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Report on the in-depth review of the first national communication
of Ukraine

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I. INTRODUCTION AND NATIONAL CIRCUMSTANCES

1. The secretariat received the first national communication on climate change of Ukraine, further referred to as the NC1, on 21 March 1998. An in-depth review of the NC1 was carried out between September 1999 and June 2000, including a visit to Kiev from 27 September to 1 October 1999. The review team consisted of Dr. Abdelkrim Ben Mohamet (Niger), Dr. Christo Vassilev (Bulgaria), Dr. Felix Christian Matthes (Germany), Mr. Randolf Granzer (International Energy Agency) (IEA) and Dr. Katia Simeonova (UNFCCC secretariat, coordinator).

2. The territory of Ukraine covers 60.4 million hectares (ha), of which in 1999 agricultural land made up 72 per cent, forest 17 per cent, water bodies 4 per cent and swamps and unplanted land the rest. Fertile soil is considered as one of the most important natural resources of the country, hence the development of agriculture. Climate is moderate continental and, on the southern coast of the Crimea, subtropical. In 1995, the population was 51.7 million and it has been declining at a rate of 0.3 per cent annually on average during the last decade.

3. Since 1990, Ukraine has undertaken political, economic and social reform aimed at shifting the country from the former centrally planned economy to a free market one. In 1991, it became an independent State. The transition period has been very painful and Ukraine has experienced immense difficulties in laying the foundations of the new economy. Major events on the pathway to this new economy included a decline in industrial output accompanied by inflation (1991-1992), hyperinflation (1994), control of inflation and introduction of the national currency, the hrivnia (Gr) (1995-1996), and macroeconomic stabilization (1997-1998). Thereafter, Ukraine suffered severely from the impact of the Russian financial crisis in August 1998, as the Russian Federation remained by far its most important trading partner. The Russian financial crisis together with the sharp rise in oil and oil product prices led to a devaluation of the currency from 1.6 Gr per US dollar in 1998 to 4.5 Gr per US dollar in 1999 and more than 100 per cent inflation in the latter year. As a result, between 1990 and 1999 the gross domestic product (GDP) fell by half.

4. In 1999, economic recovery was on the way. By then, most prices had been liberalized and more than 60 per cent of the economy was in private ownership. Expectations were that 2000 would be the first year of economic growth, of around 2 per cent, and this would be considered as an indication of the success of the market reform. The difficulties Ukraine experienced in the last decade were mainly due to the slow pace of political, economic and administrative reform combined with limited indigenous energy resources and a heavily industrialized and highly energy-intensive economic structure. Economic policy in recent years has centred on structural reform and the Government has also tried to attract more foreign direct investments into key sectors, e.g. energy, iron and steel, chemicals, machine building, food processing and agriculture, as a way to stimulate restructuring. The level of these investments has, however, remained very low in comparison to other countries of the region.

5. Due to the heavily industrialized structure of the economy, the energy sector has played an important role in the economic development of Ukraine. With regard to energy supply, the

share of indigenous energy production and energy imports in total primary energy supply (TPES) has remained broadly unchanged since 1992. Coal is the most important domestic energy resource, covering not only the country's own demand for coal and coal products but also being exported. However, in the period between 1990 and 1998, coal export exceeded coal import only in 1990, whereas in recent years there was a net coal import. Although the domestic oil and gas production has been growing in recent years, only around 15 per cent of oil demand and 18 per cent of natural gas demand are met by domestic sources.

6. TPES dropped by 41 per cent from 252 million tonnes oil equivalent (Mtoe) in 1990 to 150 Mtoe in 1997, due to the economic recession.[1] Among energy products the decline was the most remarkable in the supply of oil and oil products, which fell by 70 per cent and of coal, which fell by 47 per cent in the same period. Natural gas supply decreased the least, by only 28 per cent. This led to significant changes in the structure of the TPES: the share of oil and oil products dropped from 24 per cent in 1990 to 12 per cent in 1997 and that of coal from 32 per cent to 29 per cent, while at the same time the natural gas share grew from 36 per cent to 44 per cent, becoming by far the country's first energy choice, and that of nuclear energy almost doubled, from 8 per cent to 14 per cent. The shares of hydro and other renewable sources remained negligible, at around 1 per cent.

7. As to final energy consumption (FEC), in 1997 industry was by far the most significant sector, accounting for 44 per cent of a total of 86 Mtoe, followed by the residential sector, 32 per cent, services 12 per cent, transport 8 per cent and agriculture 4 per cent. Two important trends in energy consumption are worth mentioning. Since 1990, energy consumption in industry and agriculture has declined almost in line with GDP, while consumption in the residential, services and transport sectors has declined less than GDP. This resulted in a slight increase in energy intensity of around 10 per cent in 1991-1992 compared to 1990, and this level has since remained virtually unchanged.

8. According to the existing distribution of competencies in Ukraine, legislative power lies with the parliament, while executive power lies with the Government (Cabinet of Ministers), which together with the local authorities is responsible for policy implementation in general, and for climate policy in particular. The President also has legislative powers in that, according to the new Constitution adopted in 1996, he not only gives final approval to the laws passed by the parliament but, when necessary, issues decrees to address urgent problems.

9. Ukraine signed the UNFCCC in 1992 and the parliament ratified it in 1996, adopting 1990 as a base year for the estimation of emissions of carbon dioxide (CO_2) and other greenhouse gases (GHG). Other important milestones in climate policy formulation and implementation include the adoption of the National Climate Programme (NCP) by the Government in 1997, the submission of the NC1 in 1998 and the preparation in the same year of the national draft Climate Action Plan.

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[1] Data for the energy sector, including on TPES and FEC, are taken from World Bank and IEA sources. Ukraine has not prepared or published its energy balances since 1990.

10. As climate policy has evolved, the institutional capacity has been strengthened to ensure concerted efforts by the governmental institutions. In April 1999, an Interagency Climate Commission (ICC) was set up (by Decree 583 of the Government), chaired by the Minister for the Environment and Nuclear Safety, and two deputies, respectively the deputy heads of the State Committee for Energy Conservation and the State Committee on Hydrometeorology, and comprising high-level representatives of all ministries responsible for policies related to climate change, such as the Ministry of Energy, the Ministry of Industrial Policy, the Ministry of Sciences, the Ministry of Construction and Municipal Policy and the State Committee on Statistics. The main tasks of the commission are to organize the preparation of a national climate strategy and action plans and coordinate their implementation, to prepare national communications and inventories, to monitor and control the implementation of mitigation measures and to organize the work on the flexible mechanisms envisaged under the Kyoto Protocol. In April 1999, the ICC launched the preparation of the National Climate Strategy.

11. The preparation of the NC1 was coordinated and in part carried out by a non-governmental organization, the Agency for Rational Energy Use and Ecology (Arena-Eco). The Ministry of the Environment and Nuclear Safety, referred to below as the Ministry of the Environment, took the political leadership in this work and more than 60 experts from different governmental and academic institutions contributed to it.

12. During the visit, the review team had meetings with representatives of government offices and non-governmental organizations working in the field of climate change, including representatives from the Ministry of the Environment, the Ministry of Energy, the Ministry of Industrial Policy, the Ministry of Transport, the State Committee on Forestry, the National Commission on Electricity Regulation, the State Committee on Statistics, the State Committee on Hydrometeorology, Arena-Eco, the Institute of Energy and the Institute of Economic Projections of the National Academy of Science, the Institute of Industrial Ecology, the Alternative Fuel Centre, the Scientific Association of Energy Engineers, the EC Environmental Awareness Programme under the Technical Assistance for Commonwealth of Independent States (TACIS) and green non-governmental organizations (Ukrainian Society of Sustainable Development, Green World, National Environmental Centre and Mama-86). The outcome of these discussions and the thorough review of the documents provided during the meetings allowed the team to conclude that the NC1 adequately reflects the key issues of Ukrainian climate policy at the time that document was prepared. Information on studies and new initiatives launched after the preparation of the NC1, and especially the results of the annual inventory, are to be found in the current report.

II. INVENTORY OF ANTHROPOGENIC EMISSIONS AND REMOVALS

13. The NC1 contained an inventory for 1990 of emissions by source of the three main GHGs, CO_2, methane (CH_4) and nitrous oxide (N_2O) and removals by sinks. It also contained estimates of precursors, such as nitrogen oxides (NO_x), carbon monoxide (CO), and non-methane volatile organic compounds (NMVOCs). Estimates of the emissions of fluorinated gases, i.e. hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) were not

provided, the main reason for this being the lack of activity data on the production and consumption of these gases, or confidentiality of such information.

14. The inventory information included in the NC1 contained emission data for 1990 and is based on the results obtained under the United States Country Studies Program, which were published in the 1995 report *Development of Greenhouse Gas Emission Inventory*. Prior to the team visit, in September 1999, Ukraine submitted to the UNFCCC secretariat the draft annual inventory, which included emissions of all three main GHGs and removals by sinks for the entire period from 1990 to 1998. During the country visit the review team was provided with an updated version of the same inventory and, subsequently, in 2000 the final version of this inventory was sent to the UNFCCC secretariat. The current report is mainly based on this recent submission, further referred to as the annual inventory.

