ENERGY USE AND ATMOSPHERIC CHANGE

A DISCUSSION PAPER

Efficiency and Alternative Energy Branch
Energy Policy Branch
Energy, Mines and Resources Canada
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PREFACE

This discussion paper was prepared by the Energy Sector of Energy, Mines and Resources. It does not represent the views of the Government of Canada but was prepared in order to stimulate discussion about the appropriate response by the Government of Canada to concerns about the impact of energy use on the atmosphere. If you have any comments or questions concerning the paper, please send them to:

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CHAPTER 1: INTRODUCTION

A. Purpose Of The Paper

The environment is likely to be the single most important issue confronting the energy sector in Canada and around the world over the next several years. The reason is clear: the environmental effects of energy production and consumption are pervasive, playing an important if not dominant role in many of the key environmental issues of the day.

The objective of this paper is to promote discussion of the appropriate response by the Government of Canada to concerns about the impact of energy use on the atmosphere. To provide focus to the discussions, this paper describes a number of energy efficiency and alternative energy initiatives. It must be stressed that these initiatives represent a menu of possible measures that could be taken by the federal government. Following consultations, the Government will reassess them and other possible initiatives in determining the appropriate package of measures for inclusion in the Government's action plan (i.e. The Green Plan).

The major policy thrust of this paper is to realize, to the fullest extent, the current economic opportunities to modify energy use, with the prime objective of reducing emissions of carbon dioxide (the major greenhouse gas) between now and the year 2000. Progress in this area would also help to alleviate other environmental problems such as acid rain and ground level ozone.

B. The Environmental Problems Associated With Energy Use

An appreciation of the nature and magnitude of the required response begins with an understanding of the environmental impact of the energy sector throughout the fuel cycle. Energy practices can affect the environment at all stages of this cycle from extraction and transformation to delivery and end-use.

1. The Fuel Cycle

At the extraction stage, the mining of coal, uranium and tar sands can disturb large tracts of land which have value in alternative uses, such as agriculture, forestry and recreation. Water systems may also be fouled by these practices unless measures are taken to contain pollutants. Hydro-electric dams have created enormous reservoirs where none previously existed, permanently altering the initial ecosystem in affected areas. Drilling for oil and natural gas brings the risks of blowouts and pipeline ruptures.

At the delivery stage, there is the possibility of tanker accidents or pipeline ruptures during the transportation to market of crude oil and natural gas, with the associated impacts on safety and environmental quality. As well, the potential impacts on human health of electrical power lines is now under close public scrutiny.

At the transformation and end-use stages, the combustion of fossil fuels generates gases, waste heat and direct solid and liquid wastes. Oxides of carbon, nitrogen (together with incompletely burned particles responsible for ozone formation) and sulphur, are the principal contributing factors in the "greenhouse" effect, urban smog, and acid rain respectively. The operation of nuclear power plants generates no combustion gases. However, the possibility of radiation-releasing accidents remains a major preoccupation. In addition, the safe, long term disposal of spent nuclear fuel and worn-out reactor core hardware remains to be demonstrated.

2. Key Environmental Issues

While there are a number of important environmental effects associated with the production, transportation and consumption of energy, a few key issues dominate the environmental concerns of Canadians today. These relate primarily to the release of atmospheric emissions at the transformation and end-use stages, with most concern focussed on those emissions that contribute to acid rain, ground level ozone (urban smog) and global climate change (the greenhouse effect).

Acid Rain

Acid rain is caused by emissions of sulphur dioxide (SO_2) -- produced primarily from non-ferrous smelting and fossil fuel combustion in electric power plants -- and nitrogen oxides (NOx) -- produced primarily by the combustion of fossil fuels in the transport, industrial and electric power generation sectors. In the atmosphere, these two forms of "acid gas" can be transformed into acidifying agents, which in turn, return to the earth as acid rain, snow, dust or fog. All of these wet and dry forms of acid precipitation are commonly referred to as acid rain, or, more correctly, as acid deposition.

For decades, acid rain has been recognized as a potentially serious long-term pollution problem for industrialized countries. Acid deposition increases the acidity of lakes, streams, ground water and soil, threatening wildlife populations and reducing the productivity of forests and agricultural lands. In addition, acid rain erodes buildings and materials and is suspected of contributing to respiratory problems in humans.

About one-half of acid deposition in Canada originates from emissions of SO_2 and NOx in the United States, while Canadian emissions of these two gases also contribute significantly to acid rain south of the border.

Ground Level Ozone

Elevated levels of ground level ozone, a major component of urban smog, are formed in the lower atmosphere by a photochemical reaction between nitrogen oxides (NOx) and volatile organic compounds (VOCs) in the presence of sunlight. Man-made emissions of NOx and VOCs originate primarily from the combustion of fossil fuels in the transportation and electrical generation sectors and from certain industrial processes and volatile commercial products (e.g., dry cleaning fluids).

Over one-half of the Canadian population is regularly exposed to concentrations of ground level ozone in summer months that are known to have adverse health effects. These levels are often more than twice the Canadian "maximum acceptable" air quality objective for ozone. There is

also evidence that high ground level ozone concentrations in rural parts of Canada are adversely affecting the growth and productivity of agricultural crops as well as forests.

Elevated ozone, like acid rain, is transboundary in nature; NOx from the central United States, for example, are the major cause of periods of elevated ozone in Southern Ontario and Quebec.

Global Climate Change

The atmosphere contains certain gases that absorb heat radiated from the earth's surface. These are commonly called "greenhouse gases" because they trap heat in the lower atmosphere which would otherwise be lost in space. The "greenhouse effect" is essential for life on this planet, keeping average global temperatures at a high enough level to support plant and animal growth and our own survival. The main greenhouse gases related to human activity are carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbons (CFCs), and nitrous oxide (N_2O). It is estimated that carbon dioxide is the leading cause of the greenhouse effect (see figure 1.1) due to its higher level of atmospheric concentration (on a molecule for molecule basis, some of the other greenhouse gases are more efficient absorbers of solar radiation; however, their atmospheric concentrations are currently much lower).

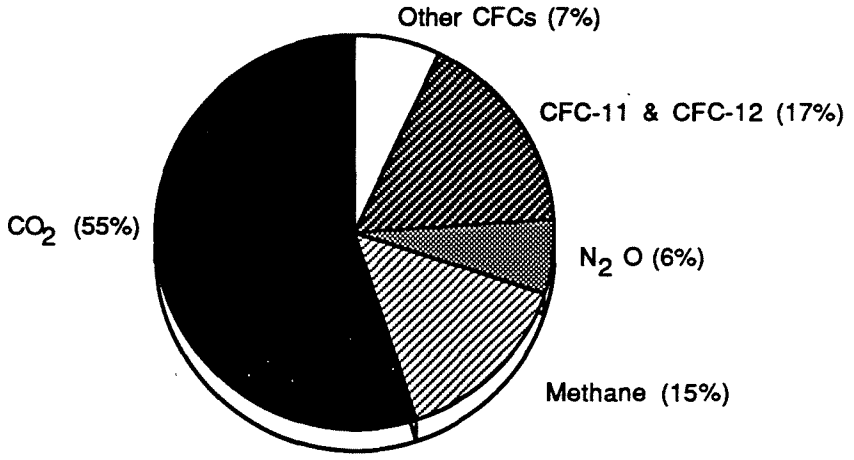
The atmospheric concentration of all of these gases has increased significantly over the last three decades. This changing chemical composition of the atmosphere has been linked to such human activities as fossil fuel combustion, biomass destruction such as tropical rainforest burning, the extension and intensification of agriculture, and industrial processes such as refrigeration and the cleaning of microchips.

Simulations of future changes in world climate are available from complex computer models. While there is a wide range in projections, most of the principal models indicate that, in a "business as usual" case, there would be a significant increase in average global temperature. Estimates indicate that global mean temperatures could be 1.5 to 3 degrees Celsius above pre-industrial (mid 18th century) levels by the year 2030 and 2.5 to 6 degrees Celsius above pre-industrial levels by the year

2090. To put these numbers in perspective, the average global temperature in the last ice age was 5 degrees Celsius below the present level. Temperature increases are expected to be larger at higher latitudes, with the greatest impacts nearer the polar regions.

Figure 1.1

GREENHOUSE GAS CONTRIBUTION TO GLOBAL WARMING



Source: IPCC, May, 1990.

Considerable scientific uncertainty remains as to the timing and magnitude of this phenomenon and the effects that could be expected to accompany an increase in average global temperature. The climate models generally indicate a rise in sea level between 10 cm and 30 cm by the year 2030 and between 25 cm and 95 cm by the year 2090. Such a rise would have an adverse effect on many coastal regions. The models also predict a higher frequency of wind storms and significant changes in patterns of rainfall and snowfall. Among other impacts, these developments could significantly upset world agricultural production.

C. The Contribution of Energy to Atmospheric Emissions

While energy use contributes to all of the atmospheric emissions described above, it is most inextricably linked to the production of carbon dioxide emissions. This is because the combustion of fossil fuels is clearly the dominant source (around 80 per cent) of man-made CO_2

emissions. The relative magnitude of the sources of other greenhouse gases, such as methane and nitrous oxide, are more difficult to quantify; however, energy is a minor contributor to their production (probably less than 30 per cent of emissions). In the case of other atmospheric emissions, such as nitrogen oxides, fossil fuel combustion is the major source, but there are, in many cases, viable technologies for removing these emissions in the absence of reducing energy demand.

Hence, the focus of this paper is on reducing CO_2 emissions, largely through enhanced energy efficiency. While the other atmospheric emissions are treated in less detail, it is nonetheless important to note that reductions in fossil fuel combustion would, in most instances, also reduce these emissions.

CHAPTER 2: THE INTERNATIONAL DIMENSION

A. Canada's Position in the World

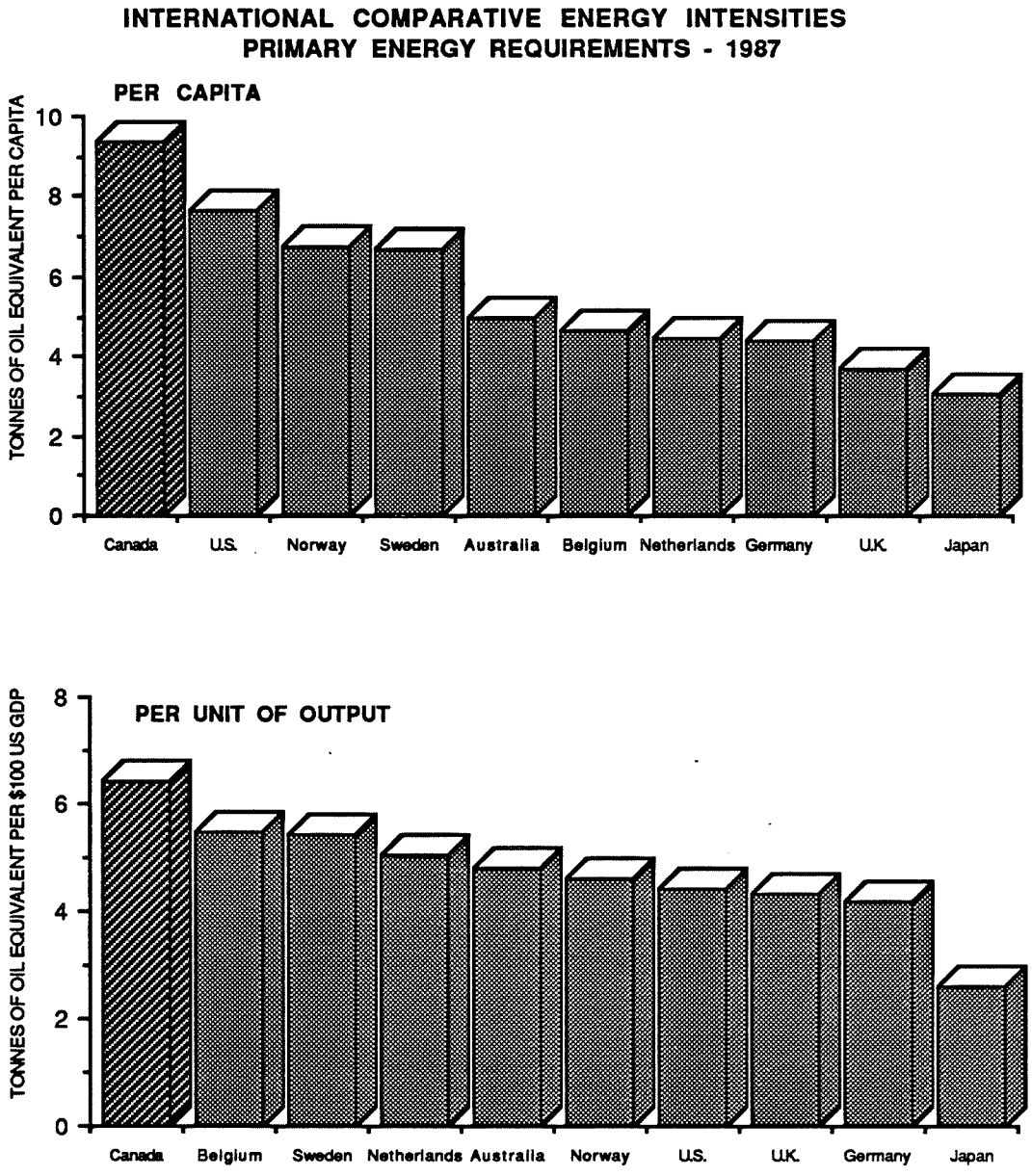
Canada cannot respond effectively to concerns about atmospheric change by acting alone. In the case of acid rain and low level ozone, cooperation between Canada and the United States is essential. With respect to global climate change, Canadian actions must be part of a larger world response. Canada accounts for only 2 per cent of the world's carbon dioxide emissions. Even if Canada could eliminate completely its consumption of fossil fuels, at an enormous cost to itself, this would not have any appreciable impact on the threat of global climate change.

