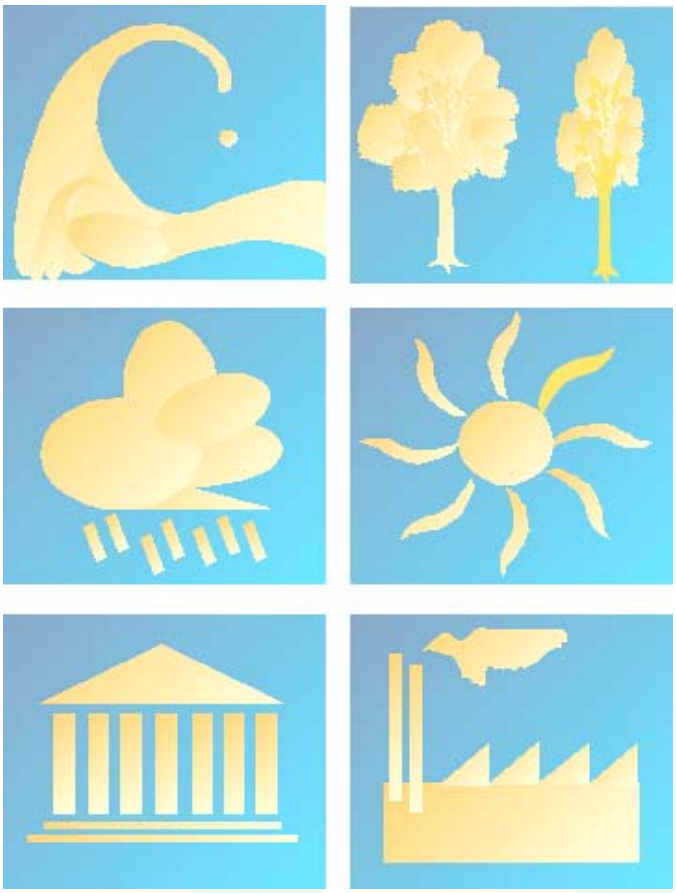
HELLENIC REPUBLIC

MINISTRY FOR THE ENVIRONMENT, PHYSICAL PLANNING AND PUBLIC WORKS

4th NATIONAL COMMUNICATION TO THE UNITED NATIONS FRAMEWORK CONVENTION ON

CLIMATE CHANGE



ATHENS
MARCH 2006

FOREWORD

ES

EXECUTIVE SUMMARY

ES.1 National Circumstances

ES.1.1 Government structure

The Constitution of 1975, as revised in 1986 and in 2001, defines the political system of Greece as a parliamentary democracy with the president being the head of state.

At the top administrative level is the national government, with ministers appointed by the prime minister. The ministries mainly prepare and implement national laws. The Ministry for the Environment, Physical Planning and Public Works (MEPPPW) is the main governmental body concerned with the development and implementation of environmental policy in Greece, while other Ministries are responsible for integrating environmental policy targets including the application of the measures identified in the *National Programme on Climate Change, 2000 – 2010* within their respective fields. The Council of Ministers is responsible for the final approval of policies and measures related to Climate Change.

ES.1.2 Population

In 2004, the total population of Greece (as estimated in the middle of the year) was approximately 11.05 million inhabitants, according to the data provided by the National Statistical Service of Greece. According to the Census of March 2001, the total population of the country was approximately 10.96 million. The total population increased by 6.8% compared to the 1991 Census results, with 35% of total population living in the greater Athens area. The average size of households is continuously decreased (2.80 persons per household according to the Census of 2001) while population density (84 inhabitants/km^2) is one of the lowest in the European Union (EU).

ES.1.3 Geographic and climate profile

Greece has a total area of 131.957 km^2 and occupies the southernmost extension of the Balkan Peninsula. The mainland accounts for 80% of the land area, with the remaining 20% divided among nearly 3000 islands. The Greek landscape, with its extensive coastline, exceeding 15,000 km in length, is closely linked with the sea, since only a small region in the northwest is further than 80 km from the sea. Approximately 25% of it is lowland, particularly the coastal plains along the seashore of the country.

Forest land covers 19% of the total area of the country. Coniferous forests represent 38% of forest land while the rest 62% is covered by broadleaves forests. Other wooded land represents 25% of the total area of Greece. Grassland (13% of the total area of the country) together with other wooded land is mainly used for grazing. Agricultural land (including fallow land) account for 29% of the total area while other uses, including in areas occupied by brushwood, alpine areas and internal waterways, account for 8% of the total area,. Uncultivated and deserted land makes up the remaining 6%.

Greece has a Mediterranean climate, with mild and wet winters in the southern lowland and island regions and cold winters with strong snowfalls in the mountainous areas in the central and northern regions and hot, dry summers. The mean temperature during summer is approximately 28°C in Athens and southern Greece, while lower in the north. Generally, temperatures are higher in the southern part of the country. Except for a few thunderstorms, rainfall is rare from June to August, where sunny and dry days are mainly observed. The dry, hot weather is often relieved by a system of seasonal breezes.

The mean annual temperature for the period 1991 – 2000, as measured at selected meteorological stations of the country, is higher in most of the stations compared to the mean annual temperature of the period 1981 – 1990.

ES.1.5 Economic profile

In January 1st, 2001, Greece became the 12th member of the Economic and Monetary Union in EU. After the accession, the Greek economy was developed with high rates, while its capacity to cope with structural problems both in public and in private sector were increased. Despite the high growth rates, certain macroeconomic indicators were not improved accordingly. The increase of employment was minor, while unemployment rate and inflation remained at the higher end within EU member states.

Since 1994, the Geek economy has presented a high growth rate, well above the average growth rates in the EU. More specific, for the period 1995 – 2004 the growth rate of the Greek economy was 3.9% while the growth rate of the EU economy was 2.3% (25 member states) and 2.2% (15 member states). Positive developments were also observed in other macroeconomic indicators as the private consumption and the gross value added. The average annual growth rate of the private consumption for the period 1990 – 2004 is estimated at 2.6%, while the average annual increase of gross value added is estimated at 2.9% for the same period.

ES.1.6 Transportation

Economic development and improved living standards have a significant effect on the ownership of passenger cars. The number of passenger cars in 1994 was almost 10 times higher compared to the number of passenger cars in 1970, while similar trends are also observed for the number of trucks, buses and motorcycles. For the time period 1990 – 2003, the number of passenger cars, trucks and motorcycles, increased continuously. In 1990, the number of passenger cars was 1.7 million cars (1 car for every 6 inhabitants), while in 2003 this figure reached 3.8 million cars. Despite these drastic changes, Greece still has one of the lowest ownership rates in EU-25. Since 1995 the number of advanced technology catalytic passenger cars is constantly increasing, while the number of medium and large size passenger cars almost doubled from 1990 to 2003. In 2003, of the vehicles that were operated for the first time, 90% were new and the rest 10% were used. For the same year, passenger cars represented 64% of total motor vehicles in operation, trucks 19%, motorcycles 16%, taxies 0.7% and buses 0.3%

The Greek maritime fleet is one of the largest in the world, and in 2002, according to the data of the Ministry of Mercantile Marine, it comprised of 3480 vessels (939 fly the Greek flag and 2541 fly

foreign flags) of a total dead-weight tonnage of approximately 98.2 GRT, that represent the 15.5% of world shipping capacity. In 2003, sea transport of passengers increased by approximately 64%, compared to 1991, while sea transport of goods increased by 57%.

Railways cover a small part of transportation activity in Greece. On the contrary, air traffic presents an average annual increase of 4.7% for the period 1990 – 2003 while the number of passengers increased by approximately 4% in the same period.

ES.1.7 Energy system

The total gross inland consumption in Greece increased continuously during the time period 1990 – 2003, with the exception of the year 1993. In 2003, gross inland consumption reached a total of approximately 30.5 Mtoe, representing an increase of approximately 35% compared to 1990 levels. However, the average annual growth rate of increase during the period 1990 - 2003 (2.4%) is lower compared to the rate of increase recorded in the 1980s (3.3%).

During the period 1990-2003, the consumption of oil and coal products have retained a high share (88% - 95%), while the only significant change in the Greek energy system in the last decade was the introduction of natural gas in 1997, which represents 7% of gross inland consumption in 2003.

The contribution of renewable energy sources (RES) to gross inland consumption, including large hydro, varies from 4.6% to 5.6% according to the fluctuations of the production of large hydropower plants. Excluding large hydro, the share of renewable energy sources is about 4% for the period 1990 - 2003. The exploitation of renewable energy sources (excluding hydro) is related with the use of biomass for space heating in the domestic sector, the use of solar energy for water heating mainly in the domestic sector and the wind energy for electricity production.

The electricity-generation system in Greece consists of thermal and hydroelectric units as well as a small, though increasing, percentage of other renewable energy sources. In 2004, the total installed capacity of the Public Power Corporation (PPC) generating system was 12.2 GW which corresponds to an increase of approximately 40% compared to 1990 levels, while the net electrical capacity of auto producers in 2004 was 257 MW. Electricity generation increased continuously with an average annual rate of approximately 4% for the period 1990-2003. Gross electricity production in 2003 totalled 58.2 TWh, of which 60% and 15% came from the combustion of coal and petroleum products, respectively, 9% from hydropower, 15% from natural gas and 1% from other (except large hydro) renewable energy sources (mainly from wind energy)

In 2003, final energy consumption in Greece totalled 23.1 Mtoe. Energy consumption in industry accounted for 29% of final energy consumption (including consumption of the energy sector). The share of transport in final energy consumption is estimated at 35% in 2003, while the share of residential and tertiary sector was 36%. The average annual rate of increase for the period 1990-2003 is estimated at 2.7%. The per capita final energy consumption has increased by 30% from 1990 to 2003 (1.61 and 2.09 toe/cap respectively).

All three sectors increased their energy use from 1990 to 2003, with the residential and tertiary sector showing the highest increase (by 75% in 2003 compared to 1990), followed by transportation (34%) and industry (18%). This resulted in a total increase of 41% between 1990 and 2003.

ES.1.8 Waste

Over the period 1990 – 2003, waste generation presented a continuous increase. Solid waste generated quantities increased from 3.1 Mt in 1990 to 5.2 Mt in 2003, while the per capita solid waste generation increased from 0.82 kg/person/day in 1990 to 1.19 kg/person/day in 2003, remaining however below the EU average (EU-15). The share of solid waste disposed in managed solid waste disposal sites (SWDS) has been noticeably increased since 1999 due to the construction of new SWDS, in the framework of the integrated national plan of solid waste disposal on land, developed according to the requirements of the Directive of the European Union 91/156/EEC.

The amount of recycled wastes does not present a remarkable increase during the last decade, while the percentage of municipal solid wastes recycled has decreased from 9.4% in 1990, to 6.2% in 2003. Biogas recovery and flaring installations operate in 4 large SWDS in Greece (Athens, Thessalonica, Larissa, Patra), which accept 87% of the waste disposed to SWDS.

The number of wastewater handling facilities under aerobic conditions has increased considerably since 1999. The percentage of population that is served by aerobic wastewater handling facilities increased from 32% in 1999 to 75% in 2002, in accordance with the targets set by the Directive 91/271/EEC concerning the collection, treatment and disposal of domestic wastewater.

ES.2 Greenhouse gas inventory information

ES.2.1 Emissions / Removals of GHG in Greece for the period 1990 – 2003

Emissions estimates were calculated according to the CORINAIR methodology, the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and the IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry. It is noted that base year emissions are calculated using 1990 as the base year for carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), and 1995 for fluorinated gases (F-gases: Hydrofluorocarbons, HFC / Perfluorocarbons, PFC / Sulphur hexafluoride, SF_6).

An overview of GHG emissions for the period 1990 – 2003 is presented In the **Table ES.1**, while emissions/removals per sector are presented in **Table ES.2**.

Table ES.1 Total GHG emissions in Greece (in Mt CO_2 eq) for the period 1990-2003

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
A. GHG emissions per gas (without LULUCF)														
CO_2	84.02	83.74	84.68	85.29	87.20	87.34	89.55	94.29	98.86	98.24	104.11	106.33	106.16	109.98
CH_4	10.01	10.00	10.13	10.22	10.45	10.57	10.76	10.83	11.11	10.39	10.35	10.05	10.12	10.17
N_2O	14.19	13.92	13.97	13.14	13.41	13.13	13.61	13.37	13.26	13.22	13.44	13.24	13.17	13.28
HFC	0.94	1.11	0.91	1.64	2.21	3.37	3.92	4.19	4.67	5.44	4.27	3.87	4.01	4.14
PFC	0.26	0.26	0.25	0.15	0.09	0.08	0.07	0.17	0.20	0.13	0.15	0.09	0.09	0.08
SF_6	Not estimated[1]													
Total	**109.42**	**109.02**	**109.94**	**110.44**	**113.36**	**114.49**	**117.90**	**122.85**	**128.10**	**127.42**	**132.32**	**133.58**	**133.55**	**137.64**
Index (B.Y.=100)	98.0	97.6	98.5	98.9	101.5	102.5	105.6	110.0	114.7	114.1	118.5	119.6	119.6	123.3
B. Emissions / Removals of GHG from LULUCF														
CO_2	-3.25	-3.60	-3.07	-3.88	-3.55	-4.41	-3.99	-3.96	-3.59	-4.44	-3.14	-5.32	-5.46	-5.53
CH_4	0.05	0.03	0.08	0.07	0.06	0.03	0.02	0.05	0.13	0.01	0.17	0.02	0.00	0.00
N_2O	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.00	0.00
Total	**-3.19**	**-3.57**	**-2.99**	**-3.81**	**-3.48**	**-4.37**	**-3.97**	**-3.91**	**-3.45**	**-4.43**	**-2.96**	**-5.30**	**-5.46**	**-5.53**

[1] SF_6 emissions are not estimated. According to information from the Public Power Corporation, fugitive emissions from the use of SF_6 were 0.23 kt CO_2 eq during the last 20 years. However, according to data presented by the Ministry for Development during the in-depth review of the 3rd National Communication (November 2004) SF_6 emissions, for the first semester of 2004, were estimated at 1.74 kt CO_2 eq. At the moment, this inconsistency has not been resolved and as a result no emission estimates are reported

Table ES.2 Total GHG emissions (in Mt CO_2 eq) by sector for the years 1990-2003

Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Energy	81.70	81.52	82.66	82.91	84.93	84.63	87.04	91.62	96.60	95.71	101.61	103.87	103.85	107.72
Industrial processes	8.67	8.65	8.53	9.31	9.79	11.40	12.01	12.59	12.80	13.64	12.81	12.36	12.40	12.58
Solvents	0.17	0.18	0.17	0.17	0.16	0.15	0.15	0.15	0.15	0.16	0.15	0.15	0.16	0.16
Agriculture	13.51	13.31	13.10	12.50	12.74	12.49	12.78	12.48	12.34	12.36	12.33	12.12	12.06	12.00
Waste	5.36	5.36	5.48	5.55	5.74	5.81	5.93	6.01	6.20	5.55	5.43	5.09	5.08	5.18
Total	**109.42**	**109.02**	**109.94**	**110.44**	**113.36**	**114.49**	**117.90**	**122.85**	**128.10**	**127.42**	**132.32**	**133.58**	**133.55**	**137.64**
Change (1990=100)	100.0	99.6	100.5	100.9	103.6	104.6	107.8	112.3	117.1	116.5	120.9	122.1	122.1	125.8
LULUCF	**-3.19**	**-3.57**	**-2.99**	**-3.81**	**-3.48**	**-4.37**	**-3.97**	**-3.91**	**-3.45**	**-4.43**	**-2.96**	**-5.30**	**-5.46**	**-5.53**

Base year GHG emissions for Greece (1990 for CO_2, CH_4, and N_2O - 1995 for F-gases) were estimated at 111.67 Mt CO_2 eq. Given that LULUCF was a net sink of GHG emissions in 1990 (and for the rest of the reporting period) the relevant emissions / removals are not considered in estimating base year emissions for Greece.

In 2003, GHG emissions (without LULUCF) amounted to 137.64 Mt CO_2 eq showing an increase of 23% compared to base year emissions and of 26% compared to 1990 levels. If emissions / removals from LULUCF were included then the increase would be 24% (from 106.22 Mt CO_2 eq in 1990 to 132.11 Mt CO_2 eq in 2003).

Carbon dioxide emissions accounted for 80% of total GHG emissions in 2003 (without LULUCF) and increased by approximately 31% from 1990. Nitrous oxide emissions accounted for 10% of total GHG emissions in 2003 and decreased by 6% from 1990, while methane emissions accounted for 7% of the total GHG emissions in 2003 and increased by 2% from 1990. Finally, F-gases emissions that accounted for 3% of total GHG emissions, increased by 23% from 1995 (base year for F-gases) or by more than four times compared to 1990 levels.

GHG emissions trends (excluding LULUCF) are mainly driven by economic development as presented in **Figure ES.1**. Moreover, and given the fact that energy is the main source of GHG emissions, emissions and energy consumption follow the same pattern. On the contrary, the impact of population increase to GHG emissions is minor.

The main parameters affecting GHG emissions trends per sector are presented in the next paragraph. A basic conclusion resulting from Figure ES.1 is that since 2000 a decoupling of GHG emissions from economic development is observed as the growth rate of GHG emissions for the period 1990 – 2003 (approximately 2.1%) is lower from both the growth rate of gross inland energy consumption (approximately 2.4% for the same period) and the GDP growth rate (approximately 2.8%).

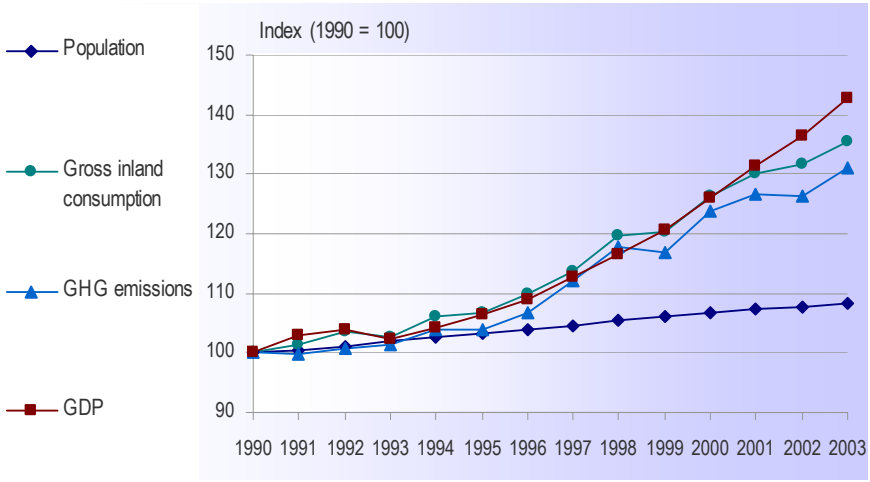


Figure ES.1 Factors underlying GHG emissions trends

ES.2.2 National System for the GHG emissions/removals inventory

The Ministry for the Environment, Physical Planning and Public Works (MEPPPW) is the governmental body responsible for the development and implementation of environmental policy in Greece, as well as for the provision of information concerning the state of the environment in Greece in compliance with relevant requirements defined in international conventions, protocols and agreements. Moreover, the Ministry for the Environment is responsible for the co-ordination of all ministries involved, as well as any relevant public or private organization, in relation to the implementation of the provisions of the Kyoto Protocol according to the Law 3017/2002 with which Greece ratified the Kyoto Protocol.

The Ministry for the Environment has designated, on a contract basis, the National Observatory of Athens (NOA) as the national institution that has the overall technical responsibility for the compilation of the annual national inventory. In this framework, NOA is responsible for the choice of methodologies, data collection (activity data and emission factors, provided by statistical services and other organizations), data processing and archiving, as well as the implementation of general quality control procedures.

The activities that are related with the planning, implementation and management of the inventory of emissions/removals are covered by an integrated QA/QC system that is being implemented since April 2004. The system is based on the ISO 9001:2000 standard.

ES.3 Policies and Measures

ES.3.1 Policy-making process

The Ministry for the Environment, Physical Planning and Public Works (MEPPPW) is the main governmental body entrusted with the development and implementation of environmental policy in Greece. MEPPPW is responsible, among others, for the formulation of policies concerning environmental protection, for the coordination of implementation efforts and to ensure compliance with the current legislative framework. For this purpose, MEPPPW cooperates both with other competent ministries and with regional, prefectural and local authorities.

Climate change mitigation is one of the main targets identified in the Greek policy for sustainable development launched by MEPPPW in 2002. The objective of the strategy is the development of a set of principles for the formulation of an action plan in line with international challenges, and in accordance with EU policy directions and adjusted to the specific national circumstances.

Policies and measures, as well as all other issues and actions regarding mitigation are discussed within the framework of an inter-ministerial committee, while the Ministerial Council is responsible for the final approval of policies and measures related to climate change.

Greece ratified the Kyoto Protocol in 2002 (Law 3017/2002) and adopted a National Programme (MEPPPW / NOA 2002) for achieving the commitment under the Kyoto Protocol of limiting GHG emissions increase the period 2008 – 2012 to +25% compared to base year emissions (1990 for CO_2, CH_4 and N_2O emissions – 1995 for F - gases) by a decision of the Council of Ministers (DCM5/2003). By Law 3017/2002 the MEPPPW is designated as the governmental body responsible for the coordination, within its responsibilities, of all other competent ministries and possibly any other public and / or private entities involved, for (a) the implementation of the provisions of the Kyoto Protocol and (b) the formulation and monitoring of the National Programme for achieving the national targets set under the Kyoto Protocol.

Moreover, with this law it is defined that all issues related to the implementation of the provisions of the Kyoto Protocol, including among others, the establishment of the necessary administrative structures and procedures, enforcement rules, etc. are specified with Common Ministerial Decisions of the Minister for the Environment, Physical Planning and Public Works and the competent, as appropriate, Ministers. The same enforcement procedure will be followed in order to introduce into the national legislation any decisions of the COP and/or COP/MOP or any necessary modifications to the National Programme.

ES.3.2 Results of policies and measures

The most important supporting policies related with the implementation of measures for the restriction of GHG emissions in Greece are:

- The **2nd National Climate Change Programme**, that was elaborated and adopted in 2002 (Act of the Ministerial Council 5/27.02.2003, Official Journal of the Hellenic Republic A' 58 – 05.03.2003) defines the additional policies and measures necessary for Greece to meet its

Kyoto target, i.e., restricting the increase of GHG emissions to 25% over the time period 2008–2012, compared to base year emissions

- The **European emissions trading scheme** (Directive 2003/87/EC) the operation of which started in 2005. In Greece, the trading system comprises 141 existing industrial installations and 27 new installations that are expected to start their operation during the period 2005-2007 (new entrants). An allowance reserve is also created which is intended to cover possible unknown new entrants in the period. According to the data presented in the National Allocation Plan (NAP), total CO_2 emissions from installations included in the EU-ETS are estimated at 228.1 Mt CO_2, for the three-year period 2005-2007, while the allowances that will be allocated during the same period were fixed at 223.3 Mt CO_2 (namely a decrease of emissions by 2.1% is required by the enterprises that participate in the system).
- The **financing mechanisms that** have been put in place in the context of the **3rd Community Support Framework (**operational programs "Competitiveness" and "Environment") for the promotion of investments which among others contribute also to the restriction of GHG emissions.

The total realistic GHG emissions reduction potential from the implemented and adopted policies and measures was calculated at 28.3 Mt CO_2eq for 2010, and at 37.6 Mt CO_2eq for 2015, if possible interferences between these implemented/adopted measures, which may restrict the estimated GHG emissions reduction potential, are excluded.

Respectively, the total GHG emissions reduction potential for the planned policies and measures was estimated at 11.1 Mt CO_2eq for 2010 and at 16.4 Mt CO_2eq for 2015, also without taking into account the possible interferences between them. Planned measures have been identified in the context of the 2nd National Climate Change Program (2000-2010), with a view to ensure compliance with the target set in the framework of the Kyoto Protocol for Greece. The estimation for the emissions reduction potential in the time horizon of 2015 has been based on specific assumptions concerning further penetration/implementation of the planned policies and measures, taking into account the dynamics that will develop from the fulfilment of the targets of the 1st Commitment Period of the Protocol.

ES.3.3 Flexible mechanisms

The 2nd National Climate Change Programme was developed in order to define the additional policies and measures necessary for Greece to meet its Kyoto target by means of domestic actions. Nevertheless, given the fact that at least some of the planned interventions have a significant cost while the implementation of others is delayed, the use of the flexible mechanisms defined in the Kyoto Protocol should not be excluded.

At the moment and since it is not clear whether and at what extent, the exploitation of flexible mechanisms for the fulfilment of the commitment under the Kyoto Protocol will be required, the national administration has not committed any resources that could be used for the acquisition of emissions credits. However at the level of individual enterprises participating in the EU emissions trading scheme, agreements for the purchase of emissions allowances which will contribute in the fulfilment of their obligations, already exist.

ES.3.4 Minimisation of adverse effects

The Kyoto Protocol aims at the implementation of effective policies and measures by Annex I Parties so as to prevent dangerous anthropogenic interference with the climate system, contributing thus in the minimisation of adverse effects of climate change on other Parties and especially developing countries. The Protocol has been designed to minimize the potential adverse effects that may be caused by the implementation of policies and measures adopted by Annex I Parties to specific sectors of economic activity, industrial sectors or other Parties to the Convention, including the adverse effects on the international trade, social, environmental and economic impacts in developing countries, etc.

The formulation of climate policy in Greece has taken into account the minimization of the adverse effects of emissions reduction policies and measures, according to Articles 4.8 and 4.9 of the Framework Convention on Climate Change.

ES.4 Projection of GHG emissions

According to the "with measures" scenario GHG emissions in the years 2010 and 2020 will be 34.7% and 49.4% above base year level (111.7 Mt CO_2 eq). It is noted that the contribution of *Land Use, Land Use Change and Forestry* is not included in the emissions projections.

According to "with measures" scenario, the energy sector accounts for approximately 74-80% of total GHG emissions (**Table ES.3**), while carbon dioxide emissions accounts for more than 75% of total emissions (**Table ES.4**). F-gases emissions are estimated to increase with a mean annual rate of more than 4 times higher compared with that of total emissions for the period 1990-2020 (6% for the f-gases compared to 1.4% for total emissions

Table ES.3 Projections of GHG emissions in the "with measures" scenario, disaggregated by sector, kt CO_2eq

Sources and Sink categories	1990	1995	2000	2005	2010	2015	2020
Energy	81704	84634	101611	112416	120326	127351	134674
of which transport	*15645*	*17317*	*19802*	*22587*	*24756*	*27398*	*29384*
Industrial processes	8670	11400	12810	12848	13910	15619	17188
Solvents	170	153	145	158	161	164	168
Agriculture	13514	12489	12330	12126	12265	12429	12606
Waste	5357	5811	5429	5328	3750	2608	2203
Total	**109415**	**114487**	**132324**	**142876**	**150413**	**158172**	**166839**
Land Use	-3193	-4369	-2959	-4702	-4773	-4509	-4264

Table ES.4 Projections of GHG emissions in the "with measures" scenario, disaggregated by gas, kt CO_2 eq

Gas	Base year	1990	1995	2000	2005	2010	2015	2020
Carbon dioxide	84021	84021	87344	104112	115021	122913	130044	137440
Methane	10011	10011	10565	10354	10280	9015	8048	7811
Nitrous oxide	14190	14190	13127	13436	13720	14042	14369	14732
HFC	3369	935	3369	4273	3779	4366	5635	6779
PFC	83	258	83	148	76	76	76	76
SF_6	Not estimated							
Total	**111675**	**109415**	**114487**	**132324**	**142876**	**150413**	**158172**	**166839**
Change from base year levels	*100.0*	*98.0*	*102.5*	*118.5*	*127.9*	*134.7*	*141.6*	*149.4*

It is clear that the fulfilment of the Kyoto Protocol commitments for Greece requires the implementation of additional policies and measures for reducing GHG emissions, which were worked out by the 2nd National Climate Change Program (March 2002). For this reason a "with additional measures" scenario was developed, which incorporates the planned policies and measures. The "with additional measures" scenario estimates that GHG emissions in Greece will increase at 24.9% in 2010 and at 27.4% in 2015 compared to base- year levels **(Table ES.5).**

For scenario development and projections two main model types / procedures have been used:

- Economic-technical model (ENPEP) for the energy sector (energy supply and use – fugitive emissions).
- Spreadsheet models for the non-energy sectors, in which future changes in activity data are mainly derived from statistical analysis while emission factors are derived from expert assessments based on the IPCC/CORINAIR methodology.

Table ES.5 Projections of GHG emissions in the "with measures" and the "with additional measures" scenario, disaggregated by sector, kt CO_2eq

Sources / Sinks	1990	1995	2000	2005	2010		2015	
				With measures	With measures	With additional measures	With measures	With additional measures
Energy	81704	84634	101611	112416	120326	110497	127351	113312
of which Transport	*15645*	*17317*	*19802*	*22587*	*24756*	*24147*	*27398*	*26329*
Industrial processes	8670	11400	12810	12848	13910	13192	15619	14083
Solvents	170	153	145	158	161	161	164	164
Agriculture	13514	12489	12330	12126	12265	12131	12429	12277
Waste	5357	5811	5429	5328	3750	3549	2608	2459
Total	**109415**	**114487**	**132324**	**142876**	**150413**	**139531**	**158172**	**142296**
Change from base-year levels	*98.0*	*102.5*	*118.5*	*127.9*	*134.7*	*124.9*	*141.6*	*127.4*

The main assumptions made for the projection of GHG emissions are presented in **Table ES.6.**

Table ES.6 Main assumptions in the "with measures" scenario

	Historic data			Projections				Average annual rate of increase			
	1990	1995	2000	2005	2010	2015	2020	2000-2005	2005-2010	2010-2015	2015-2020
Population (mio)	10157	10634	10917	11082	11261	11366	11377	0.30%	0.32%	0.19%	0.02%
Household size (cap/hh)	2.99	2.91	2.82	2.73	2.65	2.56	2.47	-0.62%	-0.64%	-0.66%	-0.69%
Households (thousands)	3397	3660	3873	4056	4257	4442	4602	0.93%	0.97%	0.86%	0.71%
GDP (bil. €$_{2000}$)	97.7	104.0	123.2	149.6	179.2	212.4	243.9	3.96%	3.67%	3.46%	2.81%
Gross Value Added (bil. €$_{2000}$)	92.8	96.1	112.0	135.8	161.1	189.6	216.7	3.92%	3.48%	3.31%	2.70%
primary sector	11.4	9.5	9.4	9.3	9.6	10.2	10.8	-0.08%	0.52%	1.21%	1.12%
industry	20.4	21.5	25.1	29.2	33.6	38.4	42.7	3.08%	2.84%	2.68%	2.17%
private services	18.6	20.4	23.3	27.0	32.1	38.7	46.3	2.97%	3.53%	3.81%	3.64%
public services	18.5	18.9	20.4	26.2	30.6	33.3	35.7	5.14%	3.18%	1.74%	1.39%
trade	24.0	25.8	33.8	44.0	55.2	69.0	81.1	5.41%	4.62%	4.55%	3.30%
International fuel prices											
Coal ($$_{2000}$/t)	63.1	50.0	33.8	39.5	37.2	36.5	37.4	3.2%	-1.2%	-0.3%	0.5%
Oil ($$_{2000}$/bbl)	27.3	21.2	27.0	32.0	23.5	25.2	26.8	3.5%	-6.0%	1.4%	1.3%
Natural Gas ($$_{2000}$/toe)	-	-	121.4	170.9	125.7	134.5	143.3	7.1%	-6.0%	1.4%	1.3%
Transport Activity											
passenger transport (bil. p-km)	84	101	128	160	193	225	250	4.56%	3.82%	3.12%	2.13%
freight transport(bil t-km)	18	23	27	32	38	44	49	3.46%	3.50%	2.98%	2.18%

ES.5 Vulnerability assessment, climate change impacts and adaptation measures

ES.5.1 Climate change impacts

(A) Current climate

The analysis of average annual temperatures shows that initially there has been a cooling period over the whole country. This period began in the middle of the'50s in Northern Greece and progressively extended also in the southern regions of the country where it started to be detected in the beginning of the'70s. The lowest average annual temperatures in Greece occurred in the decade of 1970 up to the beginning of 1980, due mainly to the very cold summers and autumns. However, during the last years of the '90s (while a little earlier in some meteorological stations), a progressive increase of temperature was observed, which in some cases this lead even to the inversion of negative trends which were registered in previous studies.

Concerning precipitation, the various studies covering the Greek territory seem to converge in that there has been definitely a reduction of precipitation during the second half of the 20th century. The trends are negative for all the periods examined, contrary to what happened in general in Europe, while they are in accordance with the general trend observed over the Mediterranean area.

In Greece, as it was also the case of Spain, the frequency of heat waves in the '90s was about three times higher than the one of the three previous decades. However, there are no signs of a similar reverse trend in the frequency of cold extremes. The data from both stations of Athens (NOA) and Corfu present statistical important increasing trends with respect to the duration of heat waves, during the summer period as well as on annual basis, while the occurrence of cooling waves during winter as well as on annual basis becomes much less frequent. The time series from the other stations do not show a certain trend or they show negative trends with respect to the duration of heat waves (e.g. Larissa and Methoni).

(B) Estimation of possible future climate change

The first systematic effort for the estimation of future climate change in Greece and in the broader Balkan region was carried out recently (2004-2005) by the research group "Climate, Weather, Water & Sustainability" of the National Observatory of Athens (NOA). The implementation of a regional climate model was selected, which allows for the supply of information and climate projections in a small geographical scale. This research effort constitutes the first attempt of Greek scientific institutions to carry out simulations of climate change in the long-term future. Specifically, the research group established and calibrated PRECIS, a regional climate model which was developed at Hadley Centre (Meteorological Office, UK) and is based on the latest version of the global climate model HadCM3. The experiments performed were the following:

- Climatic simulation for the period 1961-1990 (which internationally is considered as a reference period)
- Climatic simulation for the period 2070-2100 under the A2 scenario of IPCC
- Climatic simulation for the period 2070-2100 under the B2 scenario of IPCC

ES.5.2 Vulnerability assessment and adaptation measures

The estimation of climate change impacts in electricity generation (in the Greek interconnected system) and in agriculture is based on the results of the regional climate model PRECIS.

- On an annual basis the electric energy demand is expected to increase by approximately 3.6% – 5.5%, solely due to the change of meteorological conditions, under the A2 scenario and 3.5% – 5.3% for the B2 scenario compared to a reference scenario where the average climatic conditions of the period 1961-1990 prevail. On a seasonal basis, these changes are not uniform. During summer and especially during July and August there is a significant increase of electricity demand (due to the use of air-cooling devices) and varies between 13% and 22% for the scenarios examined. On the contrary, during winter the electricity demand decreases up to 7% due to the increased mean temperature predicted by PRECIS for the A2 and B2 scenarios of global GHG emissions.
- In order to estimate climate change impacts on agricultural species, the DSSAT 4 simulation model is applied, while other models are also used for cultivations that are presently not covered by DSSAT (e.g. vines). Preliminary results on the impacts of future climate on the production yields of maize show a significant decrease of the production yield of maize. This reduction is at the order of 42%-60% in Northern Greece, 35-47% in Western and Central Greece and 40-52% in Southern Greece.

An integrated study on national level for the estimation of the vulnerability of Greek coastal areas in climate change has not been carried out yet. Some research studies focus on some particular regions of the country, as for example the wetland Alyki Kitrous in the Delta of the river Axios (2003), the Kotihi lagoon (2003), and Kos (2002). Within the framework of the project "Fulfilment of national commitments under the UNFCCC and the Kyoto Protocol", the research group “Energy Planning and Sustainable Development” of NOA is in the progress of assessing climate change impacts in Greek coastal areas.

Regarding the management of water resources, in January 2003 a particularly important study concerning the management of water resources, namely the “Draft Programme for the Management of Water Resources in Greece” was completed. The study was carried out by the Ministry for Development, in collaboration with the National Technical University of Athens (NTUA), the Institute of Geology & Mineral Exploration (IGME) and the Centre for Planning and Economic Research (KEPE). In addition, an important project was the development of the “National Bank of Hydrologic and Meteorological Information”, the implementation of which was assigned by the MEPPPW to the National Technical University of Athens (NTUA).

Desertification constitutes a complex phenomenon, resulting from the extreme degradation of soil and water resources in a region. Necessary actions for dealing with this problem, as foreseen by the National Action Plan for Combating Desertification (2001) and the relevant Common Ministerial Decision for its implementation (Common Ministerial Decision 996005/31719), are integrated within the general national development program and specifically for endangered regions. The National Action Plan sets as an objective to combat efficiently the desertification trends in the 35% of the whole Greek territory that is under direct threat and to prevent the desertification process in the 60% of the national territory.

ES.6 Financial Resources and transfer of technology

Greece contributed 1,531,700,000 Greek drachmas to the second GEF Replenishment in 1997 which covered the period 1/7/1998 – 30/6/2002. In the third GEF Replenishment in 2002, covering for the period 1/7/2002 – 30/6/2006, Greece committed to a total contribution of 5.73 million €. The Greek contribution is submitted in four annual payments.

In addition, Greece contributes financially to various international organizations which play an important role in the promotion of sustainable development. This contribution is given by means of regular payments for the support for specific projects or programmes. Funding supplied to these institutions totalled ***73 million €*** **(Table ES.7)** over the time period 2001 – 2005. Approximately 48.5% of this contribution refers to World Bank and the European Bank for Reconstruction and Development. However, the exact amount out of this contribution which is related to activities on climate change is unknown.

Table ES.7 Financial contribution of Greece to international organisations and programmes

Institution or Programme	Contributions (thousands €)				
	2001	2002	2003	2004	2005
World Bank	6242.1	7200.0	3700.0	3561.8	3660.8
Organization for Economic Co-operation and Development (OECD)	1232.6	1406.9	1122.5	719.4	1808.7
European Bank for Reconstruction and Development (EBRD)	2184.2	2328.8	1828.8	1828.8	1828.8
United Nations Industrial Development Organization (UNIDO)	328.2	534.8	555.0	544.2	536.7
United Nations Development Programme UNDP)	205.4	293.5	293.5	293.5	293.5
UNFCCC [1]	48.7	95.8	95.8	95.8	109.9
Black Sea Trade and Development Bank (BSTDB)	6712.6	6423.5	5231.9	4850.5	4718.9

[1] These credits are reported in thousands $, and for the year 2005 the national contribution within the framework of the Kyoto Protocol is included

The total support provided by Greece to developing countries for the implementation of actions related to the mitigation and/or adaptation to climate change (bilateral programs), amounts at approximately ***3 million $.***

ES.7 Research and systematic observation

ES.7.1 Research

Research in Greece is carried out at Research Centres, Universities, and to some extent in industry. It is funded through public funds and grants provided by the Greek government and the European Commission and through private funds from industry, foundations and other enterprises. In 2001, according to the latest official data available, the overall amount spent on research was 0.64% of the GDP, of which 0.43% came from Greek state funds and the remaining 0.21% from private funds.

Climate-related research is carried out in two of the national research centres, namely the National Observatory of Athens (NOA) and the National Centre for Marine Research (NCMR). In addition, the majority of Greek universities, as well as a small research group in the Academy of Athens carry out meteorological and climatological research that covers a wide range of research issues. Finally, the National Foundation for Agricultural Research of the Ministry of Rural Development and Food carries out some research on the impact of climate change to agricultural activities.

Within the framework of the 3rd Community Support Framework and in particular the Operational Programme "Competitiveness" of the Ministry for Development for the period 2000-2006, research projects on three activities related to environmental protection are in progress.

The first activity entitled "Natural Environment and Sustainable Development" has a total budget of 32,657,000 € (of which 69% comes from public funds) and supports research projects related to the promotion of technologies for the observation of marine environment, the rational management of coastal ecosystems and water resources, the reduction of atmospheric pollution and forest fires and recycling.

The second activity entitled "Renewable Energy Sources and Energy Conservation" has a total budget of 15,848,000 € (of which 50% comes from public funding) and supports projects which contribute to the reduction of cost and the improvement of the efficiency of Renewable Energy Sources (RES), to the optimal integration of RES in electricity networks, as well as to the development of new technologies and applications of energy conservation in buildings, industry and the transport sector.

The third activity named "Built Environment and Seismic Risk Management" has a total budget of 18,737,000 € (of which 65% comes from public funding) and focuses on projects for research and long-term technological development, aiming at the production of innovative products or services which contribute to sustainable development of the built environment and the mitigation of risks caused by seismic activity.

ΕΠ.7.2 Systematic observation

The network of systematic observation in Greece includes the Hellenic National Meteorological Service (HNMS), services of the Greek Armed Forces, the Ministry for the Environment, Physical Planning and Public Works, the Ministry for Rural Development and Food as well as a number of research centres. In addition, the Public Power Corporation operates a network of meteorological stations in the regions where thermal and hydro power plants are located and operate.

The National Observatory of Athens has recently installed a station in a remote location on top of Mount Helmos (2,350m above MSL) for the measurement of CO_2 and other greenhouse gases concentration as well as climatological parameters.

Greece is a member of EUMETSAT (EUropean organisation for the exploitation of METeorological SATellites), the consortium which operates the meteorological monitoring satellite METEOSAT. It is also a member of ECMWF (European Centre for Medium-range Weather Forecast) in which it provides human staff. In both these international efforts, Greece is represented by the HNMS.

ES.8 Education and public awareness

It is generally acknowledged that combating climate change will be a success only if the danger is widely known and understood by the public and especially by those who have to undertake mitigation measures. This can be accomplished with intensive education, awareness and training efforts at all levels. For this purpose, Greece has carried out a series of actions with respect to education and information. These actions concern in the planning and implementation of environmental education programmes, the establishment of new university departments dealing with environmental issues and the enlargement of the scientific content of many existing ones, the organization of training seminars for the dissemination of scientific knowledge in the public administration, private enterprises and social institutions and public awareness / information campaigns on climate change and environmental issues in general.

The planning and the implementation of those actions are accomplished by official governmental institutions (ministries and organizations), by non-governmental organisations (NGOs), by scientific and professional unions, etc.

Finally, the National Network for Environmental Information (NNEI) is an integrated information system for the registration and processing of information related to the state of the environment in local, regional and national level. The network is foreseen to stand as the main mechanism for the storage and management of all information on environmental issues which is of national importance.

A significant part of input data is available through the internet (http://hermes.edpp.gr/) where the environmental data are presented by means of a Geographical Information System (GIS).

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1 NATIONAL CIRCUMSTANCES

This chapter includes a short description of Greece's government structure, and geographical, climate, population, and economic profiles of the country. Emphasis is given in identifying those parameters related to national circumstances that affect greenhouse gases (GHG) describe more completely the national conditions which influence the national emissions/removals over time.

1.1 Government structure

The Constitution of 1975, as revised in 1986 and in 2001, defines the political system of Greece as a parliamentary democracy with the president being the head of state.

Legislative power is vested in the national parliament, which comprises 300 members, each elected by direct, secret, and universal ballot. The parliament's term is four years. The parliament deals with legislative work (i.e. the right to propose legislation lies within the parliament and the government), while it controls the government and national administration in general.

At the top administrative level is the national government, with ministers appointed by the prime minister. The ministries mainly prepare and implement national laws. At the next level are 13 administrative regions **(Figure 1.1),** each headed by a secretary general who is appointed by the Council of Ministers and who reports to the minister for the interior. The primary responsibility of the regional authorities is the development and implementation of regional economic-development plans. Such plans are financed by the Ministry of Economy and Finance. Below the 13 administrative regions, are 50 prefectures. Regional authorities coordinate the activities of the prefectures in its jurisdiction. A prefect directly elected for a four-year term, heads each of the 50 prefectures.

An additional administrative level, below the prefectures, comprises local authorities which according to the Constitution are independent in administrative level. There are 1033 municipalities and communities, 900 of which are municipalities (i.e. with population greater than 10,000 people). The local authorities are responsible for issues concerning licensing procedures for installations in urban areas and certain industrial units, planning and implementation on waste management, etc.

The Ministry for the Environment, Physical Planning and Public Works (MEPPPW) is the main governmental body concerned with the development and implementation of environmental policy in Greece, while other Ministries are responsible for integrating environmental policy targets including the application of the measures identified in the *National Programme on Climate Change, 2000 – 2010* within their respective fields. The Council of Ministers is responsible for the final approval of policies and measures related to Climate Change.

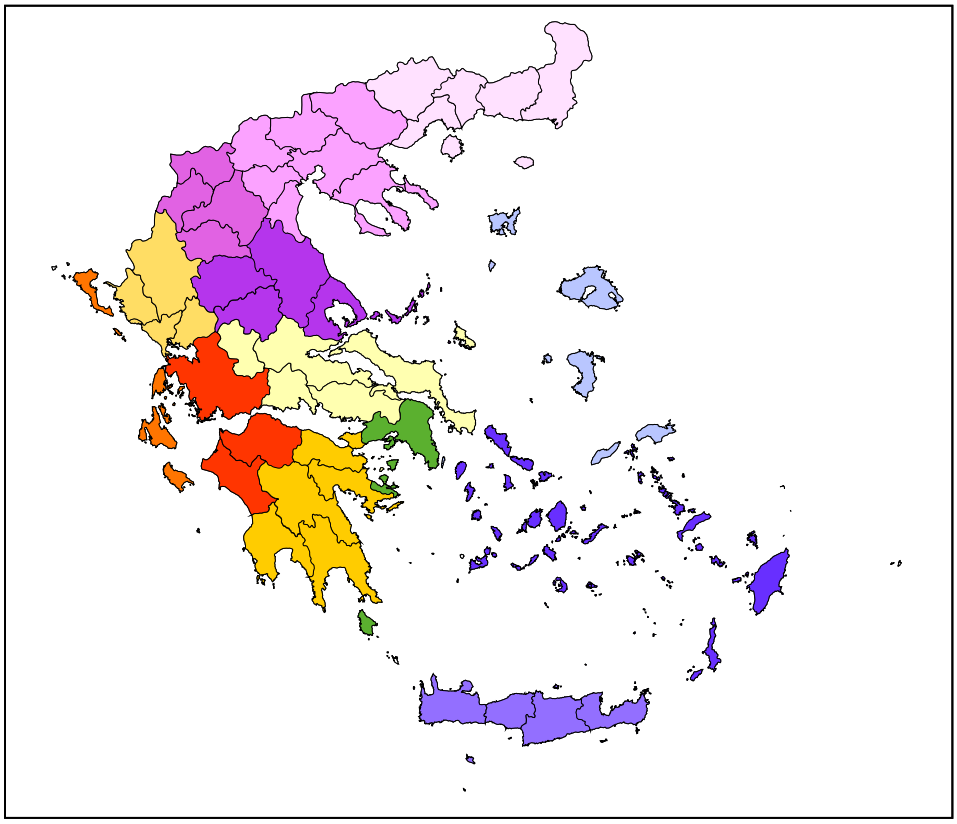


Figure 1.1 Major administrative regions of Greece

Policies and measures, as well as all other issues and actions regarding mitigation are discussed within the framework of an inter-ministerial committee, comprising representatives from the following ministries/organisations:

- Ministry for the Environment, Physical Planning and Public Works
- Ministry of Foreign Affairs
- Ministry of the Interior, Public Administration and Decentralisation
- Ministry of Economy and Finance
- Ministry for Development
- Ministry of Mercantile Marine
- Ministry of Transport and Communications
- Ministry of Rural Development and Food
- Public Power Corporation

This committee is responsible for the initial formulation of policy, as well as for the monitoring, evaluation and modification/completion of the National Programme on Climate Change.

1.2 Population

In 2004, the total population of Greece (as estimated in the middle of the year) was approximately 11.05 million inhabitants, according to the data provided by the National Statistical Service of Greece. According to the Census of March 2001, the total population of the country was approximately 10.96 million. The total population increased by 6.8% compared to the 1991 Census results, with 35% of total population living in the greater Athens area. According to the population census results, the average household size is continuously decreasing. The average household size decreased from 2.97 persons per household according to the 1991 population census to 2.80 persons per household according to the 2001 population census (**Figure 1.2**).

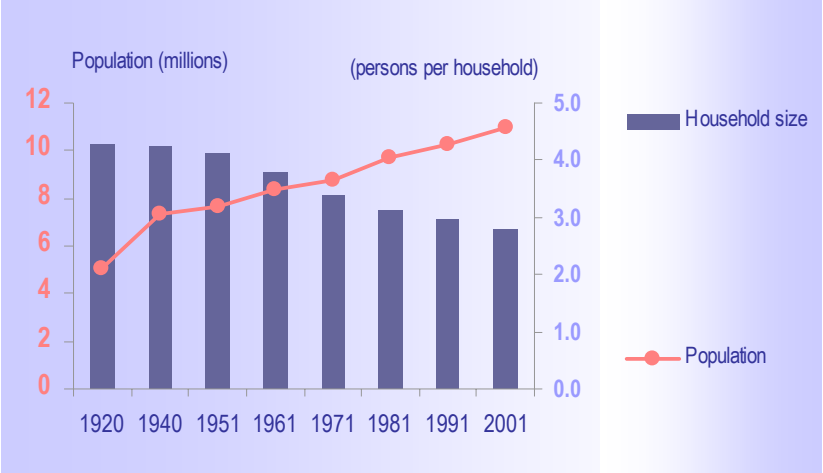


Figure 1.2 Population of Greece and average household size

Population density in Greece is estimated at 84 inhabitants/km^2, which is one of the lowest in the European Union (EU).

1.3 Geographic profile

Greece has a total area of 131.957 km^2 and occupies the southernmost extension of the Balkan Peninsula. The mainland accounts for 80% of the land area, with the remaining 20% divided among nearly 3000 islands. The Greek landscape, with its extensive coastline, exceeding 15,000 km in length, is closely linked with the sea, since only a small region in the northwest is further than 80 km from the sea. Approximately 25% of it is lowland, particularly the coastal plains along the seashore of the country.

1.3.1 Geomorphologic characteristics

Greece is a mountainous country, two thirds of which are largely covered by mountains of medium height. The great mountain masses run the length of the country from NNW to SSE (the Pindos complex, the Agrafa, Tymfristos, Panetolikon, Oiti, Vardousia, Parnassos, Giona in northern and

central Greece, and Panachaikon, Erymanthos, the Aroania mountains, Kyllene, Maenalon, Parnon, Taygetos in the Peloponnese) and divide it into two distinct climatic and phytogeographic regions. The mountain ranges of the east part of the country (Bermio, Pieria, Olympos, Ossa, Mavrovouni, Pelion) are directed from North to South. Finally the mountain ranges of Northern Greece (Voras, Tzena, Paiko, Beles, Angistro, Falakron mountains and the Rhodope range) run east-west, shielding the country from the cold north winds.

Greece presents a variety of rock formations. Geologically and petrologically the rocks of Greece can be divided into pre-Alpine, Alpine and post-Alpine formations. The pre-Alpine formations contain the crystalline schist rocks of the crystalline masses of Greece, and some small areas of sedimentary and igneous rocks. The Alpine and post-Alpine formations include the greater part of the sedimentary cover of Greece, as well as quite large igneous outcrops.

1.3.2 Ecosystems

The main floristic regions found in Greece are the Mediterranean, the European (Eurasian) and the Irano-Caspian. The Mediterranean flora is found in a zone of varying width along the coasts and on the islands of the Ionian and Aegean Seas. The width of this zone and the altitude to which it reaches decrease with increasing latitude. The Central European flora predominates on the mountains of Northern and Central Greece, gradually losing ground as we move south. Representatives of the Irano-Caspian flora, such as the oriental oak and others, are found in North-East Greece (Thrace) and on the islands of the North-East Aegean. In Crete representatives of the north-African flora are also found. Due to the geographical position and the coexistence of the above-mentioned flora regions, the flora of Greece is very rich, consisting of approximately 6,000 phanerogamous plants. Also, the country's mountainous nature and many islands favour conditions of isolation and endemism. As a result, significant proportion of plant species and subspecies (13%) are endemic.

The large climatic variation in Greece is expressed by the variation of vegetation zones (types) of the natural vegetation, ranging from the thermomediterranean formations of the Oleo-Ceratonion sub-type, such as the most Xerothermophilous ecosystems of the natural palm forest in Crete island (Vai), to the most psychrobious (cold resistant) formations of Mid-European type of Pinus sylvestris and Picea excelsa as in the area of Drama (Elatia). The limits of the five vegetation zones are often overlapped and the illustration on the map is not well defined. These zones are:

- Coastal, hill and sub-mountain zone with Mediterranean vegetation (Quercetalia ilicis).
- Sub-Mediterranean-Para-Mediterranean vegetation zone. Hill, sub-mountain, mountain (Quercetalia pubescentis).
- Zone of beech, beech-fir and mountain para-Mediterranean conifer forests (Fagetalia). Mountain-sub Alpine
- Zone of boreal conifers (Vacinio-Picetalia) Mountain, sub-Alpine
- Highland zone above the treeline, mountain Mediterranean, sub-Alpine and Alpine (Astragalo-Acantholimonetalia, Daphno-Festucetalia).

1.3.3 Land use

The various forms of land use in Greece in 2000 are presented in **Figure 1.3**.

Forest land covers 19% of the total area of the country. Coniferous forests represent 38% of forest land while the rest 62% is covered by broadleaves forests. Other wooded land represents 25% of the total area of Greece.

Grassland (13% of the total area of the country) together with other wooded land is mainly used for grazing. Agricultural land (including fallow land) account for 29% of the total area while other uses, including in areas occupied by brushwood, alpine areas and internal waterways, account for 8% of the total area,. Uncultivated and deserted land makes up the remaining 6%.

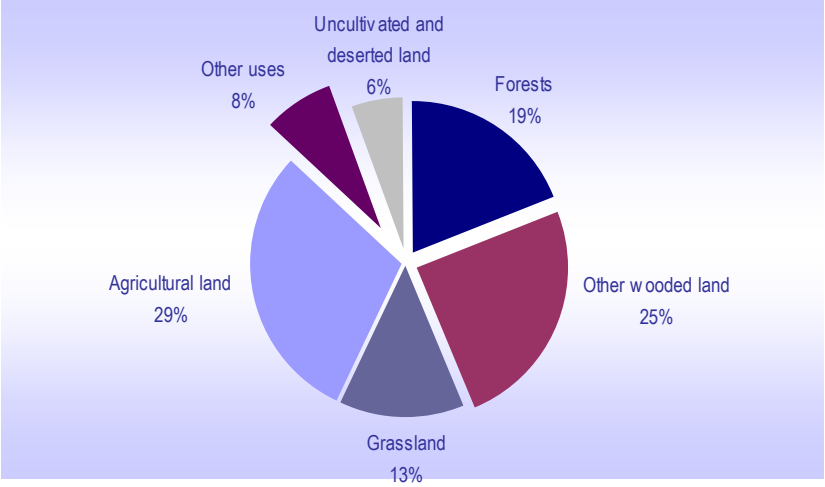


Figure 1.3 Distribution of the area of Greece by land cover category

1.4 Climate profile

Greece has a Mediterranean climate, with mild and wet winters in the southern lowland and island regions and cold winters with strong snowfalls in the mountainous areas in the central and northern regions and hot, dry summers. The mean temperature during summer is approximately 28°C in Athens and southern Greece, while lower in the north. Generally, temperatures are higher in the southern part of the country. Except for a few thunderstorms, rainfall is rare from June to August, where sunny and dry days are mainly observed. The dry, hot weather is often relieved by a system of seasonal breezes.

As shown in **Figure 1.4,** the mean annual temperature for the period 1991 – 2000, as measured at selected meteorological stations of the country, is higher in most of the stations compared to the mean annual temperature of the period 1981 – 1990.

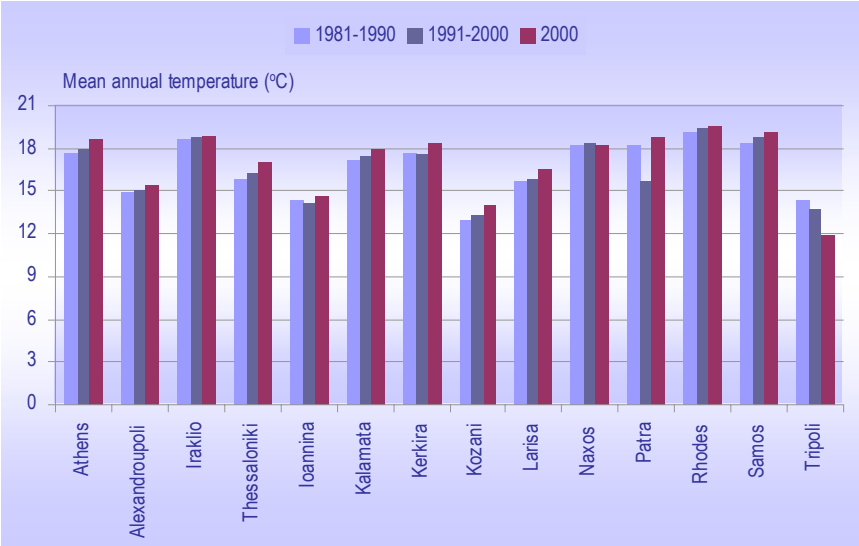


Figure 1.4 **Mean annual temperature (in ˚C) at selected meteorological stations for the periods 1981 – 1990 and 1991 – 2000 and for the year 2000**

Winters are mild in the south, much colder in the north. The average winter temperature in Athens and southern Greece is approximately 11°C, while lower in the north. January is generally the coldest month. Below-freezing temperatures and snow occur mainly in the mountains. Winters are mild in the lowlands with rare frost and snow. Rainfall occurs mostly between October and March. **Figure 1.5** presents the average annual precipitation (in mm) for the periods 1981 – 1990 and 1991 – 2000 as well as for the year 2000, as measured at selected meteorological stations of Greece.

