UNITED
NATIONS

UNFCCC Framework Convention on Climate Change

Distr.
GENERAL

FCCC/IDR.3/CAN
1 December 2003

ENGLISH ONLY

CANADA

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

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I. INTRODUCTION AND NATIONAL CIRCUMSTANCES RELEVANT TO GREENHOUSE GAS EMISSIONS AND REMOVALS

A. Introduction

1. Canada ratified the United Nations Framework Convention on Climate Change (UNFCCC) on 4 December 1992 and its Kyoto Protocol on 17 December 2002. Its first national communication (NC1) under the UNFCCC was submitted in 1994, followed by the second (NC2) in 1997. The English version of *Canada's Third National Report on Climate Change (3NR)* was submitted to the UNFCCC on December 31, 2001.[1]

2. The in-depth review of the NC3 was carried out from June to October 2002 and included a country visit by a review team to the National Capital Region (Ottawa-Gatineau) from 17 to 21 June 2002. The team comprised Mr. Philip Acquah (Ghana),[2] Mr. Jose Villarin (Philippines), Mr. Christo Christov (Bulgaria), Mr. Knut H. Alfsen (Norway), Mr. Stephen Bygrave (Organisation for Economic Co-operation and Development) (OECD) and Ms. June Budhooram (UNFCCC secretariat, coordinator). During the visit, the team met with federal government officials involved in the preparation of the NC3 from Environment Canada (EnvCanada) and Natural Resources Canada (NRCan), and with business and environmental non-governmental organizations (ENGOs).

3. Preparation of the NC3 started in April 2000 with collaboration among EnvCanada, NRCan, and numerous federal and provincial experts. An editorial board from EnvCanada and NRCan was formed to oversee the preparation of the report, with an inter-departmental steering committee established for oversight and approval purposes. During the summer of 2001, the NC3 was peer reviewed with input from provincial governments and NGOs, and submitted for final ministerial (EnvCanada and NRCan) approval in December 2001. The team learned that government officials, NGOs and the public consider the NC3 (reproduced in Canada's two official languages, French and English) as the most comprehensive document on climate change in Canada, and that the NC3 serves as an important tool in policy making.

B. National circumstances

4. Canada extends for roughly 5,300 km from east to west and 4,600 km from north to south. Despite being the second largest country in the world in size, it has a relatively small population of 30.8 million and one of the world's lowest population densities (3 persons/square km). Over 85 per cent of its population live within 350 kilometres of the border with the United States, in widely distributed urban clusters, a condition which leads to travel over long distances between and within urban centres.

5. With its vast area of 9.9 million sq km (50 per cent of which is covered by forests) and its three ocean boundaries, there are huge climatic zones with wide variations. These range from the Arctic Cordillera characterized by extreme cold with continuous permafrost, to dry continental and temperate coastal climates in the south.

6. Canada's federal system of government and the division of jurisdictional responsibility among various orders and levels of government require that decisions on climate change policies be shared among federal, provincial, territorial and municipal governments. Therefore, implementation of international agreements is often preceded by active and extensive multi-stakeholder consultation, including that with the public. This process is complex, given that Canada's 10 provinces, three

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[1] The submission date of third national communications was 30 November 2001 (decision 11/CP.4). The English version was embargoed until the French translation was available on February 19, 2002 at which point Canada officially released the report in both official languages.

[2] The Canadian Government covered the cost of the participation of an additional non-Annex I expert for the review.

territories and thousands of municipalities are characterized by very different economic, geographic and demographic circumstances that create different greenhouse gas (GHG) emission profiles and reduction opportunities. Moreover, provincial governments are the key to actions to reduce GHG emissions as many activities such as the generation and distribution of electricity; waste management; transportation infrastructure; and, the exploration, development, conservation and management of non-renewable natural resources and forests in provinces fall under their direct responsibility.

7. Canada's economic structure, natural resource base and trade patterns are the most significant factors that directly determine the development of actions and policies on climate change. Although the economic base continues to shift away from natural resources towards manufacturing and services, which together accounted for 66 per cent of gross domestic product (GDP) in 2000, Canada still has a high level of resource-based and energy-intensive industries.

8. After ratifying the UNFCCC, Canada embarked on its National Action Program on Climate Change (NAPCC), marking the beginning of a national strategy to improve knowledge on the science of climate change as well as to mitigate GHG emissions and adapt to the expected impacts of climate change. In 1997, on signing the Kyoto Protocol to the UNFCCC, the Government agreed to reduce its GHG emissions to 6 per cent below 1990 levels during the 2008 to 2012 commitment period.

9. Since the review of the NC2, a National Climate Change Process was launched in response to the Kyoto Protocol in 1998, to develop a National Implementation Strategy on Climate Change (NIS). A national climate change secretariat was created to oversee this process. Under this arrangement, 16 "issue tables" (working groups) were formed involving 450 experts from industry, academia, and NGOs to examine the options to reduce GHG emissions in a range of sectors under the NIS. In 2000, two important initiatives were launched: the federal Government introduced its cornerstone Action Plan 2000 on Climate Change (AP 2000), committing Can$ 500 million over five years on measures in major GHG emitting sectors; and, the NIS itself which included the release of a first National Climate Change Business Plan as part of an agreed upon annual business planning process for outlining the status of planned and implemented climate change policies and measures in Canada. Critical to Canada's climate change response is that no region be asked to bear an unreasonable burden as a result of policies and measures to meet GHG reduction commitments. The review team also noted from discussions with Canadian officials that the issue of carbon taxes is not under consideration within the Canadian context.

10. The NIS is a multi-phased approach to addressing climate change and sets out a three step approach for achieving Canada's climate change objective of reducing annual greenhouse gas (GHG) emissions by 238,000 Gg. CO_2 equivalent.[3] Phase I has comprised actions that are the most cost--effective ("no regrets"). Phase II is being introduced and elaborated upon subsequent to Canada's ratification of the Kyoto Protocol through the *Climate Change Plan for Canada: Achieving our Commitments Together* released on 21 November, 2002. The plan will evolve through extensive consultations during its implementation phase. The Plan[4] anticipates covenants, emission reduction targets and domestic emissions trading for the large industrial emitters, the introduction of targeted measures, strategic infrastructure investments, a coordinated innovation strategy incorporating the climate change agenda, a Partnership Fund to cost-share emissions reductions in areas such as energy efficiency, and an extensive social marketing effort to encourage behavioural change by individual Canadians. Phase III and subsequent phases will evolve as the climate change process unfolds

11. In spite of a strengthened climate change policy-making framework in the last decade, data presented in table 1 below indicate that, by 2000, GHG emissions had increased by 19.6 per cent compared to 1990. Projections in the NC2 had anticipated that emissions would increase by 8.2 per cent.

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[3] Canada's annual Kyoto target or "gap" has been revised since the June 2002 in-depth review from 199,000 Gg. CO_2 equivalent to 238,000 Gg CO_2 equivalent.

[4] See Section III Policies and Measures for an overview of Canada's Climate Change Plan.

12. Growth in emissions came from fossil fuel consumption in electricity generation, increased energy consumed in transport and an unprecedented growth in fossil fuel production, largely for export. GDP in current dollars increased by 33 per cent during the decade, outpacing an increase in total aggregated emissions of 19.6 per cent (from 607,000 Gg CO_2 equivalent in 1990 to 726,000 Gg CO_2 equivalent. in 2000), an 11 per cent growth in population, and a 17 per cent growth in energy consumption. Canadian experts mentioned that these figures demonstrate that the trend in the growth of GDP is greater than growth in GHG emissions, energy consumption and population, and that energy intensity is decreasing. However, the review team is of the view that even though GHG emissions per unit GDP have declined by roughly 17.4 per cent, from 0.86 kg CO_2 equivalent/1997 Can$ in 1990 to 0.71 kg CO_2 equivalent/1992 Can$ in 2000, this trend may reflect more the impact from changes in the structure of Canada's GDP (e.g. the move to a larger service economy and away from heavy industry) rather than a direct result of policies and measures designed to achieve reductions in emissions or improvements in energy intensity.

Table 1. Main macroeconomic indicators and GHG emissions for Canada, 1990 and 2000

	1990	1995	2000	1995/1990 % change	2000/1990 % change
Population (millions)	27.8	29.5	30.8	6.1	10.8
GDP (billion 1997 Can$)	764.4	835.6	1 009.2	9.3	32.0
Primary energy demand (petajoules, PJ)	9 604	10 314	10 815	7.4	12.6
Energy produced (PJ)	7 752	n.a.	11 729	n.a.	51.3
Energy exported (PJ)	3 049	n.a.	7 044	n.a.	131
GHG emissions (thousand Gg CO_2 equivalent)	607	658	726	8.4	19.6
GHG emissions per capita (Mg CO_2 equivalent)	21.8	22.3	23.6	2.3	8.3
GHG emissions per unit GDP (kg CO_2 equivalent 1997 Can$)	0.86	0.85	0.71	–1.2	–17.4

Source: Table 1, Canadian Economic Observer, Statistics Canada 2000/2001.
n.a. = not available.

13. The reduction in the rate of growth in GHG emissions between 1990 and 2000 can be attributed in part to the fact that non-GHG-emitting sources – hydropower (62 per cent) and nuclear energy (12 per cent) in 2000 – dominated electricity generation. Coal, natural gas and oil collectively accounted for 19 per cent, and non-hydro renewables[5] 7 per cent, in that year. There are still substantial hydro resources available in Canada that may be economic, and environmentally and socio-economically acceptable. While the share of non-hydro renewables has not increased significantly in the recent past, efforts are underway to change this trend. Since 2000, the Government has announced investments to encourage emerging renewable energy sources, mostly in the electricity sector.[6] The recently released *Climate Change Plan for Canada* proposed to build on this momentum by seeking an additional 10 per cent of new electricity capacity in Canada to come from emerging renewable electricity sources. However, whether non-emitting sources overall can be maintained at such current high levels remains doubtful to the team, since large increases in hydro capacity are not on the table, no new nuclear construction is expected for the future and the share of non-hydro renewables (e.g. wind, solar) has not increased significantly in the past.

14. Canada is the world's third largest natural gas producer and the second largest exporter. A challenge to the mitigation of GHG emissions is Canada's large reserves of oil (including from oil sands) and natural gas, given that their exploration and development are projected to increase in the future.

[5] Non-hydro renewables include wind, solar and biomass.

[6] The most important measure, the Can$ 260 million Wind Power Production Incentive, was introduced in 2002 to encourage the construction of 1,000 megawatts of new wind power capacity over five years. Several provincial governments have since responded to federal leadership by announcing similar measures of their own (see policies and measures section for details).

Canada records a substantial trade surplus in energy (energy-intensive goods, oil, natural gas and electricity), much of it with the United States of America. Between 1995 and 2000, the energy trade surplus averaged approximately Can$ 18 billion per year, but almost doubled to Can$ 35 billion in 2000, in response to energy supply problems in the United States. This increase in trade led to a rise in emissions associated with accelerated fossil fuel production for export. It is estimated that 46,000 Gg CO_2 equivalent resulted from energy production for export to the United States in 2000.

II. GREENHOUSE GAS INVENTORY INFORMATION

A. Inventory preparation

15. The Greenhouse Gas Division of Environment Canada is mandated under the Canadian Environmental Protection Act (CEPA 1999), revised in 2000, to develop, monitor, analyse and report GHG emissions and removals. The amended CEPA gives the Division broader and mandatory data-gathering and reporting powers specific to inventories. This amendment could now be used for entity-level disclosure of point-source data, which would enhance the accuracy of inventories and allow for tracking actual emissions and for the assessment of crediting and reduction incentives. To improve the accuracy of the inventories, the Division is working with other stakeholders to examine ways in which to improve the detail and accuracy of the national inventory including linkages with a Large Emitters Covenants system. Through the activities of its GHG Verification Centre, it is also developing entity-level estimation and verification protocols.

