following criteria:

a) survey of the domestic research activities on the protection of climate;
b) development of domestic research programs, carried out in co-operation with the international scientific community and the domestic participation to international programs - with higher priority to the activities conducted under WMO and IPCC.

2.3 Within April 30, 1999, the Minister of Agriculture, in agreement with the Ministers of the Environment, Industry, Transport, Finance, University and Scientific and Technological Research, having heard the Unified Conference, submits for approval by CIPE the "National Program to make the most of biomass from agriculture and forest" - in order to achieve the targets of table 1 and the objectives of the Guidelines - which has to indicate the criteria and the directions towards:

a) cultivation totally or partially devoted to the production of energy;
b) recovery of residues and by-products - coming from agriculture, forests, cattle breeding, food and drink industry - for energy production;
c) production of bio-fuels;
d) production of electric or thermal energy from biomass;
e) use of energy from biomass in the transport and space heating sectors;
f) awarding of incentives and subsidies for the production and use of non-food agriculture outputs and bio-fuels;
g) removal of carbon by forest biomass;
h) voluntary agreements, between the administrations and the brokers of the agriculture and food and drink industry sectors, with the aim of achieving the targets of table 1 and the objectives of the Guidelines.

2.4 Within April 30, 1999, the Minister of Industry, in agreement with the Ministers of the Environment, Agriculture, Public Works, Finance, University and Scientific and Technological Research, having heard the Unified Conference, in order to achieve the targets of table 1 and the objectives of the Guidelines, submits for approval by CIPE the "White Book to enhance energy production from the use of renewable sources", prepared on the basis of the Green Book mentioned in the premise.

2.5 Within December 31, 1999, on the basis of the work of the Committee for Sustainable Development, in the framework of the General Transportation Plan, the Minister of Transport, in agreement with the Ministers of the Environment, Industry, Public Works, having heard the Unified Conference, in order to achieve the targets of table 1 and the objectives of the Guidelines, submits for approval by CIPE a "White Book for a Sustainable Transportation".

3. Within June 30, 1999, on the basis of the work of the Committee for Sustainable Development, in order to achieve the targets of table 1 and the objectives of the Guidelines, the Minister of the Environment, in agreement with the Ministers of Public Health, Industry and Agriculture, having heard the Unified Conference, adopts measures related to:

a) the definition of the criteria for the implementation and use of the best available techniques, as required by the Directive 96/61/CE, in order to reach the highest energy efficiency in factories and power plants;
b) the regulation of biomass combustion for energy production;
c) the regulation of bio-fuels use, in compliance with article 2 of law # 349 of July 9, 1986.

4. Within December 31, 1999, on the basis of the work of the Committee for Sustainable Development, the Minister of Industry, in agreement with the Ministers of the Environment, and Public Works, having heard the Unified Conference, sets standards and guidelines for the use of the most efficient

energy devices and the reduction of energy consumption in space heating and air conditioning, in the building sector, both public and private, in order to achieve the targets of table 1 and the objectives of the Guidelines.

5. Within December 31, 1999, in the sectors where voluntary agreements between the Public Administrations and the brokers do not comply with the targets of table 1 and the objectives of the Guidelines, on the basis of the work of the Committee for Sustainable Development:

5.1 The Minister of the Environment, in agreement with the Ministers of Public Health, Industry, Agriculture, and Transport, having heard the Unified Conference - taking into account also the directive 96/62/CE for the protection of the air quality, the European directive "Auto-oil" concerning emissions from motor-vehicles, the decisions adopted by the Council of EU Ministers to reduce the consumption of fossil fuels, the national law # 413/97 concerning the prevention of the atmospheric pollution from benzene and aromatic poly-cyclic hydrocarbons, in order to achieve the targets of table 1 and the objectives of the Guidelines, adopts measures related to:

a) mandatory use of biodiesel on the motor-vehicles for public transportation, starting from cities with 100,000 inhabitants or more;
b) mandatory use of biodiesel, to be mixed with diesel oil and distributed on the network;
c) use of bio-ethanol for the production of ETBE, to be mixed with gasoline and distributed on the network;
d) mandatory use of biodiesel, to be mixed with diesel oil and used in yachting.

