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

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I. INTRODUCTION AND NATIONAL CIRCUMSTANCES

1. Canada ratified the Convention on 4 December 1992. Its first national communication (NC1) was submitted to the secretariat on 7 February 1994 and the second national communication (NC2) on 5 May 1997. The in-depth review of the NC2 was conducted between April and August 1998 and included a visit to Quebec from 11 to 15 May 1998. The team comprised Mr. Buruhani Nyenzi (United Republic of Tanzania), Mr.Todd Ngara (Zimbabwe), Mr. Jan Pretel (Czech Republic), Mr. Kenneth Andrasko (United States of America), Ms. Jane Ellis (International Energy Agency) and Ms. June Budhooram (UNFCCC secretariat, coordinator).

2. Environment Canada (EnvCan) and Natural Resources Canada (NRCan) are the two principal institutions responsible for coordinating climate change policy at the federal government level in Canada. A key feature in the development of this policy is consultation with experts from public and private organizations. During the visit, the team held discussions with representatives from federal and provincial governments, research institutions, industry associations, and non-governmental organizations.

3. A distinctive feature of Canada is its legislative structure of federal, provincial, territorial and municipal governments. Provincial governments have primary responsibility for managing resources, with shared federal/provincial jurisdiction over protection of the environment, while all orders of Government establish guidelines and standards. The federal Government has limited power to impose either policy targets or policy mechanisms on provincial or municipal governments. Therefore, consensus-building within the different levels of government is crucial for advancing Canadian greenhouse gas mitigation strategies. Coordination between federal and provincial governments and between energy and environment administrations is handled jointly through the Canadian Council of Ministers for the Environment and the Canadian Council of Energy Ministers. Both provide direction to the National Air Issues Coordinating Mechanism (NAICM), which was established in 1993 to provide a framework for coordinating actions on major air issues that are regional, national or international in scope, such as urban smog, acid rain and climate change. Among other initiatives, the NAICM has produced Canada's National Action Program on Climate Change (NAPCC) in 1995 and the related Voluntary Challenge and Registry (VCR).

4. The NAPCC sets strategic directions in pursuit of the objective to stabilize net emissions of greenhouse gases (GHG) (aggregated on a global warming potential (GWP) basis) at 1990 levels by the year 2000, as well as providing guidance for actions beyond 2000. But the NC2 and subsequent information obtained by the team during its visit give every indication that Canada's GHG emissions will remain substantially above the 1990 level. Evidence of this is the gap between targeted and projected rates of emission which have been revised upward from 8.2 per cent to 11 per cent since the publication of the NC2. Among other factors this is largely due to the current shutdown of seven nuclear reactors in Ontario, replaced for the time being mainly by coal-fired stations. Moreover, Canada's economy was in recession in the early 1990s, though economic performance has greatly improved in recent years. Since 1994, gross domestic

product (GDP) growth has been about one per cent annually. Economic growth has been led by major commodity exports such as uranium, oil, natural gas, coal, and pulp and paper and other manufactured products such as automobiles which have remained buoyant as a result of productivity gains, lower costs and strong demand in the United States (Canada's major trading partner).

5. Notwithstanding the effects of a stronger economy the overall trend in net emissions in the 1990s is still unclear, mainly owing to the as yet unmeasured effects of Canada's large forest in the land-use change and forestry category on total GHG emissions. All indications are that Canada will not be able to meet the first-phase objective of stabilizing GHG emissions at 1990 levels by the year 2000.

6. In spite of these circumstances, the development of climate change policy in Canada has been rapid. Following publication of the NC1 in 1994, the federal and provincial governments produced the NAPCC in 1995, the NAPCC review in 1996, and the NC2 in 1997. Since then a number of policies have been adopted or strengthened. In December 1997, the Prime Minister and provincial Premiers agreed that climate change is an important global issue and that Canada must do its part and must do so in such a way that no region is asked to bear an unreasonable burden. A National Climate Change Secretariat was established early in 1998 to coordinate the preparation of Canada's national implementation strategy on climate change for delivery to Ministers at the end of 1999. In April 1998, federal, provincial and territorial environment and energy ministers agreed to a process involving governments and stakeholders to examine the impact, the cost and the benefits of implementing the Kyoto Protocol and the various options that are open to Canada. The ministers also decided to develop 'early actions' resulting in reductions of GHG emissions. Also in April, the Federal Government signed the Kyoto Protocol.

7. The Kyoto target of reducing aggregate anthropogenic GHG emissions by 6 per cent in carbon dioxide equivalent terms below the 1990 levels in the commitment period 2008-2012, is having a significant impact on Canadian climate change policy, and budget increases have recently been announced for implementing federal policies arising out of the NC2. The first increase was of Can$ 60 million spread over the years 1998 - 2000, and the second of Can$150 million spread over the same three year period. All this has resulted in new GHG initiatives, some of which were already in place at the time of the team's visit while others are getting under way. But the team learned as well that mixed signals are being sent by the government on matters related to climate change. While the federal budget for climate change mitigation activities has increased, provincial budgets for the most part have been cut or held steady.

8. To achieve the Kyoto target, Canada's GHG emissions must decrease on average by 1.6 per cent annually between 2000 and 2010. But the current emissions trend is upwards, underscoring the difficult challenges facing Canada in the years ahead. Historically, the only sustained period of emission reduction occurred during the 1980-1985 recession, when emissions fell by an average of one per cent annually.

II. INVENTORIES OF ANTHROPOGENIC EMISSIONS AND REMOVALS

9. The NC2 inventories cover the period 1990-1995 for all prescribed GHGs, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), carbon tetrafluoride (CF_4), hexafluoroethane (C_2F_6), chlorofluorocarbon (CFC) substitutes not controlled by the Montreal Protocol, and hydrofluorocarbons (HFCs). The 1995 Intergovernmental Panel on Climate Change (IPCC) Guidelines were used in preparing the latest GHG inventories, though in some cases the 1996 Revised IPCC Guidelines were applied. The NC2 contains basic tables on emission trends for CO_2, CH_4 and N_2O, 1990-1995. It also clearly explains the changes made to Canada's 1990 GHG inventory, which is the result of a continuing effort by the Government to improve data quality and coverage. The NC2 is supplemented by the publication *Trends in Greenhouse Gas Emissions 1990-1995*, which contains a complete set of standard data tables in the recommended IPCC format, and these have been used in preparing this report. Added to this are data on carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOCs), but not sulphur dioxide (SO_2).

10. While the opinion of the team is that inventory data substantially improved in the NC2, compared to the NC1, there still exists a major shortcoming in the failure in both national communications to account for land-use change and forestry sinks. During the first in-depth review, the Canadian inventories team reported that the land-use change and forestry category was still being researched in order to clarify whether the total Canadian forest was a CO_2 source or sink. While the previous in-depth review noted that “most of the forest area is believed to be unaffected by human interference” the team concluded that “the development of net anthropogenic emissions or sequestration from this sector could be significant inside a net approach.” During the present review, the team was informed that research in this area is nearing completion. Canada intends to release its annual GHG inventory for 1996 later in 1998 that includes estimates from the managed forest for the first time.

11. The preparation of Canada's GHG inventory was coordinated by EnvCan. Activity data and emission factors came from a number of participating government agencies including NRCan, Agriculture Canada, Industry Canada, Transport Canada, and Statistics Canada, and stakeholders. The team was informed that the energy data provided by these institutions are gathered in a centralized database at Statistics Canada. These data are augmented by additional data collected at the federal and provincial levels and together with appropriate emission factors and models, estimates of emissions are developed by EnvCan and summarized in the national inventory. Through the National Emissions Inventories and Projections Task Group (NEIPTG) which is part of the National Air Issues Coordinating Mechanism (NAICM) the results are verified and approved for publication.

12. For the 1990 to 1995 emission inventories of CO_2, CH_4 and N_2O, a top-down approach was applied to federal and provincial activity data using sectoral level detail. Emission factors were developed by EnvCan in consultation with other government departments and industry associations for many of the specific source categories. A mass-balance approach was used for fuel carbon or stoichiometric relationships. This process avoids double-counting between - and

within - categories of the inventory. Emission factors for major energy and industrial activities are shown in the NC2 supplementary document, but not specific factors for solvent use, agriculture and waste management activities. Canada continues revising its emission factors through a systematic consultative process between relevant public and private experts for many specific source categories. Although average values used for a given category may differ from actual emissions for a specific facility or region, Canada does not see any major discrepancies with the IPCC methodology. Generally, the team found emission factors well developed for most sources of CO_2, but less well defined for CH_4 and even less so for N_2O.