16. The inventories presented in the NC3 were prepared using the Intergovernmental Panel on Climate Change (IPCC) *Revised 1996 Guidelines for National Greenhouse Gas Inventories, and the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000)* as well as country-specific methods for calculating emissions, where available. As required by the 1999 UNFCCC guidelines for the preparation of national communications by Parties included in Annex I to the Convention (the guidelines), the NC3 summarizes net anthropogenic sources (emissions) and sinks (removals) for carbon dioxide, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) from 1990 to 1999 and it discusses the underlying trends in emissions. Emissions for biomass and international bunker fuels are presented separately. It also covers in detail the levels of uncertainties associated with the data provided.[7]

17. Between the NC2 and the NC3, total GHG emissions for 1990 were recalculated and revised downward (1 per cent), from 612,000 Gg CO_2 equivalent to 607,000 Gg CO_2 equivalent. The national inventory team explained that this was due primarily to revised emission factors and updated activity data for N_2O and CH_4 in the agriculture and energy sectors respectively. These revisions are consistent with recalculation procedures and do not affect overall GHG emission trends, but the percentage breakdown of the main gases has changed: CO_2 emissions increased by 2 per cent and CH_4 by 1 per cent, while N_2O decreased by almost 2 per cent.

18. Based on a study in 1994 involving stochastic simulations by the Monte Carlo method, the uncertainty associated with the calculation of emissions is estimated (for the 1990 inventory) at about 4 per cent for CO_2, 30 per cent for CH_4, and 40 per cent for N_2O. Uncertainties for sectoral emissions may be greater. These estimates are considered to be valid for the current inventory data and are to be revised based on future studies of emission uncertainty that are planned for 2003.

19. In general, the inventory for Canada is well prepared and complete. However, owing to editorial problems, the latest information available at the time of publication of the NC3 was not included and so some tables that are required by the guidelines were missing. The inventory team noted that this appeared to be simply an omission, since the required tables were available in the published National

[7] Emissions of HFCs prior to 1995 are considered negligible and this is noted in the NIR.

Inventory Report. The review team was able to analyse trends with additional and more up-to-date information provided during the review, including the updated inventory series 1990–2000 as well as the published National Inventory Report (NIR) in which all required CRF tables for the period covered by the NC3 (1990–1999) were provided.

B. Overall emission trends

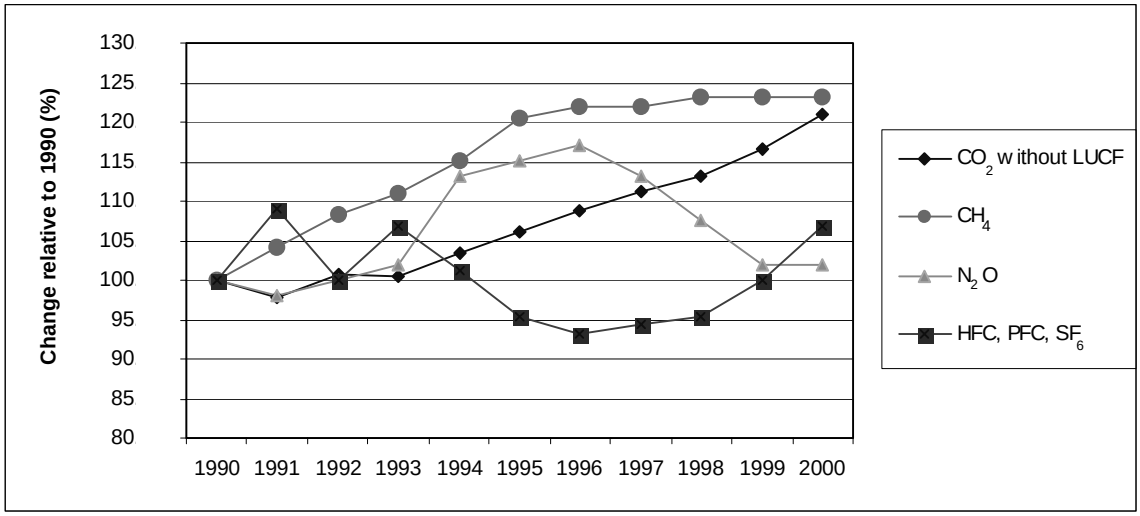
20. Trends in total GHG emissions between 1990 and 2000 are shown in table 2 and figure 1. In 2000, total aggregated emissions excluding land-use change and forestry (LUCF) rose by 19.6 per cent. The energy sector was responsible for 80 per cent of the increase and CO_2 was the main gas contributing to the GHG total in 2000 (78.7 per cent). CH_4 emissions accounted for 12 per cent, 13.4 per cent and 12.6 per cent of GHG emissions without LUCF in 1990, 1995 and 2000, respectively, and N_2O accounted for 8.7 per cent, 9.2 per cent and 7.4 per cent in 1990, 1995 and 2000, respectively.

Table 2. GHG emissions by gas, 1990–2000 (thousand Gg CO_2 equivalent)[a]

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	(1995-1990)/1990	(2000-1990)/1990
CO_2	472	462	475	474	488	501	513	525	534	550	571	6.1	21.0
CH_4	73	76	79	81	84	88	89	89	90	90	91	20.6	24.7
N_2O	53	52	53	54	60	61	62	60	57	54	54	15.1	2.0
HFCs, PFCs, SF_6	8.8	9.6	8.8	9.4	8.9	8.4	8.2	8.3	8.4	8.8	9.4	–4.6	6.8
GHG without LUCF	607	600	616	619	641	658	672	682	689	703	726	8.4	19.6
LUCF	–59	–61	–45	–36	–31	–12	–22	–18	–24	–8	–14	–79.7	–76.3
GHG with LUCF	546	535	568	580	606	640	648	663	663	693	710	17.2	30.0

[a] Data were updated by the inventory team in Canada and provided during the review. Data for 2000 are preliminary.

Figure 1. GHG emission trends, 1990–2000



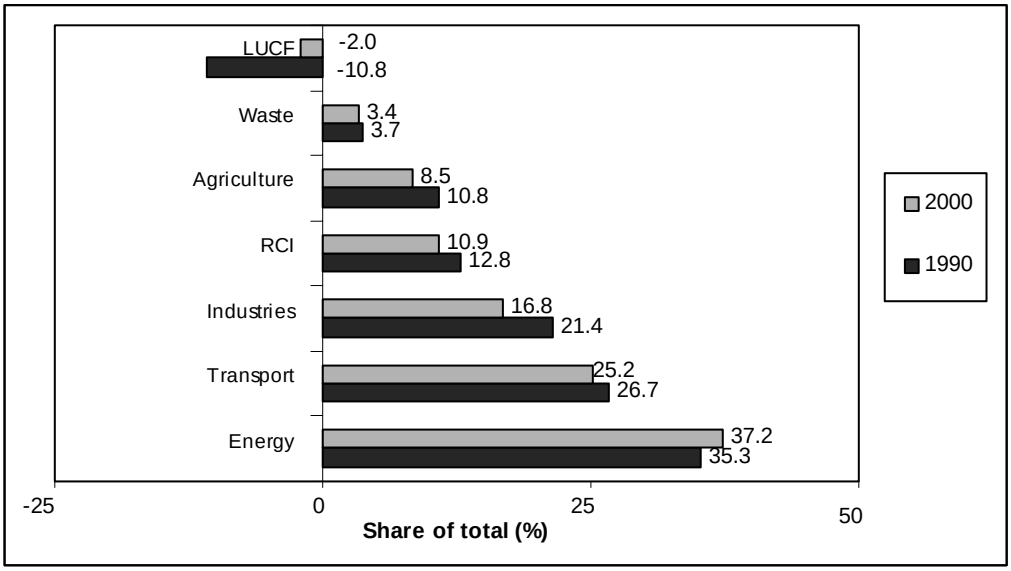
21. HFCs, PFC and SF_6 contributed 1.3 per cent to total emissions in 2000, and increased by 6.8 per cent between 1990 and 2000. Emissions of individual gases also increased. CO_2 emissions grew by 21 per cent, CH_4 by 25 per cent and N_2O by 2 per cent. CO_2 removals from LUCF were 14,000 Gg in 2000. Between 1990 and 2000, the LUCF sector was a net sink, even though its capacity declined by 76 per cent in that period (from 59,000 Gg to 14,000 Gg).

C. Trends in key emission sectors

22. Between 1990 and 2000, energy was the main source of GHG emissions: in particular electricity generation and petroleum production and distribution accounted for 33 per cent and transport for

31 per cent of this sector's emissions. While fugitive emissions accounted for only 9 per cent of total emissions, they experienced the highest sectoral increase (42 per cent) in 10 years. Table 3 and figure 2 show the distribution of GHG emissions by major sectors. There were four notable trends in sectoral performance and GHG emissions over the decade: substantial increases in CO_2 emissions from energy and transport; moderate increases in the residential/commercial/institutional (RCI) and waste sectors (10 per cent and 20 per cent respectively), relative stabilization in agriculture and a reduction in industrial processes (2 per cent and –5.9 per cent respectively), and a decline in the sink capacity.

Figure 2. Share of GHG emissions by sector, 1990 and 2000



23. ***Substantial increases in emissions from energy and transport*** – Emissions from the energy sector increased by 24.4 per cent between 1990 and 2000. Between 1990 and 2000, emissions from energy industries such as electricity and petroleum increased by 35 per cent and 40 per cent respectively. Although electricity generation grew by only 19 per cent, emissions in this subsector grew due to an increase in the use of coal, petroleum and natural gas. A decline in nuclear generation between 1995 and 2000, which was substituted by coal, also contributed to emissions growth. The net increase in emissions from the petroleum industry came from upstream activities (exploration and production) rising in the decade by 54 per cent and downstream activities (refining and distribution) decreasing by 6 per cent as a result of improvements in refinery operating efficiency. The transport sector continued to be the major single contributor to GHG emissions (32 per cent) in the energy sector. Road transport was the largest source of emissions within this sector (73 per cent) in 2000. The inventory team explained that most of the emissions growth came from increases in passenger–km and from the use of more heavy-duty diesel vehicles for freight transport (tonne-km).

Table 3. GHG emissions by sector and subsector, 1990–2000 (Thousand Gg CO_2 equivalent)[8]

Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Change (%) 1990–2000
Energy	472	464	482	482	498	513	528	540	549	564	587	24.4
Energy industries	147	146	155	146	149	156	155	163	180	195	191	29.9
Manufacturing and construction	63	59	58	58	61	62	65	65	62	61	68	7.9
Transport[a]	154	148	152	156	165	169	174	180	184	189	190	30.1
Other sectors	72	71	74	77	76	77	82	79	71	75	79	11.3
Fugitive emissions	38	40	42	44	47	50	53	53	52	53	54	42.1
Industrial processes	53	54	53	54	56	56	58	57	53	52	51	–5.9
Solvents[b]	0.42	0.42	0.43	0.43	0.44	0.44	0.45	0.45	0.46	0.46	0.50	19.0
Agriculture	59	58	58	58	60	61	61	61	61	61	60	1.7
LUCF	–59	–61	–45	–36	–31	–13	–22	–18	–23	–8	–4	–23.4
Waste	18	19	20	20	20	20	20	21	21	22	22	22.2

[a] This number differs from that given in the NC3 for transport because of the inventory recalculations from 1999 to 2000.