However, there is a case for Canada to take a position in the vanguard of those countries attempting to come to grips with the climate change issue. Canada is one of the most energy intensive countries in the world. Energy intensity is a measure of a country's dependency on energy and is usually estimated in terms of energy consumption per capita or per unit of economic output. Figure 2.1 shows that, using either of these two measurements, Canada is the most energy intensive of the major, free market, industrialized nations.

This does not mean, however, that Canada is the most, or even one of the most energy inefficient countries in the world. There are several valid reasons why Canadian energy intensity is so high. The Canadian climate is harsher than that of many other countries. On average, Canada is about 40 per cent colder (in terms of heating degree days) than either the U.S., Germany, France or Italy. As a result, more energy is used in Canada per household for space heating. Canada also has a relatively low population density. Population per square mile in Canada is 6.6 as compared to 66.8 in the U.S. (and much higher densities in Japan and Europe). This leads to greater energy use per capita in the transportation sector. Perhaps most importantly, Canada has a plentiful and relatively inexpensive energy resource endowment. Energy costs are lower in Canada than in many other countries and this is reflected in our energy prices. As a consequence of this comparative advantage vis-à-vis the rest of the industrialized world, many of our industrial processes are relatively energy intensive. This makes good economic sense, much in the same way

that a country with relatively cheap labour adopts industrial processes that are relatively labour intensive.

Figure 2.1



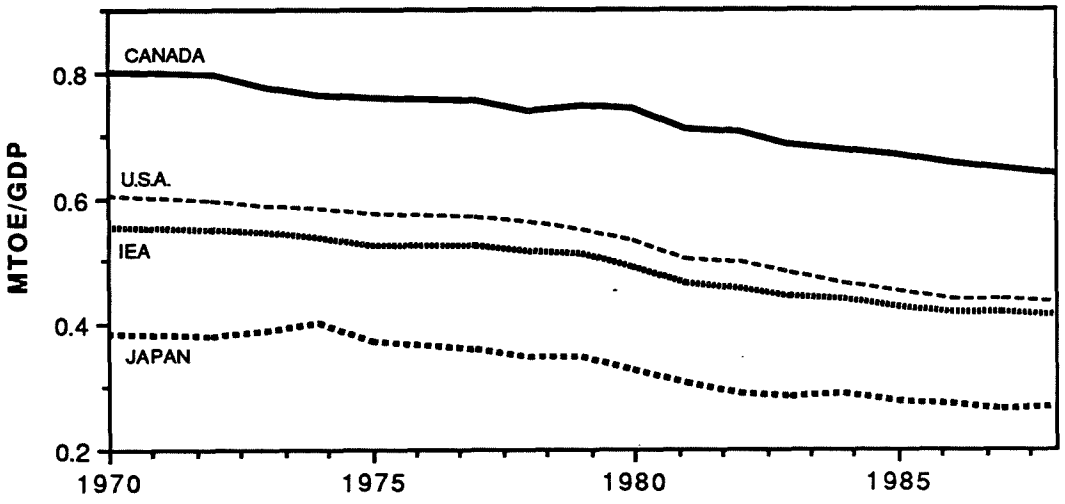
Energy intensity in Canada has fallen since the 1970s, although not quite as significantly as in some other countries (see figure 2.2). Between 1970 and 1988, energy use per GDP in Canada declined 1.3 per

cent per year, compared to an average decline of 1.6 per cent per year for IEA countries. To a large extent, this reflected a greater tendency in Canada to reduce oil demand (in response to the two oil crises) through substitution rather than conservation. In many instances, it was more economic to substitute natural gas or electricity for oil than to install more energy efficient equipment. Between 1980 and 1988, the average decline in Canadian energy intensity -- 1.9 per cent per year -- was closer to the IEA average -- 2.1 per cent per year.

Figure 2.2

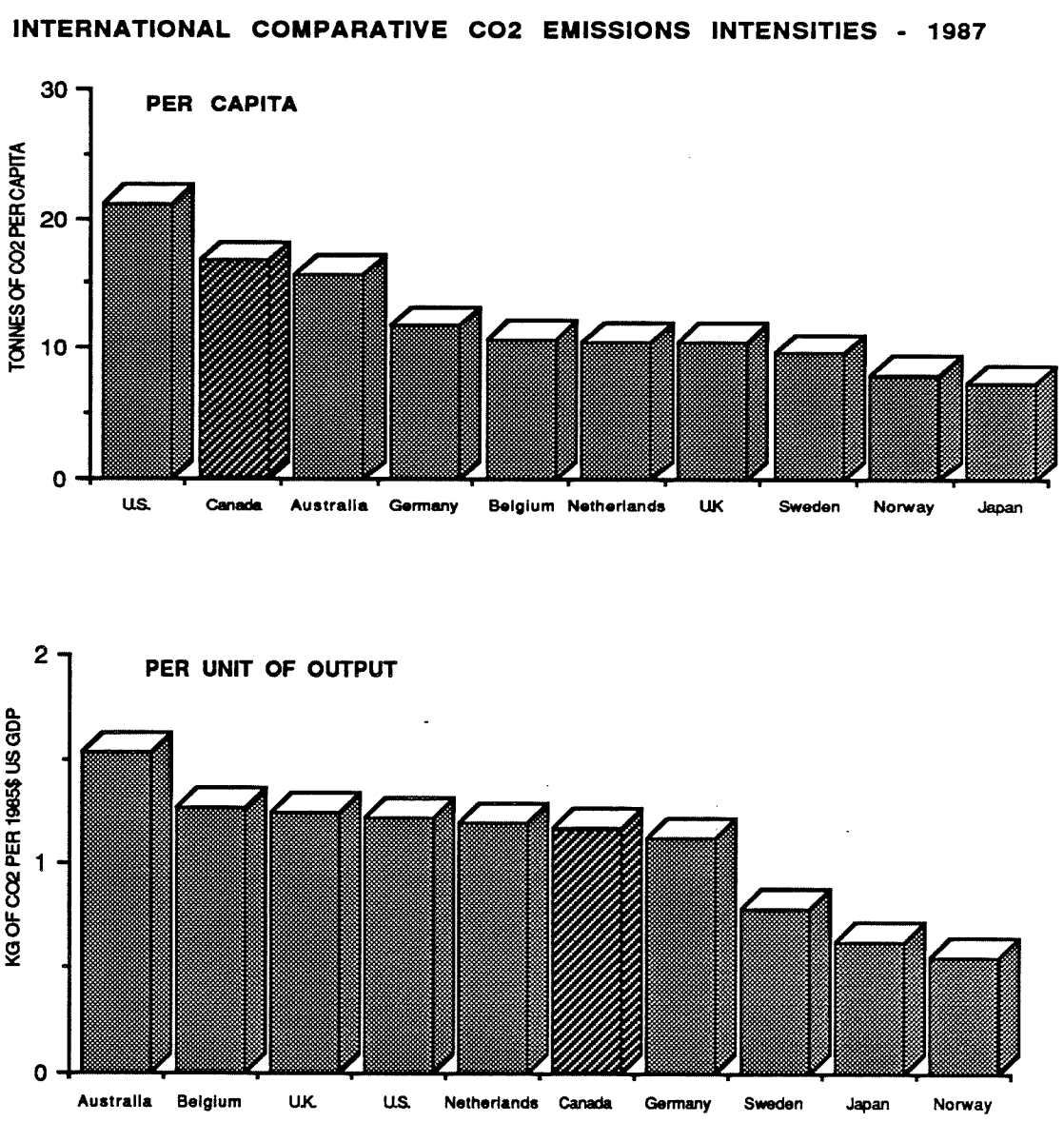
ENERGY USE PER UNIT OF GDP (1970 - 1988)

MILLION TONNES OF OIL EQUIVALENT/GDP ($U.S. 1985 BILLIONS)



There are industrialized countries that are more CO_2 intensive than Canada. The United States produces more CO_2 emissions per capita, while several countries (including Australia, Belgium, the U.K., the U.S. and the Netherlands) produce more CO_2 per dollar of GDP (see figure 2.3). This is because a much larger proportion of electricity generation in Canada comes from hydro and nuclear.

Figure 2.3



The above discussion is not intended to imply that Canada does not have a useful or important role to play in responding to the threat of global climate change. It is important, however, to appreciate the international policy context. While additional steps to improve energy efficiency in Canada are indeed possible, it should be noted that the most significant energy inefficiencies in the world are thought to exist in the centrally planned economies and in many developing nations. However,

Canada, as a significant user of energy, can benefit economically from being more energy efficient, and simultaneously display real leadership in responding to a global problem that affects every nation.

B. Seeking an International Response

Increasing concern about atmospheric pollution has given rise to concerted action by international organizations -- where Canada has played a very active role -- to achieve a better understanding of the problems and of possible policy responses to them.

In 1979, Canada was party to the United Nations' Economic Commission for Europe Convention on Long Range Transboundary Air Pollution (LRTAP). The convention recognized the possible adverse environmental effects of air pollution and sought to encourage countries to reduce emissions, including transboundary pollution.

In 1985, under the LRTAP Convention, Canada joined in the signing of the SO_2 Protocol along with roughly twenty other countries. The participants agreed to reduce their national annual sulphur emissions, or their transboundary fluxes, by at least 30 per cent (from 1980 levels) by 1994 at the latest. Furthermore, Canada and the other signatories to the protocol agreed to examine the need for further reductions in SO_2 as environmental conditions might warrant.

In 1987, Canada signed the Montreal Protocol to halve CFC consumption by 1999. (CFCs, which are not associated in a significant manner with energy use, are the major cause of the depletion of upper level ozone as well as being a greenhouse gas.) This target was recently reviewed at a 93-nation meeting in London, England where it was decided that more urgent action was required. Industrialized countries committed to phasing out all CFCs by the year 2000. Developing countries have until 2010 to end CFC use and will receive some financial assistance from the industrialized countries to help them find substitutes. Canada indicated that it will phase out all use of CFCs by 1997.

In 1988, the Canadian government signed a second Protocol to the LRTAP Convention directed towards achieving specific NOx emission

reduction targets. Canada and other signatories to the protocol agreed to ensure that, by 1994, their total emissions of NOx, or their transboundary fluxes, do not exceed their 1987 levels. The countries involved also agreed to begin negotiating further measures, to commence in 1996, to control NOx emissions at the level required to achieve "agreed upon environmental quality targets". A similar international protocol to control VOCs emissions is currently under negotiation.

The international scientific community has been aware of, and concerned about, the risk of global warming for several years. It was not, however, until quite recently that this issue moved to near the center of the public environmental agenda. The 1988 Toronto Conference on the Changing Atmosphere was a major event that served to focus attention on the global warming issue and resulted in the principal recommendation that, by 2005, CO_2 emissions be reduced by 20 per cent from 1988 levels.

The Intergovernmental Panel on Climate Change (IPCC) was established in the fall of 1988, under the auspices of the United Nations and the World Meteorological Organization, to provide a framework for international collaboration on the global warming issue. The IPCC is working towards the submission of a major report to the Second World Climate Conference in November 1990. This report may serve as the basis for the negotiation of an international framework convention on climate change (with related protocols on CO_2 and other greenhouse gases), possibly to be adopted at the U.N. Conference on Environment and Development to be held in Brazil in 1992.

