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Report on the in-depth review of the national communication of Greece

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Under Articles 4 and 12 of the Convention, Parties are required to prepare national communications on their implementation of the Convention. Guidelines for the preparation of national communications and the process for their review were agreed on by the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change, by its decisions 9/2 and 10/1, and by the Conference of the Parties, at its first session, by its decisions 2/CP.1 and 3/CP.1 (see FCCC/CP/1995/7/Add.1). In accordance with these decisions, a compilation and synthesis of the first 33 national communications from Annex I Parties was prepared (FCCC/CP/1996/12 and Add.1 and 2).

When reviewing the implementation of the Convention by Parties, the subsidiary bodies and the Conference of the Parties will have this report available to them in English, as well as the summary of the report in the six official languages of the United Nations. (These bodies will also have before them the executive summary of the first national communication of Greece and country-specific information drawn from a compilation and synthesis report covering all countries that have submitted national communications.)

Summary

1. The in-depth review was carried out during the period from March 1997 to May 1998, including a country visit to Athens from 8 to 11 April 1997. The review team included experts from Ghana, the Czech Republic and Canada. During the in-depth review, a considerable amount of additional relevant information was shared with the review team, greatly improving the understanding and comparability of information provided with the national communication.

2. Greece has a national goal to restrict the overall increase in carbon dioxide (CO_2) emissions to 15 per cent (± 3 per cent), between 1990 and the year 2000, i.e. from 82,000 Gg in 1990 to 94,000 Gg in 2000. Under the "business as usual" scenario (meaning without abatement measures), CO_2 emissions would increase by 27 per cent or to 104,000 Gg. In order to attain this goal, Greece has established an inter-ministerial committee to facilitate decision-making on climate change issues at the ministerial council level. This committee is responsible for planning and implementing the National Action Programme for the Abatement of CO_2 and other Greenhouse Gas Emissions, and also for overseeing greenhouse gas (GHG) inventories.

3. The trend in Greece's CO_2 emissions from 1970 to 1990 was marked by a drastic increase from 22,000 to 82,000 Gg. Nevertheless, energy consumption and CO_2 per capita emissions in 1994 (8.4 t CO_2) remained slightly below the average for the European Union (EU), but will most probably be higher by 2000. The main CO_2 contributor is the power generation sector, which increased its share of total CO_2 emissions from 31 per cent in 1973 to more than 55 per cent in 1994 (much higher than the average for countries of the Organisation for Economic Co-operation and Development (OECD) of 34 per cent). This increase is due to the high percentage of fossil fuel use, specifically lignite and oil for electricity generation.

4. The national greenhouse gas inventory submitted in the communication was prepared in accordance with the 1995 Intergovernmental Panel on Climate Change (IPCC) guidelines, using 1990 as the base year, but it did not include the IPCC standard data tables format. Emission factors used in the estimations were those proposed by the IPCC and CORINAIR methodology. For certain critical sectors, specific factors were based on direct measurements, e.g. for lignite.

5. During the in-depth review, a revised version of the inventory for the 1990 base year, as well as inventories for 1991 to 1994, were presented. Newly presented data for 1990 differ slightly from the inventory submitted in the communication. Specifically, the total aggregate national emissions in CO_2 equivalent are about 2.5 per cent higher, owing to revised figures for CO_2, methane (CH_4), and nitrous oxide (N_2O). No estimate of uncertainty levels for particular GHGs and/or source categories were included, or presented during the visit. All relevant data on the land-use change and forestry sector were presented during the visit, but Greece did not provide an estimate of the emissions and removals from this sector.

6. The updated inventory estimates the total CO_2 emissions in 1990 at 84,217 Gg. Emissions from fuel combustion were 77,176 Gg, representing about 80 per cent of all GHG emissions and as much as 92 per cent of the total amount of CO_2 released into the atmosphere. The largest emission sources of CO_2 were in the following sectors: energy and transformation (55 per cent), transport (21 per cent), industry (11 per cent), and residential, commercial and agricultural (10 per cent).

7. Greece has implemented, but to a varying degree, policies and measures to mitigate CO_2 emissions in all sectors. The Government's main energy and environmental priority, as stated in the National Action Programme, is the large-scale introduction of natural gas in the national energy system. During the visit the team was informed that the Government has taken important steps, with financial support from the EU, to develop an extensive natural gas grid in order to maximize natural gas penetration, including combined heat and power (CHP) generation use. It was stressed that the large-scale introduction of natural gas in the industrial sector is one of the most cost-effective measures to improve efficiency and to mitigate CO_2 emissions. It will also have an impact on the reduction of CO_2 emissions in the residential, commercial and public sectors. Another government priority is the greater exploitation of hydropower and other renewable energy sources.

8. There are two principal legislative acts related to climate change mitigation. The first, Law 1892/90, in force since 1990, on Incentives for Investments in Greece, has significant potential for reducing CO_2 emissions. Article 9, on special investments, is designed to provide grants and to promote investments for the protection of the environment, the exploitation of renewable sources of energy, and energy conservation; and Article 23b, on special investments for industrial processes, provides grants and promotes the introduction and adaptation of environment-friendly technologies in the production processes and the establishment of industrial units for ecological dismantling/breaking-up of products consumed in Greece. In April 1998, this Law, 1892/90, was replaced by Law 2601/98 on Aids for Investments in Greece, and is expected to have significant potential for reducing CO_2 emissions. The second, Law 2244/94, in force since 1994, on the Permission of Electricity Production by the Private Sector through Renewable Energy Sources or Cogeneration, was promulgated to promote and offer incentives for the independent production of electricity. Although these laws were not enacted specifically in response to the FCCC, they will nevertheless contribute to CO_2 mitigation.

9. The imposition of a CO_2 tax, following an EU initiative, has been considered by the Greek authorities, *inter alia*, as a way to increase financial resources for the implementation of CO_2 abatement measures. After a detailed evaluation, it was concluded that a CO_2 tax would not be applied in the near future.

10. The team was also informed of tax incentives put in place by the Government relating to car engine capacity and fuel differentiation. Other measures include a reduction in cost to residential consumers of natural gas and liquified petroleum gas and tax exemption for electricity produced from renewable sources.