15. The GHG inventory presented in the NC1 and the annual inventory were compiled by Arena-Eco on a request by the Ministry of the Environment in close cooperation with experts from several other national institutions, *inter alia*, the Institute of Energy of the National Academy of Sciences, the National Agricultural Academy, the Institute of Agricultural Economics, the Ukrainian Research Institute of Forestry and Agro-Forest Melioration, the State Committee of the Municipalities, the State Committee on Statistics and several industries. As of 1999, the ICC and, in particular, the Ministry of the Environment assumed responsibility for coordination of the inventory preparation. The team noted that, in spite of some gaps in the inventory identified in this report and the limited resources available for this work, it was possible with the existing institutional arrangement to produce the national inventory of reasonable quality and to recalculate the time-series, when necessary.

16. To compile and report the inventories presented in the NC1 and the draft annual inventory Ukraine used the 1995 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, further referred to as the 1995 IPCC Guidelines, while for the annual inventory it used the 1996 Revised IPCC Guidelines. Standard data tables in the case of the use of 1995 IPCC Guidelines were not provided. However, the annual inventory contained sectoral tables following the 1996 Revised IPCC Guidelines. Still, information on activity data and emission factors provided in the NC1 was limited and in the annual inventory such information was missing.

17. To estimate emissions from the energy sector, both "top-down" and "bottom-up" methods recommended by the IPCC Guidelines were used for the NC1 inventory, i.e. for 1990. For the annual inventory, the same two methods were used. Due to the very small difference in the results obtained, less than 2-3 per cent, "top-down" figures were not provided. The difference was explained by some consistency and incompleteness of the national statistical data, differences in the level of fuel aggregation and rounding of figures.

18. To estimate emissions from sources other than energy and for sinks, different tiers of the 1996 Revised IPCC Guidelines were used. The Ukrainian inventory does not contain estimates of emissions from international bunker fuel due to the lack of activity data, nor does it contain estimates of uncertainties. The team advocated that the "top-down" estimates should be done for

each year and the relevant figures should be provided in the report to ensure the transparency of the inventory. Furthermore, efforts should be made to separate emissions associated with international bunker fuel, and uncertainty estimates should be provided as required by the IPCC Guidelines.

19. Mostly, official statistics were used as a source of activity data for the inventory. The inventory team faced significant difficulties associated with the availability and quality of statistical information. For example, the sectoral structure of data in the official statistics was significantly different from that recommended by the IPCC Guidelines. The fuel and energy nomenclature was also different and much broader than the IPCC one. Assumptions therefore had to be made in transforming the activity data to IPCC formats, which introduced some uncertainty. In addition, not all the data for the supply and demand part of energy balances were available. From the available energy balance data, only the data for electricity production and consumption were considered reliable, due to the introduction of a system for compulsory metering of consumption. Uncertainties in estimates of the other data vary widely and are highest for oil and oil products, at around 30 per cent.

20. The most recent officially published energy balance of Ukraine was for 1990. For the years 1991-1998 the inventory team had to use the primary data on energy production and consumption obtained from national statistics, and to produce the inventory using these data without having an energy balance, which introduces an additional uncertainty to the estimates. Moreover, using primary energy data together with changes in the statistical forms for energy resulted in an inconsistency in the time-series of emissions from different energy sources.

21. With regard to activity data other than on energy, for the agricultural sector, a relatively complete set of such data was collected on a yearly basis by the Institute of Agricultural Economics. Activity data to estimate emissions and sinks in the land-use change and forestry sector were taken from the 1988 forest inventory for the NC1 and from the 1996 forest inventory for the annual inventory. Data for the quantity of municipal solid waste and its different categories were last collected in 1990. For waste water, activity data were collected by the State Committee of the Municipalities and the Ministry of the Environment. Data for the solvents sector were not available and the emissions from this sector were not estimated. For forest management and forest fires, data were taken from the State Committee on Forests.

22. With a very few exceptions, the emission factors used in the annual inventory were taken from the 1996 Revised IPCC Guidelines. Examples of country-specific emission factors include the emission factor for fugitive methane emissions from coal mining, which was provided by the Institute of Gas to the National Academy of Sciences separately for the three major coal basins of Ukraine. They also include the emission factors used for nitric and adipic acid production, and ammonia and carbamide production, which were obtained from stoichiometric equations of the chemical reactions typical for these industrial processes. Finally, for sink estimates, to calculate the above-ground biomass growth rate, a country-specific carbon content in dry matter and wet-to-dry wood weight ratio was used. The country-specific factors used were within the range of values recommended by the 1996 Revised IPCC Guidelines.

23. To assess the emissions and sinks in land-use change and forestry, Ukraine broadly followed the 1996 Revised IPCC Guidelines. Emissions and sinks in conversion of forest to agricultural land, conversion of grasslands and pastures, and abandonment of managed lands were not considered as Ukraine has an established land-use pattern, the only exception in that regard being the region around the Chernobyl nuclear power plant (NPP). To estimate emissions from forest fires, a national method similar to that recommended by the IPCC was used. The main difference in the estimates in different inventories stems from the use of a 10-year average to estimate the effect of forest fires in the NC1, while in the annual inventory information for each year was used. This resulted in a slight increase in the estimated forest sink for 1990, from 51,976 Gg CO_2 in the NC1 to 52,107 Gg CO_2 in the annual inventory.

24. In its annual inventory, Ukraine made the first attempt to estimate emissions of PFCs resulting as a by-product from aluminium production, but as the results obtained were preliminary they were not included in the national totals. Ukraine is not a producer of the new gases but other possible sources could include HFCs used as substitutes for ozone-depleting substances in refrigerators, air-conditioners and fire extinguishers, and SF_6 from electric equipment and in very small quantities from magnesium production. The team noted the importance of estimating new gas emissions in view of their high global warming potential and their potential growth.

25. The estimates of total GHG emissions for 1990 published in the NC1 were revised upwards in the annual inventory from 905,878 Gg CO_2 equivalent to 932,575 Gg, mainly due to the use of the 1996 Revised IPCC Guidelines. Other factors contributing to this difference were the use of more accurate activity data and improved emission factors. The change in CO_2 emission estimates was small: 700,107 Gg in the NC1 compared with 704,842 Gg in the annual inventory. This change is explained mainly by refining of the estimates of CO_2 emissions from carbamide production. In addition, CO_2 emissions from the production of iron and steel, aluminium, ferromagnesium and calcium carbide were estimated in the annual inventory, but only the last-mentioned were included in the national totals as the team was told that other emissions have been already accounted for by using the "reference approach" for emissions from energy. The team noted that in the annual inventory the sectoral approach was used for the emissions from energy and therefore all emissions from industry should be reported and included in the national totals.

26. Estimates of total CH_4 emissions for 1990 were revised slightly upwards from 9,453 Gg CH_4 in the NC1 to 9,486 Gg CH_4 in the annual inventory, the main change being the estimates of emissions from industrial waste water. A major change occurred in the estimates of N_2O emissions, from 23.4 Gg in the NC1 to 92 Gg in the annual inventory. This is explained by a substantial revision of emissions of N_2O from all categories, with the sole exception of energy. The major increase came in the emission estimates from agricultural soils, which increased more than threefold due to the use of the Revised 1996 IPCC Guidelines. These revisions also include higher estimates of emissions from manure management, inclusion of a new source, municipal wastewater, and the use of more accurate information for emissions associated with adipic acid production.

27. An analysis of the emission trend for 1990-1998 suggests that the GHG emission pattern remained practically unchanged. CO_2 remained by far the most important GHG with a share of 76 per cent in total 1990 emissions of 932,575 Gg CO_2 equivalent, followed by CH_4, 21 per cent, and N_2O the rest. Between 1990 and 1998, the total emissions plummeted by 64 per cent, a decline driven by the overall decline in the economy, and in particular of the industrial output, and the corresponding decline of energy consumption. Interestingly, between 1990 and 1992 the GHG emission drop outstripped that of the GDP as the latter was primarily attributed to heavy industry, which declined the most. After 1992, the situation was reversed and the GDP drop exceeded that of the GHG emissions.

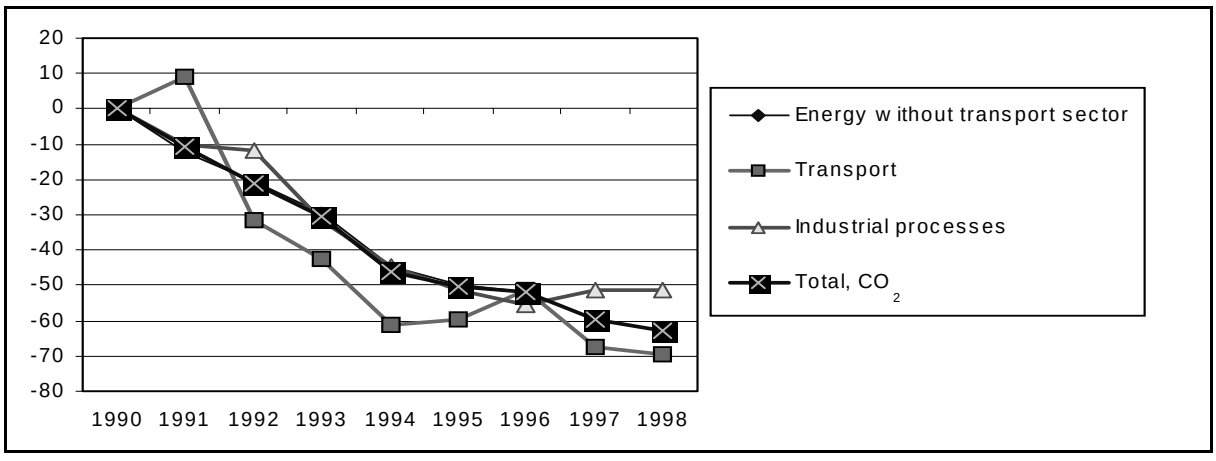
28. Emissions of CO_2 dropped by around 63 per cent between 1990 and 1998, primarily because of a decrease in emissions from fuel combustion, 69 per cent from transport and 63 per cent from fuel combustion sources other then transport. Emissions from industrial sources dropped to a lesser extent, by 51 per cent. The forest sink increased by 32 per cent for the same period, mainly due to a lower-than-planned forest cut consequent upon lower demand for forest products during the recession.

