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## **SLOVAKIA**

Report on the in-depth review of the second national communication of Slovakia

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## I. INTRODUCTION AND NATIONAL CIRCUMSTANCES

1. The Slovak Republic ratified the Convention on 25 August 1994. It subsequently submitted its second national communication (NC2) in August 1997. The in-depth review was carried out during the period February to September 1998 and included a visit to the country by a team from 14 to 17 April 98. The review team consisted of Dr Raquel Francisco (Philippines), Ms Eva Elbaek Jorgensen (Denmark), and Ms Amrita Narayan Achanta (UNFCCC secretariat, Coordinator).

2. Located at the heart of Europe, Slovakia is a mountainous country with an area of 49,036 km<sup>2</sup>, and a mild climate. The population at the end of 1997 was 5.38 million. According to a United Nations Economic Commission for Europe report (ENERGY/1997/6), Slovakia ranks first in terms of the rate of economic recovery after the recession among the countries with economies in transition (EIT), with a gross domestic product (GDP) growth rate of 4.3 per cent in 1994, 7.7 per cent in 1995, 6.9 per cent in 1996 and 6.5 per cent in 1997. The structural changes which have marked the country's transition to a market economy include a decline in the share of industry (from 50 per cent in 1990 to 28.2 per cent in 1997) and an increase in the share of services (from 19 per cent in 1990 to 43.4 per cent in 1997). Agriculture showed a negligible decline over the same period.

3. Though the structure of Slovakia's primary energy supply changed little between 1990 and 1996, total primary energy supply (TPES) declined by a quarter between 1990 and 1994. In 1996, the structure of TPES by fuel was: coal (29 per cent), natural gas (30 per cent), oil (20 per cent), nuclear (17 per cent) and others (3.5 per cent). Seventy-three per cent of TPES is imported, including coal, crude oil, natural gas, nuclear fuel and electricity. Among the limited indigenous energy resources are low-quality lignite and hydropower. The phasing-out of lignite usage in power generation is likely to be in 2010.

4. In 1996, nuclear energy constituted the main source of the country's electricity with a share of approximately 49 per cent, followed by thermal power (32 per cent) and hydropower (18 per cent). While energy intensity declined between 1992 and 1996 by approximately 16 per cent, mainly due to structural changes, Slovakia still uses an amount of energy per unit GDP approximately three times the average for European country members of the Organization for Economic Co-operation and Development (OECD Europe). Per capita energy consumption is similar to that of OECD Europe. In 1996, the final energy consumption by sector was as follows: industry (46 per cent), household (18 per cent), services (16 per cent), transport (9 per cent), and non-energy consumption, which includes use of fuel as feedstock, in kilns and incinerators (7 per cent).

5. Slovakia is also negotiating for membership of the European Community (EC) and the OECD. Currently it enjoys the status of an associate member of the EC.

6. The team noted that Slovakia was committed to implementing measures aimed at achieving two targets. The NC1 identified the "Toronto target" as the Slovak national target,

which would require them to reduce energy-related carbon dioxide (CO<sub>2</sub>) emissions by 20 per cent with respect to the 1988 level (58,484 Gg CO<sub>2</sub>) by 2005. Consequently this target was included in the 1993 National Energy Strategy and Policy of the Slovak Republic up to 2005. The team noted that in the NC2 the "Toronto target" was reiterated, along with the United Nations Framework Convention on Climate Change (UNFCCC) aim of stabilizing greenhouse gas (GHG) emissions at 1990 levels by 2000. The host country also reiterated that it did not seek to apply the provisions of flexibility contained in Article 4.6 of the Convention given to Parties with economies in transition, and had adopted 1990 as the base year instead of an earlier year when emissions were higher, in spite of the difficulties experienced during the complex process of transition to a free market economy.

7. The team noted that the NC2 was adopted by the Government in June 1997. The host country informed the team that the NC2 focussed on the energy sector. During its preparation the host country used the UNFCCC guidelines, with a few exceptions. The ministries of the environment (coordination), economy, transport, posts and telecommunication, agriculture and foreign affairs, government institutes, including the Slovak Hydrometeorological Institute and the Research Institute of Transport, a number of institutions under the national climate change programme, and the private company PROFING Limited, were all involved in the preparation. The Ministry of Finance and the non-governmental sector were not directly involved in this exercise, although the impression conveyed to the review team by the latter group, which had contributed indirectly to the NC2, was that they were satisfied with the efforts of the Ministry of the Environment and would await the implementation of the measures mentioned in the communication.

8. The team was informed that the NC2 contained a limited amount of new information in comparison to the NC1. Among some of the major changes in the interim period having climate change implications were the change in number of administrative units (33 to 79 districts) with implications for energy plans, the updating of the 1993 National Energy Strategy and Policy of the Slovak Republic up to 2005, to the period 2010, the new Energy Act also known as the Energy Management Act (Act no. 70/1998), the amended Act on the Protection of the Air against Pollutants (also referred to as the Air Protection Act or Clean Air Act), the Act on Prices, and the completion of the United States sponsored country study on Slovakia. The team was also informed of the draft Energy Efficiency Act (also called the Act on Energy Conservation). The review team nevertheless concluded that the country lacked a coordinated national greenhouse gas strategy, in spite of the existence of individual pieces of legislation such as the Air Protection Act, which had indirect implications on the reduction of GHG emissions.

## **II. INVENTORIES OF ANTHROPOGENIC EMISSIONS AND REMOVALS**

9. The NC2 contained inventory data for 1988, and 1990-1995 for CO<sub>2</sub> (table 1 and figure 1), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), sulphur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs), and chlorofluorocarbons (CFCs). Preliminary data for 1995 were not included in the main text of the NC2, but in the annex. Subsequent to the visit, 1995 and 1996 emission data were submitted

to the UNFCCC secretariat in September 1998. The team has used the 1995 emission values contained in the NC2 for the following analysis due to a lack of consistency noted between the latest submission to the secretariat and the NC2. Both the discussions with national experts and additional information contained in the United States country study on Slovakia allowed the team to gain a better understanding of the national inventory.

10. In 1995, Slovakia's total emissions were 48,516 Gg CO<sub>2</sub> (compared with 60,030 Gg CO<sub>2</sub> in 1990), 315 Gg CH<sub>4</sub> (409 Gg CH<sub>4</sub> in 1990), and 7.8 Gg N<sub>2</sub>O (12.5 Gg N<sub>2</sub>O in 1990). In 1995, total CO<sub>2</sub> emissions were 19 per cent lower than in 1990. Of the total CO<sub>2</sub> emissions in 1995, 93.6 per cent were from the energy sector (94.2 per cent in 1990), and 6.4 per cent from industrial processes (5.7 per cent in 1990). The team noted that in 1990 the estimated per capita CO<sub>2</sub> emissions from fuel combustion were 10.71 tonnes, in comparison to the average value for OECD countries of 10.73 tonnes. In 1995, Slovakia's per capita CO<sub>2</sub> emissions from fuel combustion was estimated at 8.52 tonnes in comparison to the average for all OECD countries of 10.81 tonnes. The team found that the inclusion of selected worksheets and data tables allowed for reconstruction of most estimates, although the variation in detail of sectoral reporting between 1990, 1995 and the intervening years posed problems of comparison. The emission data had not been adjusted.

11. The team noted the high share of CO<sub>2</sub> emissions from the energy sector, the largest part of which came from the energy and transformation sector (52 per cent), followed by industry (20.8 per cent), and transport (9.3 per cent). The residential sector contributed 8.5 per cent, the commercial and institutional sector 7.2 per cent and agriculture 2 per cent. The team gathered that the availability of detailed sectoral data from the national inventory system allowed for a sectoral approach to be used only for 1990 and 1995. The use of this approach was not possible in the intervening years, as the CO<sub>2</sub> emissions from energy combustion had been categorized into stationary and transport sources instead of the standard categories recommended by the Intergovernmental Panel on Climate Change (IPCC) methodology, namely energy and transformation, industry, transport, commercial/institutional, residential, agriculture/forestry. The review team stressed the importance of availability of disaggregated data, due to the importance of the energy sector.