[b] Includes emissions from solvents and other product use.

24. ***Moderate increases in the residential/commercial/institutional and waste sectors*** – Emissions from the RCI sector grew by 10 per cent between 1990 and 2000. However, residential emissions increased by only 2.3 per cent, while commercial/institutional emissions increased by 23.4 per cent. The increase in energy use in the commercial/institutional subsector was to some extent offset by energy efficiency improvements in the building stock, warmer weather and replacement of fuel oil by natural gas. Waste emissions, mostly CH_4 from landfills, rose over the period by more than 22 per cent, in spite of increased gas recovery systems. This sector contributed 3 per cent to overall GHG emissions as a result of higher volumes of solid waste disposal in landfills, the source of 93 per cent of these emissions.

25. ***Relative stabilization in agriculture and industrial processes*** – Emissions from industrial processes decreased by 4 per cent between 1990 and 2000 in spite of an increase in industrial production. This stabilization was due mainly to an 8,000 Gg reduction in N_2O emissions from technical improvements in adipic acid production and fuel switching in the pulp and paper subsector from coal and fuel oil to electricity and natural gas. Emissions from agriculture increased by 2 per cent in 2000 compared to 1990. The sector contributed 8.3 per cent to total national emissions. A decrease in CO_2 emissions from agricultural soils, as a result of conservation tillage and reduced frequency of summer fallow in the prairies, contributed to a levelling-off of emissions in this sector between 1990 and 2000. But emissions from manure management rose by 13 per cent and from enteric fermentation by 11 per cent.

26. ***Decline in estimated sink*** – In 2000, the LUCF sector removed 14,000 Gg of CO_2**.** The estimated LUCF sink therefore declined by almost 75 per cent in a decade. The national inventory team explained that sink estimates are derived from an accounting model with great uncertainty in defining the system boundary. The large decline in the sink estimate was attributed mainly to the increased frequency of forest fires observed during the decade and a 16 per cent rise in tree felling for the production of industrial roundwood between 1990 and 2000. Natural forests were a net source of CO_2, while managed forests were a net sink. As there is no systematic observation of land-use change, scattered initiatives on using satellite data are used to provide sink estimates in the inventory. In the coming years, improvements are expected in establishing the data for the base year and 2000 with more precision.

27. **The share of HFCs, PFCs and SF_6 in total GHG emissions remains small** – In 2000 the share of these gases in total emissions remained small, at 1.3 per cent. However, since 1990 (see table 4) these emissions have increased significantly, by 7 per cent. HFC emissions doubled in five years and PFC emissions increased by 5 per cent in the decade. In spite of measures in place to curb the use of these

[8] Due to rounding, individual values may not add up to totals.

gases, HFC use in air-conditioning and refrigeration is increasing rapidly. Increased aluminium production accounted for the growth in PFC emissions. A notable decrease of 21 per cent between 1990 and 2000 in SF_6 emissions resulted from a commitment by magnesium producers to progressively eliminate this gas in the production process. As industries are now required to report GHG emissions under the new CEPA, an improvement in the reliability of data is expected.

Table 4. Trends in emissions of HFCs, PFCs and SF_6, 1990–2000 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Change (%) 2000–1990
HFCs	0.0	0.0	0.0	0.0	0.0	480	890	860	920	920	920	91.7[a]
PFCs	5 900	6 300	6 600	7 400	6 900	6 000	5 900	6 000	6 000	6 200	6 200	5.1
SF_6	2 900	3 300	2 200	2 000	2 000	1 900	1 400	1 400	1 500	1 700	2 300	–20.7

[a] Increase 1995 to 2000.

III. POLICIES AND MEASURES

A. Policy framework

28. The reporting of climate change policies and measures (P&Ms) improved in the NC3 compared with the NC2. The NC3 describes in detail policies in all sectors, and by provinces and territories, and quantifies the aggregate mitigation effects of most of the P&Ms but not on a gas-by-gas basis. However, the NC3 lists general information on policies that are no longer in place, and does not list those that would result in greater levels of GHG emissions. Unfortunately, the report provides no information on GHG reductions in 1995, 2000 and 2005 and there is little information on the costs of individual measures. However, costs of combined policies are provided. Although these issues were identified in the report on the in-depth review of the NC2, they were not addressed in the NC3. In addition, despite the focus on non-greenhouse benefits (sustainable development, reduced pollution, health benefits, etc.) from possible options in the current consultation process,[9] little or no information is provided on these benefits from Canada's current mix of policies and measures.

29. As the NC3 is not consistent with the guidelines in reporting emissions by sector, it is difficult to make an assessment of the GHG reduction on a gas-by-gas basis. Appendix 1 of the NC3 provides a detailed list of all of Canada's programmes at the federal, provincial and territorial level. It includes the objective of the programme and the GHG affected. It does not explain the status of implementation, nor the emission reductions associated with each measure in 1995, 2000 and 2005, as required by the guidelines. There is little quantification of the objectives of each measure. Instead, P&Ms are sorted under the five themes of: enhancing awareness and understanding; promoting technology development and innovation; governments leading by example; investing in knowledge and building the foundation; and encouraging action. It is therefore difficult to get a concise picture of the significant energy policies and measures that have been effective in reducing greenhouse gas emissions over the 1990 to 2000 period.

30. P&Ms have been developed through extensive consultation with all orders and levels of government and a wide variety of external stakeholders from industry, non-governmental organizations and the general public. Canada's policy framework concerning greenhouse gas emissions is outlined in the 1995 National Action Program on Climate Change. This was further strengthened and mentioned in October 2000, when the Joint Ministerial Meeting of Energy and Environment Ministers (JMM) from the Government of Canada (federal), provincial and territorial governments, formally adopted the National Implementation Strategy on Climate Change. The NIS, Action Plan 2000 (AP2000) and annual national

[9] A consultation process was conducted between June and October 2002 in Canada, involving roughly 900 stakeholders on the possible options for meeting Canada's target under the Kyoto Protocol.

business plans provide the analytical and policy framework that led to the November 2002 Climate Change Plan for Canada to meet Canada's 6 per cent reduction target under the Kyoto Protocol. Many of these measures reflect Canada's particular national circumstances and greenhouse gas emission profile as noted in section I of this report.

31. AP 2000, a five-year Can$ 500 million for climate change activity, builds upon the NAPCC, and targets sectors that account for 90 per cent of total GHG emissions. It includes 45 measures, 28 of which have direct GHG reduction impacts on the energy sector, transportation, industry, buildings, and non-energy areas such as forestry, agriculture and international projects. There are additional initiatives in technology, science and adaptation.

32. When fully implemented, the measures are projected to provide more than one-quarter of the emission reductions necessary to meet the Kyoto target. To ensure that the objectives of the NIS are met, a national monitoring and reporting framework has been developed**.** The National Air Issues Coordinating Committee on Climate Change (NAICC–CC), comprising the federal, provincial and territorial government representatives, meets frequently and reports to energy and environment ministers on progress made in implementing these initiatives. This committee is responsible for monitoring the P&Ms under the NIS and is supported at the federal level by NRCan, Environment Canada, Agriculture Canada, and Statistics Canada.

33. The NC3 outlines the P&Ms under the AP 2000. Since 2000, there have been a number of further developments in the policy framework and enhanced funding for GHG mitigation. Prior to the November 2002 release of its Climate Change Plan, Canada focused on five main themes (see paragraph. 29) for phase I of its greenhouse gas response, under the NIS. Key policy instruments included a combination of voluntary action with manufacturers and major energy users, fiscal incentives and regulations, and information to the public for changing behaviour.

34. Policies and measures announced under the NAPCC are expected to result in reductions of GHG emissions of 60,000 Gg CO_2 equivalent by 2000, while the measures under AP 2000 are expected to reduce greenhouse gas emissions by some 65,000 Gg CO_2 equivalent in 2010.[10] Of these 65,000 Gg, 20,000 Gg CO_2 equivalent are projected to come from international activities such as the clean development mechanism (CDM) and joint implementation (JI).

35. As of 2000, there were some 665 P&Ms already implemented or planned by federal, provincial and territorial governments directly related to climate change. The International Energy Agency reported in 2000 that Canada had the highest number of planned and implemented energy-related policies and measures among the Agency's 26 member countries.

36. It would be valuable if there were a comprehensive assessment of P&Ms against Canada's emission profile. For example, while many of the individual policies and measures are outlined in appendix 1, chapter 4 could highlight and prioritize, by sector, those P&Ms that have been particularly effective in reducing GHG emissions, and those that are replicable, or innovative.

37. During the review, Canadian experts referred to the difficulty they encountered in separating the impact of individual policies and measures from that of other orders of government (attribution), as GHG emission reductions were presented at an aggregated level. This is further complicated by the fact that most of the P&Ms are behavioural in nature and impacts are difficult to assess. Despite reporting omissions, during the in-depth review it was apparent from the presentations that over the past two years new work has been undertaken on developing performance indicators to assess the impact of particular measures. The review team was also informed that many initiatives under AP 2000 are designed to lay the foundation for future policies; they do not have specific direct GHG reduction potential but on aggregate may do so over the long term.

[10] Includes estimated benefits arising from CDM/JI projects.

38. Under the Business Plan 2000, there is a commitment to quantify GHG reductions from individual P&Ms in the future. There are also plans to develop better monitoring and reporting for the impacts of P&Ms, and climate change indicators to assess progress. Further efforts are currently being made to put in place an effective monitoring and reporting framework and the review team is optimistic that, once the monitoring system is up and running, there will be detailed reporting on P&Ms. At the time of this review (mid-June 2002), the Government was undertaking a comprehensive consultation process with a wide range of stakeholders and seeking input on four possible options to reduce GHGs.

39. Based on inventory data, GHG emissions were 19.9 per cent higher in 2000 compared to 1990. The NC2 estimated that GHG emissions would increase by 8.1 per cent by 2000 with the NAPCC and its voluntary initiatives, and educational and research measures**.** One of the key reasons for the difference is the large increase in the emissions from electricity generation and an increase in the production of fossil fuels**.** This would suggest that further actions are required to make a sufficient impact on GHG emissions in Canada.

40. Since the NC2 of 1997, Canada has experienced a strong and growing economy. This growth, in turn, has increased pressures for higher GHG emissions in areas such as the higher demand for fossil fuel production (oil and gas) and increasing transportation requirements – major contributors to GHG emissions. The increase in emissions required Canada to revise its emission estimates for 2001 from 705,000 Gg CO_2 equivalent to 720,000 Gg CO_2 equivalent. The total GHG emission projection for 2010 now stands at 809,000 Gg CO_2 equivalent, further increasing the "Kyoto gap"[11] to 238,000 Gg CO_2 equivalent. In order to meet the challenges of climate change and to support Canada's ratification of the Kyoto Protocol the Government of Canada released on 21 November, 2002, the Climate Change Plan for Canada: Achieving our Commitments Together.[12] The plan sets out a three step approach for achieving Canada's climate change objective of reducing annual greenhouse gas (GHG) emissions by 238 Gg CO_2 equivalent, the revised gap. First, there are the investments to date that will address one third of the total reduction (80 Gg CO_2 equivalent). Second, it articulates a strategy for a further 100 Gg CO_2 equivalent reduction. And, finally, it outlines a number of current and potential actions that should enable Canada to address the remaining 60 Gg CO_2 equivalent reduction. Proceeding on this basis is designed to enable Canada to make a smooth transition to a more energy efficient and less emissions intensive society.