13. Canada has quantitative estimates for the uncertainty of different emission sources of CO_2, CH_4 and N_2O. Overall inventory uncertainties, estimated using a stochastic model, are about 4 per cent for CO_2, 30 per cent for CH_4 and 40 per cent for N_2O, with a confidence level of 95 per cent. (These figures are similar to the NC1 estimates). Estimated emission uncertainties for perfluorocarbons (PFCs), HFCs and SF_6, on the other hand, are not yet available. Based on the distribution of different inventoried GHGs, national experts estimated that the uncertainty in the total CO_2 equivalent emissions (i.e. excluding sinks) is about 10 per cent. Canadian experts informed the team that further methodological improvements are expected.

14. A number of revisions and additions have been made to the 1990-1995 inventory data in the NC2. The NC2 inventory is generally more complete covering a broader range of information, especially with the inclusion of new gases, new activity data (sources), and revised emission factors. Some of the more prominent changes include the addition of SF_6 emissions from magnesium production and HFC emissions from air-conditioning units, solvents and other sources. More accurate estimates of PFCs, and CF_4 and C_2F_6 from aluminium smelting, are also contained in the NC2. Overall, these and other revisions resulted in a 1.9 per cent increase in the base year (1990) emissions compared with the NC1.

15. Using improved methodologies, Canada re-estimated fugitive CH_4 emissions from natural gas distribution and transmission systems. This resulted in a higher estimate of fugitive CH_4 from the distribution system. The former 18 kt CH_4 (NC1) value was updated to 110 kt CH_4 in NC2.These are now incorporated into the inventory. Other important changes in the NC2 inventory are: the addition of CO_2 emissions from agricultural soils, based on the Century model developed by Agriculture Canada, and a downward revision of CH_4 emissions from farm animals. The latter is a result of revised animal population estimates based on recent agricultural studies.

16. The overall accuracy of emission estimates in the transport sector improved in the NC2 through the introduction in 1996 of an updated model for determining emissions from mobile sources. This model incorporates new research data from EnvCan and the United States Environmental Protection Agency (USEPA) on N_2O emissions from catalytic converters in vehicles, resulting in a reduction in base year estimates from 38 Gg in the NC1 to 29 Gg in the NC2. The review team was informed that estimates may change once further test work is completed both by the USEPA and EnvCan.

17. International air and marine bunkers emissions which were aggregated in the national totals found in the NC1 base year inventory, were reported separately in the NC2, in keeping with the IPCC Guidelines. Emission estimates are based on reported fuel sales to air and marine vessels of foreign registration. Although actual quantities of fuel sold are not given, total emission volumes on a CO_2 equivalent basis are given as 4,814 Kt, or about one per cent of total GHG emissions in 1995. However, the team was informed that these figures have a high level of uncertainty.

18. The review team considers the GHG inventories in the NC2 very transparent (except for the land-use change and forestry sector) as is the supplementary information on methodologies for the calculation of emission factors and uncertainties. Worthy of special mention is Canada's pioneering studies on inventory uncertainties. Furthermore, the inclusion of activity data on the new gases, namely HFCs and SF_6, is another improvement in the NC2. Canada is also commended on its efforts in compiling the NC2 inventory, which is based on the fruitful cooperation between federal and provincial agencies, a process that is time-consuming but rewarding in terms of improving the GHG inventory.

19. In the land-use change and forestry category, as previously noted, the team was told that Canada's 1996 GHG inventory will include emissions data from forests. This will improve the inventory substantially, especially given that Canada's forested area is the second largest in the world (approx. 417 million hectares). The team was shown information indicating that the 1996 national GHG inventory is likely to reflect a net CO_2 sink from forests of about 100-120 Mt per year for the period 1990-1996, which is equal to about 15-20 per cent of Canada's total emissions. When made available, these data will need to be reviewed, and compared with forest data contained in the first IDR, which reported a sink of about 200-260 Mt of CO_2 per year through 1970, changing to a net source by 1989. Similarly, scientific literature on Canadian forests shows a wide range of estimates, some with varying signs (source or sink) depending on methods and definitions applied.

20. The team was told that land-use change and forestry inventory figures for 1990 and later have not been released for the following reasons:

(a) Primarily, an inability to satisfactorily define and separate anthropogenic emissions and uptake from natural activity, both in forest biomass inventory data and in the CBM model;

(b) The changing sign on emissions produced by the Carbon Budget Model (CBM), which was developed to assess forest GHG inventories and fluxes, thus creating a large degree of uncertainty over the estimate;

(c) A proliferation of fire and pest cycles during the past two decades, resulting in significantly higher emissions from those sources;

(d) Inconsistencies in applying the IPCC Guidelines to Canadian forests, particularly with respect to the treatment of harvested products; and

(e) The incomplete national forest biomass inventory, which was compiled to estimate commercial timber harvest potential not forest carbon fluxes.

21. The team was informed that the Carbon Budget Model is currently being revised so it also reports on anthropogenic ("managed" or commercially accessible forests), natural forest activity data, and for the purpose of assessing issues on sinks related to the Kyoto Protocol, all of which is part of the Canadian national implementation strategy. Canada has numerous activities proposed or under way to address forest inventory issues. EnvCan and NRCan reported that the 1996 GHG inventory, - which will include forests, using the revised 1996 IPCC Guidelines, - should be available by August 1998.

22. GHG emissions in 1995 estimated at 619 Mt in CO_2 equivalent, increased by 7 per cent over the revised 1990 estimate of 576 Mt. This higher growth rate is attributed to an increase in Canadian population (7 per cent), GDP (8 per cent) and energy consumption (9 per cent) over the same period. The projection of the gap for 2000 has since widened further to 11 per cent, because of the recent shut-down of Ontario nuclear plants. Based on the 1995 IPCC 100-year GWP for total aggregated emissions in CO_2 equivalent, CO_2 emissions accounted for 81 per cent of the total, CH_4 13 per cent, N_2O 5 per cent, and new gases 1 per cent. Adjustments for climate variation and trade patterns in electricity were not made. In 1995, energy production was responsible for 39 per cent of emissions, transportation 27 per cent, industrial processes 15 per cent, the residential sector 7 per cent, the commercial and institutional sector 4 per cent, and agriculture 5 per cent and waste management 3 per cent.

23. In the supplementary document, Canada provided additional inventory data for provinces and territories, and their respective GHG emission trends for the period 1990-1995. For emissions in CO_2 equivalent, Alberta accounted for 30 per cent of total Canadian output, Ontario for 29 per cent, Quebec 13 per cent, British Colombia 9 per cent, and Saskatchewan 8 per cent. Growth rates in GHG emissions during the last five years were registered as follows: Saskatchewan (23 per cent), Alberta (18 per cent), British Columbia (16 per cent), New Brunswick (11 per cent), and Ontario and Quebec (2 per cent each). Geographically, emissions showed significant increases in western Canada, remained relatively constant in central Canada, and declined in three of the four Atlantic provinces.