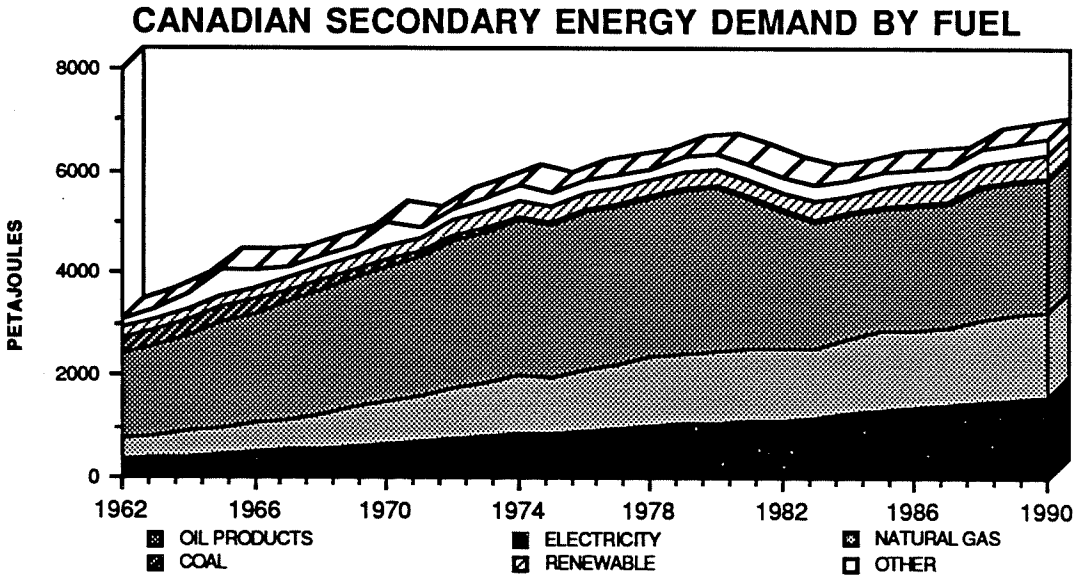
Most recently (May 16, 1990), Canada was party to the Bergen Ministerial Declaration on Sustainable Development. In that Declaration, Environment Ministers of the member countries of the Economic Commission for Europe (ECE) agreed to "commit to establish national strategies and/or targets and schedules following the report of the IPCC and no later than the start of the negotiations of a framework convention on climate change to limit or reduce CO_2 emissions and other greenhouse gas emissions as much as possible and to stabilize them". Most ECE countries, including Canada, expressed the view that "such stabilization at the latest by the year 2000 and at present levels must be the first step".

CHAPTER 3: ENERGY USE IN CANADA

A. Historical Energy Demand

Canadian energy demand rose rapidly in the 1960s and early 1970s fueled by declining real energy prices and a fast growing economy (see figure 3.1). In the late 1970s and early 1980s, the energy environment was quite different, characterized by high real energy prices, expectations of further price increases, and periods of low economic growth. This led to a levelling off in energy demand. Indeed, between 1980 and 1983, there were three years of actual and significant decline in energy use as a result of the combined impact of the second world oil crisis and the worst economic downturn in Canada since the Second World War.

Figure 3.1

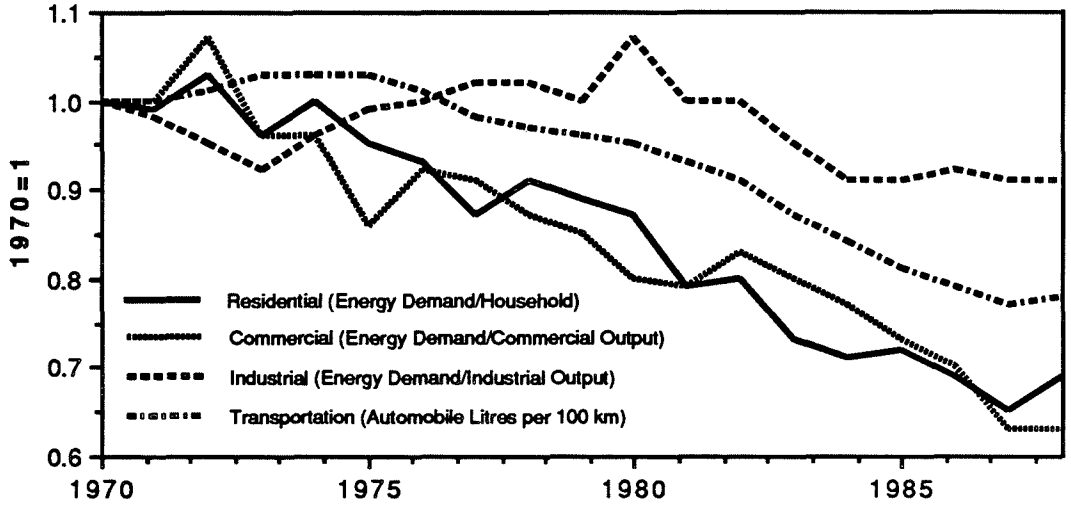


Energy consumption per dollar of GDP dropped about 18 per cent between 1973 and 1988 with much of the improvement coming in the 1980s. During the 1970s, the residential, commercial and transportation sectors experienced modest reductions in energy intensity. These improvements were in response to rising energy prices and the implementation of information and incentive programs. In the industrial

sector, energy intensity rose slightly (see figure 3.2). Since 1980, there have been marked energy intensity improvements in the transportation sector -- reflecting improved vehicle design and changes in purchasing habits; in the residential sector -- reflecting better insulation and more efficient furnaces, water heaters and windows; and in the commercial sector -- reflecting better automatic heating, ventilation and air conditioning controls and lighting systems.

Figure 3.2

CANADIAN ENERGY INTENSITY BY SECTOR



B. Energy Conservation Programs

The improvement in energy intensity in the 1980s partly reflected the impact of a number of programs undertaken by the federal and provincial governments to accelerate energy conservation and substitution away from oil.

In the years immediately following the 1973 oil crisis, federal activities focussed mainly on the promotion of economic opportunities, information distribution and encouraging government departments to adopt energy efficiency practices in their operations. Some examples of these early initiatives include the labelling of household appliances and federal tax provisions to allow faster write-offs on the purchase of

specific energy conserving equipment. During this period, domestic oil and gas prices were held below international levels to maintain economic growth and to protect Canadian consumers and manufacturers from undue inflationary pressures. As a result, Canadian consumers continued to receive price signals which dampened their incentive to make cost-effective investments.

In 1977-8, the Government of Canada introduced the Canadian Home Insulation Program (CHIP), the Forest Industry Renewable Energy Program (FIRE) and other grant programs designed to offset these price signals and encourage investment in energy saving and alternative energy projects. With the introduction of the National Energy Program (NEP) in 1980, the allocation of funds to conservation, alternative energy and oil substitution programs grew significantly. By 1984, more than $550 million per year was being allocated to these activities by the Department of Energy, Mines and Resources alone.

By 1984, however, both international and Canadian energy market circumstances had changed considerably. World oil prices had peaked in 1981 and, by 1984, Canadian oil prices had almost reached world levels. Grant programs were becoming expensive and government revenues from energy were declining rapidly.

In 1985, the National Conservation and Alternative Energy Initiative (NCAEI) was announced. NCAEI was designed specifically to facilitate the transition away from direct grants. It was subsequently replaced by the Energy Efficiency and Diversity (EED) Initiative in 1988. The EED Initiative emphasized information and technology transfer, support for energy research and demonstrations, and improved consumer awareness. It was designed to serve as a catalyst in the marketplace through selectively targeted activities.

C. Energy Demand Outlook

The prospects for addressing the problem of atmospheric emissions, particularly CO_2, in Canada depend critically on expectations concerning future energy demand. EMR and Environment Canada have jointly developed a reference projection of energy demand to the year 2010 assuming

"business as usual". That is to say, the forecast is predicated on no significant changes in government policies from those currently in effect.

The projection was largely developed using EMR's Inter Fuel Substitution and Demand (IFSD) model. The IFSD is a large econometric model that forecasts energy demand regionally for various fuels and sectors of the economy. As with other models of this type, the forecast level and composition of energy demand are largely determined by the historical interaction between energy consumption and prices, economic performance and population growth. Energy demand is then forecasted using reasonable assumptions concerning future trends in these latter variables.

The forecast does not, however, ignore the possibility of technological development, in particular in the area of energy efficiency. It assumes, in the main, that the technological trends of the past, modified by the impact of prices and economic growth, will be continued in the future. Nor is this forecast entirely based on historical evidence. In the case of electricity generation, for example, the forecast reflects, as far as possible, the announced plans of the utilities. Further, in the area of gasoline demand, the model explicitly recognizes changes in the structure of the automobile market. Finally, the forecast reflects many points raised by the provinces during discussions of the Federal-Provincial-Territorial Energy Ministers' Task Force on the Environment over the past year.

Tables 3.1 and 3.2 show the key pricing and economic assumptions underlying the energy demand projections presented in this Chapter.

Table 3.1

EMR Reference Case
World Oil Price
West Texas Intermediate Crude at Cushing
U.S. $/BBL (1989 dollars)

1990	$19
1995	$21
2000	$25
2005	$25
2010	$25

Table 3.2

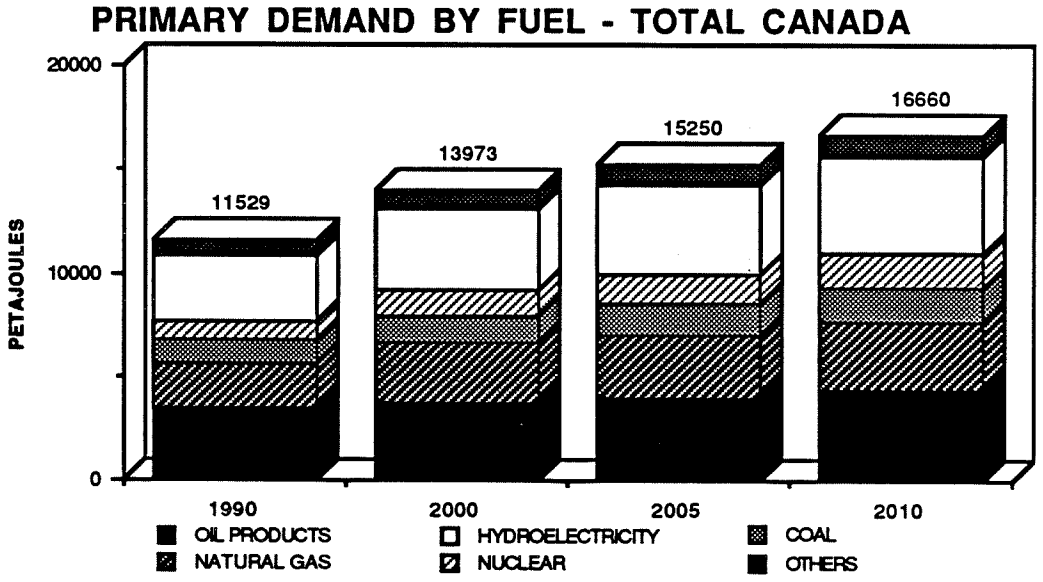
EMR Reference Case
Major Macro-Economic Assumptions

	1990-2000	2000-2005	2005-2010
	(Average Annual Growth Rates) %		
Real GDP	2.4	1.8	2.0
Industrial RDP	2.7	1.9	2.2
Services RDP	2.2	2.1	1.7
Inflation	4.0	4.0	4.0
Total Population	1.0	0.8	0.9
Total Households	1.3	1.2	1.3
Exchange Rate (US$/C$)	0.80	0.80	0.80

A moderate decline in energy intensity of about 0.5 per cent per year is projected between 1990 and 2010. Nevertheless, total secondary energy consumption is expected to increase at the average rate of 1.8 per cent per year over the forecast period, reflecting the continuing expansion

of the Canadian economy. At present, nearly 65 per cent of total Canadian primary energy demand is derived from fossil fuels (based on the conversion of hydraulic and nuclear electricity at 10.5 MJ/KWH, which is a measure of their fossil fuel equivalent). In the Reference Case, this per centage is not expected to change significantly over the next twenty years (See figure 3.3), although there is forecast to be a larger role for coal (as a source of electricity generation) among the

Figure 3.3



fossil fuels and a smaller role for crude oil. In terms of secondary demand, the industrial and transportation sectors will continue to be the largest users of energy, accounting on a combined basis for two-thirds of total demand by the year 2010 (see figure 3.4).