12. The emission factors used to estimate CO<sub>2</sub> emissions from the energy sector are national emission factors based on typical fuel composition and mean emission factor value for individual fuel types. The team noted that while biomass consumption data were recorded for 1990-1992, they were included under the category of "other solid fuels" for 1993, were lacking for 1994 at the time of finalization of the NC2, and were included for 1995. Furthermore biomass consumption declined steeply from 16,814 terajoules (TJ) in 1990, to 3,249 TJ in 1995. The team noted that although this would not influence the calculation of national CO<sub>2</sub> emissions, it could assume significance for calculation of non-CO<sub>2</sub> gases arising from biomass combustion.

**Table 1. Emissions of carbon dioxide by source, 1990-1996 (Gigagrams)**

	1990	1991	1992	1993	1994	1995	1996 <sup>d</sup>
Fossil fuel combustion <sup>a</sup>	56 583	50 038	45 616	43 584	40 389	45 426	43 104
Transport	5 168	4 426	4 116	4 029	4 189	4 216	4 164
Industrial processes	3 447	2 717	3 109	2 831	3 065	3 090	3 001
<b>Total CO<sub>2</sub><sup>b</sup></b>	<b>60 030</b>	<b>52 755</b>	<b>48 725</b>	<b>46 415</b>	<b>43 454</b>	<b>48 516</b>	<b>46 105</b>
Total land use change and forestry <sup>c</sup>	-4 257	-4 257	-4 257	-4 257	-5 116	-5 116	-5 281

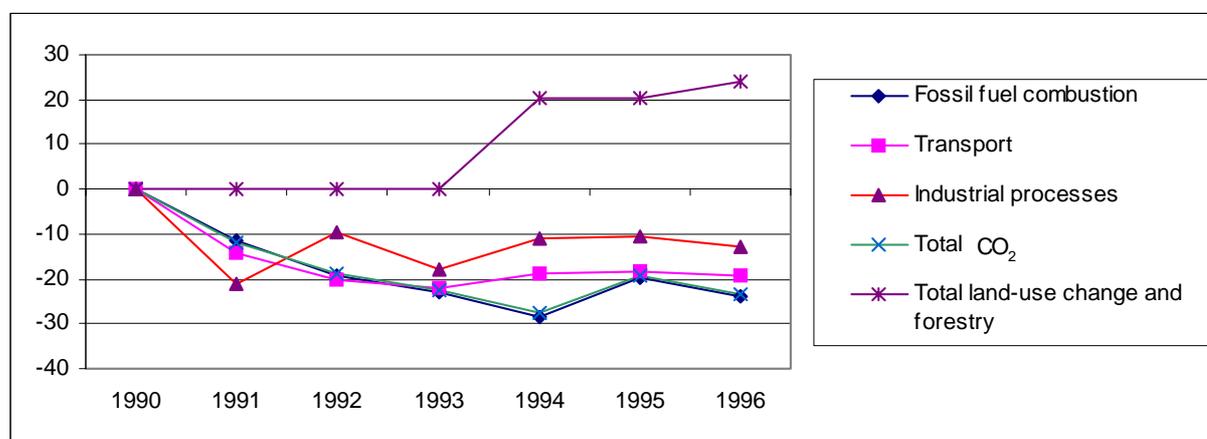
<sup>a</sup>: The data for fossil fuel combustion includes transport data but the transport data are also presented separately in the table so that the sectoral trend may be observed.

<sup>b</sup>: The estimate of total CO<sub>2</sub> includes those emissions from energy and industrial processes. It does not include the emissions from land-use change and forestry.

<sup>c</sup>: Both emissions and removals are included in the estimate for land-use change and forestry.

<sup>d</sup>: The data for 1996 were submitted to the secretariat subsequent to the review.

**Figure 1. Carbon dioxide emissions, percentage change from 1990 by source**



13. The estimate of emissions from the transport sector was based on a comprehensive coverage of the sector. The host country team used a bottom-up model called COPERT with input data on the total fuel consumed in the sector, detailed numbers of the vehicle fleet, driving regime, and average trip distance. The use of this method led to a less than 3 per cent difference in CO<sub>2</sub> estimated in comparison with the results obtained using the IPCC reference approach. The host country experts stated that the exclusion of some categories of vehicles in the model calculation, decrease in fuel consumption in 1995 and 1996 and the entry of fuel-efficient cars into the vehicle fleet are possible reasons for the relative stability of emissions from this sector. International bunker fuels were not included in the summary report, as the GHG emissions from this source were negligible (<0.5 per cent).

14. The calculations of CO<sub>2</sub> emissions from the land-use change and forestry (LUCF) sector included consideration of emissions from harvest, on-site burning, forest fires and grassland conversion. The team was informed that the uptake due to the growth increment had stabilized at around 9,680 Gg CO<sub>2</sub>/year. The higher net sink in managed forests of 4,460 Gg CO<sub>2</sub> in 1994 (4,012 Gg CO<sub>2</sub> in 1990) was due to a decrease in biomass harvest in 1994 (4,127,000 m<sup>3</sup> in 1994 from 4,910,000 m<sup>3</sup> in 1990).

15. For the category of land-use change, the team found that CO<sub>2</sub> emissions in 1990 were 462 Gg, amounting to around 30 per cent of the total land-use change and forestry emissions, and could not be regarded as negligible as stated in the NC2. Additionally, the team noted that the NC1 estimate of the forest-uptake potential for 1990 was 4,913 Gg CO<sub>2</sub> in contrast to the NC2 figure of 5,766 Gg. The team was further informed that the similarity in estimates for the land-use change and forestry sector for the periods 1990-1993, and 1994-1995 was due to the fact that the estimates were made in 1990 and 1994.

16. In 1995, the allocation of CH<sub>4</sub> emissions by sector was 38.7 per cent for agriculture (45 per cent in 1990), around 34 per cent for fugitive fuel emissions (29.8 per cent in 1990), 20 per cent for waste (16 per cent in 1990), approximately 5 per cent for fuel combustion (6 per cent in 1990) and 0.3 per cent for others (2.4 per cent in 1990). The 35 per cent decrease in agriculture-based CH<sub>4</sub> emissions between 1990 and 1995 (table 2 and figure 2) was due to a decrease in livestock numbers and lowered fertilizer application as a result of transformation of the economy from a planned system to a market system. While the emission factors used in estimating emissions from manure management were country specific, those used for emissions from enteric fermentation were IPCC default values.

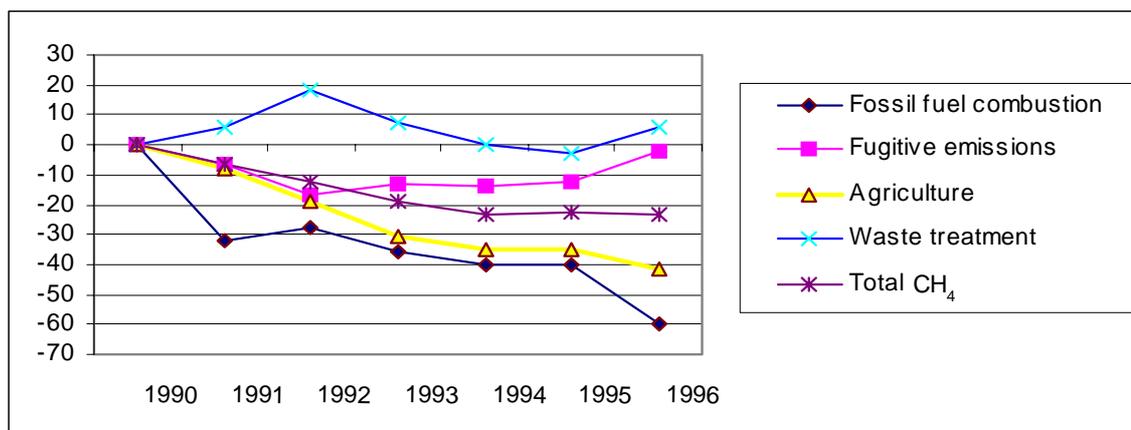
17. Fugitive emissions, the second largest source of CH<sub>4</sub>, amounted to 107 Gg in 1995 in comparison to 122 Gg in 1990. For the calculation of fugitive emissions from the natural gas transit pipeline (81.4 billion m<sup>3</sup> of gas transported in 1996), which transports Russian natural gas to the Austrian and Czech Republic borders, the IPCC default factors were used. Seventy-seven per cent of the fugitive emissions were due to leakage in oil and gas systems, and the rest to coal mining. The national experts felt that the use of the current IPCC default emission factor for mining led to an overestimation and instead should be zero. The third major source of CH<sub>4</sub> is the waste management sector, with an estimated contribution of 63 Gg CH<sub>4</sub> in 1995 (65 Gg CH<sub>4</sub> in 1990). The NC2 improved upon the NC1 in the estimation of emissions from municipal solid waste disposal sites.