A. Carbon dioxide

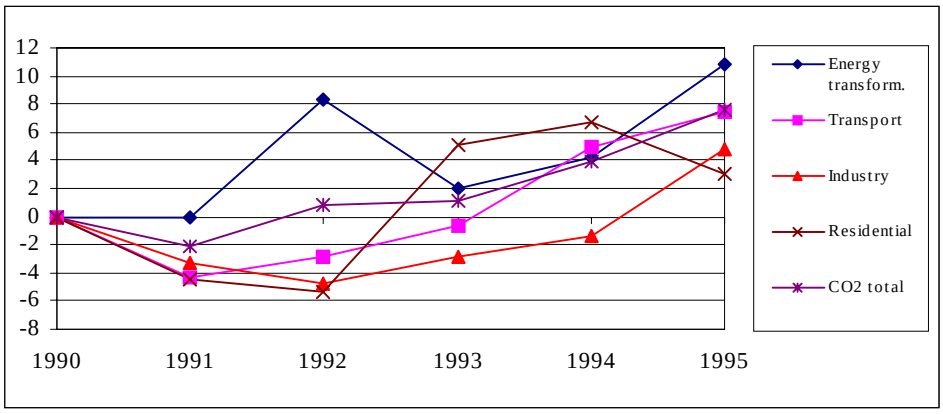
24. Total anthropogenic emissions of CO_2 in 1995 period were estimated at 499.5 Gg, an increase of 8 per cent over 1990 levels (see table 1 and figure 1). The bulk of emissions came from energy sources, which accounted for 85 per cent of the total. Energy transformation accounted for 32.1 per cent of the total, transport 30.1 per cent, industry and industrial processes 20.1 per cent, the residential sector 8.3 per cent, the commercial and institutional sector 5.9 per

cent, agriculture 0.8 per cent, and other sectors 2.7 per cent. While CO_2 alone make up 81 per cent of total 1995 GHG emissions, CO_2 emissions increased by 7.7 per cent between 1990 and 1995.

Table 1. CO_2 emissions by sector, 1990-1995 (Gg)

	1990	1991	1992	1993	1994	1995
Energy transformation	145 000	145 000	157 000	148 000	151 000	160 690
Transport	140 000	134 000	136 000	139 000	147 000	150 453
Industry	71 900	69 500	68 500	69 900	70 900	75 319
Residential	40 700	38 900	38 500	42 800	43 400	41 950
Commercial/institutional	26 000	25 800	26 300	28 600	28 100	29 867
Industrial processes	21 800	22 100	22 000	24 000	25 100	24 834
Agriculture	7 090	5 820	5 000	3 940	3 490	2 841
Others	11 510	12 880	14 700	12 760	13 010	13 932
CO_2 total	464 000	454 000	468 000	469 000	482 000	499 526

Figure 1. CO_2 emissions, percentage change from 1990 by major sources



25. The increase in emissions by industry and industrial processes is associated with a rise in industrial output, especially iron and steel production. Emissions from transport increased as 1995 gasoline and diesel consumption in road vehicles rose by 9 per cent over their 1990 levels. National experts explained that the decline in CO_2 emissions from agriculture is the result of changing agricultural practices, such as no-tillage methods and a reduction in fallow areas during the summer.

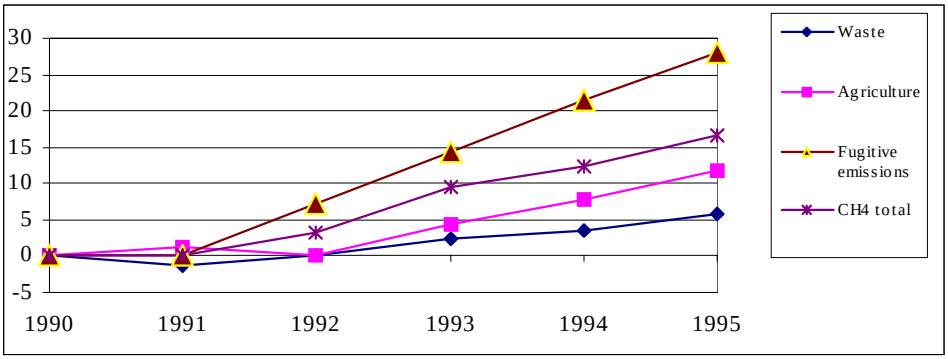
B. Methane

26. Total CH_4 emissions in 1995 were estimated at 3732 Gg, a 16 per cent increase over the 1990 level of 3,200 Gg (see table 2). Fugitive emissions from oil and gas production accounted for nearly half the total (47.9 per cent), agriculture 26.7 per cent, landfills 23.9 per cent, and other areas (mainly coal mining) 1.5 per cent. The significant rise in methane emissions is due to high growth rates in oil and gas production (38 per cent over five years), as seen in figure 2.

Table 2. CH_4 emissions by sector, 1990-1995 (Gg)

	1990	1991	1992	1993	1994	1995
Waste	840	830	840	860	870	889
Agriculture	890	900	890	930	960	996
Fugitive	1 400	1 400	1 500	1 600	1 700	1 791
Others	70	70	70	110	70	56
CH_4 total	3 200	3 200	3 300	3 500	3 600	3 732

Figure 2. CH_4 emissions, percentage change from 1990 by major sources

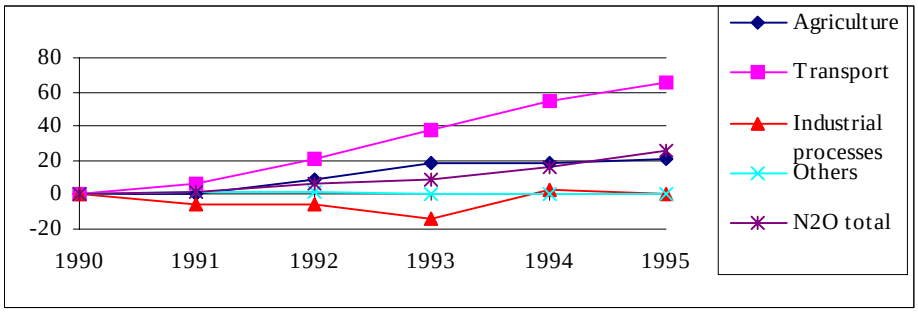


27. Methane emissions were responsible for the 12 per cent increase in total CO_2-equivalent GHG emissions between 1990 and 1995. This trend, as shown in figure 2, is directly proportional to the increase in natural gas production, processing, distribution, storage and flaring. The category 'others' in table 2 is on a downward trend owing to an 11 per cent decrease in emissions from underground coal mines, resulting from mine closures in eastern Canada and a subsequent drop in coal production. It also includes methane emissions from transport, where the vehicle fleet and fuel consumption are on the rise, but where a 30 per cent drop was recorded reflecting the increasing penetration of better emission control technology in new cars such as advanced three-way catalytic convertors. Methane emissions from enteric fermentation and livestock manure dominated agricultural emissions, which constitute the largest of the non-energy CH_4 sources of emissions. The upward trend from 1990 to 1995 is largely the result of a growing livestock population during the period. While Ontario and the Atlantic provinces showed a decline in cattle population, there was an overall increase of 15 per cent nationally.

Table 3. N_2O emissions by sector, 1990-1995 (Gg)

	1990	1991	1992	1993	1994	1995
Agriculture	11	11	12	13	13	13.3
Transport	29	31	35	40	45	48
Industrial Processes	37	35	35	32	38	37.1
Others	9	10	10	9	4	9.6
N_2O total	86	87	92	94	100	108

Figure 3. N_2O emissions percentage change from 1990 by major sources



C. Nitrous oxide

28. Emissions of N_2O in 1995 were estimated at 108 Gg (see table 3) representing a five-year increase of 26 per cent. Of this, increasing transport demand and the use of catalytic converters in vehicles accounted for 44 per cent, industrial processes 34 per cent, and fertiliser use 12 per cent. The large increase in transport emissions (66 per cent in five years) has overshadowed more modest trends in other subsectors, as shown in figure 3. With the manufacture of adipic acid for making nylon remaining constant since 1990, N_2O emissions from industrial processes have remained relatively constant. The increasing trend observed in the agriculture sector, on the other hand, is attributed to a methodological revision and the inventory inclusion of N_2O emissions from agricultural soils.

D. The new gases

29. Canada reported both actual and potential emissions of HFCs in the NC2. Total 1995 HFC emissions were estimated at 500 Gg of CO_2 equivalent. Emission levels were estimated by applying emission factors to production, import, and consumption data. The factors are based on loss rates adapted from the 1996 Revised IPCC Guidelines. The only major source of PFCs in Canada is primary aluminium smelting, which in 1995 produced an estimated 800 tonnes of CF_4 and 79 tonnes of C_2F_6. The NC2 reported total PFC emissions of 1 kt of CF_4 and 0.08 kt of C_2F_6. Emissions of these gases are increasing with the higher rates of production in primary aluminium smelting. SF_6 is imported for use in the magnesium industry. In 1995, emissions of SF_6 were estimated at 0.1 kt, reflecting a 34 per cent decline in consumption since 1990.