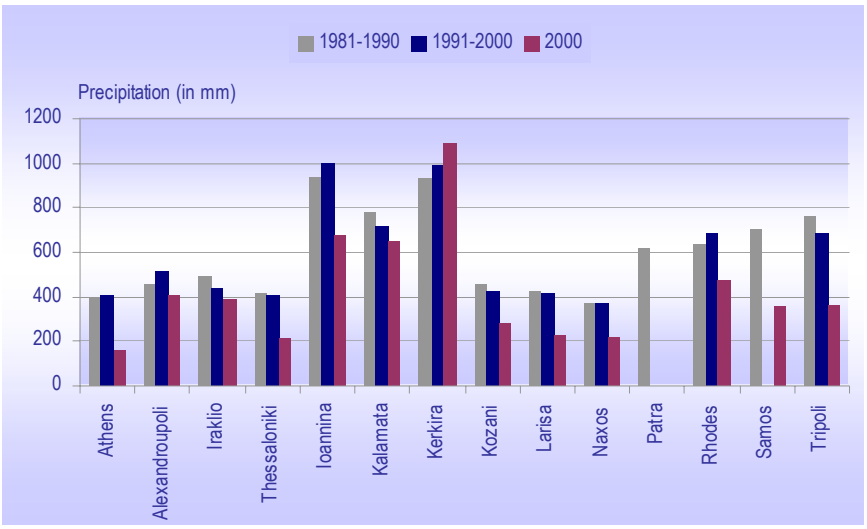


Figure 1.5 **Mean annual (1981 – 1990 and 1991 - 2000) and annual (for 2000) precipitation height (in mm) at selected meteorological stations**

1.5 Economic profile

In January 1st, 2001, Greece became the 12th member of the Economic and Monetary Union in EU. After the accession, the Greek economy was developed with high rates, while its capacity to cope with structural problems both in public and in private sector were increased. Despite the high growth rates, certain macroeconomic indicators were not improved accordingly. The increase of employment was minor, while unemployment rate and inflation remained at the higher end within EU member states.

The main objective of the governmental economic policy is to maintain the conditions of macroeconomic stability and to continue the strengthening of structural changes, so that Greece achieves real convergence with the other countries of the European Union.

1.5.1 General

The annual rate of increase of the Gross Domestic Product (GDP) during the period 1971–1980 was approximately 5.9% but dropped to 0.7% during the next decade. During the period 1990-2004, the annual rate of increase of the GDP (**Figure 1.6**) was in the order of 3%. The last year that the GDP decreased compared to the previous year was 1993 (GDP decreased by approximately 1.5%). Since 1994, the Geek economy has presented a high growth rate, well above the average growth rates in the EU. More specific, for the period 1995 – 2004 the growth rate of the Greek economy was 3.9% while the growth rate of the EU economy was 2.3% (25 member states) and 2.2% (15 member states).

Positive developments were also observed in other macroeconomic indicators as the private consumption and the gross value added (**Figure 1.6**). The average annual growth rate of the private consumption for the period 1990 – 2004 is estimated at 2.6%, while the average annual increase of gross value added is estimated at 2.9% for the same period.

Despite the high rate of economic development and the low rate of population increase (0.4% for the period 1995 – 2004) GDP per capita (15,140 € per capita in 2004, current values) is lower compared to EU average and corresponds to approximately 75% of the relevant EU figure (EU-15, in terms of Purchasing Power Parity, PPP).

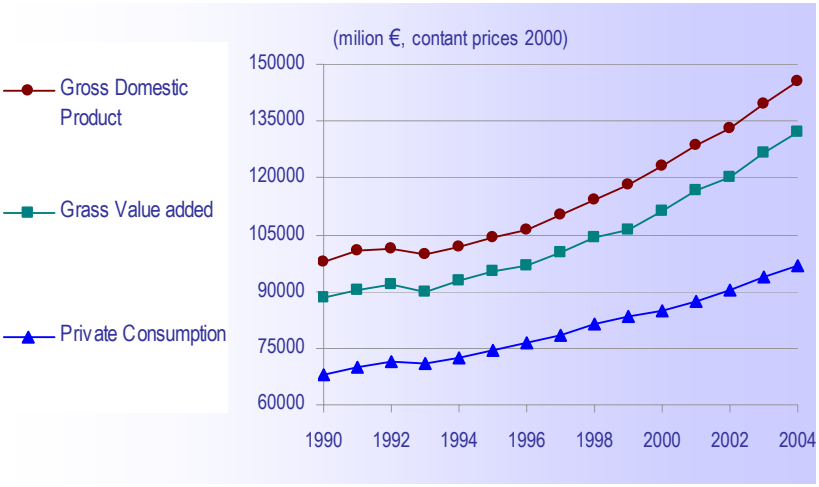


Figure 1.6 **Basic macroeconomic indicators of the Greek economy for the period 1990 - 2004**

The contribution of the primary, secondary (industry – construction) and tertiary sectors to the total gross value added is presented in **Figure 1.7.**

In 2004, the tertiary sector accounted for 72% of the total gross value added (69% in 1995). The contribution of the primary sector decreased during the period 1995-2004 (6% in 2004 compared to 9% in 1995), while the contribution of industry (including energy industry) decreased from 15% in 1995 to 13% in 2004. On the contrary, the contribution of the construction sector increased by approximately 1.5% from 1995 up to 2004.

With the exception the primary sector, the rest sectors of economic activity presented positive growth rates. The construction sector presented the highest average annual growth rate (approximately 6%) due to the significant infrastructure investments realised during this period and to a large extent were related to the organisation of the Olympic Games of 2004. The average annual rate of increase of gross value added in industry and in the tertiary sector, during the period 1995-2004, was 2.2% and 4.2% respectively. The gross value added of the primary sector in 2004 remained at 1995levels.

In 2003, the value of imports increased by 5% compared to the previous year (calculated at constant 1995 prices), while the value of imports in 2004 showed an increase by 9%. Exports showed a slight increase in 2003 compared to 2002 (approximately 1%), and increased by 12% in 2004. During the whole period 1990 – 2004 the exports – imports balance was negative. Finally, the characteristics of external trade (countries of destination and origin, products, etc.) have not been differentiated compared to those presented in the 3rd National Communication.

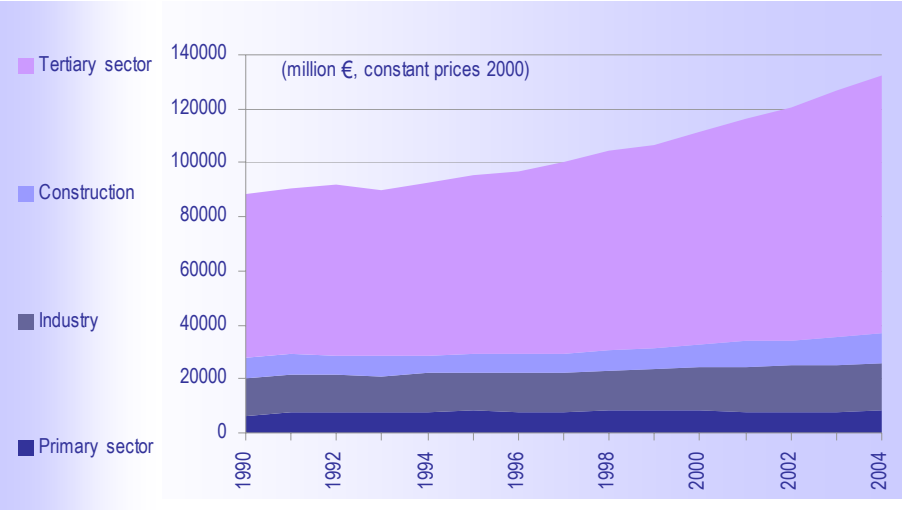


Figure 1.7 **Gross value added (in constant prices 2000) per economic sector for the period 1990 – 2004**

1.5.2 Primary sector

The contribution of the primary sector to the total gross value added decreased by 2.5% from 1995 to 2004. During the same period employment in the sector decreased by 20% and as a result employment in the primary sector accounts for 15% of total employment in 2004. The corresponding figure in 1995 was approximately 20%.

1.5.2.1 Agriculture

In 2003, the total area of agricultural land in Greece was approximately 3.8 Mha, more than half of which is on relatively steep slopes on which cultivation is carried out without protection against soil erosion. The area of agricultural land decreased by 5% in 2003 compared to 1990.

No significant changes took place since 2000 concerning fallow land, irrigated land **(Figure 1.8)** and the average area of agricultural holdings.

- The percentage of irrigated agricultural land has remained constant since 2000 (38%), while total irrigated land in 2003 increased by 22% compared to 1990.
- The majority of cultivated areas (76%) are holdings with an area less than 5 ha. Holdings with an area between 5 ha and 20 ha represent the 20% of cultivated areas and only the rest 4% of the cultivated area is distributed among holdings with an exceeding 20 ha.

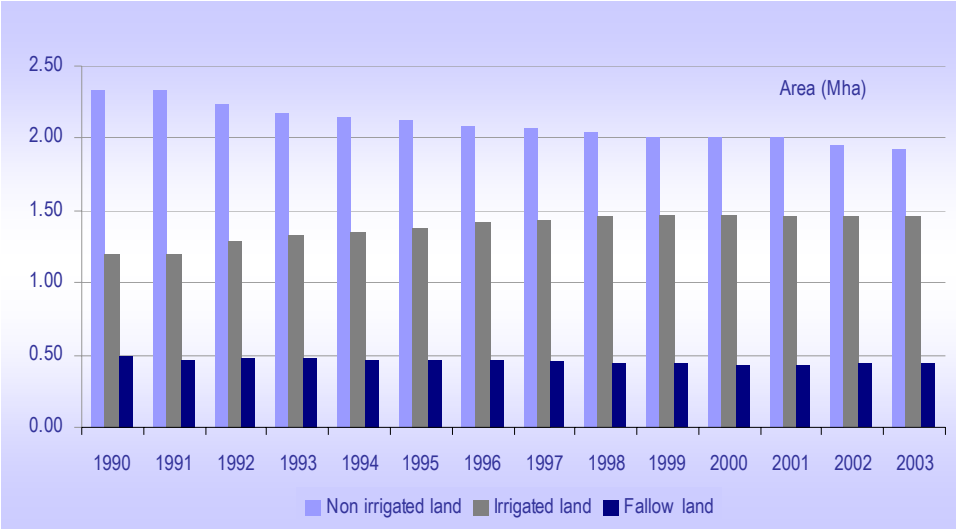


Figure 1.8 **Distribution of agricultural land in irrigated and non-irrigated and fallow land (in Mha) for the period 1990 – 2003**

Figure 1.9 presents the distribution of agricultural land (excluding fallow land) by basic categories of cultivation types for the year 2003. Arable cultivations account for 64% of the total agricultural land (excluding fallow land), while tree crops, vineyards and garden area represent the 29%, 4% and 3% respectively of the total agricultural land. Compared to 1990, the area of arable cultivations decreased by 2% while the area of tree crops increased by the same percentage.

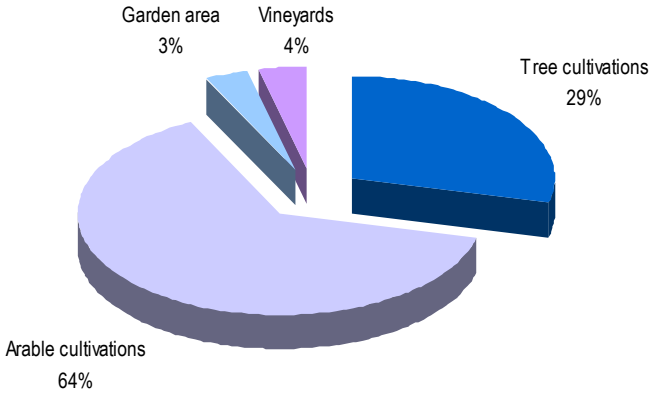


Figure 1.9 **Agricultural land by cultivation type for the year 2003**

Cereals for grain represent the most important cultivation in Greece (37% of total agricultural land in 2003 excluding fallows). The total cultivated area with cereals for grain was reduced since 1990 by 13%, while the production increased by 1.6%. In 2003 the production of corn, rice and oat increased by 15%, 60% and 31% respectively compared to 1990 levels, while the production of wheat, barley and rye decreased by 11%, 28% and 21% respectively.

The use of synthetic nitrogen fertilizers in 2003 decreased by approximately 42% compared to 1990, and as a result the amount of nitrogen applied to soils decreased from 0.1 t N/ha in 1990 to 0.08 t N/ha in 2003.

1.5.2.2 Livestock

In 2003, according to preliminary data from the National Statistical Service of Greece, livestock population amounted to approximately 48 million animals, of which: cattle 1%, sheep 19%, goats 12%, pigs 2% and hens and other poultry 66%. Livestock population increased by approximately 4.5% compared to 1990 levels, while the larger increases are observed in the number of poultry, sheep and goats (7%, 5% and 6% respectively). The total number of horses/mules/asses, rest poultry and pigs decreased by 50%, 24% and 6% respectively compared to 1990 levels (see **Table 1.1**).

Table 1.1 Number of animals (thousands) by species for the period 1990 – 2003

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Dairy cows	246	242	238	235	233	230	229	227	226	226	224	222	219	217
Rest cows	380	363	351	346	347	350	351	354	362	374	380	380	376	376
Buffaloes	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Sheep	8692	8673	8688	8725	8792	8856	8883	8904	8922	8958	8987	9020	9050	9083
Goats	5339	5345	5360	5395	5449	5513	5565	5595	5610	5623	5645	5677	5711	5744
Horses	46	42	40	38	36	35	33	32	31	30	29	27	26	25
Asses & Mules	187	174	161	150	140	130	122	114	108	104	98	92	85	79
Pigs	994	994	1000	1008	1005	997	993	995	990	986	969	966	967	964
Poultry	28747	28648	28972	29151	29231	29198	29266	29482	30005	30195	30856	31151	31453	31756

1.5.2.3 Forestry

According to the results of the First National Forest Inventory, the forests and other wooded land in Greece cover 6.5 Mha (49.3% of the area of Greece), of which 3.4 Mha are considered as productive forests. 40% of the productive forests area is covered by coniferous types and the rest is covered by broadleaved types. The remaining 3.1 Mha are considered as other wooded land. The area per forestry type as well as the volume and the density of the growing stock are presented in **Table 1.2.**

The majority of forest and other wooded land in Greece are located in the mountainous areas of the country. Forest management practices during the 20th century were focussed on the protection of soil and of water resources. However, the productivity of Greek forests is lower compared to European average values. This is due to the low density, quality and quantity of growing stock, a result of human induced activities of the past as wildfires, grazing, illegal felling, as well as the lack of systematic silvicultural treatment.

Table 1.2 Area and growing stock per forest type in Greek forests

Forest types	Area (ha)	Growing stock (volume overbark 1000 m³)	Density of growing stock (volume overbark m³/ha)
Conifers			
Abies sp.	543,308	47,406	87.25
Pinus halepensis & P. brutia	567,731	14,986	26.40
Pinus nigra	281,692	15,269	54.20
Pinus sylvestris	20,955	2,574	122.83
Pinus leucodermis	8,300	2,230	268.67
Picea abies	2,754	941	341.77
Broadleaves			
Quercus sp.	1,471,839	26,537	18.03
Fagus sp.	336,640	30,437	90.41
Platanus orientalis	86,579	2,116	24.44
Castanea vesca	33,081	1,862	56.29

The distribution of Greek forests according to ownership status **(Table 1.3)**, is the result of the interaction of historical, social, economic and political parameters. The high percentage of public forests and other wooded land (74.1%) is considered favourable, as it serves better the environmental and social role of forests.

Table 1.3 Distribution of forest and other forest areas per type of ownership

	Forests (1000 ha)	Percentage %	Other wooded land (1000 ha)	Percentage %	Total forest area (1000 ha)	Percentage %
State	2,200	65.5	2,626	83.3	4,826	74.1
Community	403	12.0	183	5.8	587	9.0
Private	269	8.0	154	4.9	423	6.5
Other	487	14.5	190	6.0	677	10.4
Total	**3,359**	**100.0**	**3,154**	**100.0**	**6,513**	**100.0**

Timber production coming from state and non state forests has fallen considerably during the last years – by 50% from 1990 to 2003. This reduction, that is sharper in fuelwood category than in commercial harvest, is due mainly to the substitution of wood as heating source by liquid fuels and electricity, the urbanization and the low competitiveness of Greek timber in the international market. Industrial roundwood accounts for 35% of the total timber production and is considerably lower than fuelwood. Sawlogs production is even smaller and accounts for 15%of the total yield.

Employment in the forestry sector refers to a total number of 26,000 employees, 4,000 of which are permanent staff and the rest are seasonally occupied personnel. Employment in the forestry sector decreased by approximately 30% during the last decade. Wood harvest represents the main activity by means of total employment in the sector.

Forestry is closely related to the economy of mountainous and semi-mountainous areas of the country. The contribution of forestry to GDP is low and decreased further over the last decade. The low contribution of the forest sector to the GDP is due to the fact that the forests of the country are of low productivity and their role is primary protective.

1.5.3 Secondary sector

The contribution of the secondary sector to the total gross value added is approximately 22% for the period 1995 - 2004. The structure of gross value added in the secondary sector presents relatively small changes (**Figure 1.10**). The contribution of *Mining* and *Energy industries* to the gross value added of the secondary sector remained almost constant (3% and 11% respectively), while the contribution of *Manufacture* decreased by 7% from 1995 to 2004. The gross value added from *Construction* presents a significant increase from 1995 to 2004 due to the preparation for the Olympic Games of 2004 and the realisation of large infrastructure investments in general.

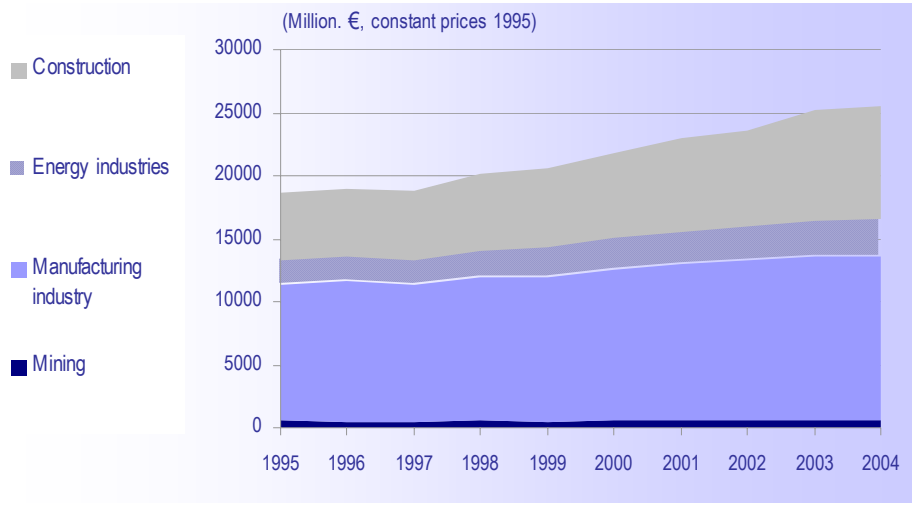


Figure 1.10 **The structure of gross value added in the secondary sector for the period 1995 – 2004**

Employment in the sector (**Table 1.4**) presents a similar to the gross value added trend. The total number of employees has remained almost constant during the period 1995 – 2004, though the share of the secondary sector in total employment decreased from 22% of the economic active population in 1995 to 20% in 2004.

Table 1.4 **Employment in the secondary sector for the period 1995 – 2004 (thousands employees)**

Categories	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Mines	17	17	17	16	15	16	16	17	11	13
Manufacture	625	626	605	622	614	602	601	582	567	561
Construction	252	252	249	275	271	280	285	295	320	324
Energy Industry	42	43	43	43	43	41	39	39	42	39

1.5.3.1 Mining

The mining sector consist of two basic categories: mining / extraction of energy resources (i.e., lignite, crude oil and natural gas) and activities related to mining/quarrying of gravel and sand, chromites, nickel ores and other non-ferrous ores, marble, bauxite, clays and kaolin.

- In 2003, the gross value added of the mining sector (in constant 1995 prices – see Figure 1.10) increased by 14% compared to 1995, with an average annual rate of increase of 1.5%.
- Gross value added from mining / extraction of energy resources remained almost constant during the period 1995 – 2004, while the gross value added from the remaining activities increased by 28% from 1995 to 2004.
- The industrial production index (base year 2000) increased from 91.5 in 1995 to 106,5 in 2003.
- Employment in the mining sector decreased from 0.4% of the economic active population in 1995, to 0.3% in 2004.

1.5.3.2 Manufacture

The contribution of *Manufacture* to the gross value added of the secondary sector decreased from 58% in 1995 to 51% in 2004. The structure of gross value added of *Manufacture* is presented in **Figure 1.11**.

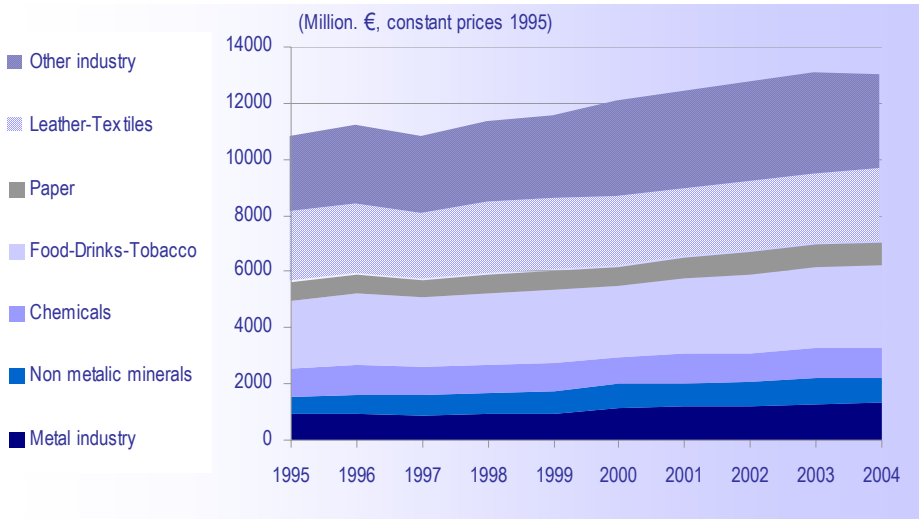


Figure 1.11 The structure of gross value added in *Manufacture* for the period 1995 – 2004

- In 2004, *Food, Beverages and Tobacco* presented the highest contribution to the gross value added of Manufacture (22%), followed by *Textiles, Textile products and Leather* (20%) and *Metal production* (10%).
- The industrial branches that presented a significant increase of their gross value added during the period 1995-2004, were those of *Metal production* (increase by 42% from 1995 to 2004),

Mineral products (increase by 40% from 1995 until 2004) and *Food, Beverages and Tobacco* (increase by 20% from 1995 until 2004).

- The total industrial production index (base year 2000) in 2003 showed an increase of 7% compared to 2000 and of 20% compared to 1995 (**Table 1.5**). For the period 1995 – 2003, the highest increase of the production index was recorded for the production of medical instruments, while the highest reduction of the production index was recorded for the production office and computing equipment.
- Employment in *Manufacture* decreased from 15% of the economic active population in 1995, to 12% in 2004. This trend is observed in almost every activity within *Manufacture*.

Table 1.5 Industrial production index for the period 1995-2003 (base year, 2000)

Branches	1995	1996	1997	1998	1999	2000	2001	2002	2003
Food & beverages	85.8	84.6	89.3	97.9	98.1	100.0	102.2	104.2	101.3
Tobacco	119.1	117.2	113.2	94.6	101.3	100.0	101.5	103.4	105.9
Textiles	100.0	98.8	104.6	104.1	87.7	100.0	92.6	90.2	87.2
Clothing	119.9	109.9	105.0	106.9	106.1	100.0	93.1	87.8	87.3
Leather & footwear	145.3	139.3	127.6	102.0	97.7	100.0	95.1	90	80.9
Wood & cork	106.1	104.9	88.1	72.4	71.8	100.0	89.3	88.1	83.5
Paper & paper products	97.2	89.7	74.1	116.4	120.1	100.0	90.7	87.7	86.5
Printing & publishing	95.0	103.8	110.7	120.3	99.3	100.0	99.0	100.4	103.3
Petroleum & coal products	74.0	86.3	89.2	101.4	85.1	100.0	98.7	100.8	101.1
Chemicals	78.0	81.9	85.6	92.2	95.2	100.0	102.4	108.7	110.9
Plastics & rubber	75.1	77.7	76.5	94.3	98.9	100.0	102.4	100.7	100.0
Non-metallic minerals	88.7	91.3	96.1	97.0	97.8	100.0	102.2	104.8	106.7
Basic metals	79.5	77.8	84.5	78.6	87.5	100.0	103.0	109.8	108.8
Final metallic products	76.6	79.6	79.9	84.1	99.1	100.0	91.4	92.4	97.7
Machinery	85.3	88.9	89.9	93.3	86.9	100.0	82.5	90	88.2
Office & computing equipment	89.8	46.1	163.5	59.7	54.9	100.0	89.7	172.2	18.4
Electrical machines	82.1	80.7	80.8	85.8	88.8	100.0	95.7	82.0	95.2
Radio. TV & comm. appliances	44.9	30.3	36.1	84.2	75.5	100.0	74.8	53.2	46.4
Medical instruments	94.9	104.0	113.5	96.3	95.9	100.0	136.8	111.7	145.8
Transport equipment	49.0	29.7	41.4	80.5	98.7	100.0	79.4	61.5	70.4
Other transport equipment	138.5	134.4	117.7	113.0	105.1	100.0	102.9	98.4	96.0
Furniture & other industries	68.3	63.8	70.9	84.7	91.3	100.0	81.5	67.9	61.4
TOTAL MANUFACTURING	**88.4**	**92.0**	**90.3**	**93.5**	**95.0**	**100.0**	**104.5**	**111.3**	**107.4**

1.5.3.3 Construction

The contribution of *Construction* to the gross value added of the secondary sector increased from 29% in 1995 to 35% in 2004. The gross value added of the sector increased with an average annual rate of 6% for the period 1995 – 2004. As a result of this significant growth, employment increased by approximately 30% during the same period and the contribution of *Construction* to total employment increased from 6% of the economic active population in 1995, to7% in 2004.

In 2003, the number of new building licenses granted to the private sector (including residential, industrial, commercial and buildings of miscellaneous use) totalled approximately 43,000,

corresponding to a building volume of 66,000 m^3 and to a building area of 18,000 m^2 (**Figure 1.12**).

During the period 1990-2003, the total number of licenses issued, exceed 700,000, the respective building volume exceeded 800,000 m^3 and the respective area exceeded 230,000 m^2. Approximately 20% of the new building volume is concentrated in Attica (mainly in the greater Athens area).

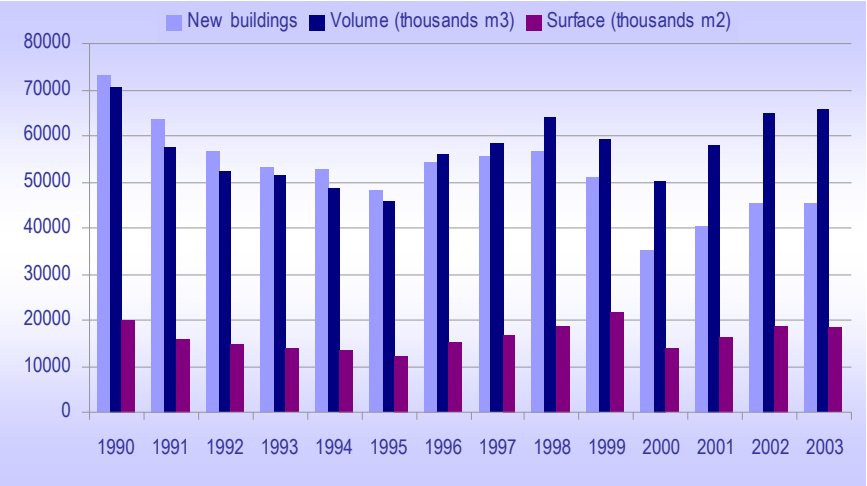


Figure 1.12 New private buildings in Greece (1990-2003)

Regarding the evolution of the public building activity, this represents a small percentage of the total: the area of new buildings in the public sector represents approximately 2.5% of the total area of new buildings each year (on an average basis).

1.5.3.4 Energy industries

The contribution of *Energy industries* to the Gross Value Added of the secondary sector remained constant at 11% for the period 1995 – 2004. The gross value added of the sector increased with an average annual rate of 4.4% for the period 1995 – 2004. Employment decreased from 1% of the economic active population of the country in 1995, to 0.8% in 2004. The technical characteristics of the sector are presented in the Paragraph 1.7 below.

1.5.4 Tertiary sector

The contribution of the tertiary sector to the total gross value added increased by 3% from 1995 to 2004, and in 2004 the gross value added of the sector constitutes 72% of the total. The structure of gross value added of the tertiary sector does not present important changes (**Figure 1.13**). The contribution of *Trade* and *Hotels - Restaurants* to the gross value added of the sector remained constant (20% and 10% respectively). Gross value added from *Transport – Communication* increased by 130% from 1995 to 2004, and as a result the contribution of this activity to gross value added of the sector increased from 10% in 1995 to15% in 2004.

Employment in the tertiary sector (Table 1.6) increased by 20% from 1995 until 2004. The share of the tertiary sector in the total employment increased from 51% of the economic active population in 1995 to 56% in 2004.

Table 1.6 Employment in the tertiary sector for the period 1995 – 2004 (thousands employees)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Trade	553	540	556	583	583	591	583	589	608	624
Hotels - Restaurants	224	224	230	239	240	247	248	262	266	260
Transport- Communication	264	262	255	267	266	266	267	262	271	281
Financial intermediation – Real estate	266	254	268	303	308	316	336	343	354	375
Other services	828	849	848	883	889	893	891	903	922	1021

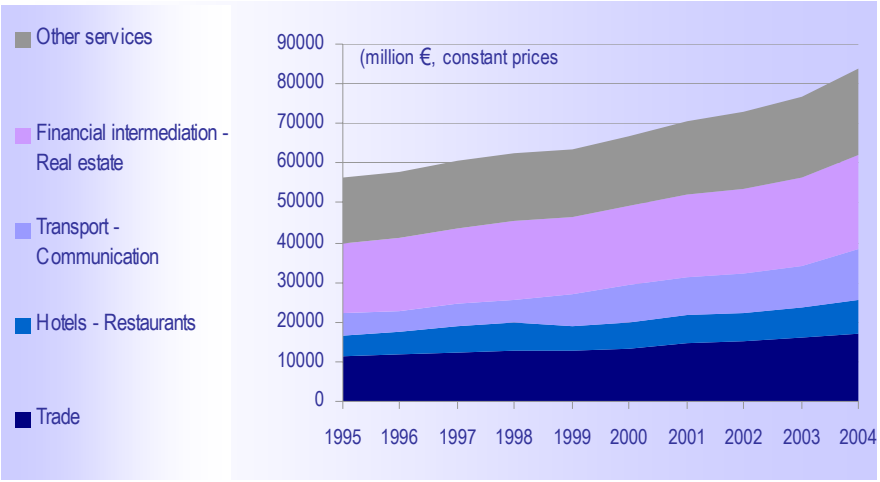


Figure 1.13 Structure of gross value added in the tertiary sector for the period 1995 – 2004

Tourism constitutes one of the more important economic activities in Greece. In 2003, Greece welcomed approximately 14 millions tourists (excluding cruises). The major portion (90%) came from Europe and 70% from EU countries, while the majority of tourists (75%) came by plane.

In 2003, the accommodation capacity was approximately 650,000 beds in more than 8,500 hotels. Compared to 1996, the number of hotel beds in 2003 increased by 20%. About 60% of the total bed capacity (hotels) is located on the islands.

1.6 Transportation

1.6.1 Road transport

Economic development and improved living standards have a significant effect on the ownership of passenger cars. The number of passenger cars in 1994 was almost 10 times higher compared to the number of passenger cars in 1970, while similar trends are also observed for the number of trucks, buses and motorcycles. For the time period 1990 – 2003, the number of passenger cars, trucks and motorcycles, increased continuously (**Table 1.7**). In 1990, the number of passenger cars was 1.7 million cars (1 car for every 6 inhabitants), while in 2003 this figure reached 3.8 million cars. Despite these drastic changes, Greece still has one of the lowest ownership rates in EU-25.

Since 1995 the number of advanced technology catalytic passenger cars is constantly increasing (**Figure 1.14**), while the number of medium and large size passenger cars almost doubled from 1990 to 2003. In 2003, of the vehicles that were operated for the first time, 90% were new and the rest 10% were used. For the same year, passenger cars represented 64% of total motor vehicles in operation, trucks 19%, motorcycles 16%, taxies 0.7% and buses 0.3%.

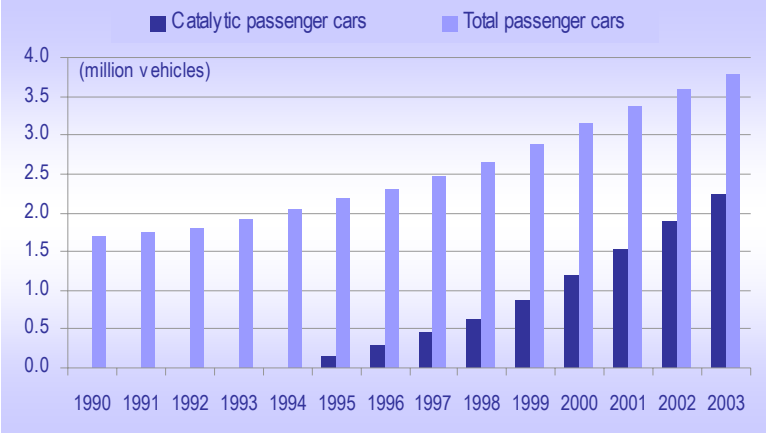


Figure 1.14 Number of catalytic and total passenger cars for the period 1990 - 2003

Until 1992, Greece was the only country in Europe that prohibited the use of diesel passenger cars (excluding taxis). The reason for introducing such a measure was the increasing atmospheric pollution in Athens, caused, among others, by smoke and dust emitted by older technology and improperly serviced buses, trucks and taxis. In 1992, the Greek government introduced Law 2052/92, which allowed the use of diesel passenger cars up to 3.5 tons in Greece, except for the areas of Athens, Piraeus and Thessalonici. As a result, the number of diesel passenger cars increased from 50 thousands in 1990 to approximately 310 thousands in 2003. At the moment, consultations regarding the removal of the restrictions on the use diesel passenger cars are in progress.

Table 1.7 Number of vehicles fleet per category, fuel and engine size or weight for the period 1990-2003

Category of vehicle	Per fuel & cubism / weight	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Passenger cars	Gasoline<1.4 l	1456160	1449929	1454366	1539280	1619305	1703090	1789657	1872574	1996055	2170301	2335593	2458220	2574124	2614733
	Gasoline 1.4 – 2.0 l	210519	258008	305126	348347	374664	416369	459958	530020	570793	638496	727197	811760	906225	1040518
	Gasoline >2.0 l	37306	38084	38128	39644	48913	52889	55788	60702	67922	74378	81316	96363	103748	119026
	Petroleum<2.0 l	17122	17125	17134	17138	17141	18080	18716	19502	20465	21810	23087	23869	24794	25341
	Petroleum >2.0 l	11415	11418	11422	11426	11428	12126	12866	15000	18462	21967	25914	31498	35367	38011
	LPG	3000	3000	2937	2804	2696	2205	2395	2203	2077	1865	1865	1970	1898	1898
Light duty vehicles	Gasoline <3.5t	615442	627081	613499	625053	634227	645394	655930	669105	671699	672555	672944	671683	668145	663008
	Petroleum <3.5 t	20694	30918	48665	60276	70469	94569	103375	120876	137638	166603	192134	213037	231143	249730
Heavy duty vehicles	Gasoline >3.5 t	6518	6640	6661	6789	6801	7061	7216	7293	7964	8268	8561	8832	9078	9320
	Petroleum 3.5 – 7.5 t	42154	43602	43878	45413	46697	48610	50316	52348	57563	59801	63127	68298	74091	79737
	Petroleum 7.5 - 16 t	34489	35675	35900	37156	38206	39772	41167	42831	48380	50176	51814	53204	54348	55420
	Petroleum 16 - 32 t	39088	40431	40687	42111	43301	45075	46656	48541	51343	53247	54986	56472	57676	58814
	Petroleum >32t	10730	11099	11169	11560	11887	12373	12807	13324	15304	15872	16390	16831	17192	17531
Urban buses	Petroleum	4277	4305	4247	4336	4472	4996	5120	4962	5161	5293	5320	5297	5297	4297
Coaches	Petroleum	12220	12699	13500	13913	14289	14745	15028	15616	15601	15461	15456	15475	15475	15475
Mopeds	Gasoline	985954	1079138	1208539	1271593	1335753	1396813	1451969	1507058	1568350	1620881	1561210	1607912	1540876	1616586
Motorcycles	Gasoline	259160	298632	342868	391756	428953	475668	517890	570966	633765	710775	781362	853366	910555	969895

Source: Elaboration of data provided by the Ministry of Transport and Communications and the NSSG

1.6.2 Shipping

The Greek maritime fleet is one of the largest in the world, and in 2002, according to the data of the Ministry of Mercantile Marine, it comprised of 3480 vessels (939 fly the Greek flag and 2541 fly foreign flags) of a total dead-weight tonnage of approximately 98.2 GRT, that represent the 15.5% of world shipping capacity. Merchant (dry cargo) ships represent approximately 34% of this total, 60% are tankers and approximately 6% are passenger ships and other type of vessels. The merchant fleet is composed of ships of average age and specialises in "tramping", or going anywhere in the world on a single trip rather than travelling regular routes. Passenger ships (including ferries and cruise ships) are primarily used for transporting both goods and passengers to and from the numerous islands in the Aegean and Ionian Sea and to countries in the Mediterranean Sea.

In 2003, sea transport of passengers increased by approximately 64%, compared to 1991, while sea transport of goods increased by 57%.

1.6.3 Railways

The total length of the railway network in Greece is 2,299 km. Greece was the last European country to develop a railway system, which dates only from the 1880s. Over the last 10 years, the network has undergone an extensive modernization, the aims of which are the improvement of existing tracks, the standardization of metric gauges, the connection to the western European network and the coordination of the development with that of roads. Both the modernization and the extension of the system have proven costly and difficult mainly due to the complex topography of the mountainous region (Pindos mountain) that divides the western and eastern parts of Greece.

The Strategic investment plan of the National Railways Organisation for the time period 2002 – 2012 foresees the modernization of the railway network with the construction of double, electrified and remote controlled track on the PATHE axis (Parta - Athens – Thessalonici – Idomeni). Those investments will enable minimum speeds of 200 km/h and will reduce travelling times. As a result the share of railways to total passengers and goods transport is expected to increase.

In 2002, the Railways Organisation had approximately 9.100 employees, presenting a continuous decrease since 1989. In 2002 the total expenditures was at 2001 levels, while total receipts decreased by approximately 30%. Finally, in 2002, the share of passengers travelling by train increased by approximately 2% compared to 2001, while the share of goods transport by rail decreased by approximately 27%.

1.6.4 Air transport

According to the Civil Aviation Organisation data, aircraft traffic in 2003 (**Figure 1.15**) increased by 7.6% compared to 2002 data, reaching a number of Landing and Take-off (LTO) cycles of approximately 394.000 (compared to 366.000 in 2002). Passengers that embark and disembark in the airports of the country, mounted approximately at 33.6 millions in 2003. Since 1990 air traffic presents an average annual increase by 4.7% and the number of passengers increased by

approximately 4% annually. Air transport of goods in 2002 decreased by 4.7% compared to 1990 levels.

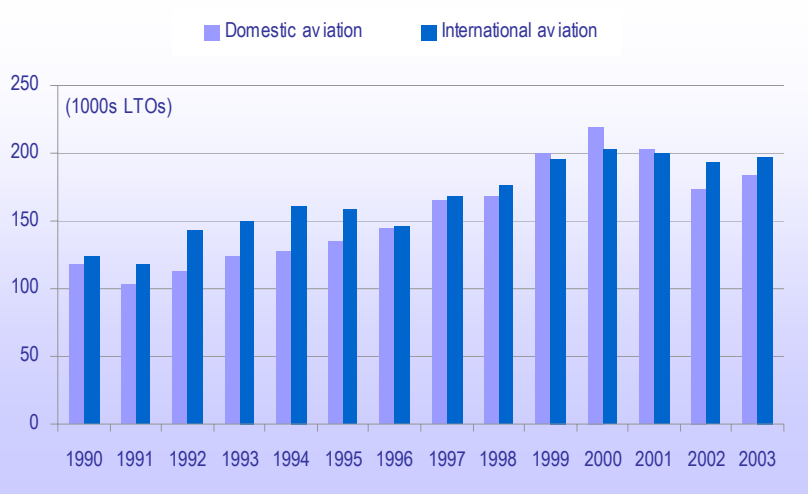


Figure 1.15 Domestic and international air traffic for the period 1990 – 2003

Concerning international traffic at the Athens airport, European airlines represent the highest share, followed by Asian, African, American and Australian airlines.

1.7 The Greek energy system

1.7.1 Energy supply

The total gross inland consumption in Greece increased continuously during the time period 1990 – 2003, with the exception of the year 1993. In 2003, gross inland consumption reached a total of approximately 30.5 Mtoe, representing an increase of approximately 35% compared to 1990 levels. However, the average annual growth rate of increase during the period 1990 - 2003 (2.4%) is lower compared to the rate of increase recorded in the 1980s (3.3%).

The composition of gross inland consumption (**Figure 1.16)** reveals the major weakness of the Greek energy system, namely, the absence of alternative solutions for covering energy demand. During the period 1990-2003, oil and coal products have provided the majority of the total energy supply (88% - 95%), but since 1997 their contribution was slightly decreased. The only significant change in the Greek energy system in the last decade was the introduction of natural gas in 1997, which accounted for approximately 7% of the gross inland consumption in 2003.

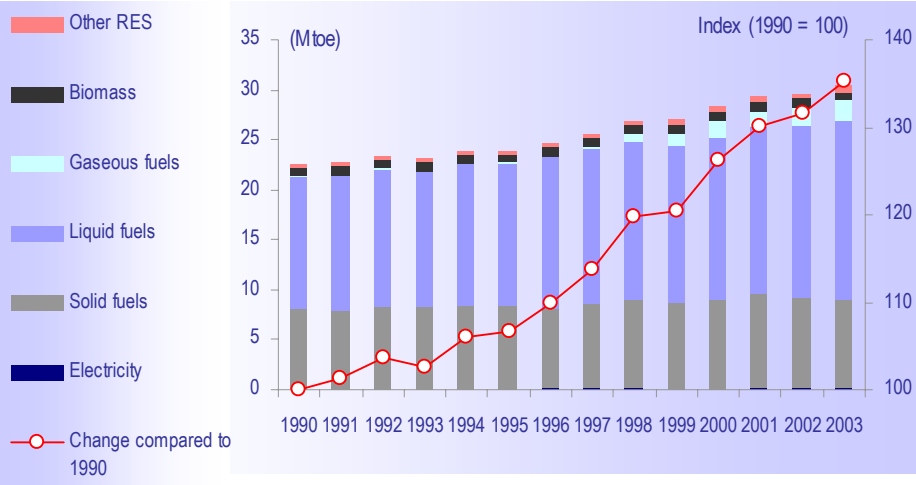


Figure 1.16 Gross inland consumption (Mtoe) in Greece for the period 1990 - 2003

In 2003, the share of oil products in gross inland consumption was at 1990 levels (58%), while the share of coal products decreased from 36% in 1990 to 29% in 2003, though, in absolute terms, the consumption of oil products increased with a mean annual rate of 2.4% and consumption of coal products increased with a mean annual rate 0.7% for the period 1990 - 2003.

The contribution of renewable energy sources (RES) to gross inland consumption, including large hydro, varies from 4.6% to 5.6% according to the fluctuations of the production of large hydropower plants. Excluding large hydro, the share of renewable energy sources is about 4% for the period 1990 - 2003. Approximately 2/3 of the total energy produced by RES in the Greek energy system derives from the use of biomass (mainly in the residential sector and in industry) and the use of solar energy for water heating mainly in the buildings sector.

Import dependency (defined as the ratio of domestic energy supply to gross inland consumption) showed an upward trend during the period 1990 – 2003, increasing from 59% in 1990 to 65% in 2000, as a result of the increased demand for oil products and the penetration of natural gas.

The energy supply sector in Greece consists of (a) primary lignite production, (b) refineries, (c) transport and distribution of natural gas and (d) electricity generation.

(A) Lignite production

Lignite is the main domestic fossil fuel in Greece. The certified geological reserves of lignite are currently estimated at 5 Gt with significant spatial distribution. Of these, approximately 3.2 Gt are considered exploitable, given current technological and economic conditions, while 1.3 Gt have been already mined. According to the estimations by the Public Power Corporation (PPC) based on planned exploitation rates, these reserves are sufficient for the next 45 years.

Greek lignites are characterized by low calorific value, which fluctuates from 900 - 1100 kcal/kg in the regions of Megalopoli, Amynteo and Drama, to 1250 - 1350 kcal/kg in the region of Ptolemaida and to 1800 -2300 in the regions of Florina and Elassona.

In Greece, lignite is almost exclusively used for the generation of electricity. Only small quantities are used, either as lignite in its natural state or in the form of enhanced lignite products (dry lignite and briquettes), directly by the metallurgy industry, various craft industries, greenhouses in Northern Greece, and a number of households which are situated close to the production areas.

(B) Refineries

The Greek market of oil and petroleum products comprises four refineries, approximately 50 companies active in the marketing of petroleum products and a large number of retailers and gas stations. The companies which are activated in the marketing of petroleum products in Greece function as follows:

- They buy ready products from the country's refineries, which they either store in their own facilities or channel directly to the customers through filling stations or by delivery to their customers' production units.
- They import ready products from refineries abroad, which they store in their own facilities and then channel to customers.

The annual refining capacity of the four refineries amounts to 20.1 Mt of crude oil, while fluid catalytic cracking units operate in two of the refineries.

Energy consumption in the refineries is based, to the extent possible, on intermediate products (low sulphur heavy fuel oil and refinery gas) while energy management practices are focused on energy conservation.

(C) Transport and distribution of natural gas

The decision for the introduction of natural gas into the Greek energy system was taken in an effort to ensure the modernisation and improvement of the energy balance, as well as the diversification of the country's energy sources. Greece is supplied with natural gas from Russia and Algeria (to a lesser extent in the case of the latter). The natural gas from Russia reaches Greece through a pipeline system, while that from Algeria is transported by special tankers in liquefied form.

The construction of the required infrastructure (apart from the distribution networks) began in 1992 and was completed in 2002. The basic infrastructure of the Greek system for the transportation, storage and distribution of natural gas includes:

- the main pipeline with a length of 512 km, and branch pipelines to several cities with a length of 450 km,
- the terminal station of the liquefied natural gas which includes two storage tanks with a total capacity of 130,000 m^3 and
- the distribution networks (of medium and low pressure) of natural gas. The foreseen length of the low pressure networks, in order to cover of needs of four cities (Athens, Thessalonica, Larissa and Volos) amounts at 6500 km. At the beginning of 2004, the length of the distribution network completed was 2751 km.

(D) Electricity generation

The electricity-generation system in Greece consists of thermal and hydroelectric units as well as a small, though increasing, percentage of other renewable energy sources. In 2004, the total installed capacity of the Public Power Corporation (PPC) generating system was 12.2 GW (**Table 1.8**) which corresponds to an increase of approximately 40% compared to 1990 levels, while the net electrical capacity of auto producers in 2004 was 257 MW.

Table 1.8 Installed capacity of the electricity generation system (in MW) in 2004

Units	Interconnected system	Autonomous islands' systems
Public Power Corporation		
Lignite	5288	
Oil	750	1507
Natural gas	1581	
Hydro	3060	1
RES	7	30
Auto producers and independent producers		
Auto-producers	257 [1]	
Independent producers - RES	460	

[1] Net installed capacity

Electricity generation increased continuously with an average annual rate of approximately 4% for the period 1990-2003 (**Figure 1.17**). Gross electricity production in 2003 totalled 58.2 TWh, of which 60% and 15% came from the combustion of coal and petroleum products, respectively, 9% from hydropower, 15% from natural gas and 1% from other (except large hydro) renewable energy sources (mainly from wind energy).

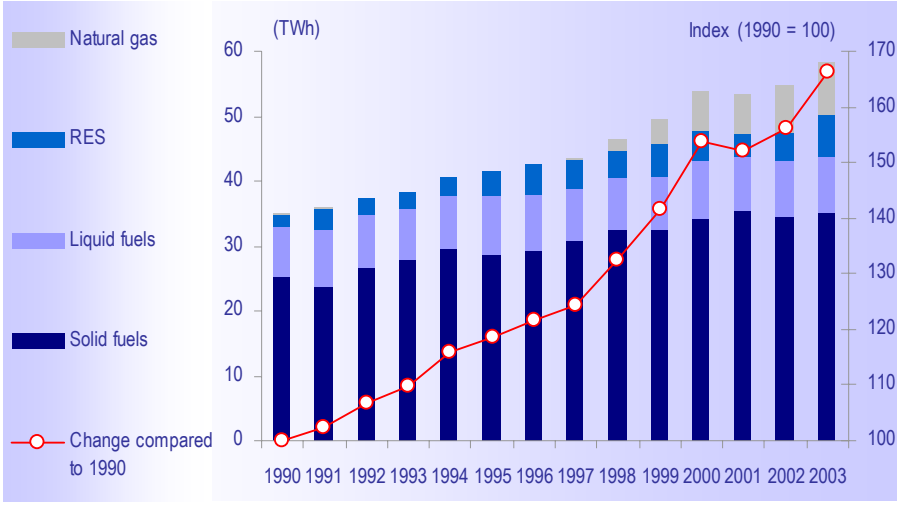


Figure 1.17 Gross electricity generation (in TWh) in Greece for the period 1990 - 2003

1.7.2 Final energy consumption

In 2003, final energy consumption in Greece totalled 23.1 Mtoe. Energy consumption in industry accounted for 29% of final energy consumption (including consumption of the energy sector). The share of transport in final energy consumption is estimated at 35% in 2003, while the share of residential and tertiary sector was 36%. The average annual rate of increase for the period 1990-2003 is estimated at 2.7%. The per capita final energy consumption has increased by 30% from 1990 to 2003 (1.61 and 2.09 toe/cap respectively).

All three sectors increased their energy use from 1990 to 2003 (**Figure 1.18**), with the residential and tertiary sector showing the highest increase (by 75% in 2003 compared to 1990), followed by transportation (34%) and industry (18%). This resulted in a total increase of 41% between 1990 and 2003.

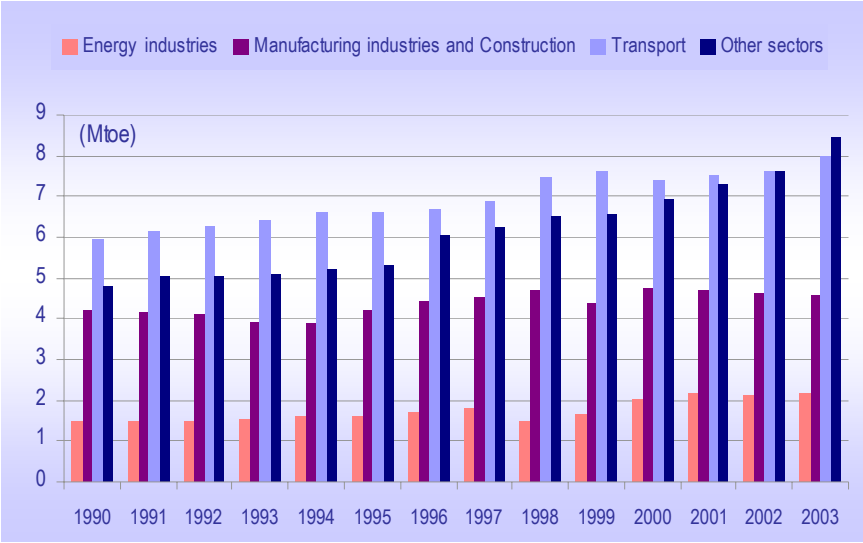


Figure 1.18 **Final energy consumption (in Mtoe) by economic sector for the period 1990 – 2003**

1.7.2.1 Industry

In 2003, the total energy consumption in industry (including energy industries and construction) totalled 6.7 Mtoe (**Figure 1.19**), accounted for 29% of the total energy demand in Greece. The consumption of the energy sector represents 32% of energy consumption in industry.

The main structural changes regarding energy consumption in industry refer to the gradual replacement of petroleum products by coal products (a trend almost solely attributed to the increased use of steam coal by the cement industry) during the time period 1980–1995 and to the penetration of natural gas for thermal uses and for use as feedstock in the chemical industry.

In 2003, oil products accounted for approximately 47% of the total energy needs of the sector, compared to 48% in 1995 and 69% in 1980. Electricity consumption has steadily increased since 1990, and in 2003 it reached a total of approximately 2.2 Mtoe or 35% of the total energy use of the

sector. The use of RES, mainly in food and wood processing industries, represents approximately 3% of total energy consumption in industry for the period 1990 – 2003.

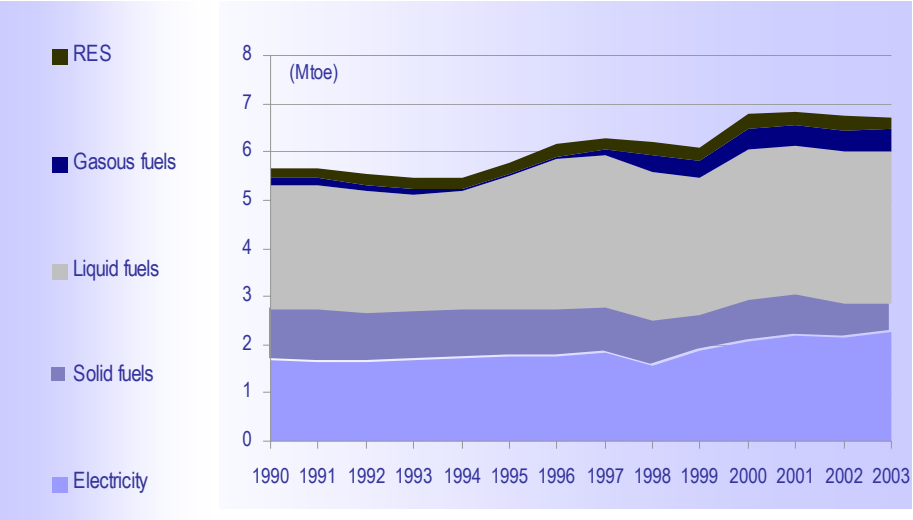


Figure 1.19 Energy consumption (in Mtoe) in industry for the period 1990 - 2003

1.7.2.2 Residential, tertiary sector and agriculture

In 2003, the energy use in the sector totalled 8.4 Mtoe or 36% of the total energy demand in Greece, compared to 4.8 Mtoe in 1990 (**Figure 1.20**). This energy was primarily used for space heating and cooling, and domestic hot water production in residential, public and commercial premises. Other energy uses were in the form of electricity for appliances/equipment and for the operation of building services systems in residential, public and commercial premises. The figure also includes energy use in agriculture (mainly for agricultural machinery).

The changes in the energy consumption of the sector reflect both the improving living standards of the Greek society and an increase in the number of dwelling. These two factors have resulted in improved levels of heating and, recently, of cooling, and a rise in the ownership of home electric appliances. The floor area of commercial premises has also increased substantially, thus contributing to an increase in electricity demand for ventilation, lighting and other office equipment.