**Table 2. Emissions of methane by source, 1990-1996 (Gigagrams)**

	1990	1991	1992	1993	1994	1995	1996
Fossil fuel combustion	25	17	18	16	15	15	10
Fugitive emissions	122	114	102	106	105	107	114
Industrial processes	7	6	7	6	6	6	6
Agriculture	187	172	151	130	121	122	115
Forest ecosystems	3	3	3	3	3	3	3
Waste treatment	65	69	77	70	65	63	63
<b>Total CH<sub>4</sub></b>	<b>409</b>	<b>381</b>	<b>359</b>	<b>331</b>	<b>315</b>	<b>316</b>	<b>310</b>

18. The contribution of CH<sub>4</sub> emissions from sources such as fuel combustion, industrial technologies and forests were much smaller compared to the above-mentioned sources. The release of CH<sub>4</sub> from soils in forest ecosystems and natural forest fires was included. For the industrial processes category, estimates of methane emissions were provided for the iron and steel industry.

Figure 2. Methane emissions, percentage change from 1990 by source



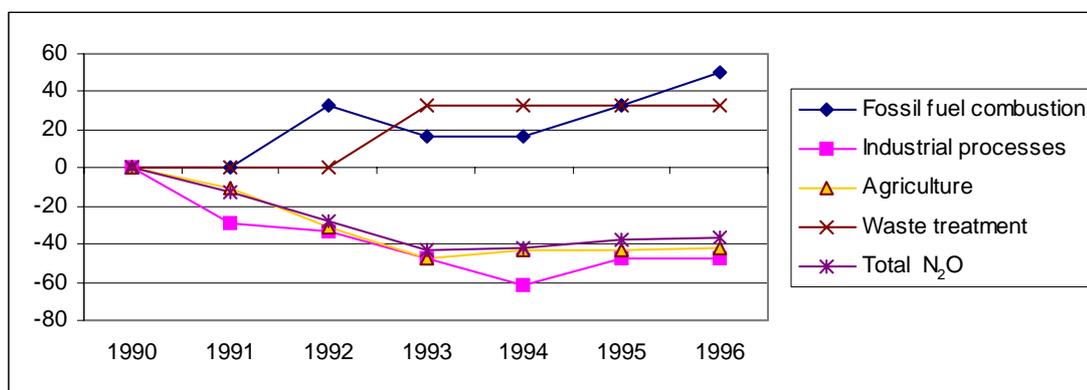
19. The NC1 estimate of total N<sub>2</sub>O emissions in 1990 was 16 Gg in comparison to the NC2 estimate of 12.5 Gg N<sub>2</sub>O. The host country attributed this difference to the use of a new IPCC default emission factor in the energy sector in the NC2 instead of the CORINAIR factor used in the NC1. In 1995 the nitrous oxide emissions declined to 7.7 Gg, with the sectoral contribution of agriculture at 69 per cent (76 per cent in 1990), industrial processes 14 per cent (around 17 per cent in 1990), fuel combustion 10 per cent (around 5 per cent in 1990) and others 5 per cent (2 per cent in 1990) (table 3 and figure 3).

**Table 3. Emissions of nitrous oxide by source, 1990-1996 (Gigagrams)**

	1990	1991	1992	1993	1994	1995	1996
Fossil fuel combustion	0.6	0.6	0.8	0.7	0.7	0.8	0.9
Industrial processes	2.1	1.5	1.4	1.1	0.8	1.1	1.1
Agriculture	9.5	8.5	6.5	5	5.4	5.4	5.5
Waste treatment	0.3	0.3	0.3	0.4	0.4	0.4	0.4
<b>Total N<sub>2</sub>O</b>	<b>12.5</b>	<b>10.9</b>	<b>9</b>	<b>7.2</b>	<b>7.3</b>	<b>7.7</b>	<b>7.9</b>

20. The decrease in agricultural emissions from 1990 to 1995 was due to a substantial decline in fertilizer application. There was a simultaneous increase in N<sub>2</sub>O emissions from the transport sector, which was attributed to the use of catalytic converters. For the industrial sector, emissions were primarily from the production of nitric acid.

Figure 3. Nitrous oxide emissions, percentage change from 1990 by source



21. Hydrochlorofluorocarbons (HCFCs) are not produced in Slovakia and their emissions are not known. Neither are there any emission estimates for HFCs, PFCs and SF<sub>6</sub>. The review team was told that HFC emissions were still low in Slovakia but were expected to increase with the phase-out of freons, as in most countries that are signatories of the Montreal Protocol. Further work on activity level data and emission factor development for these gases in the near future was unlikely, due to budgetary constraints. In 1994, emissions of hexafluoroethane (C<sub>2</sub>F<sub>6</sub>) and tetrafluoromethane (CF<sub>4</sub>) from aluminium production were estimated at 0.001 Gg C<sub>2</sub>F<sub>6</sub> (0.002 Gg C<sub>2</sub>F<sub>6</sub> in 1990) and 0.045 Gg CF<sub>4</sub> respectively (0.74 Gg CF<sub>4</sub> in 1990).

22. The team learnt that the revisions in 1990 emission estimates between the NC1 and NC2 arose because of the increased application of country-specific emission factors, adoption of a sectoral approach for CO<sub>2</sub> emissions, consideration of fugitive emissions, use of the 1995 IPCC Guidelines and inclusion of additional sources such as methane from horses and nitrogen input to soil through biological fixation, and altered emission factors in the industrial process sector. The team was uncertain whether the CO<sub>2</sub> emissions reported from bread, beer and grape wine production were incorrectly reported as biogenic emissions or whether they had been calculated from NMVOC emissions from these processes as indicated by the IPCC.

23. The review team noted that in general Slovakia used the 1995 IPCC Guidelines, and default emission factors whenever country-specific data were unavailable. In the energy and transport sectors, country-specific emission factors were used. In general, CO<sub>2</sub> emission estimates obtained using the national inventory system (bottom-up approach) and those obtained using the IPCC reference approach were within 5 per cent of each other, although the host country experts suggested that further investigation was needed. With regard to the use of the 1996 Revised IPCC Inventory Guidelines, no difficulty was anticipated.

24. Based on the qualitative estimates included in the NC2 and discussions, the host country experts expressed a high level of confidence in the estimates of CO<sub>2</sub> emissions from fuel combustion and low confidence in the estimate of fugitive fuel emissions. In the case of the land-use change and forestry sector, the degree of confidence was high except in the category of

grassland conversion, where confidence levels were moderate. A moderate degree of confidence was expressed for the estimation of CH<sub>4</sub> from fugitive emissions, industrial processes, agriculture and solid wastes. The level of confidence in methane emissions from fuel combustion, on-site burning and forest fires, and waste-water treatment were described as low. The level of confidence in the N<sub>2</sub>O emission estimates was low.

25. The team observed that since 1987, under the Clean Air Act, emission data on SO<sub>2</sub>, NO<sub>x</sub>, CO and dust were being collected. There was no collection of CO<sub>2</sub> or other direct GHG data, under the framework of the current national database. Using the inventory system for the Clean Air Act, sectoral CO<sub>2</sub> emissions were computed based on fuel consumption and quantity of products produced. In the future, data collection was to be limited to the local environmental offices and the Slovak Hydrometeorological Institute, under the Poland and Hungary Assistance for Restructuring Economies (PHARE) capacity-building project. The team also gathered that inventory studies to collect activity level data and emission factor data were being conducted at the Slovak Hydrometeorological Institute, the Research Institute of Traffic and the Forest Research Institute.

### **III. POLICIES AND MEASURES**

26. In the section of the NC2 on policies and measures for GHG mitigation, information was presented in a transparent way by sector and gas, in compliance with the guidelines. The team learnt that the measures implemented and planned in the energy, industrial, and land-use change and forestry sectors were likely to lead to a reduction of CO<sub>2</sub>, CH<sub>4</sub> and NMVOC emissions and increase in CO<sub>2</sub> sink capacity in the period up to 2010. Though the NC2 gives an overview of the policies and measures for reducing CO<sub>2</sub> emissions and their estimated effect, only a limited number of the measures listed were implemented at the time of the review visit. Some intermediate indicators of progress for the measures already implemented could be added in the "monitoring" column, as required by the guidelines.