5.2 The Minister of Industry, in agreement with the Ministers of the Environment, and Public Health, having heard the Unified Conference, - also considering the directive 96/61/CE for Integrated Prevention and Pollution Control and the directive 96/92/CE for the liberalisation of the market and the efficient use of the electric energy – indicates criteria and measures to increase the efficiency of thermal-electric power plants, beginning from the plants with the higher consumption and lower yield, which are going to play a marginal role, as a result of the liberalisation of the electric energy market.

5.3 The Minister of Industry, in agreement with the Minister of the Environment, having heard the Unified Conference, in order to achieve the targets of table 1 and the objectives of the Guidelines, establishes standards and guidelines for the reduction of energy consumption in the industry and tertiary sectors.

5.4 The Minister of Transport, in agreement with the Ministers of the Environment, Industry and Public Works, having heard the Unified Conference, in order to achieve the targets of table 1 and the objectives of the Guidelines, takes measures to reduce carbon dioxide emissions from transportation, with the following priority order:

a) progressive renewal of the public fleet with new low emission motor-vehicles;
b) development of rapid mass transport in the urban and metropolitan areas, restricting at the same time the circulation of private motor-vehicles and promoting the creation of urban cycle tracks;
c) shifts of increasing shares of goods transport from road to railway/coasting.

5.5 The Minister of the Environment, in agreement with the Ministers of Industry, and Agriculture, having heard the Unified Conference, in order to achieve the targets of table 1 and the objectives of the Guidelines, takes measures to reduce emissions from non-energy sectors, with the following priority order:

a) reduction of Nitrous oxide (N_2O) emissions from industrial processes;
b) promotion of waste recycle;
c) reduction of methane (CH_4) emissions from landfills;
d) reduction of methane (CH_4) emissions from livestock;
e) restriction to the use of Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF_6) in industrial processes and devices.

Such measures can be issued also in the specific sectors, where voluntary agreements – aiming to achieve the targets of table 1 and the objectives of the Guidelines - have not been signed or in case of non compliance with existing voluntary agreements.

6. Within June 30, 1999, on the basis of the work of the Committee for Sustainable Development:

6.1 The Minister of the Environment, in agreement with the Ministers of Industry, Agriculture, Public Works, University and Scientific and Technological Research, Finance, the Treasury, Foreign Trade, and Foreign Affairs, having heard the Unified Conference, identifies criteria and measures to support the activities to be developed in the frame of "Joint Implementation" and "Clean Development Mechanism", and particularly, it establishes:

a) the modes by which the Italian Representatives at the countries that signed the Kyoto Protocol, at the United Nations and at the multi-lateral financial institutions, will promote and assist the Italian co-operation programs in the frame of the Kyoto Protocol flexible mechanisms, enhancing the greenhouse gas emissions reduction effects resulting from the economic and industrial co-operation programs. To this purpose, the Ministry of Foreign Affairs issues the proper directives to the above mentioned Italian Representative Offices;
b) the measures to support the enterprises participating in the international co-operation programs, in the frame of the Kyoto Protocol Mechanisms, on the basis of voluntary agreements with the Public Administrations;
c) the creation of a Secretariat for the "Flexible Mechanisms of the Kyoto Protocol" with the co-operation of the Ministries of the Environment, Industry, the Treasury, Foreign Affairs, to promote projects to be implemented in the frame of voluntary agreements between enterprises and Public Administrations.

6.2 The Minister of the Treasury, in agreement with the Ministers of Finance, Industry, the Environment, and Foreign Trade, having heard the Unified Conference, in the frame of the "Emission Trading" Mechanism adopted by the Kyoto Protocol, establishes the procedures to trade emission permits and indicates the modes by which the above mentioned Secretariat certifies the transactions.

7. Within December 31, 1999 the Ministry of the Environment, on the basis of the proposals suggested by the Committee for Sustainable Development, will submit to CIPE and the Unified Conference a report on the implementation of this deliberation. The report will give evidence of the implementation of planned measures and programs and it will indicate, as much as possible, the modes of application of the reduction measures at regional level.

Annexe 5: Bibliography

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