The general upward trend of the energy demand, as illustrated in Figure 1.19, is mostly the result of an increased demand for electricity and to a smaller extent for petroleum products. In 2003, consumption of oil products accounted for 55% of energy consumption in the sector (as in 1990), while the contribution of electricity to total energy consumption in the sector increased from 29% in 1990 to 35% in 2003. The use of natural gas in the sector is limited as the construction of the distribution networks is under development.

The contribution of biomass to the total energy consumption in the sector decreased by 6% from 1990 up to 2003. Until 1985, most of the biomass was used in the countryside as the primary energy source to meet the heating requirements of households and holiday homes. Since then,

however, there is a gradual shift of biomass use from the countryside to large urban areas (as a secondary energy source). This change is the result of both the increasing population of the large cities in Greece and the renewed demand for the installation of fireplaces in both private residences and apartment buildings.

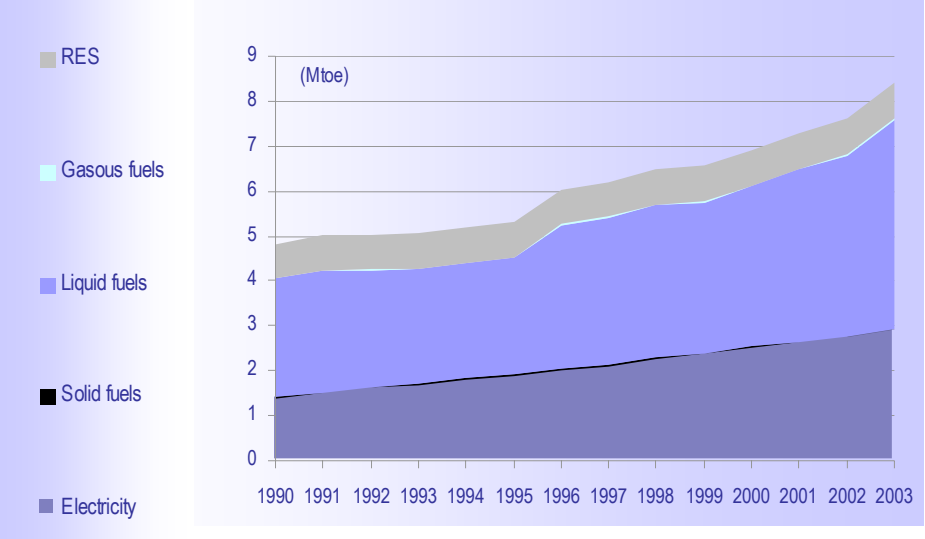


Figure 1.20 Final energy consumption (in Mtoe) in the residential, tertiary sector and in agriculture for the period 1990 - 2003

1.7.2.3 Transport

The energy use in transport has almost doubled during the 1980–1995 period. In 2003, energy consumption for transportation accounted for 8.0 Mtoe (6.0 Mtoe in 1990) or 34% of the total final energy demand in Greece. Oil products accounted for more than 99% of the final energy use. The energy use is in the form of gasoline consumption mainly by passenger cars, while other uses include diesel oil for trucking, maritime transport and railroads; jet fuel for aircraft; and smaller amounts of LPG and diesel oil used by taxis. Small amounts of steam coal are used exclusively by railroads (until 1996), while electricity covers the needs of the electric buses (trolleys) and of the metro that operate in the central Athens area. Due to the operation of the metro (2 new lines after 2000) and the planned extensions of the network, electricity consumption is expected to increase in the future.

1.8 Waste

1.8.1 Solid waste

Over the period 1990 – 2003, waste generation presented a continuous increase. Solid waste generated quantities increased from 3.1 Mt in 1990 to 5.2 Mt in 2003, while the per capita solid waste generation increased from 0.82 kg/person/day in 1990 to 1.19 kg/person/day in 2003, remaining however below the EU average (EU-15). The share of solid waste disposed in managed solid waste disposal sites (SWDS) has been noticeably increased since 1999 due to the construction of new SWDS, in the framework of the integrated national plan of solid waste disposal on land, developed according to the requirements of the Directive of the European Union 91/156/EEC. The main objectives of the plan is gradual closure of all the unmanaged SWDS, the reduction of waste generation rates, the exploitation and re-use of the materials including energy recovery and the reduction of biodegradable wastes led to disposal sites according to the provisions of the Directive 99/31/EC. The solid waste disposal / management practices applied in Greece are presented in **Figure 1.21**.

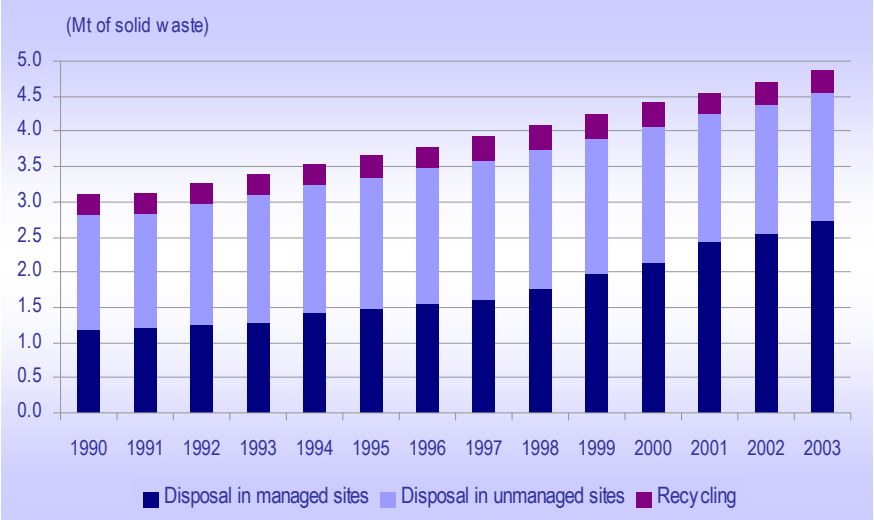


Figure 1.21 Solid waste disposal / management practices applied in Greece

Concerning the composition of waste in 2003, food wastes make up the largest share with 45.2% followed by paper with 21.2%, plastic 9.7%, glass 4.4%, metal 3.9% and other 15.6%. Paper and plastic wastes increase with a rate of 0.2% annually, while food wastes, metals and glass decreased with a rate of 0.3%, 0.1% and 0.02% respectively.

The amount of recycled wastes does not present a remarkable increase during the last decade, while the percentage of municipal solid wastes recycled has decreased from 9.4% in 1990, to 6.2% in 2003. Biogas recovery and flaring installations operate in 4 large SWDS in Greece (Athens, Thessalonica, Larissa, Patra), which accept 87% of waste disposed to SWDS.

To date, sludge produced in waste water treatment plants is disposed in SWDS. Sludge disposed in the SWDS of Ano Liosia (Attici) was estimated at approximately 110 kt annually, until 2002. This quantity was decreased significantly in 2003 (59 kt), due to disposal problems. The construction of a sludge dehydration unit is planned to facilitate the on-site combustion of sludge. The project is expected to be completed by the end of 2007.

Since 2002, the hospitals in the Attica region have the possibility to dispose clinical wastes in the central incineration unit in Ano Liosia, which can process a total of 30 tons of waste per day. In 2004 this unit accepted approximately 1.2 kt of clinical waste, i.e. it is still operating well below its nominal capacity due to high operational costs. Up to 2001 a small incinerator with a capacity of approximately 600 kg per day was in operation in Ano Liosia.

1.8.2 Wastewater

The number of wastewater handling facilities under aerobic conditions has been increased considerably since 1999. The percentage of population that is served by aerobic wastewater handling facilities increased from 32% in 1999 to 75% in 2002, in accordance with the targets set by the Directive 91/271/EEC concerning the collection, treatment and disposal of urban waste water. In the wastewater treatment centres serving the needs of Attica (with a population of approximately 4 millions), the sludge produced is treated under anaerobic conditions resulting in the production of biogas. The biogas produced covers the energy needs of the wastewater treatment facilities, while the surplus is flared

2 GREENHOUSE GAS INVENTORY INFORMATION

2.1 Overview

This chapter summarizes greenhouse gas (GHG) emissions of Greece for the time period 1990–2003 as reported in the National Inventory Report submitted in 2005 (MEPPPW, NOA 2005).

Emissions estimates were calculated according to the CORINAIR methodology (EEA 2001), the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (henceforth IPCC Guidelines), the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (henceforth IPCC Good Practice Guidance) and the IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry (henceforth LULUCF Good Practice Guidance). It is noted that base year emissions are calculated using 1990 as the base year for carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), and 1995 for fluorinated gases (F-gases: Hydrofluorocarbons, HFC / Perfluorocarbons, PFC / Sulphur hexafluoride, SF_6). Global warming potential (GWP) values in a time horizon of 100 years as well as the sources of the necessary statistical data are presented in **Annex I.**

An overview of GHG emissions for the time period 1990–2003 is presented in **Table 2.1**. The detailed CRF trend tables are presented in **Annex I.** Following the IPCC Guidelines, emissions from international air transport and marine bunkers are not included in the national totals and are presented separately in **Table 2.2.** Finally, emissions of the ozone precursors gases (NOx, CO and NMVOC) along with SO_2 are presented in **Table 2.3**.

Total uncertainty for 2003 is estimated at 11.5% (including *Land Use, Land Use Change and Forestry* - LULUCF), while the uncertainty carried over into the GHG emissions trend is approximately 8% (MEPPPW, NOA 2005). The uncertainty estimates for GHG emissions per gas (including LULUCF), in 2003, were estimated at:

- 5.0% for CO_2 emissions,
- 34.4% for CH_4 emissions,
- 104.4% for N_2O emissions
- 69.9% for F-gases

Table 2.1 Total GHG emissions in Greece (in Mt CO_2 eq) for the period 1990-2003

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
A. GHG emissions per gas (without LULUCF)														
CO_2	84.02	83.74	84.68	85.29	87.20	87.34	89.55	94.29	98.86	98.24	104.11	106.33	106.16	109.98
CH_4	10.01	10.00	10.13	10.22	10.45	10.57	10.76	10.83	11.11	10.39	10.35	10.05	10.12	10.17
N_2O	14.19	13.92	13.97	13.14	13.41	13.13	13.61	13.37	13.26	13.22	13.44	13.24	13.17	13.28
HFC	0.94	1.11	0.91	1.64	2.21	3.37	3.92	4.19	4.67	5.44	4.27	3.87	4.01	4.14
PFC	0.26	0.26	0.25	0.15	0.09	0.08	0.07	0.17	0.20	0.13	0.15	0.09	0.09	0.08
SF_6	Not estimated[2]													
Total	109.42	109.02	109.94	110.44	113.36	114.49	117.90	122.85	128.10	127.42	132.32	133.58	133.55	137.64
Index (B.Y.=100)	98.0	97.6	98.5	98.9	101.5	102.5	105.6	110.0	114.7	114.1	118.5	119.6	119.6	123.3
B. Emissions / Removals of GHG from LULUCF														
CO_2	-3.25	-3.60	-3.07	-3.88	-3.55	-4.41	-3.99	-3.96	-3.59	-4.44	-3.14	-5.32	-5.46	-5.53
CH_4	0.05	0.03	0.08	0.07	0.06	0.03	0.02	0.05	0.13	0.01	0.17	0.02	0.00	0.00
N_2O	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.00	0.00
Total	-3.19	-3.57	-2.99	-3.81	-3.48	-4.37	-3.97	-3.91	-3.45	-4.43	-2.96	-5.30	-5.46	-5.53

Table 2.2 GHG and other gases emissions from international transport for the period 1990 - 2003

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
A. GHG emissions (Mt CO_2 eq)														
CO_2	10.48	10.48	9.48	10.67	12.21	13.25	13.86	12.40	12.34	13.60	12.69	13.86	13.35	12.21
CH_4	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
N_2O	0.09	0.09	0.08	0.09	0.10	0.11	0.12	0.11	0.11	0.12	0.11	0.12	0.11	0.11
Total	10.58	10.58	9.58	10.77	12.34	13.39	14.00	12.53	12.47	13.73	12.82	14.00	13.49	12.34
B. Emissions from other gases (kt)														
NOx	198.9	181.9	208.0	241.4	257.7	274.8	242.9	243.7	271.2	244.4	278.3	270.1	243.1	249.4
CO	22.0	20.2	23.2	26.7	28.5	30.3	26.8	27.2	30.2	27.7	31.3	30.4	27.5	28.2
NMVOC	6.5	6.0	6.9	8.0	8.5	9.1	8.0	8.0	9.0	8.0	9.2	8.9	8.0	8.2
SO_2	148.4	133.1	148.4	176.3	184.8	189.7	172.0	172.9	199.9	175.6	206.9	208.7	186.8	195.9

[2] SF_6 emissions are not estimated. According to information from the Public Power Corporation, fugitive emissions from the use of SF_6 were 0.23 kt CO_2 eq during the last 20 years. However, according to data presented by the Ministry for Development during the in-depth review of the 3rd National Communication (November 2004) SF_6 emissions, for the first semester of 2004, were estimated at 1.74 kt CO_2 eq. At the moment, this inconsistency has not been resolved and as a result no emission estimates are reported

Table 2.3 Ozone precursor gases and SO_2 emissions for the period 1990 – 2003 (kt)

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NOx	299.9	311.8	314.3	313.8	321.0	320.5	325.4	331.9	349.4	337.3	329.7	343.4	340.5	342.7
CO	1301.7	1312.3	1340.7	1343.9	1339.5	1333.6	1360.4	1361.1	1390.9	1315.8	1363.6	1275.1	1244.2	1200.5
NMVOC	280.4	288.3	296.0	302.1	307.7	304.7	309.3	308.1	312.4	307.1	299.1	294.4	288.9	287.8
SO_2	486.9	524.7	543.5	541.7	512.5	536.0	523.2	518.0	527.2	544.2	492.8	502.1	513.1	545.1

Base year GHG emissions for Greece (1990 for CO_2, CH_4, and N_2O - 1995 for F-gases) were estimated at 111.67 Mt CO_2 eq. Given that LULUCF was a net sink of GHG emissions in 1990 (and for the rest of the reporting period) the relevant emissions / removals are not considered in estimating base year emissions for Greece.

In 2003, GHG emissions (without LULUCF) amounted to 137.64 Mt CO_2 eq showing an increase of 23% compared to base year emissions and of 26% compared to 1990 levels. If emissions / removals from LULUCF were included then the increase would be 24% (from 106.22 Mt CO_2 eq in 1990 to 132.11 Mt CO_2 eq in 2003).

Carbon dioxide emissions accounted for 80% of total GHG emissions in 2003 (without LULUCF) and increased by approximately 31% from 1990. Nitrous oxide emissions accounted for 10% of total GHG emissions in 2003 and decreased by 6% from 1990, while methane emissions accounted for 7% of the total GHG emissions in 2003 and increased by 2% from 1990. Finally, F-gases emissions that accounted for 3% of total GHG emissions, increased by 23% from 1995 (base year for F-gases) or by more than four times compared to 1990 levels.

GHG emissions trends (excluding LULUCF) are mainly driven by economic development as presented in **Figure 2.1**. Moreover, and given the fact that energy is the main source of GHG emissions, emissions and energy consumption follow the same pattern. On the contrary, the impact of population increase to GHG emissions is minor.

The main parameters affecting GHG emissions trends per sector are presented in the next paragraph. A basic conclusion resulting from Figure 2.1 is that since 2000 a decoupling of GHG emissions from economic development is observed as the growth rate of GHG emissions for the period 1990 – 2003 (approximately 2.1%) is lower from both the growth rate of gross inland energy consumption (approximately 2.4% for the same period) and the GDP growth rate (approximately 2.8%).

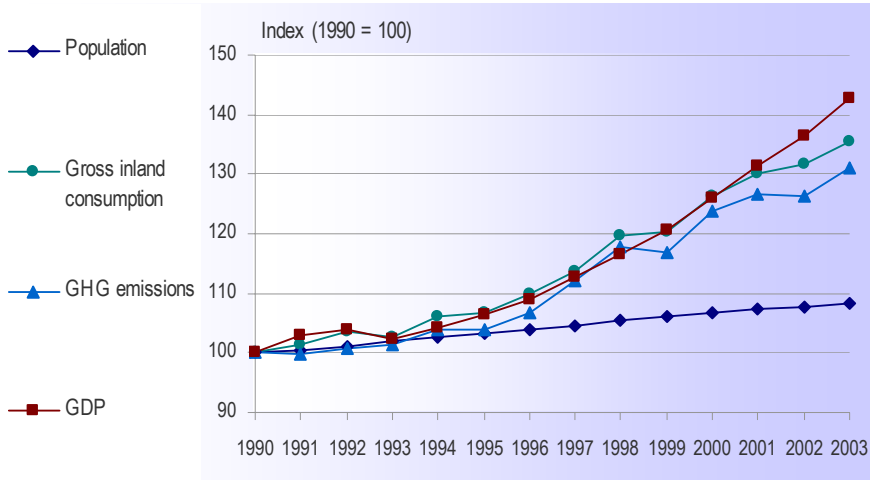


Figure 2.1 Factors underlying GHG emissions trends

2.2 GHG emissions trends per sector

GHG emissions by sector for the period 1990 - 2003 are presented in Table 2.4, while the sectoral contribution to GHG emissions for 2003 (excluding LULUCF) is presented in Figure 2.2.

Table 2.4 Total GHG emissions (in Mt CO_2 eq) by sector for the years 1990-2003

Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Energy	81.70	81.52	82.66	82.91	84.93	84.63	87.04	91.62	96.60	95.71	101.61	103.87	103.85	107.72
Industrial processes	8.67	8.65	8.53	9.31	9.79	11.40	12.01	12.59	12.80	13.64	12.81	12.36	12.40	12.58
Solvents	0.17	0.18	0.17	0.17	0.16	0.15	0.15	0.15	0.15	0.16	0.15	0.15	0.16	0.16
Agriculture	13.51	13.31	13.10	12.50	12.74	12.49	12.78	12.48	12.34	12.36	12.33	12.12	12.06	12.00
Waste	5.36	5.36	5.48	5.55	5.74	5.81	5.93	6.01	6.20	5.55	5.43	5.09	5.08	5.18
Total	**109.42**	**109.02**	**109.94**	**110.44**	**113.36**	**114.49**	**117.90**	**122.85**	**128.10**	**127.42**	**132.32**	**133.58**	**133.55**	**137.64**
Change (1990=100)	100.0	99.6	100.5	100.9	103.6	104.6	107.8	112.3	117.1	116.5	120.9	122.1	122.1	125.8
LULUCF	**-3.19**	**-3.57**	**-2.99**	**-3.81**	**-3.48**	**-4.37**	**-3.97**	**-3.91**	**-3.45**	**-4.43**	**-2.96**	**-5.30**	**-5.46**	**-5.53**

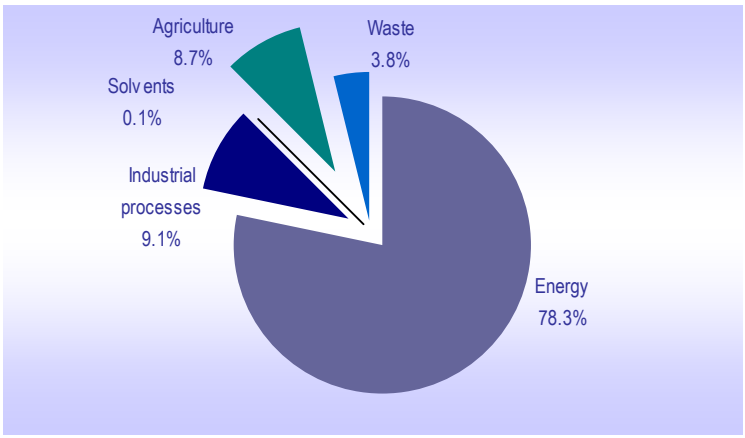


Figure 2.2 Contribution of activity sectors to total GHG emissions (without LULUCF) in 2003

- Emissions from *Energy* in 2003 accounted for 78.3% of total GHG emissions (without LULUCF) and increased by 32% compared to 1990 levels. The majority of GHG emissions (54.2%) in 2003 derived from energy industries, while the contribution of transport, manufacturing industries and construction and other sectors is estimated at 20.3%, 9.7% and 14.3% respectively. The rest 1.5% of GHG emissions from the energy sector derived from fugitive emissions from fuels. The sector with the greatest increase of emissions since 1990 is "Other sectors" (i.e. residential, tertiary and agriculture sectors), showing an average rate of increase of 4.3%. GHG emissions from transport and energy industries increased with an average annual rate of 2.6% and 2% respectively, for the period 1990 - 2003. Emissions from manufacturing industries and construction decreased with an average annual rate of 0.4%, while fugitive emissions from fuels increased with an average annual rate of 2.9%.

  The living standards improvement, due to the economic growth of the period 1990 – 2003, the important growth of the services sector and the introduction of natural gas in the Greek energy system represent the basic factors affecting emissions trends from *Energy*.

  The living standards improvement resulted in an increase of energy consumption and particularly electricity consumption (mainly in the residential – tertiary sector), of passenger cars ownership and transportation activity. The increase of electricity consumption led not only to the increase of direct emissions (due to combustion for electricity generation) but also of fugitive methane emissions from lignite mining. At the same time total CO_2 emissions per electricity produced (**Table 2.5**) have decreased by 22% (from 1150 kg CO_2 / MWh in 1990 to 900 kg CO_2 / MWh in 2003) mainly as a result of the introduction of the natural into the electricity system. It should be mentioned that the availability of hydropower has a significant effect to emissions trends. For instance, the significant increase of electricity demand in 1999 was not followed by a similar increase of emissions because of the penetration of natural gas and the high availability of hydropower (the highest of the period 1990 – 2003).

  The increase of energy consumption in the domestic and tertiary sector in combination with the delays in the construction of natural gas distribution networks (restricting the penetration of natural gas) as well as with the limited penetration of energy conservation measures and

RES technologies (with the exception of the use solar energy for water heating) resulted in a continuous increase of GHG emissions. This situation is also depicted in the indicators presented in Table 3.4 as CO_2 emissions per inhabitant from the residential sector have almost doubled from 1990 until 2003, while the intensity of CO_2 emissions from the tertiary sector has increased by approximately 45% during the period 1990 – 2003. On the contrary, the intensity of CO_2 emissions from industry has decreased by 23% due to the modernization investments realised in energy intensive sectors with significant exporting activity (e.g. cement, steel production etc) and the use of natural gas.

The substantial increase of GHG emissions from road transport is directly linked to the increase of vehicles fleet but also to the increase of transportation activity. The renewal of the passenger car fleet (cars of new technology constitute 60% of total passenger cars in 2003) and the implied improvement of energy efficiency (Table 2.5) limit the increase of GHG emissions. However, the positive results from the improvement of the vehicles performance are reduced by the high use of passenger cars in transportation activity.

- Emissions from *Industrial processes* accounted for 9.1% of the total emissions (without LULUCF) and increased by 45% compared to 1990 levels. Emissions from *Industrial processes* are characterized by intense fluctuations during the period 1990 – 2003, reaching a minimum value of 8.53 Mt CO_2 eq in 1992 and a maximum value of 13.64 Mt CO_2 eq in 1999, that are mainly attributed to changes in industrial production. In total, the increase of emissions from *Industrial processes* is mainly due to the increase of cement production and HCFC-22. The sector of solvents and other products use, with minimum contribution to total GHG emissions (0.1%), presents a small decrease.

- Emissions from *Agriculture* that accounted for 8.7% of total emissions in 2003 (without LULUCF), decreased by approximately 11% compared to 1990 levels. Emissions reduction is mainly due to the reduction of N2O emissions from agricultural soils, because of the reduction in the use of synthetic nitrogen fertilizers (see Chapter 1). The changes of the rest determining parameters of GHG emissions from the sector (e.g. animal population, crops production etc.) have a minor effect on GHG emissions trend.

- Emissions from the *Waste* sector (3.8% of the total emissions, without LULUCF), decreased by approximately 3% from 1990. Solid waste disposal on land constitutes the main source of emissions from the sector.

  Living standards improvement resulted in an increase of the generated waste and thus of emissions. Moreover, the increase of the number of managed solid waste disposal sites (SWDS), without a systematic exploitation of the biogas produced, and the limited application of alternative management practices resulted in the increase of methane emissions. Emissions reduction which is observed in 1999 is mainly due to the extension of the network for collection and flaring of the biogas produced in the largest SWDS of the country (in Ano Liosia), which receives approximately 30% of municipal solid waste produced.

  At the same time, emissions from wastewater handling have considerably decreased, due to the continuous increase of the population served by aerobic wastewater handling facilities.

Table 2.5 Basic indicators for the assessment of GHG emissions trends for the period 1990 – 2003

Sector	Index	1990	1995	2000	2001	2002	2003
Total	Emissions intensity, (t CO_2 / M€)	860	840	845	828	797	787
Energy - Total	Emissions intensity, (t CO_2 / M€)	789	767	779	763	735	729
Electricity generation	CO_2 emissions from electricity generation (kg CO_2 / MWh)	1161	1014	957	978	944	905
Industry	Emissions intensity, (t CO_2 / M€)	640	583	558	539	517	473
Tertiary sector	Emissions intensity, (t CO_2 / M€)	8,6	10,1	10,0	12,1	12,0	12,4
Residential sector	Emissions per capita, (kg / capita)	459	460	696	745	775	908
Road transport	CO_2 emissions from passenger transport, (t CO_2 /Mp-km)	84.8	78.5	73.0	73.2	73.0	72.5
Road transport	CO_2 emissions from goods transport, (t CO_2 /Mt-km)	508.1	442.7	392.6	368.6	359.0	357.8
Waste	CH_4 emissions solid waste disposal on land, (kt CH_4 / kt waste)	45.1	47.3	40.1	40.5	40.2	41.0

2.3 Emissions trends per gas

2.3.1 Carbon dioxide

Total CO_2 emissions increased from 84.0 Mt in 1990 to 104.4 Mt in 2003 (without LULUCF), presenting an increase of 31% (**Figure 2.3**).

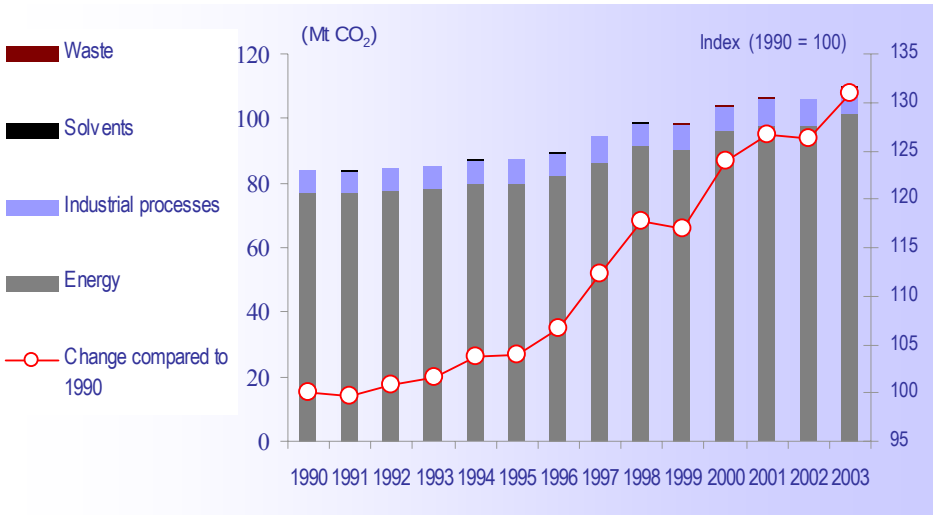


Figure 2.3 CO_2 emissions by sector (in Mt) for the years 1990 – 2003 (without LULUCF)

CO_2 emissions from *Energy* increase almost continuously, from 77.1 Mt in 1990 to 101.6 Mt in 2003, presenting a total increase of 32% from 1990 to 2003. Carbon dioxide emissions from

Industrial processes in 2003 increased by 18% compared to 1990 levels. On the contrary, emissions from *Solvents and other products use* decreased by 8% compared to 1990 levels. Finally, emissions from Waste in 2003 increased almost 11 times compared to 1990.

2.3.2 Methane

The trend of methane emissions from 1990 to 2003 by sector is presented in **Figure 2.4.**

Source categories in the waste sector represent the largest anthropogenic source of methane emissions in Greece, accounting for 45% of total methane emissions in 2003 (without LUCF), but presenting a decrease of 9% compared to 1990 levels. Methane emissions from Agriculture, which is the second largest anthropogenic source of methane emissions, account for 34% of total methane emissions in 2003 and increased by 1.1% from 1990. Methane emissions from the Energy sector (mainly fugitive emissions from coal mining and production, processing, and distribution of liquid fuels and natural gas) account for the remaining 21% of the total methane emissions and increased by 36% from 1990.

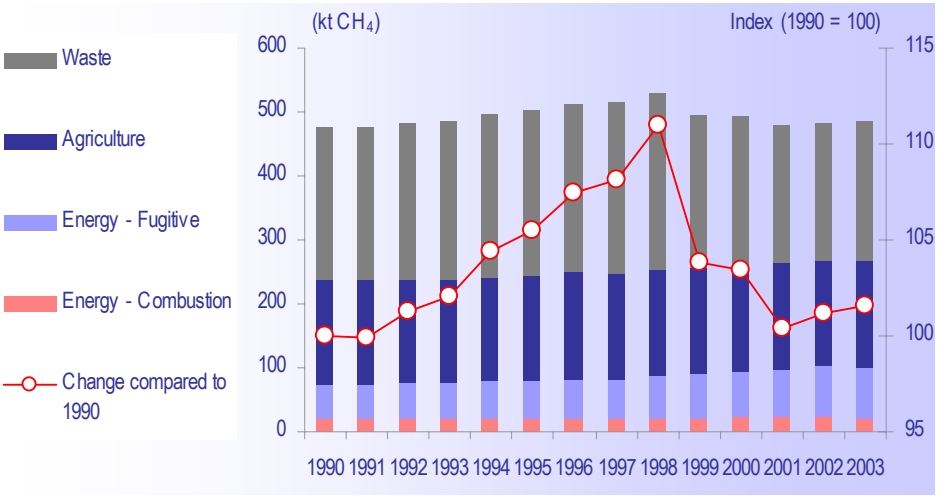


Figure 2.4 CH_4 emissions by sector (kt) for the years 1990 – 2003 (without LULUCF)

2.3.3 Nitrous oxide

The trend of nitrous oxide emissions from 1990 to 2003 by source category is presented in **Figure 2.5.**

Agriculture represents the largest anthropogenic source of nitrous oxide emissions in Greece (64% approximately of the total nitrous oxide emissions in 2003, without LULUCF). Emissions from this sector decreased by 15% since 1990, mainly because of the agricultural practices applied, affecting the use of synthetic nitrogen fertilizers. Nitrous oxide is also produced from the reaction between nitrogen and oxygen during fossil fuel combustion. Nitrous oxide emissions from fossil fuels combustion accounted for 30% of total nitrous oxide emissions in 2003. This increase is mainly attributed to the transport sector as a result of the increasing number of new technology, catalytic

passenger cars. Nitric acid production is the major source of N_2O emissions from *Industrial processes* and accounts for 3% of total N_2O emissions in 2003. Nitrous oxide emissions from this source decreased by 44% from 1990, due to the reduction of nitric acid production in Greece. N_2O emissions from waste in 2003 (3% of total emissions without LULUCF) increased by 15% compared to 1990 levels.

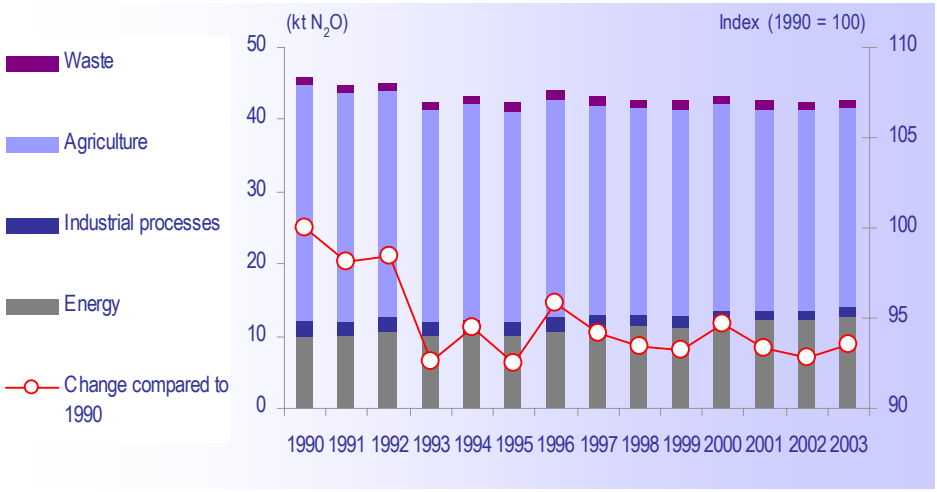


Figure 2.5 N_2O emissions by sector (kt) for the years 1990 – 2003 (without LULUCF)

2.3.4 Halocarbons and SF_6

HFC and PFC are chemical substances, the production of which aims mainly to the substitution of ozone depleting substances (see Montreal Protocol – 1987). HFC and PFC are not harmful to the stratospheric ozone layer and thus their emissions are not controlled by the above-mentioned Protocol. However, many of these substances, as well as SF_6, are powerful greenhouse gases; in addition, apart from being characterized by a high Global Warming Potential (GWP), these gases have extremely long atmospheric lifetimes, resulting in their essentially irreversible accumulation in the atmosphere. Especially sulphur hexafluoride is the most potent greenhouse gas according to the IPCC evaluation.

HFC and PFC emissions in Greece (**Table 2.6**) originate from:

- The production of HCFC-22 (emissions of HFC-23) and aluminium production (emissions of CF_4 and C_2F_6). HFC-23 emissions have been increasing steadily up to 1999 due to the increase of HCFC-22 production, while PFC emissions from aluminium decreased due to the control/reduction of the "anode effect" during the production process, since 1990 (with the exception of the period 1997 – 2000).
- Manufacturing, operation and maintenance of refrigeration (residential sector only) and air conditioning equipment. Emissions from the use of HFC increased significantly since 1995 (base year), mainly due to the increase of air conditioning equipment in the residential sector and the new passenger cars with air-conditioning systems.

Moreover, potential emissions are not estimated, as, for the time being, imports/exports of the relative chemical compounds are not recorded separately.

Table 2.6 F-gases emissions for the years 1990-2003 (in kt CO_2 eq)

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Total HFC	935.1	1106.8	908.4	1637.9	2209.0	3369.0	3916.1	4194.3	4669.6	5436.3	4273.5	3873.0	4008.6	4139.5
HFC-23	935.1	1106.8	908.4	1606.6	2143.9	3253.1	3746.3	3960.2	4359.9	5023.0	3735.1	3181.5	3194.6	3194.6
HFC-32				4.1	8.9	14.4	19.9	26.4	34.3	44.7	57.7	75.8	87.2	101.4
HFC-125				18.3	39.5	63.8	88.3	117.3	152.0	197.5	254.7	333.5	384.3	446.5
HFC-134a				8.9	16.7	37.8	61.6	90.3	123.5	171.1	225.9	282.3	342.5	397.1
Total PFC	257.6	257.6	252.3	152.6	93.6	83.0	71.7	165.3	203.8	131.7	148.4	91.4	88.3	77.3
SF_6	Not estimated													
Total F-gases	1192.7	1364.4	1160.7	1790.5	2302.6	3452.0	3987.9	4359.6	4873.3	5568.0	4421.8	3964.4	4096.9	4216.8

2.4 Emissions trends for indirect greenhouse gases and SO_2

The role of carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane organic volatile compounds (NMVOC) is important for climate change as these gases act as precursors of tropospheric ozone. In this way, they contribute to ozone formation and alter the atmospheric lifetimes of other greenhouse gases. For example, CO interacts with the hydroxyl radical (OH), the major atmospheric sink for methane, to form carbon dioxide. Therefore, increased atmospheric concentration of CO limits the number of OH compounds available to destroy methane, thus increasing the atmospheric lifetime of methane.

These gases are generated through a variety of anthropogenic activities, including fossil fuel combustion, solid waste incineration, oil and gas production and processing, industrial processes and solvent use and agricultural crop waste burning.

From the data of Table 2.3 which presents emissions from indirect greenhouse gases and SO_2 for the period 1990 – 2003, and of the **Figure 2.6** which shows the contribution of the several sectors in total emissions per gas for the same period, arise the following results:

- NOx emissions increased by 14.3% from 1990 to 2003 overall, due to the increased energy consumption in the residential sector. The decrease in NOx emissions from transport after 1998 is attributed to the substitution of old technology vehicles by new catalytic ones. Emissions from industrial processes decreased due to reductions in industrial production.
- The transport sector is the main source of CO emissions. Due to the substitution of old technology vehicles by new and more efficient ones, CO emissions from transport in 2003 decreased by 8.2% compared to 1990, a fact that leads to a total reduction of CO emissions from energy by 6.7%. Emissions from *Industrial processes* remained almost constant.
- NMVOC emissions increased by 2.6% from 1990 to 2003, due to the increased contribution of the transport sector, which is the major source of NMVOC emissions, as a result of the increasing number of motorcycles during the last years. Emissions from industrial processes

decreased due to reductions in the production of certain products such as ammonia. Emissions from Solvents were also decreased.

- SO_2 emissions increased by 12% from 1990 to 2003. Emissions from electricity generation, which is the main source of SO_2 emissions in Greece, increased with a mean annual rate of increase of 2.7% during the period 1990 – 2003. The operation of a desulphurisation plant at a large installation for electricity generation (Megalopoli) since 1998 resulted in the restriction of the increase of SO_2 emissions from electricity generation. Reductions with respect to the sulphur content of liquid fuels had a positive effect in the restriction of the increase of SO_2 emissions from the rest of the energy sector (SO_2 emissions decreased by 21% from 1990 to 2003 in the transport sector and increased by 12% in other sectors despite the significant increase of energy consumption). Emissions from industrial processes decreased due to reductions in industrial production (sulphuric acid production).

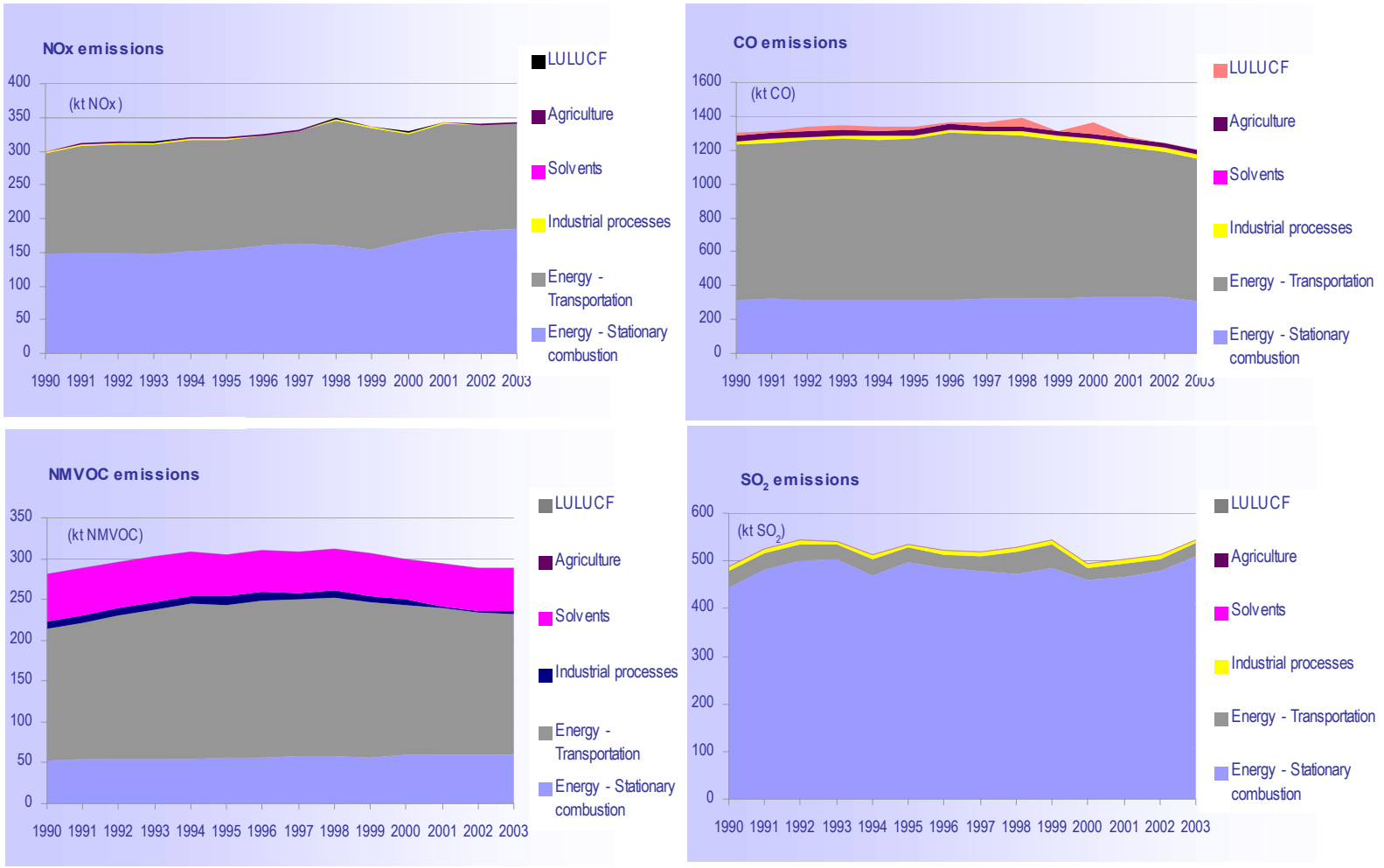


Figure 2.6 Emissions from indirect greenhouse gases and SO_2 per gas and sector for the period 1990 – 2003

2.5 Improvement of GHG emissions / removals inventories

Annual inventories of greenhouse and other gases emissions form an essential element of each national environmental policy-making process. They can be used to derive information on emissions trends, with reference to a pre-selected base year, and can assist in monitoring the progress of existing abatement measures for the reduction of greenhouse gases emissions. Also, they comprise an important tool for the monitoring of the implementation of the provisions of international conventions.

The planning, preparation and management of the national GHG emissions /removals inventory are accomplished according to the provisions of the relative decisions of the Framework Convention, the Kyoto Protocol and the EU (Decision 280/2004/EC of the European Parliament and of the Council *concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol* and Decision 2005/166/EC of the European Committee on the establishment of implementation rules of the Decision 280/2004/EC).

The improvement of the national GHG emissions/removals inventory at a technical level (calculation methodologies, inventory completeness, data processing, documentation) is an on-going activity. The parameters determining the improvements to be made are related with: (a) the results of the various review stages of the national GHG inventory, in national and international level, (b) the results of the key categories analysis and (c) the internal (from the inventory team) evaluation of the inventory.

The main improvements of the Greek GHG inventory implemented since 2002 (submission of 3rd National Communication) are presented in brief, hereafter.

- Calculation of CO_2 emissions from cement production on the basis of the Tier 2 methodology described in the IPCC Good Practice Guidance.
- Calculation of indirect N_2O emissions from Agricultural soils for the first time in the 2004 inventory submission.
- Calculation of CH_4 emissions from enteric fermentation of sheep (approximately 50% of emissions from enteric fermentation) on the basis of the Tier 2 methodology, as CH_4 emissions from enteric fermentation is a key category.
- Concerning the sector of *Waste* (a) CH_4 emissions from industrial waste water handling and (b) N_2O emissions from protein consumption and their consequent treatment through waste water handling systems were calculated for the first time in the 2004 inventory submission.

Figure 2.7 presents GHG emissions estimates according to the 2004 inventory submission (for the years 1990-2003) and the estimates presented in the 3rd National Communication. In total, emissions which presented in the present National Communication are higher compared to those presented in the previous National Communication by approximately 3.5% during the period 1990 - 2000. On the contrary, the average annual rate of emissions increase for the period 1990 – 2000 was decreased from 2.2% in the 3rd National Communication to 1.9% in the 4th National Communication.

In addition a number of actions aiming at the improvement of completeness, the correction of errors and the better documentation were also implemented (for a detailed presentation of actions for the improvement of the national GHG emissions/removals inventory, see MEPPPW, NOA 2004 and MEPPPW, NOA 2005).

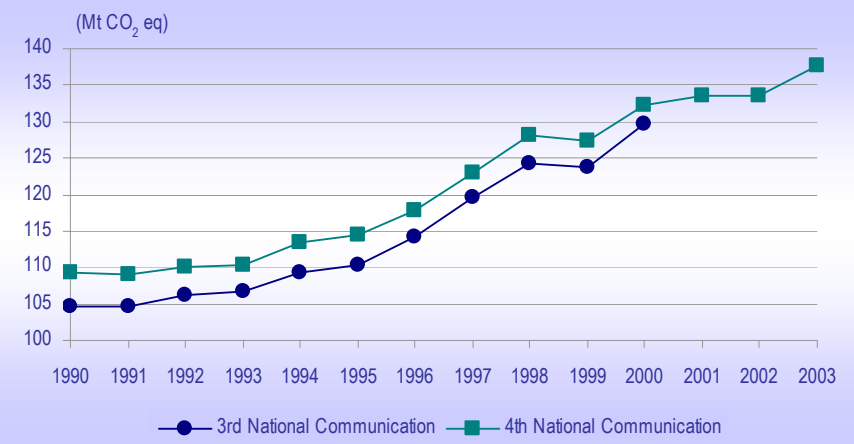


Figure 2.7 GHG emissions (in Mt CO_2 eq) in the 3rd and 4th National Communication

2.6 National System for the GHG emissions/removals inventory

The Ministry for the Environment, Physical Planning and Public Works (MEPPPW) is the governmental body responsible for the development and implementation of environmental policy in Greece, as well as for the provision of information concerning the state of the environment in Greece in compliance with relevant requirements defined in international conventions, protocols and agreements. Moreover, the Ministry for the Environment is responsible for the co-ordination of all ministries involved, as well as any relevant public or private organization, in relation to the implementation of the provisions of the Kyoto Protocol according to the Law 3017/2002 with which Greece ratified the Kyoto Protocol.

In this context and according to the Presidential Decree 51/1988 with which the present organisation for the operation of the Ministry for the Environment was set up, the Ministry and more specifically the ***Department of International Relations and EU Affairs*** (Address: 15, Amaliados str., 11523 Athens, Greece – Contact person: Ms. Elpida Politi, e-mail: epoliti@minenv.gr, tel.: ++30 210 6435740) has the overall responsibility for the national GHG inventory.

2.6.1 Roles and responsibilities in the inventory development process

The Ministry for the Environment has designated, on a contract basis, the National Observatory of Athens (NOA) as the national institution that has the overall technical responsibility for the compilation of the annual national inventory. In this framework, NOA is responsible for the choice of methodologies, data collection (activity data and emission factors, provided by statistical

services and other organizations), data processing and archiving, as well as the implementation of general quality control procedures.

According to the contract signed between NOA and MEPPPW, NOA has the following obligations in relation to GHG emissions/removals inventory:

- Estimation of GHG emissions/removals per source / sink category.
- Compilation of the National Inventory Report and the Common Reporting Format tables.
- Reporting of the required information according to Article 3 of the Decision 280/2004/EC of the European Parliament and of the Council.
- Improvement of the existing inventory system

The National Observatory of Athens co-operates with the following government agencies and other entities (see **Figure 2.8**) for the preparation of the inventory as those agencies and entities develop and maintain statistical data necessary for the estimation of GHG emissions / removals.

- The **Ministry for the Environment, Physical Planning and Public Works** regarding information and data for Large Combustion Plants, solid waste management and domestic wastewater handling practices.
- The **National Statistical Service of Greece,** supervised by the Ministry of Economy and Finance, represents the main source of information for the estimation of emissions / removals from most of the IPCC source / sink categories
- The **Ministry for Development**, that is responsible for reporting and maintaining annual statistical data for energy consumption and production as well as for providing those data to international organizations such as the International Energy Agency (IEA), the European Statistical Service EUROSTAT, etc.
- The **Ministry of Rural Development and Food**, regarding information and data (through the National Statistical Service of Greece which processes primary data collected by the Ministry) for the main indices and parameters of rural economy (e.g. animal population, cultivated areas, crops production, etc.) and forestry.
- The **Ministry of Transport and Communications**, regarding information and data for the vehicle fleet and its technical characteristics. Data from the **Association of Motor Vehicles Importers Representatives** are supplementary to the official data and are only used in cases where official data are temporarily not available.
- The **Civil Aviation Organisation**, regarding information on Landing and Take-off cycles for both domestic and international aviation.
- **Public Power Corporation**, with a view to improve the representation of the power plants as electricity generation is the main source of GHG emissions in Greece
- **Individual industrial installations**, in order to handle confidentiality issues (e.g. aluminium production, production of chemical compounds).

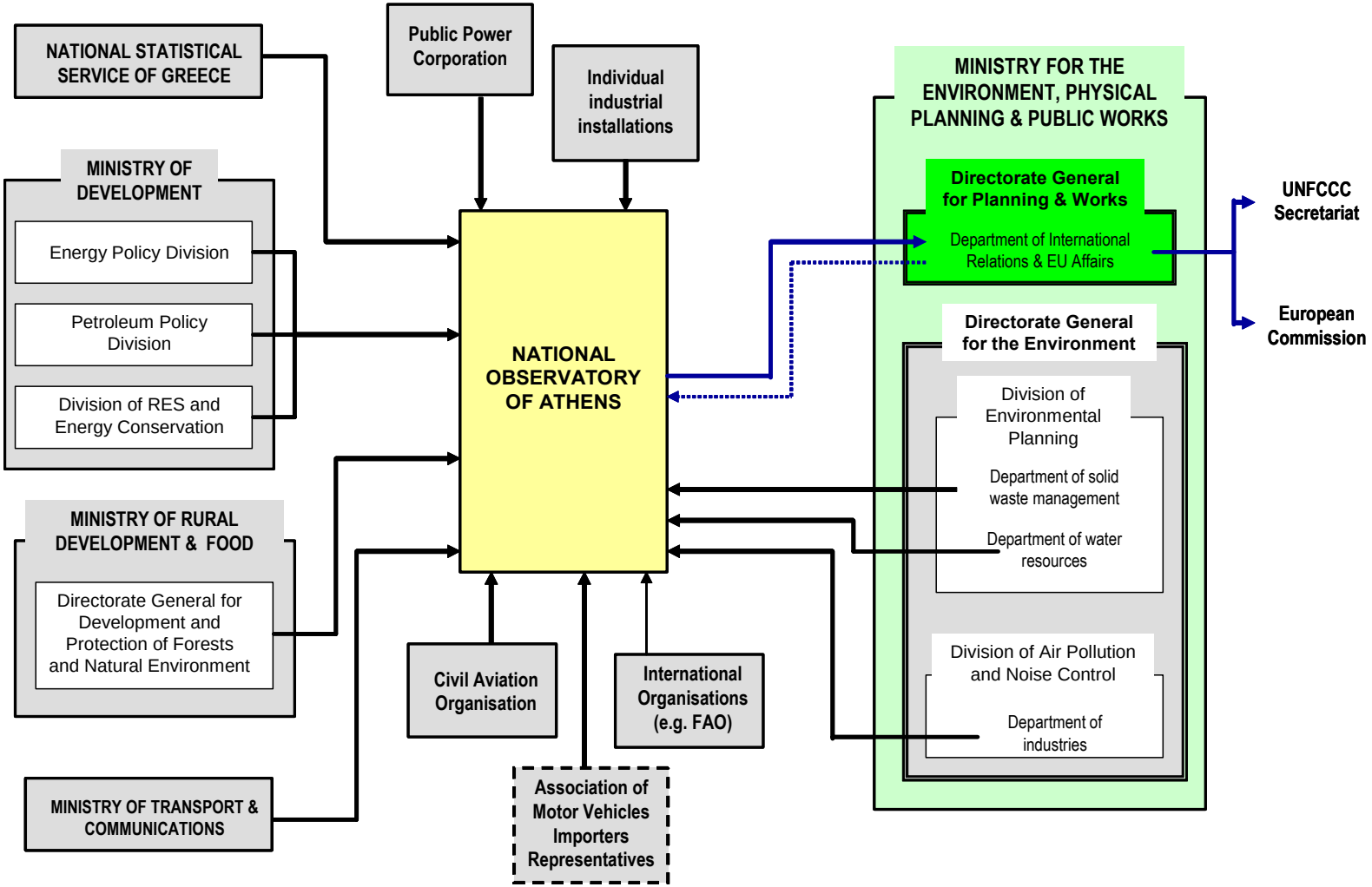


Figure 2.8 Current organizational structure of the national inventory system

The Ministry for the Environment is responsible for the **official consideration and approval** of the inventory prior to its submission. A committee has been set up within the Ministry, aiming at the monitoring of the inventory preparation/compilation process so as to officially consider and approve the GHG inventory prior to its submission to the European Commission and to the UNFCCC Secretariat and ensure its timely submission.

2.6.2 Inventory preparation process

The preparation of the Greek GHG emissions inventory is largely based on the application of the CORINAIR (CORINe AIR emissions inventory) methodology. The compilation of the inventory is completed in three main stages (**Figure 2.9**), while the timetable for their implementation is presented in **Figure 2.10**.

- The **first stage** consists of data collection and processing per source/sink category, taking under consideration the results from the analysis of key source categories of emissions/removals. The main data sources are those mentioned in Paragraph 2.6.1. Once the reliability of the data is assessed, emissions/removals per source/sink category can be estimated
- GHG emissions are estimated (**Stage 2**) on the basis of the methods described in the IPCC Guidelines, the IPCC Good Practice Guidance, the LULUCF Good Practice Guidance and the CORINAIR methodology. Emissions estimates are then transformed to the format required by the CRF tables. This stage also includes the evaluation of the emission factors used and special attention is paid in selecting the emission factors from the above-mentioned methodological resources that better describe practices in Greece.
- The **last stage** involves the internal (i.e. within NOA) check of CRF tables and the compilation of the NIR, which is then commented by the involved government agencies. On the basis of these comments, the final version of the report is compiled and then the NIR is submitted, by the MEPPPW, to the European Commission and to the Secretariat of the Convention.

The information that is related to the annual GHG emissions inventory (activity data, emission factors, analytic results, compilation in the required level of analysis for the CRF tables) is stored in MS Excel spreadsheets. Moreover, the final results (NIR and CRF tables) are available in the NOA Internet site (www.climate.noa.gr).