27. The team was informed that the 1993 National Energy Strategy and Policy of the Slovak Republic up to 2005 and its updated version, referred to as the Revised Slovak Energy Policy up to the Year 2005 with Prognosis to 2010, passed by the Government in September 1997, both mention the "Toronto target". Additionally, a Government resolution passed at the time of the NC2 adoption requested all the ministries to implement the target via their various sectoral programmes. There are no sectoral targets. Further, the team learnt that the Slovak Ministry of the Environment, its regional and district offices, and the municipalities constitute the executive authorities for the environment under the Act (595/1990) on state administration of the environment. The distribution of competencies between the central government and the municipalities with regard to the implementation of legislation is variable. For instance, in the Energy Act there are no competencies for the municipalities, in contrast to the transport sector where they have a significant share, with the central government role restricted to monitoring the implementation of the technical and legislative aspects of transportation, which include measures such as issuance of emission control and roadworthiness permits, support of electric traction and combined transport systems.

### **A. Energy supply and transformation**

28. The energy supply and transformation sector is not only considered strategically important and therefore a state monopoly but is also the largest single contributor to the national CO<sub>2</sub> emissions in Slovakia, with a share of approximately 50 per cent of net CO<sub>2</sub> emissions. There is a high reliance on non-fossil fuel for electricity generation. In 1997, nuclear power accounted for 10.8 GWh, followed by thermal power, using low-quality lignite and imported coal at 9.4 GWh, hydropower at 4.3 GWh and imports at 6.8 GWh. The electricity system is constituted by four public utilities involved in production and distribution, apart from many small industrial cogenerators and privately owned hydropower plants. The mitigation policies and measures within this sector primarily concern expansion plans of various energy sources, and are influenced by legislation such as the Energy Act of July 1998, the amended Act on the Protection of the Air against Pollutants (Clean Air Act), and the Act on Prices. The 1993 National Energy Strategy and Policy of the Slovak Republic up to 2005 is not discussed in this report as it was handled in the first review report. Some of the key elements of this document include the intention to eliminate energy price distortions by 2002, enhanced attention to the convergence of Slovak energy policy with that of the EC, and the decision to commission only two of the four units of the nuclear power plant at Mochovce at present.

29. Both the NC1 and the NC2 stressed the role of nuclear power in reducing emissions from the power sector. The review team felt that it would be important to assess how future scenarios on the likely development of nuclear power take political decisions into account. Nuclear power as a mitigation measure assumes importance in Slovakia due to its 49 per cent share of domestic electric supply and also due to its role in enabling the country to reach the national target. The host country experts referred to the government pledge that the units to be retired at Bohunice would be replaced by the two new units at Mochovce, although a decision on the timing of the phaseout of the two units at Bohunice is under consideration and is likely to be taken by September 1999. No overall increase in the share of nuclear was anticipated, as the two units at Bohunice NPP were to be phased out by 2005 and the new units at Mochovce were to start up by 1998. The first reactor of the plant at Mochovce was connected to the national electricity grid in July 1998 and the second reactor is likely to be connected in January 2000. The team also learnt that a political decision was yet to be taken about the operation of the third and fourth reactors at Mochovce.

30. The 1995 Clean Air Act was presented as the most effective tool to decrease the CO<sub>2</sub> emissions, though its primary aim was the reduction of CO, SO<sub>2</sub>, NO<sub>x</sub> and particulate emissions. This Act influences the construction of both new (as of 1.4.1998) and retrofitted fossil fuel combustion units and encourages the application of the principle of the "best available technologies not entailing excessive cost". Thus, while not directly addressing CO<sub>2</sub> emissions, it promotes decommissioning of old coal-fired power plants, fuel switching to natural gas, the use of renewables and cogeneration and the use of state-of-the-art technologies. Currently the largest thermal power plants at Novaky and Vojany are involved in a modernization programme following the above-mentioned principle, in order to comply with European Community emission standards by 1999. These retrofits under the Clean Air Act involve the adoption of

fluidized bed combustion and flue-gas-desulphurization respectively, impacting particulates, SO<sub>2</sub>, NO<sub>x</sub> and CO, but not causing a significant decrease in the level of CO<sub>2</sub> emissions. The review team was informed that the implementation of flue gas desulphurization would be accompanied by a boiler retrofit in order to improve plant thermal efficiency which would have otherwise been lowered. The expected reduction of CO<sub>2</sub> emissions till 2000 based on the techno-economic feasibility of replacing older technologies under this Act, was estimated at 478 Gg in the industrial energy sector, 206 Gg in the non-industrial energy sector such as the residential and commercial sectors and the energy production sector, and 31 Gg in centralized heating supply. The potential for penetration of such technologies as combined cycles, fluidized bed combustion and promotion of increased boiler efficiency, fuel switching, and use of low-sulphur coal were translated into CO<sub>2</sub> reduction estimates (SK/tonne CO<sub>2</sub> and tonne CO<sub>2</sub>/year). The country identified fuel switching and combined cycle technology as the most promising options for reducing CO<sub>2</sub> emissions.

31. The use of lignite is not expected to be phased out until after 2005, with the planned decommissioning of the country's largest lignite-fired generating plant at Novaky. The team therefore gathered that the Slovak Government sees the continuation of lignite mining (at a level of approximately 3.7 million tons till 2005) as a key element of its medium-term energy strategy, enhancing security of supply. This level of production is likely to fall to approximately 2.9 million tonnes by 2010. Overall, lignite mining is to continue only till the design lifetime of the Novaky power plant ends in 2020.

32. The recent Energy Act includes a provision obliging distribution companies to purchase energy from renewable energy sources. Additionally, the team noted that measures to promote renewable energy sources included low import duties for renewable equipment, a low level of value added tax (Act 289/1995) for biogas, fuel wood, wood waste from industry, solar collectors and heat pumps, and a five-year exemption under the amended Income Tax Act (No.286/1992) granted to operators of small hydropower plants, CHP, wind power plants, solar-powered facilities, heat pumps, biogas and geothermal plants. The use of renewable energy in the apartment-building sector opens access to government support in the form of partial refund of interest on the loans up to 70 per cent.

33. There has been a change in the installed combined heat and power (CHP) capacity since the NC1, due to the setting up of a plant in 1998 with an estimated capacity of 165 MW<sub>el</sub> and 218 MW<sub>th</sub>. The country's total CHP output was estimated at 1,035.7 MW<sub>el</sub> and 8,546.6 MW<sub>th</sub>. The team learnt that the legislation such as the Clean Air Act, Act 286/1992 on income tax, which provides a five-year tax exemption for implementation of cogeneration, and the Energy Act promotes CHP, with the result that some independent manufacturing companies produce power using CHP for their own consumption and sell the surplus to public utilities. The stated intention of the energy policy was to increase CHP electricity by 24 per cent by 2010. In 1996, an Austrian study showed the high potential for CHP, with a high rate of capacity utilization in the Slovak industrial structure dominated by the upstream sectors such as raw products and semi-finished goods, which are energy-intensive. The study estimated that, under full-load operation, pay-off periods of three to five years could be achieved for CHP projects in these industries.

The current low energy prices have been identified as a barrier to exclusive use of cogeneration in district heating systems but not for industrial power production. CHP is also used in a major way for district heating. Nevertheless the team was informed that the district heating industry was facing inter-fuel competition, as there are currently no mandatory requirements for consumers to use district heat where buildings are connected to the public district heating system, allowing households to switch at their convenience to natural gas. Consequently the heating industry is unable to increase prices to remain viable, which poses a difficulty to many small district heating companies.

34. The team formed the impression that the Energy Act (Act no. 70/1998), due to come into force in July 1998, would play a significant role in the energy sector's organization and development and had the potential to lead to concrete results in this sector. This Act is in line with the EC legislation, especially the electricity and gas directives, relates to the power sector, heating and natural gas supply and contains licensing provisions for production, transmission, distribution and sale or purchase of electricity, natural gas and heat. Under this Act, the Ministry would issue a decision appointing a licence holder ("single buyer system") who shall purchase the electricity for the electricity network contracted by customer. This "single buyer" is obliged to purchase all electricity from energy sources provided such sources are environmentally justifiable and the technical and economic conditions make such purchases possible. In the case of heating, the heating supplier is obliged to purchase heat from renewable or waste heating sources or from CHP facilities, in order to supply heat to consumers, unless it results in an increase in the price of heating to be paid by the consumers or in a reduction of the energy efficiency. The Act also envisages a split-up of the vertically organized electricity structure and the establishment of a regulatory body in the Ministry of the Economy, with price-setting competency retained by the Ministry of Finance and energy-related issues by the Ministry of the Economy. Further, energy planning functions are to be divided between the state, districts and around 2,900 municipalities, and utilization of renewable energy sources and CHP potentials are to be promoted by power purchase obligations by the distribution companies. The review team noted that currently financial mechanisms were lacking, and some measures had an attached condition "not entailing excessive costs".