11. Trends towards deregulation of the European electricity market may also have some impact on Greece. The degree of this impact will depend on two main factors: (a) the type of regulatory and market changes applied at the national level; and (b) the degree of interaction with the country's non-EU neighbours.

12. Nevertheless, most policies and measures for the abatement of CO_2 pertain to the production, distribution and consumption of energy, mainly electricity. The team also noted that a considerable number of the measures described in the communication are either planned or are at the planning stage.

13. Projections of energy-related CO_2 emissions up to 2000 were prepared using a general equilibrium model (MIDAS). For CH_4, N_2O and the indirect GHGs, the communications gave assessments of developments for different source categories. Hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride were only dealt with during the review visit, which also provided relevant information in relation to the projections that were actually given. During the visit, an updated version (up to year 2020) of results was presented, making the exercise consistent with the expansion plans in the power sector. Updated scenarios for stabilization of CO_2 emissions and a 10 per cent reduction at European Community level were shown to the team. In these scenarios, Greece showed a higher growth path in emissions than average, with a particularly substantial growth in the transport sector.

14. In the communication, the CO_2 emissions were projected to grow from 82,000 to 94,000 Gg, or about 15 per cent, between 1990 and 2000 in a "with measures" scenario and to 104,000 Gg or about 27 per cent in a "business as usual" scenario for the same period. In the latter scenario, the economic growth of Greece is expected to be more rapid than that of its EU partners, with the service sector accounting for most of the increase. This would make the Greek economy less energy- and CO_2-intensive in the long run.

15. The implementation of policies and measures took place somewhat slower than assumed in the "with measures" scenario, while economic growth was also relatively low in this period, resulting in a growth of CO_2 emissions by about 7 per cent from 1990 to 1995, according to preliminary figures. The effects of measures listed in the updated material suggest that the national target of limiting CO_2 emissions growth to 15 per cent (± 3 per cent) by 2000, compared to 1990, is achievable.

16. Regarding expected impacts of climate change, the team was informed of studies carried out in 1991 on the resilience of the forest ecosystem with respect to pest infestation, fires, and decreased precipitation. Some studies have also been carried out on the effects of climate change

on the yields of maize, wheat and cotton. Other studies are going on with respect to the development of techniques to prevent and combat forest fires, as well as the impacts of climate change on activities such as agriculture, fisheries, tourism and coastal zones. Forest management plans have been developed and are being implemented to ensure sustainable and rational use of forest resources. Greece has also started some assessment studies aimed at developing a coastal zone integrated management plan, and already several policy instruments and legislative provisions are being employed to manage coastal resources on a sustainable basis.

17. With respect to research and systematic observation, the team was informed during the visit that Greece follows the regulations within the European Union regarding network sites, and so climate monitoring systems are well developed in Greece. More than 29 first-class synoptic stations exist in the country and systematic full-range climate data have been recorded since the turn of the century. Long-term research (up to 20 years) on the fluctuation of temperature and precipitation data is currently under way. Greece also participates actively in several international research activities and programmes. These include the work of the World Climate Research Programme, the International Geosphere-Biosphere Programme, the Programme on Man and the Biosphere, and the Intergovernmental Panel on Climate Change.

I. INTRODUCTION AND NATIONAL CIRCUMSTANCES

18. Greece ratified the Convention on 4 August 1994. The secretariat received Greece's first national communication on 23 March 1995. The in-depth review of the national communication was carried out during the period from March 1997 to May 1998, including a country visit to Athens from 8 to 11 April 1997. The review team consisted of Mr. George Manful (Ghana), Mr. Jan Pretel (Czech Republic), Mr. Robert Audet (Canada), Mr. Peer Stiansen (UNFCCC secretariat, visit coordinator) and Ms. Martha Perdomo (UNFCCC secretariat, report coordinator). The team met with representatives of several ministries, as well as with members of the academic community and representatives of other governmental organizations.

19. Greece covers a total area of 131,957 km^2 and is located in the southern part of Europe. As a Mediterranean country, it has a temperate climate with hot summers and mild winters, which implies moderate heating, but heavy cooling requirements. The population in 1993 was 10.4 million, growing at a rate of 0.6 per cent annually, with a population density of 78 people per km^2 growing at an annual rate of 0.3 per cent, compared to the OECD average of 0.7. A migration to urban centres characterizes the population pattern, particularly to Athens, which has approximately 4 million inhabitants.

20. Greece’s economy has been characterized by a lower gross domestic product (GDP) per capita than the European Union (EU) average. This situation made the country eligible for major EU structural funds under the operational programmes of the second Community Support Framework. The objective of these funds is to enhance growth and reduce the gap between eligible countries and the more advanced countries of the EU.

21. Greece's convergence towards EU economic standards has been accompanied by a stabilization of the economy, a drop in the inflation rate from 15 per cent in 1990 to 6-7 per cent in 1995, and an estimated 4.5 per cent in 1998[1], an increase in private and public investments, and a decrease in the general government deficit as a percentage of GDP from 10.0 per cent in 1994 to 4.0 per cent in 1997 (only 1.6 per cent below the EU average)[1]. The unemployment rate was still more than 10 per cent, but is expected to decrease as the economy continues to expand and major infrastructure projects are undertaken, such as the Athens metro, hydropower projects, and new gas pipelines. There is a trend towards privatization in order to streamline the government budget and thereby lower the general government debt.

22. The main feature of Greece's national energy balance is a high share of fossil fuels in primary energy supply and electricity generation. In an effort to enhance energy security, Greece's energy policy since 1973 (after the first oil crisis) has targeted the substitution of oil by developing domestic energy sources, namely, by expanding lignite extraction with the intention of making it becoming the dominant fuel source for non-mobile uses, although it is an energetically poor fossil fuel with a relatively high CO_2/kW emission rate. In 1992 the sources of primary energy supply were: imported oil, 57 per cent (second highest among OECD countries); domestic lignite, 31 per cent; imported hard coal, 5 per cent; and natural gas less than 1 per cent. During the visit the team was informed that, as much greater volumes of natural gas were coming on stream in 1996/97, the fuel mix would be significantly altered owing to the decrease in the share of imported fuels. Greece also has considerable potential to develop biomass, solar, wind, geothermal and hydro energy sources.