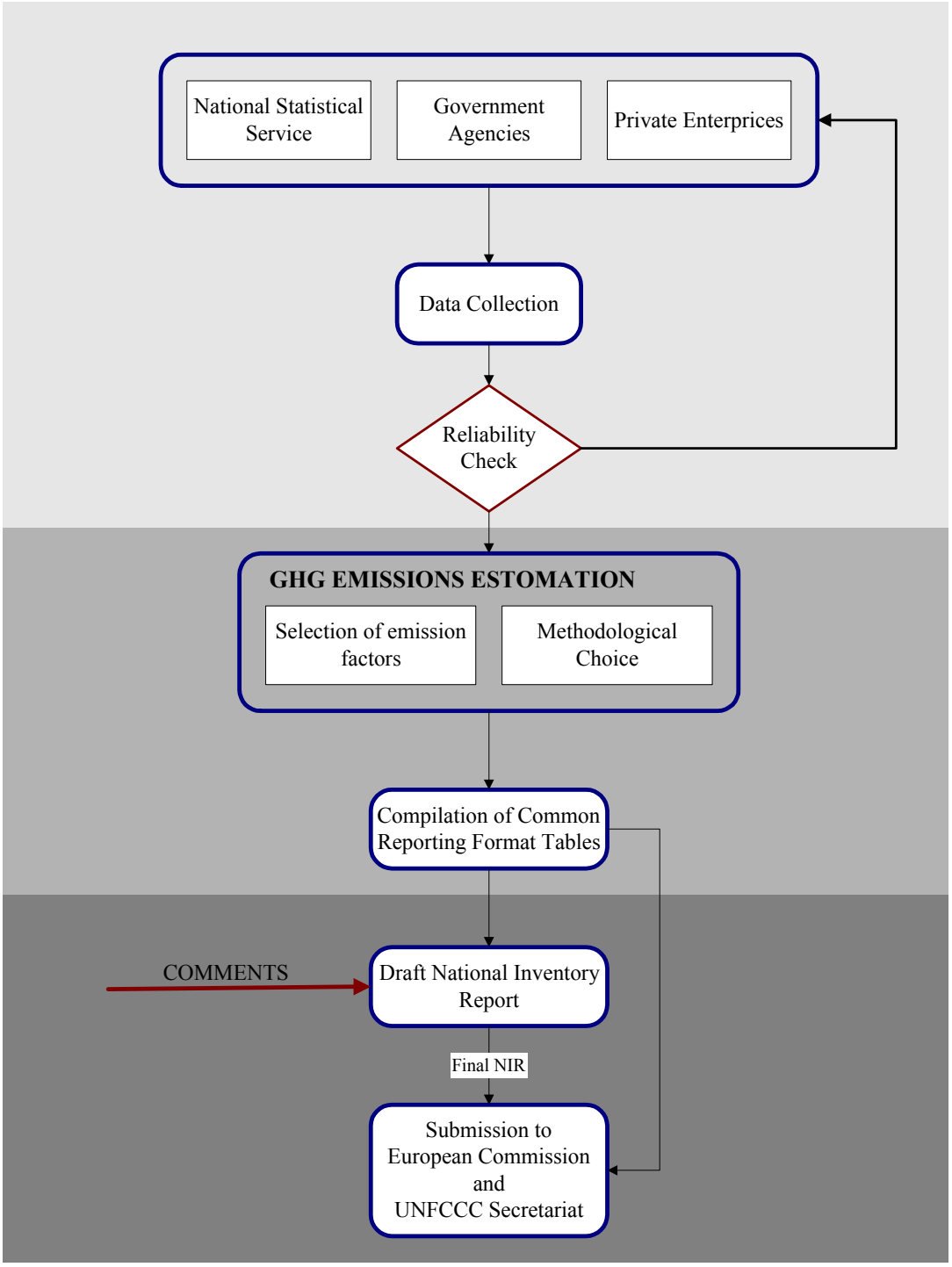


Figure 2.9 GHG emissions/removals inventory preparation process in Greece

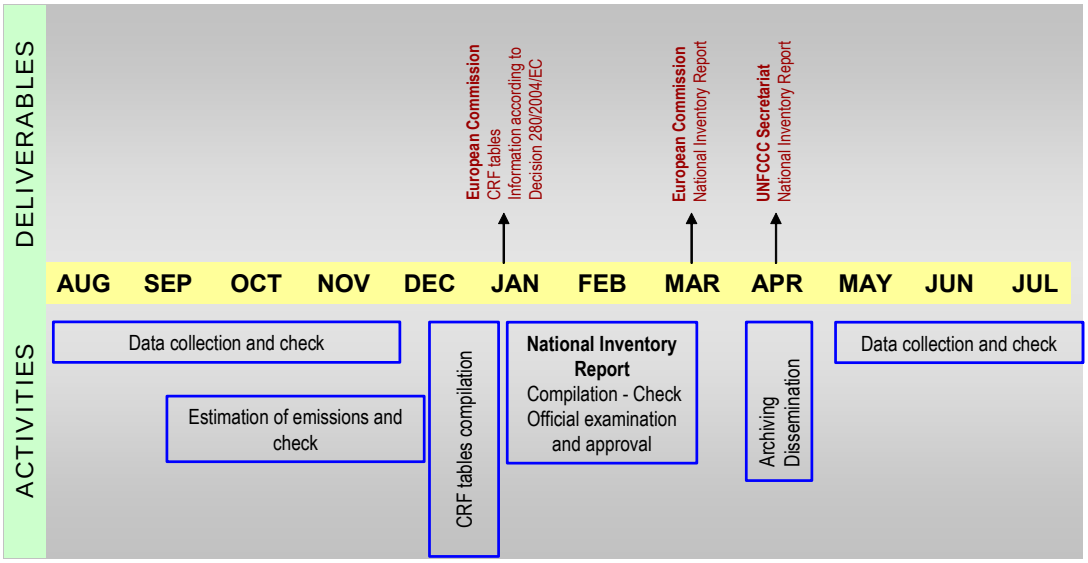


Figure 2.10 Time table for the preparation and submission of GHG emissions/removals inventory in Greece

The GHG emissions /removals per source / sink category have been estimated based on the methodologies described in the IPCC Guidelines, the IPCC Good Practice Guidance, LULUCF Good Practice Guidance and the CORINAIR programme[3]. The applied methodologies for the calculation of emissions/removals for the Greek inventory system are presented in brief in **Annex I**.

Special attention was paid in selecting the emission factors from the above-mentioned methodological resources that better describe practices in Greece. In some cases (e.g. PFC emissions from primary production of aluminium), plant-specific emission factors are used.

The key categories analysis (see Paragraph 2.6.3) constitutes the basic tool for methodological choice so as to ensure the accuracy, the precision and the completeness of produced. At the same time, however, the availability of resources (human and financial) is also considered so that the on time preparation of the inventory is not affected.

Recalculation of emissions/removals represents an important activity during the inventory preparation, as it is a basic tool to improve the inventory in such a way that it would be in agreement with the requirements of the IPCC Good Practice Guidance. The results of the various review stages of the national GHG emissions/removals inventory, in national and international level, determine the general framework of the required recalculations, while the priorities are set by the inventory team taking into consideration the results of the key categories analysis.

2.6.3 Key categories analysis

The IPCC Good Practice Guidance defines, among others, procedures (in the form of decision trees) for the choice of estimation methods within the context of the IPCC Guidelines aiming at the

[3] Emissions estimates from road transport derive from the implementation of the COPERT III model (COmputer Program to calculate Emissions from Road Transport), developed for the Commission of the European Communities

reduction of the uncertainty of the relative calculations, considering at the same time the cost for the implementation of analytic and low uncertainty methods. Therefore it is good practice to identify those source categories (key source category). In that context, a "key source category" is one that is prioritised within the national inventory system because its estimate has a significant influence on a country's total inventory of direct greenhouse gases in terms of the absolute level of emissions (level assessment) or/and to the trend of emissions (trend assessment). For these key sources the most accurate of the recommended methods should be applied, according to the availability of financial resources, and appropriate programs for the improvement of inventories should be formulated, where it is judged as necessary. As a result of the adoption of the LULUCF Good Practice Guidance (Decision 13/CP.9) the concept of key sources has been expanded in order to cover LULUCF emissions by sources and removals by sinks. Therefore the term key category is used in order to include both sources and sinks.

The determination of the key categories for the Greek inventory system is based on the application of the Tier 1 methodology (see MEPPPW, NOA 2005 for the analytic presentation of calculations) described in the IPCC Good Practice Guidance, adopting the categorization of sources that is presented in the relevant table of the IPCC Good Practice Guidance. Tier 1 methodology for the identification of key categories assesses the impacts of various categories on the level and the trend of the national emissions inventory. Key categories are those which, when summed together in descending order of magnitude, add up to over 95% of total emissions (level assessment) or the trend of the inventory in absolute terms

In **Table 2.7** the results of key categories analysis, according to the 2005 inventory submission are presented.

Table 2.7 Key categories for the Greek inventory system including LULUCF

IPCC source categories	Gas	Criteria
ENERGY		
Stationary combustion – Solid fuels	CO_2	Level, Trend
Stationary combustion – Solid fuels	N_2O	Level
Stationary combustion – Liquid fuels	CO_2	Level, Trend
Stationary combustion – Liquid fuels	N_2O	Level
Stationary combustion - Gas	CO_2	Level, Trend
Transport – Road transport	CO_2	Level, Trend
Transport – Road transport	N_2O	Trend
Transport – Navigation	CO_2	Level, Trend
Coal mining and handling	CH_4	Level
INDUSTRIAL PROCESSES		
Cement production	CO_2	Level, Trend
Limestone and dolomite use	CO_2	Trend
Nitric acid production	N_2O	Trend
Production of HCFC-22	HFC-23	Level, Trend
Consumption of halocarbons and SF_6	F-gases	Trend
AGRICULTURE		
Enteric fermentation	CH_4	Level, Trend
Agricultural soils – Direct emissions	N_2O	Level, Trend
Agricultural soils – Animal production	N_2O	Level, Trend
Agricultural soils – Indirect emissions	N_2O	Level, Trend
LAND USE, LAND USE CHANGE AND FORESTRY		
Forest land remaining forest land	CO_2	Level, Trend
Cropland remaining Cropland	CO_2	Level, Trend
Land converted to Forest Land	CO_2	Trend
WASTE		
Solid waste disposal on land	CO_2	Trend
Solid waste disposal on land	CH_4	Level, Trend
Wastewater handling	CH_4	Trend

2.6.4 Quality assurance – Quality control system

The development and the implementation of an inventory Quality Assurance / Quality Control (QA/QC) plan represents a key tool for meeting the objectives of National Systems under Article 5(1) of the Protocol as described in Decision 20/CP.7.

With the Protocol into force, it is expected that the pressure upon national GHG emissions inventories will increase and therefore quality management would be essential to comply with the requirements of (a) producing transparent, consistent, comparable, complete and accurate emissions estimates, (b) establishing a reliable central archiving system concerning all necessary information for GHG emissions inventories development and (c) compiling national reports according to the provisions of the adopted decisions.

In this framework, NOA, in close co-operation with MEPPPW, has developed an inventory QA/QC system that is being implemented since April 2004. The system is based on the ISO 9001:2000 standard and its quality objectives, as stated in the quality management handbook, are the following:

1. Compliance with the IPCC guidelines and the UNFCCC reporting guidelines while estimating and reporting emissions/removals.
2. Continuous improvement of GHG emissions/removals estimates.
3. Timeliness submission of necessary information in compliance with relevant requirements defined in international conventions, protocols and agreements.

The accomplishment of the above-mentioned objectives can only be ensured by the implementation, from all the members of the inventory team (see **Figure 2.11** for the organisation chart of NOA activities concerning emissions inventory), of the QA/QC procedures included in the plan for:

- data collection and processing,
- applying methods consistent with IPCC Good Practice Guidance and LULUCF Good Practice Guidance for calculating / recalculating emissions or removals,
- making quantitative estimates of inventory uncertainty,
- archiving of information and record keeping and
- compiling national inventory reports

The QA/QC system developed covers the following processes:

- **QA/QC system management**, comprising all activities that are necessary for the management and control of the inventory agency in order to ensure the accomplishment of the above-mentioned quality objectives.
- **Quality control** that is directly related to the estimation of emissions. The process includes activities related to (a) data inquiry, collection and documentation, (b) methodological choice in accordance with IPCC Good Practice Guidance, (c) quality control checks for data from secondary sources and (d) record keeping.
- **Archiving of inventory information**, comprising activities related to centralised archiving of inventory information and the compilation of the national inventory report.
- **Quality assurance**, comprising activities related to the different levels of review processes including the review of input data from experts, if necessary, and comments from the public.
- **Estimation of uncertainties**, defining procedures for estimating and documenting uncertainty estimates per source / sink category and for the whole inventory.
- **Inventory improvement**, that is related to the preparation and the justification of any recalculations made.

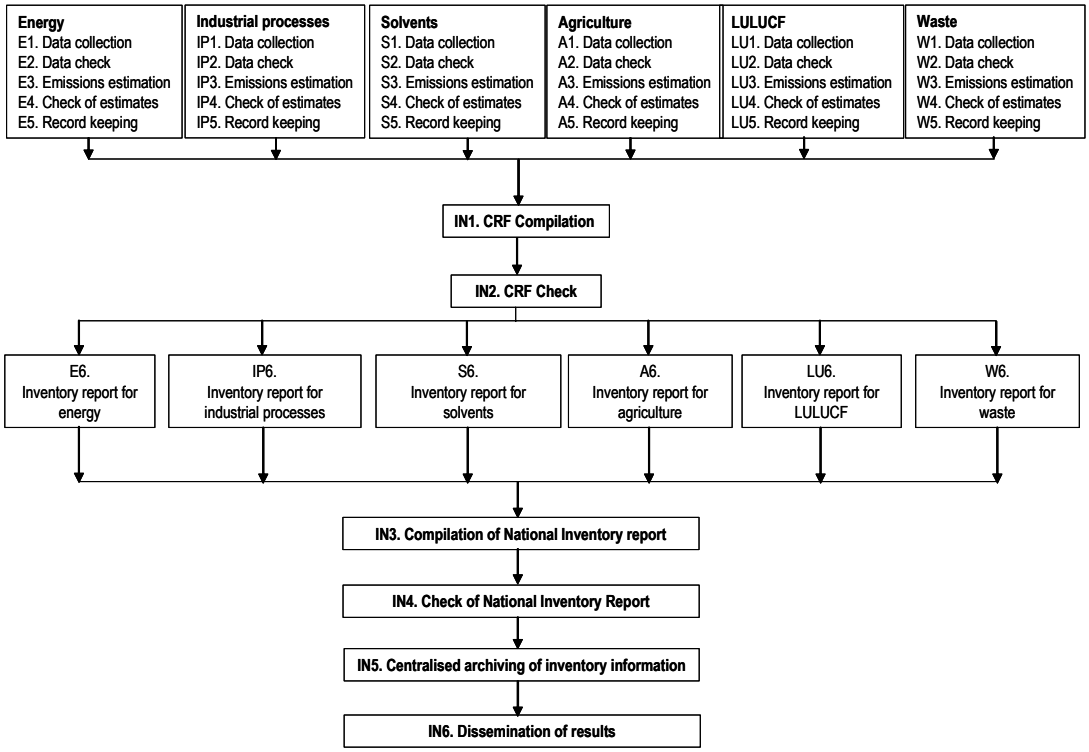


Figure 2.11 Organisation chart of NOA (inventory team) activities concerning emissions inventory

The list of procedures within each process and the relationship between the processes and the activities for the implementation of the inventory (according to those reported in Paragraph 2.6.2) are presented in **Figure 2.12**.

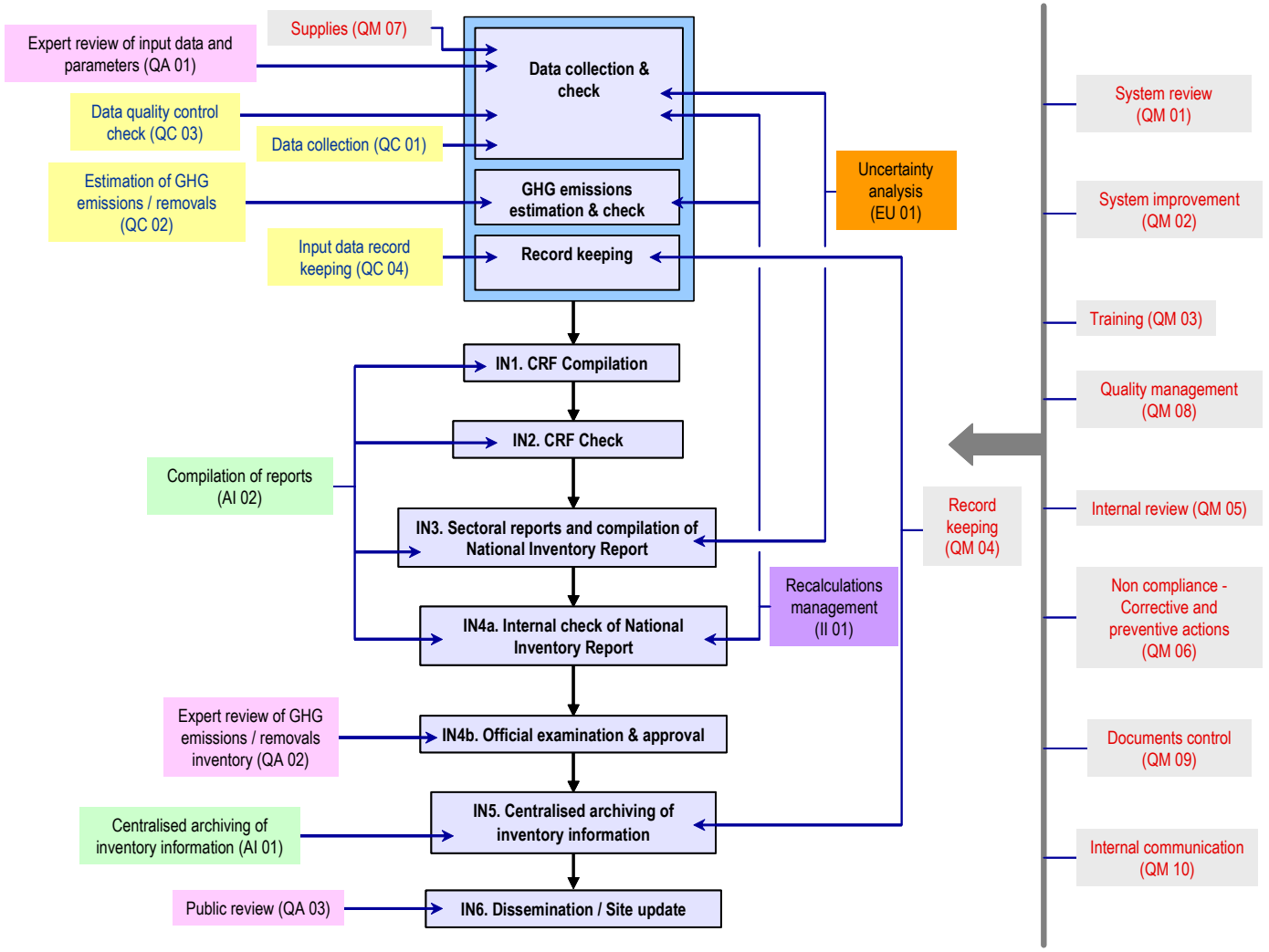


Figure 2.12 QA/QC processes and procedures and inventory related activities

3 POLICIES AND MEASURES

3.1 Policy-making process

3.1.1 Overview

The Ministry for the Environment, Physical Planning and Public Works (MEPPPW) is the main governmental body entrusted with the development and implementation of environmental policy in Greece. MEPPPW is responsible, among others, for the formulation of policies concerning environmental protection, for the coordination of implementation efforts and to ensure compliance with the current legislative framework. For this purpose, MEPPPW cooperates both with other competent ministries and with regional, prefectural and local authorities. Other ministries are responsible for integrating environmental policy targets within their respective fields (see **Table 3.1**).

Table 3.1 Responsibilities of other Ministries (except MEPPPW) concerning issues of environmental policy in Greece

Ministries	Responsibilities
Ministry of Rural Development and Food	Protection of forests – Management of water resources for agricultural use – Implementation of agricultural/environmental measures – Information of farmers on environmental issues
Ministry for the Aegean & Island policy	Environmental management and sustainable development of the Aegean islands
Ministry for Development	Control of fuel quality - Management of water resources – Industrial development and prevention of pollution – Energy policy – Severe Industrial accidents
Ministry of Mercantile Marine	Protection of marine environment
Ministry of Foreign Affairs	International environmental obligations
Ministry of Employment and Social Protection	Safety in the environment of work – Risk management in professional places
Ministry of the Interior, Public Administration and Decentralisation	Natural and technological disasters
Ministry of Macedonia and Thrace	Pollution control of in North Greece
Ministry of Transport and Communications	Control of vehicles
Ministry of Economy and Finance	Support of environmental investments – Energy and Environmental taxation - System of products distribution
Ministry of Culture	Conservation of historical and cultural monuments
Ministry of Health and Social Solidarity	Management of environmental risk and hygiene
Ministry of Tourism	Touristic policy and environment

The responsibilities on environmental issues at regional level concern the approval of environmental impact studies and the issuance of decisions on environmental terms. The responsibilities of prefectural authorities concern, among others, (a) the development and application of environmental policies and strategies at local level, (b) the adoption of Prefectural or Common Prefectural Decisions on local environmental issues, and (c) the implementation of the physical planning projects which have been approved by the Ministry. Finally, the municipal and community authorities are responsible for licensing procedures for installations in urban areas,

including specific industrial installations, as well as for issues related to solid waste disposal on land.

Climate change mitigation is one of the main targets identified in the Greek policy for sustainable development launched by MEPPPW in 2002. The objective of the strategy is the development of a set of principles for the formulation of an action plan in line with international challenges, and in accordance with EU policy directions and adjusted to the specific national circumstances. The key environmental issues examined in this framework are:

- Climate change mitigation
- Reduction of air pollutants
- Reduction and rational waste management
- Rational management of water resources
- Prevention of desertification
- Protection of biodiversity and ecosystems

Policies and measures, as well as all other issues and actions regarding mitigation are discussed within the framework of an inter-ministerial committee, comprising representatives from the following ministries/organisations:

- Ministry for the Environment, Physical Planning and Public Works
- Ministry of Foreign Affairs
- Ministry of the Interior, Public Administration and Decentralization
- Ministry of Economy and Finance
- Ministry for Development
- Ministry of Mercantile Marine
- Ministry of Transport and Communications
- Ministry of Rural Development and Food
- Public Power Corporation

Final approval of policies and measures related to climate change mitigation rests with the Council of Ministers.

3.1.2 Legislative arrangements and administrative procedures for the implementation of the Kyoto Protocol

In response to the emerging evidence that climate change could have a major global impact, the United Nations Framework Convention on Climate Change (henceforth the Convention) was adopted on 9 May 1992 and was opened for signature in Rio de Janeiro in June 1992. Greece signed the Convention in Rio and ratified it in 1994 (Law 2205/94).

In that framework, the third meeting of the Conference of the Parties (COP) to the Convention, held in Kyoto (1-11 December 1997), finalised the negotiations related to the establishment of a legal instrument; the Kyoto Protocol on Climate Change. The Protocol provides a foundation upon which future action can be intensified and introduced, for the first time, legally binding commitments for developed countries to reduce emissions of greenhouse gases. Detailed rules for the implementation of the Protocol were set out at the 7th Conference of the Parties (in Marrakech) and are described in the Marrakech Accords adopted in 2001.

The Protocol entered into force on 16 February 2005, after its ratification from 141 Parties (with the exception of USA and Australia) including developed countries with a contribution of more than 55% to global CO_2 emissions in 1990.

With respect to the EU target under the Kyoto Protocol (i.e. reduction of emissions at 8% for the period 2008-2012), EU has stated that this will be achieved jointly by EU Member-States under the provisions of Article 4 of the Protocol. The Burden-Sharing agreement between all Member States was finalised during the Environment Council in June 1998 and entered into force with Decision 2002/358/EC concerning the approval, on behalf of the European Community, of the Kyoto Protocol. According to this agreement, Greece is committed to limit its GHG emissions increase for the period 2008 – 2012 to +25% compared to base year emissions (1990 for CO2, CH4 and N2O emissions – 1995 for F - gases).

Greece ratified the Kyoto Protocol in 2002 (Law 3017/2002) and adopted a National Programme (MEPPPW / NOA 2002) for achieving its commitment by a decision of the Council of Ministers (DCM5/2003). By Law 3017/2002 the MEPPPW is designated as the governmental body responsible for the coordination, within its responsibilities, of all other competent ministries and possibly any other public and / or private entities involved, for:

1. the implementation of the provisions of the Kyoto Protocol and
2. the formulation and monitoring of the National Programme for achieving the national targets set under the Kyoto Protocol.

Moreover, with this law it is defined that all issues related to the implementation of the provisions of the Kyoto Protocol, including among others, the establishment of the necessary administrative structures and procedures, enforcement rules, etc. are to be resolved and adopted by Common Ministerial Decisions of the Minister for the Environment, Physical Planning and Public Works and other, as appropriate, competent Ministers. The same procedure is to be followed in order to introduce into the national legislation any decisions of the COP and/or COP/MOP or any necessary modifications to the National Programme.

With the Common Ministerial Decision 54409/2632 (2005), the Directive 2003/87/EC "establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC" has been transcribed into the Greek legislation. With this Decision, the Ministry for the Environment, Physical Planning and Public Works is designated as the responsible authority for the implementation of the relative provisions. The co-ordination of all competent authorities is assigned to a seven-member inter-ministerial committee (3 members from the MEPPPW, 2 members from the Ministry for Development and 2 members from the Ministry of Economy and Finance). The competent authority for the monitoring of the implementation of the

provisions of the Directive 2003/87/EC is assigned to Office for Emissions Trading, established in the framework of the above-mentioned Decision, and operating within the Directorate General for the Environment. Finally, with the same Decision the National Centre of Environment and Sustainable Development, an institute supervised by MEPPPW, is responsible for operating the National Registry.

As already mentioned, the Ministry for the Environment, Physical Planning and Public Works (MEPPPW) is responsible for the monitoring of the implementation of the 2nd National Programme for Climate Change, 2000 – 2010. In this context, the development of a computational system (a database in SQL environment) aiming at improving the co-ordination of all competent authorities and the provision of all necessary information regarding the expected effects of policies and measures in place, is in progress.

This system, which is under development (the first version of the system has already been installed in MEPPPW for evaluation) will carry out the following tasks:

1. Provision of information regarding the policies and measures that are already implemented.
2. Evaluation of the progress regarding the implementation of the policies and measures through the development and assessment of appropriate indicators.
3. Provision of necessary information and data to facilitate the compilation of National Communications and other progress reports.

To this end, the database is organised into 4 thematic areas:

(A) **Basic data**. This category includes general data as population, GDP, buildings etc, energy production and consumption data, as well as information from the GHG emissions / removals inventory.

(B) **Horizontal policies and measures**, where the existing legislative framework for the implementation of the provisions of the Kyoto Protocol, policies for the reduction / enhancement of emissions / removals as well as elements of the energy policy (e.g. taxation) are included.

(C) **Sectoral measures**, where the measures identified in the 2nd National Programme are described.

(D) **Flexible mechanisms of the Protocol**, where general information from the National Registry will be included.

3.2 Policies and measures and their effects

3.2.1 Supporting policies for the restriction of GHG emissions

In this Paragraph a short overview of the most important supporting policies and tools which are related with the implementation of measures for the restriction of GHG emissions in Greece is presented. Emphasis is given in the 2nd National Climate Change Program which aims in the restriction of emissions in the time horizon of 2010, in establishing a system of emissions allowance trading which has already began to be applied since 2005, and in the financing mechanisms that have been developed in the frame of the 3rd Community Support Framework in order to support the implementation of projects which inter alia also contribute in the restriction of GHG emissions.

3.2.1.1 The 2nd National Climate Change Program of GHG emissions reduction for the period 2000-2010

The 2nd National Climate Change Programme, that was elaborated and adopted in 2002 (Act of the Ministerial Council 5/27.02.2003, Official Journal of the Hellenic Republic A' 58 – 05.03.2003) defines the additional policies and measures necessary for Greece to meet its Kyoto target, i.e., restricting the increase of GHG emissions to 25% over the time period 2008–2012, compared to base year emissions.

The 2nd National Program has been presented in detail in the 3rd National Communication on Climate Change. The main actions foreseen include:

- Further penetration of natural gas in all final demand energy sectors as well as in power generation, including co-generation.
- Promotion of renewable energy sources (RES) for electricity and heat production.
- Promotion of energy saving measures in industry and in the residential – tertiary sectors.
- Promotion of energy efficient appliances and energy equipment in the residential – tertiary sectors.
- Structural changes in agriculture and in chemical industry.
- Emission reduction actions in transport and waste management sectors.

The above mentioned generalised actions comprise specific interventions in each sector of economic activity, for every one of which the potential of GHG emissions reduction is estimated. There is a distinction between: (a) technological potential, for which a higher degree of penetration / implementation of the examined measures and no interferences between them is assumed and (b) economic potential, for which more realistic degrees of penetration / implementation of the various measures are assumed while possible interferences between two or more parallel implemented measures are also taken into consideration. Based on the calculations included in the 2nd National Program the implementation of the aforementioned measures will lead to the achievement of the Kyoto objective for Greece, exclusively with domestic actions and measures. It is also pointed out that this consideration does not exclude the potential exploitation of Kyoto Protocol Flexible Mechanisms, provided that it is judged advisable and all rules for these mechanisms are applied.

The implementation of policies and measures included in the 2nd National Program is at its initial phase. Some major parts of the program, as for example the penetration of natural gas into the energy system as well as the further development of RES, have made considerable progress, while additional supporting actions for the continuation and enforcement of these actions (e.g. completion of the legislative framework for the liberalization of electricity and energy markets that will allow the installation of new power generation units using natural gas as fuel, extension of the natural gas networks in the cities, enforcement of electricity transmission networks that will allow the exploitation of the rich wind potential of some remote areas, etc.) have been adopted. Actions to introduce energy conservation measures in the residential/tertiary sectors on the other hand, have encountered major delays due mainly to administrative problems in the adoption of the Regulation for Rationale Use and Conservation of Energy, which is also to incorporate the Community Directive 2002/91/EC for energy efficiency of buildings.

3.2.1.2 Emissions trading system

In 2005 the European CO_2 emissions trading system (EU-ETS) started operating. It covers a number of industrial and energy sector installations which exceed specific capacity limits set by Community Directive 2003/87/EC. The major objective of EU-ETS is to help the EU Member States to achieve their obligations in the frame of the Kyoto Protocol in terms of economic efficiency.

In brief, the basic functional characteristics of the emissions trading system include: (a) the determination of a number of emissions allowances which are allocated a priori in the liable installations based on specific rules, while the above mentioned installations are obliged to hand over emissions allowances in annual base equal to the CO_2 emissions that emitted in the year in question, (b) the total number of allowances for distribution is lower than the emissions that the indebted installations would emit if the trading system did not exist, so that the created closeness of allowances constitutes an incentive for emissions reductions, (c) in the first implementation period (2005-2007) the trading of allowances is limited to CO_2 and in installations of specific industrial sectors which exceed the predetermined capacity limits (in the future the Directive can be modified and include also other gases and/or sectors), (d) the distribution of emissions allowances is made on the basis of an allocation plan which is formulated, placed on consultation and is completed before the beginning of the trading period, (e) a strict framework for monitoring and compliance enforcement of the liable installations is put in place which provides for substantial fines in case on non-compliance, and (f) all the transactions of emissions allowances are recorded in national and interconnected community-wide Registries.

In Greece, the trading system comprises 141 existing industrial installations and 27 new installations that are expected to start their operation during the period 2005-2007 (new entrants). An allowance reserve is also created which is intended to cover possible unknown new entrants in the period. According to the data presented in the National Allocation Plan (NAP), total CO_2 emissions from installations included in the EU-ETS are estimated at 228.1 Mt CO_2, for the three-year period 2005-2007, while the allowances that will be allocated during the same period were fixed at 223.3 Mt CO_2 (namely a decrease of emissions by 2.1% is required by the enterprises that participate in the system).

3.2.1.3 Operational Programme Competitiveness (OPC)

The Operational Programme Competitiveness of the Ministry of Development, which comes under the 3rd Community Support Framework (3rd CSF) for the period 2000-2006, constitutes one of the major tools for the promotion of interventions that may lead to GHG emissions reduction. The total budget OPC amounts to €6.6 billion, of which the community contribution is 2.06 billion €, the Greek public spending €1.29 billion and the private funding €3.32 billion.

The OPC includes 9 priority sectors with 41 measures, which in turn comprise a total of 134 actions. These actions are designed to implement the corresponding policies in the Programme's areas of intervention. A central feature of the Operational Programme is to support entrepreneurship in such areas as new technologies, the liberalized energy markets, environment, tourism but also to fund actions for business modernization, especially addressed to small and medium-sized enterprises engaged in manufacturing-processing, tourism and the service sectors. Under the OPC, projects are promoted projects to upgrade industrial regions, the national quality assurance system, energy infrastructures and regional structures providing information, consultation, education and management support to businesses.

As reported analytically below, the OPC aims to finance or co-finance the further development of infrastructure for the penetration of natural gas (through interconnections with networks of natural gas of neighbouring countries, further development of local networks, etc.) and RES into the electricity system (through the development of special energy infrastructures, interconnection of island grids, upgrading of electric transmission networks, etc.). It also finances specific investments for energy savings, installation of co-generation systems, installation of RES systems, etc. The total cost of measures in the OPC that aim at the further penetration of natural gas and RES as well as in the implementation of measures for energy saving amounts to €2.27 billion (34% of the total budget of the program), of which the public expenditure is €0.54 billion.

3.2.1.4 Operational Programme Environment (OPE)

The Operational Programme Environment, which also comes under the 3rd Community Support Framework, promotes inter alia special actions for the reduction of atmospheric pollution, particularly for the regions of Athens and Thessalonica. It also finances or co-finances actions for the reinforcement of infrastructure for monitoring the quality of atmospheric environment and developing information management systems that support measures for the reduction of atmospheric pollution, as specified in relevant European Legislation.

Specifically, it includes measures, actions and interventions aiming at:

- Fulfilling the country's commitments that arise from the relative Directives of the EU and international conventions.
- Interventions in the sources of atmospheric pollution.
- Actions for the fulfilment of obligations which arise from international Treaties and Conventions concerning climate change issues and protection of the ozone layer.
- Traffic management in the big urban centres of the country.
- Reducing noise in urban and tourist developed regions.

The total budget for OPE is €21.47 million and the implementation of its actions is expected to also contribute to the restriction of GHG emissions.

3.2.2 Implemented – Adopted – Planned measures

In this Paragraph the implemented, adopted and planned policies and measures in Greece aiming at reducing GHG emissions in order to meet the Kyoto target are presented in brief. These policies and measures were analyzed in sufficient detail in the context of the 2nd National Climate Change Program (2000-2010) and the 3rd National Communication to the UNFCCC, with respect to their emissions reduction potential and economic efficiency. In **Annex II** updated estimates of the expected effects of these policies and measures are given in the time horizon of the year 2010, which in addition constitutes the midpoint of the 1st commitment period of the Kyoto Protocol, as well as certain preliminary estimations for 2015.

The differences observed between the emissions reduction potential presented in this report and the corresponding estimates included in the 3rd National Communication are mainly attributed to the following reasons:

- The "with measures" scenario of GHG emissions has been updated on the basis of more recent information and data on critical parameters for the analysis (e.g. growth rate of GDP, energy prices, etc). Furthermore, the "with measures" scenario incorporates a number of new policies implemented at EU level (e.g., Directive 2003/30/EC on the promotion of biofuels, Regulation 2037/2000 on substances that deplete the ozone layer, etc.), which affect GHG emissions.
- More recent data regarding the penetration of renewable energy sources in the various sectors of economy and particularly in the power sector became available and therefore have been used in this analysis.
- The degree of implementation of some measures, mainly in the residential and tertiary sectors, has been slightly revised, taking into account more realistic assumptions.

The total realistic GHG emissions reduction potential from the implemented and adopted policies and measures was calculated at 28.3 Mt CO_2eq for 2010 and at 37.6 Mt CO_2eq for 2015, if possible interferences between these implemented/adopted measures, which may restrict the estimated GHG emissions reduction potential, are excluded. Thus, it is obvious that the application of the already implemented and adopted measures for the restriction of GHG emissions contributes considerably in the restriction of the augmentative trend of emissions that characterizes the Greek economy which is developed with particularly high rates.

Respectively, the total GHG emissions reduction potential for the planned policies and measures was estimated at 11.1 Mt CO_2eq for 2010 and at 16.4 Mt CO_2eq for 2015, also without taking into account the possible interferences between them. Planned measures have been identified in the context of the 2nd National Climate Change Program (2000-2010), with a view to ensure compliance with the target set in the framework of the Kyoto Protocol for Greece. The estimation for the emissions reduction potential in the time horizon of 2015 has been based on specific assumptions concerning further penetration/implementation of the planned policies and measures,

taking into account the dynamics that will develop from the fulfilment of the targets of the 1st Commitment Period of the Protocol. The implementation of the planned policies and measures contributes in substantial further reductions of GHG emissions leading to the achievement of the Kyoto objectives exclusively with domestic measures and actions. The effect of the above measures in the long-term development trend of emissions per sector of economic activity is presented more analytically in the next Chapter (Paragraph 4.5). However, it is pointed out that the implementation of the examined measures influences mainly the emissions trend in the sectors of energy and industrial processes, slowing down considerably the expected sectoral rates of emissions growth in both cases.

3.2.2.1 Promotion of natural gas

The introduction of natural gas into the national energy system is one of the largest investments ever carried out in Greece. An important part of the infrastructure that is mainly related to the high-pressure transmission system and the medium-pressure network, which are necessary to transport of natural gas to the main consumption regions, has been completed. The development of low-pressure networks in the cities is ongoing and is also financed in the framework of OPC.

The penetration of natural gas into the Greek energy system constitutes a high priority of the Greek energy policy. This is also reflected in the pricing policy that has been adopted for natural gas. The Value Added Tax (VAT) is fixed at 9%, while the consumption of natural gas is exempted from any excise tax up to 1 Jan 2014. With the incorporation into the national legislative framework of Directives 1998/30/EC and 2003/55/EC, the liberalization of the gas market has started, while a number of issues concerning natural gas supply and transmission, the role of Regulatory Authority for Energy, the enhancement of gas security of supply etc. are also addressed.

In the context of OPC, funding of €800 million has been provided to the Public Gas Corporation investment programme for the period 2000-2006 for a number of projects that (a) enhance access to alternative sources of gas supply through the connection of the Greek system with Italy and Turkey - Actions 6.1.1 and 6.1.2 of the OPC -, (b) upgrade of the terminal station of Liquefied Natural Gas of Revithousa - Action 6.2.1 of the OPC -, (c) further increase penetration of natural gas in big industrial consumers as well as in the sector of transports - Actions 7.1.2 and 7.1.3 of the OPC -). Also, with the Action 7.1.1 of the OPC the extension of the cities networks aiming at a further penetration of natural gas in the residential - tertiary sectors is financed.

According to the most recent energy balance (2003), the penetration of natural gas seems to be at satisfactory levels in the power generation sector (1462 ktoe) where the installed capacity of power units that use natural gas has reached 1581MW as well as in the industrial sector (504 ktoe), but less so in the residential and tertiary sectors (a total consumption of approximately 46 ktoe has been recorded) mainly due to delays in the development of the low-pressure networks in cities. Small quantities of natural gas (approximately 12 ktoe) were also consumed in the transport sector where CNG buses were introduced into the Athens public transport network in 2000.

Based on the already *implemented and adopted policies and measures for natural gas promotion*, it is expected an increased penetration of natural gas in both the power generation sector where in the framework of the liberalized market additional power units using natural gas as fuel will be

installed in the upcoming years and in the final demand sectors. ***The reductions of GHG emissions due to these interventions are estimated at 18.6 Mt CO_2 eq in 2010 and at 24.0 Mt CO_2 eq in 2015***.

Regarding the *planned interventions for the further promotion of natural gas* it is foreseen (a) a wider exploitation of natural gas combined cycle power plants units, (b) the installation of new co-generation units in the industrial and tertiary sectors (an increase of the installed capacity by 50 MW concerning the "with measures" scenario in the time horizon of 2010 is foreseen) and (c) a further penetration in the sectors of final consumption (for 2010 it is projected an increase of penetration in industry by 20%, in the tertiary sector by 15% and in the residential sector by 5% with respect to the "with measures" scenario). ***The reduction of GHG emissions from the implementation of the above mentioned measures are estimated at 3.5 Mt CO_2eq in 2010 and at 4.7 Mt CO_2eq in 2015***.

3.2.2.2 Improvements in the conventional power generation system

PPC, the basic player up to now in the domestic electricity market, has been actively involved in the field of energy conservation both in its internal activities as well as in implementing demand side management projects. The main actions of PPC include: (a) efficiency improvements in the existing lignite-fired power stations through the technical enhancement of boilers, turbines, lignite mills, cooling towers and remaining equipment, (b) reduction of distribution losses through the replacement of normal loss distribution transformers and (c) implementation of a cogeneration programme in the lignite-fired power plants by setting up district heating networks in northern Greece. The implementation of these programs was estimated to ***decrease GHG emissions by 0.5 Mt CO_2eq in 2000***, while emissions reductions is expected to increase in the upcoming years, since the corporation is planning the upgrade/replacement of old units. It is characteristic that according to PPC estimations in the frame of the program ENERGY WISDOM 2003-2004 of EURELECTRIC the estimated emissions reduction amounted at 1.07 Mt CO_2eq in 2003 and at 1.30 Mt CO_2eq in 2004.

3.2.2.3 Promotion of renewable energy sources

The Ministry for Development considers the exploitation of renewable energy sources among its energy policy priorities. The OPE (Operational Programme Energy within the 2nd Community Support Framework, 1994-1999) and the provisions of the National Development Assistance Act providing investment cost subsidies in combination with Law 2244/93, which specifies favourable buy-back tariffs for electricity generated from renewable energies, were the main policy instruments for the promotion of RES until 2001. In the frame of the OPC both infrastructure projects to assist the further exploitation of RES (Action 2.1.2 "Extension of infrastructure of technical support in co-production, RES and energy conservation") as well as RES investments in the private and public sector (Measures 2.1, 6.3, 6.5) are supported. It should be also noted that Directive 2001/77/EC for the promotion of electricity produced from renewable energy sources in the internal electricity market (Greece has an indicative target for the electricity production by RES to reach 20.1% by 2010) as well as Directive 2003/30/EC for the promotion of the use of biofuels

or other renewable fuels for transport (in Greece consumption of biodiesel and ethanol should reach a percentage of 5.75% of the total consumption of diesel and gasoline in road transport by 2010) have been already incorporated into the national legislative framework.

As regards ***wind energy***, the total installed capacity of wind systems in Greece reached 371MW in 2003, generating 1021 GWh of electricity, while in 2005 the installed capacity exceeded 470MW. Through the Operational Programme Energy (2nd Community Support Framework) 14 wind farms (~116 MW) were financed, while additional financing in wind parks was provided through the Development Assistance Acts 1892/1990 and 2601/1998. Support for wind energy is continued in the frame of the OPC through subsidies that amount to 30% of the eligible cost of the investments (in case of generation units) and reach 50% of the investment cost in the case of transmission networks for connecting the installations under development with the electricity grid. The interest of the investors for installation of wind systems is very high, and it is characteristic that the Regulatory Authority for Energy up to now (9/2005) has issued initial installation permits for 363 units reaching 4200MW total capacity. Nevertheless, delays are present in the implementation of the above investments due to bureaucratic problems and the complex institutional framework regarding issuance of installation permits. At the same time, it should be pointed out that areas of high wind potential (island regions, Evia, Lakonia, Thrace) have already attracted a large number of investors so much so that enhancement of the existing transmission lines is now required in order to connect additional planned wind parks. In the framework of OPC, the funding for transmission network enhancement is foreseen both stand-alone island grids (Action 6.3.1 and 6.3.3) and the main the interconnected system (Action 6.3.4). According to the "with measures" scenario, which incorporates the existing and adopted policies and measures for reducing GHG emissions, it is estimated that the installed capacity of the wind parks will reach 1281MW in 2010 and 1670MW in 2015. Also, with the implementation of additional supporting policies the installation of another 600MW is expected in the time horizon of 2010, which can reach 750MW in 2015.

The installed capacity of the ***small hydro units*** (< 10 MW) in Greece has reached 69MW in 2003. The Development Assistance Act financed 12 investments of small hydro of total capacity 35 MW during the period 1998 – 2001, while the Operational Programme Energy financed 9 investments of a total capacity of 11.5 MW (they concern units with a capacity smaller than 1 MW) during the same time period. The OPC continues to support the realization of small hydro projects under the Action 2.1.3. Support for small hydro projects is also foreseen through the latest Development Assistance Act. As regards ***large hydro systems*** (including pumped-storage units) their installed capacity reached 3043MW in 2003. Based on implemented and adopted policies and planning, it is estimated that the total installed capacity of hydro units in Greece will amount to 3560MW in 2010 and 3732MW in 2015. Despite already high exploitation of the hydro potential, it is estimated that possibilities for further exploitation of hydro resources is feasible and based on this, interventions are planned for the additional installation of another 150 MW in 2010 that could reach 350MW in 2015.

The penetration of ***photovoltaic units*** in the Greek energy system is still limited and the installed capacity barely amounted to 1 MW in 2003. In the framework of OPC (Action 2.1.3), investments of photovoltaic systems are to be supported, while the Regulatory Authority for Energy has issued

permits for additional 12 units of total capacity 2MW. According to the "with measures" scenario, a substantial penetration of photovoltaic units in the energy system for the time horizon 2010 and 2015 is not expected. At the same time the installation of photovoltaic units is also promoted in the tertiary sector (approximately 5 MW up to 2010). It should be pointed out that even though the implementation of this measure does not aim at the reduction of large quantities of GHG emissions, acquisition of know-how for future application, when the available technologies will be also more mature in commercial terms, is a very worthwhile gain.

No new substantial investments in ***geothermal units*** for electricity generation are expected now. Nevertheless, in the framework of the OPC (Actions 6.3.2 and 6.3.5), finance is provided for the preparation, development of infrastructures and installation of geothermal unit in Lesvos island. This installation of a geothermal unit with a capacity of 8MW by 2010 (for which the Regulatory Authority for Energy has already issued a permit) is feasible, while additional units with a total capacity of 12 MW are planned for the next decade.

Exploitation of ***biomass*** for steam production in industry as well as in power generation, have been financed in the framework of the Operational Programme Energy and supportive policies continue through OPC (Action 2.1.3). Up today, the Regulatory Authority for Energy has issued permits for 17 power units with a total capacity of 57MW that use biomass, while in the interconnected power generation system, small power units that use biomass with an installed capacity of about 22MW are already in operation. The implemented and adopted measures which are incorporated in the "with measures" scenario are expected to lead to an increase of the installed capacity of biomass units of 52MW in 2010, while with the application of additional policies, the further installation of 70MW up to 2010 reaching 100 MW in 2015 is possible. In the industrial sector the use of biomass for steam production constitutes a widespread practice in various industrial sectors. The application of additional measures aims at the further penetration of biomass in the industrial energy balance, increasing its exploitation by 5% in the time horizon of 2010 and by 10% in 2015.

The promotion of ***solar collectors*** constitutes one of the most important measures of both the 1st and the 2nd National Programme for GHG emissions reduction. The total surface of installed solar collectors amounted to 3,140,000 m^2 in 2003, the majority of which is used for the production of hot water in the residential sector. The implementation of the measure proceeds satisfactorily. Given however that in the last years the installation rate of new solar collectors has been decreased (to approximately 50,000 – 90,000 m^2 per year), the objective of the 2nd National Program for Climate Change for 2010 (i.e. the surface of installed solar collectors to reach 4.5 millions m^2) for solar panels is difficult to reach and thus suitable additional initiatives should be undertaken (e.g. enhancement of incentives with the form of tax exemptions, etc). The penetration of solar systems for combined space and water heating in the residential sector as well as the exploitation of solar energy in the industrial sector are currently exceptionally low, and additional supporting promotion policies are required.

Finally, the penetration of ***biofuels*** in the energy balance of the transport sector began in 2005. According to the 1st National report on the Promotion of Biofuels and other Renewable Energy Resources Use in the Sector of Transports in Greece, the consumption of biodiesel and bioethanol in 2010 is expected to reach 5.75% of total diesel and gasoline quantity that is consumed in road transport. In the frame of OPC, the installation of two biodiesel production units (with a total

generating capacity of 80,000 t) in Kilkis and in Volos was financed, while according to the L. 3340/2005 the excise tax for these fuels is null for the years 2005 to 2007.

Based on the results of the quantitative analysis that was carried out in the frame of the 4th National Communication on Climate Change, the RES exploitation decreased the GHG emissions by 2.1 Mt CO_2eq in 2000, while it is expected that the relative ***implemented and adopted measures will lead to total emission reductions at 6.4 Mt CO_2 eq in 2010 and at 7.5 Mt CO_2eq in 2015***. The realization of the ***planned measures for RES promotion will result in additional GHG emission reductions, estimated at 3.7 Mt CO_2eq in 2010 and at 5.6 Mt CO_2eq in 2015***.

3.2.2.4 Measures in the transport sector

GHG emissions from the transport sector present high rates of growth both in Greece and in the European Union, and consequently the implementation of suitable policies and restriction measures is particularly critical. The main axes of intervention and implemented policies and measures in the sector, beyond the introduction of biofuels for road transports and natural gas in the public system of transport that were already described previously, are shortly presented below:

(A) Interventions in the transport system

Public works to enhance the existing infrastructure described in the previous National Communications (road-grid improvements in the large urban centres, reconstruction of major highways, improvements in the traffic-light system) are in progress.

(B) Interventions in public transport

Important interventions have already been implemented or are under development aiming at the enforcement of public transport. Two new metro lines were completed and started operation in 2000 and extended in 2004. An additional 12.8 km of new underground lines of urban railway are now under development and will be completed up to 2009. The operation of suburban railway in the wider area of Athens already started the connection to Corinthos was completed, while the connections with Livadia and Chalcida are expected to operate in 2006. Also in 2004, a new tram started operating in Athens with 2 lines reaching from the centre of the city to the southern waterfront suburbs. Also, an extended network of bus lanes of approximately 48 km length has already been created, resulting in the increase of the average speed of buses in Athens from 16 km/h to 21 km/h. The fleet of buses has been renewed to a large extent, while approximately 416 buses use natural gas as fuel. Moreover the renewal of the fleet of electrically driven buses (trolleys) began in 1998 with the supply of 224 vehicles and was extended with the supply of additional 142 vehicles by the end of 2004. In addition, by Law 2963/2001 (A 268), an age limit of 23 years has been instituted for all urban, semi-urban and long distance buses. Also the limit of 11 years was set as the higher permissible age for buses in public transport. Under the provisions of the same law, economic incentives were given in the owners for the replacement of vehicles with new or used vehicles of small age. Of the 5.500 buses licensed in Greece, 3.100 buses have been replaced since 2000, of which 2.400 new and 700 used.

Finally, the public transport system in Athens has been reorganized on the basis of the new metro and tram lines, with buses and trolleys also playing a complementary role of connecting the metro and tram stations with other areas of the city.

(C) Interventions in vehicles

The main regulation that aims at the restriction of GHG emissions from vehicles is the one requiring regular technical checks of vehicles, which has been mandatory since 1983 and takes place at the Centres for Technical Control of Vehicles (CTCV). The law provides for the establishment of private Centres for Technical Control, the improvement of public ones and the development of a special organization to supervise the operation of the above-mentioned Centres. Currently, 58 public and 20 private centres operate in Greece, with 19 new private centres expected to start operation in the coming period. The percentage of vehicles that is checked is still relatively low, as the number of existing CTCVs is not sufficient to cover the needs. If one takes into account that the average annual rate of increase of vehicles the last decade is in the order of 5% the problem becomes even more intense. With the increase of the CTCV number during the next period, the essential conditions and infrastructures for an important increase of the number of checked vehicles per year are created, in accordance with the objectives of the National Program.

An equally important intervention for GHG emissions reduction from vehicles is the exhaust-control card, which is required for all vehicles and should be renewed on an annual basis by private passenger cars and trucks up to 3.5 t. Certified auto-repair shops expressly certified to carry out this task and issue the control card.

The establishment of a renewal program of the fleet of motorcycles, with incentives for the final withdrawal of two-wheeled motorcycles over 50 c.c. and aged ten years and more (categorized until 1994) is another important intervention in the sector of vehicles. The program was put in force with Law 3245/2004 – article 2 (A 110) and its force was extended by Law 3333/2005 (A 91).

Also, by Law 3109/2003 (A 38), the age limits for the withdraw of public use cars (taxi) were revised and scaled from 10 to 21 years, depending on the vehicle's engine displacement, the region and its population. In the framework of the same law, economic incentives were given to the owners of taxis for the replacement of their vehicles with new ones. The result of the measure was the replacement of approximately 9,300 cars out of a total of 35,000 taxis active in the country overall.

Finally, the voluntary agreement between the European Commission and the European, Japanese and Korean car-manufacturers associations to improve the fuel efficiency of new cars is considered as an adopted measure aiming at the reduction of GHG emissions. The agreement foresees the improvement of the fuel efficiency of new cars, so as the CO_2 emission factor to reach down to 140gr/km in 2008. The measure is expected to have an important long-term output through the penetration of low emissions vehicles in the total fleet. Thus the implementation of this measure is expected to ***decrease GHG emissions by 0.4 Mt CO_2eq in 2010 and by 1.1 Mt CO_2eq in 2015***.

P*lanned interventions* that will contribute in additional GHG emissions reductions, concern the improvement of road signalling which can lead to reductions in the consumption of fuel in the order of 0.8% - 3.5%, as well as the further reinforcement of public transport means aiming at the

important increase of their share in transportation work they cover in the large urban centres. ***These measures can result to additional emissions reduction which by 0.6 Mt CO_2 eq in 2010 and by 1.1 Mt CO_2 eq in 2015***.

3.2.2.5 Measures in the industrial sector

Energy-efficiency improvements in various areas of the industry sector have been promoted since the 1st National Climate Change Program through the provisions of the Development Assistance Acts, Law 2244/93 (for CHP plants) and the OPE (Measures 2.2 and 2.3). The support of energy conservation interventions in industry is also continued through the OPC. Selective projects of energy conservation are being financed (Action 2.1.3) as well as supporting policies for energy conservation in industry (Actions 2.1.1 and 2.1.2).

Concerning *planned interventions*, apart from the further promotion of natural gas and RES (biomass, solar energy) in industry, further implementation of energy conservation programs in various industrial units is pursued to be supported by OPC, the Development Assistance Act and also the operation of the EU-ETS. It is estimated that the emissions reductions which can be achieved from the implementation of ***additional energy conservation measures in industry can reach 0.3 Mt CO_2 eq in 2010***.

3.2.2.6 Measures in residential and tertiary sector

The Community Directive on the "Energy Performance of Buildings" (2002/91/EC) which constitutes an addition to Directive 1993/76/EEC and approaches the subject in the light of new challenges resulted from the Kyoto Protocol implementation has been incorporated to the existing national framework for energy conservation in buildings. The directive proposes specific actions, such as a common methodology of calculation of the integrated energy performance of buildings, energy certification of new and existing buildings, inspection of boilers and minimum requirements on the energy performance. Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with the Directive at the latest on January 2006.

The 2nd National Climate Change Program includes actions that aim at the conservation and rational use of energy in the buildings of the residential and tertiary sector. Beyond the penetration of natural gas and RES, specific quantitative intervention objectives are set which mainly concern:

- *Improvement of the thermal behaviour of residential sector buildings*. The largest heat losses in non insulated buildings appear through the walls and windows. Therefore, the examined retrofit measures concern (a) roof insulation in residential buildings (10% of existing buildings) because it is more cost-efficient and easier than wall insulation and (b) replacement of single glazing by double-glazing in buildings of the tertiary sector. The penetration rate in the tertiary sector varies according to the use of the building.
- *Promotion of energy efficient appliances and heating equipment.* It includes the maintenance/replacement of boilers, the penetration of efficient electric appliances and lamps, etc.

- *Other energy conservation measures*. This measure aims at the reduction of (a) the cooling load through the external shading of buildings, night ventilation and the use of roof fans and (b) electricity consumption for lighting through the use of advanced lighting-control systems.

It is clear that at a certain degree the interventions identified will be realized because of the expected development of the buildings sector, nevertheless their mass implementation, which will allow approaching the objectives and the penetration rates set by the National Programme requires the systematic construction of supporting policies and monitoring mechanisms. Currently the application of the above measures is in the stage of planning. The adoption and application of the Regulation of Energy Performance of Buildings (REPB) specifying energy inspections, as well as energy and environmental certification of buildings, constitutes a crucial step for the realization of these interventions. The REPB is foreseen to be completed at the end of 2005 incorporating and the above mentioned EC Directive on "Energy Performance of Buildings". ***It is estimated that the total decrease of GHG emissions from the implementation of the planned measures in the residential and tertiary sector will reach the 2.0 Mt CO_2eq in 2010, while for 2015 these reductions are estimated at 2.9 Mt CO_2eq.***

3.2.2.7 Measures in the sector of waste

National policies and measures for the waste sector are related to the operation of managed solid-waste disposal sites and the construction of municipal wastewater plants.

Regarding solid waste disposal on land, with Decision 50910/2727 (December 2003), the measures, the terms and the processes for the rational management of waste in national and regional level have been specified. Fundamental objectives are the elimination of unmanaged solid waste disposal sites, the coverage of all urban and rural areas of the country with modern installations for final disposal and the promotion of measures for the prevention and reduction of produced waste, as well as the exploitation of materials with maximization of recycling and recovery of products and energy.

In addition the necessity to reduce the quantities of biodegradable wastes landfilled through the installation of treatment facilities in agreement with Directive 1999/31/EC is acknowledged. According to this Directive the targets set for the reduction of biodegradable wastes landfilled are at 75%, 50% and 35% for the years 2010, 2013 and 2020 respectively compared to their production in 1995. The implementation of the Directive is expected to contribute in the ***reduction of GHG emissions at approximately 2.9 Mt CO_2eq in 2010 and at 5.1 Mt CO eq in 2015***.

As regards wastewater, a collection network with its corresponding wastewater treatment plants has already been developed during the last five-years, covering the needs of 70% of the population in 2001. The new objective is to increase the percentage of the population served by 95% by 2006.