35. The host country clearly recognized that the implementation of various GHG mitigation policies was hampered by the slow process of price liberalization under the 1996 Act on Prices. The Government, though mindful of the limited scope for increased energy prices in some sectors, recognized the need for elimination of price distortions according to the Revised Slovak Energy Policy. Currently heat and electricity prices are regulated by the State, with centralized heat supply and coal prices for households being subsidized. Additionally, cross-subsidization prevails across sectors, with industry subsidizing households. The team gathered that, though there have been efforts to gradually increase energy prices since 1991, even the most recent increase in 1997 of energy prices by 10 per cent for industrial and commercial consumers and 5 per cent for households was unlikely to bridge the gap between domestic and international energy prices. In 1999 subsequent to the visit, the team learnt that electricity prices were further expected to rise by 80 per cent for the household sector and by 10 per cent for the industrial sector within the year. Though it was difficult to estimate the impact of this measure at this stage

and current pace of implementation, the review team perceived it to be an important measure which could contribute to energy saving and climate change mitigation.

36. The draft Energy Efficiency Act (Act on Energy Conservation), addresses measures and activities directed towards increasing the efficiency of energy transformation, lowering specific energy consumption in industry and tertiary sectors such as services, and optimizing energy consumption in households. It is also meant to promote the optimal use of renewable energy. Further, the team learnt that the use of energy labels and appliance standards for household equipment and electric motors is to be encouraged under this Act. Other elements include the development of district energy plans, and obligatory energy audits for organizations financed out of the state budget. The team enquired whether the effective implementation of energy planning at the decentralized level would be affected by the current number of 79 districts and approximately 2,900 municipalities. Under the Act, a fund for renewable energy and energy saving is to be set up to supplement the existing Energy Saving Fund (supported by PHARE, the European Bank for Reconstruction and Development, and the national budget). It is to be based on fines for over-consumption, state subsidies, allowances and gifts, among other sources. Loans and subsidies from the fund are to be made available to projects on training, education and information. Subsequent to the visit, the host country informed the team that the Act in its current form had not been approved by parliament because of some serious reservations concerning the Energy Saving Fund, though it was likely to be passed in 1999 as it will facilitate convergence with EC directives. The Fund was expected to be covered under another Act.

## **B. Transport**

37. The contribution of the transport sector to total CO<sub>2</sub> emissions is approximately 9 per cent. Road transport accounts for 84 per cent of energy use in the transport sector. Though there has been an overall decline in the performance (in terms of passenger- and tonne-kilometres) of road, rail and water transport since 1988, due to the sectoral sensitivity to the ongoing economic revival, a growth in emissions is expected. Among the major developments are an increase in goods transport by lorries at the expense of rail transport, an overall decrease in railway transport since 1989 due to development of road transport, and an increase in the price of public transport, making it less attractive to the population. Indicators of the potential growth in emissions from this sector are the fact that gasoline and diesel consumption increased by 13 per cent between 1994-1995 and the sale of new vehicles increased from 27,000 to 75,000 vehicles between 1995-1996. This recent trend was not yet reflected in the emission data up to 1996, as fuel consumption fell in 1996 despite the increasing number of cars. After the visit the review team was informed that the 1996 data on fuel consumption in road transport used at the time did not include the quantity of imported fuel, as this information was unavailable at the time to those making the emission estimates. Subsequent to the visit, information provided by the government indicated that fuel imports in 1996 constituted approximately 10 per cent of the total gasoline consumption and 5 per cent of the diesel consumption. This would imply that the 1996 data on fuel consumption and the emissions from road transport be modified accordingly.

38. In terms of share of competencies, the Ministry of Transport is responsible for the technical and legislative aspects of transportation, which includes issuance of emission control and roadworthiness permits, support of electric traction and combined transport systems. The municipalities are involved in optimization of car traffic in cities, parking payment, traffic control, and development of public transport. The host country experts singled out the application of road tax and consumption tax on hydrocarbon fuels and oils, development of combined transport, preference of electric traction to diesel for rail transport, and acceleration of fleet replacement as being significant among the measures listed in the NC2.

39. The consumption tax on hydrocarbon fuels and oils (Act 316/1993), which is meant to encourage the use of gaseous fuels instead of liquid fuels, was reported in the NC1 and the NC2. The level of the tax is currently highest for gasoline, followed by diesel, liquefied petroleum gas and natural gas. The revenue from the tax is considered an important contributor to the state budget, part of it being allocated to subsidies for public transport and construction of a railway network. The team noted that there did not seem to be any evaluation or monitoring of either the cost effectiveness or the impact of implementation of the tax, which would enable the authorities to assess the effect and consequences of the tax, related to consumption levels and savings as well as GHG emission mitigation. The road tax (Act 87/1994) is applied only to motor vehicles used for business and therefore transporters and not to personal vehicles. Recently the tax was enhanced by 50 - 100 per cent, with some allocation directed to the state road fund. The tax increase for personal business cars (personal cars used for business purposes) of more than 1200 cm<sup>3</sup> capacity was approximately SK 200 - 600/year, and less for smaller fuel-efficient cars. From a climate change standpoint, the team learnt that the tax would be completely reimbursed in the event that 120 journeys were made using either train or water transport. In the case of a lesser number of journeys completed in a year, there was a progressive reduction in taxation from 25 - 75 per cent depending on the number of journeys and the extent of participation in train and water transport.

40. The present vehicle fleet is considered to be out of date, the average age being 14.8 years for personal cars, 13.7 years for lorries and 7.7 years for buses. In 1995, in order to encourage vehicle fleet renewal, an investment subsidy of 500 million SK was provided to the transport companies responsible for public transport. Between 1996-1998 only non-investment subsidies were provided to cover financial losses occurring to such transport companies due to losses arising from reduced fares and limited passengers. From September 1995 till December 1996 both import tax and duty were cancelled for the import of passenger cars with an engine capacity of 1500 cubic cm. In 1996, the freight charge exemption for personal vehicles accelerated fleet replacement, with 75,000 personal vehicles being imported. The development of the combined transport system, a mode of rail transport using basket wagons, was considered a major mitigation measure in transportation by the host country, although it was less developed than elsewhere in Europe. The first terminal started operation in 1996, and additional terminals were projected at Bratislava, Zilina and Kosice. Further expansion was expected to depend on the development of the necessary infrastructure. Public transport was being rapidly replaced by private transport and, given that the vehicle fleet was old, it was expected that a state subsidy of around SK 2.5 billion would be required to permit modernization of the current bus fleet. In

1998, the Government provided a subsidy of SK 136 million. Urban transport is also co-financed for the five largest cities. The review team also learnt of the new Act on Road Traffic (Act No.315/96 Coll. of the National Council of the Slovak Republic on Road Traffic Operation) and its implementing decree on conditions of vehicle operation on roads (Decree No. 116/97 Coll. of the Ministry of Transport, Posts and Telecommunications on the Conditions of Vehicles Operation on the Roads), which together with the decree on road worthiness of vehicles (Decree No. 327/97 Coll. of the Ministry of Transport on Roadworthiness of Vehicles), specify conditions for performing roadworthiness inspections of road motor vehicles in operation, and also, together with the decree on emission inspections of motor vehicles (Decree No. 265/96 Coll. of the Ministry of Transport on Emission Inspections of the Road Motor Vehicles), specify conditions for performing emission inspections of road motor vehicles in operation. Both the Decree No. 116/97 Coll. and the Decree No. 265/96 Coll. are currently undergoing amendment to extend emission inspections to all kinds of motor vehicles in operation. The review team noted that implementation of some of the identified measures was conditional on the availability of financial resources. The host country experts said that not all the measures in this sector could be carried out by the Ministry of Transport. No analysis of the effects of these measures (some of which were also identified in the NC1) with regard to GHG mitigation was provided to the team.