23. Energy consumption and carbon dioxide (CO_2) per capita emissions in 1994 (8.4 t CO_2) remained slightly below the EU average but will most probably be higher by 2000. The main CO_2 contributor is the power generation sector, which increased its share of total CO_2 emissions from 31 per cent in 1973 to more than 55 per cent in 1994 (much higher than the OECD average of 34 per cent). This increase is due to the high percentage of fossil fuel use, specifically lignite and oil for electricity generation.

24. Electricity generation is the largest CO_2 emitting sector of the economy, accounting for 55 per cent of total CO_2 emissions in 1994. The continuously increasing demand for electricity drove consumption from 88 kWh per capita in 1950 to more than 4000 kWh in 1994, with production rising steadily at an average annual rate of approximately 3.5 per cent over the last decade. The percentage breakdown by fuel for the production of electricity in 1994 was as follows: coal (68 per cent), petroleum products (21 per cent), hydro (9 per cent), and natural gas (2 per cent). The second largest CO_2 emitting sector, accounting for 19 per cent of total emissions in 1994 (which is below the OECD average), is transport. With few energy-intensive industries (the two biggest being production of cement and aluminium), the industrial sector accounted for 10 per cent in 1994, also below the OECD average. The residential, commercial

[1] These figures are revised estimations from the Ministry of National Economy

and agricultural sector accounted for 9 per cent of total CO_2 emissions in 1994, and the remaining 7 per cent were generated by other sectors. On the other hand, Greece's energy-related CO_2 emissions per unit of GDP have been growing. In the period 1990-1994 Greece had the second highest growth rate in the EU at 1.5 t CO_2/thousand ECU 1985. The low conversion efficiency of lignite, used for electricity generation, is partly responsible for such high emission rates.

25. Greece has established an inter-ministerial committee to facilitate decision-making on climate change issues at the ministerial council level. This committee is responsible for planning and implementing the National Action Programme for the Abatement of CO_2 and other Greenhouse Gas Emissions, which was formulated in 1995, and also for the overseeing of greenhouse gas (GHG) inventories. The Programme is coordinated by the Ministry of the Environment, Physical Planning and Public Works, in cooperation with the Ministry of Development, which was formerly the Ministry of Industry, Energy and Technology, as well as other competent Ministries, and receives inputs from academic institutions and other public organizations.

26. The Government’s main energy and environmental priority, as stated in the National Action Programme, is the large-scale introduction of natural gas in the national energy system. During the visit the team was informed that the Government has taken important steps, with financial support from the EU, to develop an extensive natural gas grid in order to maximize natural gas penetration, including combined heat and power (CHP) generation and use. Another government priority is the greater exploitation of hydropower resources. The total installed capacity of hydropower in 1995 was 2,524 MW with 303.1 kilotonnes of oil equivalent (ktoe) of energy produced.

27. The European Community has committed itself to stabilizing total Community-wide CO_2 emissions at the 1990 level by 2000. However, like several other member States, Greece enjoys a somewhat differentiated treatment owing mainly to its relatively lower level of economic development. This differentiation means that Greece could actually increase its emissions of CO_2, as long as they are offset by a reduction in emissions elsewhere in the Community.

28. The Greek National Action Programme for the Abatement of CO_2 concluded that a realistic goal regarding mitigation of greenhouse gas emissions, taking into consideration the needs of the Greek economy as it follows the European Convergence Programme, is to restrict the overall increase in CO_2 emissions to 15 per cent (± 3 per cent) between 1990 and the year 2000, i.e. from 82,000 Gg in 1990 to 94,000 Gg in 2000. No goals have been given for other GHG in this Programme. Under the "business as usual" scenario (meaning without abatement measures), CO_2 emissions would increase by 27 per cent or to 104,000 Gg.

II. INVENTORIES OF ANTHROPOGENIC GHG EMISSIONS AND REMOVALS

29. The Greek inventory covered carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), nitrogen oxides (NO_x), carbon monoxide (CO), and non-methane volatile organic compounds (NMVOCs). Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) were not included.

30. The national greenhouse gas inventory was prepared in accordance with the 1995 Intergovernmental Panel on Climate Change (IPCC) guidelines, using 1990 as the base year. Most emission factors used in the estimations were those proposed by the IPCC. For cases where such factors were not available, corresponding emission factors suggested by the CORINAIR[3] methodology were used, reflecting specific national conditions in Greece. For certain critical sectors, specific factors were based on direct measurements, e.g. for lignite. The inventory also includes a list of all emission factors employed in the estimations.

31. During the in-depth review, a revised version of the inventory for the 1990 base year as well as inventories for 1991 to 1994 were presented. Newly presented data for 1990 differ slightly from the inventory submitted in the communication. Specifically, the total aggregate national emissions in CO_2 equivalent are about 2.5 per cent higher owing to higher figures for CO_2, CH_4 and N_2O. Discrepancies in CO_2 emissions were the result of using different methodologies (CO_2 emissions from combustion processes having been estimated formerly by using the International Energy Agency (IEA) statistics for consumed fuel and emission factors supplied by EUROSTAT); the inclusion of CO_2 emissions from non-energy use of oil products; and the inclusion of clinker production in the cement industry.

32. In addition, the emissions of CO_2 from the transport sector increased as a result of an increase in the number of vehicles in circulation provided for the revised inventory estimates, after a detailed analysis of the statistics was carried out.

33. CO_2 emissions in the revised version were estimated from annual energy balance data, using IPCC default emission factors and the IPCC bottom-up methodology. An exception is the case of lignite-fired power generation, where an emission factor estimated by the Public Power Corporation (PPC) was used. The Corporation regularly monitors the quality of the lignite, which is important in so far as fuel quality varies between layers and different sites, thus changing over time. The quality of Greece's lignite is poor, which gives a factor higher than

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[3] CORINAIR is the component dealing with air emissions inventories of the European Community's CORINE (Coordinated Information System on the State of Natural Resources and the Environment).

those generally given for similar fuels cited in the literature. The emission inventories of the other greenhouse gases were established separately for each sector. The emission factors from CORINAIR were applied to other gases from the energy and transformation (including fugitive emissions) sector as well as for industry and transport. For the agriculture and waste sectors the IPCC factors were used.