41. The five key instruments of the plan include: emissions reductions targets for large industrial emitters established through covenants with a regulatory or financial backstop and domestic emissions trading that would create an incentive for shifting to lower-emissions technologies and energy sources, while providing flexibility for these emitters through trading and access to domestic offsets and international permits; a Partnership Fund that will share the costs of emissions reductions in collaboration with provincial and territorial governments, as well as municipalities, Aboriginal communities, non-governmental organizations, and the private sector to increase energy efficiency and reduce emissions in the most effective way; strategic infrastructure investments in innovative climate change proposals such as urban transit projects, intermodal transportation facilities and a CO_2 pipeline; a coordinated Innovation Strategy that allows Canada to benefit fully from the innovation possibilities of the climate change agenda and builds on programmes such as Technology Partnerships Canada, the Industrial Research Assistance Program (IRAP), Sustainable Development Technology Canada and the Technology Early Action Measures (TEAM); and targeted measures including information, incentives, regulations and tax measures that will help achieve climate change objectives in specific sectors and programme areas.

42. On 17 February, 2003, the Government of Canada presented its 2003 budget which identified Can$ 2 billion over five years to support climate change initiatives identified in the Climate Change Plan

[11] The "Kyoto gap" is the difference between projected emission levels and Canada's target under the Kyoto Protocol in 2010.

[12] For more information on the Climate Change Plan for Canada go to http://www.climatechange.gc.ca

for Canada. Can$ 250 million has been allocated for Sustainable Development Technology Canada and Can$ 50 million for the Canadian Foundation for Climate and Atmospheric Sciences. The remaining Can$ 1.7 billion will support innovation and cost-effective measures leading to GHG reductions in Canada. Actions to promote energy efficiency, renewable energy, sustainable transportation and new alternative fuels in such areas as building retrofits, wind power, fuel cells and ethanol, will be considered. At least Can$ 200 million of the Can$ 1.7 billion set aside for other measures will be dedicated to further investments in longer-term climate change technologies. In addition, strategic and municipal infrastructure projects that support Canada's objectives to reduce GHG emissions will be eligible for funding under a new infrastructure programme with funding of Can$ 3 billion over 10 years.

B. Energy production and transformation

43. The largest GHG emitting sector is energy production and transformation. In 2000 it accounted for 80.3 per cent of total emissions. Public electricity generation and heat production accounted for 16.9 per cent of these emissions and was responsible for 25 per cent of the total emissions growth between 1990 and 2000. Emissions from the electricity sector are projected to be 16 per cent of Canada's total in 2010. Most of the initiatives aimed at reducing greenhouse emissions in this sector are focused on encouraging energy efficiency, fuel switching and promoting renewable energy.

44. Electricity production and distribution fall under the responsibility of the provinces, which often own a sizeable share of the production capacity. Most of them have created their own government-owned companies for producing, transmitting and distributing electricity on their territory. In addition to 17 major utilities there are about 60 industrial establishments that generate electricity for their own use (pulp and paper, mining, and aluminium). The electricity industry in Canada is highly integrated, and electricity prices are generally lower than in other developed countries. The industry is gradually being deregulated, but liberalization comes about mainly as a consequence of pressure from the United States of America to secure access to Canadian markets. The expectation is that further liberalization will take place in the future. The impact of liberalization and deregulation on GHG mitigation was not discussed in the NC3.

45. The Canadian electricity industry has announced planned reductions in emissions of approximately 3,000 Gg CO_2 equivalent by 2000 (gases not specified) in its submission under the Voluntary Challenge Registry (VCR) Program[13]. However, total emissions from this sector are projected to be 25 per cent above 1990 levels by 2008–2012, and there do not appear to be any effective measures in place to reduce this growth. There are some activities under way aimed at displacing oil- and coal-fired generation by natural gas combustion, and some utilities are participating in pilot programmes to purchase GHG credits from sinks.

46. The production, processing and distribution of fossil-fuel producing industries (oil, natural gas and coal) contributed 137 Gg CO_2 equivalent of GHG emissions in 2000. Almost 40 per cent of the emissions came from producing and processing natural gas, oil and oil sands. Over 50 per cent of the oil and natural gas produced is exported to the United States and for this reason Canada estimates that 46,000 Gg CO_2 equivalent of emissions resulted from producing and transporting fuels for export. VCR submissions have shown that there are significant energy-efficiency improvements in this sector. Although the industry has not been able to reduce absolute emissions, it has reported a 20 per cent reduction in GHG emissions per unit of production since 1995. Future mitigation measures concentrate on reducing flaring and venting of oil and gas, and carbon dioxide capture and storage.

47. There was a marked improvement in end-use energy efficiency over the period 1990 to 2000. The Office of Energy Efficiency has developed some notable indicators on changes in energy use, and it

[13] The Voluntary Challenge Registry (VCR) is a stand-alone non-profit corporation for industries to reduce GHG emissions on a voluntary basis. It was developed in 1994 as a core element of the NAPCC.

is estimated that overall energy efficiency improved by 9.4 per cent in Canada between 1990 and 2000. Energy efficiency improvements helped mitigate growth in energy demand to 17 per cent even though GDP grew by 31.4 per cent during the same period. However, due to the absence of monitoring and reporting, it is difficult to determine whether these improvements would have occurred in the absence of measures.[14] Canada has been working with the International Energy Agency on monitoring energy efficiency improvements relative to best practice in other industries in other OECD countries.

48. The programmes of Office of Energy Efficiency are targeted at improving energy efficiency in a range of sectors and areas including housing, building, equipment, industry, and transportation. Other NRCan programmes address emissions from the forestry and electricity sectors. Programmes range from being voluntary, regulatory, aimed at information exchange or provide financial incentives for energy-efficient, commercial building retrofits and design. The Government has implemented labelling programmes for equipment and appliances. Two such programmes are EnerGuide for Equipment, a programme for mandatory labelling; and Energy Efficient Equipment and Appliances – which includes regulation aimed at eliminating inefficient energy-using equipment from the market by prescribing minimum energy efficiency standards. New major household appliances and room airconditioners must now comply with the Energy Efficiency Act. The Accelerated Standards Action Program provides for the introduction of initiatives to encourage consumers to purchase 'best in class' efficient products and sets performance standards that are prescribed under the Energy Efficiency Act. These minimum standards are estimated to have accounted for over 10,000 Gg CO_2 equivalent of emission reductions in 2000.

49. The building sector accounted for over 10 per cent of total GHGs in 2000. Improving energy intensity in buildings in the residential and commercial sectors is a newly enhanced initiative for reducing emissions in these sectors. The EnerGuide for Houses Program (Can$ 9 million over three years – 1998–2001) is aimed at providing homeowners with information on how to improve energy use and efficiency in the home. Action Plan 2000 allocates Can$ 35 million over five years to the Energy Efficient Housing Initiative (EEHI). The R-2000 HOME Standard is a technical performance standard that encourages Canadian builders to construct new houses that are more energy-efficient and environmentally responsible than is required by current Canadian building codes. In terms of the commercial sector, the Commercial Building Incentive Program, with funding of Can$ 30 million over three years (1998-2001), is aimed at encouraging owners and developers to incorporate energy-efficient technologies and practices for new commercial and institutional buildings. These programmes continue to receive funding.

50. The Government has also taken a number of actions to promote energy efficiency and renewable energy use at federal facilities. As part of the House in Order Initiative, the federal Government has a target of a 31 per cent reduction in emissions from 1990 to 2010 and it is estimated that there has been a 19 per cent reduction already. There is a Greenpower purchasing incentive programme for their facilities throughout Canada, and a programme to support energy efficiency improvements in non-federal facilities such as schools.

51. As many programmes focus on behavioural change, the Office of Energy Efficiency is undertaking innovative work in the area of assessing the impact of such programmes on reducing GHG emissions, particularly through the utilization of Discrete Choice Theory methods.

52. Canada's measures to support renewable energy include the Renewable Energy Deployment Initiative (REDI), Renewable Energy and Hybrid Systems for Remote Communities (REHSRC), and the Renewable Energy Technologies Program (RETP). The REDI has funding of Can$ 12 million over three years and supports the promotion of renewable energy systems for space and water heating. The

[14] The factorization analysis used by NRCan/OEE does not rely on aggregate energy intensities such as energy/GDP but undertakes more detailed assessments in order to net out the influence of structural changes.

REHSRC programme is targeted at the deployment of renewable energy technologies to more than 300 remote communities. The RETP is aimed at developing and commercializing advanced renewable energy technologies, including active solar, wind, small hydro (less than 20 MW) and biomass. There is also the Tax Incentive for Renewable Energy and Energy Efficiency aimed at improved access to financing for renewable energy and energy efficiency by relaxing the "specified energy property" rules, and providing accelerated tax write-offs.

53. Despite the focus on support for renewable energy, emission reductions associated with these initiatives will be small since non-hydro renewable energy sources such as biomass and wind made up only 7 per cent of the total energy supply mix in 2000. Emission reductions are also expected as a result of the refurbishment of large hydro plants over the coming years, resulting in efficiency improvements through the replacement of turbines and upgrading of facilities. The Government has supported the development of fuel cells and in 1999 provided an additional Can$ 30 million towards the new National Fuel Cell Research and Innovation Initiative.

54. As one of its GHG reduction options, Canada is assessing the role of nuclear energy, and whether increased electricity demand could be met through expansion of the nuclear industry. For the moment however, it is not included as an option in meeting GHG commitments.

55. There is a strong focus on research and development in energy. The Program of Energy Research and Development (PERD), with an annual budget of Can$ 57.5 million, promotes the development and use of Canada's non-nuclear energy resources in a clean and safe manner, and the development of energy-efficient, renewable, and alternative energy sources and technologies. Seventy-seven per cent of PERD's current programmes are aimed at finding technological solutions to Canada's climate-change challenges. Research-and-development activities are mainly focused on: diversified oil and gas production; cleaner transportation; energy-efficient buildings and communities; energy-efficient industry; reducing the environmental impacts of Canada's electricity infrastructure; and climate change. Funding of research and development on nuclear energy amounted to Can$ 78 million between 1999 and 2000.

C. Transport

56. Transport emissions are high relative to other OECD countries, due to national circumstances such as a large land area, and a relatively small and highly dispersed population. In 2000, the transport sector constituted 26 per cent of total emissions and 36 per cent of energy emissions (including from pipelines). Emissions in this area have grown significantly – transport was the leading sector in 2000 for GHGs, accounting for 40 per cent of Canada's emissions growth in the decade. Over the past decade, average energy consumption decreased for large and small cars by 23 per cent and 8 per cent respectively. The stock of cars declined by 6.6 per cent while the stock of light duty trucks (LDTs) grew by almost 68 per cent, reflecting a significant shift from light duty gasoline vehicles to LDTs such as sports utility vehicles (SUVs) and light trucks. The latest figures indicate that LDTs account for about 44 per cent of new vehicle sales (in 2000, SUVs alone accounted for about 12 per cent of all new vehicles sold in Canada).

57. Energy efficiency improvements have reduced emissions growth in this sector. It is estimated that emissions would have been 10 per cent higher without these improvements. The main initiatives aimed at reducing greenhouse gas emissions from the transport sector outlined in the NC3 include intelligent transport systems, transit infrastructure enhancement including the expansion of Sky Train fuel efficiency, fleet management (government), and alternative fuels. AP 2000 is expected to reduce emissions in transport by 8,900 Gg CO_2 equivalent by 2010.