Finally concerning *planned measures* for emissions reduction in the sector, the only measure examined is the flaring of landfill gas in all managed sites for urban centres with population more than 100,000 inhabitants. It is noted that the measure is partially integrated (managed disposal sites covering the three largest cities of Greece) in the “with measures” scenario. ***Emissions reductions estimated are about 0.2 Mt CO_2eq in 2010***.

3.2.2.8 Measures in agricultural sector

The restriction of nitrogen fertilizers use in combination with the promotion of organic farming constitutes a main policy initiative of the Ministry of Rural Development and Food to reduce pollution caused from agriculture. According to the Ministry of Rural Development and Food records, the total land with organic farming in 2002 was 29,500 ha, representing 0.8% of the total cultivated land of the country, while in 2003 this percentage increased to 1.01%. Based on projections for measures already implemented, it is expected that up to 2010, the cultivations without use of synthetic fertilizers will represent approximately 2.5% of total agricultural land (approximately 100,000 ha). Further promotion of organic farming, already planned, might raise that to 200,000ha by 2010.

The introduction of wet systems for manure management for cattle and pigs constitutes a basic measure of N_2O emissions reduction. Today, most cattle breeding activity and over 10% of pig raising farms utilize dry treatment of manure. Further penetration of this practice in the sector in order to decrease N_2O emissions is pursued. The N_2O emission factor per unit of nitrogen excreted from animals is much smaller in wet systems.

In total, ***manure management systems and organic farming are expected to reduce GHG emissions in the sector by 0.15 Mt CO_2eq in annual basis***.

3.2.2.9 Measures in the sector of industrial processes

The policies and measures in the sector of industrial processes concern the restriction of f-gases emissions from chemical industries and their consumption in a number of appliances and applications. The remaining activities which are included in the sector of industrial processes were not examined, as the most important of them (cement and steel production) have already proceeded in implementing investments for modernization, while the contribution of the rest to the total GHG emissions of Greece is low.

Regarding HCFC-22 production, which constitutes a source of HFC-23 emissions, Regulation (EC) 2037/2000 of the European Parliament and of the Council adopts a time schedule for the reduction of HCFC-22 production, with specific quantitative targets for the periods 2000 – 2007, 2008 – 2013, 2014 – 2020 and 2021 – 2025 compared to 1997 production. Production of HCFC -22 is not allowed after 31 December 2025.

Concerning the planned measures, recovery of f-gases from discarded air-conditioning units (both stationary and mobile) and refrigeration equipment was examined according to the Directive 2003/108/EC. Totally, ***the reduction of GHG emissions from the implementation of this measure is calculated at 0.7 Mt CO_2eq in 2010 and at 1.5 Mt CO_2eq in 2015***.

3.2.2.10 Measures in Land Use Change and Forestry

The 2nd National Climate Change Program (2000-2010) does not determine additional measures of removals through sinks (measures in the sector of Land Use, Land Use Change and Forestry). However, in recognition of the role of forests in addressing the greenhouse effect, the sustainable

management of the Greek forests was strengthened through financing of forest management practices as well as measures for the prevention and control of forest fires.

Also, in the frame of the program Agricultural Land Forestation of the Ministry of Rural Development and Food, which targets the non-public sector, projects for agricultural lands forestation and improvement of existing forest lands have been financed. On the basis of the Regulation 2080/92, 35,840ha of agricultural lands were forested during the period 1994-2001 while 4,835ha were forested in the years 2002 and 2003 based on the Regulation 1257/99. ***CO_2 removals from these forestations are estimated to amount at 0.7 Mt CO_2 in 2010***.

3.3 Complementarity of flexible mechanisms

A set of domestic policies and measures (implemented, adopted and planned) aiming at the restriction of the increase of GHG emissions in order for Greece to fulfil the commitment under the Kyoto Protocol was presented in Paragraph 3.2.2. The 2nd National Climate Change Programme was developed in order to define the additional policies and measures necessary for Greece to meet its Kyoto target by means of domestic actions.

Nevertheless, given the fact that at least some of the planned interventions have a significant cost while the implementation of others is delayed, the use of the flexible mechanisms defined in the Kyoto Protocol should not be excluded. To this end, analyses examining the possibilities to use Joint Implementation and Clean Development Mechanisms in order to achieve the Kyoto target in terms of economic efficiency have been financed by the Ministry for the Environment, Physical Planning and Public Works. The preliminary analysis identified several projects, both in developing countries and in countries with economy in transition that could be used in order to acquire CERs and ERUs. At the moment and since it is not clear whether and at what extent, the exploitation of flexible mechanisms for the fulfilment of the commitment under the Kyoto Protocol will be required, the national administration has not committed any resources that could be used for the acquisition of emissions credits. However at the level of individual enterprises participating in the EU emissions trading scheme, agreements for the purchase of emissions allowances which will contribute in the fulfilment of their obligations, already exist.

3.4 Minimisation of adverse effects

The Kyoto Protocol aims at the implementation of effective policies and measures by Annex I Parties so as to prevent dangerous anthropogenic interference with the climate system, contributing thus in the minimisation of adverse effects of climate change on other Parties and especially developing countries. The Protocol has been designed to minimize the potential adverse effects that may be caused by the implementation of policies and measures adopted by Annex I Parties to specific sectors of economic activity, industrial sectors or other Parties to the Convention, including the adverse effects on the international trade, social, environmental and economic impacts in developing countries, etc.

The formulation of climate policy in Greece has taken into account the minimization of the adverse effects of emissions reduction policies and measures, according to Articles 4.8 and 4.9 of the Framework Convention on Climate Change. More specific:

- The implemented/adopted/planned measures concern various interventions and actions in all sectors of economic activity which are related with GHG emissions. Thus, policies and measures for the restriction of GHG emissions are applied to almost all sources of emissions, taking however at the same time into account the contribution of each source to the total GHG emissions, the existing emissions reduction potential, but also the economic attractiveness of the planned interventions.
- Even though the majority of implemented/adopted/planned policies and measures aim at the restriction of CO_2 emissions, nevertheless policies and measures focusing on the reduction of the non-CO_2 GHG are already implemented. As a matter of fact, the reduction of CH_4 emissions in accordance with the provisions of the Directive 1999/31/EC (reduction of the biodegradable wastes landfilled) as well as the reduction of f-gases emissions on the basis of the Regulation 2037/2000, are of major importance for Greece in order to meet its target under the Kyoto Protocol.
- The penetration of natural gas and RES both in electricity generation and in final consumption (industry, residential – tertiary, transports) represents two fundamental policy axes for the fulfilment of the Kyoto target. Therefore, the differentiation of energy supply as well as the exploitation of domestic and environmental friendly energy resources (RES) is achieved. It is evident that the above-mentioned policies improve the safety of energy supply of the country while new commercial relationships are developed with those countries from which either natural gas is imported (e.g. Russia, Algeria, etc.) or transported through pipelines (e.g. Bulgaria, Turkey, Italy).
- The EU emissions trading scheme provides the opportunity to achieve emissions reduction, at installation level, in terms of economic efficiency. Therefore, potential adverse effects are spread between the different sectors of economic activity In addition, the possible transactions of CERs and ERUs could allow for the development of new commercial relationships between developed and developing countries.
- Greece has financed capacity building projects related to climate change in developing countries (e.g. Albania, FYROM, etc.) as well as in countries with economy in transition (e.g. Romania, Bulgaria).

4 PROJECTIONS OF EMISSIONS

4.1 Overview

This Chapter describes firstly a baseline or "***with measures scenario***", which estimates the evolution of GHG emissions in Greece up to the year 2020, **taking into consideration the implemented and adopted policies and measures for reducing GHG emissions and assuming that no additional emission reduction actions are adopted.** The "with measures" scenario foresees that emissions will be 34.7% and 49.4% above base year levels[4] (111.7 Mt CO_2eq) by 2010 and 2020 respectively.

Given that the sector *Land Use, Land Use Change and Forestry* was a net sink of GHG emissions in 1990, the relevant emissions/removals are not considered in estimating base year emissions for Greece. It is also noted that the contribution of the LULUCF sector is not included in GHG emissions projections, as according to the Protocol:

- Emissions/removals by anthropogenic activities are included when: (a) they lead to land use changes due to forestation, reforestation and deforestation, (b) they were realized after 1990 and (c) have been calculated with verifiable methodologies (Article 3, Paragraph 3). However, the available data on the land use in Greece, do not allow, currently, the projection of relative emissions/removals.
- An Annex I Party that has ratified the Kyoto Protocol, has the possibility, provided that a relative decision is been taken, to include emissions/removals from activities, what were realized after 1990, and concern revegetation, forest management, cropland management and grazing land management. Given that on one side certain relative decision does not exist and on the other the available data are not sufficient, in the frame of present report certain relative forecast is not included.

According to "with measures" scenario, the energy sector accounts for approximately 74-80% of total GHG emissions **(Table 4.1),** while carbon dioxide emissions accounts for more than 75% of total emissions (**Table 4.2).** F-gases emissions are estimated to increase with a mean annual rate of more than 4 times higher compared with that of total emissions for the period 1990-2020 (6% for the f-gases compared to 1.4% for total emissions).

[4] 1990 has been used as base year for CO_2, CH_4, N_2O emissions and 1995 has been used for HFCs, PFCs and SF_6.

Table 4.1 Projections of GHG emissions in the "with measures" scenario, disaggregated by sector, kt CO_2eq

Sources and Sink categories	1990	1995	2000	2005	2010	2015	2020
Energy	81704	84634	101611	112416	120326	127351	134674
of which transport	*15645*	*17317*	*19802*	*22587*	*24756*	*27398*	*29384*
Industrial processes	8670	11400	12810	12848	13910	15619	17188
Solvents	170	153	145	158	161	164	168
Agriculture	13514	12489	12330	12126	12265	12429	12606
Waste	5357	5811	5429	5328	3750	2608	2203
Total	**109415**	**114487**	**132324**	**142876**	**150413**	**158172**	**166839**
Land Use	-3193	-4369	-2959	-4702	-4773	-4509	-4264

Table 4.2 Projections of GHG emissions in the "with measures" scenario, disaggregated by gas, kt CO2eq

Gas	Base year	1990	1995	2000	2005	2010	2015	2020
Carbon dioxide	84021	84021	87344	104112	115021	122913	130044	137440
Methane	10011	10011	10565	10354	10280	9015	8048	7811
Nitrous oxide	14190	14190	13127	13436	13720	14042	14369	14732
HFC	3369	935	3369	4273	3779	4366	5635	6779
PFC	83	258	83	148	76	76	76	76
SF_6	Not estimated [1]							
Total	**111675**	**109415**	**114487**	**132324**	**142876**	**150413**	**158172**	**166839**
Change from base year levels	*100.0*	*98.0*	*102.5*	*118.5*	*127.9*	*134.7*	*141.6*	*149.4*

[1] SF_6 emissions are not estimated as according to the estimations of the Public Power Corporation (PPC) these emissions (removals) mounted at 0.23 kt CO_2 eq. during the last twenty years while according to the data presented by the Ministry for Development during the examination of the 3rd National Communication in the Framework Convention (November 2004), the relevant emissions for the first semester of 2004 were estimated at 1.74 kt CO_2 eq. Due to the substantial difference of the relevant estimations, the aforementioned information are under examination and thus in the inventory that was submitted to the Framework Convention in 2005, SF_6 emissions estimations are not included.

It is obvious that the fulfilment of the Kyoto Protocol commitments for Greece requires the implementation of additional policies and measures for reducing GHG emissions, which were worked out by the 2nd National Climate Change Program (March 2002). In this Chapter the results of a ***with additional measures scenario*** are also presented, which is formulated on the basis of the "with measures" scenario incorporating the additional policies and measures presented in the previous Chapter. As a result of these additional policies and measures GHG emissions in Greece will increase at 24.9% in 2010 and at 27.4% in 2015 compared to base year levels (**Table 4.3**).

Table 4.3 Projections of GHG emissions in the "with measures" and the "with additional measures" scenario, disaggregated by sector, kt CO_2eq

Sources / Sinks	1990	1995	2000	2005	2010		2015	
				With measures	With measures	With additional measures	With measures	With additional measures
Energy	81704	84634	101611	112416	120326	110497	127351	113312
of which Transport	*15645*	*17317*	*19802*	*22587*	*24756*	*24147*	*27398*	*26329*
Industrial processes	8670	11400	12810	12848	13910	13192	15619	14083
Solvents	170	153	145	158	161	161	164	164
Agriculture	13514	12489	12330	12126	12265	12131	12429	12277
Waste	5357	5811	5429	5328	3750	3549	2608	2459
Total	**109415**	**114487**	**132324**	**142876**	**150413**	**139531**	**158172**	**142296**
Change from base-year levels	*98.0*	*102.5*	*118.5*	*127.9*	*134.7*	*124.9*	*141.6*	*127.4*

4.2 Methodology

For scenario development and projections two main model types / procedures have been used:

- Economic-technical model (ENPEP) for the energy sector (energy supply and use – fugitive emissions).
- Spreadsheet models for the non-energy sectors, in which future changes in activity data are mainly derived from statistical analysis while emission factors are derived from expert assessments based on the IPCC/CORINAIR methodology.

4.2.1 Energy sector

The Energy and Power Evaluation Program (ENPEP) has been used, as in the 3rd National Communication, for the simulation of the Greek energy system, the projection of its future structure and of the implied GHG emissions. ENPEP was developed by Argonne National Laboratory and contains a set of analytical tools for use in integrated energy/electricity system planning and the quantification of environmental burdens. Its basic module (BALANCE) is used to trace the flow of energy throughout the entire energy system from resource extraction, through processing and conversion, to meet demands for useful energy (e.g. heating, transportation, electrical appliances) and employs a market-based simulation approach to project future energy supply/demand balances.

ENPEP model uses a non-linear, equilibrium approach to determine the energy supply demand balance. The equilibrium modelling approach used in the BALANCE Module is based on the concept that the energy sector consists of autonomous energy producers and consumers that carry out production and consumption activities, each optimizing individual objectives. For its simulation, the model uses an energy network that is designed to trace the flow of energy from primary resources through to final energy. A fundamental assumption of the model is that

producers and consumers both respond to changes in price. Furthermore, energy demand is sensitive to the prices of alternatives, as supply price is sensitive to the quantity demanded. ENPEP seeks to find, besides the intersection of the supply and demand curves, the intersection for all energy supply forms and all energy uses that are included in the energy network. The equilibrium is reached when the model finds a set of prices and quantities that satisfy all relevant equations and restrictions. As market shares of energy are dependent on energy prices and energy prices are dependent on the quantity of fuel demands, ENPEP uses an iterative process to bring network prices and quantities into equilibrium.

The energy network used represents all energy production, conversion, transport, distribution, and utilization activities in a country or region, as well as the flows of energy and fuels among those activities. The data that are necessary to calibrate the model for a base year as well as to project the future energy needs can be divided in the following categories:

- Macro-economic data that correspond to demographic national accounts, sectoral economic activity and income variables.
- Energy consumption data and relative activity data for the base year (production, dwellings, passenger-kilometres, etc.).
- Technical-economic data for available technologies (e.g. capital cost, unit efficiency, variable costs, unit efficiency, lifetime, etc.).

The Greek Energy system is presented in the BALANCE model by sub-systems and sectors, which covers the main economic and energy activities. More specifically, the network developed, comprises the following sub-systems:

- *Energy supply.* Energy supply is disaggregated into solid fuels (lignite and imported coal), imported liquid fuels (crude oil, diesel, gasoline, heavy fuel oil, LPG, jet fuel, naphtha and other liquid fuels), domestic liquid fuels (crude oil), natural gas, renewable energy sources (wind energy, solar energy, biomass, hydro and geothermal energy) and imports/exports (small quantities of various oil products as well as solid fuels and electricity mainly in other Balkan countries and Italy).
- *Energy conversion.* Energy conversion is disaggregated into the refineries (based on the total installed capacity of the four Greek refineries) and the power generation sector that is further disaggregated into the interconnected system in the mainland and the autonomous island systems. Liberalization of the electricity market is simulated through the definition of four main categories of producers, which are differentiated on the basis of their economic characteristics and the needs that they cover: (a) large electric utilities, (b) industrial auto-producers, (c) independent producers in the industrial sector, covering their needs in heat and electricity through co-generation and (d) independent producers in the tertiary sector, covering their needs in heat and electricity through co-generation.
- *Final demand.* Final demand includes six main sectors (agriculture, industry, transport, services, residential and non-energy uses), which are further decomposed into sub-sectors and then into specific energy uses (e.g. space heating, air conditioning, steam production, etc.). A technology operates at the level of an energy use and utilizes energy forms (fuels).

The strength of this approach is that it allows for a comprehensive assessment of the various interactions between the different sectors of the energy system. The market-based equilibrium together with the detailed technical description of the energy sectors and uses enables the realistic representation of the energy system as well as the modelling of different policy instruments. However, it should be noted that the solution obtained is closely related to the level of detail of the developed energy network. Analysis undertaken in the context of the 4th National Communication is based on a particular detailed development of the energy network that includes more than 70 different energy uses and 300 alternative technologies. Each technology uses final energy form (fuels) to cover a specific energy use.

4.2.2 Non-energy sectors

GHG emissions in the non-energy sectors are calculated using spreadsheet models that calculate emissions based on activity data, emission factors and sector specific assumptions, according to the following general equation:

$$E_{g,t} = \sum_{j=1}^{J} A_{0,j} \cdot \left(1 + r(x_i)\right)^t \cdot C_{g,j}$$

where,

j : an activity, which constitutes a source of GHG emissions (source)

$E_{g,t}$: Projection of emissions of g-greenhouse gas in year-t

$A_{0,j}$: Activity data of the j-source of emissions in base year.

$r(x_i)$: Growth rate of activity data for j-source based on the changes of the determinant parameter x_i.

$C_{g,j}$: Emission factor of the g-greenhouse gas for the j-source.

The growth factor accounts for changes (increases or decreases) in the emission-generating activity. In estimating the growth factor, time-series analysis and/or regression analysis using appropriate determinant parameters of the available activity data is used. Potential determinant parameters include population, value added, product output, etc.

In determining the future year emission factors, three basic parameters must be quantified: regulation control, rule effectiveness, and rule penetration. Regulation control is the level of reduction expected by assuming a fully complied measure. Rule effectiveness accounts for the level of expected compliance with the regulation. Rule penetration indicates the fraction of emissions within a source category, which are subject to the regulation, accounting for possible exemptions. These parameters are quantified by experts' assessments in close consultation with the governmental departments responsible.

It should be pointed out that the main drawback of this analysis is that the models do not take into account any overlaps or synergies between sectors or policy areas. Moreover, the extrapolation of past correlations overlooks the effects of future technological advances.

4.3 Main assumptions in the "with measures" scenario

The level of emissions estimated in any scenario depends on assumptions regarding main parameters, such as population, economic growth, energy prices etc. It also depends on the specific reduction policies incorporated into the scenario. The main assumptions made for the projection of GHG emissions are presented in **Table 4.4.** The most important of them are analysed in more detail as follows:

- *Demographic characteristics:* According to the population census conducted by the National Statistical Service in 2001, the population of Greece increased with an average annual rate of 0.66% during the period 1991-2001, while the average annual population growth rate during the period 2000-2020 is estimated to be approximately 0.2%. This rate is higher during the period 2000-2010 (approximately 0.3%) mainly as a result of integration of a significant number of immigrants in the Greek society, which is likely to decrease after 2010. During the period 2000-2020, the average household size (in number of individuals per household) is estimated to decrease by approximately 0.65% annually, reflecting ageing of population, as well as new living standards that are progressively adopted. Consequently, the total number of households for the period 1990-2020, which represents a total increase of 35.5%, is estimated to reach 4.6 million households by 2020.

- *Weather conditions*: Future weather conditions have been assumed to remain the same as those during the period 1995-2000. Assuming that weather conditions will be closer to the historical average would ignore the fact that the average annual temperature has already increased noticeably in the last decades, and consequently the use of the lower historical average temperature would lead to a sudden, non-justifiable increase of space heating requirements after the year 2000 while it would probably underestimate the energy demand for air conditioning.

- *Macroeconomic data*: In the context of the "with measures" scenario it is assumed that the program of convergence of Greek economy with the average European levels will continue throughout the period examined, maintaining constantly higher rates of development compared to the Community average. More specifically, it is assumed that the GDP will increase during the period 2000-2005 with an average annual increase rate of about 4% (according to estimations by EUROSTAT), while during the period 2005-2010 this rate is reduced to 3.7%. For the period following 2010, the annual financial growth rate is expected to be around 3.1%.

  More analytically, the tertiary sector excluding public services shows the highest annual rate of growth (an average of 4.1% annually for the period 2000-2020), while its share in GDP in 2010 and in 2020 is estimated correspondingly at 54.2% and 58.8% (45.9% in 1990). The public sector is also projected to develop with an average annual rate of 4.2% during the period 2000-2010, while this rate falls to 1.6% after 2010. The annual rate of increase in industry is approximately 3.0% during the period 2000-2010 and 2.4% during the period 2010-2020, while its contribution to the total GDP decreases from 22.0% in 1990 to 20.9% in 2010 and to 19.7% in 2020. Finally, the annual rate of growth in the primary sector is 0.2% for the period 2000-2010, while this rate increases to 1.2% for the next decade. The above

analysis is based on recent data provided by DG Transport and Energy (DG TREN) of the European Commission.

- *Prices / Taxation of fuels*: The level of energy prices influences not only the future total demand of the energy system, but also the shares of various energy resources/technologies in order to cover this demand, thus affecting the total emissions from the energy sector. The projection of fuel prices development in short- or long-term horizon depends on the conditions that prevail in the international oil, natural gas and coal markets, as well as on the national taxation policy that it is followed. In the frame of energy systems analysis, the interest focuses on the long-term trends of energy prices fluctuation that are shaped by the total energy demand and supply.

  In the context of the present analysis the following assumptions for the international fuel prices have been incorporated, based on the estimations of the World Energy Outlook Report (2004) of the US Department of Energy:

  - Solid fuels prices will remain during the decade 2000-2010 approximately at the same levels (despite some fluctuations) as those recorded at the end of the last decade (1998-1999). After 2010 it is expected that they will follow a slightly increase trend.
  - Crude oil prices after the substantial increases of the period 2000-2005 will be de-escalated in the upcoming years, while after 2010 will follow again a slight increasing trend.
  - Natural gas prices will follow the fluctuations of crude oil prices.

  It should be pointed out that these prices do not represent spot market prices. In addition the above assumptions are not significantly different from the ones adopted in the European Commission study on the development of energy systems in most European countries. Moreover, it has been assumed that the basic characteristics of the existing tax policy for fuels will not be altered and a carbon tax will not be imposed on fuel prices during the period under consideration. Based on the Law 2960/2001 the implementation of excise tax for electricity is suspended up to 1/1/2010.

- *Discount rate*: The discount rate used for the evaluation of alternative energy technologies, is different depending on the profile of the particular decision-maker active in the energy sectors under consideration. In particular, consumers in the domestic sector usually prefer investments with small payback period, so a discount rate of 14% was adopted. On the other hand, the industries, utility companies, refineries, etc, prefer long-term investment policies, so that a discount rate of 6% was considered more suitable. Finally, for the tertiary sector a discount rate of 9% has been adopted.

- *Policies and measures*: The "with measures" scenario defines the future development of the energy system under current policies and consumers' behaviour, as well as under the emerging future trends. Specifically, the "with measures" scenario includes the impacts from the following policies / interventions:

  - The liberalization of electricity market.
  - The continuation of infrastructure projects for the further penetration of natural gas in the residential/tertiary and industrial sectors as well as the enhancement of the security of gas

supply through the interconnection of the Greek gas network with the networks of neighbouring countries (Turkey, Italy) and the extension / reinforcement of the liquefied gas station.

- The voluntary agreement between the European Commission and motor manufacturers (ACEA, KAMA, JAMA) for the introduction of low emissions vehicles in the market.
- The completion of a series of infrastructures that are implemented or planned in the transport sector and include new motorways, upgrades in public transportation, modernization of railway network, etc. These developments result in the preservation of high rates of increase for the transportation activities.
- The continuation of present policies (Law 2244/1995, Development Law, etc.) for the promotion of RES, co-generation, natural gas and energy conservation. It is noted that especially for RES and co-generation their support through subsidy of the investment cost (in the context of the 3rd E.U. Framework Programme) is foreseen to continue along with the obligatory absorption of energy produced by RES at predetermined price.
- The incorporation of the results from the implementation of RES projects and energy conservation, in the context of the Operational Programme of Energy of the 2nd E.U. Framework Programme and part of the Operational Programme of Competitiveness of the 3rd E.U. Framework Programme.
- The Council Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants.
- The Council Directive 2002/91/ EC on the energy performance of buildings.
- The Council Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport.
- The Council Directive 2003/17/EC relating to the quality of petrol and diesel fuels. As a result of the implementation of this Directive, in the "with measures" scenario GHG emissions have been increased due to the operation of new units or the increased operation of existing units in the Greek refineries, in order to produce fuels of higher quality.
- The Council Directive 1999/31/EC on the landfill of waste, using the 4 year grant regarding the accomplishment of the targets set by the Directive for biodegradable waste, resulting in achieving the targets of the Directive by the years 2010, 2013 and 2020 instead of 2006, 2009 and 2016 that were initially determined.
- The Regulation (EC) 2037/2000 of the European Parliament and of the Council on the substances that destroy the ozone layer. This Regulation adopts a time schedule for the reduction of HCFC-22 production (which results in the restriction of HFC-23 production), with specific quantitative targets for the periods 2000 – 2007, 2008 – 2013, 2014 – 2020 and 2021 – 2025 compared to 1997 production. Production of HCFC -22 is not allowed after 31 December 2025.

Table 4.4 Main assumptions in the "with measures" scenario

	Historic data			Projections				Average annual rate of increase			
	1990	1995	2000	2005	2010	2015	2020	2000-2005	2005-2010	2010-2015	2015-2020
Population (mio)	10157	10634	10917	11082	11261	11366	11377	0.30%	0.32%	0.19%	0.02%
Household size (cap/hh)	2.99	2.91	2.82	2.73	2.65	2.56	2.47	-0.62%	-0.64%	-0.66%	-0.69%
Households (thousands)	3397	3660	3873	4056	4257	4442	4602	0.93%	0.97%	0.86%	0.71%
GDP (bil. €2000)	97.7	104.0	123.2	149.6	179.2	212.4	243.9	3.96%	3.67%	3.46%	2.81%
Gross Value Added (bil. €2000)	92.8	96.1	112.0	135.8	161.1	189.6	216.7	3.92%	3.48%	3.31%	2.70%
primary sector	11.4	9.5	9.4	9.3	9.6	10.2	10.8	-0.08%	0.52%	1.21%	1.12%
industry	20.4	21.5	25.1	29.2	33.6	38.4	42.7	3.08%	2.84%	2.68%	2.17%
private services	18.6	20.4	23.3	27.0	32.1	38.7	46.3	2.97%	3.53%	3.81%	3.64%
public services	18.5	18.9	20.4	26.2	30.6	33.3	35.7	5.14%	3.18%	1.74%	1.39%
trade	24.0	25.8	33.8	44.0	55.2	69.0	81.1	5.41%	4.62%	4.55%	3.30%
International fuel prices											
Coal ($2000/t)	63.1	50.0	33.8	39.5	37.2	36.5	37.4	3.2%	-1.2%	-0.3%	0.5%
Oil ($2000/bbl)	27.3	21.2	27.0	32.0	23.5	25.2	26.8	3.5%	-6.0%	1.4%	1.3%
Natural Gas ($2000/toe)	-	-	121.4	170.9	125.7	134.5	143.3	7.1%	-6.0%	1.4%	1.3%
Transport Activity											
passenger transport (bil. p-km)	84	101	128	160	193	225	250	4.56%	3.82%	3.12%	2.13%
freight transport(bil t-km)	18	23	27	32	38	44	49	3.46%	3.50%	2.98%	2.18%

4.4 The "with measures" scenario by sector

4.4.1 Energy sector

The main results of the "with measures" scenario regarding the energy sector are presented below, while in **Table 4.5** a brief presentation is given on the development of the energy balance of the country for the period 1995-2020.

According to these results, ***gross inland consumption*** in Greece increases continuously during the entire time period (from 23.8 Mtoe in 1995 to 35.3 Mtoe in 2010 and to 41.2 Mtoe in 2020), with an average rate of growth in the order of 2.2%. Liquid fuels still cover the major part of gross inland consumption, but their contribution decreases from 59.1% in 1995 to 54.1% in 2010 and to 53.1% in 2020. Solid fuels consumption ranges between 8.4-9.2 Mtoe during the period 1995-2020, while their share falls from 35.2% in 1995 (approximately 8.4 Mtoe) to 21.3% in 2020 (approximately 8.8 Mtoe). It is also projected that natural gas covers a significant part of the gross inland consumption, which is estimated at 14.8% in 2010 and at 19.6% in 2020, thus resulting in a decrease of the relative contribution of solid and liquid fuels. The share of RES including large hydro in gross inland consumption for the entire period examined increases from 5.2% in 1995

(1.23 Mtoe) to 5.8% in 2010 (2.05 Mtoe) and to 6.0% in 2020 (2.47 Mtoe). In absolute values, their exploitation is doubled from 1995 up to 2020.

Electricity demand is expected to expand with an average annual rate of 3.1% during the period 2000 – 2010, while this rate declines to 2.3% during the following decade. As a result, total installed power generation capacity in Greece increases by some 9.6 GW in the period 1995-2020. The use of traditional lignite and oil power plants does not change significantly during the study period. In addition, the analysis undertaken takes into account the closure of the units Megalopoli 1 and 2 by 2015 as a result of the implementation of the Directive 2001/80/EC, as well as the implementation of a rehabilitation programme that aims the replacement of 1600 MW of old power units with new ones, which will use either natural gas (in the Aliveri power plant) or solid fuels. The increased capacity needs are mainly covered with the installation of natural gas combined cycle power plants. Their capacity increases by almost 5 times over the period 2000–2020, to reach 5.9 GW or approximately 31.4% of the total installed capacity by 2020. At the same time, the installed capacity of large hydro units increases during the period 2000-2020 by 0.66 GW, while 2 GW of wind farms are expected to be installed until 2020, as a result of the rich wind potential in Greece and the support policies implemented by the Greek government.

Final energy consumption increases continuously during the entire time period (from 16.3 Mtoe in 1995 to 25.8 Mtoe in 2010 and to 30.4 Mtoe in 2020), with an average rate of growth in the order of 2.5%. Liquid fuels have the highest share in final energy consumption, presenting however a slight decrease of their contribution from 69.3% in 1995 to 65.6% in 2010 and to 63.4% in 2020. Electricity contribution to final energy consumption increases from 18.8% in 1995 (3.1 Mtoe) to 20.2% in 2010 (5.2 Mtoe) and to 21.5% in 2020 (6.5 Mtoe). Natural gas represents approximately 6.4% of final energy consumption in 2010 (1.6 Mtoe), while this percentage increases to 7.8% in 2020 (2.4 Mtoe). The share of RES declines from 5.6% in 1995 to 4.9% in 2010 and to 4.6% in 2020, mainly due to the decreased use of biomass for heating in the residential sector. The structure of final energy consumption per sector is in line with the characteristics of the economic development. The share of industry sector in final energy consumption is reduced from 32.0% in 1995 to 29.6% in 2010 and to 28.4% in 2020. Similarly the share of agricultural sector decreases from 6.3% in 1995 to 5.3% in 2020. The contribution of tertiary and residential sector increases significantly during the reference period (by 4.4% and 1.8% respectively). Finally, the share of transports in final energy consumption is slightly decreased during the examined period from 35.4% in 1995 to 33.7% in 2020, even though in absolute values energy consumption in the sector increases from 5.8 Mtoe in 1995 to 8.6 Mtoe in 2010 and to 10.2 Mtoe in 2020.

Table 4.5 Summary energy balance according to "with measures" scenario (ktoe)

	1995	2000	2005	2010	2015	2020
Primary production	9161	9872	10190	10531	10496	10764
Solid fuels	7416	8306	8536	8436	8278	8293
Liquid fuels	468	261	100	50	0	0
Renewables	1233	1305	1554	2045	2219	2471
Natural Gas	44	0	0	0	0	0
Net imports	14651	18318	22101	24774	27807	30446
Solid fuels	970	823	628	552	501	480
Liquid fuels	13612	15768	18502	19066	20552	21888
Renewables	0	0	0	0	0	0
Natural Gas	0	1728	2787	5242	6740	8064
Electricity	69	-1	185	-86	15	15
Gross Inland Consumption	23812	28190	32291	35304	38303	41210
Solid fuels	8386	9129	9164	8987	8778	8773
Liquid fuels	14080	16029	18602	19116	20552	21888
Renewables	1233	1305	1554	2045	2219	2471
Natural Gas	44	1728	2787	5242	6740	8064
Electricity	69	-1	185	-86	15	15
Net electricity generation	3236	4230	4824	5751	6377	7096
Lignite	2251	2604	2739	2707	2661	2666
Oil	652	656	671	602	658	725
Natural gas	6	592	891	1744	2239	2735
Renewables	327	378	522	699	819	970
Final energy demand	16260	19594	23030	25757	28205	30369
by sector						
agriculture	1018	1130	1300	1400	1509	1624
industry	5195	6359	7077	7625	8140	8621
residential	3348	4365	5257	5906	6360	6800
tertiary	940	1313	1840	2272	2678	3085
transport	5759	6427	7556	8554	9518	10239
by fuel						
solid fuels	979	815	592	515	465	444
liquid fuels	11268	13602	15832	16886	18148	19259
electricity	3063	3841	4601	5214	5876	6539
thermal energy	0	55	99	232	344	362
renewables	906	914	995	1268	1322	1390
natural gas	44	365	911	1643	2050	2374

According to the "with measures" scenario the total increase of CO_2 emissions from the energy sector is estimated at 47.4% for 2010 compared to 1990 emissions, and at 65.2% in 2020 (**Table 4.6**). CO_2 emissions are projected to have an annual average increase by approximately 2.2% for the period 1990-2000, while this rate declines to 1.7% for the period 2000-2010 and to 1.1% in the following decade. The rate of increase of emissions is slowed down, mainly because of the penetration of natural gas and of various renewable energy sources especially in the power generation sector.

For the period up to 2020, the sectors with the fastest increase in emissions are those where energy demand is expected to grow fastest, namely the tertiary and residential sector. CO_2 emissions from the transport sector also exhibit important increases, with an annual average rate of 2.1% for the period 2000-2010, while this rate declines to 1.7% in the following decade, as a result of the penetration of biofuels and more efficient vehicles in the transport system. However, in terms of absolute contribution to the total CO_2 emissions arising from the Greek energy sector, it is the electric sector, which accounts for more than 48% of the total emissions in the period 1990 - 2020. The transport sector is also a major and continually increasing source of CO_2 emissions and its share in the total CO_2 emissions from the energy sector increases from 19.9% in 1990 to 21.0% in 2010 and to 22.3% in 2020. On the contrary, the share of CO_2 emissions arising from the industrial sector is continually reduced in the reference period from 16.9% in 1990 to 14.4% in 2020.

The evolution of non-CO_2 GHG emissions arising from the Greek energy sector is also presented in Table 4.6. Regarding CH_4 emissions, lignite mining, oil and natural gas distribution constitute the most significant sources accounting for more than 70% of total CH_4 emissions. CH_4 emissions are expected to increase by 1.2% per annum after 2000. On the other hand total N_2O emissions increase with an average annual rate of 1.4% for the period 2000-2020, with electric sector being the major source of N_2O emissions accounting for more than 47% of the total N_2O emissions overall the study period.

In terms of CO_2eq, GHG emissions from the Greek energy sector increase from 81.7 Mt in 1990 to 120.3 Mt in 2010 and to 134.7 Mt in 2020 with an average annual rate of 1.7% (**Table 4.7**). Tertiary and residential sectors present the highest increase rates of GHG emissions, while the transports sector presents also an important increase during the examined period. On the other hand it seems that GHG emissions arising from the agriculture sector increase slightly mainly due to the modest development of this sector. In the industrial sector, GHG emissions grow with lower rates compared with the corresponding economic growth of the sector because of the improvements in energy efficiency and the penetration of natural gas. Finally, power generation constitutes the major source of GHG emissions in the energy sector, however the average annual increase rates of GHG emissions slow down from 2.4% in the period 1990-2000 to 1.0% in 2000-2010 and to 0.8% in the following decade as a result of the increased role that natural gas and renewables play into the power system.

Table 4.6 Evaluation of GHG emissions from the energy sector in the "with measures" scenario (in kt)

Sector	Gas	1990	1995	2000	2005	2010	2015	2020
Total								
	CO_2	*77065*	*79772*	*95898*	*106068*	*113578*	*120313*	*127296*
	CH_4	*73.7*	*80.3*	*95.2*	*98.7*	*108.5*	*113.7*	*119.8*
	N_2O	*10.0*	*10.2*	*12.0*	*13.8*	*14.4*	*15.0*	*15.7*
Electricity generation								
	CO_2	40632	42146	51549	54593	56958	58723	61763
	CH_4	0.3	0.3	0.3	0.5	0.7	0.7	0.8
	N_2O	5.4	5.8	6.7	7.1	7.2	7.2	7.5
Industry [1]								
	CO_2	13052	12549	14018	15540	16676	17657	18317
	CH_4	3.8	3.5	4.0	3.9	4.3	4.6	5.3
	N_2O	1.9	1.8	1.9	2.1	2.1	2.2	2.3
Transport								
	CO_2	15355	16966	19304	21813	23868	26422	28346
	CH_4	5.4	6.8	7.6	7.5	8.0	8.4	8.7
	N_2O	0.6	0.7	1.1	2.0	2.3	2.6	2.8
Agriculture								
	CO_2	2815	2601	2659	3148	3334	3570	3831
	CH_4	0.4	0.4	0.4	0.6	0.7	0.8	0.9
	N_2O	1.1	1.0	1.0	1.2	1.3	1.4	1.5
Residential								
	CO_2	4684	4851	7592	9684	11082	12005	12846
	CH_4	9.8	9.9	9.8	6.5	5.5	4.6	3.8
	N_2O	0.9	0.9	1.2	1.3	1.4	1.4	1.5
Tertiary								
	CO_2	527	659	777	1290	1660	1935	2193
	CH_4	0.0	0.0	0.0	0.1	0.1	0.1	0.1
	N_2O	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Fugitive emissions								
	CO_2	0	0	0	0	0	0	0
	CH_4	54.0	59.3	73.0	79.6	89.2	94.4	100.2
	N_2O	0.0	0.0	0.0	0.0	0.0	0.0	0.0

[1] GHG emissions from the industrial sector include also the emissions from ammonia production and from fuel consumption as reduction agent in the ferroalloys production.

Table 4.7 Evaluation of GHG emissions from the energy sector (kt CO_2eq)

Sector	Gas	1990	1995	2000	2005	2010	2015	2020
Total	CO_2 eq	*81704*	*84634*	*101611*	*112416*	*120326*	*127351*	*134674*
	CO_2	*77065*	*79772*	*95898*	*106068*	*113578*	*120313*	*127296*
	CH_4	*1548*	*1685*	*1998*	*2072*	*2278*	*2387*	*2517*
	N_2O	*3090*	*3177*	*3714*	*4276*	*4470*	*4651*	*4862*
Electricity generation	CO_2 eq	42326	43947	53626	56801	59190	60983	64099
	CO_2	40632	42146	51549	54593	56958	58723	61763
	CH_4	6	6	7	10	15	15	16
	N_2O	1688	1795	2070	2198	2218	2245	2320
Industry [1]	CO_2 eq	13727	13188	14684	16261	17428	18443	19143
	CO_2	13052	12549	14018	15540	16676	17657	18317
	CH_4	79	74	83	83	89	96	112
	N_2O	595	565	583	639	663	689	714
Transport	CO_2 eq	15645	17317	19802	22587	24756	27398	29384
	CO_2	15355	16966	19304	21813	23868	26422	28346
	CH_4	114	142	160	158	167	177	182
	N_2O	175	209	338	617	721	799	855
Agriculture	CO_2 eq	3149	2908	2972	3523	3737	4007	4304
	CO_2	2815	2601	2659	3148	3334	3570	3831
	CH_4	8	8	9	12	15	18	20
	N_2O	326	299	304	362	388	419	453
Residential	CO_2 eq	5172	5342	8185	10238	11629	12546	13386
	CO_2	4684	4851	7592	9684	11082	12005	12846
	CH_4	205	208	206	137	116	97	80
	N_2O	283	282	387	416	431	445	460
Tertiary	CO_2 eq	550	686	809	1335	1712	1992	2253
	CO_2	527	659	777	1290	1660	1935	2193
	CH_4	1	0	0	1	1	2	2
	N_2O	22	26	31	44	50	55	59
Fugitive emissions	CO_2 eq	1135	1246	1532	1671	1874	1983	2105
	CO_2	0	0	0	0	0	0	0
	CH_4	1135	1246	1532	1671	1874	1983	2105
	N_2O	0	0	0	0	0	0	0

[1] GHG emissions from the industrial sector include also the emissions from ammonia production and from fuel consumption as reduction agent in the ferroalloys production.

4.4.2 Industrial processes

Projected emissions from industrial processes are based mainly on the analysis (a) of the activity data of the respective industrial branches and (b) the apparent consumption of refrigeration and air-conditioning appliances. The emission factors used are those reported in the latest inventory since no technological advances or reduction policies are integrated in the "with measures" scenario.

The main assumptions that were adopted in the context of the present analysis in order to evaluate the future development of GHG emissions from the sector of industrial processes are presented in **Table 4.8**. It is considered that the installed capacity of the installations under the industrial processes sector is not foreseen to increase in the future, given the important investments realized in the period 2000-2003 in cement and metal production installations.

Table 4.8 Main assumptions for the "with measures" scenario in Industrial processes sector

	Historical data			Projections		
	1990	1995	2000	2000-2005	2005-2010	2010-2020
Clinker production (Mt)	10.6	11.7	12.1	0.6%	0.9%	0.8%
Steel production (Mt)	1.0	0.9	1.1	16.2%	1.9%	0.4%
Other mineral products				Production of other mineral products (e.g. lime, glass, etc.) increase with an mean annual rate of 2% for the period 2000-2020		
Aluminium production				Aluminium production is kept constant at 2000-2003 levels		
Chemical industry				Nitric acid production is kept constant at 2000-2003 levels		
Production of F-gases				HCFC-22 production decreases following the phase-out schedule defined in Regulation 2037/2000		
Consumption of F-gases				All new and replaced refrigeration and air-conditioning equipment use HFC as the refrigerant agent		

The projections of GHG from industrial processes in the "with measures" scenario show a total increase of 60% in 2010 and 98% in 2020 compared with 1990 levels (**Table 4.9**). Key highlights include:

- CO_2 emissions increase by 14% in 2010 and by 15% in 2020 compared to 2000, while nitrous oxide emissions decrease significantly. The increase of CO_2 emissions is due to the continuing high degree of exploitation of the recently upgraded and expanded capacity for cement and iron and steel production.
- PFC emissions from aluminium production remain at the average level of the period 2000-2003, while HFC emissions from the production of HCFC-22 decrease following the phase-out schedule set by the Regulation 2037/2000 for the production of HCFC-22.
- HFC emissions due to the use of refrigeration and air-conditioning equipment increase with a rate of 13% per annum for the period 2000 – 2020. This increase is attributed both to the high rates of air-conditioning penetration and to the final disposal of these equipments. As a result, the contribution of this sub-sector to the total emissions from industrial processes increases to 21% in 2010 and to 36% in 2020. At the same time the share of CO_2 emissions is decreased from 78% in 1990 to 65% in 2010 and to 58% in 2020.

Table 4.9 Evaluation of GHG emissions from the industrial processes sector (in kt CO_2eq)

	1990	1995	2000	2005	2010	2015	2020
A. Emissions per source category							
Mineral products	6330	6969	7387	7733	8151	8569	8988
Chemical industry [1]	713	565	496	438	438	438	438
Metal production [2]	692	498	653	898	955	978	983
Production of F-gases	935	3253	3735	2561	1386	792	594
Consumption of F-gases	0	116	538	1219	2980	4843	6185
B. Emissions per gas							
CO_2	6764	7384	7892	8554	9030	9471	9895
N_2O	713	565	496	438	438	438	438
HFC	935	3369	4273	3779	4366	5635	6779
PFC	258	83	148	76	76	76	76
Total	**8670**	**11400**	**12810**	**12848**	**13910**	**15619**	**17188**

[1] CO_2 emissions from ammonia production are reported under the energy sector.

[2] CO_2 emissions from ferroalloys production are reported under the energy sector.

4.4.3 Solvents and other products use

Population is considered as the determinant parameter (in accordance to the methodology used for emissions calculation in the National Inventory) of the emissions from solvents and other products use. It is estimated that emissions (**Table 4.10**) will show a total increase (compared to 2000 levels) by 11% in 2010 (161 kt CO_2) and by 14% in 2020 (166 kt CO_2).

Table 4.10 GHG emissions from solvents and other products use (in kt CO_2eq)

	CO_2 emissions
1990	170
1995	153
2000	145
2005	158
2010	161
2015	164
2020	166

4.4.4 Waste

Solid waste disposal on land is the major source of GHG emissions from the waste sector. The main assumptions for the projection of emissions from solid waste disposal on land are related to the generation rates per region (urban, semi-urban and rural) and type of population served (permanent, tourists), to the quantities of waste land filled in managed and unmanaged waste disposal sites (SWDS), to the composition of waste in landfills and, finally, to the quantities of waste recovered. **Table 4.11** summarizes the parameters mentioned above for the period 1990 – 2020.

Table 4.11 Main assumptions in the "with measures" scenario for solid waste disposal on land

	Historical data			Projection			
	1990	1995	2000	2000-2005	2005-2010	2010-2015	2015-2020
Generation rate (kg / cap / day)	0.82	0.94	1.09	1.25	1.41	1.57	1.73
Waste land filled in managed sites (kt)	1,166	1,477	2,133	3,178	3,214	3,153	3,373
Waste land filled in unmanaged sites (kt)	1,633	1,879	1,935	1,505	596	225	1.24
Fraction of organic waste land filled (%)	65.8	65.6	65.1	64.2	48.8	33.9	25.7
Recycling (%)	9.4	8.1	7.6	8.7	35.2	48.9	53.7

Policy issues that affect significantly the projection of GHG emissions from solid waste disposal on land and wastewater handling include: (a) the implementation of Council Directive 1999/31, regarding sanitary landfill (which is the main reason for the significant increase of waste recycled, especially from 2005 and onwards) and (b) the establishment of managed disposal sites and municipal wastewater plants according to the strategic plan of Ministry for Environment.

The default IPCC methodology was followed for all source categories (solid waste disposal on land, domestic wastewater handling, human sewage and industrial wastewater handling). The key results of the analysis are summarized below (**Table 4.12**):

- Methane emissions from solid waste disposal on land show an increase of 12% in 2010 (3.0 Mt CO_2eq) compared to 1990 levels (2.7 Mt CO_2eq) but a decrease of 45% in 2020 (1.5 Mt CO_2eq) compared to 1990 levels. The highly decreasing trend of emissions expected after 2005 is mainly due to the implementation of EU Directive 1999/31 regarding the recovery of organic waste. The Directive has been incorporated since 2002 in the Greek law (Joint Ministerial Decision 29407/3508) and its implementation is mandatory.
- As a result of the establishment of wastewater plants that will serve 95% of population from 2006 and onwards, the methane emissions from wastewater handling (domestic and commercial wastewater) decrease by 88% in 2005 and 94% in 2010 compared to 1990 levels and remain almost constant the following decade.
- The nitrous oxide emissions from human sewage increased by 14% up to 2002 and are expected to continue their increasing trend during the next decades with an average annual rate in the order of 0.18%.
- Methane emissions from industrial wastewater handling increase by 28% in 2020 (136 kt CO_2eq) compared to 1990 levels (106 kt CO_2eq). The average annual rate remains constant at 0.85% for the entire period of the projections.

Table 4.12 GHG emissions from the waste sector (kt CO_2eq)

	1990	1995	2000	2005	2010	2015	2020
A. Emissions per source category							
Solid waste disposal on land	2673	3369	3602	4555	3107	1952	1538
Domestic wastewater handling	2252	1988	1327	274	131	132	133
Industrial wastewater handling	106	102	122	120	125	131	136
Human sewage handling	327	352	378	379	387	393	397
B. Emissions per gas							
CO_2	21	35	177	241	145	96	82
CH_4	5009	5424	4873	4708	3219	2119	1724
N_2O	327	352	378	379	387	393	397
Total	**5357**	**5811**	**5429**	**5328**	**3750**	**2608**	**2203**

4.4.5 Agriculture

The main determinant parameters of GHG emissions from agriculture are the agricultural areas, the animal population and the quantities of synthetic nitrogen fertilizers applied on soils.

The number of sheep, goats and poultry increases with a rate of 0.6%, 0.4% and 1% per annum respectively between 2000 and 2020, while swine population decreases by 0.3% per annum. The number of dairy cows and other cattle decreases with a mean annual rate of 0.4% for the period 2000-2020, while the horse population decreases by 4.6%. The above-mentioned rates are based on the analysis of the trends observed in the last decade. In **Table 4.13** the evolution of animal population is presented, for the period 1990 - 2020.

Table 4.13 Animal population (thousands) per species (3-year average)

	Historical data			Projection			
	1990	1995	2000	2005	2010	2015	2020
Dairy cattle	246	230	224	213	202	193	183
Non dairy cattle	380	350	380	376	375	375	375
Buffalos	1	1	1	1	1	1	1
Sheep	8,692	8,856	8,987	9,150	9,320	9,493	9,669
Goats	5,339	5,513	5,645	5,810	5,977	6,150	6,327
Horses	46	35	29	22	18	14	11
Asses & mules	187	130	98	69	49	35	25
Swine	994	997	969	959	947	935	924
Poultry	28,747	29,198	30,856	32,376	34,002	35,740	37,593

The use of synthetic nitrogen fertilizers (**Table 4.14**) decreases continuously and as a result total nitrogen deposition on land decreases with a mean annual rate of 1.2% for the period 2000 – 2010, while the total reduction in 2010 is estimated at 11% compared to 1990. Data for the period until 2003 derive from the international database of the United Nations Food and Agriculture

Organization (FAO), while the projections are based on the index of nitrogen quantities applied in soils per unit of agricultural areas, estimated at 0.08 kg N/ha for the years 1999 - 2003.

Table 4.14 Projection of nitrogen inputs in soils from synthetic fertilizers

	Historical data			Projections			
	1990	1995	2000	2005	2010	2015	2020
Synthetic fertilizers (kt N)	428	315	285	253	253	255	257

Agricultural areas, which are responsible for most of N_2O emissions, are expected to increase slightly up to 2020, following an increase rate of 0.13% annually. At the same time the productivity index is expected to improve during the 2000-2020 period. In **Table 4.15** the projections of the agricultural areas for the period examined are presented.

The emission factors used for the estimation of CH_4 emissions from enteric fermentation and manure management are those suggested by the IPCC Guidelines for Eastern Europe, as far as cattle are concerned, and for developed countries for the rest animal species. Especially for the estimation of emissions from enteric fermentation of sheep, which account for 50% of methane from this sub-source, Tier 2 methodology was applied. The average value of the emission factor for sheep, according to Tier 2 methodology, was estimated at 7.4 kg CH_4/animal/year. The emission factors used for N_2O estimations from manure management are the ones suggested by the IPCC Guidelines for Mediterranean countries, while the methodologies and emission factors suggested by the IPCC Good Practice Guidance were used for the estimation of GHG emissions from agricultural soils, rice cultivations and field burning of agricultural residues. Other parameters like manure management systems and percentage of agricultural residues burned on site are kept constant at 2000 levels.

Table 4.15 Projection of agricultural areas (1000 ha)

	Historical data			Projection			
	1990	1995	2000	2005	2010	2015	2020
Trees and vines	1068	1085	1127	1149	1152	1161	1169
Arable	1986	1944	1912	1864	1869	1883	1896
Rice	16	26	20	26	28	31	33
Market gardening	114	121	123	118	118	119	120
Fodder plants	331	316	294	320	321	323	325
Fallow land	501	469	441	455	457	460	463
Total area	*4016*	*3962*	*3918*	*3931*	*3946*	*3977*	*4007*

Total GHG emissions from agriculture decrease by 9% in 2010 (12.3 Mt CO_2eq) and 7% in 2020 (12.6 Mt CO_2eq) compared to 1990 levels (13.5 Mt CO_2eq) (**Table 4.16**). The contribution of agricultural soils to the total emissions of the sector is 70%, when at the same time the contribution of enteric fermentation is around 23%.

Table 4.16 GHG emissions from agriculture in the "with measures" scenario (kt CO_2eq)

	1990	1995	2000	2005	2010	2015	2020
A. Emissions per source category							
Enteric fermentation	2861	2832	2880	2889	2909	2932	2958
Manure management	798	766	777	767	760	754	749
Rice cultivation	69	110	84	96	96	97	98
Agricultural soils	9749	8740	8549	8337	8462	8608	8761
Field burning of agricultural residues	37	41	40	37	38	38	39
B. Emissions per gas							
CH_4	3454	3456	3483	3499	3518	3542	3570
N_2O	10060	9033	8848	8627	8747	8887	9036
Total	**13514**	**12489**	**12330**	**12126**	**12265**	**12429**	**12606**

4.4.6 Land Use, Land Use Change and Forestry

Projections of GHG emissions and removals from the LULUCF sector were based on methods and assumptions used for the estimations of emissions and removals during 1990 – 2003. Emission factors used are the ones used in the preparation of the last inventory. An analysis of data and trends of the last decades was elaborated in order to estimate the evolution of GHG emissions and removals, and the following assumptions have been made:

- According to the forest definition used in the inventory, the area of managed and harvested forest land will remain constant.
- Annual biomass increment in these lands will remain constant, equal to that estimated for the period 1990 – 2003, while fellings will be stable at 2003 levels.
- Areas affected by wildfires each year will be equal to the average area burnt in the period 1990 – 2003 (this assumption results in reduced inter-annual variation in net emissions / removals of GHG from this sector in relation to the variation observed during 1990 – 2003).
- Afforestation of croplands is expected to continue until 2006 with a rate equal to the average afforestation rate of the period 1994 – 2003. The average carbon sequestration in living biomass in these lands is assumed stable for 30 years after the establishment of the plantation.
- For the projections of carbon stock changes and emissions / removals of CO_2 from croplands, the assumptions related to the evolution in the areas of each crop type described in the previous section (Agriculture, Table 4.15), were followed.

Table 4.17 presents emissions (with positive sign) and removals (with negative sign) of the three GHG from this sector, in CO_2 equivalent, as estimated for the years 1990, 1995 and 2000, and their projected evolution until 2020.

Table 4.17 Net emissions / removals of GHG from LULUCF sector per gas in the "with measures" scenario (kt CO_2eq)

	1990	1995	2000	2005	2010	2015	2020
CO_2	-3248.20	-4406.97	-3141.90	-4758.32	-4829.54	-4565.37	-4320.26
CH_4	49.87	34.76	166.10	51.00	51.00	51.00	51.00
N_2O	5.06	3.53	16.86	5.18	5.18	5.18	5.18
Total	-3193.27	-4368.69	-2958.93	-4702.15	-4773.37	-4509.19	-4264.08

According to the projection of GHG emissions and removals from the LULUCF sector, the net annual removals will decrease from 5.5 Mt CO_2eq/yr in 2003 to 4.8 Mt CO_2eq/yr in 2010 and to 4.3 Mt CO_2eq/yr in 2020, remaining though larger than the average annual removals in the period 1990 – 2003. This removal reduction is mainly due to the saturation of the sink that has been created in cropland during the last decades from the substitution of arable lands by tree crops.

Uncertainties of projected emissions and removals are increased because, apart from the high inherent uncertainties in estimations for this sector, the uncertainty regarding the area burned (which is taken to be equal to the average value of the period 1990-2003), is high due to high annual variation of the phenomenon.

In **Figure 4.1** the projection of net emissions / removals per category and the total sector are presented, in CO_2eq.