Table 1. Carbon dioxide emissions and removals, by source and sink, 1990-1998 (Gg)

	1990	**1991**	**1992***	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Energy and transformation	274 569	115 258	252 028	228 056	189 757	178 902	161 647	138 602	125 846
Industry	213 887	307 118	139 030	109 114	78 186	59 779	72 284	49 255	47 103
Transport	54 044	58 805	36 853	31 072	20 898	21 650	26 394	17 535	16 403
Small combustion	121 675	68 843	50 173	49 312	36 586	38 129	44 700	59 266	55 812
Other	7 900	50 675	50 331	48 735	37 267	34 394	20 198	1 860	1 750
Industrial processes	32 766	29 395	28 900	22 451	18 184	15 882	14 659	15 883	15 909
Total, CO_2	**704 841**	**630 094**	**557 315**	**488 740**	**380 878**	**348 736**	**339 882**	**282 401**	**262 823**
LUCF removals	-52 107	-55 635	-56 550	-57 445	-58 013	-59 214	-66 151	-68 806	-68 708

Note: "Other" includes emissions from small combustion sources other than commercial/institutional, residential and agriculture/forestry/fishing.
* For 1992, the sum of emissions is different from the data reported in the annual inventory.

Figure I. Carbon dioxide emissions, percentage change from 1990, by source



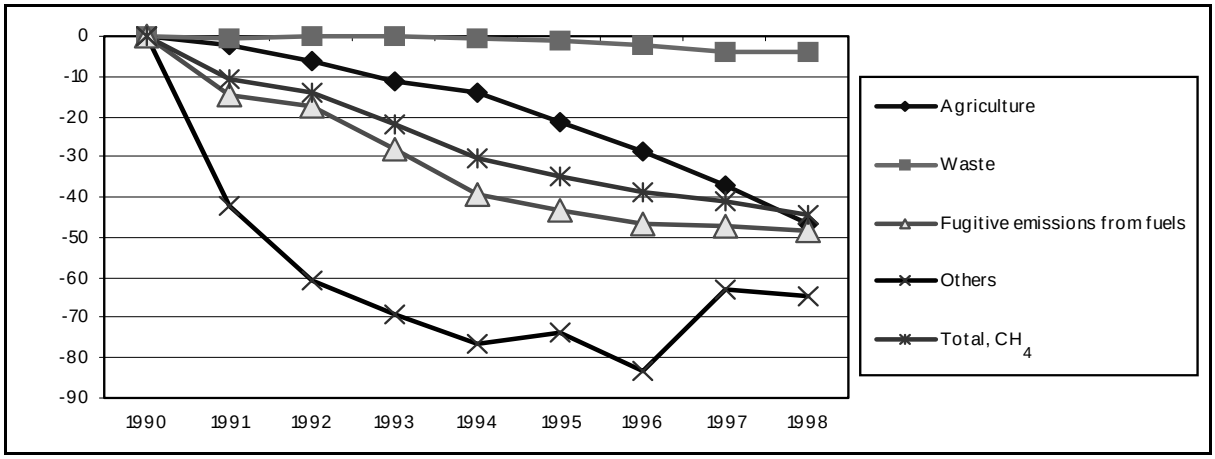
29. The energy sector, in particular coal mining, remained the largest source of CH_4 emissions, accounting for 60 per cent of total emissions in 1998, followed by agriculture, 23 per cent, and waste and fuel combustion the rest. Total CH_4 emissions dropped by 44 per cent between 1990 and 1998, a major decrease being observed in emissions from the two major sources, fugitive emissions and agriculture, while emissions from waste declined by only 3 per cent due to decrease in population.

Table 2. Methane emissions, by source, 1990-1998 (Gg)

	1990	1991	1992*	1993	1994	1995	1996	1997	1998
Agriculture	2 254	2 200	2 118	2 006	1 938	1 774	1 608	1 414	1 196
Waste	892	890	891	892	889	881	873	859	859
Fugitive emissions	6 178	5 284	5 089	4 453	3 757	3 485	3 310	3 267	3 173
Other	162	94	64	50	38	42	27	60	57
Total, CH_4	**9 486**	**8 468**	**8 162**	**7 401**	**6 622**	**6 182**	**5 818**	**5 600**	**5 285**

* For 1992, the sum of emissions is different from the data reported in the annual inventory.

Figure II. Methane emissions, percentage change from 1990, by source

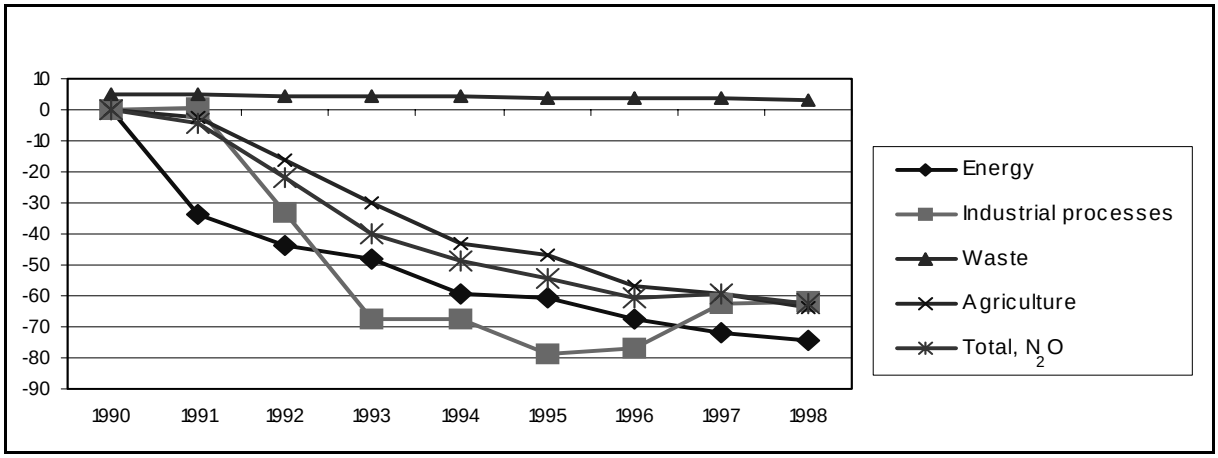


30. The 64 per cent drop in N_2O emissions between 1990 and 1998 stems mainly from the drop in emissions from the two main sources - agriculture and industrial processes. These sources accounted for 64 and 62 per cent of the total N_2O emissions in 1998 respectively, with fuel combustion making up the rest.

Table 3. Nitrous oxide emissions, by source, 1990-1998 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Energy	7.1	4.7	4	3.7	2.9	2.8	2.3	2	1.8
Industrial processes	22.9	23.1	15.3	7.5	7.5	4.9	5.3	8.6	8.7
Waste	5.1	4.8	4.6	4.3	4.1	3.9	3.7	3.5	3.4
Agriculture	56.8	55.3	47.6	39.9	32.4	30.3	24.4	23	20.5
Others	0.2	0.1	0.7	0.1	0.6	0.3	0.9	0.1	0.3
Total, N_2O	**92.1**	**88**	**72.2**	**55.5**	**47.5**	**42.2**	**36.6**	**37.2**	**34.7**

Figure III. Nitrous oxide emissions, percentage change from 1990, by source



III. POLICIES AND MEASURES

31. The NC1 contains two chapters where mitigation policies and measures are described: the policies and measures chapter, which provides information on CO_2 policies and estimates of their mitigation potential with the aim of defining the context for projections; and the projections chapter itself, where a description of the non-CO_2 policies was included along with the non-CO_2 projections. This presentation of information did not follow the guidelines strictly, making its interpretation by the team difficult. The team noted that the information on policies should be given in the NC in a clear and concise way and the tables prescribed by the guidelines should be used to present this information in a systematic manner. The team also noted that, although the NC1 contained detailed information on the expected effect of policies and measures, it is important also to evaluate the effect actually achieved, which is essential for effective implementation.

32. The information in the NC1 and the discussion during the team visit centred mainly on the CO_2 policies and measures. The primary aim of these policies and measures was to facilitate the economic reform and improve economic efficiency, energy efficiency and the competitiveness of industrial production, but they have also had an impact on emission levels.