58. The Motor Vehicle Fuel Efficiency Initiative is aimed at a fuel efficiency improvement target for light duty vehicles. The North American vehicle production market is highly integrated and the new fuel

efficiency target will take this into account, as well as Canada's practice of harmonizing product performance standards for motor vehicle safety and emissions with the United States, to the extent possible. The new target will be negotiated with manufacturers and the Government of Canada would be willing to consider alternative programme designs to the existing Company Average Fuel Consumption standards programme that requires each manufacturer's new vehicle fleet not to exceed a maximum fuel consumption of 8.6 litre/100 km for passenger cars, and 11.4 litres/100km for light trucks. A strong fuel efficiency campaign aimed at purchasers and drivers will support the vehicle efficiency policy.

59. The enhancement of transit infrastructure and the improved transit service initiative are intended to improve transportation and reduce GHG emissions. Canada's rail system is the third largest among OECD countries. Deregulation in the transport sector is leading to increased competition for freight transport between rail and trucking industries. There was a further shift from rail to road freight over the 1990–2000 period for transport within the borders, while the rail industry focused on transborder business. This shift resulted in a large increase in freight transport emissions. To address this concern, AP 2000 through voluntary agreements will target a 2,000 Gg CO_2 equivalent reduction in GHG emissions by improving driving practices that could improve energy efficiency by 2 per cent by 2010; increasing load matching that would reduce kilometres travelled by 0.6 per cent; and increasing use of advanced tyres and lubricants that can improve energy efficiency by 2.5 per cent.

60. The Future Fuels initiative will increase the supply and use of ethanol produced from biomass such as plant fibre, corn and other grains. This component of 2000[15] targets a four-fold increase in Canada's ethanol production and use, by adding 750 million litres in capacity by 2010. This could enable as much as 25 per cent of Canada's total gasoline supply to contain 10 per cent ethanol, for a reduction in GHG emissions of 800 Gg CO_2 equivalent by 2010. The Canadian Transportation Fuel Cell Alliance will demonstrate hydrogen refuelling pathways for fuel-cell vehicles that emit low or no emissions. This initiative involves fuel-cell suppliers, fuel providers, the automobile industry and government. It will demonstrate options for refuelling as well as address regulatory barriers to the increased use of fuel-cell vehicles, for a reduction in GHG emissions of 100 Gg CO_2 equivalent by 2010. The Program of Energy Research and Development (PERD) invests approximately Can$ 11 million annually in technologies to reduce emissions from transportation sources to improve air quality and to improve the energy efficiency and economic performance of next generation vehicles and systems.

D. Industry

61. The industry sector contributed 16 per cent to total GHG emissions in 2000. Industries covered by the Canadian Industry Program for Energy Conservation (CIPEC) emissions increased by 1.7 per cent between 1990 and 2000, despite a larger increase in the productivity of the sector. These data exclude the electricity generation sector and upstream fugitive emissions that CIPEC will examine to incorporate in future analyses. There is a range of largely voluntary and grant initiatives aimed at reducing GHG emissions in industry. The VCR is a notable example as the oil and gas sectors were its founding members. It is seen as an important step for reducing GHGs associated with the production of oil and natural gas. Since its introduction, retrofitting and new techniques have resulted in improved energy efficiency in this subsector. The CIPEC is a voluntary industry-government alliance aimed at energy efficiency improvement targets. This includes 35 trade associations, and covers sectors such as aluminium, breweries, cement, fertilizer, food processing, rubber, textiles, wood products, pulp and paper and general manufacturing.

[15] Canada's Climate Change 2003 budget stipulates that the ethanol or methanol portion of blended diesel fuel will be exempted from the federal excise tax on diesel fuel. Bio-diesel, which is produced from biomass or renewable feedstocks, will also be exempted from the federal excise tax on diesel fuel when used as a motor fuel or blended with regular diesel fuel.

62. Specific measures that target the industry sector include the Can$ 60 million Technology Early Action Measures federal Government initiative. As of December 2000, 50 domestic and 17 international partnerships had been approved, for a total investment of Can$ 700 million. Other programmes include the Climate Change Technology and Innovation Program and the Sustainable Development Technology Fund, but these do not target the industry sector alone. The Program of Energy Research and Development (PERD) provides approximately Can$ 11 million annually for R&D to reduce the overall energy intensity of Canada's industrial sectors, and consequently, their associated GHG emissions, while, at the same time, improving productivity and providing Canadian companies with potential economic opportunities.

63. The Climate Change Technology Development and Innovation Program consists of a package of innovation initiatives, including technology R&D projects, basic research into new innovative approaches, and technology road-mapping in areas of importance to industry, including fuel cell commercialization, bioproducts/bioenergy, and clean coal power generation. Sustainable Development Technology Canada (SDTC) is a funding foundation, established in 2001 by federal legislation with an initial endowment of Can$ 100 million.[16] The SDTC provides leveraged funding to consortia of private sector and academic partners for projects involving the development and demonstration of climate change and air quality technologies.

64. The Can$ 50 million Green Municipal Enabling Fund and Can$ 200 million Green Municipal Investment Fund are both endowment funds supporting activities at municipal level in Canada. The latter provides loans for up to 25 per cent of the capital cost of projects. There is further scope to introduce other measures that target the electricity and oil and gas sectors of industry, as emissions in these sectors continue to grow despite the implementation of the existing suite of largely voluntary measures.

E. Agriculture

65. Agriculture contributed 8 per cent to total GHG emissions in 2000. Emissions from agriculture are primarily N_2O associated with fertilizer and animal manure use and CH_4 associated with livestock rearing.

66. Major reductions in GHG emissions (sources) and increased soil carbon sequestration (sinks) from the agriculture sector are expected from a range of measures, including increased use of no-till practices, reduced summer following, improved nutrient management, additional land forage crops under improved efficiency in fossil fuel use, greater use of ethanol, and reduced CH_4 and N_2O emissions from livestock and manure owing to improved feeds and management practices. It is expected that the measure with the highest potential for contributing to Canada's target under the Kyoto Protocol is the enhancement of soil sinks through increased use of no-till practices.

67. With respect to programmes, the Can$ 21 million Greenhouse Gas Mitigation Program is the most important in terms of budget. It is a programme under the AP2000 initiative aimed at reducing GHG emissions in the agriculture and agri-food sector through improved soil, nutrient and livestock management; and increasing carbon sinks by 5,800 Gg of CO_2 equivalent. Furthermore, there are additional initiatives outside the Greenhouse Gas Mitigation Program in the areas of planting shelterbelts and undertaking conservation projects.

68. Other key policies and measures include the Agricultural Environmental Stewardship Initiative, a Can$ 10 million programme over three years that addresses the regional impacts of agricultural practices on water, soil, and air quality, biodiversity and GHG reductions through education and awareness, stewardship tools such as environmental clubs and land-use planning.

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[16] A further endorsement for Can$ 250 million has been provided for SDTC under Canada's 2003 budget and the Climate Change Plan for Canada.

69. Other mitigation programmes are supported by a series of research programmes or initiatives. For instance, the Model Farm Program (Can$ 5 million) supports teams of scientists in Canada who measure GHG emissions as a function of soil, crop, and livestock management practices on Canadian farms, including the demonstration sites under the GHG Mitigation Program. Furthermore, the National Carbon Greenhouse Gas Accounting and Verification System (NCGAVS) for agricultural land has been created. It is a transparent and verifiable accounting system for estimating the amounts and uncertainties of soil carbon stock changes and GHG emissions at the provincial, regional, and national level. The accounting system includes climate, land use and management databases linked to ecological models and temporal and spatial scaling processes. The system will also incorporate IPCC methods and algorithms for reference and comparison purposes.

F. Forestry

70. The contribution of sinks to reducing CO_2 emissions declined over the past decade. While some efforts have been undertaken to date to promote afforestation/reforestation activity in Canada, they have not been substantive. The Feasibility Assessment of Afforestation Carbon Sequestration initiative (FAACS) has focused efforts on information gathering, research, and regional workplan development to understand better the potential of these activities and in assessing programme development issues. FAACS is evaluating the feasibility of large-scale afforestation in Canada including the assessment of various afforestation/reforestation incentive options (see page 68, NC3 for further details). Recent work has also targeted developing carbon accounting tools for afforestation/reforestation and a network of afforestation/reforestation projects. Efforts are in progress to assess policy issues such as potential design, mechanics, incentives, and co-benefits from forestry and GHG activities. If cost effective, incentives could be made available in the future to private landowners for them to undertake afforestation/reforestation on marginal agricultural land as a GHG-reducing activity.

71. The Forest Carbon Measurement and Monitoring System is supported under the Climate Change Action Fund (CCAF), with funding of Can$ 5.7 million over three years. Activities are under way to develop a new national forest inventory, land-use change assessment tools, and remote sensing tools. The national forest inventory will be based on a grid of sample plots that will be assessed both through remote sensing and ground measurements. Land-use change detection is another important element of the work under way in the measurement and monitoring system. A carbon stock change-accounting framework including carbon budget modelling is expected to be available in 2005.

72. In terms of institutional arrangements, a National Forest Sinks Committee, comprising forest science and policy representatives from federal, provincial and territorial governments was established in December 2001 to undertake joint and coordinated work on forest sinks and improve forest sink and deforestation source estimates. Some offset activities are occurring in this area, such as the SaskPower Carbon Offset Agreement.

G. Waste

73. Methane emissions from landfills increased by nearly 18 per cent between 1990 and 2000, despite an increase in landfill gas capture of 33 per cent in this period. Total landfill capture at 37 sites across Canada is 5,400–6,700 Gg CO_2 equivalent annually. Both the Green Municipal Enabling Fund and the Green Municipal Investment Fund have supported waste management activities. The PERD funds a coordinated research initiative to reduce the energy intensity of the agriculture and food sector and thereby reduce the GHG emissions of the sector, including manure management, which can be used to replace chemical fertilizer requirements, and agronomic practices that reduce fossil fuel use.

74. Programmes include regulations and management criteria for landfills, and some requirements for the collection and management of landfill gas. The Government of Ontario has introduced a regulation to capture landfill gas from expanded and new large landfills.

IV. PROJECTIONS AND THE TOTAL EFFECT OF POLICIES AND MEASURES

75. The Analysis and Modelling Division (AMD) of Natural Resources Canada is responsible for preparing projections of emissions from energy use, in consultation with federal, provincial and territorial organizations both before and after the development of the projections. This consultation took place via the Analysis and Modelling Group (AMG), which is composed of officials and analysts from NRCan and Environment Canada, and the governments of the provinces and territories.[17] Emissions from non-energy sources were prepared in consultation with Environment Canada and Agriculture and Agri-Food Canada.

76. The overall modelling structure for preparing projections is very complex. Macroeconomic indicators – changes in economic activity, employment, trade and competitiveness and government balances – are projected using the Informetrica Model. Energy demand by fuel is projected using the Interfuel Substitution Demand Model (IFSD), an econometric top-down model covering all major fuel types. Bottom-up, end-use process models are also used for sectoral energy demand (residential, commercial, industrial and transportation) for all provinces and territories. Two energy technology models – the Market Allocation Model – MARKAL, and the Canadian Integrated Modelling System (CIMS) – are used for electricity supply. It was pointed out to the team that these two models differ in their approach to energy pricing in that MARKAL employs marginal cost pricing so that the price of carbon is determined by the last tonne abated, while CIMS assumes that the average cost of all emissions reduced is incorporated in the price. This distinction is not critical for pricing oil products or natural gas but it is crucial for the pricing of electricity.

77. Crude oil, natural gas and coal supply are modelled separately by considering planned projects as reported by the oil and gas industry. Coal supply is determined by industrial demand, and energy export to the United States is determined residually by taking the planned production of crude oil and gas and subtracting domestic demand. Emissions from agriculture are projected using the Canadian Economic Emissions Model for Agriculture (CEEMA), which incorporates the effects of government programmes and policies in the sector.