III. POLICIES AND MEASURES

30. The NC2 clearly outlined the objectives and impacts of the NAPCC, and described key actions taken thus far by federal, provincial and municipal governments under this programme. The NAPCC was approved by federal and provincial ministers of energy and environment in February 1995 - too late for inclusion in the NC1. While inclusion of the NAPCC in the NC2 is commendable, the description of mitigatory measures in the report does not fully comply with the UNFCCC Guidelines. Specifically, the measures are not organized by gas; not all sectors are covered (no policies and measures are presented that aim at reducing emissions of HFCs, PFCs

or SF_6); quantitative estimates of the effects of individual measures are often missing (partly because of the difficulty in measuring the effects); and measures that are presented are not ranked in order of importance. Finally, it is difficult to determine which of the projects were pre-existing and which are new.

31. During the team's visit, the need for cost-effective mitigation policies was a topic repeatedly emphasized by the Canadian experts. However, there is very little information in the NC2 on the costs of current policies or those under consideration. Also, the impact that many of these measures might have was difficult to quantify. In the case of the NAPCC, the experts pointed out that while the majority of actions classified under the programme are voluntary, regulatory measures, financial incentives and research and development are also being employed. Gauging the effectiveness of voluntary measures is inherently uncertain because (i) many more assumptions must be made concerning rates of uptake than is the case with regulatory or market-based instruments; and (ii) various measures may be indistinguishable from behavioral changes that would otherwise occur independently. Another problem was the consensus-building process between the federal and provincial governments. Patterns of energy production, energy use and GHG emissions - and so the potential impact of climate change policies - are strikingly different by province.

32. The NAPCC comprises approximately 475 measures and sets the strategic policy direction for Canada's emissions mitigation. The NAPCC divides mitigation action under three broad headings: the role of governments; broad-based measures; and sectoral actions. These headings are founded on four main initiatives: the Voluntary Challenge and Registry (VCR); joint implementation (JI); information/suasion programmes; and international cooperation. In addition there are programmes using six policy instruments: (a) regulation; (b) fiscal incentives; (c) research and development; (d) voluntary action; (e) federal leadership; and (f) information. Many of the actions defined under the NAPCC are not exclusively - or even principally - directed at mitigating GHG emissions. Instead, they were designed to meet other environmental and financial objectives that predate the NAPCC.

33. The VCR, a significant measure of the NAPCC, is a cross-sectoral programme under which companies, federal government departments, and provincial, territorial and local governments are asked (though not required) to develop action plans to reduce GHG emissions and then submit these plans to a central registry where they are made available to the general public. Discussions with the VCR representative during the review revealed that there has been a moderate degree of success in soliciting action plans and baseline emissions data on individual entities, and in quantifying the contribution of the VCR in reducing GHGs. While the VCR began as a government-run initiative, the intention from the outset was to privatize the VCR. Quebec has a similar voluntary programme called ÉcoGeste administered by the provincial government. In October 1997, the VCR was incorporated as an independent and non-profit organization under the name of VCR Inc. to strengthen the public-private partnership necessary to address climate change. The new organization is governed by a Board of Directors, two thirds of which are private-sector representatives, and one third of which are government representatives. The organization's funding structure reflects this composition.

34. The review team observed that there is at present no adequate system for monitoring and reporting on the progress of initiatives coming under the NAPCC, and that the format used to report on VCR actions varies greatly across participating firms. The team learned that by 1998 some 700 companies had already registered. The team noted that some currently registered companies claim they do not have the necessary resources to implement a wide range of voluntary actions and will require financial backing from the Government.

35. Other factors adversely affecting the ability of the VCR to contribute to reducing GHG emissions is the lack of mandatory reporting of information that is needed to monitor and assess the credibility of voluntary action plans. Such information includes baseline emissions, emission projections, and future actions. The team was informed that since the introduction of NAPCC two independent reviews have been conducted, one in November 1996 and the other in April 1998. The reviews found that, among other things, there must be a system in place to measure impacts emanating from the programme. Another recommendation was to consider introducing fiscal incentives to promote greater voluntary action by making it more attractive and profitable. In 1998, NRCan began to deliver fiscal incentives of up to Can$ 20 million a year over three years for programmes to promote energy efficiency and renewable energy in the commercial sector. However, the team was informed that the current prime minister has not introduced, and seems reluctant to introduce, a carbon tax, at least for the time being, and no moves are afoot to change the structure of energy pricing either by increasing energy taxes or by incorporating the cost of environmental externalities associated with energy use.

36. Currently in Canada there are several factors working against stronger climate change efforts: first, tax fatigue on the part of Canadian taxpayers; second, other domestic priorities such as job creation and regional economic well-being; and third, a high dependency on foreign trade. Moreover, the legislated power of provincial governments to determine their own energy policies and sources of energy supply means that the ability of the federal government to issue "command and control" measures such as quotas and regulations is limited. The differences between each province - whether in fuel mix, energy intensities, population densities, climate, or all of these combined - also mean that it is not always feasible to adopt nationwide prescriptive measures.

37. In addition, the importance of the United States as a trading partner in both goods and energy, and Canada's desire to maintain its international competitiveness, mean that climate change mitigation policies in the energy sector often go hand in hand with those of the United States. One example is the difficulty for Canada to develop vehicle efficiency standards which are more stringent than those in the United States given the integrated North American automotive industry. The imposition of an externality charge on fossil fuel for domestic use or export also appears unlikely.

38. The team learned that there is a general consensus among all stakeholders that the current structure of the VCR needs to be strengthened. Others believe that voluntary action alone will not be sufficient to meet Canada's climate change commitments. The federal government currently offers support (eg., information training, list of qualified Energy Service Companies, project financing options, workshops, case studies, international database of energy efficient

technologies) to VCR registrants. The team believes it would be advisable for the federal Government to introduce a GHG monitoring system, and provide companies with more information, expertise and financial support if the VCR is to make a substantive contribution in reducing GHG emissions. GHG emission reduction objectives and performance targets for each programme may also be helpful. Despite these shortcomings, the opinion of the team is that some limited progress has been made in the form of the National Action Program on Climate Change (NAPCC), beginning with its launch in 1995.

39. In 1995, emissions per capita and per unit of GDP were both high in Canada, at 20.9 tons and 1012 tons CO_2 equivalent respectively in United States 1986 dollars. The majority of these emissions (85 per cent) are energy-related - mainly fuel combustion and fossil fuel production. Transport is the largest single source of emissions, followed by electricity and heat production and industrial energy use. Residential, commercial and agricultural energy use combined account for only 20 per cent of energy-related emissions, yet one third of policies and measures to reduce emissions of greenhouse gases target these smaller sectors.

40. CO_2 emissions in the oil and gas industry come from three principal sources: fossil fuel use for exploration, extraction, and transport of crude oil, natural gas and coal. Recoverable oil reserves in Canada represent 13 years of supply at current rates of production; however, very large oil-sand deposits in the western provinces could extend the supply to several hundred years. Given prevailing market conditions and expected rates of oil production (including oil-sands) CO_2 emissions are expected to grow. The Canadian Association of Petroleum Producers reported that there are 170 companies involved in the exploration, development and production of oil and natural gas in Canada. In 1998, over 96 per cent of the Association's member companies were included in the VCR, with 90 per cent having filed action plans for GHG reduction. In their VCR programmes, these companies have targeted emission reduction strategies that are the most cost-effective and that suit their particular circumstances. For CO_2, these initiatives concentrate on improving production practices and employing new technologies in oil sand operations.

41. The Canadian economy is relatively electricity-intensive, partly because of its climate geography and the presence of many energy-intensive industries. Nevertheless, electricity generation by itself was responsible for only 17 per cent of Canada's 1990 GHG emissions. This low share is due to the importance of hydropower and nuclear power, which together accounted for 80 per cent of total electricity generation in 1995. Power generation, however, is a sector where provincial differences are particularly marked. For example, CO_2 emissions per kWh of electricity produced ranged from approximately 920 g of CO_2/kWh in Alberta (which relies on coal-fired power) to under 5 g of CO_2/kWh in Quebec, which is hydro-based.