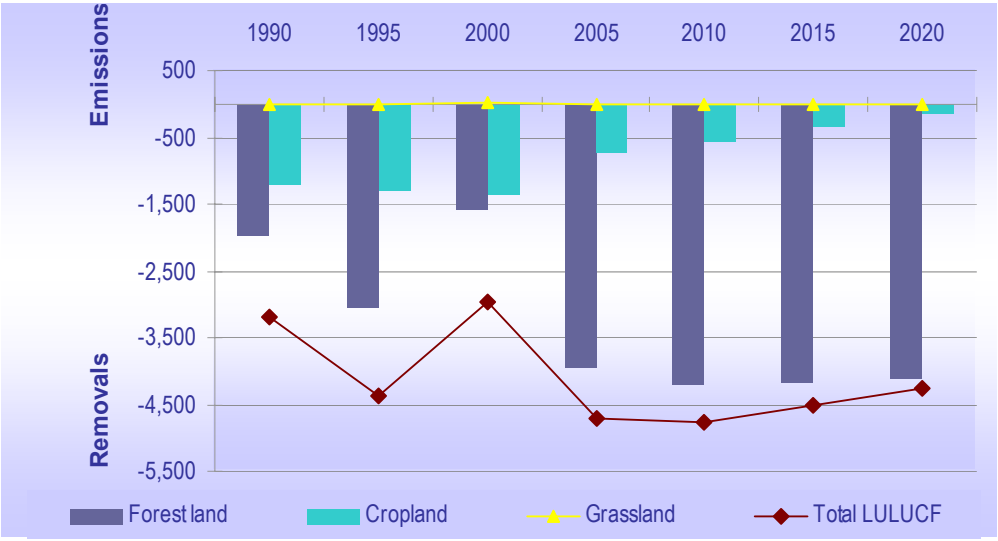


Figure 4.1 Net emissions / removals of GHG (in kt CO_2eq) from the LULUCF sector, per land category and in total

4.4.7 Evaluation of GHG emissions development in Greece

Table 4.18 presents the evolution of specific sectoral indicators, which evaluate the effectiveness of the implemented and adopted policies and measures aiming at reducing GHG emissions in Greece. These indicators were estimated on the basis of the background information and the results obtained by the "with measures" scenario. The main findings of this analysis are summarized below:

- Despite the substantial increase of ***total CO_2 emissions*** in the country, emissions intensity per GDP unit is projected to show a significant decrease during the period 2000-2020 (from 845 t CO_2/M€ in 2000 to 686 t CO_2/M€ in 2010 and to 563 t CO_2/M€ in 2020) as a result of the implemented and adopted policies and measures, and particularly because of the penetration of natural gas and various renewable energy sources into the energy system.
- In the ***transport*** sector emissions per passenger-kilometre covered are projected to decrease during the period, particularly after 2005, mainly because of the penetration of biofuels as well as the modernization of the fleet and the increased use of vehicles with lower specific consumption. Similarly emissions per ton-kilometre covered are estimated to decrease mainly due to the modernization of the fleet.
- In the ***industrial*** sector, the intensity of CO_2 emissions decreases during the entire period examined (from 640 t CO_2/M€ in 1990 to 558 t CO_2/M€ in 2000 and below 500 t CO_2/M€ in the decade 2010-2020) as a result of the implementation of energy conservation policies in the sector and the penetration of natural gas.
- In the ***residential sector,*** CO_2 emissions per household were substantially increased during the last decade and this trend is expected to continue until the end of the 2000-2010 decade as a result of the improved standards of living. This increasing trend is projected though to slow down during the next decade because of the penetration of natural gas into the sector and the promotion of policies that aim at the improvement of energy efficiency of buildings as well as the stabilization of the population live in the country.
- In the ***tertiary sector,*** an increase of CO_2 emissions intensity is projected until 2010, which is reserved during the decade 2010-2020. These trends are primarily attributed to the improved working conditions and the high growth rates of the sector, as well as to the natural gas penetration, which is expected to substitute oil and electricity in some energy uses (e.g. heating, air-conditioning, etc.).
- In the ***power generation*** sector, CO_2 emissions per unit of energy produced from conventional fossil-fuelled power plans shows a remarkable decrease during the entire period under examination, primarily as a result of natural gas penetration into the electric system, and secondarily due to the refurbishment of some old lignite-fired power units.
- In the ***agricultural*** sector, N_2O emissions per nitrogen unit from the use of fertilizers and animal manure, remain at the same levels during the entire period examined. This is mainly attributed to the fact that the management practices in the sector will remain unchanged. Per animal CH_4 emissions from cattle show a slight decrease especially after 2010.

- Finally in the ***waste*** sector, CH_4 emissions per kt of landfill waste presents a substantial decrease mainly after 2010, as a result of the implementation of the Directive 1999/31 for landfill of waste.

Table 4.18 Projection of basic indices for the evaluation of policies and measures implementation to reduce GHG emissions.

Sector	Index	1990	1995	2000	2005	2010	2015	2020
Total	Emissions intensity (t CO_2 / M€)	860	840	845	769	686	612	563
Transport	Specific CO_2 emissions of passenger cars (t CO_2/p-km)	0.085	0.079	0.073	0.072	0.063	0.060	0.058
Transport	Specific CO_2 emissions of freight transport (t CO_2/t-km)	0.51	0.44	0.39	0.35	0.32	0.31	0.29
Industry	Emissions intensity (t CO_2 / M€)	640	583	558	532	496	460	429
Residential	Specific CO_2 emissions of households (t CO_2 / household)	1.38	1.33	1.96	2.39	2.60	2.70	2.79
Tertiary	CO_2 emissions intensity (t CO_2 / M€)	8.63	10.13	10.03	13.27	14.08	13.72	13.44
Electricity generation	CO_2 emissions of large power plants (t CO_2 / TJe)	378	343	320	304	274	260	248
Agriculture	Specific N_20 emissions of fertilizer and manure use (kt N_20 / kt N)	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Agriculture	Specific CH_4 emissions of cattle production (t CH_4 / head)	81.20	81.32	80.49	80.20	79.86	79.52	79.19
Waste	Specific CH_4 emissions from landfills (kt CH_4/kt waste)	0.05	0.05	0.04	0.04	0.04	0.03	0.02

4.5 "With additional measures" scenario

As already mentioned in Chapter 3 the total potential of GHG emissions reduction from the ***implementation of additional policies and measures*** reaches 11.1 Mt CO_2eq in 2010 (i.e. the middle of the 1st Commitment Period of the Kyoto Protocol) and 16.4 Mt CO_2eq in 2015. However during the estimation of total emissions reduction potential, the secondary effects from the implementation of several policies and measures, which restrict to a certain percentage the estimated potential, have not been considered. The problem mainly concerns the measures that are related to electricity generation and consumption, given that the implementation of the planned interventions in the electricity generation sector will reduce the overall efficiency of those measures that aim at reduction of electricity use in the sectors of final consumption.

For the estimation of GHG emissions reduction potential from the combined implementation of additional policies and measures at both the supply and demand sectors, the following process is followed:

1. Based on the results of the "with measures" scenario, the emissions reduction potential that will be achieved by the implementation of additional policies and measures in the sectors of energy supply and conversion is estimated.
2. Based on emission reductions estimated in the previous stage, the future evolution of GHG emissions factor from the power generation sector is recalculated.

3. GHG emissions reduction potential from the implementation of energy conservation measures in the sectors of final consumption is estimated taking into account the new emission factor calculated in stage 2 for the electric system.

4. Finally, the total emissions reduction potential is estimated on the basis of the individual emission reductions estimated in stage 3 as a result of the examined policies and measures in the sectors of final consumption and the emissions reduction potential estimated in step 1 from interventions in the sectors of energy supply and conversion.

The reduction potential of GHG emissions in the sectors of economic activity, taking into account the consequences from the concurrent implementation of the various measures, is presented in **Table 4.19**. This potential is estimated at 10.9 Mt CO_2eq in 2010 and at 15.9 Mt CO_2eq in 2015.

As presented in **Figure 4.2** it is obvious that Greece has the ability almost with exclusively domestic policies and measures to reach its Kyoto Protocol target for the 1st Commitment Period. Table 4.3 in the beginning of this Chapter presents comparatively the results of the "with measures" scenario and the "with additional measures" scenario, while **Figure 4.3** shows graphically the evolution of GHG emissions according to the two scenarios examined separately for each sector. However, considering the fact that at least some of the planned interventions have a significant cost, the use of credits from the exploitation of the Kyoto Protocol Flexible Mechanisms should not be excluded. It is worth mentioning that the Ministry of Environment, Physical Planning and Public Works is funding studies to examine the overall attractiveness of various JI and CDM projects, which will allow the fulfilment of the Kyoto Protocol commitments with higher economic efficiency.

Table 4.19 **Sectoral GHG emissions abatement potential taking into account the interactions from the combined implementation of the planned policies and measures (kt CO_2eq).**

Sector	2010	2015
Electricity generation	5321	7502
Industry	928	1056
Residential – tertiary sectors	2971	4412
Transport	609	1069
Industrial processes	718	1536
Waste	201	149
Agriculture	134	152
Total	*10882*	*15876*

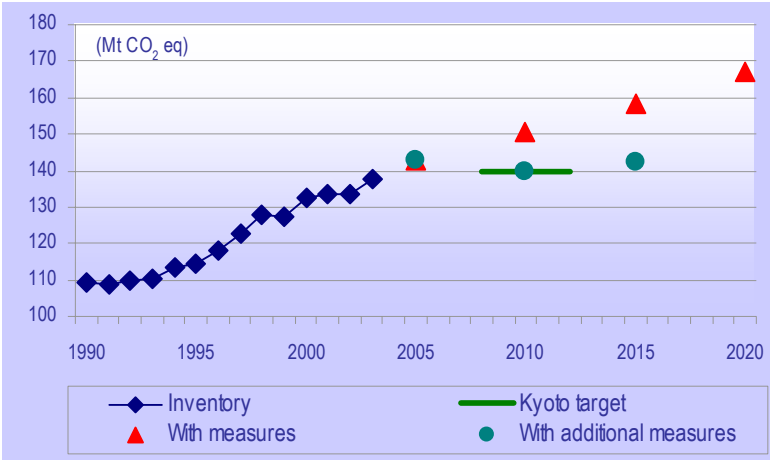


Figure 4.2 **Projections of GHG emissions in the "with measures" and the "with additional measures" scenarios.**

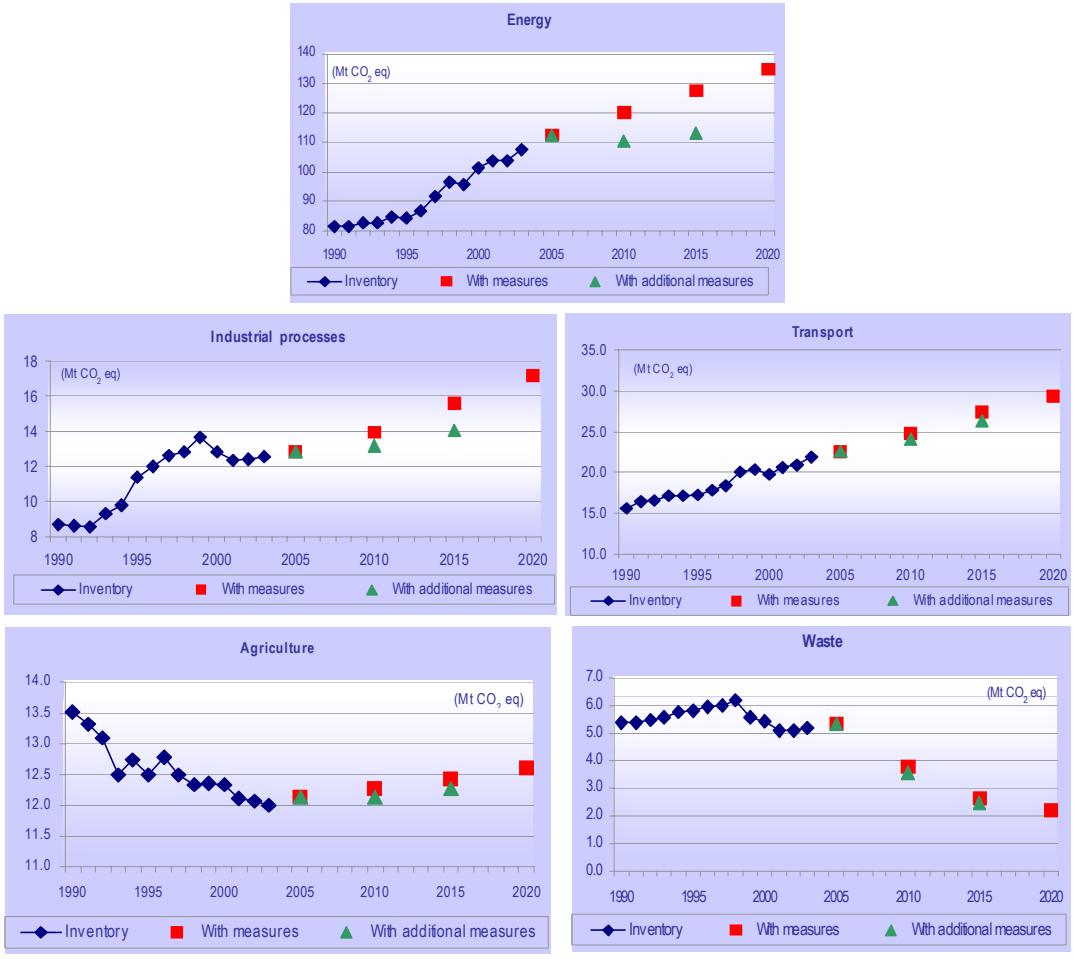


Figure 4.3 **GHG emissions reduction potential from the implementation of additional policies and measures per sector.**

4.6 Sensitivity analysis

As already mentioned previously, the energy sector constitutes the major source of GHG emissions in Greece. The results of the "with measures" scenario clearly show that, despite the substantial changes that have already been realized or have been adopted in this sector, energy associated GHG emissions continues to increase. In order to analyse the sensitivity of the results obtained, three additional scenarios regarding the future evolution of GHG emissions from the energy sector, which were formulated for the MEPPPW in 2004, are shortly presented in this paragraph. These scenarios are differentiated with respect to the "with measures" scenario according to various parameters, while the quantitative analysis is based again on the use of the energy model ENPEP. Specifically, these scenarios include:

- Reference Scenario (RS), which has significant similarities with the "with measures" scenario of the present Report, however it does not take into consideration some of the already adopted policies and measures (e.g. the introduction of biofuels), while it considers slightly lower international energy prices and slightly lower economic growth rates.
- Carbon Tax Scenario (CTS), in which an environmental tax on GHG emissions from the production and consumption of energy is imposed.
- Weak Growth Rate Scenario (WGRS), in which significantly lower rates of economic development for the Greek economy are adopted.

Figure 4.4 presents comparatively the evolution of GHG emissions from the energy sector according to the results of the various scenarios examined. It is obvious that with the exception of the CTS all the other scenarios lead to similar results in the time horizon of 2010 as also for 2020, despite the differentiations in the background assumptions adopted by each scenario. In the following a short presentation of the results of the three additional scenarios examined is given and the main differences compared to the "with measures" scenario are outlined.

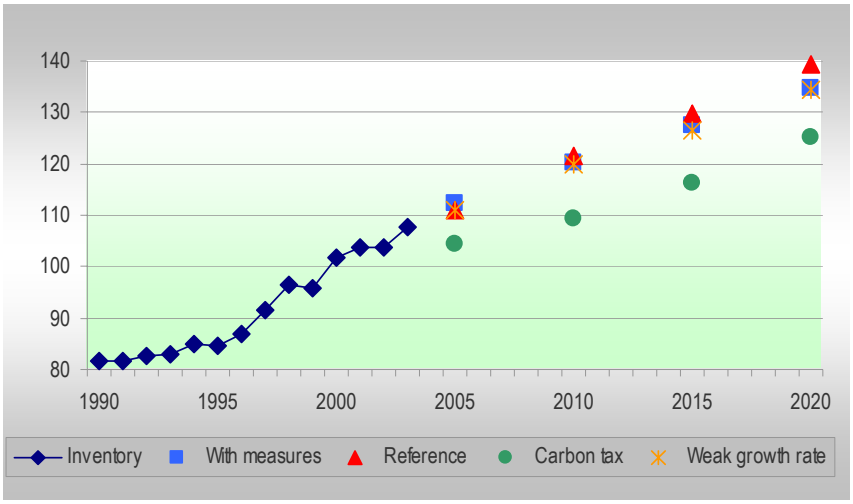


Figure 4.4 **Evolution of the GHG emissions from the Greek energy sector according to five different scenarios.**

4.6.1 Reference scenario

The Reference Scenario (RS) constitutes a scenario which has significant similarities with the "with measures" scenario, however it does not take into consideration a series of recently adopted policies and measures (e.g. introduction of biofuels in the transports sector, adaptation of the Greek refineries for the production of higher quality fuels, recent decisions regarding future developments in the Greek power sector, etc). In addition, RS adopts relatively lower energy prices and temperate rates of economic growth with respect to the "with measures" scenario.

According to the RS results, total GHG emissions from the Greek energy system increase from 81.7 Mt in 1990 to 121.7 Mt in 2010 (increase by 49%) and to 139.3 Mt in 2020 (increase by 70.5%) with an average annual rate of 1.8%. RS leads to relatively higher emissions compared to "with measures" scenario (by 1.8% in 2010 and by 5.6% in 2020), which is mainly attributed to the absence of certain already adopted policies as well to the consideration of relatively lower energy prices. For the period up to 2020, the sectors with the fastest increase in emissions are those where energy demand is expected to grow fastest, namely the tertiary and transport sectors. On the contrary, although emissions in the residential sector present important increase during the period 1990-2000, it is expected that this rate will decline in the following decades. In terms of absolute contribution to the total CO_2 emissions arising from the Greek energy sector, it is the electric sector, which accounts for more than 50% of the total emissions between 1990 and 2020. At the same time, it seems that GHG emissions deriving from the sectors of industry and agriculture increase slightly, mainly due to the modest growth of these sectors. Finally, it should be noted that as in the "with measures" scenario GHG emissions do not grow at the rate of economic growth because of the improvements in energy efficiency.

4.6.2 Carbon Tax Scenario

The CTS examines the impacts on the Greek energy system and on the associated GHG emissions, from the imposition of a carbon tax. Given that CO_2 is responsible for more than 94% of GHG emissions in the energy sector, the tax has been imposed only on CO_2 emissions from production and consumption of energy. The CTS examined assumes an environmental tax that is equivalent to 41.8$ (2000 prices)/t CO_2, which is very similar to the excess emissions penalty (40 €/t CO_2 in current prices) adopted within the context of the EU Directive on Emissions Trading (2003/87 EC) for the 1st trading period (2005-2007). With the exception of fuel prices, which are influenced by the implementation of the carbon tax, the CTS adopts similar assumptions on population, climatic conditions, macroeconomic factors, existing policies and measures and discount rates, as those presented in the RS.

According to the CTS, GHG emissions from the energy system increase from 81.7 Mt in 1990 to 109.4 Mt in 2010 and to 125.2 Mt in 2020 with an average annual rate of 1.4% for the whole study period. Total increase of GHG emissions compared to 1990 levels is estimated at 33.9% in 2010 and at 53.2% in 2020, significantly lower compared to the corresponding figures of both the "with measures" and reference scenarios. The electricity generation sector presents the largest GHG emissions abatement potential (10.2 Mt CO_2eq in 2010 and 11.7 Mt CO_2eq in 2020), mainly due to

the considerable decrease of electricity demand, as well as from the use of cleaner and, particularly, renewable energy forms in electricity production. Apart from the power generation sector, emission reductions compared to the RS are also expected in the industrial and residential sectors (6% and 5.1% respectively), and to a lesser extent in the transport sector. These reductions are achieved with the use of more efficient technologies as well as the further penetration of cleaner energy resources in final energy demand (natural gas, biomass, solar energy, etc.). On the contrary, GHG emissions from the tertiary sector are projected to increase slightly, mainly due to a substitution of electricity with other conventional fuels (e.g. natural gas for air-conditioning, diesel for space heating, etc.) in various energy uses.

4.6.3 Weak Growth Rate Scenario

The WGRS examines the impacts on the Greek energy system and the associated GHG emissions assuming that the growth rates of the Greek economy in the coming years will be lower compared to those adopted in the "with measures" scenario and in RS. More specifically, WGRS assumes that the GDP will increase during the period 2005-2010 with an average annual rate of about 3% (in the "with measures" scenario the respective growth rate is 3.7%). For the period following 2010, the average annual economic growth rate is expected to reach 2.7% for the years 2010-2015 (3.5% in the "with measures" scenario) and 2.6% for the rest of the period examined (2.8% in the "with measures" scenario). It is worth mentioning that WGRS assumes that the convergence of the Greek economy with the average European levels will continue throughout the period examined, but with lower rates compared to "with measures" scenario. The rest assumptions of the above scenario are identical to those in RS.

According to WGRS, GHG emissions are projected to increase from 81.7 Mt in 1990 to 120 Mt in 2010 and to 134.5 Mt in 2020. This means that the above scenario leads to an increase of emissions by 46.9% in 2010 and 64.6% in 2020 compared to 1990 levels, while the RS for the same years presents an increase by 49% and 70.5%. The sectors with the most important differentiations concerning RS are the tertiary and transport sector. Indicatively, it is mentioned that the tertiary sector presents a reduction of emissions compared to RS by 2.1% in 2010 and 6.1% in 2020. Finally, the power generation sector shows a reduction of emissions compared to the RS by 0.8 Mt in 2010 and 2.0 Mt in 2020. The difference in projected GHG emissions from WGRS and RS is relatively small, and this is mainly attributed to the fact that as WGRS projects lower levels of electricity demand (due to the lower rates of economic growth adopted), some of the new combined cycle power plants, which use natural gas, included in the RS are not installed. Therefore in WGRS the old lignite-fired power plants that already operate in the Greek energy system play a crucial role for covering future electricity demand, thus resulting to higher GHG emissions.

5 CLIMATE CHANGE IMPACTS, VULNERABILITY ASSESSMENT AND ADAPTATION MEASURES

5.1 Climate change impacts

5.1.1 Present climate – Observed changes

5.1.1.1 Temperature

Given the discrepancy between the estimated climatic trends that result from different data grid analyses, the trends of temperature time series during the last 50 years deriving from measurements in nine meteorological stations of Greece were recently studied (NOA, 2005).

The analysis of average annual temperatures (**Figure 5.1**) shows that initially there has been a cooling period over the whole country. This period began in the middle of the'50s in Northern Greece and progressively extended also in the southern regions of the country where it started to be detected in the beginning of the'70s. The lowest average annual temperatures in Greece occurred in the decade of 1970 up to the beginning of 1980, due mainly to the very cold summers and autumns. However, during the last years of the '90s (while a little earlier in some meteorological stations), a progressive increase of temperature was observed, which in some cases this lead even to the inversion of negative trends which were registered in previous studies. However, by checking the time series of measurements from the meteorological stations at the National Observatory of Athens (NOA) and the Aristotle University of Thessaloniki (1893 – to date) which are the longest available, the existence of an additional warming period, starting approximately at the middle of the period 1910 – 1920, can be observed.

During the summer period (**Figure 5.2**), the average temperature followed the general cooling trend that started from the end of 1950 until the middle of 1960, reaching its minimum level during 1975 – 1980 and then started to rise again. This recovery is significant and lead, in the majority of meteorological stations, to the inversion of negative trends observed up to 1993, into positive ones when adding the data up to the year 2001. This warming period started in the '90s. The addition of data from the latest years (i.e. up to 2004) indicates in certain stations, such as Larissa, a shift from positive to negative trends.

On the contrary, during winter period of the last decade, negative trends (cooling) were observed in all the stations under study except the one of NOA in Athens. The period of decreasing winter temperatures seems to start in the middle of '60s and extends up to 1980. By examining in this case as well the longest available time series of NOA and the Aristotle University of Thessaloniki (1893 – to date), the existence of an additional winter cooling period is observed, starting in the '20s.

Based on the above, the recovery of the declining trend of the annual temperature observed in several meteorological stations after 1990, despite the fact of the significant reduction of winter temperatures, seems to be caused from a more intensive warming during the summer period.

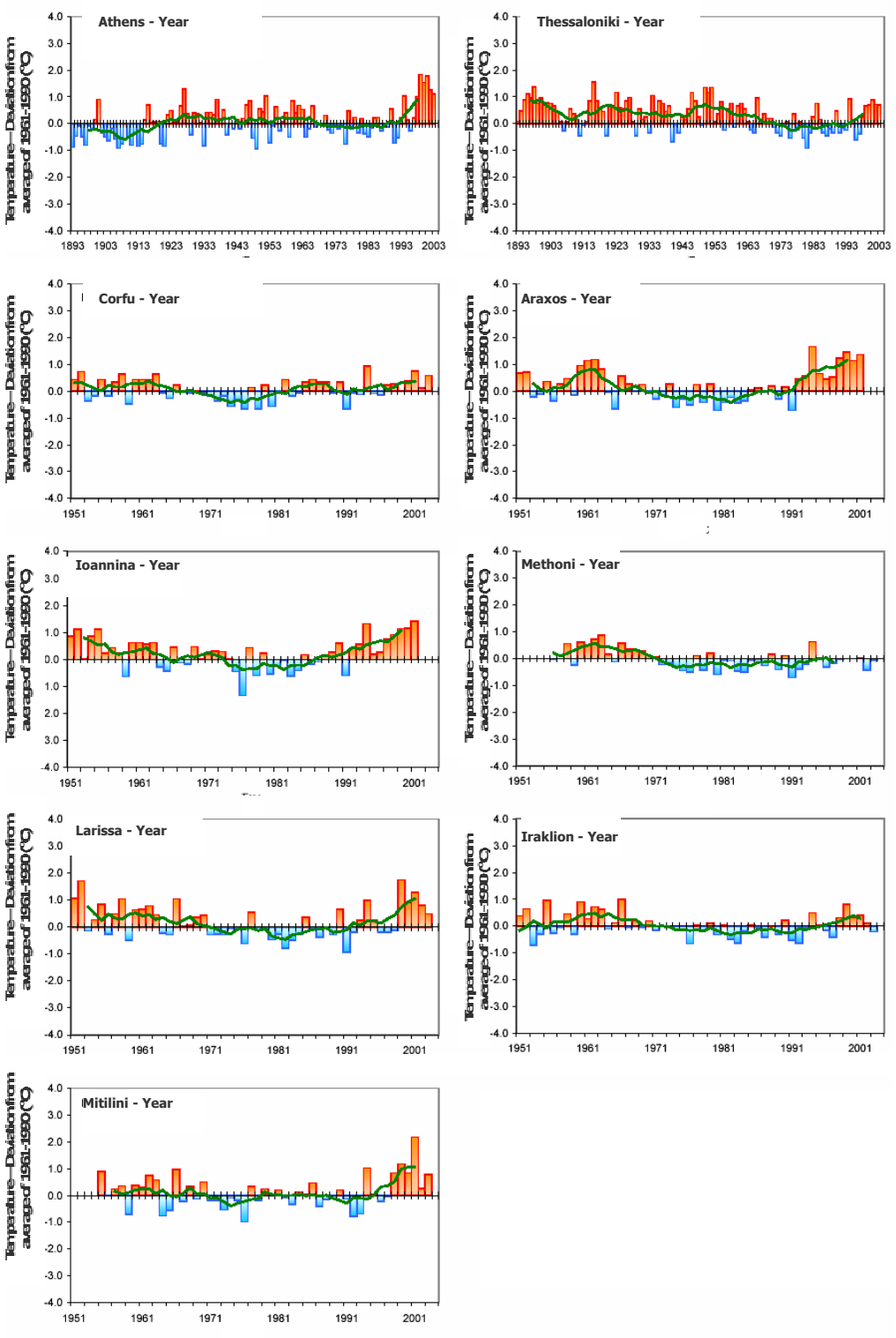


Figure 5.1 Deviation of the average annual temperature from the average of the period 1961 – 1990 in selected meteorological stations of Greece and 5-year moving average (note: 11-year moving average for Athens and Thessaloniki)

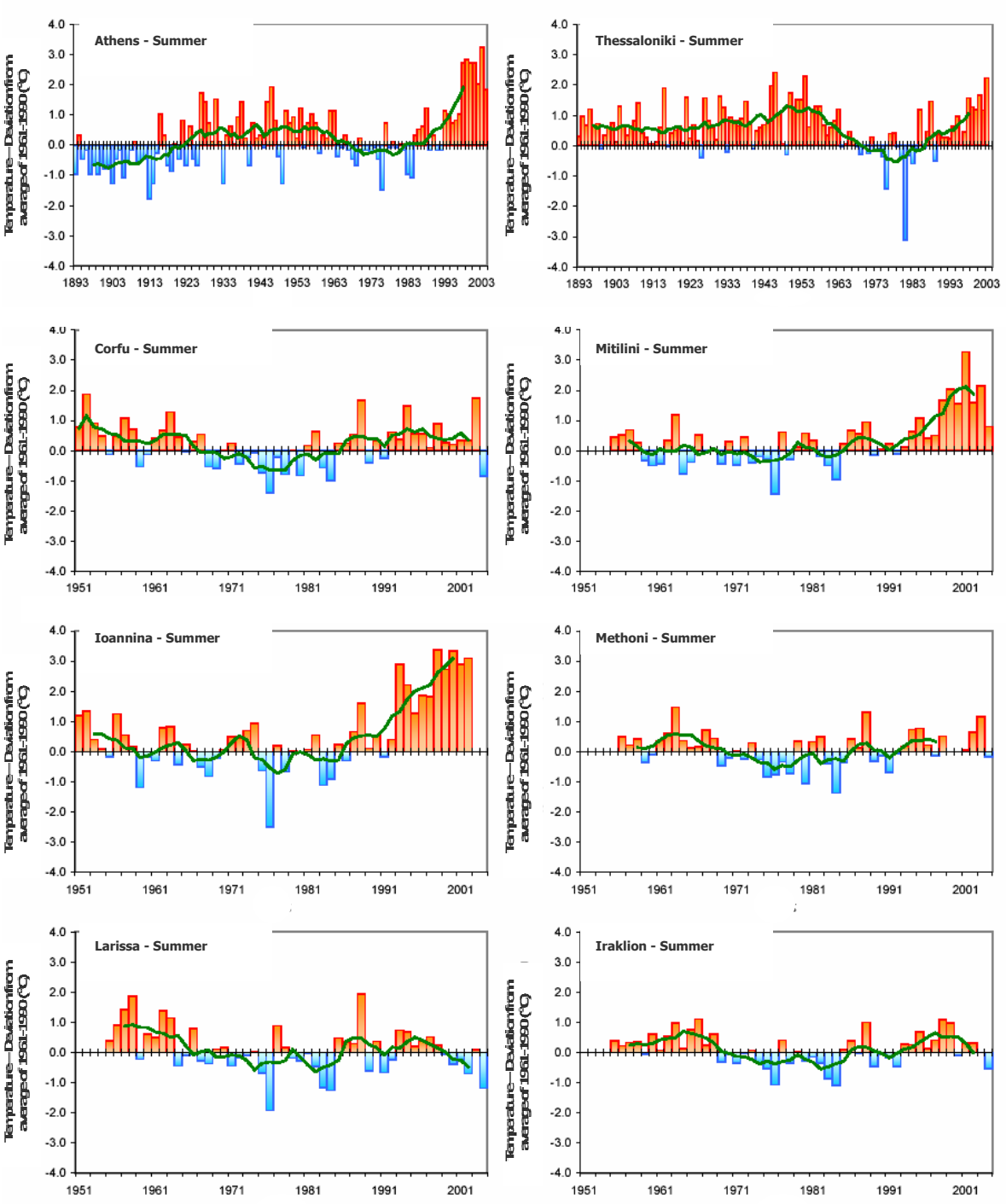


Figure 5.2 **Deviations of the average summer temperature from the average rates of the period 1961 – 1990 in selected meteorological stations of Greece and 5-year moving average (note: 11-year moving average for Athens and Thessaloniki)**

Also, it could be argued that the change of average annual temperatures in Greece generally from 1970 up to date is mainly due to the change of summer temperatures, which is also indicated by grid data.

5.1.1.2 Precipitation

The various studies covering the Greek territory seem to converge in that there has been definitely a reduction of precipitation during the second half of the 20th century. The trends are negative for all the periods examined, contrary to what happened in general in Europe, while they are in accordance with the general trend observed over the Mediterranean area. Indeed, concerning the whole year and the winter period, the trends (-8 and –5 mm/decade respectively) are statistically important and the reduction period seems to start in the ’70s.

The results of relevant studies for various meteorological stations in Greece show that the annual precipitation has a positive trend (increase) during the period 1894-1940, while a negative trend is observed during the period 1950-1992. This negative trend is mainly due to the reduction of precipitation height during the winter period (October-March) when the largest part of annual precipitation occurs, and not to the reduction of the number of rainy days. The analysis of the fluctuation of rainfall on annual basis (**Figure 5.3**) shows that from the middle of the ’80s there has been a very dry period in all stations except the one in Larissa and perhaps the station of NOA in Thission-Athens.

However, in certain meteorological stations an inverse trend is observed during the latest two or three years. In total, the trend of precipitation in Greece is negative both on annual as well as on seasonal basis, reaching particularly high reduction figures in certain stations on islands (-64 mm/decade in Corfu and -52 mm/ decade in Mitilini).

5.1.1.3 Extreme weather events

In Greece, as it was also the case of Spain, the frequency of heat waves in the ’90s was about three times higher than the one of the three previous decades. However, there are no signs of a similar reverse trend in the frequency of cold extremes. The data from both stations of Athens (NOA) and Corfu present statistical important increasing trends with respect to the duration of heat waves, during the summer period as well as on annual basis, while the occurrence of cooling waves during winter as well as on annual basis becomes much less frequent (**Figure 5.4**). The time series from the other stations do not show a certain trend or they show negative trends with respect to the duration of heat waves (e.g. Larissa and Methoni).

Particularly in Athens, the analysis of temperature time series from the station of NOA in Thission for the period 1897-2003 shows that the number of days with a maximum temperature greater than 35 – 38 ^{o}C reached its peak during the last decade, when it almost doubled compared to the period before 1992. This significant increasing trend is due solely to the very hot years 1998 – 2001, while it becomes moderate afterwards.

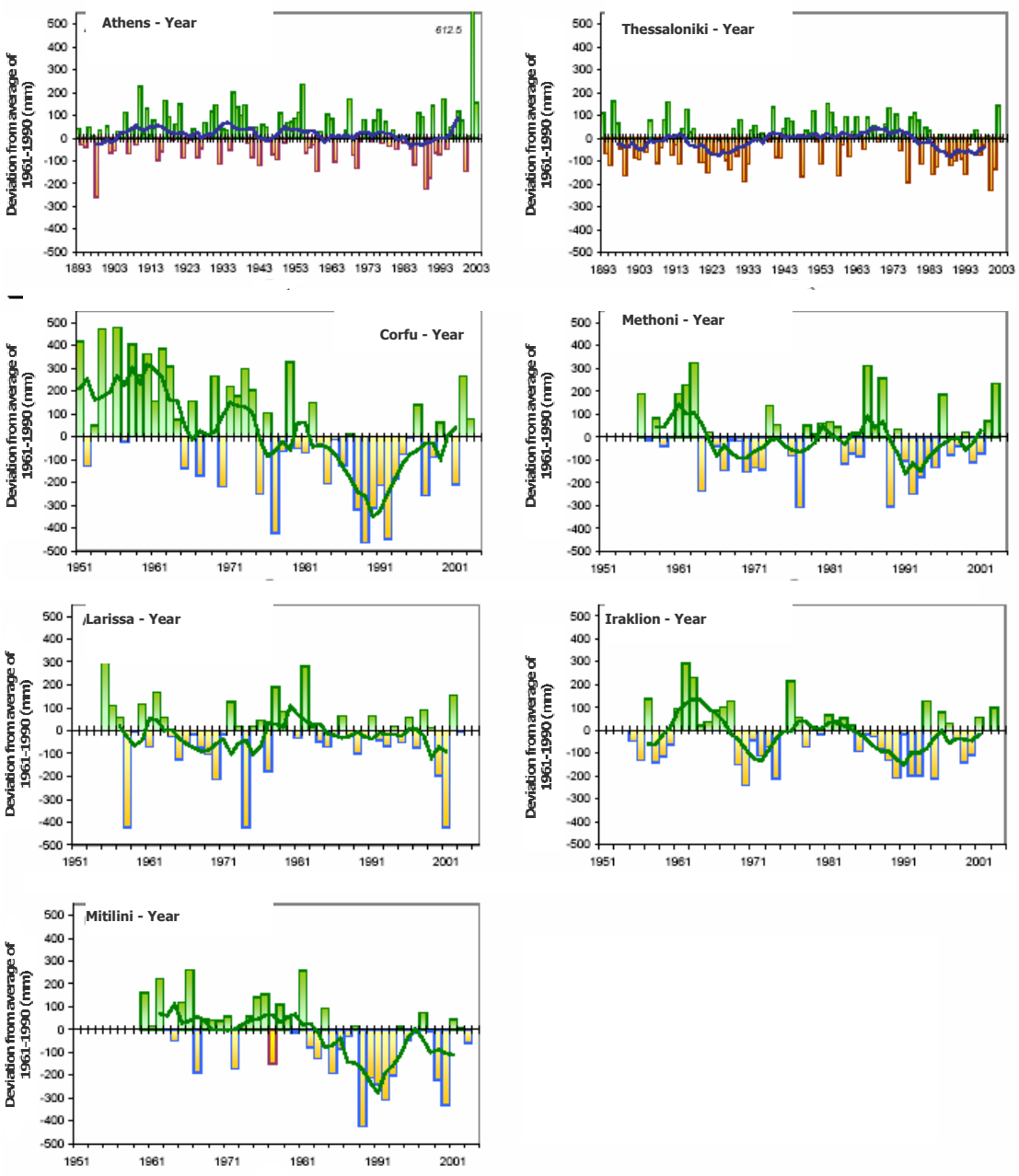
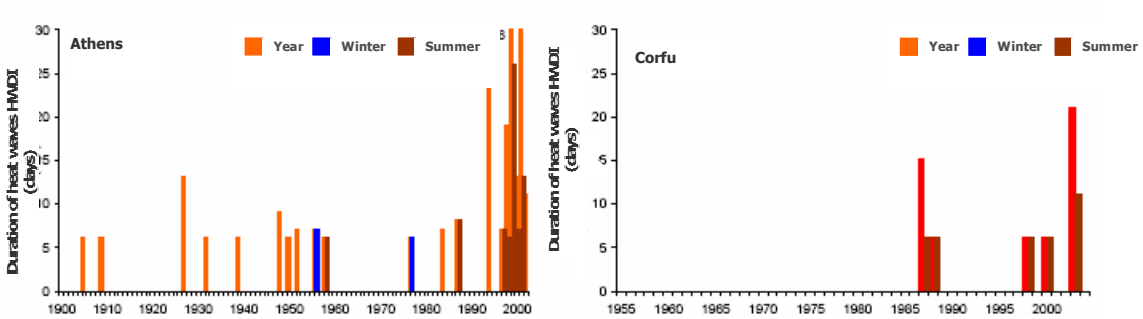
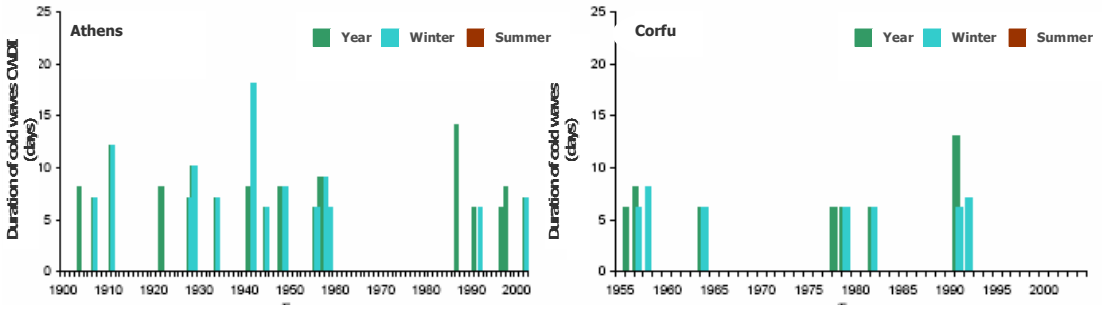


Figure 5.3 **Deviations of the annual precipitation height from the average values of the period 1961 – 1990 in selected meteorological stations of Greece and 5-year moving average (note: 11-year moving average for Athens and Thessaloniki)**



(a)



(b)

Figure 5.4 **(a) Heat waves duration (HWDI[5]) and (b) cold waves duration (CWDI[6]), in Athens and Corfu**

With respect to events of extreme precipitation, the average daily intensity of summer precipitation presents a positive trend in all stations except the one in Larissa, while for the intensity of winter and annual precipitation presents a negative trend. The situation is completely different in Athens, where the annual precipitation presents a positive trend due to the severe precipitation events that occurred during the last years (**Figure 5.5**).

During the period 1900-2003, the 24-hour cumulative precipitation in Athens exceeded 100 mm only in 3 cases, while 11 out of a total of 105 cases (which are the ones with the highest 10% of daily precipitation height) belong to the four-year period 2000-2003, being the highest figure among all 4-year periods during 1900-2003.

By examining the maximum observed duration of periods with consecutive dry days, an increasing trend is observed both on annual basis as well as during winter. In the case of Iraklion, this increasing trend is statistically important. During summer, an increasing trend of the duration of drought is observed in Methoni and Athens (despite the intense precipitation events of the year 2002). The other meteorological stations present an increasing trend of precipitation during summer.

[5] HWDI: Heat Wave Duration Index
[6] CWDI: Cold Wave Duration Index

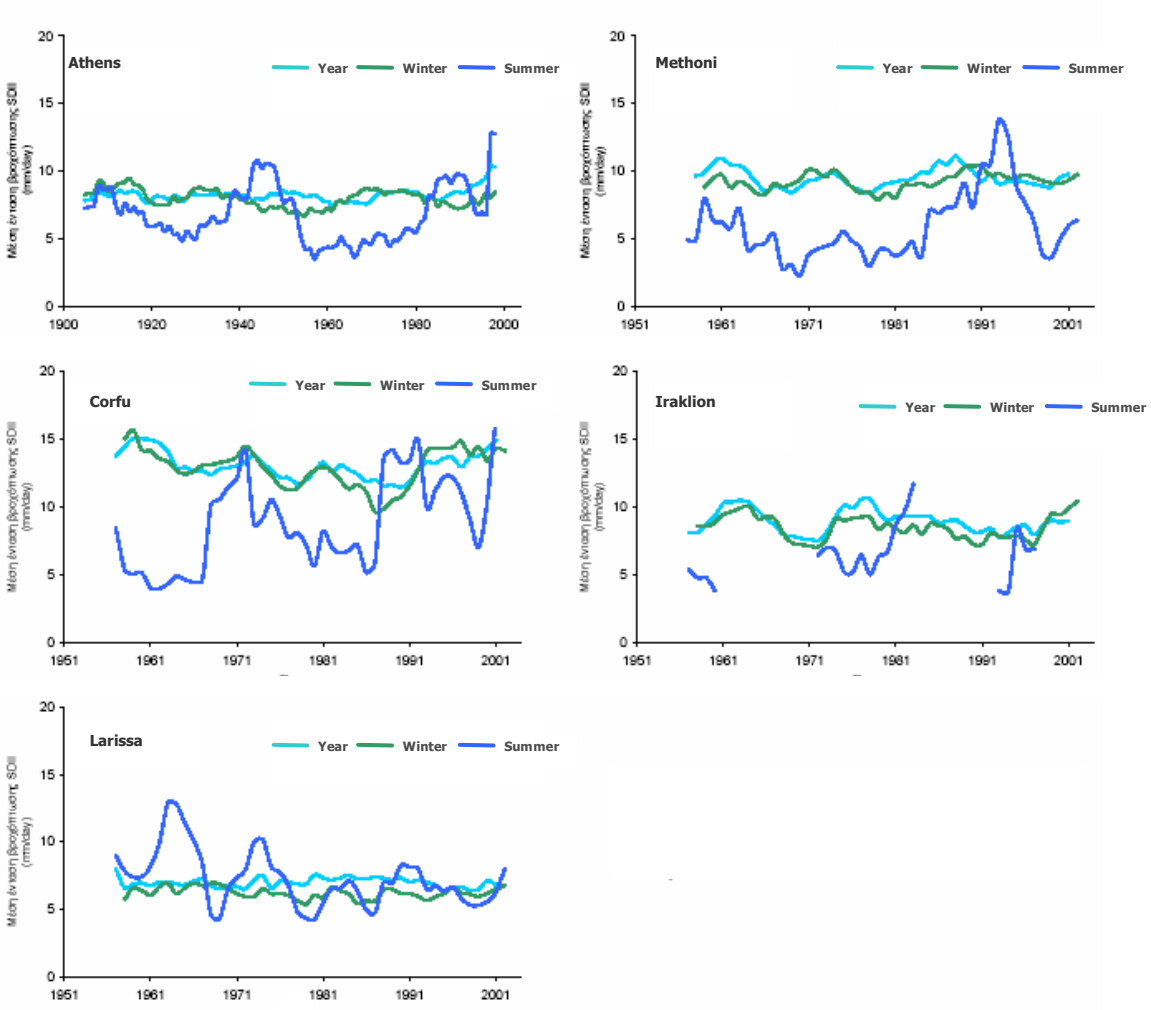


Figure 5.5 Average daily intensity (SDII[7]) in selected meteorological stations of Greece

5.1.1.4 Sea level

No systematic research has been carried out on the long-term trends of sea level changes in Greece. It should be noted that sea level measurements practically started after 1970, whereas the most reliable time series start in 1985. Based on the data from PSMSL[8], there are contradictory trends with respect to sea level in various regions of the country, which do not allow for explicit conclusions.

[7] SDII: Simple Daily Intensity Index
[8] PSMSL: Permanent Service for Mean Sea Level

5.2 Future climate and climate change

5.2.1 The regional climate model PRECIS

In order to estimate the future climate change in regional / local scale, the methodology applied should provide high spatial analysis since the projection of climate change by means of global scale grids does not provide enough information on the differentiation of changes that are expected to occur in regional and local level. These latter changes are those that determine the vulnerability of receptors and constitute a guide in planning and implementing appropriate adaptation measures.

The first systematic effort for the estimation of future climate change in Greece and in the broader Balkan region was carried out recently (2004-2005) by the research group "Climate, Weather, Water & Sustainability" of the National Observatory of Athens (NOA). The implementation of a regional climate model was selected, which allows for the supply of information and climate projections in a small geographical scale. This research effort constitutes the first attempt of Greek scientific institutions to carry out simulations of climate change in the long-term future. Specifically, the research group established and calibrated PRECIS, a regional climate model which was developed at Hadley Centre (Meteorological Office, UK) and is based on the latest version of the global climate model HadCM3. The horizontal analysis of the model varies between 25 and 50 km, while for the vertical analysis the model uses 19 vertical levels (from the ground until 30 km, inside the stratosphere) as well as 4 levels below ground. PRECIS includes also a representation of the sulphur cycle. This feature is very important as sulphur aerosols generated by sulphur dioxide emissions play an important role in the radiation balance within the atmosphere. For the application of the regional climate model PRECIS at the National Observatory of Athens, the region presented in **Figure 5.6** was selected for the simulations.

All simulations were realized with a horizontal analysis of 25 km, which is so far the highest analysis used in climatic simulations for this region. The experiments performed were the following:

- Climatic simulation for the period 1961-1990 (which internationally is considered as a reference period)
- Climatic simulation for the period 2070-2100 under the A2 scenario of IPCC
- Climatic simulation for the period 2070-2100 under the B2 scenario of IPCC

The increase of international GHG emissions up to 2100 varies between 62% for the B2 scenario up to 250% for the A2 scenario. The A2 and B2 scenarios do not constitute extreme cases but give a picture of the range of potential climate change impacts in the case of very limited climate change mitigation measures (A2) and in the case of a more environmentally friendly way of development (B2).

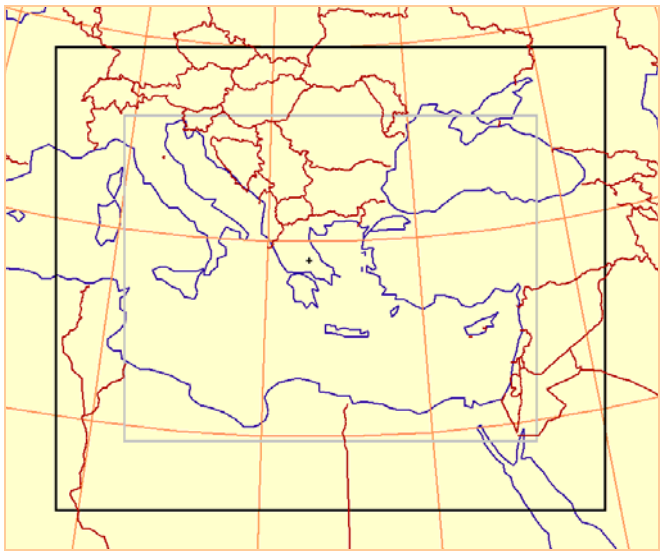


Figure 5.6 **Geographical area over which climatic simulations using the regional climate model PRECIS were carried out at NOA. The black line indicated the external boundaries of the simulation area. The blue line surrounds the region for which results are presented.**

5.2.2 Results for the A2 and B2 scenarios of the IPCC

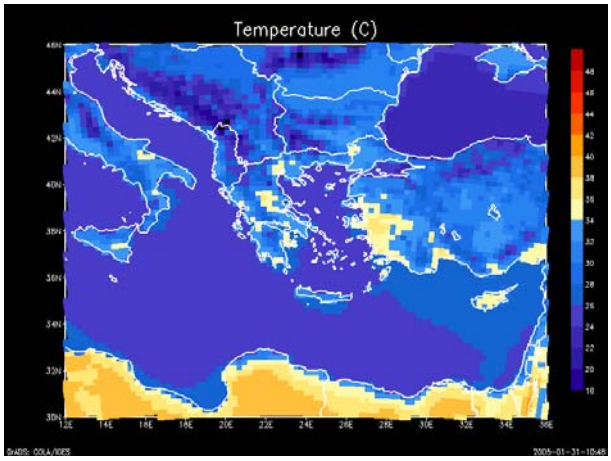
The results of climatic simulations for the A2 and B2 scenarios carried out by means of PRECIS at NOA are presented below and compared to the results for the reference period (current climate, for the 30-year period 1961-1990). This comparison provides an estimation of the expected climate changes in Eastern Mediterranean up to the end of the century, compared to current climatic conditions.

5.2.2.1 Maximum temperatures

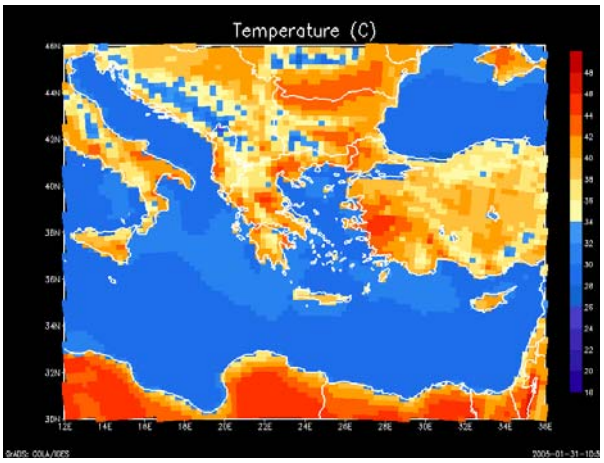
Figure 5.7 presents the mean maximum temperature in July for the periods 1961-1990 and 2071-2100 in the case of A2 and B2 scenarios of IPCC.

In the case of A2 scenario, results obtained indicated a significant increase of the mean maximum temperature over the entire region, but mainly in Balkan countries where the mean maximum temperature for this month increases by up to 12 ^{o}C compared to current values. In Greece, the increase is at the order of 7-8 ^{o}C in southern regions (including the area of Athens), while in Central and Northern Greece the increase is higher and varies between 8 and 10 ^{o}C. In June and September the increase of the maximum temperature is slightly lower, varying from 6 up to 8 ^{o}C in Greece. In the case of the B2 scenario, the increase of temperature in July is lower (in the order of 4-6 ^{o}C).

Current climate (1961-1990)



2071-2100 - A2 SCENARIO **2071-2100 - B2 SCENARIO**



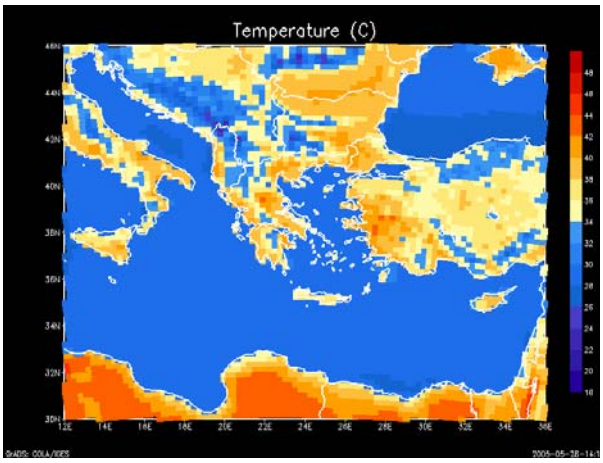


Figure 5.7 **Mean maximum temperature in July for the periods 1961-1990 and 2071-2100 under the A2 and B2 scenarios of IPCC. The colour scale varies from 18 °C (dark blue) to 48 °C (dark red).**

Under the B2 scenario, the increase of the mean maximum temperature in Greece during July is clearly lower compared to the one obtained for the A2 scenario and varies between 6-7 °C in southern regions (including the Athens area) up to 7-8 °C in Central and Northern Greece.

5.2.2.2 Minimum temperatures

Figure 5.8 presents the mean minimum temperature in July for the periods 1961-1990 and 2071-2100 in the case of the A2 scenario.

As it was the case for the mean maximum temperature, there is an increase of the mean minimum temperatures over the entire region examined, particularly in the Balkans where the mean minimum temperature in July increases by up to 9 °C compared to current values. In Greece, the increase is about 6-7 °C in southern regions (including the area of Athens) and between 7-8 °C in Central and Northern Greece.

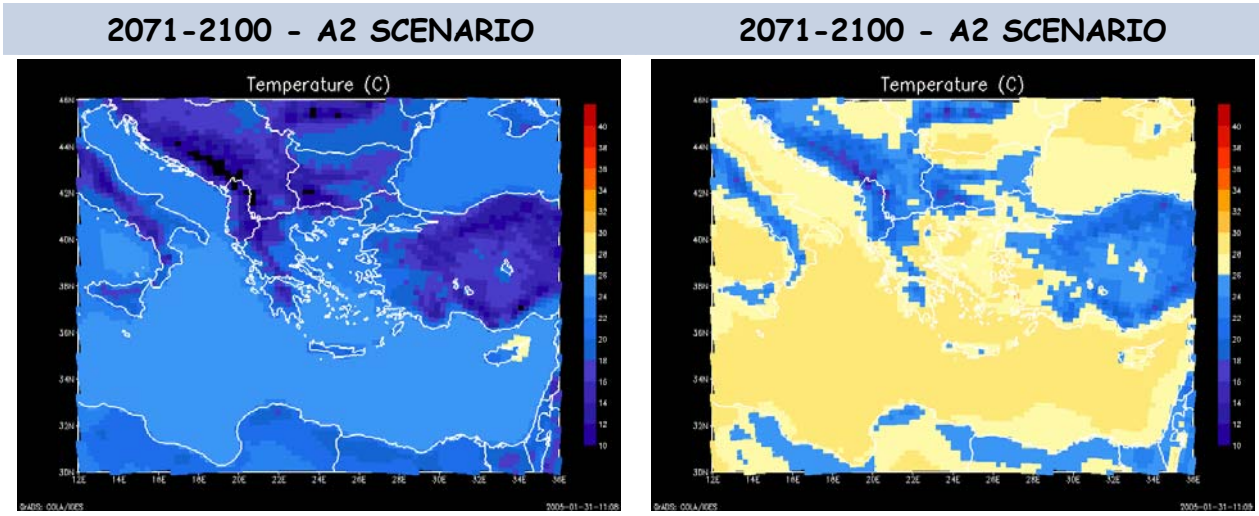


Figure 5.8 **Mean minimum temperature in July for the periods 1961-1990 and 2071-2100 under the A2 scenario of IPCC. The colour scale varies from 10 °C (dark blue) to 40 °C (dark red).**

5.2.2.3 Precipitation

Figure 5.9 presents the mean precipitation in December for the periods 1961-1990 and 2071-2100 in the case of A2 and B2 scenarios, while **Figure 5.10** presents the mean precipitation in July for the same time periods and IPCC scenarios.

In the case of A2 scenario, the reduction of precipitation in December (which at present is the most rainy month in the majority of Greek regions) is significant, mainly over the marine regions of the Eastern Mediterranean as well as in Western Greece, where the mean precipitation for the period 2071-2100 is approximately 60-70% of the current levels. In Northern and Eastern Greece, in the islands of the Eastern Aegean and in Crete the decrease of precipitation is lower.