They found inclusion in the following programmes and legislation: the 1992 Law of Ukraine on Protection of the Atmosphere, the 1995 Programme of Restructuring of the Ukrainian Economy, the1993-1996 National Development Programmes of the Industrial Sector, the 1996 National Energy Programme; the 1994 Law of Ukraine on Energy Conservation; the 1996 Comprehensive State Energy Conservation Programme, (referred to below as the Energy Conservation Programme), the 1997 Programme on the Development of Forestry and Forest Industry for the Period up to 2015, and the 1995 National Programme on the Development of Agricultural Production for 1996-2005. A summary of 28 mitigation measures was presented in the NC1, targeting emissions of the main GHGs, with savings estimated at 373,547 Gg CO_2 equivalent annually by 2015.

33. Moreover, these policies, and in particular energy efficiency policies, formed the core of the Draft National Action Plan on Climate Change prepared by Arena-Eco, which in 1999 was yet to be adopted by the Government. After reviewing the NC1 policies and measures and those presented to the team during the visit, the team concluded that although these policies were not climate driven, their presentation in a single conceptual framework in the NC1 represented a successful step towards identifying the contemporary climate policy of Ukraine. Another important step was the launch of the 1997 NCP, focusing primarily on climate research and observation, described in chapter VII below. The National Climate Strategy, preparation of which was in its early stages at the time of the team visit, is likely to represent the next step towards strengthening climate policy in Ukraine.

A. Carbon dioxide

1. Energy supply and transformation

34. The energy policy of Ukraine in recent years has been geared towards energy sector deregulation, energy price liberalization, introduction of privatization and competition, improvement of energy efficiency and security of energy supply. Among these, policy to promote energy efficiency was given priority due to the lack of sufficient indigenous energy resources and the high energy intensity in most of the economic sectors, which in turn increased energy import dependency. At the same time, the problem of non-payment for the energy consumed, which appeared after the energy prices liberalization, soon became one of the main barriers to market reform in the sector and, in particular, to promoting energy efficiency.

35. In 1998, the installed electricity generation capacity amounted to 53,900 MW. Among the power stations were 44 thermal plants with an installed capacity of 36,400 MW, five nuclear power plants with an installed capacity of 12,800 MW and eight large hydro plants with an installed capacity of 4,700 MW. In terms of electricity generated, out of the total 173 billion kWh produced in the same year, 81.9 billion kWh, or 47.3 per cent came from coal, gas and residual oil, 75.2 billion kWh, or 43.5 per cent from nuclear, and only 15.9 billion kWh or 9.2 per cent from hydro.

36. Among the important developments in the energy sector was the adoption of the 1996 National Energy Programme of Ukraine, which set the priorities for fundamental change in the sector. First of all, it set the goal for increasing the share of coal at the expense of natural gas with the aim to improve security of supply and decrease the import dependency. This goal was to be achieved chiefly by an accelerated uptake of new technologies, fluidized bed combustion for example. This in turn would bring improvements in plant efficiency, from the existing 28-32 per cent to 42 per cent and, consequently, an overall increase of the energy system efficiency.

37. Further development of the combined heat and power (CHP) systems was also seen as a tool to achieve this goal. Currently, CHP based on natural gas operates in all large cities in Ukraine and some of them are envisaged to switch from natural gas to coal. Thousands of heat boilers exist in other cities for centralized heat supply, which could be upgraded to CHP, but new CHP is unlikely to be built in view of the existing overcapacity. The team was informed that the only major energy efficiency project financed recently by public money is the World Bank project for rehabilitation of the Kiev district heating system at a cost of $250 million. The team noted that increasing the share of coal may counter the objectives of climate change mitigation.

38. The National Energy Programme also accords priority to increasing the share of renewable energy. New renewable capacity of around 3 MW, mainly of wind power, has been installed annually in recent years, bringing the total installed capacity of wind farms to around 10 MW in 1999. Economic incentives have been used to enhance this development. In particular, the 1994 Programme for Wind Energy Development set up a fund to support wind projects. This fund is financed by revenue collected through a very small levy on the electricity price (around 0.5 per cent). As to the traditional renewables, the support for large hydro also remained a priority. By1999, a significant part of the proven potential on the large rivers had already been tapped. Still, the new 1,600 MW Dnestrovskaia plant was under construction at that time, financed by the Ministry of Energy and through a special energy tax.

39. Nuclear energy is expected to continue to play a vital role in the country's overall energy balance despite the tragic accident at the Chernobyl NPP in 1986. To help mitigate the consequences of the accident, the European Bank for Reconstruction and Development (EBRD) set up the Chernobyl Shelter Fund to support the implementation of the plan adopted by Ukraine and the seven industrialized nations (G7) to make the existing sarcophagus safe. Two of the remaining three units at Chernobyl NPP were phased out in 1991 and 1996, and the closure of the last one was scheduled for the end of 2000. Their capacity was planned to be replaced by new nuclear units committed in the Chmelnitski and Rovno NPPs, so as to maintain the current share of nuclear in the overall balance.

40. Two presidential decrees in 1994 marked the beginning of the process of restructuring the electricity market, introducing competition and setting up the National Electricity Regulatory Commission (NERC). The NERC was given the mandate to ensure the efficient performance of the energy sector and the formation of an electricity market. Among its most important tasks were the implementation of the price and tariff policy and the promotion of competition in the electricity, heat, gas, oil and oil products markets. A wholesale electricity market

(Energomarket) was established by the same decrees following broadly the United Kingdom model, but its goals were achieved only partly, mainly because of the non-payment problem.

41. The former national electricity utility was split into independent generators (four thermal, one nuclear and two hydro companies), a grid operator (the national energy company Ukrenergo) and 27 local distributing companies (50 per cent privately owned). Energomarket buys electricity from nuclear and hydro plants at a fixed price, and from thermal plants at the lowest marginal price according to the hourly price bid. It sells the electricity to the distributing companies, which in turn delivers to end-users on the basis of a tariff controlled by the NERC. In this scheme, distributors are not allowed to deal directly with the generators, which limits competition.

42. A milestone in the reform of the energy sector was the adoption in 1997 of the Law of Ukraine on Power Sector. It introduced new market principles in production, transmission and distribution of electricity and laid down the legislative and regulatory framework necessary to implement them.

43. Not only did the share of gas in TPES increase significantly in the last ten years, but development of the gas infrastructure continued as well, as Russian natural gas transits through the Ukrainian network to the European market. In 1997, the transit amount was108 billion m^3. Like other energy industries, the gas industry was restructured and demonopolized. The former monopoly, Ukrgasprom, was split into production, transportation and trading companies, which were then partly privatized.

44. Similar processes of decentralization and privatization, but at a much faster pace, occurred in the oil sector, where the share of private companies is the highest in the energy sector. Oil is processed in Ukraine in six refineries with a total capacity of 62 million tonnes annually. Systematic operation of these refineries below their capacity has led to a worsening of their economic and energy efficiency. In 1998, as part of the structural reform in the oil and gas sectors, state-owned companies in these sectors which were excluded from the process of privatization formed a state-owned joint stock company called Neftogas Ukraine, which due to its monopolistic position may hamper competition on the domestic oil and gas market.

45. After 1992, average energy prices grew about four times faster than other industrial prices. Thereafter, the difference diminished and as of 1998 the rate was only 20 per cent higher. Still, in most cases, price formation did not follow strictly the cost recovery principle, mainly due to social reasons, cross-subsidies and the non-payment problem. A typical example in this regard is the pricing of natural gas. The price set by the Government at the level of $80 per 1000 m^3 was based on the border price and was identical for both industry and households. However, households paid only 80 per cent of this price, the remaining 20 per cent being subsidized by the Government for social reasons. In turn, industrial customers who paid in cash were given a preferential price of $30 per 1000 m^3.

46. In the coal sector, subsidies were still needed because in the predominantly small mines the cost of producing coal exceeded its market value, but the closure of these mines was made

difficult by the potential mass unemployment. Electricity prices were formed following a principle established by the NERC, i.e. on the basis of the wholesale price of the grid and adding to that incentives specific for each region of the country. Electricity prices for households were still subsidized via cross-subsidies. Among the energy prices, oil and oil product prices were the closest to the world market prices because the market for these products was liberalized the most.

47. Improving energy efficiency has been underlined already as one of the priorities of Ukraine in its transition to a market economy. Moreover, in view of the immense potential for energy saving, energy efficiency has been considered as one of the least-cost options for restructuring of the energy sector and closure of the Chernobyl NPP. To attain this priority the necessary institutional and legislative frameworks were established after 1992. In 1994, the Law of Ukraine on Energy Conservation was passed and in 1995 a State Committee for Energy Conservation was set up. The law envisages regulatory measures (e.g. standards), economic measures (setting up a fund to support energy efficiency projects and introducing financial incentives for energy saving) and monitoring of implementation by specialized agencies.

48. As of 1999, only the regulatory measures seemed to be in place: more than 50 standards and regulations had been drawn up, mainly by the State Committee for Energy Conservation, and partly enforced, laying the foundation for energy saving in the country. The goal of setting up energy efficiency funds with the revenue collected from the local energy tax or local budgets was materialized to a very limited extent. The team noted that it would be worth exploring a more market-oriented option of setting up a revolving fund, from which loans are granted to the most promising projects. In 1997, the regulation on setting up energy-saving companies (ESCO) was adopted by the Government and in 1999 an agreement between Ukraine and the EBRD was signed for financing schemes for the first UkrESCOs.