Figure 3.5 shows the current breakdown of primary energy demand by region. Not surprisingly, there is a marked difference between regions in terms of their reliance on fossil fuels, and these differences are expected to persist. At one end of the spectrum, the Prairie Provinces rely on fossil fuels for virtually all of their energy needs. On the other hand, in Quebec, where the majority of electricity is hydro generated, less than

Figure 3.4

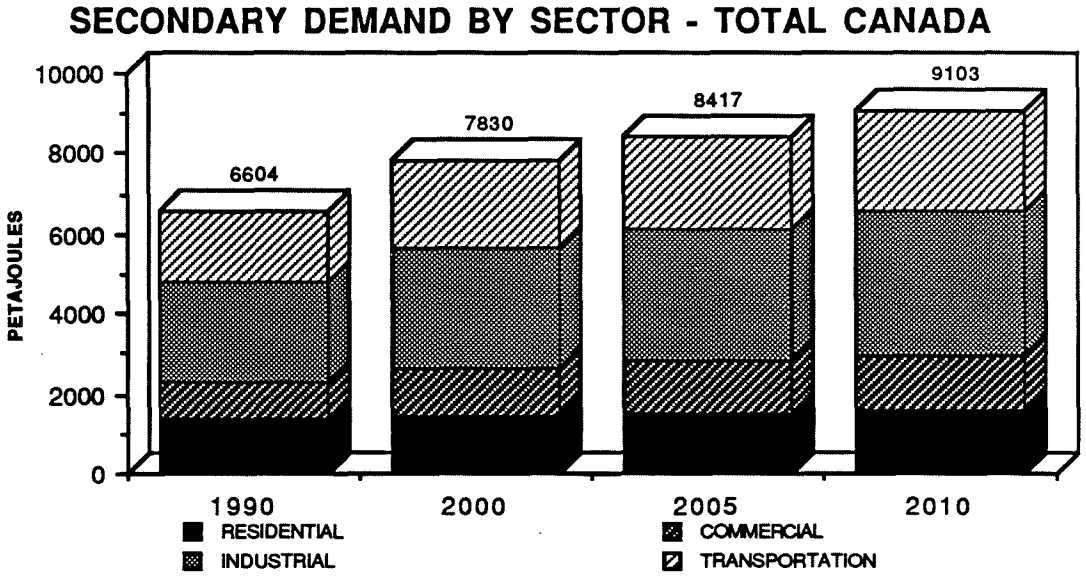
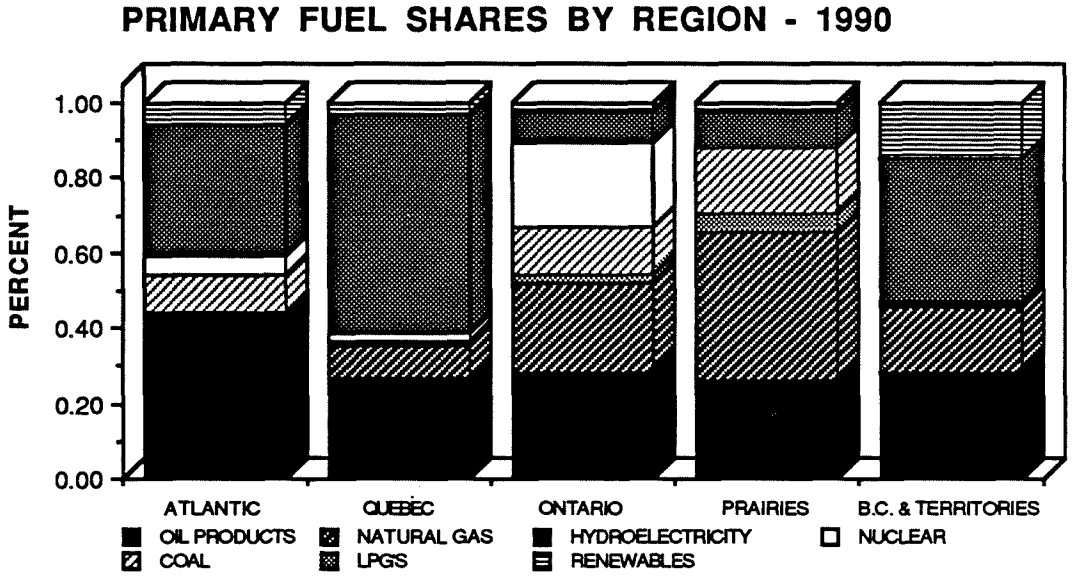


Figure 3.5



one-half of primary energy demand is from fossil fuels. Most of the biomass consumption in Canada occurs in British Columbia (wood wastes

from the pulp and paper industry) and in the Atlantic Provinces (where the lack of access to natural gas makes it economic to use wood as a heating fuel in residences).

D. Projected Carbon Dioxide Emissions

Given the dominant linkage between fossil fuel consumption and carbon dioxide emissions, it is relatively straight-forward to convert a forecast of total primary energy demand into a forecast of total carbon dioxide emissions. In the case of the other greenhouse gases, however, energy use plays a much less important role, making the linkage much less direct. Total methane emissions, for example, are more likely to be a function of waste disposal than of energy use. The fact that this Chapter focusses entirely on CO_2 emissions, therefore, is not meant to downgrade the importance of the other greenhouse gases but merely to reflect the smaller role that energy plays in their creation.

Conversion factors have been developed, with assistance from Environment Canada, for translating the energy demand forecast into a projection of atmospheric emissions. These conversion factors are summarized in Table 3.3. Wide ranges for petroleum products, coal and

Table 3.3

Conversion Factors: Carbon Dioxide Emissions

	Tonnes per Petajoule (thousands)
Hydro and Nuclear	0
Natural Gas	49.7
Refined Petroleum Products	67.5 - 100
Coal	83 - 94.3
Fuel Wood and Spent Pulping Liquor	81.5 - 107.4*

*The numbers for wood and pulping liquor are for combustion only, and do not take into account CO_2 depletion due to photosynthesis.

wood reflect the significant variation in emissions between different end-uses and products. For example, diesel produces more CO_2 per PJ than gasoline and lignite coal produces more CO_2 per PJ than anthracite coal.

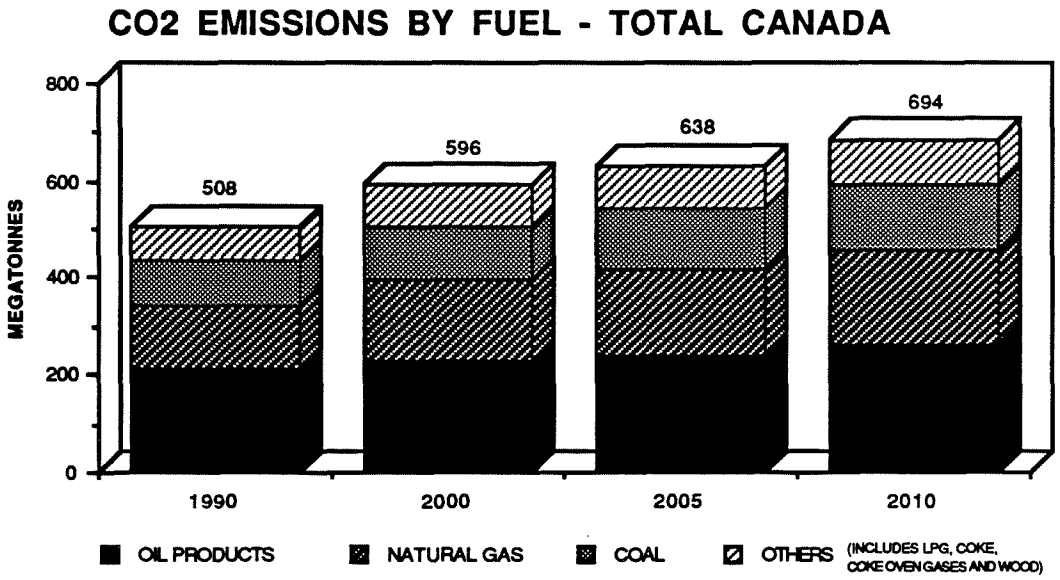
These conversion factors represent the best available estimates at this time, and are believed to be sufficiently accurate for the purpose of broad policy development. There is, however, a considerable degree of uncertainty associated with these conversion factors and additional work is being done to refine them as our knowledge and information improve in this area.

It should also be noted that there are some areas that are not fully captured in the conversion from energy demand to CO_2 emissions. Rough estimates have been included of the CO_2 emissions produced by natural gas flaring and pipeline transmission. However, there are other cases of energy being consumed as part of the energy production/transformation process where no estimates of total energy consumption are currently available. In addition, no indirect CO_2 impacts have been calculated (for example, the construction of hydro dams and of nuclear power plants may result indirectly in the production of CO_2 emissions to the extent they cause an increase in cement and steel production).

Total emissions of carbon dioxide from energy use in Canada are estimated at 508 megatonnes for 1990. By 2000, the emissions level in the Reference Case is projected to be around 596 megatonnes rising to about 694 megatonnes by 2010, an average increase of 1.5 per cent per year. The rate of increase in carbon dioxide emissions is forecast to be lower than the rise in total energy demand (1.8 per cent per year) due to a significant increase in the share of electricity in total end-use demand and an associated increase in the share of hydro and nuclear generation (which produce no direct CO_2 emissions) in total primary energy demand.

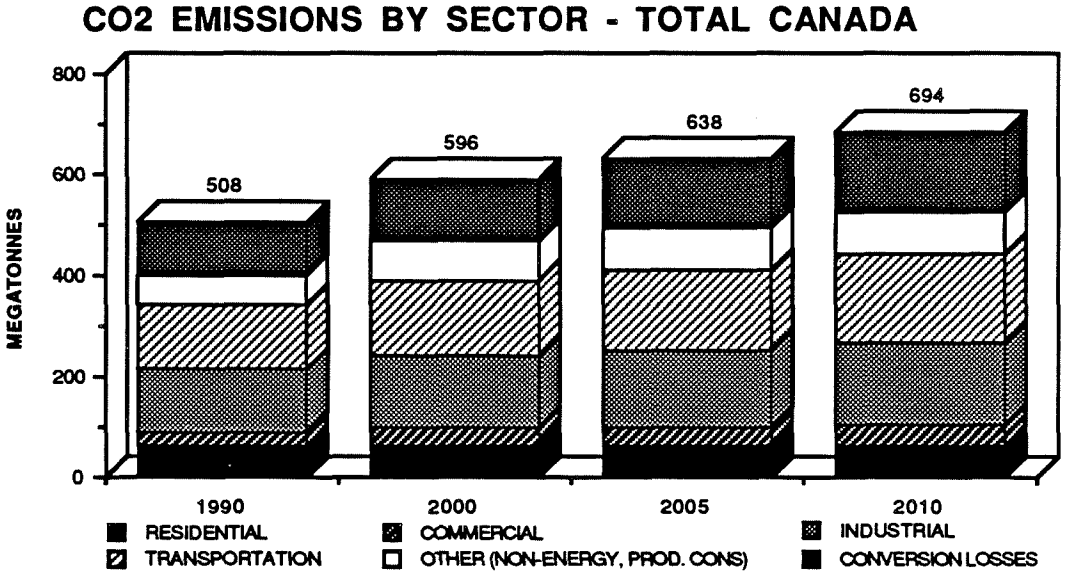
The consumption of oil products and natural gas will account for about two-thirds of total CO_2 emissions during the forecast period (see figure 3.6). The remaining one-third will come from the consumption of coal and other products (i.e. liquified petroleum gases [LPG], coke and wood).

Figure 3.6



On a sectoral basis, industry and transportation account for about one-half of carbon dioxide emissions in 1990 (see figure 3.7). Of the remaining one-half, about 21 per cent will result from the conversion of fossil fuels to electricity, about 18 per cent will be produced by direct

Figure 3.7



fossil fuel consumption in the residential and commercial sectors, and roughly 12 per cent will be associated with producer and non-energy consumption.

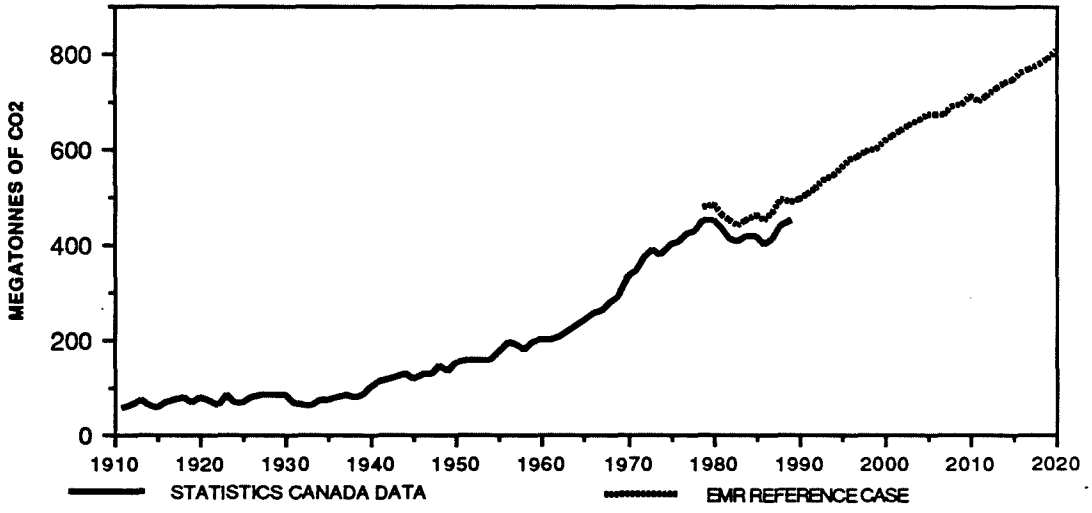
E. Stabilizing CO_2 Emissions

Assuming CO_2 emissions from non-energy sources (e.g. cement and ammonia production, incineration, deforestation) remain constant, a reduction in energy-related carbon dioxide emissions of 88 megatonnes (from the forecast level of 596) would be required to achieve stabilization in 2000 at 1990 levels. This is equivalent to a 17 per cent reduction in CO_2 emissions in the year 2000. The required reduction in energy demand might be somewhat more or less than 17 per cent, depending on the fuels being saved.