A. Scenario definitions and key assumptions

78. The NC3 presents three scenarios: a business as usual (BAU) scenario which assumes that no mitigation measures have been implemented since 1990; a scenario with the effects of measures under the NAPCC (1995) and a third scenario with further measures for GHG mitigation formulated in AP 2000. This scenario includes reductions from 2000 onwards, and potential reductions that can be achieved abroad under the clean development mechanism. Of a total of 65,000 Gg CO_2 equivalent in GHG reduction expected from AP 2000 in 2010, 20,000 Gg CO_2 equivalent are estimated to come from such measures. The effects of the measures on projected emissions are exogenously subtracted from modelled emissions and the economic costs of the P&Ms are not taken into account. Experts explained that to generate accurate scenarios for 2010 and 2020 federal and provincial energy and environment policies are held constant, therefore they; assume that these policies are maintained.

79. The NC3 presents the key economic and policy framework assumptions. Modelled output in the NC3 assumes a GDP growth of 2.3 per cent annually (NC2 – 2.2 per cent). Compared to 2000, the economy is 34 per cent larger in 2010 and 77 per cent in 2020; the population increases from 30.8 million in 2000 to 34 million in 2010 (NC2 – 33.8 million) and to 37.4 million in 2020; relatively

[17] With ratification of the Kyoto Protocol, and the requirements for implementation of Canada's Climate Change Plan, the future of a national process, including analysis and modelling, is currently under examination and discussion.

low and stable energy prices are assumed – crude oil at US$ 22 per barrel; natural gas at US$ 2.3/mcf and electricity prices maintained constant at 2000 levels or declining.

80. Similar to the NC2, the assumptions in the NC3 reflect development with high economic growth, relatively high rates of technological improvements (reduced emissions per value added of 2.2 per cent annually over the projection period) and low and stable or even declining energy prices. Electricity pricing is determined by average cost in the electricity producing sectors, which reflects utility pricing methodologies and could imply that capacity expansion to meet future demand may be subject to subsidies. Domestic demand for coal is expected to rise, with electricity generation accounting for most of this increase due to the anticipated retirement of nuclear plants and an increase in the demand for electricity. The team noted that presenting data on taxes and on the energy price regime (electricity in particular) would have been useful for overall evaluation of the projections.

81. Recalculations of inventory data as new methodologies and emission factors became available between the NC2 and the NC3 resulted in an upward revision in total GHG emissions for the base year 1990, by 43,000 Gg CO_2 equivalent from 564,000 Gg CO_2 equivalent to 607,000 Gg CO_2 equivalent (8 per cent). Projection experts explained that there was also a 57,000 Gg CO_2 equivalent increase in the data for 2010 from changes made to sectoral assumptions in the NC3 which, when added to base year adjustments, increased emissions for 2010 by 100,000 Gg CO_2 equivalent. Table 5 presents these adjustments in emissions by sector.

Table 5. Changes in assumptions between the NC2 and NC3 (thousand Gg CO_2 equivalent)

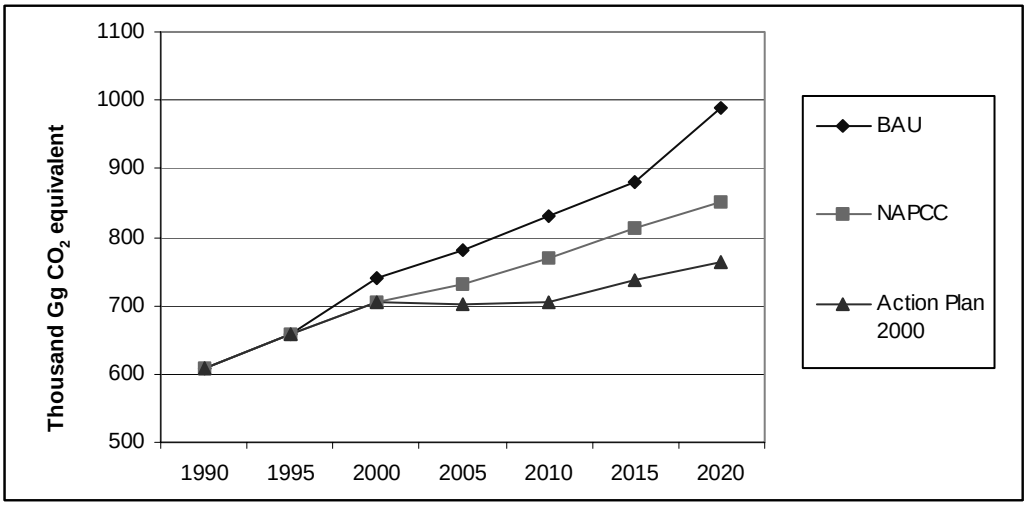
	Energy		Industry		Residential commercial institutional		Transport		Agriculture		Others		Total	
	1990	2010	1990	2010	1990	2010	1990	2010	1990	2010	1990	2010	1990	2010
NC2	178	206	119	135	70	71	149	188	30	38	19	31	564	669
NC3	170	243	137	148	72	78	146	194	59	72	23	34	607	770[a]

[a] Without Action Plan 2000 measures and with NAPCC measures.

B. Projected emission trends

82. Figure 3 presents a comparison of the three emission scenarios. This figure suggests that the NAPCC initiatives implemented to date checked CH_4, N_2O, and precursor gases between 1995 and 2000 and are projected to decrease emissions further through 2020. The BAU emission level of approximately 740,000 Gg CO_2 equivalent in 2000 is projected to increase to 830,000 Gg CO_2 equivalent in 2010 and 990,000 Gg CO_2 equivalent by 2020. The NAPCC reduces emissions by 35,000 Gg CO_2 equivalent in 2000 by 60,000 Gg CO_2 equivalent in 2010 and about 139,000 Gg CO_2 equivalent by 2020. By 2010, AP 2000 is estimated to reduce total GHG emissions from 770,000 Gg CO_2 equivalent with NAPCC to 705,000 Gg CO_2 equivalent.

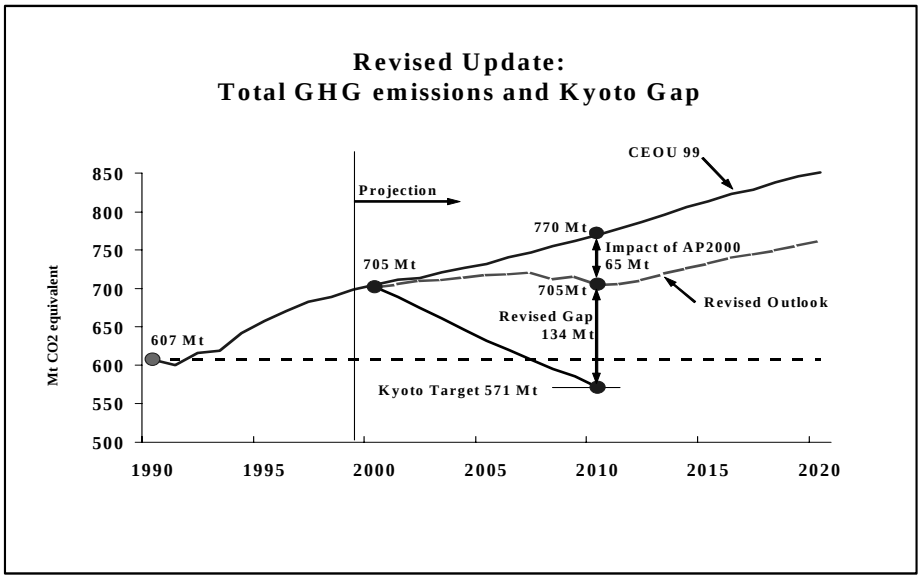
Figure 3. Comparison of three GHG emission scenarios (thousand Gg CO_2 equivalent)



83. The NC3 assesses GHG mitigation commitments in terms of the "Kyoto gap". Figure 4 shows the magnitude of the gap after including the effects of the NAPCC and Action Plan 2000.

84. Under the Kyoto Protocol commitments, reducing emissions by 6 per cent from 1990 GHG levels during 2008–2012 means reducing emissions from 770,000 Gg CO_2 equivalent[19] in 2010 in the NAPCC inclusive scenario, to 571,000 Gg CO_2 equivalent in 2010, a difference or "Kyoto gap" of 199,000 Gg CO_2 equivalent.[18] AP 2000 is expected to reduce the gap by 65,000 Gg CO_2 equivalent. These projected AP 2000 reductions reduce Canada's Kyoto gap to 134,000 Gg CO_2 equivalent Even though the rate of growth of GHG emissions appears to have been reduced by the NAPCC, significant additional policy action beyond the Action Plan 2000 will be required to reduce these emissions to meet the reduction target.

Figure 4. The Kyoto gap



[18] Projection of Canada's GHG emissions revised since the June 2002 in-depth review shows that total GHG emissions by 2010 would be 809,000 Gg CO_2 equivalent instead of 770,000 Gg CO_2 equivalent in the NAPCC inclusive scenario of the NC3. This estimate excludes the impacts of AP 2000. As a result the revised Kyoto gap is 238 Mt or 29 per cent instead of 199,000 Gg CO_2 equivalent.

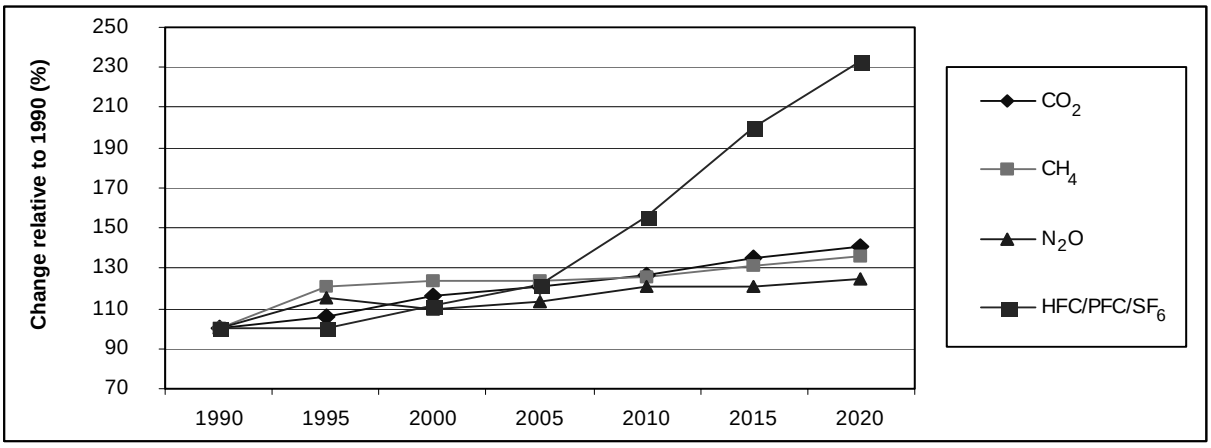
85. Most of the planned emission reductions under AP 2000 would come from reduced energy consumption either through more energy efficient or cleaner technologies or through fuel switching. The greatest potential for emissions reduction (40–60 per cent) is in electricity generation. Two actions – capture and storage of CO_2 and an increase in inter-provincial hydroelectricity trade account for the bulk of this reduction. Electricity demand will continue to rise, but at a much slower rate and the participation of natural gas, hydro, wind and biomass in generation will increase. The transport sector shows the most significant reductions of 20 per cent in energy consumption compared with the BAU but reduction in energy use in industry is low.