49. The Committee also elaborated in 1996 the Energy Conservation Programme on the basis of the 1996 National Energy Programme. The programme envisaged a phased approach and a three-step policy. By mitigating energy losses, improving efficiency of processes, introducing energy efficient equipment and increasing the share of high-tech and low energy-consuming production, the programme aimed to increase energy saving from about 24-26 Mtoe in 2000 to 98-100.3 Mtoe in 2015. These savings are significant, as for example the expected savings in 2015 are equal to around 67 per cent of the TPES in 1997. It is envisaged that most of the measures will be financed by the enterprises themselves, through bank loans or from their own profit for example, but this will be hampered by the immense difficulties faced by most of these enterprises.

50. The policy reform in the energy sector was expected to continue and the team was informed of the set of new laws to be promulgated soon after the visit. This included laws on: operation of the wholesale power market, the privatization of state property within the enterprises of the fuel and energy complex of Ukraine, natural monopolies, restructuring of the tax debts of the enterprises of the fuel and energy complex of Ukraine, and oil and gas.

2. Industrial sectors

51. Most of the measures contained in the 1996 Energy Conservation Programme targeted efficiency improvement in industry. Around 20 per cent of all emission saving was expected to come from this sector, an estimate which the team found realistic given the high energy intensity of the sector and the immense potential for energy and emission saving. The major barrier to implementation remained project financing. The team learned that the EBRD, together with the State Committee for Energy Conservation and some foreign assistance agencies, was working on financial schemes with preferential conditions for investment in energy saving projects.

52. Data on the implementation of the programme were not provided to the team. However, at the macro level an improvement in energy efficiency of a few per cent can be observed in this sector, which the host country officials attributed primarily to the implemented no-cost or low-cost measures. The team noted that the actual effect may have been greater, as the increase in the share of heavy industry, which is more energy intensive, may have partly offset the effect of the measures taken. Moreover, as of 1999 more than 50 per cent of the industry was privatized. The energy audits suggested that the private owners are more willing to finance energy efficiency measures in order to improve their competitiveness. These investments were not monitored and the improvements were difficult to assess.

53. The review team was provided with information on an industrial energy efficiency project implemented jointly by Arena-Eco and the Pacific Northwest National Laboratory of the United States. This two-year project was launched in 1997 and envisaged energy efficiency measures in five large industrial enterprises at an overall project cost of $16 million. Along with technical measures, the project envisages changing management practices and promoting awareness and interest in energy saving. When fully implemented, the project will result in annual savings of 7 million m^3 of natural gas, 144 million kWh of electricity and 1.5 million GJ of heat, representing energy savings worth $8 million annually for the enterprises.

54. The 1996 Programme for Renewables and Other Non-traditional Sources of Energy analysed options to use coke oven gas, blast furnace gas and methane from coal mines as a substitute for traditional energy sources in industry. Estimates suggest that savings could reach 1.2 Mtoe or around 1 per cent of the TPES in 2000, corresponding to energy import savings of $100 million. A portfolio of 200 projects has been prepared, with a financial requirement of $380 million which is expected to come from private enterprises and local budgets.

3. Residential, commercial, public and agricultural sectors

55. The 1996 Energy Conservation Programme envisaged a set of measures to improve energy efficiency in the residential, commercial, public and agricultural sectors, which if implemented was expected to contribute 10 per cent of the overall emission saving envisaged under the programme in 2015. These measures centered on the enforcement of new building standards, installation of heat, electricity and gas consumption meters and energy labelling. New building standards, which are in line with the Western European levels, were adopted in 1993. They are to be implemented in all new buildings constructed after 1994. However, these

standards are not likely to influence significantly the efficiency of the entire building stock in near term due to its very slow turnover rate and the lack of enforcement mechanisms.

56. Similarly, the installation of energy consumption meters, although obligatory for new buildings, has not progressed much. Since 1996, the State Committee for Energy Conservation has launched several programmes to install such meters (for hot water, heating and temperature control). Their implementation, however, has been hampered by the limited access to financial resources of private owners and municipalities, which possess large parts of the building stock.

57. In the public sector, a $35 million World Bank project is under way covering 1,300 public buildings in Kiev, which is the first project of the bank in Ukraine targeting energy efficiency. The project envisages among other things weather stripping of windows and doors, as well as installing of reflectors behind radiators, ceiling fans, hot water heat exchangers, and low-flow shower heads. The experience from a few demonstration projects suggests that the overall effect of the project could be a reduction in energy consumption of around 25 per cent.

4. Transport

58. Transport still accounts for less than 10 per cent of total CO_2 emissions in Ukraine. However, this sector has already undergone some change, typical for countries with economies in transition, associated with the decline in commercial activity and the use of public transport on account of the growing number of private cars. Indeed, statistical data, although highly uncertain, suggest an increase of energy intensity in this sector of about 10 to 30 per cent in different years compared to 1990.

59. The NC1 did not mention any policies aimed at improving efficiency and reducing emissions in this sector and this is understandable given that such policies are costly, as in case of subsidizing public transport, and difficult to implement, as in the case of imposing significant taxation on private cars or gasoline. Still, the team was informed of some measures being implemented which could contribute to arresting the possible growth of emissions from this sector. One of these measures refers to municipal transport programmes aimed at improving the electric vehicle fleet (trams and trolleybuses). Another measure is the introduction of a road toll on a part of the so-called European Transport Corridor. The team noted that, if successful, the revenue raised from the toll could be used to subsidize public transport.

5. Land-use change and forestry

60. As of 1999, forest land covered 10.4 million ha, which corresponds to 17 per cent of the total area of Ukraine. The forest composition was 45 per cent coniferous (including pine 36 per cent) to 55 per cent deciduous (including oak and beech 33 per cent). According to the 1994 Forest Code, Ukrainian forest has predominantly environmental functions (preserving the land from wind erosion and solving groundwater problems) and there are therefore some limitations on its commercial use. All the forest is state-owned and is unlikely to be privatized in the near future.

61. The emphasis in the forest mitigation policy as laid down in the NC1 is on planting new forests on marginal land and creating shelterbelt plantations to combat soil erosion. Estimates suggest that the optimal share of forest land to the total area of the country is 20 per cent. To reach this value planting of new forest on 2.5 million ha is needed.

62. The National Programme on Preserving Lands by 2010, which dates from the period 1995-1998, is the main policy document on forestry in Ukraine. The programme is based on two other programmes, the 1997 Programme of Development of Forestry and Forest Industry in Ukraine for the period up to 2015 and the 1995 National Programme on the Development of Agricultural Production of Ukraine for 1996-2005. The target for new forest set in the programme is for 1.123 million ha of new forest to be planted by 2010, which would increase the proportion of forest land to 17.4 per cent. So far, the implementation of the programme has been financed from the state budget and has been delayed by budget restrictions. The team was informed that, for full-scale implementation of the programme, it would be necessary to resolve some issues related to the ownership of the land and to ensure fresh investment.

63. The inventory data indicate that the forest sink has been constantly increasing in recent years. Between 1990 and 1998, this increase was of around 30 per cent, which corresponds to an additional 16,600 Gg CO_2 sequestered. However, this was the result of the cut in existing forest being less than planned due to the lower demand for forest products, rather than to the introduction of new measures. Moreover, the NC1 emphasized that withering of oak, pine and other plantations has been observed in recent years, which affects the forest sink and requires increased attention as well as new and different approaches to forest management. In this context, the team felt that it is important to explore ways of improving forest management and forest sink capacity, not only by afforestation of new land as described in the NC1, but also by improving the age structure of existing forests and by proper choice of the tree species composition, which could help the forest to adapt easily and naturally to possible climate change.

B. Methane

64. Mitigation of CH_4 emissions in Ukraine was planned to be achieved chiefly by measures targeting fugitive emissions and emissions from waste and to some extent as a result of the changes in the agricultural sector described in more detail in the section on N_2O emissions. At the time of the team's visit the measures envisaged, with very few exceptions, were at the conceptual stage and financial backing was generally missing.

65. Concerning fugitive emissions, the officials of the host country were of the opinion that some measures in the gas sector, especially related to the reduction of losses at the end-user stage, could be implemented at very low cost. Other much more costly measures would require replacement of the existing technologies in oil and gas production by state-of-the-art ones.

66. Coal-bed methane utilization was presented by the representatives from the Alternative Fuel Centre, a non-governmental organization set up especially to address this issue, as not only an economically viable option, but also as an option which would improve the existing poor safety record in the coal mines. Implementation has so far been limited to the preparation of a

handbook with a list of mines and estimates of their potential for coal-bed methane utilization. Fugitive emissions from coal mines dropped by half between 1990 and 1998 mainly as a result of a fall in coal production and the closure of some inefficient mines, and this trend is likely to continue in the near future.

67. As to the waste sector, the 1998 Law on Waste and the 1998 Main Directions of the Ukrainian State Policy on Environmental Protection, Natural Resource Use and Environmental Safety laid the foundation of a modern approach to waste management in the country. The law stipulates that the main principles of waste management include, in line with the similar legislation of other European countries, waste prevention, minimization, separation and utilization. It also allocates responsibilities for waste and waste management between the waste producers and central and local authorities. More specifically, it requires the local authorities to allocate financial resources in their budgets for waste incineration plants and landfills.