If no new measures were taken (i.e. continuation of the Reference Case), carbon dioxide emissions would, by the year 2020, reach 807 megatonnes, which would be double the level of 1987 (see figure 3.8).

Figure 3.8

CO2 EMISSIONS IN CANADA



Chapters 4 and 5 develop and describe a set of energy efficiency and alternative energy initiatives that could be introduced by the federal government to alter energy demand and reduce carbon dioxide emissions. The possible impact of these initiatives relative to the projected levels described above is examined in Chapter 6.

CHAPTER 4: DEVELOPING A RESPONSE

A. Options for Reducing Atmospheric Emissions

There are five general responses which can be adopted to reduce or offset the atmospheric emissions associated with the combustion of fossil fuels. These are as follows:

1. Installation of control technologies

Emissions can be reduced by installing control devices in smokestacks or vehicle tailpipes. Feasible control devices exist for certain emissions (e.g. SO_2) but not for others (e.g. CO_2). In certain circumstances, installing control devices is the least-cost option for reducing emissions. Some of the drawbacks of this option are that an alternative form of waste is often produced which requires disposal; and reducing one form of emission can sometimes increase the output of other emissions.

2. Increasing energy efficiency

Reducing the consumption of energy will reduce the level of all energy-related emissions. It will also reduce other environmental stresses to the extent that, as a result, less energy is produced, transported and stored. Through upgrading the energy efficiency of our capital stock (i.e. energy-using equipment, buildings, vehicles and industrial processes) and through changing our energy use practices, significant reductions in energy consumption could be achieved. It is important to realize, however, that energy efficiency and economic efficiency are not the same. Some efficiency gains, although technically achievable, would not be economic and would be achievable only at a cost in terms of reduced economic growth.

3. Improving fuel quality

Improvements in fuel quality can also reduce certain environmental impacts. The phasing out of lead in gasoline since the mid-1970s has

contributed to a substantial decline in lead concentrations (which in urban areas have been reduced to one-quarter of the 1974 level). The use of low sulphur coal by Canadian utilities has resulted in a significant reduction in SO_2 emissions.

4. Fuel switching

Atmospheric emissions can be reduced by switching from high carbon fossil fuels to low carbon fossil fuels and by switching from fossil fuels to other energy sources. Among fossil fuels, the burning of coal generally produces more emissions per GJ than the burning of oil which in turn produces more emissions per GJ than the combustion of natural gas. Nuclear and hydro power and a number of alternative forms of energy (e.g. solar, wind) normally have minimal impacts on the atmosphere. Biomass may or may not have a net negative effect on the atmosphere depending on how it is used and whether its feedstock is replenished. No energy source, however, is environmentally neutral. Those that have less of an impact on the atmosphere may have more of an impact on land or water use, creating greater waste disposal problems.

5. Creating carbon "sinks"

Additional quantities of CO_2 can be removed from the atmosphere by expanding some of our natural carbon "sinks"; in particular our forests. Canada has an abundance of non-commercial land compared to other countries. Hence, to some extent, growing more trees could be a viable CO_2 management option to complement reductions in fossil fuel consumption. Once the new forests are mature, however, they release as much CO_2 from the decay of old trees as they capture through new growth. Thus, this option, though an important one, has a finite potential impact.

The appropriate long run response to concerns about the impact of energy use on the atmosphere is a mix of the above options. In terms of achieving an immediate impact, most governments are focussing principally on options 1 and 2 where the largest potential for emission reductions is seen to exist. Some move towards more benign energy sources is possible in the short-to-medium term and is under consideration in some countries (particularly the substitution of natural

gas for coal). However, a major switch away from fossil fuels would require a fundamental change in technology and/or in the way that conventional fuels are priced and is not a realistic option prior to 2000. Improving fuel quality and the creation of carbon sinks are being investigated as possible supplementary measures to the three major options.

B. The Canadian Response to Date

In 1985, the Government of Canada initiated the Canadian Acid Rain Program in response to its commitments under the SO_2 Protocol and domestic concerns over the possible effects of acid rain. Under this Program, agreements were reached between the federal and provincial governments (east of Saskatchewan) calling for an overall 50 per cent reduction in SO_2 emissions in eastern Canada by 1994. As a result of this program, several provinces have introduced strict regulations governing emissions of SO_2 from their electric utilities. The appropriate targets for SO_2 emissions beyond 1994 are currently under discussion.

In 1988, the Canadian Council of Ministers of the Environment (CCME) requested the development of a Management Plan to resolve our domestic NOx and VOCs related environmental problems and meet Canada's obligations under the NOx Protocol. A draft Plan was completed in March 1990 and circulated to stakeholders for discussion. While the emphasis of the Plan is on encouraging a greater use of emission controls, there is also a recognized need for enhanced energy efficiency (and the development of energy efficiency performance standards). It is estimated that the Management Plan, when fully implemented, would result in NOx and VOCs emissions nationally in the year 2005 being 16 per cent and 19 per cent respectively below 1985 emission levels, with reductions of about 30 per cent in key urban ozone problem areas.

In August, 1988, Federal, Provincial and Territorial Energy Ministers established a Task Force on Energy and the Environment to review the Toronto Changing Atmosphere Conference recommendation to reduce CO_2 emissions to a level 20 per cent below 1988 levels by 2005. In response to the report of the Task Force, Energy Ministers agreed on August 28, 1989, to "pursue national and regional initiatives that would reduce

greenhouse gas emissions and that would be socially, economically, and environmentally attractive to society". Ministers also asked the Task Force to provide a more in-depth and regional assessment of the potential for reducing CO_2 emissions and the possible impacts of such reductions. In a follow-up report, reviewed by Energy Ministers on April 2, 1990, the Task Force concluded that "significant reductions (in CO_2 emissions) can be achieved through measures which are desirable on their own merits (but) achievement of a 20 per cent reduction in CO_2 emissions by 2005 from 1988 levels would cause significant economic dislocation and would require significant changes in lifestyle".

In March, 1990, Canadian Environment Ministers agreed on the need for a comprehensive "national action strategy" to address global climate change. They instructed a steering committee of Deputy Ministers of the environment to develop such a strategy, and to report on the strategy at the November, 1990 meeting of CCME. Ministers instructed that, in developing the national action strategy, the steering committee of Deputy Ministers should seek close cooperation with a parallel committee of Deputy Ministers of energy.

The Government of Canada has also announced that it will be releasing The Green Plan: A National Challenge later this year. This Plan will describe some of the programs, laws and other actions the Government will implement in order to address Canada's most serious environmental problems, including those associated with atmospheric change.

C. Developing an Energy Efficiency and Alternative Energy Initiative

The prime objective of an Energy Efficiency and Alternative Energy Initiative would be to serve as an immediate response to the problem of rising CO_2 emissions. In addition, such an initiative would contribute to existing or emerging SO_2, NOx and VOCs management plans. As such, the emphasis of the Initiative would be on enhancing energy efficiency and on selected measures to facilitate the greater use of alternative energy in those areas where the economics are favourable.

In developing the guiding principles for such an Initiative, it is necessary to recognize the following factors:

1. There are major uncertainties

There are a number of uncertainties affecting both our understanding of environmental problems as well as our assessment of potential solutions. There are uncertainties about the relationship between energy use and atmospheric degradation; about the likely response of other countries; and about the evolution of technology. Given the risks created by such uncertainties, the prudent immediate response is to take those actions that respond to environmental concerns, serve multiple policy objectives, and make good economic sense in their own right.

2. There are international constraints

In developing policies, it must be recognized that it is difficult for Canada to move at a pace that is significantly out of step with its major trading partners. It is important to show leadership, but to undertake policies that place our industry at a competitive disadvantage relative to other countries could result in an economic loss for us without necessarily responding to the environmental problem. For example, companies might simply relocate their manufacturing processes to countries not pursuing such a policy without there being any overall reduction in atmospheric emissions. Given the international nature of the environmental problems, it is important that the policy response reflect an understanding of the full international implications of the proposed actions.

3. There is a need for consistency with other policy objectives

The policy response should be consistent with economic objectives that seek to achieve economic efficiency through a strong reliance on market forces. This means bringing about changes in behaviour by building on market forces rather than by attempting to override them. The response should also recognize the importance of energy as an input to Canadian industry and the importance of resource development to the

Canadian economy and to particular regions of the country.

4. There must be built-in flexibility

As our understanding of the environment improves, there could be significant shifts in the future in our economic and environmental priorities. Today's response should be flexible enough to allow for a smooth and effective transition to a more aggressive policy tomorrow, should that become necessary.

An effective package of energy efficiency and alternative energy initiatives should also demonstrate the following characteristics:

1. Be Broadly-Based

There is no "quick fix" for achieving a significant reduction in atmospheric emissions. Energy efficiency gains must be achieved in all end-use sectors -- residential, commercial, industrial and transportation -- and for all major fuel types. Thus, while it is important to achieve greater efficiency in the major oil-using sectors (such as transportation), it is also important to improve efficiency in our use of electricity (18 per cent of which is generated from coal), natural gas and even wood (to the extent we are not re-generating our forests). In those provinces where electricity is largely generated from hydro, reductions in electricity demand would not translate directly into reductions in atmospheric emissions. However, to the extent that enhanced energy efficiency freed up hydro-electric capacity, fossil fuel consumption in other provinces or in the U.S.A. could be displaced, with a corresponding reduction in greenhouse gas emissions.

2. Respond to the Barriers to Energy Efficiency

There are several reasons why energy might be over-consumed relative to the optimal social level. A major barrier to energy efficiency is poor information. Purchasers of equipment, vehicles or buildings are often unaware of more energy efficient models and the financial savings that could be gained from buying them. Similarly, users of energy equipment often fail to employ energy saving practices or to engage in

energy saving maintenance/retrofits, again due to an ignorance of the resulting benefits. Other barriers to energy efficiency stem from prices that fail to reflect marginal costs or externalities (such as environmental costs) and from the application of abnormally high discount rates (often a function of restricted access to new capital). A variety of integrated policy tools is required to address these different barriers.

3. Be Forward Looking

A strong link between energy efficiency and technology must be fostered. To be effective, policies must allow for and keep pace with technological change. Energy efficiency standards or guidelines will be of little value unless they are frequently updated. Similarly, information and training programs need to reflect the latest technological developments.

4. Be Co-operative

There are limits on how successful the federal government can be in improving energy efficiency in the absence of cooperation and assistance from industry, consumers and all levels of government. The federal government can perform a catalytic role by establishing a national framework for action and can play a key role in facilitating the flow of information between regions. In many instances, however, the Government of Canada has no direct authority to require participation from the relevant decision-makers or intermediaries. The effectiveness and impact of many federal initiatives will depend critically on the extent to which complementary actions are taken by others in their respective areas of responsibility.

CHAPTER 5: AN EFFICIENCY AND ALTERNATIVE ENERGY INITIATIVE

This Chapter describes a package of possible efficiency and alternative energy initiatives to alter future energy requirements and reduce atmospheric emissions. These initiatives are designed to be consistent with the principles and objectives described in Chapter 4. This means that they are intended to achieve energy savings at no net economic cost to society (and, in many instances, there would be net economic benefits). Such a package of initiatives would represent a strong first step in reducing the atmospheric emissions associated with energy use and in responding to the threat of global climate change.

The bulk of the initiatives pertain to energy efficiency and are presented on the basis of affected end-use; that is, equipment, buildings, industry and transportation. In addition, there are measures to encourage alternative energy and cleaner fuels. There are also several general initiatives (such as a demonstration program and public energy data base) that would relate to both energy efficiency and alternative energy. Finally, there is a package of initiatives for reducing energy use in the federal government.