34. National experts noted some technical difficulties with activity data collection. Annual energy balance data have usually been available within a year, but final data concerning the agriculture sector, for example, could come with a delay of several years and solvent quantities used in paint have not been recorded for the last five years. Similarly, road vehicle data such as average distance travelled and tonne-km transported, have not been compiled in a statistically rigorous manner.

35. In accordance with the IPCC methodology, emissions arising from the burning of biomass fuel were reported separately and have not been taken into consideration in the national aggregate emissions estimates. Further, emissions resulting from energy consumption in international transport are also reported separately, in the category of air/marine bunkers, and are not included in the estimates of total national emissions. The team was informed that their estimates were based on fuel sales data (e.g. from Olympic Airways, refineries of EKO). However, in allocating the quantity of this fuel to international bunkers, there was a high level of uncertainty.[4]

36. The inventory submitted in the communication includes the minimum data tables containing activity levels and aggregated emission factors. It did not use the standard data tables format prescribed by the IPCC, which makes for some difficulty in comparing the results. However, the revised version of the inventory which was presented during the in-depth review puts all recommended tables in the IPCC format. No estimate of uncertainty levels for particular GHGs and/or source categories were included, or presented, during the visit.

37. In the inventory submitted in the communication, Greece did not provide the estimation of the emissions and removals associated with the land-use change and forestry sector. All the relevant data were presented during the in-depth review and are contained in annex V of the revised version of the inventory. Nevertheless, an estimation in the IPCC format was not presented as there are major uncertainties in the actual emission levels associated with different types of land-use and changes in land-use. Following the completion of the national land census

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[4] It is known that ships engaged in international voyages are relative small GHG emission sources, and less significant air polluters. Any approach to common action to reduce CO_2 emission from marine bunker use in international shipping would solely depend on decisions to be taken by the competent body in this field, i.e. the International Maritime Organisation (IMO). The new Air Pollution Regulations contained in Annex VI of MARPOL 73/78 adopted by the Parties to the Convention in September 1997, which control, *inter alia*, the composition of marine fuel oils, are effective in reducing emissions, including those of GHGs, from ships, at the international level.

that was under way during 1997, a reliable estimate of the contribution of this sector is expected. Preliminary (i.e. unofficial) figures contained in the annex give 3,600 Gg CO_2/year or 1.07 t CO_2/ha/year as the estimated annual potential sequestration rate of all managed forest, and 2,400 Gg CO_2/year or 0.7 t CO_2/ha/year as the actual sequestration rate (after subtracting the amount of CO_2 sequestered by harvested biomass).

38. Emissions of NMVOCs from solvent use were also omitted as adequate activity data were not yet available. Nevertheless, annex IV of the revised version of the Greek inventory presented the partial estimate of NMVOC emissions from solvents consumed for the period 1990-1992, ranging from 62 Gg in 1990 to 58 Gg in 1992. These estimates have a high level of uncertainty, resulting from the use of emission factors which are imprecise, as well as the quality of data used in the estimates.

39. The review team was informed that in future a detailed analysis of emissions from industrial waste will be carried out. Appropriate emission factors have reportedly not yet been established for real climatic conditions and practices in Greece.

40. As reported in the 1990 inventory submitted with the communication, the total CO_2 emissions were 82,100 Gg. Emissions from fuel combustion processes were 76,210 Gg. CO_2 emissions represented 88 per cent CH_4 emissions 8 per cent and N_2O 4 per cent for a total of 95,877 Gg in CO_2 equivalent, using global warming potential (GWP) values according to IPCC 1995 (21 for CH_4, 310 for N_2O).

41. According to the revised version of the inventory, the total CO_2 emissions in 1990 were 84,217 Gg. Emissions from fuel combustion were 77,176 Gg, representing about 80 per cent of all GHG emissions and as much as 92 per cent of the total amount of CO_2 released into the atmosphere. The largest emission sources of CO_2 are in the following sectors: energy and transformation (55 per cent), transport (21 per cent), industry (11 per cent), and residential, commercial and agricultural (10 per cent).

42. Regarding CH_4, total emissions in 1990 amounted to 356 Gg, or 7,469 Gg in CO_2 equivalent, with 50 per cent of emissions originating from agriculture, 31 per cent from waste disposal sites, 13 per cent being fugitive fuel emissions, and 5 per cent from combustion of fuels for energy production.

43. Total N_2O emissions in 1990 were 13.5 Gg or 4,191 Gg in CO_2 equivalent, with 62 per cent of emissions related to agriculture (fertilizer use), 28 per cent to fuel combustion in the energy sector, and 10 per cent to other industrial processes.

44. Also for 1990, emissions of NO_X were reported to be 356 Gg, emissions of CO 1,465 Gg, and emissions of NMVOCs 228 Gg. With respect to HFCs, PFCs and SF6), emission estimates were considered preliminary and therefore were not included in the inventories. The review team was informed by Greek national experts that the industry is working together with the

Government in order to provide estimates of emissions of these gases from 1993. Emissions of HFC-23, as a by-product of HCFC-22 production, were reported to be 240 tonnes, while emissions of PFCs were 590 tonnes in 1996. Emissions of PFCs and HFCs will be reported in future national communications.

45. The review team was informed that future updates of national inventories will be made annually.

III. POLICIES AND MEASURES FOR REDUCTION OF CARBON DIOXIDE EMISSIONS

46. Since CO_2 is the main GHG and fuel combustion is the main source of these emissions in Greece, the programme aims at achieving the abatement of CO_2 emissions with policies and measures directed towards:

(a) Diversification of energy supply

(i) Introduction of natural gas
(ii) Further development of renewable sources

(b) Improving energy conservation

47. There are two principal legislative acts, Law 1892/90 replaced by Law 2601/98 and Law 2244/94, that directly and indirectly address the issue of CO_2 reduction. Although these laws were not enacted specifically in response to the FCCC, they will nevertheless contribute to CO_2 mitigation.