### **C. Industry**

41. The team noted that, whereas in the NC1 this sector had been combined with the energy and transformation sector, measures in industry were reported separately in the NC2, which was a positive step. The sector constituted by energy-intensive industry such as chemicals, steel, pulp and paper and cement, currently accounts for approximately 46 per cent of the final energy consumption, and approximately 45 per cent of the electricity consumption, with just three of the largest companies accounting for 22 per cent of the industrial electricity consumption. Significantly, the Slovak industrial sector is also characterized by a high prevalence of outdated technology and production processes. A decline in energy demand was expected consequent upon the closure of nickel production at Sereď, iron ore treatment in Rudňany, and of some chemical production units. Overall, there had been no substantial change in this sector but the anticipated privatization resulting from future entry into the EC was expected to lead to some restructuring.

42. Among the sectoral measures identified were the use of combined cycle technology and continuous casting in steel production at the metallurgical enterprise at VSZ Kosice. The future application of combined cycle technology was expected to lead to a reduction of CO<sub>2</sub> emissions, and continuous steel casting, which has already commenced, was likely to lead to reduced fuel consumption. The implementation of continuous instead of batch steel casting and a reduction in electricity consumption in the electrolysis process of aluminium production (15.9 kWh to 13.5kWh per unit production) were expected to lead to a reduction of 48 Gg of CO<sub>2</sub> emissions by 2000. The team noted that renovation of the aluminium smelter at Hronov, to be carried out between 1988 and 2005, has commenced, including discontinuation of the Bayer process (for alumina production) and the import of alumina instead. The team was also informed that gas and

coal consumption had fallen and was expected to decline further to 32.8 per cent in 2005, with respect to the amount consumed in 1988. The use of old tyres in combustion in the cement industry was also expected to reduce CO<sub>2</sub> emissions. The team also learnt of the use of ecolabelling, incorporating life cycle considerations for various products and the adoption of environmental management systems in the iron and steel, oil, tyre and pharmaceutical industries.

#### **D. Residential, commercial and institutional sectors**

43. The residential sector accounted for 18 per cent of the final energy consumed in 1996. Around half of the energy used in the residential sector is gas, the remainder being electricity used for heating, the operation of electrical appliances and lighting. Electric space heating in the residential sector has grown extremely rapidly (37 per cent increase in 1996 over 1995) but is still low in absolute terms. Though the Government has identified an energy saving potential of 25-30 per cent in space heating, actual implementation is complex, primarily because of the high costs of replacing heat insulation and regulation systems compared to the low energy prices. Government financial support under the Programme of Energy Consumption Reduction in apartments and family houses allows for a partial refund of interest on loans, and provision of financial support. During 1992-1997, the Government provided SK 540.8 million for 10,937 flats for this purpose, which included improvement of thermal insulation. This programme was discontinued in 1997 and a housing development fund was started in 1998. Both the NC1 and the NC2 mentioned the upgrading of heat insulation standards in new buildings, which requires an annual energy consumption of 85 kWh/m<sup>2</sup> in comparison to the 1992 requirement of 102 kWh/m<sup>2</sup>. The measure has been estimated to lead to an energy saving of more than 105 PJ in the period 1992-2005. Future measures include a tax allowance for the purchase of energy-efficient appliances, and education and training.

#### **E. Land-use change and forestry**

44. On the basis of the presentation made to the team of the measures included in the NC2 (afforestation of non-forest areas, tree species composition change and protection of carbon stock in forests affected by air pollution), only afforestation had assumed significance and had increased since 1995. Furthermore, the team was told that entry into the EC was likely to lead to a higher priority being given to afforestation. During 1996-1998, approximately 1000 ha had been afforested, the expectation being that a total of 4000 ha would be afforested by 2000. In 1996, the Government directly supported (to the amount of approximately SK 8 million) the afforestation of non forested areas by land owners based on projects developed by the Forest Research Institute. The NC2 clearly states that it was difficult to estimate the reduction associated with the individual measures in this sector, although the host country expert stated that the "low level of implementation" scenario of afforestation of 43,000 ha of non-forest areas up to 2050 leading to a sequestration of 13.9 Tg CO<sub>2</sub> was most realistic.

## **F. Agriculture**

45. This section is new with respect to the NC1 and the measures relating to both CH<sub>4</sub> and N<sub>2</sub>O emissions with a few exceptions are also new. The 1996 voluntary code of good agricultural practice, which deals with soil fertility protection, protection against pollution, and an environment-oriented agriculture system, is expected to lower CH<sub>4</sub> and N<sub>2</sub>O emissions from agriculture. Under a ministerial decree, subsidies are offered to support good agricultural practice; for instance, if a farmer undertakes to use organic fertilizers for five years, within a two-year period he receives an amount of SK 4,000/ha/year for arable soil and SK 2000/ha/year for grasslands. The team learnt that the process of alignment with the EC was likely to alter the agricultural policy through the following Acts, which are at varying stages of preparation: the Plant Nutrition Act, which concerns nitrogenous fertilizer application, and the Ecological Agriculture Act, which concerns organic farming. The team observed that, based on the information provided, it was difficult to assess the level of implementation and the specific impacts of these measures on GHG mitigation, although the team expected that there would be a reduction in both methane and nitrous oxide emissions.

## **G. Waste**

46. The country's 1993 Waste Management Programme up to 2000 (also included in the NC1), administered by the Ministry of the Environment, appeared to be the cornerstone of the policy to reduce CH<sub>4</sub> emissions. The programme targets implementation of separated waste collection, reducing the quantity of municipal waste by 20 per cent, utilization of biological waste as organic fertilizer, application of sanctions to unmanaged landfills, construction of new incinerators, composting facilities and regional landfills. Though the team noted that the Waste Management Programme was reviewed in 1996, the effect of the programme remained uncertain. The team observed that the NC2 no longer listed the technical regulations for recovery and utilization of CH<sub>4</sub> mentioned in the NC1. The team was further informed that an amendment of the Act on Waste, drafted in response to the proposed EC directive on landfilling of waste, was under consideration and was due to be submitted to the Government in September 1999. The intention of the amendment is to reduce the amount of CH<sub>4</sub> emitted from landfills by reducing the quantity of biodegradable organic waste entering landfills by 25 per cent, 50 per cent and 75 per cent, for 2002, 2005 and 2010 respectively, in comparison to 1993. CH<sub>4</sub> mitigation measures directed at fugitive emissions from the gas distribution and transportation system, focus on ongoing improvements of the distribution system and transit pipelines. No information was provided on the status of implementation and impact of measures.

## **H. Mitigation of other gases**

47. The measures listed in this section of the NC2 focus on lowering levels of the precursor emissions, but no information was provided to the team on the effect achieved so far. Both the ongoing national programme of NMVOC emission reduction and the Convention on Long Range Transboundary Air Pollution were mentioned in this regard.

#### IV. PROJECTIONS AND EFFECTS OF POLICIES AND MEASURES

48. The team noted that a significant effort in terms of modelling had been undertaken, with a greater degree of clarity and consistency than in the NC1, the projections being presented by gas and sector, and summary tables provided as required by the revised UNFCCC guidelines. Prior work carried out under the United States Country Studies Program was the basis of projections of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O emissions and aggregated emissions of GHGs till 2010. Energy consumption was modelled under various scenarios using the BALANCE module of the ENPEP software developed at the International Atomic Energy Agency, Vienna and Argonne National Laboratory, United States of America. The module is used for energy planning due to its capability to track energy flows from primary energy consumption to final energy use. The model allows for the estimation of CO<sub>2</sub> and other GHGs and their disaggregation to individual sectors. Depending on sectoral data availability, both top-down and bottom-up approaches were used.

49. Five scenarios for aggregated modelling of the energy sector were used to examine the effect of different policy options on energy-related CO<sub>2</sub> emissions. These included a "baseline" or "without measures" scenario and four "with measures" scenarios. Within each sector the identified measures were studied under three levels of implementation, namely, high, medium and low. In comparison to the NC1 where the period modelled was till 2005, in the NC2 it was extended till 2010.