42. Electricity supply is the responsibility of each provincial government, with federal involvement in the sector limited to electricity trade at the international and inter-province level. While there is little inter-province trade, electricity exports to the United States are quite significant, particularly from the eastern provinces and Manitoba. Except in Alberta, Prince Edward Island, Nova Scotia and Newfoundland, most electricity is supplied by

provincially-regulated public monopolies. Limited inter-province electricity trade, combined with provincial responsibility for electricity supply, over-optimistic demand forecasts, and a captive rate base means that some provinces have some overcapacity at present, while others, notably British Columbia, Saskatchewan and Alberta face pressure to add to capacity in order to meet rising demand. This is a situation that is likely to continue for some time. Ontario, however, is the exception, with the recent shutdown in 1997 of 7 of its 19 nuclear units. This temporary shutdown has resulted in increased use of Ontario Hydro's coal-fired units. It should be noted that TransAlta, Alberta's largest power supplier, has set a goal of returning GHG emissions to the 1990 level by the year 2000, without committing to stabilization thereafter. This company is also pursuing various sequestration and efficiency opportunities in Canada as well as in other countries. The NC2 reported that some provinces are supporting the development of new renewable energy. Alberta has approved 18 projects representing 108 MW of generating capacity, including two of Canada's largest wind farms. Construction has begun on Le Nordais, a 100 MW wind farm project in Gaspé, Quebec.

43. There are major changes taking place in the North American electricity market. Complete deregulation of these markets is expected within the next 10 years and this may affect current trends in GHG emissions. In Canada, the exact form of deregulation in each province is still not entirely clear. During the review, Canadian experts explained that it may combine elements of unbundling utilities into competing units, privatization and regulatory reform. The traditional base rate approach to electricity pricing will probably disappear. Alberta has already deregulated and Ontario has indicated it will be open to competition in electricity supply by the year 2000. Other provinces are studying scenarios for a comprehensive restructuring of their operations. All of this indicates some major changes looming on the horizon. Although overcapacity in some provinces presently limits the need for new capacity, open competition may lead to significant changes in the fuel mix in the longer term. It could also open up opportunities for generation from non-hydro renewables, whose current supply contribution is quite small, apart from the use of biomass in the pulp and paper industry. The NAPCC reported that utilities are increasingly turning to renewables to serve small off-grid niche markets.

44. Canada's vast area and low population density, plus the fact that it manufactures motor vehicles for both Canadian and American markets and has the second lowest gasoline prices of OECD countries are all factors which have led to a heavy reliance on road travel, making emissions reduction in the transport sector difficult to achieve. Transport accounts for 27 per cent of Canada's GHG emissions, with emissions growing from 140 Gg CO_2 in 1990 to 150 Gg CO_2 in 1995. Over the five-year period, there was a 2 per cent shift from motor gasoline to diesel, which contributed to a slight decline in the carbon intensity of transport fuels. Motor gasoline and diesel, respectively, accounted for 59 per cent and 26 per cent of total fuel consumption. The most significant factor causing transport energy consumption to increase was in the freight segment, where a modal shift toward greater truck transport occurred. Elsewhere in the sector, energy intensity declined during the same five-year period. In rail transport especially, low-capacity and low-profit lines were eliminated and this resulted in energy intensity improvements for that sector that would be offset somewhat by a shift to the trucking industry that now services centres on those abandoned lines.

45. The use of personal vehicles and light trucks accounted for approximately half of total transport emissions. Encouragement of modal shifts in urban centres, moving away from private autos and trucks, is largely the purview of individual municipalities as they have responsibility for public transport expenditure and urban planning. Municipalities have suffered large budget cuts since the early 1990s, often having to reduce public transport in their areas. This development has further eroded the potential customer base for public transport.

46. The importance of freight transport to total transport emissions is a reflection of the long distances over which goods have to be carried, as quite a high proportion of total freight transport is currently carried by rail. However, emissions from rail transport of freight has decreased, whilst those from trucks have been increasing rapidly, and no policies seem to be in place to maintain or increase rail's share of freight transport.

47. The team was briefed on Fleetwise, a federal programme to reduce CO_2 emissions, aimed at cutting the number of federal vehicles on the road, training drivers in efficient operation techniques, and increasing the use of alternative fuels. Between 1990 and 1995 there has been an increase in the use of natural gas and propane in light vehicles, and in 1995 the federal Government passed Bill S-7 which requires federal government agencies to gradually convert their vehicle fleets to cleaner propane, ethanol and natural gas where economical and where these fuels are available.

48. The NC2 listed 13 initiatives under the NAPCC for improving vehicle efficiency which could offer substantial GHG mitigation, since average fuel efficiency is currently estimated at 8.1 l/100km (compared to best available technology of 4.9 l/100km for cars and 7.5 l/100km for trucks). However, the Canadian Government is not pursuing mandatory vehicle efficiency measures. Instead, Canada has voluntarily adopted the United States fuel efficiency standards for automobiles, and, in an integrated North American vehicle market, taking unilateral action on fuel efficiency is difficult. Instead, the federal Government aims to reduce fuel use, and therefore emissions, through driver awareness and information programmes. Fuel efficiency standards legislation (similar to that of the United States) is on the statute books, but has not been promulgated as industry is judged to be responding voluntarily. The Government has signed a memorandum of understanding with the United States Government on vehicle fuel efficiency and alternative transportation fuels. The team was informed that there are no plans to introduce a carbon tax in the transport sector or to invest substantially in public transport infrastructure.

49. The NC2 reported that CO_2 emissions from energy consumption in industry increased between 1990 and 1995 owing to a shift towards more energy-intensive industries, as well as a slight increase in energy intensity in the same period. The carbon dioxide intensity of industrial energy use decreased by 6 per cent as some industries moved towards fuels with a lower carbon content. The six largest energy-intensive industries accounted for 70 per cent of total sectoral emissions. These included mining, smelting and refining of minerals, iron and steel, pulp and paper, industrial chemicals and cement.

50. Major fuel shifts from 1990 onwards were concentrated in mining, which used more natural gas, and in the pulp and paper industry which utilized a combination of more natural gas, wood waste and pulping liquor for electricity and steam production. In aluminium production, smelting coal, coke and oil lost ground to electricity. Metal production industries are particularly energy-intensive. As such their size, growth and technological evolution are key determinants in the large volume of GHG emissions from this sector. As a group, these industries account for 13 per cent of total GHG emissions in Canada. With a rate of energy productivity (dollars of output per unit of energy consumed) over seven times lower than in general manufacturing operations, each of these industries is expected to be a prime candidate for emission reductions in the future. From April 1998, a limited number of federal economic incentives became available to industry to install certain types of renewable energy systems.

51. Federal measures in place and contained in the NACPP to mitigate energy-related greenhouse gas emissions in the residential and commercial sectors in Canada concentrate mainly on information/education programmes, energy efficiency regulations, financial incentives and on voluntary adoption of economically attractive ("no regrets" or low-cost) mitigation policies, often related to energy efficiency. These include energy efficiency and alternative energy initiatives under the federal component of the NAPCC which is managed by NRCan. The Energy Efficiency Act was introduced to give the federal Government authority to make and enforce regulations on the performance levels of buildings and energy labelling of building infrastructure and appliances. More efficient homes are being promoted through initiatives such as the National Code for Houses; building retrofit; the R-2000 Home Programme; and the Buildings Energy Technology Advancement Plan. However, the slow turnaround of housing stock makes this a longer-term emission mitigation option. The federal Government also has programmes which deal with retrofits of existing buildings (Energy Innovations, EnerGuide for Houses and Reno$ence), which have stronger near-term results. The Renewable Energy Deployment Initiative (a measure not described in the NC2) was introduced by NRCan in April 1998. This is a three-year Can$ 12 million project to stimulate market demand for commercially reliable, cost-effective renewable energy systems for space and water heating and cooling.

52. The NC2 listed only two federal initiatives in the forestry subsector. Tree Plan Canada, a federal initiative, is intended to encourage companies and organizations to plant trees as a means of sequestering CO_2 and other gases. The NC2 reported that 52 million trees have been planted since 1992. At maturity these trees will have sequestered and reduced emissions by approximately 6.2Mt of CO_2. There are also forest education programmes where seedlings are given to schools and other interest groups for demonstration purposes.

53. The team was informed that the oil and gas sector is concentrating its efforts on modifying and improving the monitoring of fugitive CH_4 emissions, as well as introducing new technology in the pipeline distribution system to reduce these emissions. These efforts are part of its VCR actions. No indication was given to the team as to the potential reductions achievable under the proposed schemes or their associated costs.