68. Furthermore, the Programme for Utilization of Waste from Production and Consumption adopted in 1997 envisaged the implementation of pilot projects on waste management and elaboration of a regulatory framework on waste. In the same year, an interagency programme on manufacturing of equipment for industrial processing of waste was launched. The review team was informed of ongoing work on a concept on waste utilization, which is expected to be completed and adopted next year.

69. As of 1999, 95 per cent of waste was landfilled (in 700 landfills, 80 per cent of which are without facilities to protect underground water and air from pollution), only 5 per cent was incinerated (in four incineration plants with obsolete equipment) and waste separation was lacking. The aim of the waste policy is for almost equal shares of waste to be landfilled and incinerated by 2015. In one landfill currently under construction (Dnepropetrovsk), a system for methane collection and utilization for energy purposes is envisaged.

70. The team acknowledged that although the above legislation and programmes were aimed at solving issues other than those of climate change, such as minimizing the environmental impact of the huge quantity of waste collected (25 billion tonnes have already been accumulated against 10 million tonnes collected annually), they will also have a positive impact on mitigation of methane emissions, if fully implemented. However, implementation may be difficult in view of the lack of financial resources within municipalities.

C. Nitrous oxide

71. In 1999, there were 33 million ha of arable land, of which 28 million were allocated to agricultural enterprises and private farmers. (The State still owns 48.8 per cent of the total land area, agricultural enterprises own 46 per cent and the rest is owned by private farmers). Like the other sectors of economy, the agricultural sector underwent major changes during the last decade: from 1990 to 1997 alone, the crop output dropped by 39 per cent and the livestock output by almost half. The final objective of the ongoing reform in this sector is to change the ownership via privatization and restructuring so that farming become a profitable business. However, for

the time being the sector faces severe difficulties, which stem from the obsolete technologies, high prices of energy and lack of access to credit.

72. Ukraine has in place an elaborate system of norms for fertilizer application, based on a detailed analysis of soils accounting for different needs of crop species and different climate conditions in all three climate zones of Ukraine. This system was launched as a result of the 1995 Presidential Decree on Land Labelling, which aimed at optimizing production while minimizing the environmental impact on soils. Indeed, driven by the rapid increase in fertilizer prices, the amount of fertilizer applied to soils plummeted from 140 kg per ha in 1990 to 20 kg per ha in 1998, much below the recommended levels, with negative implications for productivity in agriculture.

73. Of all the new legislation adopted or under preparation in the recent years in agriculture, two laws have relevance to climate change. The first, the 1997 Pesticides and Agrochemicals Act, aims to regulate the application of pesticides and fertilizers in order to minimize the impact on the environment and improve the quality of production. Ensuring productivity while minimizing soil erosion is the main goal of the other law, the Land Protection and Rational Land Use Act, which has yet to be promulgated.

74. While the new laws and recent trends in crop management are likely to lead to reduced N_2O emissions, the ongoing changes in livestock may bring about an increase in CH_4 and N_2O emissions as the breeding of smaller herds on open pasture replaces big, closed farms.

D. New gases

75. The new gases are currently neither estimated nor regulated in Ukraine. Even though the share of these gases may be small, with the phasing-out of ozone-depleting substances by 2000 in accordance with the national programme and the schedule agreed upon in the London Agreement (to the Montreal Protocol), the emissions of HFCs used as substitutes for such substances are likely to increase, together with the import of products containing them. In this context, the team acknowledged that it is necessary at least to initiate assessment of the new gases and, thereafter, to launch policies to mitigate emissions if necessary.

IV. PROJECTIONS AND ESTIMATES OF THE EFFECTS OF MEASURES

76. Ukraine provided in its NC1 projections of the direct GHGs, CO_2, CH_4 and N_2O, for three scenarios and of the precursors, NO_x, CO and NMVOC, for one scenario. The NC1 also contained projections of the forest sink for two scenarios. Information on projections was presented by sector and by gas according to the guidelines. In addition, detailed information on the potential effect of mitigation options, mainly the expected effect of energy efficiency measures, was given. Projection data were presented for the years 2000, 2005, 2010 and 2015. Limited detail on the methodology used was provided in the NC1, but more information on that matter was given to the team during the visit. Future trends of emissions of PFCs, HFCs and SF_6 were not estimated. The NC1 did not contain projections of emissions from bunker fuel due to the lack of information on how to split bunker fuel emissions from the national totals, a problem

already outlined in the inventory section. Despite these omissions however, the team concluded that Ukraine broadly respected the guidelines with regard to projections.

77. Projections were prepared by Arena-Eco in cooperation with several institutes under the National Academy of Sciences. Projections of energy-related CO_2 emissions and emissions from industrial processes were constructed on the foundations of several framework documents adopted by the Government, namely, the 1996 National Energy Programme, the 1995 Programme of Restructuring the Ukrainian Economy, the 1996 Energy Conservation Programme and a series of programmes underlying the development of specific sectors of industry, inter alia, copper, mining and smelting, aluminium and titanium.

78. The three projections presented in the NC1 for the direct GHGs encompass a "baseline scenario", an "optimistic scenario" and a "pessimistic scenario". These scenarios did not follow strictly the definitions given in the guidelines for baseline, “without measures” and “with measures” scenarios. Rather, they reflected possible pathways for macroeconomic development in the Ukraine under different sets of assumptions concerning the success of economic reform, the timing of economic recovery, and the pace of future economic development in terms of GDP growth and structural change, as well as the rate of replacement of outdated technologies by new ones, including by energy efficient technologies.

79. Among these assumptions, that on GDP growth rate was considered by the host country experts as the most important. At the time the NC1 was prepared, the most recent projections of GDP growth available were those of the 1996 Energy Conservation Programme and hence those were the projections used in the NC1. Almost at the same time, the Greenhouse Gas Mitigation Options Analysis was completed in the framework of the United States Country Studies Program. That analysis took a more pessimistic view of future economic development and used lower GDP growth rates in estimating the effect of energy efficiency measures.

80. To analyse the NC1 projections, the review team compared the two sets of GDP growth rates mentioned above with the statistical data on actual GDP development and the most recent macroeconomic projections prepared by the Institute of Economic Projections of the National Academy of Sciences. The data from different sources on GDP growth rate given in table 4. have been recalculated to make the time-series consistent. The team remarked that, because of the decline of economic output since 1990, in every case the GDP level at the projection horizon of 2015 is likely to be lower than anticipated in the baseline scenario. What is more, it could be lower even than anticipated in the pessimistic scenario. Even though the team became aware of some serious problems in the statistical coverage of the published GDP figures, further improvement in the GDP estimation methodology is unlikely to change greatly the overall assessment of the future GDP trend.

Table 4. Statistical data on historical and projected levels of GDP

	1990	1995	1996	1997	1998	1999	2000	2005	2010	2015
	1990 level = 100[a]									
Statistical data[a]	100	47.8	43	41.6	41					
NC1 baseline[b]	100	47.9					56.1	79.9	114.2	132
NC1 optimistic[b]	100	47.9					61.7	87.4	124.7	150
NC1 pessimistic[b]	100	47.9					49.5	66.8	90.9	105
MOA 3 pessimistic[c]	100	47.9					43.6	49.4	53.5	59.3
Recent projection I[d]	100				41.1	40.6	40.6	46.2	58.9	71.7
Recent projection II[d]	100				41.1	41	41.8	59.2	86.9	121.9

[a] Statistical data may differ from data used for projections because of recent revisions.
[b] 1996 Energy Conservation Programme.
[c] Country Study on Climate Change in Ukraine. Greenhouse Gas Mitigation Options Analysis, Kiev 1996.
[d] Data of the Institute of Economic Projections of the National Academy of Sciences made available to the team during the visit.

81. The three scenarios of emissions from fuel combustion and industrial processes given in the NC1 could be considered as "with measures" scenarios because each one of them implies a different degree of implementation of the 1996 Energy Conservation Programme. However, due to the lack of sufficient funding, implementation of this programme is likely to be postponed.

82. For the forestry sector the two scenarios prepared included baseline and mitigation scenarios. The latter reflects the likely impact of the implementation of the 1995 Programme of Development of the Forestry and Timber Industry of Ukraine for the Period up to 2015. Due to problems of funding, the impact is likely to be small. For agriculture, a set of three scenarios for emissions of CH_4 and N_2O was prepared - pessimistic, baseline and optimistic. The 1996 Draft National Programme of Development of Agricultural Production in Ukraine for 1996-2005 served as the basis for emissions scenarios and for estimating the effect of mitigation measures in this sector.

83. Projecting future economic development, energy and emission trends is an extremely difficult task in economies in transition because historical trend analysis is of little relevance in their situation. In the case of Ukraine, the lack of an energy sector modelling tradition brought about by the centralized modelling practices in the former Soviet Union introduced an additional level of complexity for the projection team. To overcome this problem the existing expertise in several institutes and state agencies was tapped and a methodological approach was adopted which combines expert estimates, accounting and optimization models.