A. Energy Efficiency

Energy efficiency can be increased by upgrading the efficiency of the equipment, systems and buildings which consume energy and by modifying the day-to-day practices of individuals and organizations concerning the use of these items.

New versus Retrofit

In designing a package of measures to upgrade the energy efficiency of equipment, systems and buildings, it is important to distinguish between new purchases and modifications/retrofits of the existing stock. Generally, it is more economic to upgrade the energy efficiency of an item during its manufacturing or initial design and construction phase. Enhancing energy efficiency by retrofitting or accelerating the

replacement of items prior to the end of their useful lives can be costly.

The average energy efficiency of new stock can be enhanced by:

- prohibiting the manufacture, construction and sale of the least energy efficient equipment, systems and buildings (regulatory strategy);

- shifting market demand in favour of the more energy efficient items amongst those that are available -- this, in turn, will cause manufacturers, designers and builders to upgrade the average energy efficiency of their product lines (suasion strategy); and

- developing new, more energy efficient technologies (research and development strategy).

The average energy efficiency of the existing stock of items can be enhanced by:

- mandating modifications/retrofits prior to resale -- practicable only for buildings (regulatory strategy);

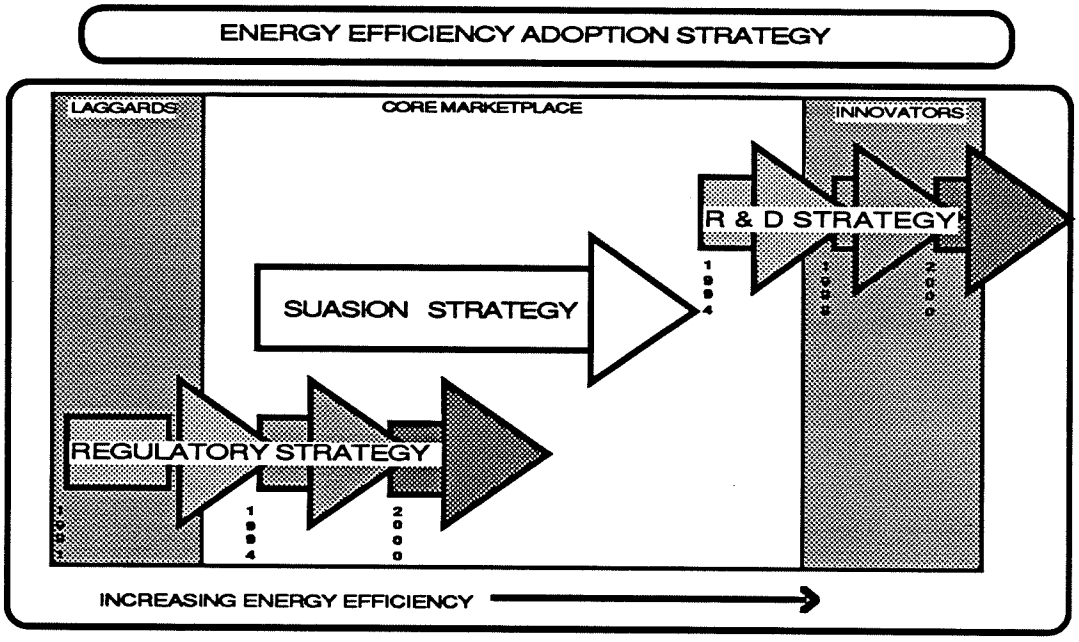
- encouraging modifications/retrofits of existing equipment, systems and buildings (suasion strategy);

- developing improved retrofit technologies (research and development strategy).

Figure 5.1 shows how the three strategies integrate to reduce overall energy consumption. Regulations eliminate the least energy efficient items (the "laggards") from the marketplace. This represents a small proportion of the total items available (otherwise there would be a major restriction on freedom of choice). However, the regulations would be reviewed on a regular basis and ratcheted upwards over time as the

level of energy efficiency improves. Suasion raises the average energy efficiency of items still in the marketplace, with the ultimate goal of convincing all consumers to use the best economically available technology. R&D pulls the marketplace toward a higher level of energy efficiency by continually improving the range of more energy efficient technologies available.

Figure 5.1



Energy Use

Energy use can be reduced in a somewhat similar fashion, except that there is often an associated requirement for changes in lifestyle. Possible measures include:

- restricting certain energy consuming activities e.g. driving downtown (regulatory strategy);

- encouraging more energy efficient maintenance and

operation of buildings and equipment plus the switching to less energy intensive activities e.g. from driving vehicles to riding buses (suasion strategy); and

- developing and commercializing improved operation practices plus new technologies that expand the possibilities for carrying out tasks in a less energy intensive manner e.g. teleconferencing instead of travelling to meetings (research and development strategy.)

The major focus of the following energy efficiency initiatives is on upgrading the efficiency of new equipment, buildings and vehicles. This is partly a reflection of economics (as mentioned above, it is generally more economic to enhance energy efficiency while an item is being produced) and partly a reflection of jurisdictional limitations (regulations governing retrofits and energy use are largely under provincial domain).

The key policy tools being proposed are (i) minimum energy efficiency standards for equipment, buildings and vehicles, as part of the regulatory strategy; (ii) information/demonstration programs and energy efficiency targets for industry, as part of the suasion strategy; and (iii) increased support for research and development of more energy efficient technologies, as part of the R&D strategy. The suasion strategy does not include the use of economic instruments which are currently the subject of study and future consultation.

I. Equipment

The equipment area consists of appliances, heating and cooling equipment, lighting products and motors. Although, on an individual basis, such items consume relatively modest amounts of energy, the total energy requirement for an average building collection can be quite significant.

At the August 1989 Federal-Provincial-Territorial Energy Ministers' Conference, it was agreed that "the development and adoption of national energy efficiency performance requirements for energy-using equipment,

including household appliances, is required". Establishing minimum energy efficiency standards prevents the least energy efficient equipment from entering the marketplace, thereby raising the average energy efficiency of new equipment purchases. Regulation can be effective in this area because most energy consuming equipment is highly standardized. The United States and Ontario have introduced regulated standards for some equipment and British Columbia is currently in the process of passing the required legislation.

In addition, the federal government would enhance and expand its existing information program for purchasers of energy using equipment (ENERGUIDE) to persuade consumers to choose the more energy efficient items amongst those still available in the marketplace. The federal government would also assist the provinces and utilities in providing information about the most efficient way to utilize equipment once purchased.

Possible Equipment Initiatives

1. Minimum Energy Efficiency Standards

Mandatory minimum standards for the energy efficiency of energy consuming products would be set by regulation as part of a possible new federal Energy Efficiency Act. The initial list of affected products would consist of major energy consuming items bought by the average householder including refrigerators, freezers, dishwashers, ranges and ovens, clothes washers and dryers, water heaters, air conditioners, ground and air source heat pumps, and furnaces. Standards would be as stringent as those established in other relevant jurisdictions.

In addition, a permanent task force would review the feasibility of expanding the regulations to cover additional residential products and types of commercial, institutional and industrial equipment. Lighting products and electrical motors would be included in this review. The task force would also consider, on a regular basis, whether existing standards should be raised to higher levels.

2. ENERGUIDE Labelling

The current ENERGUIDE program requires manufacturers to label six residential appliances (refrigerators, freezers, ranges, dishwashers, clothes dryers and clothes washers) in terms of their energy consumption. The enabling legislation for this program would be updated and transferred to the Energy Efficiency Act. The information effectiveness of the program would also be enhanced by improved labelling and a more aggressive marketing campaign, co-ordinated with applicable utility programs.

Following consultation and analysis, the federal government would announce, by mid-1991, the extension of ENERGUIDE to include additional household equipment items. Candidates for inclusion would be furnaces, water heaters, central and room air conditioners, and ground and air source heat pumps. Other residential items, as well as commercial and institutional equipment, would be added later.

3. Systems Information

Typically, energy consuming products are used in various combinations or types of systems, such as space and air conditioning, lighting, and industry processes. Thus, the performance of an energy efficient product not only depends upon how the item is used or maintained, but is also partly dependent upon its interaction with other components of the system and the interaction between systems within a building or process.

The maximization of efficiency gains requires recognition of these relationships. For example, the efficiency potential of commercial building lighting activities can only be achieved if the proper equipment choices are made, if the equipment is installed correctly in a complementary system, and if the system is operated in an efficient manner. This initiative would establish a variety of information activities to improve product and system use; for example, information programs to improve decision making on product selection, installation, maintenance, operation and integration in systems which minimize energy use.

2. Buildings

Developing an effective energy efficiency program for the buildings sector is complicated by the diverse nature of the building stock, the generally conservative approach to change in this sector, and a limited federal jurisdiction. The buildings initiatives strive, above all, to develop a more informed and discriminating public and industry which, in turn, will demand and produce a greater integration of energy efficiency with building practices.

The federal government has already been quite active in promoting greater energy efficiency for new residential buildings. Previous measures include the development of the "leading edge" R-2000 house and the establishment of the federal "Measures for the Conservation of Energy in New Buildings" which recommend, for new buildings, the appropriate minimum levels of energy efficiency for products and construction methods. The application of the Measures, however, has been fairly limited. Federal jurisdiction is restricted to the construction of buildings owned or financed by the Government of Canada. To date, Quebec is the only province that has incorporated the Measures fully into its provincial building code.

A major thrust of the following initiatives is to make the Measures more amenable to provincial adoption by providing updated regionalized versions. In addition, there are initiatives to develop and transfer energy efficiency knowledge and technology to members of the building industry and to provide information on energy efficiency to purchasers through the labelling of new and existing buildings. In pursuing these initiatives, it is essential that indoor air quality not be compromised. Rather, every effort would be made to improve the quality of indoor environments.

Possible Buildings Initiatives

1. Building "Measures", Performance Guidelines and Codes

The federal "Measures for Energy Conservation in New Buildings" would be updated and regionalized following a thorough review of current economically viable products and construction methods which is now in

progress. In addition, a performance version would be developed to allow flexibility in how the energy conservation and efficiency objectives inherent in the Measures are achieved at the local level. The incorporation of the Measures or Performance Guidelines into provincial and local building codes would be encouraged through the establishment of a consultative mechanism with provincial and municipal governments.

2. Energy Efficiency Labelling

The federal government would examine the feasibility of developing an energy efficiency labelling program for new and existing buildings through a process of consultations with regulatory authorities, technical advisors and the building and real estate industry. It would be necessary to establish testing and labelling methods and, while this may not be possible for all forms of building structures, there could be sufficiently large groupings of similar types of buildings to make it feasible for a significant segment of the sector. If it is decided that building energy labelling is practicable, the government would commit to introducing such a program in cooperation with interested parties.

3. Training and Technology Transfer

Building codes, energy labelling and performance guidelines, and new energy efficient building products and construction methods may be well conceived and developed and have technical merit, but unless individuals are able and motivated to use them as designed, their impact on energy use will be reduced. Through their associations and educational institutions, builders and designers would receive information and education packages on building standards and on advanced building products and methods. Building operators, financial institutions and the real estate industry would be involved in programs to enhance the general awareness of building energy efficiency opportunities in new and renovated buildings.

4. R-2000 Partnerships

EMR would continue to support the R-2000 program through agreements with provinces and utilities and, in conjunction with regional

Home Builders' Associations, to provide a viable and proven "leading edge" energy efficient housing standard in the market and to encourage the market towards greater housing efficiency. International transfers of R-2000 technology would be encouraged, while further R&D work is done on the Advanced House concept, which will test technologies for the next century. In addition, EMR would work in cooperation with the Department of the Environment to develop additions to the existing R-2000 standard, such as measures for water use, that will enhance its environmental attributes.

5. Enhanced Research and Development

Current funding allows for R&D and technology transfer initiatives for individual technologies, particularly high performance windows, daylighting and integrated mechanical systems. New R&D would focus on improving the energy efficiency of new building stock and that part of the existing building stock that will be subject to renovation. The emphasis would be placed on large-scale buildings which typically have high energy consumption, high impact on peak loads and limited adoption of new technologies.

The aim would be to extend the R-2000 concept to all new and renovated buildings to provide a mechanism and the infrastructure needed for rapid adoption and integration of technically sound, cost-effective, reliable and safe energy-efficient building technologies, products, equipment and services. The program would seek co-funding for most activities and would be implemented primarily through joint ventures and contracts.

3. Industry

The Industrial Sector accounts for about 38 per cent of secondary energy demand. A large proportion of this energy use is concentrated in a few industries. For example, pulp and paper, mining, iron and steel and chemicals together account for about 60 per cent of total industrial energy demand. While the industrial sector has achieved significant gains in energy efficiency over the past fifteen years, the rate of gain has been slowing due to lower energy prices and higher rates of interest.