48. Law 1892/90, in force since 1990, on Incentives for Investments in Greece, is of special interest as it has significant potential for reducing CO_2 emissions. Article 9, on special investments, is designed to provide grants and to promote investments for the protection of the environment, the exploitation of renewable sources of energy, and energy conservation. Depending on the geographical area, grants for energy conservation projects can go as high as 40-55 per cent of overall project costs. Article 23b, on special investments for industrial processes, provides grants and promotes the introduction and adaptation of environment-friendly technologies in the production processes and the establishment of industrial units for the ecological dismantling/breaking-up of products consumed in Greece. In April 1998, Law 1892/90 was replaced by Law 2601/98, on Aids for Investments in Greece, and is expected to have significant potential for reducing CO_2 emissions.

49. Since electricity production was in the hands of the state-owned Public Power Corporation, Law 2244/94, in force since 1994, on the Permission of Electricity Production by the Private Sector through Renewable Energy Sources or Cogeneration, was promulgated to promote and offer incentives for the independent production of electricity. More specifically it

aims to encourage independent producers to make investments in electricity generation, which can only be sold to the Corporation; and to ensure that the Corporation enters into long-term contracts with independent producers.

50. The imposition of a CO_2 tax, following an EU initiative, has been considered by the Greek authorities, *inter alia*, as a way to increase financial resources for the implementation of CO_2 abatement measures. After a detailed evaluation, it was concluded that a CO_2 tax would not be applied in the near future, as this measure may not result in a substantial reduction of CO_2 emissions. On the other hand it is believed that technological measures on the demand and supply sides of the energy system could have a higher impact on emissions reduction.

51. During the visit, the team was informed of some tax incentives put in place by the Government. Examples of these incentives are:

(a) For the purchase of cars of smaller capacity (up to1200 cc 10-15 per cent tax, compared to 45 per cent for cars of more than 1200 cc capacity);

(b) For fuel differentiation, for example, from the total price of unleaded gasoline, a 5 GRD tax is to be used for environmental projects;

(c) A reduction in cost to residential consumers of natural gas and liquified petroleum gas (LPG); and

(d) Tax exemption for electricity produced from renewable sources.

52. Greek authorities introduced a value added tax (VAT) of 18 per cent on gasoline in August 1992. In addition, a road tax was introduced in 1996, which was more than double for larger cars (Dr 45,000/year for smaller cars and Dr 100,000/year for larger cars).

53. Most policies and measures for the abatement of CO_2 pertain to the production, distribution and consumption of energy, mainly electricity.

A. Electricity generation

54. The large-scale introduction of imported natural gas on the Greek market remains one of the Government's energy priorities, for electricity generation. This is the largest investment in the energy sector ever to have been carried out in Greece. Its cost is estimated at ECU 2 billion for the period of the project (1988-2020) and is largely financed by the European Investment Bank. This increase in the use of natural gas will have the largest impact in reducing CO_2 emissions.

55. Total consumption of natural gas is expected to reach 3.5 billion Nm^3 per year by 2005, of which approximately 84 per cent will be imported from the Russian Federation through Bulgaria and 15 per cent from Algeria in liquefied form. The construction of the main high-pressure gas pipeline linking Greece to the Bulgarian network was completed in 1996 and the supply of natural gas to the first gas-fired power station (Keratsini) of the PPC was expected to begin in the summer of 1997. A total of four natural gas power stations are expected to become operational by 2001, which has forestalled the installation of additional coal-fired plants.

56. The total reduction in CO_2 emissions as a result of natural gas introduction for electricity generation is estimated at 4,200 Gg by 2000.

57. Different efficiency improvement measures are being evaluated by the PPC. These include improvement in the operation of cooling towers and the installation of new lignite mills that will improve the combustion efficiency of coal-fired stations. The total CO_2 emissions reduction potential as a result of efficiency improvement measures is estimated at 300 Gg by 2000.

58. The implementation of a cogeneration programme in the PPC lignite-fired plants has been initiated by setting up a district-heating network in northern Greece. The town of Kozani is already receiving heat that is a by-product of electricity generation at the Agios Demetrios station. Also, the power station of Ptolemais is used for district-heating of a neighbouring town. The potential CO_2 emissions reduction is estimated at 70 Gg by 2000.

59. The total estimated CO_2 emissions reduction from electricity generation abatement measures is 4,570 Gg by 2000.

B. Renewable energy

60. Since the entry into force of Law 2244/94 and up to March 1997, the Ministry of Development had received 135 applications for the implementation of renewable energy sources (RES) programmes. The majority of these applications are for the installation of wind turbines and small hydroelectric units. As of March 1997, 11 permits had been granted for a total of 38.5 MW. Although the additional wind energy capacity from these applications will more than double wind power productions in 1995, much higher penetration rates will be obtained by 2000 with a more rigorous implementation of Law 2244/94. The potential CO_2 emissions reduction as a result of the generation of electricity from wind energy is estimated at 1,000 Gg by 2000.

61. Further substantial CO_2 abatement is also expected from the construction and operation of several hydroelectric power stations. These stations will total more than 600 MW installed capacity by 2000 and will replace electricity generated by fossil fuel plants. The construction and operation of small hydroelectric power stations (with a total installed capacity of less than 34 MW) are also in progress. The potential CO_2 emissions reduction as a result of the operation of these stations is estimated at 221 Gg for 2000.

62. In 1995, approximately 650,000 homes in Greece were using flat plate collectors for water heating applications. The annual energy production from these units is estimated at 1.2 TWh, thus reducing CO_2 emissions by approximately 1.5 Gg per year. It is estimated that the total installed area of flat plate collectors will increase from 2.0 million m^2 in 1995 to 2.5 million m^2 in 2000. Regarding installed capacity of solar photovoltaic plants, no significant changes are expected in the near future owing to their high capital cost. The potential CO_2 emissions reduction as a result of the generation of electricity from solar systems is estimated at 976 Gg by 2000.

63. Biomass projects are also being considered by Greece as CO_2 abatement measures, but as of March 1997 they were in the planning or pending decision stage. Nevertheless, the potential CO_2 emissions reduction from this renewable source is estimated at 910 Gg by 2000.