50. The five energy sector scenarios were as follows: In scenario 1, the baseline scenario, the requirements of emission limits were based on the amended Act on the Protection of the Air against Pollutants being applied to only new air pollution sources. Scenario 2 considers the application of the same Act to both new and existing air pollution sources. Scenario 3 includes the measures envisaged in scenario 2 plus the additional implementation of energy-saving measures such as demand-side management, measures to promote improved space heating in residential and non-residential buildings, a decrease in fuel consumption in transport, and continuous casting and combined cycle implementation in the metallurgical enterprise at Kosice. Scenario 4 includes measures envisaged in scenario 3 plus enhanced industrial restructuring leading to a decline in energy intensity by 1 per cent from 1997 levels. In the fifth scenario, the penetration of renewable energy is foreseen to have reached its full potential by 2010. Additionally, within the energy sector, four sub-scenarios of electricity generation in public power plants were defined and analysed to provide an understanding of the impact of the electricity supply system on the level of CO<sub>2</sub> emission reduction. The current expansion plans of public utilities, including hydropower and the nuclear option, were also incorporated into the projections. The projections of non-energy-related CO<sub>2</sub> emissions in industry were based on the inventory and the projected annual growth rate of the cement, lime and magnesium oxide industries. The team was informed that, for the industrial and non-industrial sectors, the modelled scenarios included a business-as-usual (BAU) scenario, a scenario examining the impact of limits set by actual environmental legislation on regional air pollutants, and a scenario examining the impact of a notional carbon tax.

51. The host country informed the review team that the methodology analysed the "economically feasible" reduction potential for CO<sub>2</sub> emissions in individual economic sectors, calculated mitigation costs, constructed mitigation scenarios and analysed the sensitivity of mitigation to the identified measures. Sectors modelled included the energy supply system (public utility expansion plans considered in the baseline), the district heating system, the industrial sector (chemicals, metallurgy, machinery, pulp and paper, steel, etc), construction, agriculture and forestry, the residential sector and transportation. Additionally, the team was informed that the implications of various major environmental and energy legislation and feasibility studies had been translated into technology options. The input data used for the projections included inventory data, energy statistics, policy information based on the 1993 National Energy Strategy and Policy of the Slovak Republic up to 2005, its updated draft version till 2010, macroeconomic forecasts of key variables for 1995-2010, and the Energy Conservation Policy.

52. The NC2 states that, because of the uncertainties associated with the current transformation process in Slovakia, it was not possible to extrapolate historical data for energy demand. The team was informed that the emphasis in the projection exercise was placed on the supply side, due to data availability and the greater complexity of simulating the demand side. The inventory data had been imported into the ENPEP model to ensure consistency between the inventory and the projections. A comprehensive approach to dealing with the projections for transport was presented. It was stressed to the team that the results emanating from the simulation modelling had assumed importance in terms of their policy implications, although the team did not obtain a clear picture of the feedback of such exercises into decision making. Given the high level of uncertainty of the rate of structural change, economic reform and development in Slovakia, a sensitivity study on the impact of these components on the future trend of GHG emissions was suggested by the team.

53. The host country presented the key assumptions used in the projections, with the exception of the transport sector. The assumptions related to: (i) scenarios of primary energy consumption, (ii) scenarios of GDP development in individual sectors for the period 1995-2010, (iii) energy intensity development in industry, (iv) energy and fuel price development, (v) maintenance of present industry structure, (vi) steel production in Slovakia, (vii) district heat consumption from centralized sources, (viii) electricity production/consumption, (ix) liberalization of fuel and energy prices, (x) higher scenario of population development, (xi) forecast of road development.

54. Additionally, the team found that the use of a higher GDP growth scenario while formulating the baseline scenario was useful, in view of the high level of uncertainty surrounding future development, because it gave a picture of the maximum effect that could be achieved by implementing different mitigation scenarios. The host country experts informed the team that the GDP growth rate assumed in the NC2 was 5.7 per cent for the period 1995 to 2000 and 4.25 per cent for the period 2000 to 2005. The NC1 had assumed a 2.8 per cent growth rate for the period 1995 to 2000. The team noted that the actual growth rate in 1997 had been 6.9 per cent, which might entail further revision of this critical assumption. While realizing the value of

using a higher GDP growth scenario in the energy consumption modelling, the review team felt that on the other hand it could be questionable in the event of full energy price liberalization, which would very likely impact energy consumption in the major industries which currently are energy intensive. Since assumptions about energy intensity improvement during the period of dramatic structural changes in the economy would have a very strong impact on the future energy consumption pattern, the team felt it would be very useful to consider the effect of alternative assumptions about energy intensity on energy demand, energy supply and GHG emissions projections.

55. The effect of implementation of the amended Act on the Protection of the Air against Pollutants on both new and existing air pollution sources, was assessed in scenario 2 and is estimated to lead to a reduction in the quantity of CO<sub>2</sub> emissions of 716 Gg in 2000, 861 Gg in 2005 and 999 Gg in 2010 in comparison with 1999.

56. The final energy uses in the industrial sector refer to electricity, heat from CHP plants and direct use in the process. For this sector, among the modelled options were included fuel switching from oil to gas, use of low-sulphur coal, and use of fluidized bed combustion technology, the prime mover being identified as environmental legislation. The team noted that an evaluation of the implementation of a notional carbon tax after 1999, showed that it would provide a limited incentive for fuel switching. The assumption in scenarios 4 and 5 of a 1 per cent decrease in industrial energy intensity (low autonomous energy efficiency improvement) after 1997 was considered conservative by the team. The country experts informed the team that there had been a slowdown in industrial restructuring. The host country estimated that the reduction in CO<sub>2</sub> emissions would be 128 Gg in 2000, 865 Gg in 2005 and 1,718 Gg in 2010 associated with the planned decrease in energy intensity in the industrial sector.

57. While the NC1 projected that emissions from the transport sector would be below their 1990 level by 2000, the NC2 projected the opposite. The team was told that the transport sector was expected to show a substantial growth of CO<sub>2</sub> emissions and therefore also had a significant reduction potential. The estimated reduction potential for this sector was 191 Gg CO<sub>2</sub> in 2000, 1,032 Gg in 2005 and 1,510 Gg in 2010. A reduction of 247 Gg CO<sub>2</sub> was associated with the planned full implementation of renewable energy sources in 2000, 989 Gg in 2005 and 2,473 Gg in 2010, under scenario 5.

58. The forestry sector projections extended to a set of three measures, which included change in tree species composition, afforestation, and revitalization measures for forests affected by pollution, under low, medium and high levels of implementation. The team noted that the country's "without measures" scenario indicated the absence of carbon sequestration in the baseline. Additionally, the team was informed of the level of current implementation of afforestation projects, the host country expert indicating that the low level of implementation of afforestation, i.e. of 43,000 ha by 2050, could be considered a realistic scenario. This was expected to lead to a reduction of approximately 220 Gg CO<sub>2</sub> emissions in 2000, and 620 Gg in 2010. Future harmonization with EC policy was expected to boost afforestation.

59. The projections show that the existing structural trends for CO<sub>2</sub> emissions in the period 1990-1995 continue into the future. For instance, CO<sub>2</sub> emissions from the energy and transformation sector almost doubled for the 1990-1995 period, while those from industrial fuel combustion fell by half and emissions from other categories declined even further. The proportion of the emissions from these three sectors remains relatively constant in the future. There did not appear any likelihood of Slovakia not achieving the UNFCCC aim by 2000. However, the team noted that the results obtained in the projections showed that the domestic target (the "Toronto target") for 2005 would only be achieved in scenarios 3 and 4. In 2010 though, scenario 3 would overshoot the national target. Scenario 5 was expected to lead to stabilization at approximately the national target level.

60. The results presented to the team indicated that the CO<sub>2</sub> emission levels in 2000 will not exceed that in 1990 (the UNFCCC aim) for all five scenarios. This was true also for the period up to 2010, as all the projected values under these scenarios fell below the 1990 level. The team felt that the aggregated emission scenarios presented in this section illustrated well the impact of the economic recession in the 1990s, and the impact on the future emission trend of the implemented and planned policies and measures. The main challenge in the policy-making process would be to implement the proper mix of some of the policies that could moderate substantially this expected future growth.

61. In the case of CH<sub>4</sub> projections for the agricultural sector, the three scenarios other than the baseline related to the level of application of animal waste and extent of enteric fermentation in livestock. No information was provided on the animal waste management practised under the business-as-usual conditions. The team questioned the underlying assumptions on livestock population under the three scenarios, given that livestock populations were on the decline. Additionally specific measures modelled in this sector included the Code of Good Agricultural Practice and the Ecological Agriculture Act. The team learnt that the medium-level implementation of measures was expected, leading to an associated level of N<sub>2</sub>O emissions which declined for agriculture and increased for waste-water treatment, relative to 1990 levels.