Much of energy use in the industrial sector is process related and hence of a specialized nature. In many instances, industry knows better than anyone else what their opportunities for energy savings are and how they can best be realized. There is a need, however, to recreate the degree of priority and cooperation, with respect to energy efficiency, that characterized industry/government efforts in the era of high energy prices.

The major thrust of the following initiatives is to ensure that the Chief Executive Officers and senior management of the major energy using companies are involved in developing and evaluating company programs to achieve targets with respect to enhanced energy efficiency. The federal government would support this by creating a Minister's Advisory Council, by developing training programs for "energy efficiency managers" and by expanding its R&D effort.

Possible Industry Initiatives

1. Minister's National Advisory Council on Energy Efficiency in Industry

A Minister's National Advisory Council would be established, comprising the Minister of Energy, Mines and Resources and CEO's representing a number of major energy-using companies. The Council would meet once per year to: set energy efficiency targets for each of the industrial sectors; encourage identification and dissemination of more energy efficient technologies; identify R & D needs in the industrial sector for potential cost-shared programs; grant annual awards to honor significant achievements in industrial energy efficiency; and review progress and problems in achieving energy efficiency targets. In addition, firms would be requested to provide energy use data in sufficient detail to permit monitoring of energy use and review by the government of the level of company energy efficiency and progress towards energy efficiency targets.

2. Industry Training Program

Companies would be encouraged to have key personnel certified as energy efficiency managers through courses offered at local universities

and community colleges. The courses would be designed to expose attendees to the latest developments in energy efficient technologies and energy monitoring techniques.

The courses would also serve to increase awareness of the environmental and economic implications of energy decisions and of appropriate decision making strategies. Such courses would be especially useful to smaller firms, particularly those not affiliated with large industry associations.

3. Enhanced Research and Development

Increased funding would permit a more pro-active approach in this area, which would be focussed on the development of improved products, processes and systems targeted to key energy consuming sectors. Partners for this program are the industries themselves, research groups, universities and other government research facilities. The proposed program would be cost shared on a 50/50 basis with the private sector partners to ensure commitment and increase the likelihood of adoption.

4. Transportation

The transportation sector accounts for 30 per cent of Canada's energy use and almost 70 per cent of petroleum requirements. Road transportation is the dominant mode.

The fuel efficiency of new cars and light trucks has improved significantly since 1978, with gains coming principally from weight and drag reduction and engine improvements. Further gains in this area and in the efficiency of vehicle use are readily available using "on the shelf" technology and techniques, but are unlikely to occur without major fuel price increases or government action. In other areas, there has been relatively little improvement. Traffic congestion, both urban and inter-city, and its environmental impacts have grown significantly. Modal shifts are occurring but away from energy efficient modes such as public transit and high occupancy vehicles.

There is little within its direct jurisdiction that the federal government can do to resolve the problems of urban traffic management

and congestion. Energy responsive modal shifts are difficult ones to encourage; they require the coordinated efforts of all levels of government. EMR is working with the Royal Commission on Passenger Transportation to address these opportunities within the Commission's mandate.

However, in collaboration with Transport Canada, EMR can deliver programs which prescribe fuel consumption targets for new motor vehicles sold in Canada, and provide private motorists and commercial fleet operators with basic information concerning fuels and fuel efficiency. In addition, EMR could undertake with other stakeholders a study to examine several possible new approaches to encourage the manufacturing and purchase of more efficient vehicles.

With respect to urban and inter-city transportation, the federal government could make available its expertise in the energy/ transportation/environment area to provincial and municipal governments to assist them in developing plans to control transportation related emissions.

Possible Transportation Initiatives

1. New Vehicle Fuel Efficiency Targets

The federal government would initiate a new round of fuel consumption targets for the periods 1994-2000 and 2000-2005, involving the same groups and principles that guided the implementation of the existing standards. The government would also consider including the targets in the possible new federal Energy Efficiency Act.

2. Study of Standards and Tradeable Rights

EMR would undertake with other stakeholders (e.g. automobile industry, other federal departments, and other affected parties) a study to examine:

- mandatory standards for efficiency improvements in new automobiles and light trucks; and

- a system of tradeable rights or credits for the "Company Average Fuel Consumption Standards Program", whereby manufacturers who exceed the "fleet average" requirements for fuel consumption are permitted to sell their "excess credits" to other manufacturers.

3. Training and Information Programs

EMR currently operates several small programs to encourage energy efficiency in vehicle operations (e.g. the Pro-Trucker and Pro-Fisher programs). The scope of these programs would be expanded in terms of coverage and depth and would include audits of fleet vehicles to assess potential energy savings. In addition, the government would: update and expand distribution of the Car Economy Book and the Fuel Consumption Guide; develop educational packages for fleet managers and drivers, schools, community groups, and auto clubs; use media campaigns and events to increase awareness of actions consumers can take to reduce fuel use in transportation; and conduct studies and surveys in support of these activities.

4. Transportation Emissions Management Plans

The federal government would work together with provinces and municipalities to develop, through studies and workshops, strategies for the reduction of CO_2 and other emissions from transportation. New measures would be implemented primarily at the provincial and municipal level, with the federal government playing a key role in the provision of essential information on, for example, new vehicle technology and analytical techniques for CO_2 emission assessment. This initiative would complement the recommendation in the NOx/VOCs Management Plan for cooperative studies to address these emissions in urban areas.

B. Alternative Energy and Cleaner Fuels

Alternative energy is generally defined to include "non-traditional" sources of supply (such as solar energy, wind, geothermal, tidal and small hydro power, bioenergy and photovoltaic conversion systems) plus new applications of the traditional energy sources (such as the use of propane

and natural gas as automotive fuels). Current market penetration of alternative energies is modest so far (representing about 5-7 per cent of total primary energy demand in Canada) because of a lack of familiarity and knowledge of them, uncertainties about their reliability, limited infrastructure, high initial costs and evolving technologies.

Nevertheless, it should be noted that:

- small and low-head hydro, wind and photovoltaic are now viable alternatives to off-grid, fossil fuel-based electrical power in remote areas (and some small hydro projects are viable within the grid);

- active solar energy has applications in factory wall systems, hot water systems and for preheating building ventilation air;

- propane and natural gas have developed important markets as alternative transportation fuels, mainly for fleets and buses;

- the use of bioenergy is significant in the pulp and paper industry, where the combustion of wood and pulping wastes account for about 50 per cent of this industry's energy use. Canada is an international leader in some biomass technologies.

The following alternative energy initiatives are directed at the most technically and economically promising alternatives, based on: market potential; technical feasibility; and economic attractiveness. Thus, the emphasis is placed on alternative transportation fuels (particularly propane, natural gas and methanol) and on bioenergy. There are also initiatives to enhance the overall awareness and knowledge of alternative energy and to advance research and development on the use of renewable energy in remote and main grid electrical applications.

In addition to switching to more environmentally benign fuels, it is also possible to reduce the atmospheric emissions from energy use by

making our conventional fuels burn cleaner. Additional research and development in this area would enable the federal government to play a larger role in the development of advanced coal technologies and cleaner methods of using oil products in the transportation sector.

Possible Initiatives

1. Auto Propane Markets

A major technology transfer program would introduce new propane fuel management systems, which have been developed through a cooperative government/industry R&D program, to existing and new auto propane markets across the country. This would be supplemented by specific auto propane market development projects planned for Atlantic Canada, where at present there is very little alternative transportation fuel activity. Potential projects include assessment of the acceptability of auto propane heavy duty vehicles in designated centers, such as Montreal, Halifax/Dartmouth and St. John's, and establishment of a test auto propane infrastructure in a selected region of Newfoundland where a significant propane surplus is currently flared at the refinery. With off-shore gas production, surplus propane in the region will increase.

2. Natural Gas Vehicle Markets

A variety of market development initiatives would be used to encourage the market introduction of new natural gas vehicle (NGV) technologies (e.g. gaseous fuel injection carburation systems, light weight composite cylinders, liquefied natural gas systems) developed through a government/industry R&D program. An extensive marketing effort would focus on the replication of heavy duty NGV technologies, particularly transit buses and large trucks, in major urban centers in central and western Canada. Provision would also be made to extend the Natural Gas Vehicle Program in the province of British Columbia beyond the current expiry date of March 31, 1991.

3. Natural Gas Vehicle Infrastructure

A program of infrastructure development would expand the existing

NGV refueling network, with an emphasis on private compression facilities, including vehicle refueling appliances (VRA; commonly referred to as "home compressors") and various commercial sized NGV compressors. The concept of "NGV corridors", such as the highway 401/20 route from Windsor to Quebec City, would also be tested and implemented where practicable.

4. Alcohol Fuel Vehicles

A program of information transfer and marketing projects would be undertaken to establish the commercial viability of methanol as a vehicle fuel in Canada. The program would be directed towards heavy and light duty vehicles and the establishment of a supporting refueling infrastructure. Heavy duty applications of methanol fuel would include a large scale technology replication program to introduce the new technologies, particularly urban transit buses, to selected centers across the country. The market development program for light duty methanol vehicle activity would focus on a large scale technology transfer project to promote the adoption of neat methanol vehicles in designated urban areas across the country, along with the establishment of the necessary methanol infrastructure to accelerate consumer acceptance of the fuel. If technological and economic barriers can be overcome, a market development program would be introduced in selected areas across Canada where local resources for low cost ethanol production are available.

5. Encouraging the Production of Alternative Fuel Vehicles

Existing consultative mechanisms would be employed to encourage the major automotive manufacturers to offer original equipment alternative fuel vehicles at the dealer level.

6. Biomass Conversion Program

The objectives of this activity would be multi-faceted and would include the production of energy in a more environmentally acceptable manner and the management, processing and reduction, through conversion to useful fuels or to energy, of waste from municipal, industrial and commercial sources. For new energy sources, proposals would be invited

for cost-shared projects in Atlantic Canada to convert commercial, institutional and industrial facilities from conventional fuels to biomass. In addition, submissions would be invited to demonstrate the plantation production of ethanol in selected areas across Canada where local resources for low cost production are available.

7. Standards and Specifications for Equipment and Fuels

Standards are a requirement before manufacturers will develop and market equipment to use alternative fuels. In the transportation fuels area, EMR would provide support to the national standards setting body, CGSB, to ensure the development of vehicle and emission standards pertaining to methanol (M85) and natural gas vehicles. Standards for propane are in place.

With respect to biomass fuels used in combustion applications, emission issues are more complex due to the range of fuels and equipment involved. To address this matter, a task force would be established to work with existing standards-writing bodies to develop appropriate specifications and standards for the fuels, combustion equipment and emission controls.

8. Increased Understanding/Awareness

There are a large number of alternative energy forms that have potential for market development, but for which the economic and environmental implications have not been properly assessed or are not yet known. This initiative would provide for a complete review of the available alternative energy forms which could potentially contribute towards our energy related environmental goals. This review would involve classifying and ranking each of the energy forms with respect to market potential, environmental effects and economics. Studies would be initiated where there is insufficient information on a particular energy form.

This initiative would also seek to enhance the general public awareness of alternative energy through exhibits accompanied by print materials and audio visuals. The exhibits would be featured across the

country at trade and consumer shows and accompanied by a series of advertised seminars directed at specific audiences. Print materials would be designed to support the displays and provide further information on the practical applications of new fuels and technologies. The audio visuals would be used as part of the display and seminar programs, and could also be made available through cable television.

9. Enhanced Research and Development of Energy From Waste

An enhanced R&D effort on energy from waste would develop technologies to increase energy supply from forest and municipal wastes. It would focus on assessing waste feedstock potential, including its sources such as biomass and methane, its conversion characteristics, facilities-siting issues and end product use. Wood waste utilization technologies would be developed on a full fuel cycle basis paying particular attention to acid rain implications, carbon dioxide production and methane reduction. The barriers to the adoption of district heating and cogeneration using waste biomass feedstocks would also be addressed.

10. Enhanced Research and Development of Renewable Energy Supply

An enhanced R&D effort on renewable energy supply would develop new technologies to allow better energy supply management both on and off the electricity grid. A new program would concentrate on: (i) the development of renewable energy electric systems in northern and remote communities; (ii) for main grid electrical applications, the development and testing, with the electric utilities and industry, of specific renewable energy technologies that could help reduce summer and winter electrical peak loads; and (iii) the development and testing, in cooperation with natural gas utilities, of an integrated solar/natural gas domestic hot water system.

11. Enhanced Research and Development of Alternative Transportation

An R&D program for alternative transportation fuels would focus both on near term and long term alternatives to petroleum. With respect to the former, the program would include the production of alcohol fuel

from lignocellulose, reformulation of gasoline to include alcohol and equipment development and application to support the use of alcohol fuels. The longer term R&D would concentrate on the development of electric vehicles, advanced batteries, low heat rejection engines, hybrid vehicles, fuel cells and hydrogen technologies.