64. The potential of geothermal energy is also being investigated for power generation in Greece. During the visit the team was informed that some projects using geothermal energy for small-scale electricity generation are being investigated. The potential CO_2 emissions reduction from this renewable source was estimated, in the first national communication, at 60 Gg for 2000.

65. The estimated potential reduction of CO_2 emissions from the extended use of renewable energy sources was reported as 3,167 Gg by 2000 in the national communication, but during the visit the team was informed that a more realistic estimate is 2,200 Gg by 2000.

C. Transport

66. Measures to restrict CO_2 emissions in the transport sector can be divided into direct, such as switching fuels, and indirect, such as the improvement of mass transport, an improved road grid and continuous renewal of the fleet.

67. Direct measures include the promotion of more efficient fuels and the use of biofuel. The estimates show that the promotion of diesel, liquefied petroleum gas and biofuel could result in an additional 56 Gg CO_2 reduction by 2000 and will bring more substantial reductions after 2000.

68. Indirect measures include:

(a) Upgrading and modernization of public transport: construction of two additional lines to supplement the Athens metro, the replacement of old buses, and special urban bus routes. During the visit, the team observed that the metro lines were under construction and the new urban bus routes were operational. The potential emissions reduction of these measures is estimated at 437 Gg of CO_2 by 2000;

(b) Improvement of standards (i.e. ensuring faster, more economical and safer transportation, improvement in signalling and road networks, restructuring of transport modes and measures to change driver attitudes) could reduce CO_2 emission by 470 Gg by 2000; and

(c) Mandatory periodic overall control and annual renewal of the exhaust control card for all road vehicles. The promotion of systematic vehicle maintenance and the use of more energy-efficient vehicles is estimated to be capable of inducing a reduction of 300 Gg of CO_2 emissions by 2000. It is expected that these activities will have an impact on engine efficiency and hence reduce fuel consumption for road transportation.

69. The estimated potential reduction of CO_2 emissions from the abatement measures in the transport sector were reported as 1,263 Gg by 2000 in the national communication. During the visit, the team was informed that, as some of these measures are still at the planning stage, a more realistic estimate is 800 Gg by 2000.

D. Industry

70. The introduction of natural gas in the industrial sector is one of the most cost-effective measures to improve process efficiency and to mitigate CO_2 emissions. The construction of a natural gas network connecting large industrial units is progressing at a satisfactory rate. It is anticipated that by 2000 large industrial units will consume 80 per cent of the natural gas sold to the industrial sector. The potential reduction of CO_2 emissions as a result of the introduction of natural gas in the industrial sector is estimated at 720 Gg by 2000.

71. During the visit the team was informed that the combined heat and power generation plants that had been built in Greece under the provisions of law 2244/94 since 1994, have a total electricity production of about 136 MW. The electricity from these plants is being used in industries such as oil refining, sugar, textiles, plastics and beer. According to data from the Hellenic Combined Heat and Power Organization, industrial CHP units in Greece provide 3 per cent of the total electricity supply. The potential reduction of CO_2 emissions as a result of applications of cogeneration is estimated at 80 Gg by 2000.

72. Other measures include regulations for energy-intensive sectors as a means of reducing energy consumption. It is expected that 808 Gg of CO_2 emissions could be reduced by 2000, as a result of the application of these measures.

73. Improvement in auxiliary operations (industrial premises, steam production, compressed air) through regulations, incentives, information and training could lead to a reduction of CO_2 emissions of 430 Gg by 2000.

74. In addition, measures to support and/or develop the institution of environmental/energy consultant companies will be introduced through legislative regulation. These independent consultant companies will be in charge of elaborating the energy balances and certifying that manufacturing units are operating efficiently from an energy viewpoint. The potential reduction of CO_2 emissions as a result of the application of these measures is estimated at 50 Gg by 2000. The team was informed that the legislation is being drafted.

75. The estimated potential reduction of CO_2 emissions from the abatement measures in the industrial sector was reported as 2,088 Gg by 2000 in the national communication. During the visit, the team was informed that, as some of these measures are still at the planning stage, a more realistic estimate is 900 Gg by 2000.

E. Residential, commercial and public sectors

76. As in the industrial sector, the introduction of natural gas in the residential, commercial and public sectors will have an impact on the reduction of CO_2 emissions. As mentioned earlier, construction of the natural gas network is progressing at a satisfactory rate but the natural gas distribution pipelines and the city networks are only expected to be completed by 2000. So it will be only after 2000 that utilization of natural gas will be extended to the residential sector. As a consequence, reduction of CO_2 emissions as a result of the introduction of natural gas in the residential, commercial and public sectors is not expected by 2000.

77. Energy conservation measures in these sectors are mainly aimed at the reduction of energy demand by rational use of energy resources and the introduction of more efficient technologies. Worthy of particular mention is the replacement of approximately 55,000 incandescent lamps by fluorescent lamps, carried out by the PPC in the island of Crete in 1996. Other programmes include information and educational campaigns on conservation measures for the general public, an eco-label system and energy audits for buildings.

78. During the visit, the team learned that a new Presidential Decree was expected to come into force after 1997 to give support to the action plan entitled “Energy 2001: Towards a Sustainable Housing in Greece”. By means of this action plan, the Ministry of the Environment, Physical Planning and Public Works of Greece will promote policies and measures as well as incentives and new technologies for energy conservation, and encourage the rational use and management of natural resources in the construction sector.

79. Some of the proposals of this plan include: improvement of the efficiency and operation of the existing central heating installations and the introduction of environment-friendly architecture in planning new buildings. Other proposals include measures for technology dissemination and education of technicians, engineers and the general public; and regulations for the promotion of certification of construction materials and of new technology products.

80. These measures are expected to result in a reduction of 700 Gg of CO_2 by 2000, if fully implemented.

F. Policy measures on research and technological development

81. The Ministry of Development is the supervising and coordinating ministry providing policy guidance for the administration of the research and technological development activities in Greece. The central authority for the implementation of these activities is its General Secretariat for Research and Technology. There are, however, more than two dozen research and technological organizations that are directly carrying out activities related to the development and adaptation of environmental technologies in the country, and technology cooperation with international programmes, primarily with EU partners.