62. The achievement of the domestic "Toronto target" by 2005 was almost a certainty due to the economic recession associated with the transition process (from a centrally planned to a market economy). The team noted a clear upward trend in CO<sub>2</sub> emissions from fuel combustion in 1994, 1995 and 1996 (estimated at 40,389 Gg, 45,426 Gg and 43,104 Gg, respectively), compared with the national target of 46,787 Gg CO<sub>2</sub>. Attaining the target would also be influenced by the rate of economic recovery, the priority accorded to environmental concerns in the national policy agenda in an uncertain political climate, the addition of new nuclear power units, the pace of industrial restructuring, and the decreases in total energy intensity on the demand side of the energy sector, including transportation. The host country experts indicated that consideration of CO<sub>2</sub> emission estimates for 1995 had led to only two scenarios reaching the target, one of which entailed the addition of nuclear units at Mochovce. The review team concluded that additional measures may have to be implemented to adhere to the "national" target. The team noted that no information was available on how entry into the EC would modify existing scenarios, although simulation had been done of a notional carbon tax.

## V. EXPECTED IMPACTS OF CLIMATE CHANGE

63. Work on assessing the vulnerability to potential climate change has been conducted since 1990 under the National Climate Programme coordinated by the Ministry of the Environment. The team noted that, though regional climate predictions were available from various models, no single model had been able to accurately predict all the weather variables under current conditions for the region, except for the Canadian Climate Centre and Goddard Institute for Space Studies models. The team noted that ongoing work in this area included the generation of climate change scenarios, and impact assessment on the hydrological cycle, the forest ecosystem and plant production.

64. The team learnt of collaborative impact studies conducted with the Czech Republic, Poland and Hungary. Since, under a changed climate, an increase in monthly precipitation had been consistently predicted for Slovakia except for the northern regions, work on the hydrological cycle, water resources and water management was proceeding at the Slovak Hydrometeorological Institute, the Technical University, the Ministry of Agriculture, the Water Research Institute and the Institute of Hydrology. Using hydrological scenarios developed from an analogue climate and general circulation model output, impact on water balance, surface runoff, groundwater and soil-water regime was studied. This output indicative of a decline in surface and sub-surface water for the time horizon 2075, when CO<sub>2</sub> doubling was predicted, was used to map the sensitivity and vulnerability of various regions under the current and future climate. For the south-eastern parts of Slovakia a decline in surface and subsurface water of 20 - 40 per cent was predicted. Monitoring of groundwater resources was also being done at 90 monitoring stations under a PHARE project. No assessment had been done of likely impacts on the country's hydropower resources.

65. Impact assessment studies were conducted using crop growth simulation models of sugar barley and winter wheat, for doubled CO<sub>2</sub> conditions. The team was informed that, as 41 per cent of the land area is covered by forest, the expected impact of climate change was considered a serious problem which could affect forest productivity. The results from the Holdridge and Forest Gap models demonstrated that spruce and fir were expected to be more affected than the broad-leaved species. Other forestry impact assessment work related to impact on alpine mountainous species.

## VI. ADAPTATION MEASURES

66. Various adaptation measures had been identified for water management and a cost-benefit analysis has been completed for this sector based on the impact assessment studies. These results were submitted to the Ministry of Soil Management for incorporation into their water management plans for 1995 - 2005. The team was not provided with any information on specific adaptation measures in the forest and agriculture sectors. The only concern in regard to the adaptation programme in the forest sector, is that for some of the measures it was mentioned that they need to be implemented "regardless of the ownership relations", an issue which would require careful examination.

## **VII. RESEARCH AND SYSTEMATIC OBSERVATION**

67. The NC2 provided a detailed description of several national climate change research programmes, focusing on climate monitoring, homogenization of data, new impact studies and examination of adaptation options. The review team also learnt of the ongoing climate monitoring and reconstruction of historical data. Stress was laid by the host country on the importance of maintaining the present station network, which would enable the construction of a homogenized data set. The team noted the country's involvement in the International Geosphere-Biosphere Programme and the World Climate Programme, and its collaborations on climate monitoring with Austria, the Czech Republic and Poland. The team learnt that no significant progress had been made on the 1993 project for national greenhouse gas emission reduction (NC2). The results of the United States Country Study Program, funded jointly by the United States and the Slovak Government, were shared with the review team in the form of a report.

## **VIII. EDUCATION, TRAINING AND PUBLIC AWARENESS**

68. The team learnt both about programmes in the government sector and about the involvement of energy companies in consultation and information dissemination. Information on ongoing collaboration between the Slovak electric utilities and Canada in demand-side management was provided. A pilot exhibition of a model house with various household appliances had stimulated approximately 400 consultations. Additionally, the information dissemination targeted at the private sector by the association of medium and small energy producers, promoting cogeneration, hydropower, biomass fuels, and power conservation in households, was mentioned to the team. The involvement of non-governmental organizations in increasing awareness through publications and seminars was briefly touched upon.

## **IX. CONCLUSIONS**

69. The Slovak Government's commitment to achieving the domestic "Toronto target" and the UNFCCC aim, is supported both by the Government resolution accompanying the adoption of the NC2 (requesting relevant ministries to consider these targets during programme implementation) and by their inclusion in both the 1993 National Energy Strategy and Policy of the Slovak Republic up to 2005, and the Revised Slovak Energy Policy. Nevertheless the country appeared to lack a coordinated national strategy to combat climate change and achieve the domestic target. In the preparation of the NC2, the UNFCCC guidelines were adhered to with a few exceptions. Significantly, there was widespread participation in the preparation of the NC2, with the exception of the Ministry of Finance and the non-governmental sector.

70. In general, Slovakia complied with the IPCC reporting requirements for the national inventory and the team found that the inclusion of selected worksheets and data tables, allowed for reconstruction of most estimates. There were however different levels of detail in reporting for the energy sector between 1990 and 1995 and the intervening years, which did not allow for easy comparison. There were also some inconsistencies between the 1995 values contained in the NC2 and those contained in the 1998 submission to the UNFCCC secretariat.

71. In terms of compliance with the reporting guidelines for policies and measures, information was presented in a transparent way by sector and gas. A significant amount of additional information was provided both during and after the visit. With regard to measures implemented and planned in the energy, industrial, and land-use change and forestry sectors, the measures to reduce CO<sub>2</sub> emissions under actual implementation included afforestation, the Clean Air Act and the continuous steel casting at Kosice. Clearly, the Clean Air Act is not aimed directly at CO<sub>2</sub> emissions, but it promotes decommissioning of old coal-fired power plants, fuel switching to natural gas, the use of renewables and cogeneration and the use of state-of-the-art technologies. Within the energy and transformation sector, positive aspects include the high reliance on non-fossil fuel resources for electricity generation, and the requirements of the amended Clean Air Act to follow the principle of using the "best available technologies not entailing excessive costs" in modernizing installations. Furthermore, a great potential for CHP in the Slovak industrial sector has been identified, with payback periods of three to five years for such projects. Additionally, the provisions of the amended Clean Air Act, the Act on income tax, which provides a five-year tax allowance for implementation of cogeneration, and the Energy Management Act consistently promote CHP growth. The process of price liberalization has already commenced and is expected to influence the pace of implementation of other GHG reduction measures. In the case of the transport sector, where there is a high sensitivity to the ongoing economic revival, implementation of some identified measures would be conditional on availability of financial resources.

72. A substantial amount of information on the projections was shared with the team, indicative of the significant underlying efforts. In accordance with the guidelines, the projections were presented by gas and sector, and summary tables were provided. The CO<sub>2</sub> emission levels in 2000 were not expected to exceed the 1990 level for any of the five scenarios modelled. With regard to the domestic "Toronto target" for 2005, it is expected to be achieved under scenarios 3 and 4, which are described above. Scenario 5 was expected to lead to stabilization of CO<sub>2</sub> emissions at approximately the national target level. Though the achievement of this target was considered almost definite, because of the economic recession associated with transition, the team's current opinion was that additional measures might be required in order to meet the target. Some of the key factors influencing progress towards this end would be the rate of economic recovery and the priority given to environmental concerns. The team observed the tendency for emissions to grow in all five scenarios subsequent to 1995, linked with the process of economic recovery. Consequently the Slovak Government may have to implement an appropriate mix of policy measures to moderate this growth.

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