54. The team also learned that only 25 per cent of all methane generated in landfills is presently captured, although attempts are being made to capture a further 25 per cent. There were 33 operating recovery facilities of CH_4 in Canada in 1997. Of the total methane captured, 30 per cent is flared and the other 70 per cent used to produce energy, including 82.5 MW of electricity in 1997. The Canadian experts explained that they are currently studying options to optimize the recovery and utilization of CH_4 from all large and medium landfills, greater than approximately 1 Mt of waste capacity.

55. Most N_2O production is linked to a specific adipic acid manufacturing process. This process is expected to be phased out gradually by 2000 so emissions of this gas are expected to decrease drastically. No mention was made in the NC2 of specific measures being taken in the agriculture sector for reducing emissions of N_2O, except for an expected decrease in the application of fertilizers.

IV. PROJECTIONS AND EFFECTS OF POLICIES AND MEASURES

56. The NC2 presented projections of GHG emissions for energy and non-energy sources for the years 2000, 2005, 2010 and 2020, using a baseline scenario as well as a "with measures scenario". GHG projections cover the six main gases: CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. While the coverage is generally good, there are several forecast omissions that decreased data transparency and comparability, specifically: non-CO_2 emissions. The omission of sinks and international aviation and marine bunkers is of particular concern. Nevertheless, there was consensus by the review team that the methodology and GHG coverage had improved significantly compared with the NC1 (except in the case of land-use change and forestry sectors). On coverage, the inclusion of GHG projections from soil is but one example.

57. Projected emissions from energy use, representing about 90 per cent of total emissions, were prepared by NRCan. Those from non-energy use were prepared by EnvCan. The Energy Policy Branch of NRCan has developed and is responsible for maintaining an integrated modelling system able to produce estimates of energy supply and demand and associated GHG emissions at the national and provincial level by fuel and sector. The integrated system consists of the Inter-Fuel Subtitution Demand (IFSD) model, the Canadian Power Planning Model for utility generation, the Oil and Gas Supply Model, and detailed end-use models for the residential, commercial, industrial and transport sectors maintained by the Office of Energy Efficiency. Together, these models constitute NRCan's modelling framework.

58. The general methodology employed by the NRCan's modelling framework model in the NC2 is the same as in the NC1, combining econometric, end-use and process techniques. The NRCan's modelling framework is highly disaggregated covering the major fuel types (coal, oil, natural gas) and the four primary end-use sectors (transport, residential, commercial and industrial) for each of Canada's 10 provinces. The NRCan's modelling framework is able to estimate the effects of various GHG policies and initiatives, but is limited in its ability to capture market responses to technological and regulatory change, such as simulating the potential impact of liberalizing electricity markets across provinces. The IFSD model, first developed about 20

years ago, was originally utilized for preparing energy security outlooks at the provincial level. Over the years the model has undergone continuous refinement and has been modified for climate change analysis, incorporating an emissions module that calculates projections of energy-based emissions of CO_2, CH_4 and N_2O. The team was informed that more work on refining CH_4 and N_2O projections is expected.

59. The key assumptions underpinning NRCan's energy and emissions forecast are coordinated by the Energy Policy Branch and the Office of Energy Efficiency and derived through extensive consultation with a wide cross-section of experts from energy industries and government officials at the federal and provincial level. Similar consultations are held to review the model's results. The entire process usually lasts about 8 to 10 months and is designed to ensure that results from the forecasting process are consistent and reliable.

60. The assumptions and tools used in the projections are well documented in the NC2, and elaborated on in the document, *Canada's Energy Outlook for 1996-2020*. The Canadian experts responsible for projections informed the team that, in most instances, the 1990 GHG inventory data are compatible with modelling structures. The model's principal assumptions are built around macroeconomic variables (e.g., economic activity, exchange rate), energy prices, demographic trends, and current energy policies and related mechanisms, such as energy taxation. The assumptions are as follows: low, almost stable real energy prices; demographic trends, NAPCC initiatives, and current energy policies and related mechanisms, such as energy taxation. Between the NC1 and the NC2, for the period 1991-2000, some estimates were revised downward. Population growth rates decreased from 1.2 per cent annually to 0.9 per cent, and oil, natural gas and coal prices were lowered on the basis of actual trends in the international and North American energy markets. Oil price estimates fell from US$ 24/bbl to US$ 20/bbl by 2000, and natural gas from US$ 2.00/thousand cubic feet (mcf) to US$ 1.90/mcf.

61. Some of the more important assumptions underlying GHG projections are energy-based, specifically the future structure of the electricity industry and the rapidly evolving market for electricity supply, and the Canadian supply of crude oil and natural gas. Assumptions on market structure for electricity generation are centred around fundamental moves toward a competitive and privatized electricity market over the next decade. This conclusion was reached after consultations with provincial utilities, and energy departments, and is a consensus of expert views regarding the future evolution of North American electricity markets in general and the Canadian market in particular. Electricity assumptions as they pertain to the evolution of the generation mix over the next several decades include: no new major capacity additions before the middle of the next decade (some small natural gas and renewable facilities are exceptions); the life of existing thermal units will be extended to 50 years; no new nuclear plants but some life-span extensions; no new hydropower larger than 500 MW, with the exception of the Grande Baleine project in Quebec; most new generation capacity will be from natural gas (combined-cycle and cogeneration); competitive and potentially more volatile electricity trading will not lead to higher transmission volumes in the long term; electricity price differentials between provinces will be reduced; and the amount of electricity derived from renewable energy (biomass, waste, wind, geothermal, small hydro) will increase by a factor of four (5.4 TWh to

20.2 TWh, which is 3 per cent of the total demand) between 1995 and 2020, with biomass and waste expected to predominate. For the purpose of forecasting, no excess capacity is assumed: the timing and sequence of capacity additions are continuously balanced against projected demand, exports and decommissioning of older power plants.

62. The key assumptions for crude oil and natural gas supply are extensive, involving major resource development projects, the extent of the reserve base, resource potential, and industry investment and replacement costs. In summary, oil production will continue to increase, with higher production from frontier areas and oil-sands offsetting slight declines expected from conventional production basins. Natural gas production is expected to grow by one third between 1995 and 2020. Both trends will keep Canada a net exporter of oil and gas over the forecast period. The key production projects supporting these assumptions are huge oil-sand developments in western Canada and conventional oil development on the east coast, including the large Sable Island gas project which will feed markets in the northeast of the United States. Additional assumptions driving oil and gas development are profitable investment opportunities and healthy industry-wide cash flows averaged over the forecast period. Replacement costs for finding and developing new sources of oil and gas (reserve additions) are expected to decline (oil) or remain flat (gas) by 2002, owing mainly to technological advance and diffusion.

63. The Canadian coal supply is not resource-constrained. Production is therefore largely a function of domestic demand and exports of metallurgical coal and thermal coal for power generation and is expected to grow by about 20 per cent between 1990 and 2010 (79 Mt), and another 11 per cent by 2020 (88 Mt). Imports are assumed to more than double by 2020 (23 Mt) and exports will increase by about 10 per cent (37 Mt) over the same period.

64. The 'with measures' scenario presented in the NC2 included 272 federal, provincial, municipal and gas and electric utility initiatives with definable impacts and 235 VCR submissions with specific action plans covered by NAPCC. These initiatives are mostly voluntary. Since there is no monitoring system in place to routinely gauge the effects of individual policies and measures, they were more or less held constant in their current form over the forecast period. Consequently, the team found it difficult to evaluate or quantify the effects of individual policy measures under the NAPCC, some of which were not considered in the projections. Offsetting this, the team felt that there was some policy overlap, resulting in a probable overestimate of emissions in certain instances.

65. Under the 'business-as-usual' scenario, Canadian GHG emissions are forecast to increase at an average annual rate of 0.6 per cent between 2000 and 2010. To achieve the commitment made under the Kyoto Protocol would require an equivalent annual GHG reduction on average of 1.6 per cent over the same period. To offset this 20 per cent differential between expected level and target level emissions will be a challenge. Based on the projections it is clear that without implementation of additional policies and measures, such as those mentioned above, aggregate GHG emissions in CO_2 equivalent will be above 1990 levels by 18 per cent in 2000, 30 per cent in 2010, and 55 per cent in 2020. By implementing the policies and measures cited in the NAPCC the numbers would be somewhat lower. Aggregate GHG emissions in CO_2 equivalent

would rise by 11.3 per cent in 2000, 18.6 per cent in 2010 and 36.1 per cent in 2020, compared with 1990 levels. These estimates, however, do not include sinks or bunkers.