86. Between 2000 and 2020, oil production is projected to increase by about 24 per cent and oil consumption by about 27 per cent. Gas demand is projected to increase to 150 billion m^3 by 2020, while exports to the United States are forecast to increase from current levels of 100 billion m^3 to 127 billion m^3. Production will increase to 227–275 billion m^3. It is assumed that 90 per cent of coal consumed will be consumed in electricity generation.

87. Renewable energy production will continue to grow; hydro will increase from 1,190 PJ to 1,375 PJ by 2020; and other renewable energy forms, mostly biomass (wood), from 641 PJ to 983 PJ. Despite these increases, the share of renewables in total primary energy is expected to remain relatively constant as other sources are expected to grow (natural gas). The role of these sources will be determined by progress in deregulating the electricity sector, as more independent power producers have access to the wholesale and retail electricity markets.

88. Projected long-term trends in GHG emissions by gas from 1990 to 2020 are presented in figure 5 for the scenario with NAPCC measures implemented. CO_2 emissions are expected to increase by 27 per cent and CH_4 by 26 per cent between 2000 and 2010 and, as CO_2 is the dominant GHG, it will account for almost 80 per cent of the increase in emissions in the future. Annual GHG emissions will increase by 5 per cent instead of 13 per cent as projected in the BAU case and would thus be 15 per cent or 123 ,000 Gg CO_2 equivalent lower in 2010 compared to the BAU case.

Figure 5. Projected emission trends for CO_2, CH_4 and N_2O, 1990–2020



Source: NC3, "with NAPCC measures implemented" scenario.

89. The increases in oil from oil sands and natural gas production generate significant increases in both CO_2 and CH_4 emissions. Although, in absolute terms, transport continues to be the largest contributor to projected emissions, a large part of this is due to an increase in the transport of oil and gas. CH_4 emissions are expected to level off after 2010, as voluntary action is taken by the industry to reduce venting and pipeline leakages. N_2O emissions grow by 20 per cent between 1990 and 2010 but stabilize

at 1995 levels as a result of business plans with industries. These emissions decrease by 10,000 Gg CO_2 equivalent from installing emission control technology in adipic acid production, but this is offset by an increase in nitrogen fertilizer use in agriculture.

90. SF_6 emissions are projected to decrease, given that in 2005 its production will be eliminated in the magnesium industry. PFC emissions are expected to remain constant while those of HFCs are expected to increase substantially.

91. On a sectoral basis, the following increase in emissions is expected between 1990 and 2010: transport 34 per cent; fossil fuel production and refining 64 per cent; electricity generation 25 per cent; agriculture 8 per cent; and waste 48 per cent. The residential sector is projected to decrease slightly by 2 per cent due to the impact of energy-efficiency regulations on buildings, heating systems and other energy-using equipment.

92. The NC3 identified the mitigation effects of various sectoral measures of the NAPCC and the AP 2000. Under the NAPCC, most of the emissions reduction comes from end-use and non-energy sectors (agriculture, soils and forests). Under AP 2000, 20 per cent of the reductions are expected from transport and a further 25 per cent from agriculture and forests, energy 15 per cent, industry 10 per cent, transport 10 per cent, and commercial, residential and institutional 20 per cent. A 10 per cent decrease in emissions is anticipated from international initiatives.

93. The NC3 presented the sensitivity of the Kyoto gap (134,000 Gg CO_2 equivalent) to the effects of changing world oil and gas prices, economic growth and reducing the rate of carbon intensity. As expected, emissions were most sensitive to higher intensity improvements (gap decreases by 6,000 Gg CO_2 equivalent), followed by economic growth (gap increases to 179,000 Gg CO_2 equivalent for high growth and decreases to 111,000 Gg CO_2 equivalent for low growth) and least affected by changes to energy prices (129,000 Gg CO_2 equivalent for high oil prices; 139,000 Gg CO_2 equivalent for low oil prices and 132,000 Gg CO_2 equivalent for high natural gas prices). Sensitivity analyses with respect to oil and gas prices, economic growth and development of emission intensities are provided in aggregate format (total CO_2 equivalent emissions in 2010).

94. Since the June 2002 In-depth review, the Government of Canada has revised its emission estimates. The total GHG emissions for 2001 were estimated at 720,000 Gg CO_2 equivalent, up from 705,000 Gg CO_2 equivalent in 2000. In addition, the business-as-usual GHG emissions projection for 2010 were estimated upward to 809,000 Gg CO_2 equivalent from 770,000 Gg CO_2 equivalent as previously projected in the NAPCC inclusive scenario outlined in the NC3. This means that during 2008–2012, Canada will need to reduce emissions by an estimated 238,000 Gg CO_2 equivalent.

C. Overall evaluation of GHG emission projections

95. Projections in the NC3 are presented in an aggregated format by gas and by sector for three scenarios. Sectoral details are provided but not always disaggregated by gas. Projections on LUCF sinks and emissions from international air and marine bunkers are not included. Furthermore, where sectoral emission data are presented, sectoral definitions are not always consistent with those in the inventories and activity data for the scenarios are not included**.** No consistency check is provided between modelled and observed developments for 1995 and 2000. Observed 2000 emissions exceeded projected 2000 emissions by some 20,000 Gg CO_2 equivalent.

96. In spite of the above omissions, the review team believes that there was a marked improvement in the overall presentation of projections in the NC3 compared to the NC2, and that the methodology for preparing the forecast is rigorous and comprehensive, covering all areas including the cost-effectiveness of certain policy options.

97. The review team was informed that, although the approach for preparing the projections in the NC3 is the same as for the NC2, major revisions to the methodology and the assumptions resulted in increasing total GHG emissions by 57,000 Gg CO_2 equivalent in 2010. The impact on emissions from changes in data is well documented in the report, as required by the guidelines, including a comprehensive analysis of aggregate effects of implemented policies and measures driving emissions.

98. On the actual data, the underlying factors driving future emissions are all high (GDP, population growth, transport, industry sectoral composition). This, combined with low energy prices, high-energy exports to the United States and development of oil sands, would lead one to expect higher rates of emissions growth than those reported. But the projections assume a very rapid change in emission intensity (emissions/GDP) to lessen the growth in emissions as a result of expected effects of policies and measures. The review team believes that, even if the effect of each single measure is accurately estimated, the effect of all the hundreds of measures is not well represented in the projections. The review team believes that the total estimated effects of AP 2000 may be somewhat optimistic, and thus that projected emissions may be biased downwards. The team also suggests that a critical element to be incorporated in the projections is the effect of existing federal, provincial and municipal energy efficiency and alternative energy initiatives resulting from the NAPCC and the VCR programme. The current projections are based on a review of about 272 initiatives and 235 VCR submissions, and therefore do not reflect the full impact of these projects.

99. Details on the sensitivity of projections to changes in key variables were also well explained in the NC3, and were very useful for interpreting results. The review team believes that projections are also sensitive to assumptions about the market structure of the electricity sector and it is probably not realistic to assume a continuation of the current regime over the next 10 years. This analysis was not done in the NC3 but the team recommends that a sensitivity analysis be done for changes in the electricity-pricing regime.

100. As the electricity market is expected to change considerably during the projection period, the projections team explained that modelling the electricity sector is becoming more and more difficult and complex. In a dynamic market, electricity demand in a specific province or region will not necessarily be met by the province or region itself. In the projections, provinces and territories are still considered as distinct markets in terms of supply and demand, after consideration of specific or anticipated amounts of energy/power transfers and exchanges.

101. The role of sinks in helping to close the Kyoto gap is still unclear. Sinks are not projected in the NC3. Even though the LUCF sink estimate declined between 1990 and 2000, it is estimated that carbon sinks, including activities under Article 3.3 and 3.4, will help to offset 30,000 Gg CO_2 equivalent (this is a function in part of the difference between National Greenhouse Gas Accounting for LUCF sinks and Kyoto Protocol sinks accounting). A more rigorous analysis of the contribution of sinks to emissions reduction in 2010 would enhance the interpretation of projected data. Flexible mechanisms with a heavy emphasis on “hot air” and some use of CDM are planned to deliver 75,000 Gg CO_2 equivalent. GHG reductions, and credits to Canada for its clean energy exports (hydroelectricity and natural gas) to a non-Party (the United States) could contribute 70,000 Gg CO_2 equivalent.

102. In 2003–2004, NRCan (AMD) will be switching completely from the current modelling system that was used to prepare projections in the NC3 to a model called the National Energy Modelling System (NEMS). This modelling system is expected to be up and running in late 2003 and will be used to produce a new set of projections for GHG emissions. The effects of this change on the forecast were not discussed during the review but some changes are expected in future results.

V. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

103. The coverage of vulnerability and adaptation (V&A) in the NC3 follows the guidelines and is much more comprehensive than in the NC2. NRCan is responsible for leading the development of a national framework for V&A and its implementation plan. The implementation of this framework occurs at the appropriate jurisdictional levels. An Executive/Policy Committee[19] provides policy direction and approval of projects, while a Technical Committee of Science Advisors makes recommendations on proposals and provides other technical advice.

104. The NC3 asserts that climate change is already occurring in Canada. The annual mean temperature trend indicates that the western and central Arctic regions have warmed by about 1.5°C and 0.5°C, respectively, over the past 40 years. The impacts of climate change are also already apparent in some regions of the country – permafrost is thawing in the western Arctic region; drought is an ongoing concern in some parts of the prairies; sea level rise and storm surges are already significant issues in Atlantic Canada. Across the country, there is evidence to suggest that forest fire frequency is increasing and communities are having to deal with extreme flood events. The appearance of southern species such as Pacific salmon and robins in the Arctic for the first time is cited by traditional knowledge research.

105. The NC3 outlines the final results of the Canada Country Studies (one report consisting of several volumes) and initial results of research projects funded by the CCAF, which identify impacts and potential adaptation measures for biophysical and socio-economic sectors, consistent with the guidelines. About 75 projects, covering 13 research sectors, have been identified in terrestrial ecosystems (11), water resources (9), agriculture (10), fisheries (6), forests (6), hazards/floods/drought (3), sea ice (1), health (5), cross-cutting (6), communities (7), industry (2), and tourism (1).

106. Additional information made available to the review team highlighted specific outcomes of initial impact and adaptation studies. They include (a) community case studies of permafrost degradation and infrastructure in the Mackenzie Valley that will assist local partners to incorporate climate change considerations into community development and engineering design, and serve as models to assess the risks from permafrost in other countries; (b) examination of the impacts of extreme summer heat on public health, leading to the development of the state-of-the-art Heat-Health Alert System to prepare for future heat waves; (c) development of a new storm surge model that can be used as an early warning system for potential severe impacts of storm surges.

107. Hydropower generation constitutes about 62 per cent of electricity generation. Consequently, the Program of Energy Research and Development has identified impacts of climate change on the energy sector as one of the priority areas, which include how impacts on water resources will affect hydropower generation.

VI. FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

108. The NC3 presented most of the information required by the guidelines to assess developments in meeting Canada's commitments in this area. All the tables provided were complete and comprehensive, including data for 2000. While the NC3 did identify those funds that are new and additional (e.g. contributions to the Global Environment Facility (GEF) and to countries with economies in transition), the concept was not defined.

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[19] Comprising representatives from federal departments and agencies of Agriculture & Agri-food Canada, Environment Canada, Fisheries and Oceans, Indian & Northern Affairs Canada, Industry Canada, Health Canada and NRCan. The other members are the National Research Council of Canada (NRC), the Natural Sciences and Engineering Research Council, Social Sciences & Humanities Research Council (SSHRC) and the Canadian International Development Agency.

109. The Canadian International Development Agency (CIDA) is the main agency providing official development assistance (ODA). Its mandate is to "support sustainable development in developing countries to reduce poverty and contribute to a more secure, equitable, prosperous world". The second in-depth review report noted that the primary mandate of CIDA is development and that it was difficult to distinguish this from climate change-related concerns.