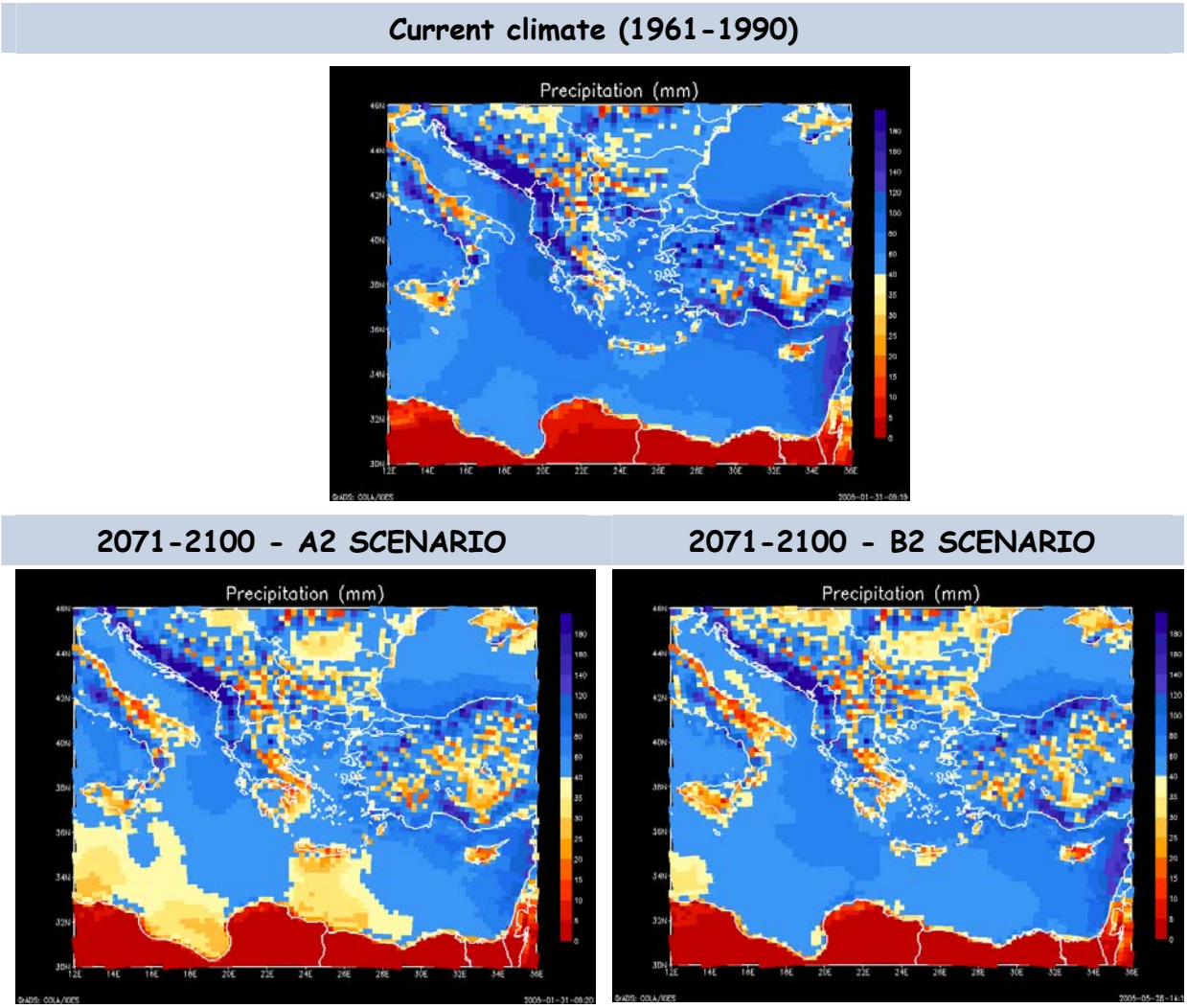
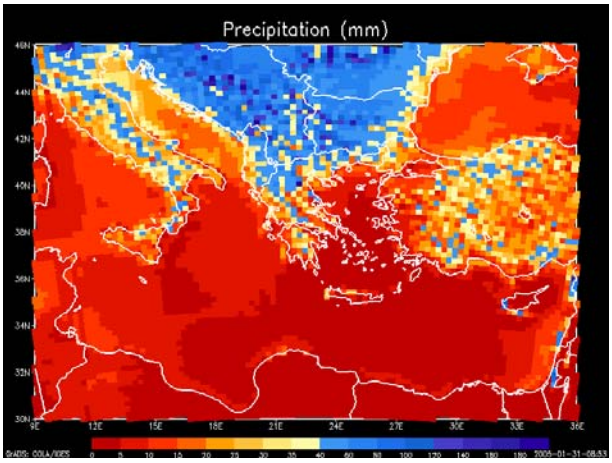


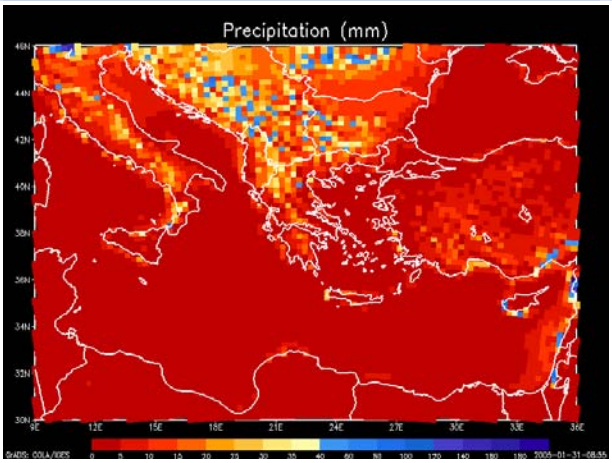
Figure 5.9 **Mean precipitation in December for the periods 1961-1990 and 2071-2100 in A2 and B2 scenarios of IPCC. The colour scale varies from 0 mm (dark red) to 180 mm (dark blue).**

During summer, the A2 scenario shows a very significant reduction of precipitation, mainly in Northern Greece and in the Balkans. The mean precipitation in these regions for the period 2071-2100 is approximately 20-30% of the current precipitation levels. Especially in regions of Serbia, Bulgaria and Romania, where at present the precipitation during summer is very important, the reduction is exceptionally high and disturbing because precipitation in these regions supplies water to big rivers which flow through Greece as well. The reduction of precipitation is also very important in regions of Northern Greece where during summer a significant storm activity is evident. In Southern Greece the reduction of precipitation is also high but these regions are characterized in general by very low precipitation during summer even under the current climate.

Current climate (1961-1990)



2071-2100 - A2 SCENARIO | **2071-2100 - B2 SCENARIO**



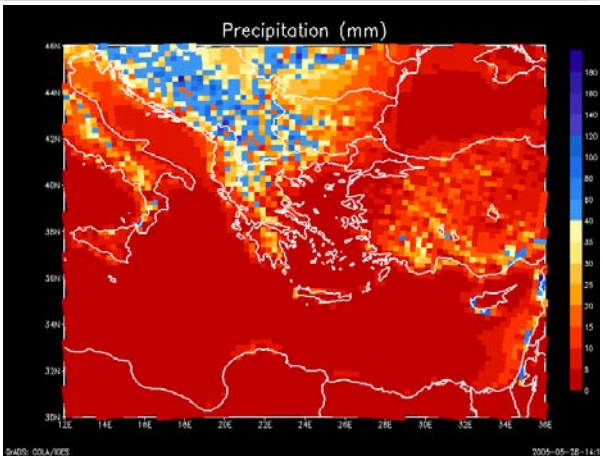


Figure 5.10 **Mean precipitation in July for the periods 1961-1990 and 2071-2100 in A2 and B2 scenarios of IPCC. The colour scale varies from 0 mm (dark red) to 180 mm (dark blue).**

5.2.2.4 Climate changes in large Greek cities

The mean maximum temperature in 4 large cities of Greece (Thessaloniki → Northern Greece, Larissa → Central Greece, Athens, Iraklion→ Southern Greece) during the whole typical year of the period 2071-2100 compared to the period 1961-1990 is presented below.

With respect to the capital Athens, the mean maximum temperature (**Figure 5.11**) under the A2 scenario presents a significant increase during all months, mainly during summer when this increase exceeds 7 ^{o}C. A similar increase is also true for Thessaloniki, a higher one is expected to occur in Larissa (where it exceeds 8 ^{o}C in July), while for Iraklion the difference between the two periods is lower (the increase is slightly higher than 6 ^{o}C in July).

In the case of B2 scenario, the increase of the mean maximum temperature is much more limited, especially in the case of Thessaloniki where it is approximately 45% lower than the one under the A2 scenario. In the other three Greek cities the difference is lower (in the order of 28-31%).

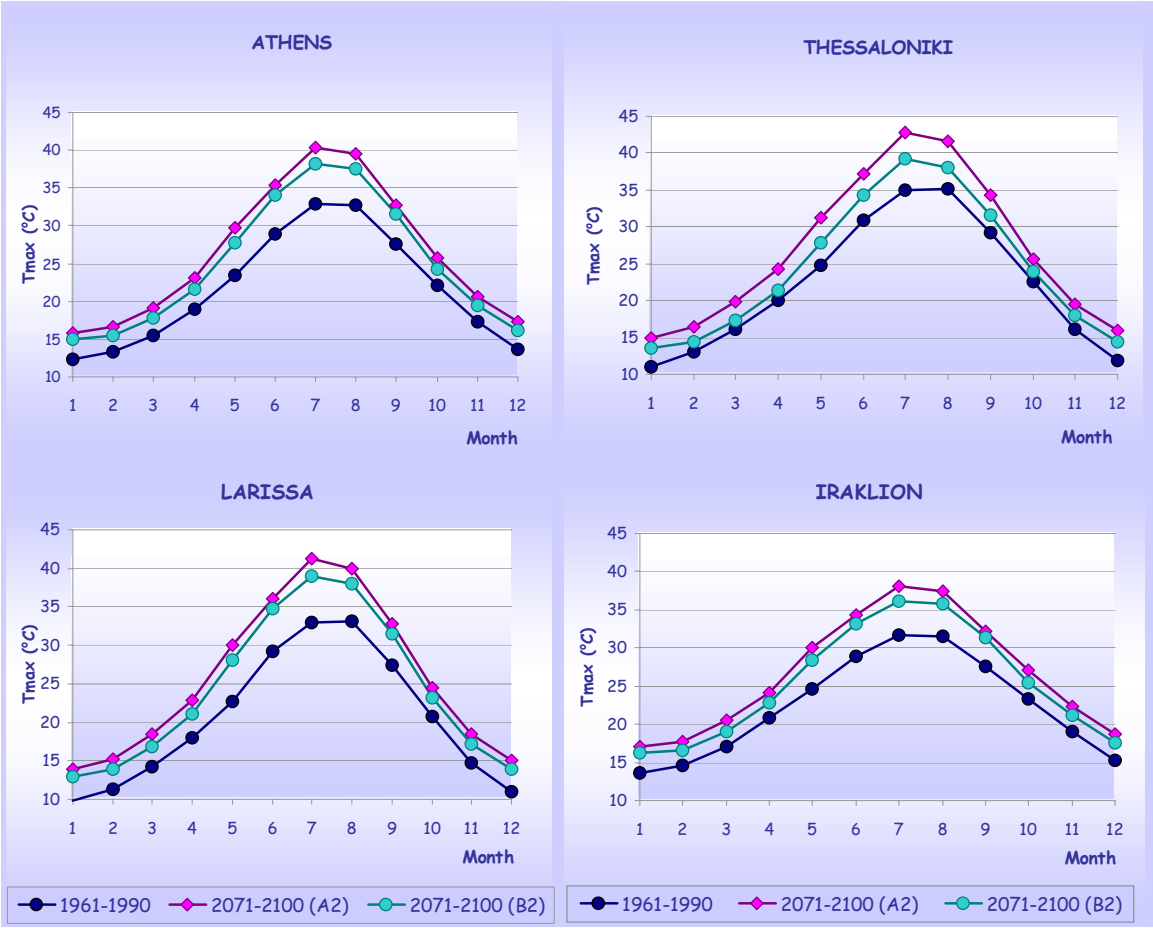


Figure 5.11 **Mean maximum temperature during the typical year of the period 1961-1990 and 2071-2100**

Regarding the change of the mean minimum temperature (**Figure 5.12**), its increase in the A2 scenario varies from 6.4 - 7.7 °C, with the highest increase expected in Larissa and the lowest one in Iraklion. Under the B2 scenario, the increase is by approximately 25% lower compared to the one in the A2 scenario in the three Greek cities (Athens, Larissa, Iraklion) and slightly lower in Thessaloniki.

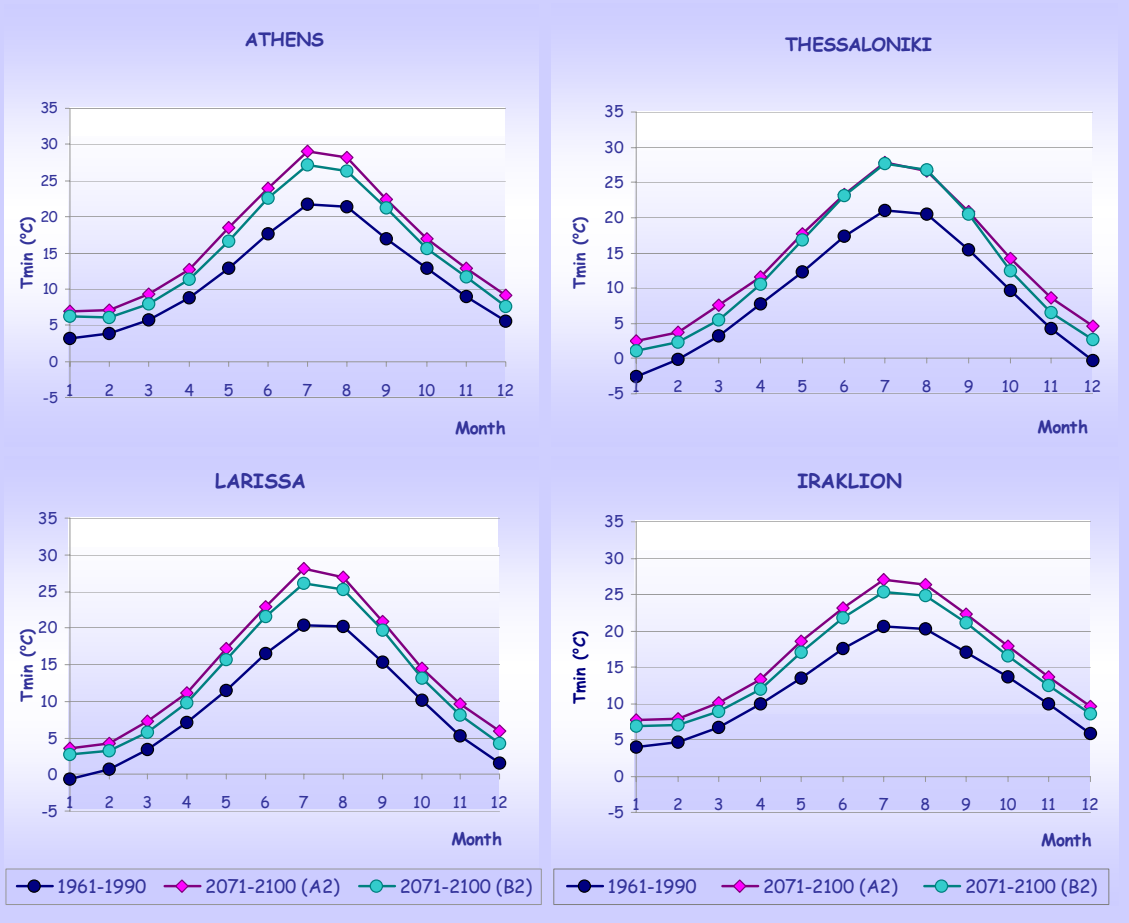


Figure 5.12 **Mean minimum temperature during the typical year of the period 1961-1990 and 2071-2100**

Finally, concerning changes in precipitation (**Figure 5.13**), the mean monthly precipitation in the A2 scenario shows a considerable decrease, following the general shift towards a more dry future climate. The highest decrease occurs in July and varies from 80-92%, and is more severe in Iraklion (-92%) and less severe in Larissa (-80%). The total annual reduction of precipitation varies between–32% and –40%.

Under the B2 scenario of IPCC the reduction of precipitation in July is considerably lower (-57% up to –78% compared to the current climate). The differences from the A2 scenario are significantly important in the cases of Larissa and Iraklion, while much lower in Athens and Thessaloniki.

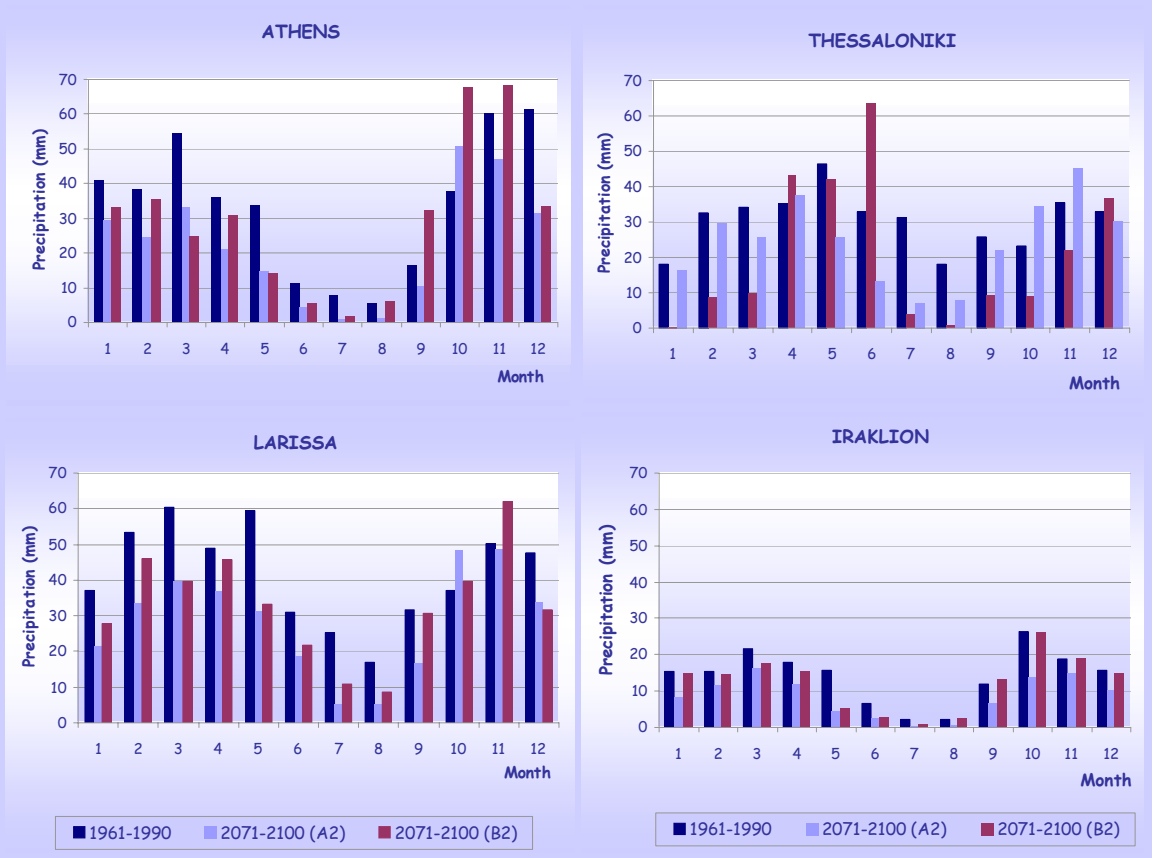


Figure 5.13 **Mean precipitation during the typical year of the period 1961-1990 and 2071-2100**

Concerning extreme weather events, it should be mentioned that while during the period 1961-1990 there was a total of 28 days with heat waves (temperature > 40 ^{o}C) in Athens, the results from the simulations of PRECIS for the A2 scenario show that the total number of days with heat waves during the period 2071-2100 increases to 1078 days, while in the case of the B2 scenario this increase, although lower than the one in A2, is also very high in absolute terms (580 days with heat waves). In the case of Larissa, the days of heat waves under the current climate, as well as under the A2 and B2 scenarios of IPCC are 59, 1289 and 800 respectively. The relevant figures for Thessaloniki are 188, 1924 and 754 respectively and for Iraklion 3, 537 and 205 respectively.

5.3 Vulnerability assessment and adaptation measures

5.3.1 Energy sector

Recently (July 2005), the research group "Energy Planning and Sustainable Development" of the National Observatory of Athens completed the first integrated assessment of climate change impacts on the electricity generation sector of the Greek interconnected system, using the results derived from the simulations of the regional climatic model PRECIS for the A2 and B2 scenarios of the IPCC.

In order to estimate those impacts, detailed econometric models simulating the operation of the electricity system were developed, which incorporate also meteorological parameters. These models were fed with the results of PRECIS for the period 2071-2100. The results obtained were compared to the situation under historic climatic conditions in the same geographic region during the period 1961-1990. The basic results of the analysis are presented in **Figure 5.14**.

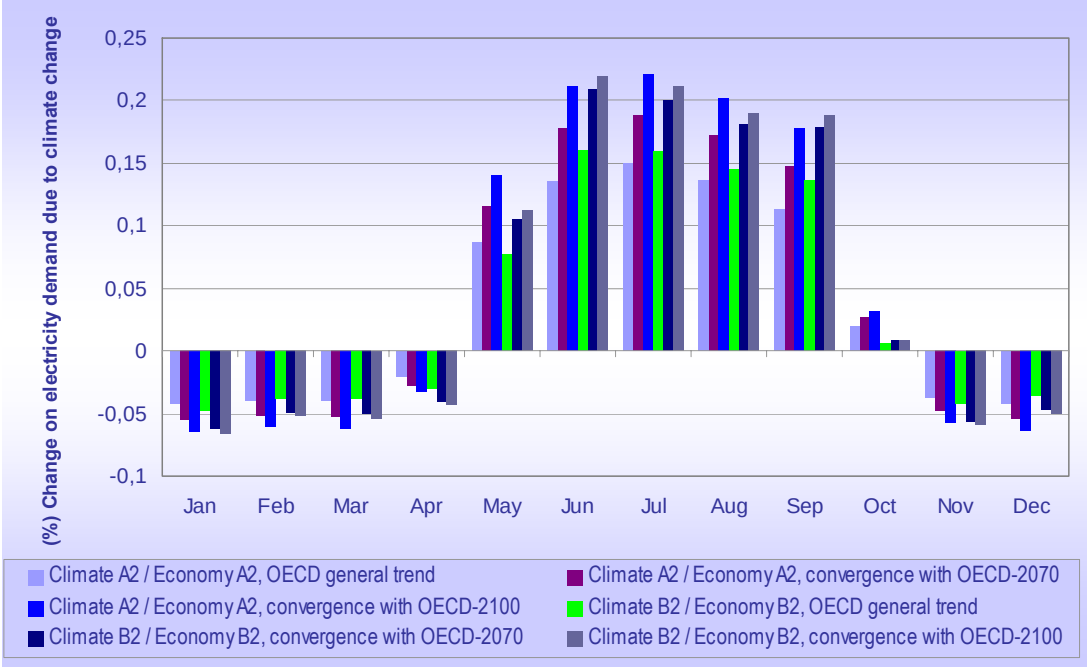


Figure 5.14 **Change of the monthly electricity demand in Greece during the period 2071-2100 exclusively as a result of climate change for the A2 and B2 scenarios of IPCC**

The results obtained show that on annual basis the electric energy demand is expected to increase by approximately 3.6% – 5.5%, solely due to the change of meteorological conditions, under the A2 scenario and 3.5% – 5.3% for the B2 scenario compared to a reference scenario where the average climatic conditions of the period 1961-1990 prevail.

On a seasonal basis, these changes are not uniform. During summer and especially during July and August there is a significant increase of electricity demand (due to the use of air-cooling devices) and varies between 13% and 22% for the scenarios examined. On the contrary, during winter the electricity demand decreases up to 7% due to the increased mean temperature predicted by PRECIS for the A2 and B2 scenarios of global GHG emissions.

5.3.2 Agriculture

Only a few studies have been published with respect to climate change impacts in certain agricultural cultivations in Greece, as for example the study of G. Kapetanaki and C. Rosenzweig which however was carried out in 1997 (i.e. before the publication of the most recent global GHG emissions scenarios of the IPCC, which include the A2 and B2 scenarios showing climate change conditions in Greece as presented in paragraph 5.2 above).

Since the beginning of 2005, the research group "Energy Planning and Sustainable Development" of NOA carries out a research activity on the assessment of climate change impacts in agricultural cultivations in Greece. This research activity is funded by the 3rd Community Support Framework / Operational Programme «Environment» of the MEPPPWW within the framework of the project "Fulfilment of national commitments under the UNFCCC and the Kyoto Protocol".

In order to estimate climate change impacts on agricultural species, the DSSAT 4 simulation model is applied, while other models are also used for cultivations that are presently not covered by DSSAT (e.g. vines). The results of PRECIS with respect to the forecasting of climatic parameters are used as input data, modified geographically within the country (see paragraph 5.2.2 above).

Figure 5.15 presents some preliminary results on the impacts of future climate on the production yields of maize. Three cultivars of maize are examined (PIO 3489, PIO 3394, PIO 3382) which are widely used in Greece. The unit production yield under the current climate (simulation of the period 1961-1990 by means of the PRECIS climatic model) is compared to the future yield under the A2 scenario and for the period 2071-2100. It should be noted that the assessment of fertilization impacts from the increased concentrations of CO_2 in the period 2071-2100 is in progress and this potentially positive impact is not included in the results presented below. Figure 5.15 shows that future climate change under the A2 scenario of IPCC is expected to lead in a significant decrease of the production yield of maize. This reduction is at the order of 42%-60% in Northern Greece, 35-47% in Western and Central Greece and 40-52% in Southern Greece.

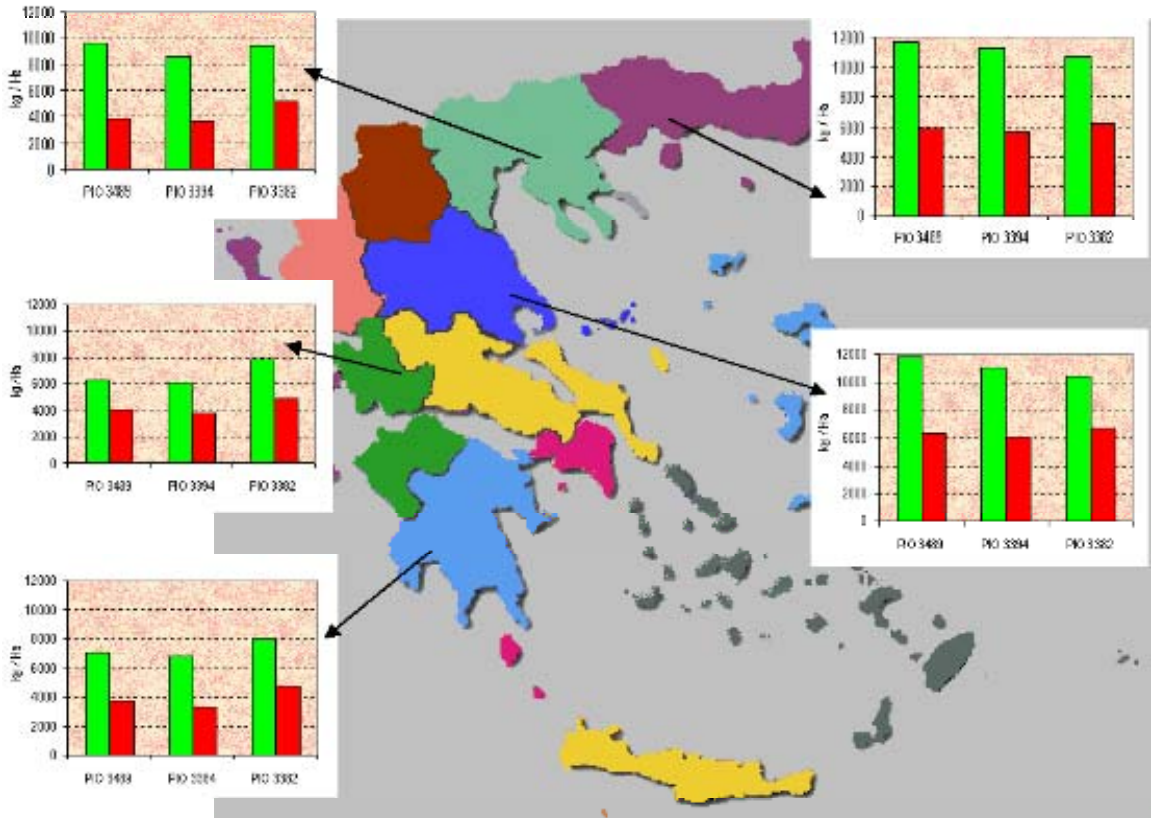


Figure 5.15 **Changes of the unit production yield (in kg per Ha) of maize in agricultural areas of Greece under the conditions of the A2 scenario of IPCC**

5.3.3 Coastal areas

An integrated study on national level for the estimation of the vulnerability of Greek coastal areas in climate change has not been carried out yet. Some research studies focus on some particular regions of the country, as for example the wetland Alyki Kitrous in the Delta of the river Axios (2003), the Kotihi lagoon (2003), and Kos (2002).

Within the framework of the project "Fulfilment of national commitments under the UNFCCC and the Kyoto Protocol" mentioned in paragraph 5.3.2 above, the research group "Energy Planning and Sustainable Development" of NOA is in the progress of assessing climate change impacts in Greek coastal areas. Some preliminary results under a pessimistic scenario of a global sea level rise by 1 m are shown below for the area of the Amvrakikos Gulf in Western Greece (**Figure 5.16**). Other regions are also examined, in combination with more moderate scenarios with respect to sea level rise.

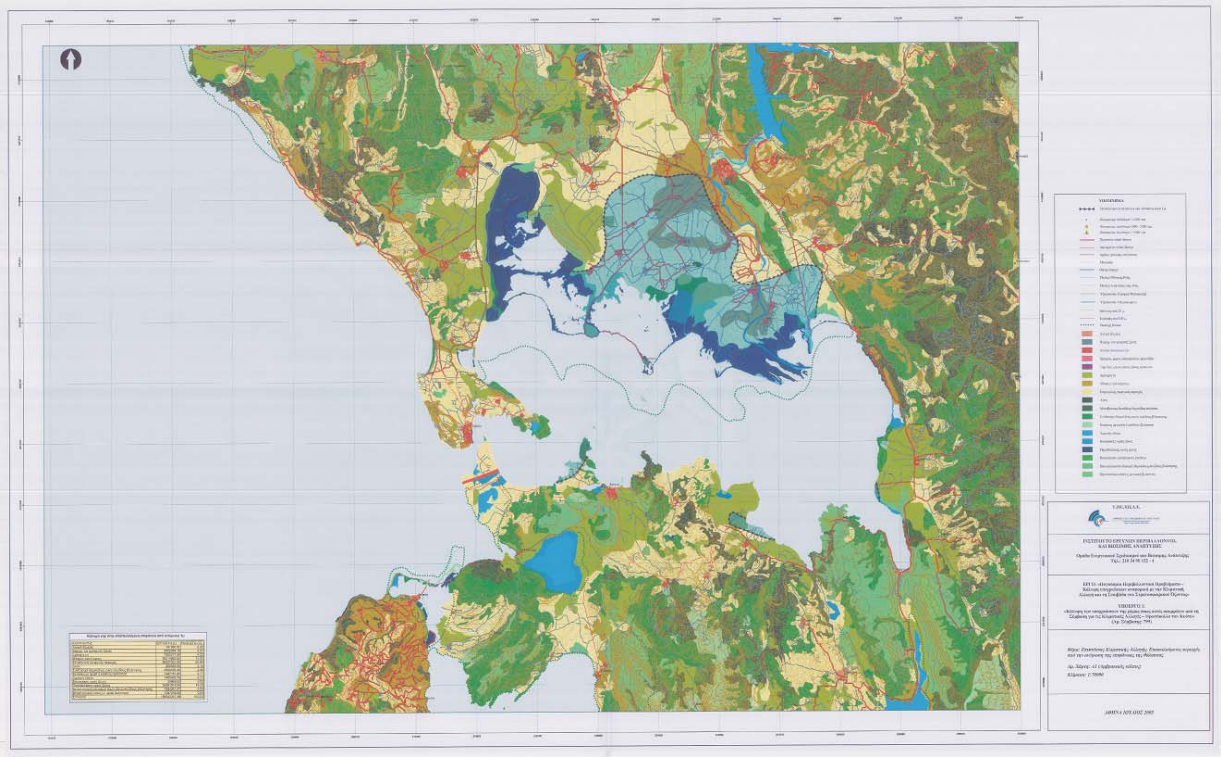


Figure 5.16 **Gulf of Amvrakikos – regions that will flood in case of sea level rise by 1 m (*note: these regions are indicated by the dotted line*)**

5.3.4 Management of water resources

Regarding the management of water resources, in January 2003 a particularly important study concerning the management of water resources, namely the "Draft Programme for the Management of Water Resources in Greece" was completed. The study was carried out by the Ministry for Development, in collaboration with the National Technical University of Athens (NTUA), the Institute of Geology & Mineral Exploration (IGME) and the Centre for Planning and Economic Research (KEPE).

In addition, an important project was the development of the "National Bank of Hydrologic and Meteorological Information", the implementation of which was assigned by the MEPPPW to the National Technical University of Athens (NTUA).

With respect to the environmental quality of water resources, under the support of the 1st and 2nd Community Support Framework, the Observation Network for Water Quality in Greece was organized. The 3rd Community Support Framework – Operational Programme "Environment" includes actions related with the extension of the National Observation Network for the quality of surface, underground, coastal and sea water resources.

Major issues within the sector are the promotion of sustainable management of water resources and the integrated protection of the aquatic environment and aquatic ecosystems. Within this framework, the full implementation in practice of the demands of the EU Framework Directive for

Community action in the field of water policy (Directive 2000/60/EC) is particularly important. The first steps for the integration of this Directive into national law were made by the adoption of the Law 3199/2003, while two accompanying Presidential Decrees are under preparation. The competent authorities on national and prefecture level have been specified, however there are some delays with respect to other requirements of the Directive. At the same time, the compilation of national plans for the management of water resources for the whole country is in progress (while in the island of Crete the relevant plan has already been completed) under the responsibility of the Ministry for Development. Data associated with the requirements of the Directive 2000/60 are incorporated in these management plans.

5.3.5 Desertification

Desertification constitutes a complex phenomenon, resulting from the extreme degradation of soil and water resources in a region (**Figure 5.17**). Necessary actions for dealing with this problem, as foreseen by the National Action Plan for Combating Desertification (2001) and the relevant Common Ministerial Decision for its implementation (Common Ministerial Decision 996005/31719), are integrated within the general national development program and specifically for endangered regions. The National Action Plan sets as an objective to combat efficiently the desertification trends in the 35% of the whole Greek territory that is under direct threat and to prevent the desertification process in the 60% of the national territory.

Figure 5.17 Area suffering from desertification

Within the framework of the implementation of the National Action Plan for Combating Desertification, the following main actions have been implemented to date:

I. Scientific infrastructure and determination of endangered regions

Members of the National Committee for Combating Desertification, in collaboration with Universities and Research Institutes in Greece and abroad, elaborated during the period 2000-2004 a significant number of research projects and studies on the process of desertification in Greece, as

well as on prevention and mitigation techniques . These activities represented the scientific basis for the following actions:

- Compilation of a map of areas in Greece threatened by desertification in order to prioritize relevant actions (**Figure 5.18**)
- Compilation of a national map of Greek soils presenting the quality of different soils, their degree of vulnerability to degradation and desertification and appropriate sustainable uses. This map can be used for the implementation of the new agricultural policy of the European Union.

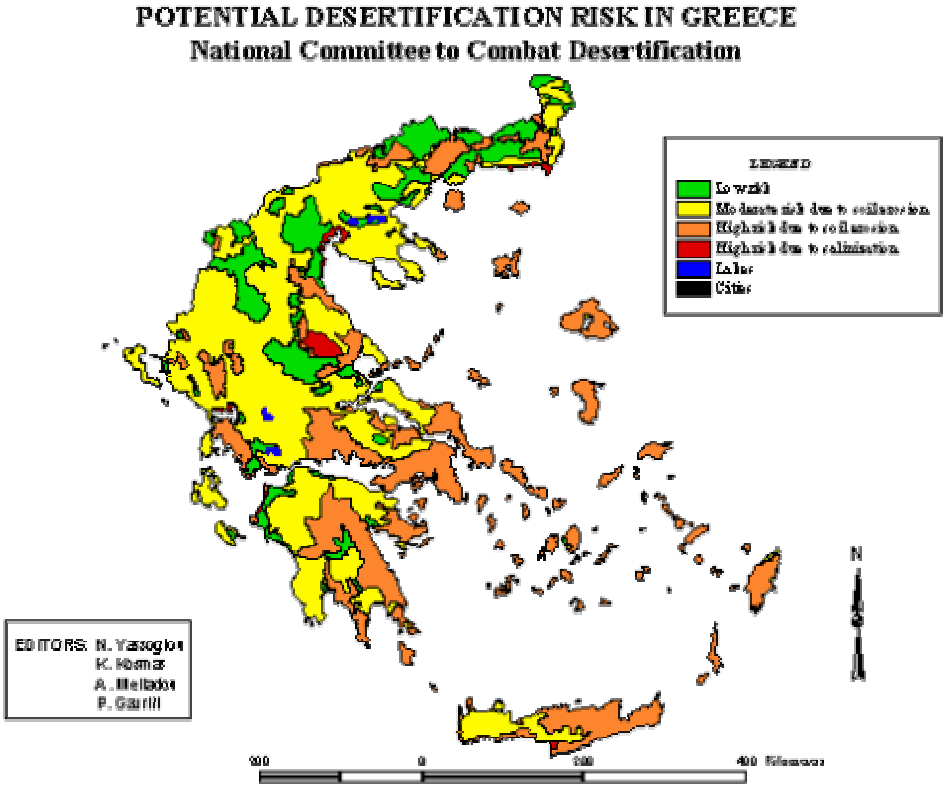


Figure 5.18 Map of soils facing desertification risks

Furthermore, the National Committee for Combating Desertification collected and published a special volume of relevant research studies carried out by Greek researchers on issues related to desertification, which provides a scientific basis for planning and implementing technical and socio-economic measures and actions to combat desertification. In addition, the National Committee carried out specific studies concerning:

- Control and warning system for the risk of desertification
- Communication system for informing competent authorities
- National Reports on the actions undertaken for combating desertification
- Participation in the compilation of a program against nitrogen pollution

II. Actions for the agricultural sector

The Operational Programme "Agricultural Development of the Countryside" (2000-2006) funded by the 3rd Community Support Framework, has as an objective the sustainable and integrated development of the countryside together with the protection and improvement of the environment. It includes a number of actions in the agricultural sector which are related directly or indirectly to combating desertification and are compatible with the relevant National Action Plan on Desertification.

- Organic farming and stockbreeding
- Long-lasting set aside of agricultural land
- Control of nitrogen pollution in underground waters
- Maintenance and reconstruction of stone-built gradient
- Implementation of the Code of Good Practice in Agriculture
- Establishment of sustainable olive plantations on sloping regions (**Figure 5.19**)

Figure 5.19 **Establishment of sustainable olive plantations on sloping regions facing desertification risks**

III. Actions in forestry

The Operational Programme for Forestry includes activities for combating of desertification and more specifically actions for the enhancement of fire prevention, reforestation, improvement of degrading forests and forest pastures and development of a forestry cadastre.

IV. Actions related to water resources

A number of actions for which MEPPPW and the Ministry of Rural Development and Food are responsible and which are related directly or indirectly to the integrated confrontation of desertification and the rational management of water resources are the following:

- Implementation of the Framework Directive 2000/60/EC for Community action in the field of water policy
- Collective projects of land reclamation (reservoirs for surface run-offs, irrigation networks including their maintenance / improvement, implementation of new technologies for the efficient exploitation of irrigation, pond reservoirs)
- Enhancement of underground aquifers and actions preventing the increase of salinity
- Emergency actions for water drought
- Measures for treatment and reuse of wastewater

V. Socio-economic sector

In the socio-economic sector, main objectives pursued are among others the sustainability in agricultural production and the protection of agricultural population through the supply of technical and information support to farmers, training and support of new farmers, implementation of the LEADER Community Initiative that supports farmers etc.

VI. International affairs and collaborations

The competent Ministries, Institutes and the National Committee for Combating Desertification have developed international contacts and collaborations having as a direct or indirect target the confrontation of desertification, and include:

- Supply of economic assistance to countries that suffer from desertification
- Participation in international research and educational activities
- Presidency of the 4th Annex of the UN Framework Convention for Combating Desertification and the Expert Group of the EU
- Organization of international meetings and conferences

VII. Assessment actions

There has been a substantial effort by competent institutions for combating desertification, mainly in the fields of risk assessment, as well as in the development of the required scientific and informational infrastructure.

VIII. Education - Information

The Ministry of Rural Development and Food and the National Committee for Combating Desertification highlighted the risk and effects of desertification through:

- Meetings (on national and international level)
- Seminars (on national and international level)
- Press conferences and articles
- Informational brochures
- Development and operation by the National Committee of an electronic database on desertification with international networking.

5.3.6 Protection of biodiversity and ecosystems

Actions carried out on national level for the protection and management of the natural environment comprised a large number of programmes, projects and actions for protected areas and species.

The greatest attention was paid to the fulfilment of national commitments with respect to the EU Directives 92/43/EEC «On the conservation of natural habitats and of wild fauna and flora» and 79/409/EEC «On the conservation of wild birds».

The Natura National Catalogue lists at present 239 proposed Sites of Community Interest, which include terrestrial ecosystems, wetlands, coastal and marine ecosystems, and 151 Special Protected Areas. The total area of the proposed Sites of Community Interest amounts to 27,641 km^2, (the terrestrial area of proposed Sites of Community Interest is 21,643 km^2 and corresponds to 16.4% of the national territory, while the area of marine proposed Sites of Community Interest is 5.998 km^2). The Special Protected Areas amount to 13,703 km^2 (terrestrial area: 13,298 km^2, marine area: 405 km^2).

Despite the high number and the relatively high percentage of the national territory covered by the proposed Sites of Community Interest and the Special Protected Areas, the protected areas enacted through national law (National Forests, National Parks, Wild Life Refuges and Landscapes of Particular Aesthetic Value) cover only 2.5 % of the Greek territory.

With the Law 3044/2002, 25 Protected Areas with Management Institutions were established, complementing two regions which were already declared as protected areas by means of the Laws 1650/1986 and 2742/1999 (National Marine Park of Zakynthos and National Park of Schinias-Marathonas). Those 27 Protected Areas include approximately 35 Natura Sites. The Law 3044/2002 includes also maps showing the external borders of each one of the 25 Protected Areas.

The different Management Institutions and their Governing Boards (GB) were established by means of separate Common Ministerial Decisions and were staffed in 2003. At present, MEPPPW is in the process of elaboration, publication and signing of the Common Ministerial Decisions determining the precise boundaries of those Protected Areas and the specific management conditions on the basis of Special Environmental Studies (SES) for management of protected areas carried out for each area. An important step in the whole process is the publication of SES (after

their approval by the General Director of the Environment) and of the draft Common Ministerial Decisions, during which local authorities have the possibility to submit comments under the coordination of the relevant Prefectural Councils.

The following actions for each Protected Area are required in order to complete the legislative framework on this type of areas:

- Four Operational Regulations of the Management Institutions (specifically, Operation of the Governing Board, Operation of Services and Staff, Projects' Implementation, and Economic Management), and
- An Operation and Management Regulation for the Protected Area

For 8 out of 27 Protection Areas where Management Institutions have been established, 2 Presidential Decrees and 6 Common Ministerial Decisions for the characterization of areas and the specification of provisions for undertaking activities in these areas have been issued. Almost 100 SES have been compiled, which include a large number of proposed Sites of Community Interest and Special Protected Areas. Also, the NATURA 2000 Committee has been created according to the Law 2742/99, while the legal and institutional framework on the protection and management of the environment was reinforced (establishment of the Body of Environmental Inspectors, Body of Inspectors for Public Administration). In addition, the incorporation of the EU Directive 2001/42/EC for the Strategic Environmental Assessment/SEA into the national law is in progress. Finally, the National Strategy for Wetlands and the National Strategy for Sustainable Development have been compiled.

6 FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

The Global Environment Facility (GEF) was established in 1991, as a pilot programme, within the framework of UN International Conventions for environmental protection, setting as its target the mitigation of global or regional environmental problems and the support of national activities on sustainable development. GEF seeks to link the local scale to global environmental and development problems, and by combining national and international resources aims at:

- protection of biodiversity
- reduction of climate change impacts
- mitigation of problems related to water resources
- protection of the ozone layer,
- mitigation of desertification and deforestation
- mitigation of soil degradation and permanent toxic pollutants

In 1995, it was decided that GEF will be a funding mechanism for programmes in sectors mentioned above, submitted by developing countries or countries with economies in transition, aiming at the fulfilment of relevant commitments resulting from International Conventions. In addition, a strategy for the operation of GEF was adopted, which has to be economically efficient and aim at maximization of environmental benefits.

Greece contributed 1,531,700,000 Greek drachmas to the second GEF Replenishment in 1997 which covered the period 1/7/1998 – 30/6/2002.

In the third GEF Replenishment in 2002, covering for the period 1/7/2002 – 30/6/2006, Greece committed to a total contribution of 5.73 million €. The Greek contribution is submitted in four annual payments. **Table 6.1** presents the contribution of Greece to GEF to date. The last annual payment to the third GEF Replenishment amounts to 1,432,500€ and is being processed.

Table 6.1 Financial contributions of Greece to the Global Environmental Facility (GEF)

	Contribution (millions €)					
	2001	2002	2003	2004	2005	2006
Global Environmental Facility	1123.8 [1]	0.0	2432.6 [2]	432.4 [2]	1432.5 [2]	1432.5 [3]

[1] Second GEF replenishment

[2] Third GEF replenishment

[3] Last annual payment to the third GEF replenishment (in progress)

In addition, Greece contributes financially to various international organizations which play an important role in the promotion of sustainable development. This contribution is given by means of regular payments for the support for specific projects or programmes. Funding supplied to these

institutions totalled ***73 million €*** **(Table 6.2)** over the time period 2001 – 2005. Approximately 48.5% of this contribution refers to World Bank and the European Bank for Reconstruction and Development. However, the exact amount out of this contribution which is related to activities on climate change is unknown.

Finally, the enhancement of democratic practices and the promotion of sustainable economic development in the neighbouring regions represent the main strategic orientation of the official Greek development aid programme. More than 80% of the Official Development Assistance (ODA) of Greece is provided to developing countries in Southern-Eastern Europe. In 2003, the total net expenses of the Official Development Assistance of Greece (bilateral and multilateral programs) amounted to €***320 million***. However, there are no detailed data on the share of these funds, which is related to climate change activities.

Table 6.2 Financial contributions of Greece to international organisations and programmes

Institution or Programme	Contributions (thousands €)				
	2001	2002	2003	2004	2005
World Bank	6242.1	7200.0	3700.0	3561.8	3660.8
Organization for Economic Co-operation and Development (OECD)	1232.6	1406.9	1122.5	719.4	1808.7
European Bank for Reconstruction and Development (EBRD)	2184.2	2328.8	1828.8	1828.8	1828.8
United Nations Industrial Development Organization (UNIDO)	328.2	534.8	555.0	544.2	536.7
United Nations Development Programme UNDP)	205.4	293.5	293.5	293.5	293.5
UNFCCC [1]	48.7	95.8	95.8	95.8	109.9
Black Sea Trade and Development Bank (BSTDB)	6712.6	6423.5	5231.9	4850.5	4718.9

[1] These credits are reported in thousands $, and for the year 2005 the national contribution within the framework of the Kyoto Protocol is included

Table 6.3 presents information on the financial support provided by Greece to developing countries for the implementation of actions related to the mitigation and/or adaptation to climate change. The total support amounts to approximately ***3 million $***.

Table 6.3 Financial support provided by Greece to developing countries related to the implementation of the UNFCCC and the Kyoto Protocol (thousands $)

Country		Mitigation actions						Adaptation actions		
		Energy	*Transport*	*Forestry*	*Agricul-ture*	*Waste*	*Industry*	*Infrastructure development*	*Management f coastal areas*	*Other vulnerability analyses*
Egypt	2003									7.9
Azerbaijan	2003							22.6		
Albania	2001							184.9		
	2003					265.7		17.3		
Armenia	2002							138.7		
	2003							188.4		
Bosnia-Herzeg.	2001							190.7		
	2003							17.3		
Georgia	2003							128.7		
Jordan	2003									7.9
Iran	2002	37.2								
Kenya	2002							7.1		
	2003							20.2		
Croatia	2003							17.3		
Lebanon	2003							112.9	282.4	7.9
Palestine	2002							71.5		
	2003							178.4		
FYROM	2001							176		
	2002							31.1		
	2003							56.9		
Serbia – Mont .	2001							190.7		
	2002	92.4						65.3		
	2003									
Syria	2002							28.6		
	2003							40.6		23.7
Turkey	2002				43.5	130.5				130.5
	2003							17.3		
Tunisia	2002			52						

In addition, Greece has repeatedly provided the services of technical experts belonging to the research group "Energy Planning & Sustainable Development" of NOA, which have been trained and officially recognized as reviewers of the UN Framework Convention on Climate Change for the technical review of National Communications of Annex I Parties.

7 RESEARCH AND SYSTEMATIC OBSERVATION

7.1 Research

Research in Greece is carried out at Research Centres, Universities, and to some extent in industry. It is funded through public funds and grants provided by the Greek government and the European Commission and through private funds from industry, foundations and other enterprises. In 2001, according to the latest official data available, the overall amount spent on research was 0.64% of the GDP, of which 0.43% came from Greek state funds and the remaining 0.21% from private funds.

The majority of the national research centres with activities in the field of physical and social sciences are funded and supervised by the General Secretariat for Research and Technology (GSRT) of the Ministry for Development. Various other ministries, such as the Ministry for Health, the Ministry for Rural Development and Food and the Ministry for National Defence also fund and supervise their own research centres focusing their activities on sectors of their interest. The budget of the GSRT for the fiscal year 2005 was 72,000,000 €, of which 70% is dedicated to the support of the 9 national research centres supervised by the GSRT.

The research priorities of Greece, as stated in the Operational Programme "Competitiveness" (2000-2006) funded by the 3rd Community Support Framework, cover the following sectors:

- renewable energy sources
- food and aquaculture
- development of high quality products addressed to tourism
- sports
- maritime transport
- health and biomedical, diagnostic and curative methods
- natural environment (atmosphere, sea, water resources, forest fires, recycling, etc.)
- built environment and protection from earthquakes
- new forms of organization in businesses
- labour and training
- e-learning and e-business
- organizational structures for research activities in technological forecasting
- selection of priorities through social consent

Climate-related research is carried out in two of the national research centres, namely the National Observatory of Athens (NOA) and the National Centre for Marine Research (NCMR). In addition, the majority of Greek universities, as well as a small research group in the Academy of Athens

carry out meteorological and climatological research that covers a wide range of research issues. Finally, the National Foundation for Agricultural Research of the Ministry of Rural Development and Food carries out some research on the impact of climate change to agricultural activities.

The National Observatory of Athens acts also as the focal point for the IPCC, as well as for the management committee of GEOSS.

A coordinated national research program on climate change des not exist. During the last 3-4 years, the GSRT and other ministries that are directly or indirectly involved in climate change mitigation have funded a number of stand-alone research projects. Most of these projects focus on forecasting of meteorological parameters, such as precipitation and wind, which may cause adverse conditions influencing the daily activity, including forest fires and floods.

GSRT provided funds to the National Observatory of Athens for improving its modelling infrastructure for both short-term prediction capability (3–5 days) and longer-term climatic forecasts (3–6 months). At present, NOA runs on an operational basis 2 mesoscale models for weather forecasting, the results of which are then presented on local level in order to be used by the public and in commercial activities. This information is widely acknowledged as being particularly reliable. Furthermore, NOA has established and operates the regional climate model PRECIS which was developed at the Hadley Centre (Meteorological Office, UK) and is based on the latest version of the global climate model HadCM3. The results of the model for the A2 and B2 scenarios have already been exploited for the estimation of impacts in various activity sectors such as energy, agriculture and tourism.

Within the framework of the 3rd Community Support Framework and in particular the Operational Programme "Competitiveness" of the Ministry for Development for the period 2000-2006, research projects on three activities related to environmental protection are in progress.

The first activity entitled "Natural Environment and Sustainable Development" has a total budget of 32,657,000 € (of which 69% comes from public funds) and supports research projects related to the promotion of technologies for the observation of marine environment, the rational management of coastal ecosystems and water resources, the reduction of atmospheric pollution and forest fires and recycling.

The second activity entitled "Renewable Energy Sources and Energy Conservation" has a total budget of 15,848,000 € (of which 50% comes from public funding) and supports projects which contribute to the reduction of cost and the improvement of the efficiency of Renewable Energy Sources (RES), to the optimal integration of RES in electricity networks, as well as to the development of new technologies and applications of energy conservation in buildings, industry and the transport sector.

The third activity named "Built Environment and Seismic Risk Management" has a total budget of 18,737,000 € (of which 65% comes from public funding) and focuses on projects for research and long-term technological development, aiming at the production of innovative products or services which contribute to sustainable development of the built environment and the mitigation of risks caused by seismic activity.

These three supportive activities are included in the relevant prefectural programs (Regional Operational Programmes for the period 2000-2006) which have been announced and are in the process of evaluation and implementation. At the same time, several other projects of the GSRT include actions and fund proposals related to environmental protection.

The policy of GSRT is to provide supplemental support to research groups which participate in projects co-funded by the European Commission through its Framework Programme on Research. Greek research teams are involved in more than 50 research projects funded or co-funded mainly by the Directorate-General for Research of the European Commission within the scope of the Environment and Climate area of the 6th Framework Programme. 17 of these research programs have been completed, while the rest are on-going. The majority of projects are related to the mechanism of climate change– impacts – vulnerability. Examples of such projects are the PRUDENCE project ("Prediction of Regional scenarios and Uncertainties for Defining EuropeaN Climate change risks and Effects") and the ENSEMBLES project ("ENSEMBLE-based Predictions of Climate Changes and their Impacts").

GSRT has also funded, through its international bilateral agreements program, some projects in meteorology and atmospheric physics carried out in collaboration with research groups in Eastern Europe, other Mediterranean countries and China. This program provides small grants for travel and miscellaneous expenses in order to assist the promotion of scientific dialogue and joint research efforts.

7.2 Systematic observation

The network of systematic observation in Greece includes the Hellenic National Meteorological Service (HNMS), services of the Greek Armed Forces, the Ministry for the Environment, Physical Planning and Public Works, the Ministry for Rural Development and Food as well as a number of research centres. In addition, the Public Power Corporation operates a network of meteorological stations in the regions where thermal and hydro power plants are located and operate.

7.2.1 Atmospheric climate observing systems

7.2.1.1 Meteorological stations and RADAR

The Hellenic National Meteorological Service (HNMS) operates a network of 26 meteorological stations that provide measurement data on a continuous basis to the international meteorological networks. It operates also 3 stations for upper air measurement. In addition, it collects data from an even larger number of stations, 28 of which are registered in WMO (World Meteorological Organization) as 1st Class stations.

The Ministry for Rural Development and Food operates a large network of agro-meteorological stations, some of which have been operating for more than 50 years. In the latest 5 years, 40 of these stations were refurbished so that they can provide a full and continuous set of data which is collected automatically and centrally stored. In addition, the Institute of Mediterranean Forest

Ecosystems and Forest Products Technology of the National Agricultural Research Foundation (NAGREF) has since 1960 a network of 21 meteorological stations, which was upgraded to automatic mode in 1994. The locations of these stations cover mainly forest areas of the country. The data from these stations are processed in such a way so as to be available shortly in a uniform database of meteorological information and cover a time period of approximately 40 years.

The National Observatory of Athens (NOA) also operates a 1st class meteorological station in Athens. This station, established in 1842, has the longest uninterrupted time series of meteorological observations in Greece. Among others, this station measures on a continuous basis a full set of solar radiation parameters. Measurements cover a time period of 10 years for the full set of parameters and 50 years for total, direct and diffuse solar radiation.

A number of national research centres and universities also operate meteorological stations. The time series of these stations vary in length from a few years to a few decades, and their data are widely available.