66. The residential sector is the only sector where emissions are projected to be reduced below the 1990 level, indeed 13 per cent below, as a direct result of the substantial mitigation effort targeted at this sector. Emissions in all other sectors are expected to grow significantly. Industrial emissions are expected to increase by 30 per cent, commercial by 27 per cent, transport by 26 per cent, and electricity generation by 16 per cent. Across provinces, the highest emission increases are expected in British Columbia (37 per cent), followed by Saskatchewan (25 per cent) and Alberta (20 per cent), mainly because of population growth and higher rates of energy use and energy production. While demand for oil in Canada is growing, in the United States oil production is declining and at the same time oil demand is increasing. Consequently, net oil imports in the United States are expected to increase from 7.1 mmb/d in 1995 to 10.2 mmb/d in 2015. This implies that GHG emissions from Canadian oil production will increase further as the three aforementioned provinces step up production to meet rising demand from the United States for imported oil. Another important determinant of future energy production, based on the latest United States Energy Information Administration forecast, is rising Canadian exports of natural gas to the United States. They imported 2.8 trillion cubic feet (tcf) in 1995, mainly from Canada. This figure is predicted to rise to 4.1 tcf in 2015, with most of the increase being met by Canada.

67. In the NC2, projected emissions of CO_2 in the year 2000 are lower by about 4 per cent compared to NC1 projections. This is a result, as was explained to the team, of a somewhat higher success rate in the past few years in implementing GHG policies and measures than was expected at the time the NC1 was prepared.

68. The NC2 included a sensitivity analysis on the "with measures" scenario using several different macro assumptions. This exercise gauged the range of possible outcomes for GHG emissions relative to 1990 against the base case reference projections of 8 per cent and 36 per cent over 1990 levels for the years 2000 and 2020. A one per cent higher rate of GDP growth, compared to the baseline, resulted in a differential of 3 per cent higher emissions in 2000 (11 per cent) and 22 per cent higher in 2020 (58 per cent) over 1990 levels. Correspondingly, a one per cent decline in GDP had emissions dropping by 2 per cent and 16 per cent, respectively. In the case of oil prices raised by US$ 5 per barrel, emissions declined by a modest 1 per cent and 2 per cent in 2000 and 2020, whereas a one per cent decrease in energy intensity, all else equal, produced a 3 and 23 per cent drop in emissions for the same years. More demanding auto fuel standards, with mileage efficiency increasing by 3 per cent per year, produced flat emission levels - or no change - for 2000 (i.e., the reference projection of 8 per cent over 1990) and a 4 per cent lower emission rate in 2020. Finally, the sensitivity of retaining current nuclear capacity against the base case assumption of declining capacity produced a somewhat surprising result: a nil emissions response in 2000 and only a 4 per cent drop in 2020.

69. Based on the findings of more recent baseline projections, presented to the team at the time of the review, Canadian experts are of the guarded opinion that to achieve the Kyoto target emissions should decline by 1.6 per cent annually between 2000-2010. In light of the anticipated economic growth, this translates into annual reductions of 3.7 per cent in the emissions intensity. This represents an enormous challenge for Canada because the only instance that Canada experienced a reduction in emissions was during the 1980-1985 economic downturn. The feasibility of these potential reductions from current emission levels will be determined based on the outcome of the national implementation strategy on climate change. First of all, the Canadian economy is projected to grow at an annual rate of 2.2 per cent over the next 25 years. By the year 2000 the economy will be 12 per cent larger and by 2020, 70 per cent larger than it was in 1990. Further, the national population is expected to be 7 million higher by 2020. In addition, there are a number of large-scale projects planned for oil-sands development. Factoring in these developments alone accounts for an additional consumption of 500,000 bbl of oil, or about 20 Mt of additional emissions, in 2010 compared to the reference case. Should Ontario maintain its nuclear capacity or begin expanding capacity at some future date, and if sinks are incorporated into the projections, then the outlook for emission reduction may improve somewhat. Other scenarios with a similar capacity to lower emissions are fuel-switching to low carbon fuels and attaining lower energy intensities (or higher efficiencies). By the same token, the emissions intensity would have to decrease by 4 per cent annually in the absence of comparably offsetting sinks, assuming that these actions are taken domestically.

70. Non-energy sources of emissions, mainly CH_4 and N_2O from industry, agriculture and waste management, represented 12 per cent of total GHG emissions in 1995. Overall, these emissions were projected to decrease by 4 per cent in 2000 from their 1990 levels, primarily as a result of phasing out the adipic acid manufacturing process between 1997 and 2000, thereby reducing N_2O emissions by 10 Mt of CO_2 equivalent. Modest growth was projected for emissions in the cement and lime industries thanks to efficiency improvements in clinker production. CH_4 emissions were projected to grow at the same rates as population and overall economic activity.

71. Pursuant to the broad discussions held during the review team felt that the quality of projections has improved in the NC2. However, the consensus of the team was that projected GHG emissions in the NC2 are underestimated. In addition, it is recommended that the standard data tables (according to decision 9/CP.2, appendix III[1]) be used for summarizing projections and the key variables contained therein, thus improving the overall transparency of the output and facilitating comparison of the results.

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[1] See document FCCC/CP/1996/15/Add.1.

V. EXPECTED IMPACTS OF CLIMATE CHANGE AND ADAPTATION MEASURES

72. The NC2 described in detail the action that Canada has taken to improve its understanding of the potential impacts of climate change on the country, as well as the mitigatory and adaptive responses taken or planned in all sectors vulnerable to climate change. The report also identified the main areas that will be affected by climate change. These include agriculture, water resources, forests, coastal zones, urban infrastructure and health. Canadian scientists informed the team that advances in climate simulations using atmospheric general circulation models (or GCMs), coupled with ocean circulation models, have significantly increased scientific confidence in projecting future climates in Canada.

73. Canadian climate projections from GCMs continue to show greater warming in the interior than in offshore regions, and greater winter warming in the Arctic than in the southern latitudes. Most models continue to project increased winter precipitation across Canada, and decreasing net soil moisture contents and water resources in the interior during the summer months. These projections further suggest that the frequency and intensity of extreme events such as hot spells and convective storms in summer and snowstorms in winter will increase, thus posing a greater threat to Canada's ecosystems and society in general.

74. A number of agencies are involved in climate impact assessment. Much of the research on impacts and adaptation in Canada has been assembled and synthesized in the series of reports that comprise the Canada Country Study: Climate Impacts and Adaptation. This study, coordinated by the Environmental Adaptation Research (EAR) Group of Environment Canada, identifies and evaluates the state of knowledge of the impacts of climate variability and climate change on Canadian natural, social and economic systems and the state of knowledge of adaptive responses. A number of regional studies, including the Great Lakes - St. Lawrence Basin Study and the Mackenzie Basin Impact Study conducted by the EAR Group, provided the foundation research for the Canada Country Study. Stakeholders and researchers from across Canada, including representatives of private industry (e.g., insurance industry), non-governmental organizations, provincial/territorial governments, and universities, contributed to the Study. Technological developments in Canada, relating to adaptive measures for climate variability and change were also cited in the NC2.

VI. FINANCIAL ASSISTANCE AND TECHNOLOGY TRANSFER

75. The NC2 was supplemented by an addendum on "Financial Assistance and Technology Transfer", which provided details on Canada's contribution to multilateral development institutions and listed climate change related bilateral projects undertaken in developing countries. Its financial assistance on an annual basis was quantified but the review team noted that the NC2 did not specify how financial resources were determined to be "new and additional," as required by the UNFCCC guidelines for the preparation of national communications. In terms of bilateral activities, the Canadian International Development Agency is the coordinating agency which has a broad portfolio of poverty alleviation and development projects, many of which offer capacity building or mitigation benefits for

developing countries and economies in transition. The Agency's representative, however, informed the team that it does not have a specific climate change mandate but a development mandate, and reported difficulties in quantifying the level of financial support for and potential GHG benefits from its activities. In the meantime, it is beginning the task of assessing the data requirements for doing so, and pointed out that donors agree on utilizing the methodology and data collection standards of the OECD Development Assistance Committee for data collection and reporting.