84. To project macroeconomic development, an accounting model and expert estimates were used to analyse 17 different sectors of the national economy including several industrial sectors as well as the transport, commercial and residential sectors. Projections of energy demand were obtained also with the help of an accounting model which combined macroeconomic sectoral development indicators with expert judgements on energy intensity improvement for various sectors. Energy supply scenarios were elaborated by dynamic linear optimization models developed by the Institute of Energy of the National Academy of Sciences. The last step in the projection exercise, calculation of emission projections, was then performed by multiplying

projections of different types of energy by the relevant emission factors. These emission factors were broadly consistent with the factors used in the inventory and in the most cases remained constant over time, one of the exceptions being the factors for fugitive emissions.

85. Energy technologies were considered explicitly in the model on the energy supply side. On the demand side, the possible rate of uptake of new energy efficient technologies was modelled in an aggregated way by assuming a specific rate of energy efficiency improvement. The team acknowledged that the methodological approach used for projections was broadly adequate for the task of preparing projections for the NC1. However, this approach did not reflect the effects of economic liberalization and of price and taxation policy on future energy and emission trends.

86. Key variables for the baseline scenario were summarized in the NC1 in several tables, broadly in line with the guidelines. It is worth mentioning several underlying assumptions used for projections, such as accelerated development of the iron and steel, chemical and petrochemical, and machine-building industries, accelerated development of the services sector and, last but not least, decreased energy import dependency as a result of increased domestic coal production.

87. As an intermediate result of the projection exercise, projections of different fuels for the baseline scenario were given in the NC1. Similar information for the optimistic and pessimistic scenarios was provided to the team during the visit. Having analysed this information, the team noted that the differences in fuel structure in the three scenarios were marginal. In terms of overall energy consumption, it was projected to increase from 220 Mtoe in 1990 to 205 Mtoe in 2015 in the baseline scenario, to 235 Mtoe in the optimistic scenario and 180 Mtoe in the pessimistic scenario. Information on the fuel prices used especially in the optimization model was not available. Furthermore, the key drivers used to prepare the optimistic and pessimistic scenarios for agriculture and industrial processes were not documented in the NC1.

88. Closer analysis of the scenarios suggests that, after a period of decrease caused by the economic recession, CO_2 emissions were to rise again in 1995 as a result of economic revival. These emissions were expected to grow by 3, 4.5 and 6 per cent annually between 1995 and 2000 for the pessimistic, baseline and optimistic scenarios respectively. After 2000 the emission growth was expected to slow down and to be within a very narrow range of 1 to 2 per cent annually for different scenarios up to 2015. As to the effect of the measures implemented, energy intensity improvements were expected to influence strongly the energy consumption and emission trends in the first 10 years of the projection period, i.e. between 1995 and 2005. Thereafter, the effect of such improvements would be less significant.

89. The team felt that the roughly constant fuel structure assumed over the whole projection period for all scenarios might be questionable. In particular, domestic coal production, which was assumed to increase steadily up to 170 million tonnes by 2015, might be considerably lower as the production cost exceeds the market value of the coal in most of the mines. The team learned that many policies and measures assumed in the scenarios, e. g. on energy efficiency, could be delayed by the lack of investment. Other measures, such as mitigation of methane

emissions from coal mines and the extension of waste incineration could be not only delayed, but even not implemented at all for the same reason. Concerning projections of N_2O emissions from fuel combustion, the team noted the unusual shape of the projection curve in the baseline scenario, for which no explanation was provided.

90. The projections presented in the NC1 indicate that in 2015 only for the optimistic scenario will the GHG emission level be close to that of the base year 1990, but it will still be around 4 per cent lower. For the baseline and pessimistic scenarios, the emission levels in 2015 are expected to be16 and 24 per cent lower than the 1990 level respectively. In the shorter term, baseline GHG emissions in 2000 were expected to be 24 per cent lower than in1990 and for the optimistic and pessimistic scenarios these levels were within a range of ±4 per cent of the baseline.

91. The year 1995 was considered in projections as a turning point in the country's economic development. Consequently, all the emissions were projected to grow after 1995. As mentioned above, the growth of CO_2 emissions, which to a large extent define the country's emission profile, was expected to be between 3 and 6 per cent annually between 1995 and 2000 in all three scenarios. The inventory data provided to the team during the visit suggest that actual emissions, instead of growing as assumed in the projections, continued to decrease until 1998, the last year for which inventory data are available. For CO_2 emissions, for example, the decline was around 8 per cent annually. Therefore, actual emissions should remain significantly lower than the baseline until 2015 and they are likely to be lower even than the emissions in the pessimistic scenario. The team gained the impression that the likely delay in the implementation of the planned policies and measures would not reverse this trend.

92. The forest sink is projected to grow steadily, but at different rates, in both the baseline and the mitigation scenarios. At the end of the projection period the difference between the two scenarios will reach 14,500 Gg CO_2 stored, the higher level applying to the mitigation scenario. However, due to the problems related to funding of the measures envisaged, the effect could be much smaller.

93. A list of 28 measures targeting emissions of CO_2, CH_4 and N_2O was presented in the NC1, with mitigation effects assessed at 373,547 Gg CO_2 equivalent in 2015. This list was prepared mainly on the basis of the options identified in the 1996 Energy Conservation Programme, which envisaged energy savings of 24-26 Mtoe in 2000, 46.5-50 Mtoe in 2005, 74-76.4 Mtoe in 2010and 98-100.3 Mtoe in 2015. Consequently, mitigation was to be achieved chiefly by energy efficiency improvement, 61 per cent of the total effect, followed by renewable energy, 12 per cent, and mitigation of fugitive emissions from natural gas systems and coal mines, 12 per cent, with energy consumption metering, demand-side management, industrial process improvement, coal-bed methane reduction, fuel switching to natural gas and improvements in waste management making up the rest. The team acknowledged that the total mitigation effect of all measures amounts to around 40 per cent of the Ukraine 1990 emissions.

94. Little information was given in the NC1 on the methodology used to estimate the effects of measures. During the review visit, the team gained an understanding that these estimates were

obtained largely following a bottom-up approach by studying in detail all the technical options possible. The team noted that measures estimated were more of a technical than of a policy nature. Consequently, the effect estimated must correspond to the technical potential, which is much higher than the economic and market potentials. Moreover, due to the lack of significant domestic and foreign investment and the restructuring of many of the enterprises in which a mitigation potential was identified, only a fraction of this potential is likely to be materialized. As mentioned above, in each of the emission scenarios a different degree of implementation of the 1996 Energy Conservation Programme was assumed. However, details of how the effect of the programme was incorporated in the scenarios and how the overlap between different measures was avoided, were not available to the review team.

95. The review team noted the difference between the base year emissions estimated in the GHG inventory section of the NC1 and those of the same year used for projections, which introduced an element of inconsistency between the GHG inventory and projections. The NC1 explained this difference clearly. The main reason was that an advanced version of the GHG inventory was used for projections, whereas the inventory section presented the original version. The revised version of the inventory included some additional non-combustion emission sources on the one hand and some more accurate emission calculations on the other hand, which led to higher emissions for non-energy-related CO_2, CH_4 and N_2O emissions. Another reason for the difference was the use of more aggregated fuel types and corresponding emission factors for projections as compared to the GHG inventory.

V. VULNERABILITY ASSESSMENT AND ADAPTATION MEASURES

96. The work on climate change modelling, vulnerability assessment and adaptation was coordinated by the ICC and Arena-Eco, with the active participation of the State Committee for Hydrometeorology and several institutes of the National Academy of Sciences. The main part of the work was accomplished under the United States Country Studies Program and published in the relevant reports. Arena-Eco also published, in 1998, a book entitled *Ukraine and Global Greenhouse Effect. Part II. Assessment of the Ecological and Economy Systems Vulnerability and their Adaptation to Climate Change in Ukraine*. The work was done in four stages, development of climate scenarios, evaluation of vulnerability by sector, analysis of adaptation options and preparation of recommendations for adaptation.

97. For the climate scenarios, outputs of four general circulation models (GCM) provided by the United States National Center for Atmospheric Research were used for equilibrium conditions. In addition, outputs from models developed by GFDL and the Max Planck Institute in Hamburg were used for transient conditions. To reflect regional climate features taking into account the three main climatic zones of Ukraine, interpolation techniques were applied for downscaling. The team was informed that this was the first experience of the Ukrainian team in utilizing GCM outputs. Climate scenarios were developed assuming maintenance of the current concentration of CO_2 in the atmosphere and doubling of that concentration. The results expressed in terms of differences between temperatures and precipitation levels suggest a likely increase of temperature in Ukraine for each season or some seasons, depending on the model,

and also a likely increase in precipitation. Steppes are expected to be the most vulnerable areas of the country with respect to climate change.

98. Results of impact studies suggest that the potential changes in temperature and rainfall pattern may adversely affect water resources, the coastal zone, forests and agriculture. Impacts on human health were not addressed because of the lack of data. Assessment of the hydrological vulnerability of the Dnieper River Basin, which supplies 65 per cent of the water used in the economy, indicates likely significant changes in runoff and ratios of total water demand to total water supply by 2075, and hence likely impacts on irrigated agriculture and river navigation. For the coastal zone, the likely impacts are expected to be significant losses and salination of arable land due to flooding of the Black Sea and Azov Sea coasts as well as loss of recreational land and of numerous archaeological and historical monuments.