The Ministry for Rural Development and Food, the Ministry for the Environment, Physical Planning and Public Works and the HMNS operate a large network of rain gages and snow gages. The network comprises more than 238 rain gages and over 1000 snow tables.

An effort is underway, with financing from the Ministry for the Environment, Physical Planning and Public Works, to gather all available meteorological and hydrological data in a single database. The project has already started and the introduction of data into the database is in progress. The policy on the availability and accessibility to this database is at present under examination.

Finally, HMNS has recently (2004) installed and operates a network of 4 stable meteorological RADAR C-Band (Imitos mountain in Athens, Aegina island in the Saronikos Gulf, Larissa in Central Greece and Mikra in Northern Greece), while NOA purchased (2002) and operates a mobile meteorological RADAR S-band.

7.2.1.2 Carbon dioxide monitoring programme

The National Observatory of Athens has recently installed a station in a remote location on top of Mount Helmos (2,350m above MSL) for the measurement of CO_2 and other greenhouse gases concentration as well as climatological parameters.

7.2.1.3 International Programmes and collaborations

Greece is a member of EUMETSAT (EUropean organisation for the exploitation of METeorological SATellites), the consortium which operates the meteorological monitoring satellite METEOSAT. It is also a member of ECMWF (European Centre for Medium-range Weather Forecast) in which it provides human staff. In both these international efforts, Greece is represented by the HNMS.

The National Observatory of Athens operates a network of stations aimed at the detection of lightning strikes. The network consists of 6 recording stations located between Denmark and Romania in the north and Cyprus and Portugal in the south. The lightning-strike data provide real-

time information regarding the location of thunder cells and severe rainstorm activity from the coast of Florida to the Persian Gulf. This information is crucial for predicting floods and for providing more accurate local forecasts. This information is supplied to the meteorological community via Internet. Recently (2003), in collaboration with the US National Oceanic and Atmospheric Agency (NOAA), the network was expanded with 2 new stations in Africa in order to cover the Northern Africa and India.

The University of Thessaloniki–Laboratory of Applied Physics operates the World Ozone Mapping Center, which utilizes measurements from the 90 stations of WMO Global Ozone System (part of GAW) and of TOMS to generate and archive global maps of total ozone density.

7.2.1.4 Ozone and UV-radiation measurements

The universities of Thessaloniki and Athens monitor the total (column) ozone concentration at two locations on a permanent basis for more than 30 years. The University of Thessaloniki also operates a station for measuring background tropospheric ozone at Livadi (1,000m above MSL). In addition, the Institute of Mediterranean Forest Ecosystems and Forest Products Technology of NAGREF, measures, since April 2000, the average monthly concentration of ozone with the use of sampling devices in three forest areas of the country (Varetada Amfilohias in Western Greece - 350 m above MSL, Agios Nikolaos Evritanias in Central Greece - 1120 m above MSL and at the Northern-Eastern part of Mount Ossa in Central Greece - 740 m above MSL).

The University of Thessaloniki, the University of Athens, the Academy of Athens and the National Observatory of Athens measure UV (UV total, UV-B and total solar radiation components) and other relevant meteorological parameters in more than 7 stations. Some of these stations are included in the GAW (Global Atmosphere Watch) network.

7.2.1.5 Monitoring of atmospheric pollution

There are local networks for the monitoring of atmospheric pollution at the most significant urban centres of Greece. These networks operate under the responsibility of the Prefectures to which MEPPPW has assigned the use of the networks. The largest network is the one of Athens, which consists of 19 stations that measure air pollutants; 16-measure ground level ozone and 12 also measure standard meteorological parameters. The network in the broader area of Thessaloniki in Northern Greece consists of 8 stations, of which 7 measure ozone as well. Eight additional stations, all of which measure ozone, are located in other cities. In addition, PPC, refineries as well as other industrial installations also operate a number of monitoring stations for air quality, which measure the concentration of major air pollutants (PM, SO_2, NO_x) as well as meteorological parameters.

7.2.2 Marine climate observing systems

The National Center for Marine Research (NCMR) is the major organization assigned with the collection of marine data from the sea surrounding Greece. NCMR operates a fleet of marine

research vessels, including a bathyscaph capable of reaching 610m below sea level. It also operates 9 buoys with both meteorological and oceanographic instrumentation.

The Hellenic Navy Hydrographic Service maintains and operates an extended network of 21 tidal (sea level) gages.

7.2.3 Terrestrial climate observing systems

In combination with the precipitation measurement networks which are operated by various services, there is also observation of rivers and lakes.

7.2.4 Support supplied to other countries to establish and maintain observing stations

During the last 10 years, within the framework of bilateral agreements, Greece has provided funds and technical assistance to neighbouring Balkan countries (Albania, Former Yugoslavia, FYROM, Bulgaria) for the establishment and operation of a network of stations that monitor the amount and quality of water in rivers which, in their way towards the sea, cross the common borders with these countries.

7.2.5 Climate Change Observatory

In 2003, the Climate Change Observatory was established at NOA, with the following activities:

- Coordination of research and climate observations as well as other relevant environmental parameters in the Greek territory
- Observation of past and existing trends and projection of emissions of greenhouse gases
- Estimation of the impacts of climate change on the natural environment and the economic activity
- Assessment of the effectiveness of measures for the mitigation of climate change impacts, adaptation measures and emissions reduction measures
- Follow-up of international developments on climate change issues and relevant international conventions (UNFCCC, Kyoto Protocol, etc.)
- Follow-up of international developments and estimation of possibilities and prospects for the development and penetration of new clean and environmentally friendly technologies

8 EDUCATION AND PUBLIC AWARENESS

It is generally acknowledged that combating climate change will be a success only if the danger is widely known and understood by the public and especially by those who have to undertake mitigation measures. This can be accomplished with intensive education, awareness and training efforts at all levels. For this purpose, Greece has carried out a series of actions with respect to education and information, which are presented below.

8.1 Environmental education

8.1.1 School education

8.1.1.1 Programmes of Environmental Education

Because of the rapid development of activities in schools with respect to environmental education, the Ministry for Education and Religious Affairs assigned the support of these activities to a third institution. The new management framework is called "School Programmes of Environmental Education" and is under the responsibility of the Aegean University.

The above approach has provided the possibility for supporting the planning and implementation of environmental programmes, a significant number of which concern climate change, in thousands schools all over Greece. The detailed framework and the implementation tools are presented through the web-site of the programme (http://www.sppe.gr).

8.1.1.2 Hellenic Association of Teachers for Environmental Education

Since 1992, the Hellenic Association of Teachers for Environmental Education (HATEE) has been established, aiming at the mutual support, the exchange of views and the coordination between teachers within the framework of environmental education activities. HATEE is a scientific non-profit organization with a memorandum of association officially recognized by the Court of First Instance of Athens, which foresees the operation of branches in the greater regions of Greece (see http://dide.reth.sch.gr/envedu/peekpe/page%20kentr.htm).

Its members are teachers from all educational stages who are involved in environmental education activities. The objectives of HATEE are the following:

- Communication and collaboration between teachers who deal with environmental education
- Exchange of information and experiences between teachers in Greece and abroad
- Promotion and support of environmental education programmes in schools
- Support of the Centres for Environmental Education
- Studies, research activities and plans dealing with environmental problems in Greece

HATEE has organized conferences, workshops, meetings and seminars on issues related to environmental education. There is an increasing specialization of presentations given on issues such as climate change within the framework of HATEE activities, reflecting the intensifying knowledge requirements posed by environmental education on these technical issues.

8.1.1.3 Non-governmental organisations (NGOs)

A substantial number of environmental non-governmental organisations (NGOs) are active on environmental education issues, promoting at the same time awareness on particular environmental issues. For instance, there are 'thematic' NGOs such as the Sea Turtle Protection Society of Greece ARCHELON and the Hellenic Ornithology Society, 'inter-sectoral' NGOs such as the Greek Association for the Protection of the Environment and Cultural Heritage (EEPECH) and WWF, as well as institutions of international cooperation between NGOs such as the Mediterranean Information Office for the Environment, Culture and Sustainable Development (MIO-ECSDE) and the Mediterranean Network SOS.

One of the most active NGOs in Greece is the Hellenic Society for the Protection of Nature (HSPN), with more than 50 years of action, which focuses a large part of its activity on environmental education, developing and supporting networks of schools and student groups (see http://www.eepf.gr/).

It should be particularly stressed that apart from raising awareness on specific environmental thematic fields, including climate change and energy, the programmes of HSPN aim at stimulating abilities such as investigating, recording and documentating information, participating in decision-making procedures, working in teams as well as undertaking the responsibility of representation to third parties.

All these points mentioned above constitute important characteristics towards the development of a future civil society that will undertake the responsibility and the cost of development choices as well as the initiatives for the confrontation of any impacts.

8.1.1.4 MEdIES programme

The Greek Government and more specifically MEPPPW is one of the major donors of the MEdIES programme (**M**editerranean **Ed**ucation **I**nitiative for the **E**nvironment and **S**ustainability) for the promotion of environmental education and sustainable development in the Mediterranean region. UNESCO, UNEP/MAP and the Government of Italy are the other partners of the programme, while the coordinator of the initiative is the Mediterranean Information Office for the Environment, Culture and Sustainable Development (MIO-ECSDE).

The relevant web site (http://www.medies.net/) of the programme provides useful information and reference material to all those involved in environmental education, while it consists a tool for seeking and communicating with relevant institutions in the Mediterranean region.

The workshops of the programme take place in different Mediterranean countries. In June 2004, a meeting for the evaluation of educational material took place in Greece.

MIO-ECSDE is a Federation of Mediterranean NGOs which are active in environmental and development issues. It functions as a technical and political platform and umbrella for the intervention of NGOs in the Mediterranean region. In co-operation with governments, international organizations and other socio-economic partners, MIO-ECSDE plays an active role in the protection of the environment and the sustainable development of the Mediterranean region.

8.1.2 Education in universities and technical education centres

The establishment of new departments dealing with environmental issues and the enlargement of the scientific content of many existing ones during the recent years, have created a significant technical knowledge on climate change issues and their causes, both at the level of research as well as - progressively - at the level of higher education.

It should be noted that many of the particular issues related to climate change are new and evolving. Consequently, the provision of education on these issues requires a permanent link between research and the educational process, with respect to both the content of education, as well as to the wider interdisciplinary approach into which this content is inevitably integrated.

New thematic issues such as

- active and passive systems in buildings,
- bioclimatic architecture,
- incorporation of renewable energy sources in energy planning,
- investigation and analysis of relations of the human community with the environment (artificial, social, cultural, natural),

emerge, since it is recognized that the effective confrontation of climate change is linked to the provision of a number of services and products – such as accommodation, transport and supply of consumable materials - with new methods presenting lower negative environmental impacts but the same or even higher social acceptance and economic opportunities for implementation.

8.1.3 Continuous education

Recognizing the rapid development of scientific fields and institutional frameworks related to climate change mitigation, an increasing number of Greek scientific and educational institutions extend their activities in the area of continuous education, in order to contribute to the enhancement of scientific knowledge in public administration, private enterprises and the citizens in general.

8.1.3.1 "Summer schools"

A characteristic example of continuous education is the Summer School entitled "ENERGY and ENVIRONMENTAL PLANNING of BUILDINGS" that took place in July 2004 on the island of Milos. The summer school aimed at informing scientists involved in the design and construction of buildings about the new EU Directive on Energy Efficiency of Buildings, as well as at introducing

them in a practical way in the process and methodology to be followed for the elaboration of specific energy and environmental studies required by this directive.

Participants received computational tools as well as relevant technical documentation and, with the help of specialized scientists, worked on specific examples and studies. The summer school lasted 2 days and was attended by 70 participants.

8.1.3.2 Educational activities undertaken by the Centre for Renewable Energy Sources (CRES)

CRES, aiming at the promotion of renewable energy sources (RES), the rational use of energy (RUE) and energy savings (ES), systematically undertakes educational and training activities addressed both to professionals who are active in these thematic fields, as well as to pupils and students in all educational stages.

Educational activities, include inter alia the production of printed, electronic and audiovisual material, which is distinguished in training material and educational material (http://www.cres.gr/kape/education.htm).

8.1.4 Other organizations

Non-educational institutions play an important role in producing educational material and in organizing activities of continuous education on issues related to climate change. In many cases, due to the specialization of these institutions, the educational material produced represents a reference material for other scientific activities.

The activities of such institutions are briefly presented below by means of indicative examples of their activities.

8.1.4.1 INIER - Interdisciplinary Institute for Environmental Research

The Interdisciplinary Institute for Environmental Research (INIER) is a non-profit organization for the environment. Its objectives are the elaboration of policies and the development of tools for the promotion of sustainable development, the provision of information and stimulation of public awareness on environmental issues and the contribution to the development of institutional framework for environmental protection (http://www.dipe.gr/indexgr.htm).

8.1.4.2 Law+Nature

The non-profit organization Law+Nature is a member of the ECNC (European Center for Nature Conservation) network (http://www.nomosphysis.org.gr/), specializes in the thematic field of environmental law and policy for environmental protection and sustainable development.

Between its scientific and informative activities that are related to climate change, one should mention the organization of the "Environmental Dialogues" forum with the following topics:

- International law for the mitigation of climate change: 10 years after the Rio Conference (Athens 2002)
- Economic tools for Sustainable Development (Athens 2003)

8.1.4.3 Hellenic Association for the Protection of Environment and Cultural Heritage

The Hellenic Association for the Protection of Environment and Cultural Heritage (http://www.ellinikietairia.gr/) is a non-profit organization aiming at highlighting the value of the Greek cultural heritage, the importance of the protection of ecosystems and ecological balance in Greece, as well as the aesthetic value of landscape and the importance of the natural environment of the country. Furthermore, it aims at promoting the concept and practices of sustainable development so that human activities coexist harmoniously with the natural and cultural heritage. During the last 3 years, the organization organized a number of workshops and press conferences especially on climate related issues, such as the contribution of the transport sector in climate change, energy conservation in the residential sector and the energy / CO_2 tax.

8.2 Environmental information and awareness

8.2.1 Governmental Initiatives

8.2.1.1 Hellenic Parliament

In 2004, a Permanent Special Committee on Environmental Protection was established in the Hellenic Parliament, comprising representatives form of all parliamentary parties. This committee is expected to promote environmental issues within the framework of parliamentary processes and particularly to contribute in a more systematic elaboration of these issues and to enhance the relative dialogue.

8.2.1.2 Ministry for the Environment, Physical Planning and Public Works

In the web site of the Ministry for the Environment, Physical Planning and Public Works / MEPPPW (http://www.minenv.gr/) one can find press releases, statements and information on climate change and actions for the promotion of solutions within the framework of international environmental conventions and agreements. These include information on the Kyoto Protocol and GHG emissions related issues, such as the National Action Plan for the reduction of GHG emissions, the National Allocation Plan for Emissions Trading, environmental laws, etc.

At the same time, the Ministry undertakes target-based initiatives for information and awareness, in collaboration with local, national or sectoral institutions, such as the Management Institutions of Protected Areas and the Technical Chamber of Greece (TEE-TCG).

In 2002, within the framework of the celebration of the Global Day of Environment, MEPPPW realized a wide awareness campaign on environmental issues. A basic tool developed for this

campaign was the publication of a Guide entitled "Simple advices for protecting the environment". The Guide included practical advices for issues like the consumption of energy, water, materials and food, highlighting their environmental impacts.

In addition, MEPPPW has decentralized to a significant extent the provision of environmental information, assigning this topic to specialized institutions supervised by MEPPPW or in some of its departments, such as the National Center for Environment and Sustainable Development (NCESD) and the National Network for Environmental Information (NNEI).

(A) National Network for Environmental Information

The National Network for Environmental Information (NNEI) is an integrated information system for the registration and processing of information related to the state of the environment in local, regional and national level. The network is foreseen to stand as the main mechanism for the storage and management of all information on environmental issues which is of national importance.

A significant part of input data is available through the internet (http://hermes.edpp.gr/) where the environmental data are presented by means of a Geographical Information System (GIS).

(B) National Center for the Environment and Sustainable Development - NCESD

The National Center for the Environment and Sustainable Development (NCESD) (http://www.ekpaa.gr/) was established in 2001, under the supervision of the Ministry of Environment, Physical Planning and Public Works, in order to provide consultancy to the Greek State on environmental and sustainable development issues. Through the provision of permanent, reliable and objective information, technical knowledge and proposals, NCESD supports training and implementation of effective policies in the above mentioned issues. It contributes, as a know-how mechanism, in the integration of the environmental dimension in sectoral development policies and, through this, to a horizontal coordination of public policies which have a direct or indirect influence in spatial and environmental management.

More specifically, with respect to climate change related issues, the following activities (compilation and publication of reports and studies) should be mentioned:

- Greece: The State of the Environment - A Brief Report
- National Strategy for Sustainable Development
- National Report on Sustainability Indicators
- Energy, Environment and Businesses
- 10-year Framework Programme on Sustainable Development

(C) Special Service of Environmental Inspectors – SSEI

The Special Service of Environmental Inspectors (SSEI) was established in 2003 and since then Greece has a control mechanism for the enforcement of environmental legislation and the protection of environment. This need had been foreseen many years ago by the Environmental Law 1650/86.

In addition, MEPPPW has provided funding to the National Observatory of Athens, as it will be analyzed below, in order to conduct research on policies and measures to be applied in different sectors aiming at selecting effective actions and providing relevant information both to the governmental and public services.

8.2.1.3 Ministry for Development

Apart from MEPPPW, the Ministry for Development (MD) constitutes the main co-competent ministry in climate change issues since it is responsible, among others, for all energy issues. MD, with the support of NOA and other consultants, organized, inter alia, two workshops in Athens (February 2005) and Thessaloniki (March 2005) on the past and future trends of GHG emissions, the EU Emissions Trading Scheme and the elaboration of the National Allocation Plan for Emissions Trading.

MD promotes the provision of information on climate change and appropriate policies and measures, mainly through NOA and through other institutions for specific issues (e.g. the Centre for Renewable Energy Sources / CRES on the topic of renewable energies). At the same time, it has also undertaken further initiatives such as the Internet Gate for Sustainable Development, and through its web site (http://www.ypan.gr) promotes also the EU *Energy Star* programme which deals with the energy performance of office equipment.

(A) National Observatory of Athens - NOA

The National Observatory of Athens and in particular the research group "Energy Planning and Sustainable Development", under the financial support mainly of MEPPPW, assists the competent departments of MEPPPW but also of other Ministries, in the fulfilment of national commitments on climate change, including also individual scientific topics. Some characteristic examples of relevant actions are the compilation of the annual National Inventory of GHG Emissions and Removals, the estimation of national emissions of pollutants as SO_2, NOx, NMVOC, etc, the examination of climatic parameters and their changes during the last 100 years etc. The results of these studies are provided to the public through also through the internet (http://www.climate.noa.gr), while assistance is offered to research institutions or individuals internationally for the collection of data, information or estimations on relevant projects. Especially with respect to energy conservation in new and existing buildings, relevant information is provided to the public by the research team "Energy Conservation" of NOA through the form of handbooks, CDs, and special workshops on this topic.

(B) Centre for Renewable Energy Sources - CRES

The Centre for Renewable Energy Sources (CRES) is the Greek national centre for Renewable Energy Sources (RES), Rational Use of Energy (RUE) and Energy Saving (ES). CRES plays an active role within the framework of national and community policy and legislation related to environmental protection and sustainable development.

CRES undertakes a significant number of initiatives for the provision of information, education and awareness on climate change, focusing in the promotion of solutions and practices as the energy saving and rational energy use.

The web site of CRES (http://www.cres.gr/kape/index_gr.htm) provides information on the ways through which a Greek household can reduce its energy consumption. By providing useful and user-friendly computational tools, it assists the pubic in quantifying the relevant cost that can be avoided through particular practices of energy conservation.

(C) Internet Gate for Sustainable Development

The Internet Gate of the MD for Sustainable Development (http://www.axiosvios.gr/) aims in providing concise and simplified information to businesses and potential investors, as well as to the broader public, on the prospects of economic growth in Greece and on the conditions that are necessary so that economic growth can go along with the long-term protection and preservation of the natural and cultural environment. Energy and climate change represent one out of the nine Development Sectors which are recorded in the Gate, while at the same time the development prospects of "clean energy" constitute one from the twelve Thematic Categories of the Gate.

(D) Research Institutions

Apart from the National Observatory of Athens which has the responsibility for the support of MEPPPW, a series of other research institutions are activated on issues related to climate change and the relative public information. Indicatively we report the National Centre of Social Researches (EKKE) and the National Center for Marine Research (NCMR).

8.2.2 NGOs Initiatives

8.2.2.1 Greenpeace

The action on climate protection constitutes one of the three basic thematic campaigns of the Greek office of Greenpeace, together with the issues of toxic and genetically modified organisms.

Within this framework, Greenpeace has undertaken a number of initiatives which address two main directions:

1. Highlighting policies and behaviours which generated and intensify the climate change problem, e.g. dependence from fossil fuels, non-rational energy use, degradation of forests, disproportionate facilitation of the use of private cars, etc. and
2. Presenting alternative solutions aiming at eliminating the above mentioned factors and at following a totally different approach with respect to relevant development processes.

8.2.2.2 Mediterranean SOS network

Through the organization of campaigns, workshops and conferences, the collection of signatures, the distribution of informative material, the creation of TV spots and the organization of cultural events, the Mediterranean SOS Network (http://www.medsos.gr/), aims at providing information to

and stimulating the awareness of the public, exercising pressure for a shift of policies towards environmental protection, educating the public on practices for waste and energy reduction and participating in the effort for a change of those production and consumption modes that are responsible for the destruction of global climate.

8.2.2.3 Institute of Energy for South East Europe - IENE

The Institute of Energy for South East Europe (IENE) is a non-profit organization which since 1998 organizes annual conferences on energy issues. Climate change and relevant policies and measures for GHG emissions reduction have always been in the agenda of these conferences. IENE also organizes meetings devoted to specific topics such as the implementation of the EU Directive on Emissions Trading and Carbon Capture and Storage (CCS).

8.2.3 Environmental information-awareness and a civil society

Apart for the NGOs, a number of institutions of the civil society show an increasing interest on energy, climate change and environmental issues. These institutions can contribute to the awareness and promotion of good practices, either due to their large membership (Greek General Confederation of Labour -GSEE, Technical Chamber of Greece - TEE), or due to their sectoral representation (Hellenic Association of Photovoltaic Companies, Greek Association of RES Electricity Producers), or finally, due to the specialization of their members in issues critical for the application of solutions for climate change mitigation (Alumni Association of Greek Environmental Scientists, Hellenic Environmental Law Society).

ABBREVIATIONS

GDP	Gross Domestic Product
PPC	Public Power Corporation
RES	Renewable Energy Sources
CSF	Community Support Framework
MEPPPW	Ministry for the Environment, Physical Planning and Public Works
NOA	National Observatory of Athens
NCMR	National Center for Marine Research
NAGREF	National Agricultural Research Foundation
GSRT	General Secretariat for Research and Technology
HNMS	Hellenic National Meteorological Service
EEC	Environmental Education Centres
NGO	Non-Governmental Organisations
NCESD	National Center for Environment and Sustainable Development
NNEI	National Network of Environmental Information
EU	European Union
VAT	Value Added Tax
OPE	Operational Programme Energy
AUTO	Athens Urban Transport Organization
OECD	Organization for Economic Co-operation and Development
MERA	Ministry of Education and Religious Affairs
CRES	Centre for Renewable Energy Sources
CORINAIR	Intergovernmental Co-ordination of Information on Air Pollution
IPCC	Panel on Climate Change
CO2	Carbon dioxide
CH4	Methane
N2O	Nitrous oxide
HFC	Hydrofluorocarbons
PFC	Perfluorocarbons
SF6	Sulphur hexafluoride
ENPEP	ENergy and Power Evaluation Program
EUMETSAT	EUropean organisation for the exploitation of METeorological SATellites
ECMWF	European Centre for Medium-range Weather Forecast
CNG	Compressed Natural Gas
LPG	Liquefied Petroleum Gas
GEF	Global Environmental Facility
DAC	Development Assistance Committee
ODA	Official Development Assistance
Mtoe	Million tonnes oil equivalent

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ANNEXES

Annex I: Emissions Inventory 1990 - 2003

Table I.1 Global Warming Potential (in t CO_2 eq per t of gas) for greenhouse gases (for the 100-year horizon)

GAS	GWP
Carbon dioxide (CO2)	1
Methane (CH4)	21
Nitrous oxide (N2O)	310
Hydrofluorocarbons (HFC)	
HFC-23	11700
HFC-125	2800
HFC-134a	1300
HFC-143a	3800
HFC-152a	140
HFC-227ea	2900
HFC-236fa	6300
HFC-4310mee	1300
Perfluorocarbons (PFC)	
CF_4	6500
C_2F_6	9200
C_4F_{10}	7000
C_6F_{14}	7400
Sulphur hexafluoride (SF_6)	23900

Table I.2 Sources of statistical data by activity sector

SECTOR [9]		STATISTICAL DATA	SOURCES
1.A1	Energy Industry	Energy use per fuel	• Greek Public Power Corporation • Energy balance (Ministry of Development)
1.A2	Industry	Energy use per fuel	• Energy balance (Ministry of Development)
1.A3	Transport	Number of vehicles	• Association of Greek Auto Importers • Ministry of Transport
		Aircraft landing and take off cycles	• Civil Aviation Organisation
1.A4	Residential, tertiary and agricultural sector	Energy use per fuel	• Energy balance (Ministry of Development)
1.B	Mining and Distribution of fuels	Amount of Fuels	• Energy balance (Ministry of Development)
2	Industrial Processes	Annual production data	• National Statistical Service of Greece • Questionnaires during the configuration of NAP • Information from Industry
3	Solvent and other products use	Amount of solvent use	• Ministry for the Environment, Physical Planning and Public Works
4	Agriculture	Agricultural area Agricultural production Number of animals	• National Statistical Service of Greece • Ministry of Rural Development and Food
		Use of fertilizers	• Food and Agricultural Organization of the UN
5	Land Use Change and Forestry	Forest areas Forest fires	• Ministry of Rural Development and Food • DG for the Forests and the Natural Environment
6	Waste	Amount and composition of waste Recycling Population / Industrial production	• Ministry for the Environment, Physical Planning and Public Works • National Statistical Service of Greece

[9] The codes presented in Table I.2 are those defined by the CRF tables of GHG emissions/removals

Table I.3 Methodologies for emissions/removals estimation for the Greek inventory system

	CO_2		CH_4		N_2O		F-gases [1]	
	Methodology	Emission factor	Methodology	Emission factor	Methodology	Emission factor	Methodology	Emission factor
1. Energy								
A. Fuel Combustion								
1. Energy Industries	C [2]	C, CS [3]	C	C	C	C		
2. Manufacturing Industries and Construction	C	C	C	C	C	C		
3. Transport	C	C	C	C	C	C		
4. Other sectors	C	C	C	C	C	C		
B. Fugitive emissions from fuels								
1. Solid fuels	NE [4]		T1 [5]	D [6]	NE			
2. Oil and Natural Gas	NE		T1, C	D, C	NE			
2. Industrial Processes								
A. Mineral Products	T1, T2 [5]	D, CS						
B. Chemical Industry	IE [7]		NE		T1	D		
C. Metal Production	T2, IE [8]	CS	NE				T3b [5]	CS
E. F-gases production							T1	D
F. F-gases consumption							T2a [5]	D
3. Solvent and Other Product Use	C	C			NE			
4. Agriculture								
A. Enteric Fermentation			T2,T1	CS, D				
B. Manure Management			T1	D	D	D		
C. Rice Cultivation			D	D				

	CO_2		CH_4		N_2O		F-gases [1]	
	Methodology	Emission factor	Methodology	Emission factor	Methodology	Emission factor	Methodology	Emission factor
D. Agricultural Soils			NE		T1a, T1b [5]	D		
F. Field Burning of Agricultural Residues			D	D	D	D		
5. Land-Use Change and Forestry								
A. Forest lands	D, CS, T2, T1	CS, D	T1	D	T1	D		
B. Agricultural lands	T2, T1	CS, D						
C. Grasslands	T1	T1	T1	D	T1	D		
D. Wetlands	NE		NE		NE			
E. Settlements	NE		NE		NE			
6. Waste								
A. Solid Waste Disposal on Land	T1	D	T1	D				
B. Wastewater Handling			D	D	D	D		

1) Only HFC and PFC emissions are included
2) C = CORINAIR
3) CS = Country Specific
4) NE = Not Estimated
5) T1, T1a, T1b, T2, T2a, T3b = IPCC Methodology T1, T1a, T1b, T2, T2a, T3b (steps) respectively
6) D = Typical methodology and IPCC emission factor
7) IE = Included Elsewhere – Concerns the production of ammonia. CO_2 emissions from the production of ammonia are registered in the *Energy* sector
8) Concerns the production of ferroalloys . CO_2 emissions are included in the *Energy* sector

Table I.4 Evaluation of CO_2 emissions for the period 1990 – 2003 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year(1)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
1. Energy	**77.065,45**	**77.065,45**	**76.839,05**	**77.729,74**	**78.162,05**	**80.087,08**	**79.772,15**	**81.987,52**	**86.442,41**	**91.203,64**	**90.324,01**	**95.897,86**	**98.002,41**	**97.887,11**	**101.624,83**
A. Fuel Combustion (Sectoral Approach)	77.065,45	77.065,45	76.839,05	77.729,74	78.162,05	80.087,08	79.772,15	81.987,52	86.442,41	91.203,64	90.324,01	95.897,86	98.002,41	97.887,11	101.624,83
1. Energy Industries	43.194,16	43.194,16	42.010,77	43.909,38	44.160,17	46.144,83	44.877,52	44.030,51	47.548,17	50.140,78	50.445,00	54.926,55	55.454,18	55.108,95	56.100,10
2. Manufacturing Industries and Construction	10.490,65	10.490,65	10.243,99	9.474,28	9.252,15	9.054,11	9.817,28	10.514,38	10.613,67	10.801,08	9.641,35	10.639,92	10.647,92	10.254,92	9.999,88
3. Transport	15.354,85	15.354,85	16.127,66	16.239,57	16.769,01	16.857,81	16.966,00	17.422,37	18.022,31	19.649,18	19.823,60	19.303,61	20.011,62	20.262,49	21.230,34
4. Other Sectors	8.025,80	8.025,80	8.456,63	8.106,50	7.980,72	8.030,33	8.111,36	10.020,26	10.258,26	10.612,60	10.414,06	11.027,78	11.888,70	12.260,75	14.294,50
5. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
B. Fugitive Emissions from Fuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1. Solid Fuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2. Oil and Natural Gas	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2. Industrial Processes	**6.764,42**	**6.764,42**	**6.698,87**	**6.757,04**	**6.934,40**	**6.920,65**	**7.383,72**	**7.374,85**	**7.659,24**	**7.464,19**	**7.584,72**	**7.892,04**	**7.974,18**	**7.900,40**	**7.963,87**
A. Mineral Products	6.329,62	6.329,62	6.262,49	6.331,48	6.500,87	6.520,39	6.969,14	6.998,37	7.234,19	6.985,74	7.118,90	7.387,14	7.400,32	7.203,82	7.306,59
B. Chemical Industry	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C. Metal Production	434,79	434,79	436,39	425,56	433,53	400,26	414,59	376,47	425,06	478,45	465,82	504,90	573,86	696,58	657,28
D. Other Production	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	NE
E. Production of Halocarbons and SF_6															
F. Consumption of Halocarbons and SF_6															
G. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3. Solvent and Other Product Use	**170,32**	**170,32**	**175,82**	**172,31**	**169,24**	**162,09**	**153,35**	**150,78**	**151,70**	**151,15**	**158,98**	**145,10**	**154,57**	**155,20**	**155,86**
4. Agriculture	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
A. Enteric Fermentation	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
B. Manure Management	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C. Rice Cultivation	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
D. Agricultural Soils (2)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
E. Prescribed Burning of Savannas	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
F. Field Burning of Agricultural Residues	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
G. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5. Land-Use Change and Forestry (3)	**-3.248,20**	**-3.248,20**	**-3.596,04**	**-3.074,99**	**-3.879,75**	**-3.553,42**	**-4.406,97**	**-3.993,22**	**-3.957,00**	**-3.590,82**	**-4.436,43**	**-3.141,90**	**-5.323,63**	**-5.459,73**	**-5.533,46**
A. Changes in Forest and Other Woody Biomass Stocks															
B. Forest and Grassland Conversion															
C. Abandonment of Managed Lands															
D. CO_2 Emissions and Removals from Soil															
E. Other															
6. Waste	**20,80**	**20,80**	**21,57**	**23,15**	**24,72**	**26,80**	**34,59**	**36,79**	**38,44**	**41,65**	**168,92**	**177,42**	**203,13**	**220,32**	**232,56**
A. Solid Waste Disposal on Land	20,80	20,80	21,57	23,15	24,72	26,80	34,59	36,79	38,44	41,65	168,92	177,42	203,13	220,32	232,56
B. Waste-water Handling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C. Waste Incineration	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
D. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Table I.5 Evaluation of CH_4 emissions for the period 1990 – 2003 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year(1)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
Total Emissions	**479,10**	**479,10**	**477,32**	**486,18**	**489,76**	**500,74**	**504,75**	**513,45**	**517,85**	**535,06**	**495,35**	**500,96**	**479,52**	**482,28**	**484,36**
1. Energy	**73,73**	**73,73**	**74,73**	**77,28**	**77,13**	**78,89**	**80,25**	**83,30**	**83,04**	**87,52**	**90,34**	**95,16**	**97,54**	**102,25**	**100,25**
A. Fuel Combustion (Sectoral Approach)	19,69	19,69	20,02	20,21	20,64	20,64	20,94	21,63	21,78	21,83	21,64	22,20	22,25	22,32	21,51
1. Energy Industries	0,35	0,35	0,34	0,36	0,35	0,37	0,37	0,38	0,39	0,40	0,40	0,45	0,45	0,45	0,45
2. Manufacturing Industries and Construction	3,71	3,71	3,57	3,38	3,55	3,40	3,47	3,61	3,64	3,44	3,36	3,85	3,80	3,82	3,18
3. Transport	5,45	5,45	5,76	6,13	6,36	6,51	6,76	7,16	7,30	7,59	7,65	7,61	7,72	7,70	7,82
4. Other Sectors	10,18	10,18	10,34	10,34	10,37	10,37	10,34	10,47	10,45	10,40	10,22	10,28	10,29	10,35	10,06
5. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
B. Fugitive Emissions from Fuels	54,04	54,04	54,71	57,07	56,48	58,25	59,32	61,67	61,26	65,69	68,71	72,96	75,29	79,93	78,74
1. Solid Fuels	52,16	52,16	52,96	55,33	55,09	56,96	57,95	60,08	59,14	61,19	62,36	64,21	66,68	70,82	68,64
2. Oil and Natural Gas	1,89	1,89	1,75	1,74	1,39	1,29	1,37	1,59	2,12	4,50	6,34	8,76	8,62	9,11	10,10
2. Industrial Processes	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
A. Mineral Products	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
B. Chemical Industry	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C. Metal Production	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
D. Other Production	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
E. Production of Halocarbons and SF_6															
F. Consumption of Halocarbons and SF_6															
G. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3. Solvent and Other Product Use	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
4. Agriculture	**164,45**	**164,45**	**163,00**	**161,49**	**162,34**	**163,56**	**164,55**	**165,28**	**165,44**	**165,59**	**165,90**	**165,84**	**165,98**	**166,18**	**166,24**
A. Enteric Fermentation	136,22	136,22	134,94	133,93	133,78	134,21	134,87	135,14	135,16	135,86	136,63	137,16	137,22	137,10	137,25
B. Manure Management	23,66	23,66	23,30	23,15	23,11	23,07	23,01	23,00	23,03	23,15	23,29	23,30	23,28	23,22	23,20
C. Rice Cultivation	3,29	3,29	2,95	2,94	4,05	4,74	5,22	5,72	5,82	5,25	4,67	3,98	4,13	4,48	4,52
D. Agricultural Soils	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
E. Prescribed Burning of Savannas	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
F. Field Burning of Agricultural Residues	1,29	1,29	1,81	1,47	1,41	1,53	1,44	1,41	1,43	1,34	1,32	1,39	1,35	1,38	1,27
G. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5. Land-Use Change and Forestry	**2,37**	**2,37**	**1,21**	**3,59**	**3,16**	**2,96**	**1,66**	**1,04**	**2,22**	**5,96**	**0,46**	**7,91**	**1,09**	**0,15**	**0,21**
A. Changes in Forest and Other Woody Biomass Stocks															
B. Forest and Grassland Conversion															
C. Abandonment of Managed Lands															
D. CO_2 Emissions and Removals from Soil															
E. Other															
6. Waste	**238,54**	**238,54**	**238,38**	**243,82**	**247,13**	**255,32**	**258,30**	**263,84**	**267,15**	**275,99**	**238,64**	**232,06**	**214,91**	**213,70**	**217,66**
A. Solid Waste Disposal on Land	126,28	126,28	128,96	136,65	143,82	153,27	158,76	166,31	173,27	184,83	153,12	163,07	172,30	176,93	186,45
B. Waste-water Handling	112,26	112,26	109,42	107,17	103,31	102,06	99,54	97,53	93,88	91,16	85,52	68,99	42,61	36,77	31,21
C. Waste Incineration	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
D. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Table I.6 Evaluation of N_2O emissions for the period 1990 – 2003 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year(1)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
Total Emissions	**45,79**	**45,79**	**44,91**	**45,07**	**42,40**	**43,28**	**42,36**	**43,90**	**43,14**	**42,80**	**42,66**	**43,40**	**42,71**	**42,48**	**42,83**
1. Energy	**9,97**	**9,97**	**10,04**	**10,67**	**10,09**	**10,29**	**10,25**	**10,65**	**11,07**	**11,48**	**11,26**	**11,98**	**12,31**	**12,32**	**12,88**
A. Fuel Combustion (Sectoral Approach)	9,97	9,97	10,04	10,67	10,09	10,29	10,25	10,65	11,07	11,48	11,26	11,98	12,31	12,32	12,88
1. Energy Industries	5,75	5,75	5,66	6,44	6,01	6,24	6,12	6,08	6,44	6,63	6,64	7,08	7,16	7,12	7,24
2. Manufacturing Industries and Construction	1,62	1,62	1,64	1,58	1,46	1,42	1,50	1,61	1,57	1,60	1,32	1,48	1,47	1,36	1,27
3. Transport	0,57	0,57	0,59	0,60	0,61	0,62	0,67	0,75	0,83	0,96	1,04	1,09	1,22	1,35	1,49
4. Other Sectors	2,03	2,03	2,15	2,05	2,01	2,01	1,96	2,21	2,24	2,28	2,26	2,33	2,45	2,50	2,88
5. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
B. Fugitive Emissions from Fuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1. Solid Fuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2. Oil and Natural Gas	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2. Industrial Processes	**2,30**	**2,30**	**1,90**	**1,98**	**1,88**	**1,83**	**1,82**	**2,08**	**1,83**	**1,50**	**1,56**	**1,60**	**1,34**	**1,29**	**1,29**
A. Mineral Products	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
B. Chemical Industry	2,30	2,30	1,90	1,98	1,88	1,83	1,82	2,08	1,83	1,50	1,56	1,60	1,34	1,29	1,29
C. Metal Production	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
D. Other Production	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
E. Production of Halocarbons and SF_6															
F. Consumption of Halocarbons and SF_6															
G. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3. Solvent and Other Product Use	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
4. Agriculture	**32,45**	**32,45**	**31,89**	**31,31**	**29,33**	**30,01**	**29,14**	**30,02**	**29,07**	**28,60**	**28,64**	**28,54**	**27,85**	**27,66**	**27,44**
A. Enteric Fermentation	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
B. Manure Management	0,97	0,97	0,95	0,93	0,92	0,91	0,91	0,91	0,91	0,92	0,93	0,93	0,92	0,92	0,91
C. Rice Cultivation	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
D. Agricultural Soils	31,45	31,45	30,90	30,35	28,37	29,06	28,19	29,08	28,12	27,65	27,68	27,58	26,89	26,71	26,50
E. Prescribed Burning of Savannas	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
F. Field Burning of Agricultural Residues	0,03	0,03	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,03	0,03	0,03	0,03	0,03	0,03
G. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5. Land-Use Change and Forestry	**0,02**	**0,02**	**0,01**	**0,02**	**0,02**	**0,02**	**0,01**	**0,01**	**0,02**	**0,04**	**0,00**	**0,05**	**0,01**	**0,00**	**0,00**
A. Changes in Forest and Other Woody Biomass Stocks															
B. Forest and Grassland Conversion															
C. Abandonment of Managed Lands															
D. CO_2 Emissions and Removals from Soil															
E. Other															
6. Waste	**1,06**	**1,06**	**1,07**	**1,09**	**1,08**	**1,12**	**1,14**	**1,14**	**1,17**	**1,18**	**1,19**	**1,22**	**1,21**	**1,21**	**1,21**
A. Solid Waste Disposal on Land	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
B. Waste-water Handling	1,06	1,06	1,07	1,09	1,08	1,12	1,14	1,14	1,17	1,18	1,19	1,22	1,21	1,21	1,21
C. Waste Incineration	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
D. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Table I.7 Evaluation of F-gases emissions per gas (in kt) and in total (in kt CO_2 eq) for the period 1990 – 2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year(1)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
Emissions of HFCs(5) - CO_2 equivalent (Gg)	**3.368,99**	**935,06**	**1.106,82**	**908,39**	**1.637,92**	**2.209,02**	**3.368,99**	**3.916,11**	**4.194,29**	**4.669,58**	**5.436,25**	**4.273,46**	**3.873,02**	**4.008,56**	**4.139,54**
HFC-23	0,28	0,08	0,09	0,08	0,14	0,18	0,28	0,32	0,34	0,37	0,43	0,32	0,27	0,27	0,27
HFC-32	0,02	0,00	0,00	0,00	0,01	0,01	0,02	0,03	0,04	0,05	0,07	0,09	0,12	0,13	0,16
HFC-41	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HFC-43-10mee	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HFC-125	0,02	0,00	0,00	0,00	0,01	0,01	0,02	0,03	0,04	0,05	0,07	0,09	0,12	0,14	0,16
HFC-134	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HFC-134a	0,03	0,00	0,00	0,00	0,01	0,01	0,03	0,05	0,07	0,09	0,13	0,17	0,22	0,26	0,31
HFC-152a	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HFC-143	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HFC-143a	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HFC-227ea	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HFC-236fa	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HFC-245ca	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Emissions of PFCs(5) - CO_2 equivalent (Gg)	**82,97**	**257,62**	**257,56**	**252,30**	**152,59**	**93,62**	**82,97**	**71,74**	**165,34**	**203,75**	**131,72**	**148,38**	**91,38**	**88,33**	**77,30**
CF_4	0,01	0,03	0,03	0,03	0,02	0,01	0,01	0,01	0,02	0,03	0,02	0,02	0,01	0,01	0,01
C_2F_6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C_3F_8	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C_4F_{10}	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
$c\text{-}C_4F_8$	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C_5F_{12}	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C_6F_{14}	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Emissions of SF_6(5) - CO_2 equivalent (Gg)	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
SF_6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Table I.8 Emissions / Removals from the sector of Land Use, Land Use Change and Forestry for the period 1990 – 2003 (in kt CO_2 eq)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
CO_2 [2]	-3.248,20	-3.248,20	-3.596,04	-3.074,99	-3.879,75	-3.553,42	-4.406,97	-3.993,22	-3.957,00	-3.590,82	-4.436,43	-3.141,90	-5.323,63	-5.459,73	-5.533,46
A. Forest Land	-2.042,79	-2.042,79	-2.344,80	-1.928,95	-2.568,79	-2.323,52	-3.091,47	-3.056,80	-2.931,93	-2.487,01	-3.139,82	-1.772,33	-4.037,95	-4.272,12	-4.361,03
B. Cropland	-1.205,41	-1.205,41	-1.251,23	-1.146,04	-1.310,96	-1.229,90	-1.315,50	-936,42	-1.025,06	-1.103,81	-1.296,61	-1.369,57	-1.285,67	-1.187,61	-1.172,44
C. Grassland	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
D. Wetlands	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
E. Settlements	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
F. Other Land	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
G. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CH_4	49,87	49,87	25,48	75,40	66,35	62,25	34,76	21,75	46,65	125,11	9,71	166,10	22,88	3,20	4,48
A. Forest Land	48,08	48,08	23,51	71,83	64,09	56,52	33,68	18,89	38,63	117,77	8,81	159,01	20,83	2,97	3,90
B. Cropland	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C. Grassland	1,80	1,80	1,97	3,57	2,26	5,73	1,07	2,86	8,01	7,33	0,90	7,10	2,04	0,24	0,58
D. Wetlands	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
E. Settlements	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
F. Other Land	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
G. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
N_2O	5,06	5,06	2,59	7,65	6,73	6,32	3,53	2,21	4,73	12,70	0,99	16,86	2,32	0,33	0,45
A. Forest Land	4,88	4,88	2,39	7,29	6,50	5,74	3,42	1,92	3,92	11,95	0,89	16,14	2,11	0,30	0,40
B. Cropland	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C. Grassland	0,18	0,18	0,20	0,36	0,23	0,58	0,11	0,29	0,81	0,74	0,09	0,72	0,21	0,02	0,06
D. Wetlands	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
E. Settlements	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
F. Other Land	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
G. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Land Use, Land-Use Change and Forestry [2] (Gg CO_2 equivalent)	**-3.193,27**	**-3.193,27**	**-3.567,97**	**-2.991,93**	**-3.806,66**	**-3.484,86**	**-4.368,69**	**-3.969,27**	**-3.905,62**	**-3.453,02**	**-4.425,74**	**-2.958,93**	**-5.298,43**	**-5.456,21**	**-5.528,53**

Table I.9 Evaluation of GHG emissions / removals per gas and per sector for the period 1990 – 2003 (kt CO_2 eq)

GREENHOUSE GAS EMISSIONS	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)														
Net CO_2 emissions/removals	80.772,78	80.772,78	80.139,28	81.607,25	81.410,66	83.643,20	82.936,85	85.556,71	90.334,80	95.269,81	93.800,19	100.970,51	101.010,66	100.703,30	104.443,66
CO_2 emissions (without LUCF) [4]	84.020,99	84.020,99	83.735,32	84.682,23	85.290,41	87.196,62	87.343,82	89.549,93	94.291,80	98.860,63	98.236,62	104.112,41	106.334,28	106.163,04	109.977,12
CH_4	10.061,09	10.061,09	10.023,71	10.209,71	10.284,98	10.515,45	10.599,79	10.782,38	10.874,89	11.236,28	10.402,35	10.520,16	10.070,01	10.127,81	10.171,66
N_2O	14.195,52	14.195,52	13.921,52	13.972,86	13.144,12	13.415,66	13.130,17	13.607,94	13.374,45	13.267,75	13.224,14	13.452,70	13.240,54	13.170,10	13.277,78
HFCs	3.368,99	935,06	1.106,82	908,39	1.637,92	2.209,02	3.368,99	3.916,11	4.194,29	4.669,58	5.436,25	4.273,46	3.873,02	4.008,56	4.139,54
PFCs	82,97	257,62	257,56	252,30	152,59	93,62	82,97	71,74	165,34	203,75	131,72	148,38	91,38	88,33	77,30
SF_6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total (with net CO_2 emissions/removals)	**108.481,34**	**106.222,07**	**105.448,89**	**106.950,51**	**106.630,28**	**109.876,95**	**110.118,76**	**113.934,88**	**118.943,77**	**124.647,17**	**122.994,65**	**129.365,21**	**128.285,60**	**128.098,10**	**132.109,94**
Total (without CO_2 from LUCF) [6] [2]	**111.729,55**	**109.470,27**	**109.044,93**	**110.025,49**	**110.510,02**	**113.430,37**	**114.525,73**	**117.928,10**	**122.900,77**	**128.237,99**	**127.431,08**	**132.507,11**	**133.609,23**	**133.557,83**	**137.643,40**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)														
1. Energy	81.703,57	81.703,57	81.521,71	82.659,08	82.909,09	84.934,99	84.634,43	87.038,91	91.617,05	96.599,61	95.711,85	101.610,52	103.865,96	103.854,66	107.723,57
2. Industrial Processes	10.929,33	8.670,05	8.651,08	8.532,43	9.308,65	9.790,83	11.400,43	12.007,62	12.585,29	12.803,63	13.636,73	12.809,56	12.355,19	12.398,38	12.581,81
3. Solvent and Other Product Use	170,32	170,32	175,82	172,31	169,24	162,09	153,35	150,78	151,70	151,15	158,98	145,10	154,57	155,20	155,86
4. Agriculture	13.514,02	13.514,02	13.308,78	13.098,47	12.500,62	12.737,28	12.488,54	12.777,30	12.484,42	12.343,43	12.363,51	12.330,24	12.117,78	12.064,50	11.998,29
5. Land-Use Change and Forestry [7]	-3.193,27	-3.193,27	-3.567,97	-2.991,93	-3.806,66	-3.484,86	-4.368,69	-3.969,27	-3.905,62	-3.453,02	-4.425,74	-2.958,93	-5.298,43	-5.456,21	-5.528,53
6. Waste	5.357,37	5.357,37	5.359,46	5.480,15	5.549,34	5.736,62	5.810,70	5.929,53	6.010,93	6.202,37	5.549,32	5.428,72	5.090,54	5.081,56	5.178,94
7. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Annex II: Effects of policies and measures

Table II.1 Effects of implemented / adopted policies and measures (in kt CO_2 eq)

Policies and Measures	Objective / Activity affected	GHG affected	Type of instrument	Status	Implementing entity/entities	Effects of policies and measures (kt CO_2 eq)			
						2000	2005	2010	2015
PROMOTION OF NATURAL GAS						*3317*	*9280*	*18596*	*23995*
Natural gas in electricity generation									
	Elec. generation	CO_2	Economic	I	PPC / Private	2888	5964	4855	4935
	Elec. generation	CO_2	Economic	A	PPC / Private	0	2043	8670	10815
Natural gas in electricity generation from auto-producers	Elec. generation	CO_2	Economic	A	MD	0	0	2105	4186
Cogeneration	Thermal/Electricity generation	CO_2	Economic	I	MD	40	192	165	151
Cogeneration	Thermal/Electricity generation	CO_2	Economic	A	MD	0	0	674	1215
Natural gas in industry	Thermal uses	CO_2	Economic	I	MD	370	592	904	1102
Natural gas in residential/tertiary sector	Thermal uses	CO_2	Economic	I	MEPWPP	19	483	1215	1581
CNG busses	Road transport	CO_2	Economic (public investments)	I	MT	0	7	7	12
IMPROVEMENTS IN THE CONVENTIONAL SYSTEM OF ELECTRICITY GENERATION	Elec. generation	CO_2	Economic (PPC investments)	I	PPC	**~530**	**n.e.**	**n.e.**	**n.e.**
PROMOTION OF RENEWABLE ENERGY SOURCES						*2057*	*3927*	*6417*	*7462*
Wind energy	Elec. generation	CO_2	Economic Regulatory	I	RAE / MD / Private	454	1083	947	880
Wind energy	Elec. generation	CO_2	Economic	A	RAE / MD / Private	0	765	2043	2823

Policies and Measures	Objective / Activity affected	GHG affected	Type of instrument	Status	Implementing entity/entities	Effects of policies and measures (kt CO_2 eq)			
						2000	2005	2010	2015
			Regulatory						
Small hydroelectric units	Elec. generation	CO_2	Economic Regulatory	I	RAE / MD / Private	58	93	81	75
Small hydroelectric units	Elec. generation	CO_2	Economic Regulatory	A	RAE / MD / Private	0	93	343	319
Large hydroelectric units	Elec. generation	CO_2	Economic (PPC investments)	I	RAE / MD / Private	0	0	369	528
Photovoltaic units	Elec. generation	CO_2	Economic	I	RAE / MD / Private	1	3	2	2
Biomass	Thermal and Electric uses in industry	CO_2	Economic Regulatory	I	RAE / MD / Private	300	288	266	256
Solar energy in the residential sector	Electricity substitution	CO_2	Economic	I	MEPWPP	1240	1227	1167	1199
Solar energy in the tertiary sector and in industry	Electricity / Oil products substitution	CO_2	Economic	I	MEPWPP	4	4	4	4
Biofuels	Road transport	CO_2	Economic Regulatory	A	MT	0	372	1194	1375
TRANSPORT						*0*	*0*	*446*	*1053*
ACEA agreement	Road transport	CO_2	Regulatory	A	MT	0	0	446	1053
WASTE						*0*	*0*	*2888*	*5130*
EU Landfill Directive	Waste management	CH_4	Regulatory	A	MEPWPP	0	0	2888	5130

I : Implemented A : Adopted n.e.: not estimated

Table II.2 Effects of planned policies and measures

Policies and Measures	Objective / Activity affected	GHG affected	Type of instrument	Status	Implementing entity/entities	Effects of policies and measures (kt CO_2 eq)			
						2000	2005	2010	2015
PROMOTION OF NATURAL GAS						*0*	*0*	*3460*	*4700*
Extended use of natural gas in electricity generation	Elec. generation	CO_2	Regulatory	P	MD / RAE / PPC	0	0	2833	3902
Natural gas in industry	Thermal uses	CO_2	Economic	P	MD	0	0	202	239
Cogeneration	Thermal uses and Elec. generation	CO_2	Economic	P	MD	0	0	257	307
Natural gas in residential/tertiary sector (space heating and cooling)	Thermal uses	CO_2	Economic	P	MEPWPP	0	0	168	252
PROMOTION OF RENEWABLE ENERGY SOURCES						*0*	*0*	*3746*	*5626*
Wind energy	Elec. generation	CO_2	Economic	P	MD / RAE / Private	0	0	1535	1783
Small hydroelectric units	Elec. generation	CO_2	Economic	P	MD / RAE / Private	0	0	581	1261
Photovoltaic units	Elec. generation	CO_2	Economic	P	MD / RAE / Private	0	0	27	50
Geothermal energy units	Elec. generation	CO_2	Economic	P	MD / RAE / Private	0	0	0	52
Biomass	Elec. generation	CO_2	Economic	P	MD / RAE / Private	0	0	394	562
Solar energy in the residential sector	Electricity substitution	CO_2	Economic	P	MEPWPP	0	0	1001	1712
Solar energy in the tertiary sector and in industry	Electricity / Oil products substitution	CO_2	Economic	P	MEPWPP	0	0	208	206
INDUSTRY						*0*	*0*	*282*	*296*
Energy conservation interventions	Thermal / Electric uses	CO_2	Economic	P	MD		0	282	296
TRANSPORT						*0*	*0*	*609*	*1069*
Improvements in road signalling	Road transport	CO_2	Economic (public investments))	P	MT	0	0	67	148
Promotion of public means of transport	Road transport	CO_2	Economic (public investments)	P	MT	0	0	542	921
RESIDENTIAL AND TERTIARY SECTOR						*0*	*0*	*1995*	*2898*

Policies and Measures	Objective / Activity affected	GHG affected	Type of instrument	Status	Implementing entity/entities	Effects of policies and measures (kt CO_2 eq)			
						2000	2005	2010	2015
Improvement of the thermal behaviour of existing buildings	Energy conservation	CO_2	Economic Regulatory	P	MEPWPP	0	0	103	140
Systematic maintenance of central heating boilers	Energy conservation	CO_2	Economic Regulatory	P	MEPWPP	0	0	181	191
Replacement of central heating boilers	Energy conservation	CO_2	Economic Regulatory	P	MEPWPP	0	0	63	104
External shading of buildings, night ventilation	Energy conservation	CO_2	Economic Regulatory	P	MEPWPP	0	0	53	79
Energy efficient air conditioning units	Energy conservation	CO_2	Regulatory	P	MD	0	0	227	377
Energy efficient electric appliances	Energy conservation	CO_2	Regulatory	P	MD	0	0	260	357
Replacement of incandescent bulbs by high efficient ones	Energy conservation	CO_2	Information	P	MD	0	0	1085	1601
Advanced lighting control systems	Energy conservation	CO_2	Economic Regulatory	P	MEPWPP	0	0	23	49
WASTE						*0*	*0*	*201*	*149*
Combustion of biogas	Waste management	CH_4	Regulatory	P	MEPWPP	0	0	201	149
INDUSTRIAL PROCESSES						*0*	*0*	*718*	*1536*
Recovery of HFC from final disposal of appliances	Restriction of F-gases emissions	HFC	Regulatory	P	MD	0	0	718	1536
AGRICULTURE						*0*	*0*	*134*	*152*
Manure management systems	Livestock-farming	CH_4	Economic	P	MRDF	0	0	67	64
Organic farming	Restructuring of cultivations	N_2O	Economic	P	MRDF	0	0	67	88