110. The NC3 listed various agencies that are involved in capacity-building and technology transfer, including the CDM/JI Office of the Department of Foreign Affairs and International Trade, the Technology Early Action Measures (TEAM) Program, the Canadian International Technology Initiative and CANMET Energy Technology Branch of NRCan, and the Trade Team Canada Environment of Industry Canada. Also, there is a technology transfer and outreach component to the Climate Change Action Plan. These are all engaged in facilitating the transfer and diffusion of technology and capacity-building in developing countries. The International Development Research Centre also provides support to a broad range of scientific research initiatives relevant to climate change in developing countries.

111. Funds allocated to the GEF have increased by 10 per cent from Can$ 111 million (1994 to 1998) to Can$ 122 million (1998 to 2002). Financial contributions to multilateral institutions and programmes have been increasing: Can$ 341 million in 1997; Can$ 375 million in 1998; and Can$ 531 million in 1999. Bilateral and regional financial contributions to assist developing countries in the implementation of the Convention have also been increasing: Can$ 34 million in 1997; Can$ 36 million in 1998; and Can$ 42.1 million in 1999.

112. Trends in bilateral assistance show that most climate change-related disbursements are in Asia, followed by the Americas, Africa and the Middle East and Eastern Europe. The sectors which received the most funding, in decreasing order, were: energy, industry, capacity building for adaptation, forestry, waste management, agriculture, transportation, coastal zone management and others including for adaptation.

113. The NC3 presented two success stories in technology transfer, exemplifying both hard and soft technology transfer in Ecuador and India. The creation of the Canada Climate Change Development Fund (Can$ 100 million) provides a welcome opportunity that is expected to lead to further substantial assistance to developing countries. As this is a recent initiative, it was mentioned only briefly in the communication.

114. The review team suggested that general indicators of project success be included in future communications. These are understandably project-specific but it is important to understand the criteria used to evaluate the success of these technology transfer projects and barriers experienced in North–South transfer of technologies.

VII. RESEARCH AND SYSTEMATIC OBSERVATION

115. The NC3 presents a comprehensive description of the main research activities in climate system science, impacts and adaptation that have taken place in Canada since the NC2 at the federal level, while ongoing work in federal departments and universities continued, the CCAF (1998–2000) allocated Can$ 15 million to science, impacts and adaptation (SIA) programmes over the three years and these form the basis for reducing uncertainties associated with climate change and risks.

116. Climate science funding, totalling Can$ 7.5 million over three years from 1998–2001, supported new work in: climate monitoring and analysis, GHG sinks science, climate model improvements, climate extremes, climate impact scenarios, Arctic climate and science assessment. Funding under the CCAF Extension (2001–2004) supports climate modelling, climate impact scenarios, climate process research and science assessment and communication. Climate Science funding from AP 2000 (totalling Can$ 20 million over 2001–2005) is helping to fill gaps in the climate monitoring network (particularly

in the north) and supporting research on biological GHG sinks. The science programme has a climate system science focus which includes regional-scale climate modelling. Impacts and Adaptation projects, as discussed in chapter 6 of 3NR, are designed to gain insight into Canada biophysical and socio-economic vulnerability to climate change.

117. The CCAF invested Can$ 15 million in the Science, Impacts and Adaptation component, with Can$ 7.5 million allocated to climate system science and Can$ 7.5 million to impacts and adaptation studies. A sectoral investment of Can$ 12 million on impacts and adaptation studies has been allocated to several sectors including water resources, agriculture, fisheries, coastal zones and sea level rise, forests, terrestrial ecosystems, hazards/floods/drought and health. Under the CCAF extension programme (2001–2005) and AP 2000, Can$ 37.5 million have also been earmarked for impact and adaptation activities, including capacity-building and networking as well as funding of research. The emphasis of this second phase will be placed on community-based projects so as to assess vulnerabilities to climate change and development of best adaptation options at the local level. This phase will also contribute to the development of the National Framework on Adaptation, in progress under the national climate change process.

118. Federal departments and universities are responsible for climate analysis. In addition to ongoing work to track changes in Canada's climate, one of the climate analysis projects, *State of the Arctic Cryosphere During Extreme Warming 1998*, was led by NRCan and Environment Canada. It documented information on the behaviour of this geographical area during an abnormally warm year.

119. BIOCAP is a new programme to undertake largely research activities into potential greenhouse gas sources and agricultural and forestry sinks (also includes funding work related to bio-fuels, PEO, and science, impacts and adaptation). As outlined, it is estimated that AP 2000 measures will achieve a reduction of 5800 Gg CO_2 equivalent for both agriculture and forestry by 2010.

120. Canada maintains a national network of climate observing stations and a comprehensive climate data management system to provide timely access to quality data. A national Global Climate Observing System (GCOS) plan was prepared in 1999 and this forms the basis for its GCOS report to the UNFCCC secretariat that was submitted in 2002.

VIII. EDUCATION, TRAINING AND PUBLIC AWARENESS

121. Education and public awareness policy and measures are implemented under the Public Education and Outreach (PEO) programme. An interdepartmental programme management committee reviews and recommends proposals for funding and implementation. Provincial, territorial and municipal governments also support education and public awareness programmes at the local level, which include funding of environmental NGOs, and scientific and community-based organizations in the development of materials for public education and school curricula, television programmes, and web-site development, and to promote public transportation.

122. The PEO programmes are coordinated at provincial, territorial and municipal government levels through networking. The federal Government leads the climate change impacts and adaptation research network, which facilitates the development of sectoral education and public awareness materials in partnership with provincial and territorial governments, universities, and other stakeholders. In addition the PEO has developed and established a national network of regional climate change centres or hubs in 10 provinces and territories through an 18-month pilot programme.

123. The PEO is a major component of the CCAF (1998–2001). It targets communities, providing them with an understanding of the science and impacts and the need for mitigation. Under the PEO, approaches for the creation of effective awareness and barriers to behavioural changes were identified, leading to the development of appropriate themes and messages for climate change science, impacts, vulnerability, and adaptation for local areas.

124. The PEO programmes and measures implemented between 1998 and 2001 were presented. Significant achievements included the funding of 152 projects at a total investment of Can$ 18 million. The leveraging system adopted attracted Can$ 33 million additional funds from more than 300 partners, including researchers, policy makers and decision makers to ensure effective communication and stimulate discussions on mitigation response measures. The review team learned from the presentation and interviews with NGOs that the PEO programme performance is rated high among other national programmes. The review team commended the consultation process in the development of the PEO component of the CCAF, which identified over 300 potential measures to mitigate climate change and which developed the current dissemination techniques.

125. The NC3 outlines the extensive involvement of stakeholder partnerships, including provincial, territorial and municipal governments, business, youth, and educators in the regional climate change centres. A national network of regional climate change centres or hubs has been established to influence people and policy at the local level.

IX. CONCLUSIONS

126. The NC3 generally followed the guidelines in reporting on what Canada is doing to meet its commitments under the Convention. It is a well-prepared document that presents a comprehensive overview of climate change-related developments since the NC2. However, reporting on policies and measures was highly aggregated and this made it difficult for the review team to get a concise picture of the significant energy policies and measures that may have been effective in reducing the growth of GHG emissions between 1990 and 2000. Despite reporting omissions, during the in-depth review it was apparent from the presentations that over the past two years there has been new work undertaken on developing performance indicators to assess the impact of particular measures. Further efforts are currently being pursued to put in place an effective monitoring and reporting framework and the review team is optimistic that, once the monitoring system is fully operational, there will be more detailed reporting on the effects of individual P&Ms on emissions reduction.

127. Canada's GHG emissions continued to increase after publication of the NC2, and in 2000 they were 19.6 per cent higher than in 1990. The NC2 had estimated that by 2000 emissions would increase to 8.2 per cent over 1990 levels. CO_2 emissions accounted for most of the growth, with CO_2 and CH_4 emissions increasing by 21 and 25 per cent, respectively, since 1990. N_2O emissions stabilized between 1990 and 2000. Most of the growth in emissions came from fossil fuel consumption in electricity generation, increased energy consumed in transport and an unprecedented growth in fossil fuel production, largely for export. Of some significance however, is the fact that GDP increased by 33 per cent during the decade, significantly outpacing the 19.6 per cent increase in emissions, the 11 per cent growth in population, and the 17 per cent growth in energy consumed. The review team was unable to ascertain whether the reduction in energy intensity by 10 per cent between 1990 and 2000 was due to more efficient energy use or to a change in the structure of GDP.

128. Since the publication of the NC2 in 1997, federal and provincial governments have strengthened the NAPCC with the NIS, its AP 2000 and the First National Business Plan to meet its 6 per cent reduction from 1990 GHG levels under the Kyoto Protocol. AP 2000 identifies measures targeting sectors that account for 90 per cent of Canada's GHG emissions. The team believes that this plan, if coupled with the effective monitoring system, could achieve its stated objectives. However, according to the projections, reducing emissions by 6 per cent from 1990 GHG levels during 2008–2012 means reducing emissions by 2010 by 134,000 Gg CO_2 equivalent beyond the reductions expected through the

NAPCC and AP 2000 programmes in order to reach the Kyoto target of 571,000 Gg CO_2 equivalent.[20] Even though the rate of growth of CO_2 emissions in Canada seems to have been slowed (with help from the NAPCC and AP 2000 policies and measures), significant additional policy action will be required to reduce these emissions in order to close the gap. Given the continuing high rate of growth of emissions from the transport sector, there is a need for stronger measures in this sector. It is also important to ascertain the role of sinks in closing the gap and the Government of Canada is well advanced in developing the rigorous analysis highlighting the importance and potential of agriculture and forestry sinks.

129. The team was impressed with the institutional support and coordination provided for climate change issues since the NC2. The Climate Change Secretariat, which is placed under the authority of the Deputy Ministers of Natural Resources and Environment, will assist in the streamlining and focusing of institutional mandates and initiatives to ensure optimal use of the Can$ 500 million allocated to initiatives under AP 2000.

130. The NC3 asserts that the impacts of climate change are also already apparent in some regions of the country, notably permafrost thawing in the western Arctic, drought in some parts of the prairies, storm surges with flooding and an increase in frequency of forest fires. The team believes that the development of the National Framework on Adaptation will contribute enormously to assisting communities in assessing their vulnerability to climate change and in developing the best adaptation options at the local level. At the same time, Canada continues its commendable and ground-breaking work on improving research networks, enhancing and coordinating systematic observations, better understanding biological sources and sinks and developing statistical and analytical tools to understand the changes in climate.

131. As a result of existing programmes, there is an enhanced awareness and understanding of climate change issues by the general public. This approach is expected to be strengthened with the establishment of a national network of regional climate change centres or hubs in ten provinces and territories over the next 18 months, especially as changing the public's behaviour with regard to energy use forms an essential step towards meeting the GHG reduction targets.

132. Official development assistance increased between 1990 and 2000. In the last few years, foreign aid averaged 0.3 per cent of gross national product. Financial contributions to multilateral institutions and programmes, including the Global Environment Facility, as well as bilateral assistance also increased over the decade.

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[20] Taking into consideration the June 2002 in-depth review emissions projection of 809,000 Gg CO_2 equivalent in 2010 instead of the NAPCC inclusive NC3 projection of 770,000 Gg CO_2 equivalent in 2010, the 134,000 Gg CO_2 equivalent grows to 173,000 Gg CO_2 equivalent when AP 2000 measures are taken into consideration and to 238,000 Gg CO_2 equivalent when AP 200 are not taken into consideration.