99. In the forestry sector, vulnerable forest functions are expected to be those providing recreation, preservation of biodiversity of ecosystems and social protection of the population. The team noted the cooperation between the UNFCCC group and the Convention on Biological Diversity group on forestry matters. In agriculture, the likely impact on winter wheat production, which accounts for 50 per cent of Ukraine's total crop production, is expected to be a significant decrease by 2075, accompanied by an extension of the cultivation area northwards, while hard grain production will grow.

100. Climate change impact assessment provided an essential foundation for developing and recommending a set of adaptation measures by sector. For water resources, the adaptation measures encompass rather expensive ones, such as increasing the usable storage capacity of reservoirs, canals and creation of necessary navigation depths, reduction of the area of irrigated land and use of artesian water to meet demands for drinking water. For the coastal zone, a national programme of coastal protection measures to monitor trends and intensity of erosion processes and to adapt to the predicted sea level rises is under development, based on the General Plan of Anti-Landslide and Coastal Reinforcement of Ukraine. Adaptation measures in the forestry sector centre on planting resistant wood species, monitoring and forecasting forest conditions, and developing legislation and financial incentives. The National Plan for Land Protection was due to be adopted by the end of 1999. The adaptation measures for crop production envisage increased use of nitrogenous fertilizers, which is likely to increase both production costs and N_2O emissions. The team was told that implementation of adaptation policy in the agriculture and forestry in Ukraine may start with the acceleration of land reform.

VI. FINANCIAL ASSISTANCE AND TECHNOLOGY TRANSFER

101. As a country with an economy in transition, Ukraine does not have a commitment to provide financial assistance to developing countries and to facilitate technology transfer and did not include such a chapter in the NC1. During the country visit the team was informed of several activities in the field of international cooperation on climate change which are summarized in this section of the report.

102. Ukraine is a party to several bilateral and multilateral agreements, which the host country officials felt help the country to strengthen its capacity to address climate change. The first comprehensive study on a GHG inventory, mitigation policies and measures and other climate change related issues was produced under the United States Climate Study Program. Later, in 1998, the Alternative Fuel Centre was launched with the support of the United States Agency for International Development and the United States Environmental Protection Agency, with the objective of stimulating research on and exploring options for economically feasible ways of recovering coal-bed methane and using it for energy purposes, and of measuring fugitive methane emissions for the purposes of the GHG emission inventory.

103. A special climate change subgroup of the bilateral Kuchma-Gore commission was set up to facilitate the exchange of information and lessons learned from the design and administration of market-based environmental programmes and climate technologies in the United States. Other tasks of the subgroup included the coordination of training programmes and programmes on raising public awareness of climate change (32 workshops were conducted in two years) and stimulating investments by United States companies in the energy, metallurgy and coal sectors of the Ukrainian economy, as well as in municipal energy management, including district heating.

104. A bilateral agreement was concluded with Canada in 1999. It aims to support Ukraine in developing its climate change strategy, strengthening the institutional framework on climate change, implementing mitigation policy and improving climate system observation. Under this agreement and an agreement between Ukraine and Finland, specific proposals for joint implementation projects on mitigation are to be elaborated together with joint work on project assessment, verification, reporting and registering

105. A long and diversified portfolio of projects is being implemented in Ukraine with the support of the EC TACIS programme. This includes projects aimed at harmonizing the energy and environmental legislation of Ukraine with that of the EU countries and projects aimed at improving energy efficiency.

VII. RESEARCH AND SYSTEMATIC OBSERVATION

106. The State Committee for Hydrometeorology is the main organization responsible for research and systematic observation and implementation of the NCP. It also serves as the focal point for Ukraine for IPCC. Climate research is being conducted in cooperation with other academic institutes and state agencies, such as several institutes of the National Academy of Sciences, the Ministry of Education and the Ministry of the Environment. The Head Geophysical Observatory provides methodological guidance on this matter.

107. The NC1 does not contain information on the climate related research and systematic observation. During the country visit, the team was informed that meteorological observations started in Ukraine in the middle of the last century, and the country participates in many programmes of the World Meteorological Organization as well as in the global exchange of data. The team noted that climate monitoring under the NCP covers all aspects of observation: ground, air, sea, and remote sensing.

108. The NCP was launched by the Government in 1997 and covers the period from 1998 to 2001. Under this programme the following activities have been performed: monitoring of GHG emission levels, development of scenarios and prediction of changes in the regional climate in Ukraine by 2050 and development of methodology to assess climate change impacts. These activities also include the development of scenarios for Ukraine using global circulation models to be completed by 2001. The programme has suffered from severe cuts in financial support. For example, in 1998 it received only 12 per cent of the Gr 580,000 envisaged, and in 1999 only 20 per cent of the Gr 419,000 envisaged.

VIII. EDUCATION , TRAINING AND PUBLIC AWARENESS

109. The team was informed that a demand exists for educational materials on climate change. Ukraine has developed special programmes for schools and higher education institutions on that matter under the broader heading of ecology courses, the content of these courses depending upon the school's profile. At university level, the series of books on scientific and policy aspects of climate change published by Arena-Eco are used as background material. More targeted education measures are yet to be put in place.

110. As to public awareness, the team found that the level of such awareness is not high. This is understandable given the difficulties Ukraine has had to face in the transition to a free market economy and the number of pending economic and social issues on its policy agenda. However, some steps to improve the situation have been already taken and the team was informed that a coordination mechanism between government agencies and non-governmental organizations, which will centre, among other things, on climate change public awareness, is under establishment.

IX. CONCLUSIONS

111. The team noted the commendable efforts made by the inventory team to improve the quality of the Ukrainian GHG inventory between the NC1 and the submission of the annual inventory to the UNFCCC secretariat. Nevertheless, significant gaps in data availability and quality remained, which affected the ability of the inventory team to produce an inventory of high quality. These gaps include a lack of national energy balances, lack of data to estimate emissions from international bunker fuels, lack of sufficient data to estimate emissions from waste using a more comprehensive approach than the currently employed method, and lack of data to estimate emissions of HFCs, PFCs and SF_6. Preparing official energy balances as well as conducting a study to identify better the remaining data gaps and actions necessary to fill these gaps could prove useful to further improving the inventory.

112. On the institutional framework, the team remarked that efforts are necessary to ensure continuity in the inventory preparation and adequate financial support for inventory work. This would allow for involvement of a sufficient number of experts, improved quality of statistical data and review of inventory results by different institutions. In terms of the results obtained, the decline of 64 per cent in overall emissions between 1990 and 1998 driven by the economic decline and recession was noteworthy.

113. With regard to general climate policy, the team acknowledged that the NC1 represents the first successful attempt to lay down within a common analytical framework climate-relevant policies. Notwithstanding the wealth of information provided in the NC1, the team stressed the importance of presenting information in line with the guidelines. The major deviation from these guidelines was the lack of estimates of the effect of individual measures or packages of measures. Such estimates could be very helpful in monitoring implementation and taking corrective action if necessary. One of the conditions to obtain such estimates is to have reliable energy data, and in particular official energy balances, which were missing at the time of the visit. The team felt that the ICC could address these issues.

114. The improvement of energy efficiency is a core element of the evolving climate change policy of Ukraine. This policy is of high priority for the country, because it meets environmental objectives while improving energy security and lessening energy import dependency. The team noted that many developments which could help save energy and consequently reduce emissions are under way. These include strengthening of the institutional framework, e.g. setting up the State Committee for Energy Conservation and ESCOs, promulgation of a broad portfolio of new laws and regulations and launching of targeted programmes and projects, including those supported bilaterally and by the World Bank, EBRD and the EC.

115. The implementation of this policy, however, has been hindered by non-payment of energy consumed and continued subsidizing of prices for some types of energy, which together prevent recovery of the investment made in energy efficiency, the limited availability of investments, very high interest rates and the economically unstable condition of many industrial enterprises, which makes investments in energy efficiency highly unlikely. The team became aware of the endeavour of the Government to work towards removing these barriers, and noted the laudable efforts of the State Committee for Energy Conservation and Arena-Eco to find innovative solutions to promote further energy efficiency.

116. With regard to other measures, the ongoing reform in the energy sector is likely to lead to improved efficiency, gradual removal of price subsidies and cross-subsidies, and full implementation of the cost recovery principle in energy pricing. However, special support is necessary, at least at the initial stage of the reform, to secure the environmental objectives and, in particular, to preserve the share of CHP in the heat and electricity market and to increase the contribution of renewables in this market. The team noted that the goal of the 1996 National Energy Strategy to increase the share of coal in TPES in order to improve energy supply security and employment in the sector may run counter to the objectives of climate change policy.

117. The review of the key data points, methodologies and results of the projection exercise suggests that, due to the economic recession, Ukraine is likely to be among the few countries to meet the aim of the UNFCCC to ensure that the GHG emissions level in 2000 is lower than in1990. In fact, emissions will be at least 24 per cent lower. In the longer term, in 2015, even if implementation of some of the measures envisaged such as energy efficiency improvement, coal-bed methane utilization and waste incineration is delayed, the emission level even in the optimistic scenario, which assumes the fastest rate of economic recovery and hence higher emissions, will likely remain below the 1990 level. The team noted the high level of uncertainty of emission projections arising from the uncertainty of the rate of structural change and economic development. In this context, better adjustment of the models against historical emissions could be useful.

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