82. For the period 1994-1999, the basic instrument for the formulation and implementation of the research and technology policy has been the Operational Programme for Research and Technology. Its strategic goal is to improve the competitiveness of the Greek industry and the economy as a whole. The programme has some specific climate-oriented projects, which focus on environmental protection and pollution control, information and renewable energy conservation technologies, and the promotion and implementation of new techniques and processes in Greece's industrial enterprises. This is envisaged to enhance the flow of technology between suppliers and users to help develop the technology market in the country.

83. Financial resources for research and technology development are primarily provided by the EU under the auspices of the second Community Support Framework for 1994-1999. However, an important contribution is also made by the public and private sectors. The total research expenditure of the country during the last years has been close to 0.5 per cent of GDP; and this figure is increasing.

IV. PROJECTIONS AND EFFECTS OF POLICIES AND MEASURES

84. The Greek Government provided quantified projections of energy-related CO_2 emissions in the communication. For CH_4, N_2O and the indirect GHGs, the communication gave assessments of developments for different source categories. HFCs, PFCs and SF_6 were only addressed during the review visit, which also provided relevant information in relation to the projections that were actually given.

A. Energy-related carbon dioxide

85. The projections for CO_2 were developed within the framework of a study initiated by the European Community covering its member States, where the University of Athens was a main contributor. This exercise was carried out up to the year 2020, using a general equilibrium model (MIDAS) which is suitable for such a horizon. During the visit, an updated version of results was presented, utilizing data up to 1995 for the model, and making the exercise consistent

with the expansion plans in the power sector. Updated scenarios for CO_2 stabilization and a 10 per cent reduction at Community level were shown to the team. In these scenarios Greece showed a higher growth path in emissions than average, with a particularly substantial growth in the transport sector.

86. In the communication, the CO_2 emissions were projected to grow from 82,000 to 94,000 Gg, or about 15 per cent between 1990 and 2000 in a "with measures" scenario, and to 104,000 Gg or about 27 per cent in a "business as usual" scenario for the same period. In the latter scenario, the economic growth of Greece is expected to be more rapid than that of its EU partners, with the service sector accounting for most of the increase. This would make the Greek economy less energy- and CO_2-intensive in the long run.

87. The implementation of policies and measures took place somewhat slower than assumed in the "with measures" scenario, while economic growth was also relatively low in this period, resulting in a growth of CO_2 emissions of about 7 per cent from 1990 to 1995, according to preliminary figures.

88. Assuming that the growth rate is achievable for this scenario, the total increase in CO_2 emissions for the period 1990-2000 would be 16 per cent, which is within the range of the reduction target of a 15 per cent increase (± 3 per cent). However, expectations were that emissions may grow at a higher rate compared to this scenario, for the second half of the decade. Furthermore, implementation of policies and measures in the plan appeared crucial for ensuring that targets stay on track with the measures already outlined in the scenario. The team also noted that time is limited to see the measurable effects of these policies and measures by 2000.

89. The Greek experts informed the team that there are a number of issues which will affect the future trends of CO_2 emissions. On the demand side, emissions from the transport sector are at a relatively low level compared to average EU emissions but they may grow considerably, depending on the efficiency of the car fleet. Further, consumption of electricity is also low compared to the rest of the EU, and it is indeed expected to grow considerably, partly to respond to a greater demand for cooling. In the 1990s, electricity demand has already been growing steadily, and energy demand and CO_2 emissions have also been faster than GDP for some years.

90. As some projects in the electricity sector require a long lead time, the developments there are believed to be fairly well known up to some time after 2000, when uncertainties increase. Post-2000, the supply side choices of fuels and technologies will be of crucial importance with respect to the potential growth patterns in electricity demand. The capacity for supplying natural gas via the pipelines presently under construction is about 4 billion Nm^3 at a plateau, which could be fully utilized between the years 2005 and 2010.

91. There may also be an option between the continued and/or expanded use of lignite and the introduction of more natural gas. Another uncertainty is related to the extent to which renewables will penetrate the electricity market. Although the remaining hydro potential is

limited, according to the modelling results, this source together with wind can provide significant economic potential for electricity generation up to 2020. In the model, most of the hydro projects seem to appear early and a majority of the wind projects at a later stage, followed by biomass/waste.

92. The trends towards deregulation of the European electricity market are also expected to have some impact on Greece. The degree of this impact will depend on two main factors:

(a) The type of regulatory and market changes applied at the national level; and

(b) The degree of interaction with its non-EU neighbours.

Later, if certain physical structures are developed (in particular a cable to Italy), there could be more direct interconnection with the western European market. Independent power producers are likely to enter the market, and there may be increased utilization of combined cycle gas turbines as well as combined heat and power plants, utilizing the new supply of natural gas. In addition, the level of CO_2 emissions will also depend on the type of industrial developments that the country pursues. It should be noted that these issues have not been considered in the projections.

B. Non-energy-related carbon dioxide

93. Regarding the land-use change and forestry sector, the first national communication does not estimate CO_2 emissions from this sector. For this reason, projections do not incorporate these emissions.

C. Gases other than CO_2

94. Based on estimates of the effects of measures in different sectors, the communication concludes that overall methane emissions are likely to be reduced. This conclusion is mainly based on an assumed reduction in emissions from waste disposal and agriculture, even though a slight increase in emissions from natural gas networks and lignite mining is expected. The team noted the major uncertainties related to estimates of emissions from these sources, which make it difficult to assess overall trends as different factors pull in different directions.

95. During the visit, the team was informed of the Operational Environment Programme, under which activities, in effect since 1994, include: an integrated national programme for waste management, restoration of abandoned waste dumps, construction of new landfills, and extended recycling programmes.

96. The team was also informed that, although national rice production had increased slightly during the last two years, the methane emissions increase from this source was negligible. Also, there has not been an increase in livestock numbers lately and no increase is expected until the

year 2000, which indicates that methane emissions from this source will remain stable. Regarding emissions from natural gas distribution networks, the leakage of methane has been steadily reduced and should be minimized by 2000, as new polyethylene pipes, which prevent leakages, are gradually installed. Also, in the new natural gas distribution network, leakage prevention equipment such as special pressure gauges is already installed.