76. The NC2 listed nine major bilateral projects directly related to climate change. The targeted areas were energy efficiency and conservation, the development of renewable energy systems, waste, recycling and forest management. The team felt that Canada has been making good progress in terms of its bilateral commitments under the Convention, highlighted by the fact that its contributions almost doubled from roughly Can$ 4.8 million in the years 1994-1995 to Can$ 8.1 million in 1996-1997.

77. A wide range of public and public/private technology transfer and capacity-building activities is also reported in the NC2, as part of Canada's bilateral and multilateral activities. Of special note is the Technology Partnerships Canada (TPC) programme established in 1996. Now in its third year of operation, TPC was established to promote investment in the development of innovative, near market high risk technology products and processes. Climate change is one factor driving demand for new environmental technologies; approximately 80 per cent of the TPC environmental proposals are climate change related.

78. Information on Canada's multilateral contributions, which was provided to the team during the review, indicated that the 1996-1997 and 1997-1998 expenditures were about equal to its previous contributions, totalling approximately Can$ 500 million per year to multilateral development institutions and approximately Can$ 2.5 million per year to multilateral scientific programmes. Canada contributed Can$ 111.1 million to the Global Environment Facility (GEF) over the three-year period 1994-1997, and has committed an additional Can$ 122 million to the current 1998-2000 GEF replenishment budget.

79. The Canadian Joint Implementation Initiative, established in 1996, is assisting primarily private-sector activities and experimenting with project-based GHG mitigation projects under the activities implemented jointly AIJ pilot phase. The review team concluded that the Initiative's public outreach and bilateral agreements have contributed to international awareness of AIJ, although no projects have been formally accepted by Canada or the host countries nor have any projects been reported to the AIJ secretariat to date. Estimates of potential GHG benefits of the program were not available, although some individual project estimates exist.

VII. RESEARCH AND SYSTEMATIC OBSERVATION

80. The NC2 provided details on areas in which the Canadian Government is engaged in climate-related research, including ecological monitoring, atmospheric modelling, energy technology research and development, and other specific initiatives included in the VCR. The information presented was detailed and wide in coverage in accordance with the reporting guidelines. An important omission in the NC2 was the actual funding and budgets for many of the activities reported. During the course of the review some of this information was provided and is presented here.

81. Expenditures for the Climate Research Network (CRN) are estimated at Can$ 5.5 million annually. The Atmospheric Environment Service of Environment Canada provides Can$ 2.5 million and the rest is provided by the Natural Sciences and Engineering Research Council (NSERC). Much of the research is conducted at Canadian universities. The Service also spends about Can$ 10 million per year on its own climate research. Overall, the largest share of this funding goes to modelling activities. The team was informed that more emphasis is given to disseminating research information to the public, industry, politicians, academics, schools, etc., through many avenues, including maintaining web sites on research findings.

82. The Boreal Ecosystem Atmosphere Study, a joint Canada-United States initiative, is an interdisciplinary experiment intended to improve the two countries' understanding of boreal forests and atmospheric interactions, CO_2 storage capacity and the consequences of climate change. Satellite data will be used to monitor the forests and improve computer simulations. The team received details on federal initiatives including the PERD, for the development of energy technology, coordinated by NRCan, including the monitoring of greenhouse gas concentrations and the study of air chemistry and past climates.

83. On an international level, Canada has made significant and commendable efforts through its research activities on developing and refining Global Climate Models and collaborating with research communities such as the IPCC, the International Geosphere-Biosphere Programme and the World Meteorological Organization and with countries such as China.

84. Researchers expressed concern about the possibility of maintaining an effective monitoring programme for climate change in light of federal fiscal restraint. They stressed the need for further private sector involvement in developing and funding research networks and in some important issues still requiring adequate research such as the Arctic climate, particularly in oceanography and the socio-economic consequences of actions to reduce climate change risks.

VIII. EDUCATION AND PUBLIC AWARENESS

85. The NC2 reported many federal, provincial, territorial and municipal activities currently under way to promote and cooperate in climate change education, training and public awareness. This process in Canada has been exemplary in involving all levels of government and a number of non-governmental organizations. Apart from Canada's UNFCCC commitment to develop

climate change awareness programmes at all levels of Government, the post-Kyoto challenge has added a sense of urgency for the implementation of awareness programmes since the success of most of the policies and measures and adaptation strategies depends on the effectiveness of climate change awareness programmes. Recently conducted market surveys revealed that national appreciation of climate change issues is still rather low.

86. In response to this, the federal Government has focussed on alliance building with partners in key economic sectors for climate change in its Action 21 programme, which was launched by EnvCan in 1995. Action 21 is the cornerstone of national climate change awareness activities. It has used the creative platform "Canada's Healthy Neighbours," a bilingual awareness campaign, through air time and printed media to inform the public on the linkage between the excessive use of cars and climate change and smog. Other activities under Action 21 are community newspaper inserts and the production and marketing of climate change educational resources. In addition, Action 21 co-sponsored a national workshop on climate change at a national municipalities meeting. Action 21 has co-funded several community-based projects focused on climate change as part of its community funding component.

87. A number of federal departments regularly disseminate education and public awareness information in the form of radio, television and printed advertising. NRCan also open an Office of Energy Efficiency (OEE) in 1998 to promote energy efficiency activities in Canada and broaden the reach of federal programmes. In addition to managing NRCan's programmes to encourage energy efficiency under a single operation, the OEE will hold an annual conference on energy efficiency and continue to develop NRCan's national database on energy efficiency in all energy end-use sectors. Provincial/territorial and municipal governments, private sector associations and non-governmental organizations are also taking part in climate change awareness programmes.

IX. CONCLUSIONS

88. The review team was of the opinion that there is an adequate system in place to collect data at the federal and provincial level for preparing inventories and projections for the purposes of reporting under the UNFCCC. Furthermore, the National Air Issues Coordinating Mechanism provides an effective institutional framework to tackle GHG-related issues with multi-jurisdictional coverage. While the consultative process is time-consuming given the large number of stakeholders involved, many lessons have been learned about how to manage this process more effectively. In the end, the process fosters a partnership approach and has resulted in all of the provinces supporting the national climate change goal as set out in the NAPCC.

89. This partnership approach has continued beyond the NC2, particularly through the process begun in 1998 to develop a national implementation strategy for the post-Kyoto period. The process is extensive, both in its coverage of possible actions and its inclusion of all pertinent stakeholders. Canada’s NC3 should provide insights into the results of this important exercise.

90. The objective of the NAPCC is to stabilize net GHG emissions aggregated on a GWP basis, at 1990 levels by the year 2000 and provide guidance for addressing emissions beyond 2000. Both the NC2 and subsequent information obtained by the team during its visit give every indication that Canada's aggregate GHG emissions in CO_2 equivalent will be above 1990 levels by 11 per cent in 2000, excluding quantifiable sinks.

91. Moreover, while the transparency of Canada's reporting on its greenhouse gas projections is commendable, there remains the issue of the country's ability to meet its stated emissions targets in the longer term. Based on NRCan projections it is clear that, without implementation of additional policies and measures, aggregate GHG emissions in CO_2 equivalent will be above 1990 levels by 19 per cent in 2010, and 36 per cent in 2020. This may require that the federal and provincial governments carefully monitor progress from the voluntary and other measures and, in particular, deal more aggressively with the transport sector under the NAPCC, since this sector has the highest emissions growth rate and is the sector the team felt was being paid the least attention.

92. The team also believes that more work is required to assess the implementation of all measures and to establish whether additional action is required to meet commitments under the UNFCCC. Emission performance targets are still lacking in the VCR and policy makers may have to modify the registry to obtain unambiguous indicators of actions taken, rates of implementation and impacts on emissions.

93. Although Canada has put in place commendable climate change awareness and outreach programmes across all sectors, the team felt that the monitoring and evaluation of these efforts could be strengthened to assess their effectiveness in changing behaviour, especially given that the country's climate change policy is based largely on voluntary measures.

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