97. The communication concludes that overall emissions of nitrous oxide will increase, mainly as a result of the introduction of catalytic converters in cars. The team was also informed that recent deregulation of the fertilizer market has led to a 25 per cent drop in consumption and presumably in emissions, the magnitude of which was not foreseen in the communication. The Greek experts indicated that it is unlikely that the growth in nitrous oxide emissions from the transport sector by 2000 will be offset by the decrease from fertilizer use.

98. Greece, as a Party to the Convention on Long-Range Transboundary Air Pollution and its protocol for the control of emissions of nitrogen oxides and of NMVOCs, since 1988, is obliged to stabilize emissions of these gases according to specific time-frames. Other measures that are already in place in the transport sector, together with the introduction of natural gas in the energy system, will also contribute to NO_x emissions reduction. Nevertheless, an increase in combustion processes in the country, which are the main source of these gases, indicates that an increase in NO_x emissions is expected by 2000.

99. The communication did not cover the new gases HFCs, PFCs and SF_6. The team was informed that the use and corresponding emissions of HFCs are likely to grow following a substitution of gases that are regulated by the Montreal Protocol. The development of PFC emissions, where the only known source is aluminium production, is still uncertain. The industry has started to assess whether there are technical possibilities for reducing the emissions of these gases. However it is believed that even if measures are taken, these may be offset by a possible expansion in aluminium production. The team was given estimates of PFC emissions from a report produced for the Commission of the European Communities, EC/DGXI, which showed an increase from 1,500 Gg of CO_2 equivalent in 1993 to 2,700 Gg in 2000.

D. Estimates of the effects of measures

100. The communication provided estimates of the effects of individual measures and also summarized the total effects of measures aimed at reducing CO_2 emissions. For CO_2, these were also updated for the review visit. Often, for the estimates of the individual effects of measures, expert assessments were used. The theoretical technical potentials were considered, while this information was modified to give more realistic effects of individual measures as well as an aggregated estimate of the total. The effects of the overall measures, in the updated material, suggest that there would be a reduction in emissions growth from about 27 per cent to 16 per cent by 2000. On the basis of this projection, the Greek experts consider that the national target of limiting CO_2 emissions growth to 15 per cent (± 3 per cent) by 2000, compared to 1990, is achievable.

V. EDUCATION, PUBLIC AWARENESS AND TRAINING

101. The Greek action programmes for education, public awareness and training are mostly supported by the Environmental Education Office of the Ministry of Education. The majority of these programmes are not directly tied to climate change (i.e. the reduction of greenhouse gas emissions), but are aimed at the protection and conservation of the environment and sustainable development, by promoting environmental education in schools. However, many programmes have indirect impacts on the reduction of greenhouse gas emissions. Given the multi-orientation of many programmes, the Government found it difficult to assess their effectiveness in decreasing greenhouse gas emissions.

102. The Ministry of Education, in collaboration with other ministries, universities, local authorities and various environmental protection groups, is working to develop and promote environmental education. Promoting and monitoring the implementation of environmental education in school and developing teaching material, reforming curricula/developing new curricula and connecting schools to the Internet, are some of the main activities.

103. The Public Power Corporation also administers a variety of training, education and public awareness programmes. For example, the PPC as part of its billing procedures also distributes regularly pamphlets concerning various energy conservation measures (e.g. the replacement of incandescent light bulbs with fluorescent lamp bulbs, and the moderate use of air-conditioners) and the rational use of electricity that the consumer can implement at home. Also, the PPC, in collaboration with the Ministry of Education, is currently preparing a multimedia CD-ROM on various aspects of energy use and conservation, for distribution to schools.

104. A natural gas information campaign is under way to inform consumers on the efficient utilization of natural gas and the specific benefits thereof. The business sector is also informed on the standards of equipment and appliances, and applicable regulations in the natural gas market.

105. Programmes for the dissemination of information on solar energy inform the public (consumers, builders, architects and designers) on the merits of solar energy and provide technical assistance on solar energy use. Another important measure is the labelling of domestic appliances (refrigerators/freezers, washing machines, dryers and combined washer/dryers) which provides information on energy consumption, energy efficiency, performance and other important aspects, so that consumers can make informed choices.

106. The Government, through different ministries, is conducting several public awareness campaigns and technical advice sessions. Topics vary from farm management (e.g. the reduction of methane emissions from farm operations and the reduction of burning crop residues) to the prevention of forest fires (the majority of which are deliberately set), to the teaching of Greek ecology in schools and for the general public.

VI. EXPECTED IMPACTS OF CLIMATE CHANGE AND ADAPTATION MEASURES

107. The Greek Climate Change Action Plan does not contain any specific section on the expected impacts of climate change and adaptation measures, so information on vulnerability assessment and potential impacts of climate change on agriculture, forest ecosystems, coastal zones, natural hazards prevention, disaster control, recreation, tourism and water resources was not provided.

108. However, during the in-depth review, the team was informed of studies carried out in 1991 on the resilience of the forest ecosystem with respect to pest infestation, fires, and decreased precipitation. Some studies have also been carried out on the effects of climate change on the yields of maize, wheat and cotton. Other studies are going on with respect to the development of techniques to prevent and combat forest fires, as well as the impacts of climate change on activities such as agriculture, fisheries, tourism and coastal zones.

109. Forest management plans have been developed and are being implemented to ensure sustainable and rational use of forest resources.

110. Greece has also started some assessment studies aimed at developing a coastal zone integrated management plan, and already several policy instruments and legislative provisions are being employed to manage coastal resources on a sustainable basis. Greek experts have determined that, in light of the geological formations, Greece's coastal zones are not vulnerable to sea level rise.

VII. RESEARCH AND SYSTEMATIC OBSERVATION

111. During the visit, the team was informed that Greece follows the regulations within the European Union regarding network sites, and so climate monitoring systems are well developed in Greece. More than 29 first-class synoptic stations exist in the country and systematic full-range climate data have been recorded since the turn of the century. Long-term research (up to 20 years) on the fluctuation of temperature and precipitation data is currently under way.

112. Greece also participates actively in several international research activities and programmes. These include the work of the World Climate Research Programme, The International Geosphere-Biosphere Programme, the Programme on Man and the Biosphere and the Intergovernmental Panel on Climate Change.

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