There would also be research on improving the efficiency of the alternative fuel combustion engine while reducing its environmentally negative emissions. Areas of research would include: enhanced combustion techniques and modelling; improved diagnostics; investigation of combustion processes to understand the pollutant formulation mechanisms; improved fuel formulation and performance; improved vehicle system development; and technologies to trap particulate emissions.

12. Development of Advanced Clean Coal Technologies

An R&D program would help develop new technologies to reduce emissions of CO_2, sulphur and nitrogen oxides and other waste products associated with coal use. The aim would be to lead research and cooperate with industry in activities that: (i) develop coal cleaning and upgrading technologies to produce a super-clean fuel amenable to use in highly efficient combustion systems; (ii) develop and prove the technology to adapt Integrated Gasification Combined Cycle (IGCC) systems to Canadian needs; (iii) develop advanced combustion systems such as fluidized-bed combustion; and (iv) explore technologies for removal, containment and disposal of CO_2.

13. Development of Cleaner Transportation Fuels

The federal government would work with industry to develop advanced processes for the production of environmentally acceptable transportation fuels from Canadian sources. R&D would be aimed at reducing the atmospheric emissions produced by transportation fuels by developing technologies to: (i) reduce aromatic hydrocarbons in diesel and jet fuels; (ii) remove benzene from gasoline; (iii) remove sulphur and nitrogen containing compounds from transportation fuels; (iv) enhance fuel quality to reduce carbon dioxide emissions; and (v) develop new

processes to regenerate and recycle spent refinery catalysts.

C. Demonstration Program, Public Energy Use Data Base and Other Initiatives

In addition to the sector specific initiatives described above, there are several general measures that need to be considered that would pertain to a number of different sectors.

The federal government could establish a demonstration program to accelerate the introduction and the adoption of efficiency and alternative energy technology. Such a program would cover both technical and market oriented demonstrations. Technical demonstrations would focus primarily on data collection, proving that the technology works and collecting information to assist with final modifications prior to manufacture. Market demonstrations would focus primarily on obtaining marketplace acceptance.

There is a need for the federal government to improve the collection, maintenance and dissemination of data and information on energy efficiency. In addition, the federal government can play a more active role in ensuring that energy efficiency achievements in one part of the country are understood and adopted in other parts of the country.

The following initiatives are designed to strengthen the federal government's partnership with utilities and provincial governments by developing and maintaining a national data base on energy use and by facilitating the transfer of information and technology between provinces. In addition to the demonstration program, there would be an R&D initiative to explore advanced approaches to integrating industrial, municipal and utility systems. There is also a proposal to increase funding of the Energy Diversification Research Laboratory at Varennes, Quebec to enable EMR to carry out more in-house research and establish a stronger leadership role in this area. The laboratory would be a showcase for the application of energy efficient and alternative technologies, with such features as light-pipes, efficient windows, heat recovery and other state-of-the-art building technology.

Finally, the federal government could assist the provinces in developing new educational modules for schools to ensure that students develop a good understanding of energy efficiency and alternative energy and their strong linkages with the environment.

Possible Initiatives

1. Demonstration Program

The federal government would establish a fund to support demonstrations of technology aimed at improving energy efficiency or reducing the environmental impacts associated with energy use. Proposals would originate from industry, government or institutions: (i) as an integral part of a planned activity already in progress; (ii) from an annual call for proposals; and (iii) on an ad hoc basis. The following program criteria would be used to ensure good leverage for federal funds and environmental benefits:

- clear need for government involvement
- strong replication potential
- good market, technical acceptability
- high level of private funding
- major positive contribution to environmental objectives

A strong emphasis would be placed on transferring the results of demonstrations at both the national and regional levels.

2. Public Energy Use Data Base

The federal government would establish and maintain a major public data/information base on energy use in all consuming sectors -- residential, commercial, industrial and transportation. This data base would be comprised of currently available data, complemented by data obtained through the reporting requirements of some of the initiatives included in this package and through new surveys of end use energy consumption. The data would be updated on a regular basis, most probably annual. The data/information base would assist the necessary monitoring of efficiency and alternative energy programs, and would provide the basis

for further analysis of consumers' behaviour in their use of energy, leading to program adjustments where required.

3. Technology Transfer

This initiative would expand the current relationship between EMR and the Canadian Electrical Association to disseminate more widely information on energy efficiency analysis, planning and practice, both within Canada and internationally. Energy efficiency planning tools, program evaluation, technology assessments and monitoring are possible subjects of inter-utility interest. The use of a variety of technology transfer tools is contemplated including data bases, software programs, literature, training and conferences. Resources would be allocated on the basis of effectiveness and user preference of each instrument.

4. Energy Systems Technology Development

R&D would be undertaken with respect to advanced approaches to energy systems technology development (i.e the integration of individual energy systems to optimize overall energy efficiency). Advances in this area would foster the greater application of cogeneration, district heating and other means of integrating industrial, municipal and utility systems.

5. Energy Diversification Research Laboratory

The Energy Diversification Research Laboratory (EDRL) at Varennes, Quebec would be expanded to enable the institute to address important energy efficiency issues and sustainable energy options. EDRL would concentrate its work on energy technologies which have potential for a positive impact on atmospheric change, in particular global warming. The research and development work would focus primarily on medium term results, although certain projects would include long term and short-term components.

EDRL would have three research programs:

- no-carbon - this would involve work on photovoltaics systems development assessment and monitoring; fuel cells and noval

battery monitoring; and passive solar energy applications for application in utility planning.

- low-carbon - this would involve work on conversion of natural gas using plasma and microwave energy; electrochemical processes for natural gas; and natural gas storage.

- energy management - this would involve work on thermally driven chillers (with applications in heat pumps, air conditioning, refrigeration, and cogeneration); transport of heat and thermal storage.

6. School Information Modules

School information packages that include films, print information, study guides, display materials and activity programs that link energy use with the health of the environment would be prepared and disseminated. They would explain the science behind energy and the environment issues, and offer a practical focus as well, describing the choices that individuals can make in their daily lives to increase energy efficiency and enhance the well-being and health of their environment.

The design and content of the packages would be determined following a study of educational curricula, to ensure implementation. The educational modules would be developed, in consultation with the provinces, in two main packages: one aimed at senior elementary grades and one for secondary schools. The packages would consist of a main module for use in general science courses and separate, smaller project modules that could be incorporated into specific subject areas.

D. Energy Use in the Federal Government

While there is no evidence that the federal government uses energy less efficiently than the private sector, this is an area where the Government of Canada can demonstrate leadership on environmental issues and its commitment to achieving the positive environmental impacts associated with enhanced energy efficiency. In addition, the initiatives described below could be used to demonstrate the economic viability and

commercial acceptability of new or underutilized energy efficient products and systems, thereby facilitating their adoption by the private sector.

The initiatives would be aimed at identifying and facilitating economically attractive measures to improve energy efficiency in the federal government. This would involve initiatives in the area of lighting and renovations of existing buildings, energy efficiency standards for new buildings, measures to recover and use waste heat, and steps to improve the fuel efficiency of new vehicle purchases.

Possible Initiatives Concerning Federal Energy Use

1. Heating/Cooling/Ventilation/Lighting

The major energy using departments in the federal government would be called upon to jointly develop mechanisms for encouraging comprehensive energy planning. The first step in such a program would be a systematic audit of all federal buildings to determine the potential for economic measures to improve the energy efficiency of heating, cooling, ventilation and lighting equipment and systems. This information would be used in the preparation of energy management plans to implement the appropriate measures. The program would then closely monitor the performance of retrofit investments. The initiative would be targeted to achieve a 10 per cent reduction in energy use for heating, cooling and ventilation, and a 20 per cent reduction in lighting energy use per square meter by 2000.

2. New Buildings

EMR (in conjunction with Public Works Canada, the National Research Council and other stakeholders) would review domestic and international building codes and collect and analyze information on energy management in federal buildings. This information would then be used to develop, within one or two years, up-to-date standards that any new residential, commercial or institutional building built for the federal government must meet. The initiative would be targeted to achieve a 30 per cent reduction in the energy use per square meter in all new buildings

purchased or leased by the federal government, as compared to the current average energy use per square meter for all federal buildings.

3. Waste Heat Recovery

There would be an examination and assessment of the potential for federal energy use reductions through the recovery of energy normally expended as waste heat generated by the burning of fossil fuels. Audits of selected federal facilities would be undertaken to assess the economics of retrofitting existing federal steam plants to provide the necessary physical infrastructure to facilitate waste heat recovery through electricity cogeneration, district heating or simply to pre-heat water to reduce the cost of producing hot water for building occupants. These audits may also suggest opportunities for tuning-up the existing plant to minimize fuel used for current operations.

4. New Vehicles

Annual targets would be established to achieve a continuous improvement of the average fuel consumption of new federal vehicles purchased by departments. The target for 1995 would be a 15 per cent improvement in average fuel consumption compared to 1990 purchases. A target for reduction of 10 per cent by 2000 would be established for the total of all forms of transportation energy use. (Most of the federal government's use of transport energy occurs in marine and air transport.)

CHAPTER 6: ESTIMATED IMPACT OF INITIATIVES

A. Introduction

This chapter reviews the estimated impact on energy demand and atmospheric emissions of the initiatives described in Chapter 5. In addition to reducing energy demand and carbon dioxide emissions, these initiatives would reduce other atmospheric emissions such as volatile organic compounds (VOCs), nitrogen oxides (NOx) and sulphur dioxide (SO_2).

Secondary energy demand is forecast to rise by 18 per cent from 6,600 PJ in 1990 to about 7,800 PJ by the year 2000, in the reference case. It is estimated that the potential impact of the initiatives described in Chapter 5, in terms of reduced secondary energy demand in the year 2000, would be roughly 500 to 700 PJ. This represents a reduction of some 6.5 to 9 per cent in forecast demand for the year 2000.

In addition to reducing secondary energy demand, implementation of the initiatives could reduce CO_2 emissions by 35 to 50 megatonnes, NOx emissions by 110 to 155 kilotonnes, VOCs by 45 to 65 kilotonnes, and SO_2 by 550 to 800 kilotonnes.

B. Major Assumptions

Reductions in energy demand and emissions resulting from the initiatives package were estimated using the same assumptions about energy prices, macro-economic developments and emission conversion factors as those described in Chapter 3. In addition, they reflect EMR's best current estimates of technology costs and potential market penetration rates. All of these calculations are characterized by some degree of uncertainty. Moreover, the initiatives are still in the discussion stage, hence there remain a number of details still to be determined concerning the overall level of resources that might be devoted to each measure. While this does not imply that the estimates provided are unreasonable, it does mean that there is a broad range of possible impacts.

In estimating the effectiveness of initiatives, an important

consideration is the expected level of provincial and local cooperation. In particular, it is assumed that:

- provincial governments take actions as needed to enable federal minimum energy efficiency standards for equipment to be effective in those areas not covered by federal jurisdiction (i.e. intra-provincial trade);

- provincial and municipal governments encourage the adoption of federal building standards into provincial and local building practices;

- motor vehicle manufacturers and others continue to cooperate fully with the government in meeting the objectives for reducing fuel consumption in road transportation;

- industry places a renewed focus on energy efficiency and is successful in realizing much of the energy savings potential in their sector that is economic; and

- individual consumers, in response to government information programs, develop a greater awareness of the economic and environmental benefits associated with enhanced energy efficiency, and act accordingly.

To the extent such cooperation is not forthcoming as anticipated, the estimated energy savings may not be realized.

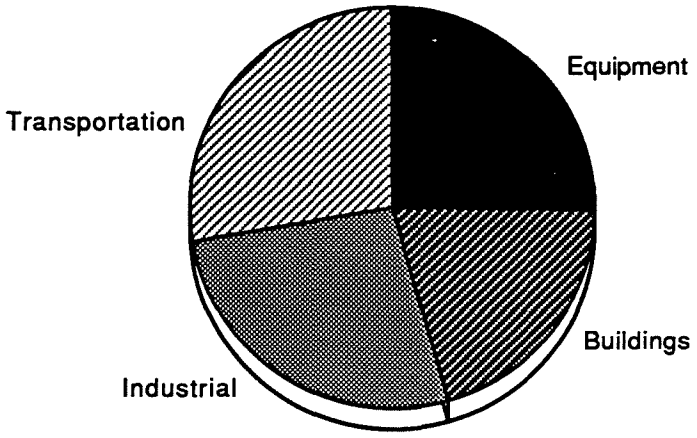
A second important consideration affecting the impact of the initiatives is anticipated developments in the U.S. It is assumed that minimum efficiency standards in Canada will generally be set at levels that are as stringent as those expected to prevail in the U.S. To the extent the U.S. government is more aggressive than expected in regulating the energy efficiency of equipment and vehicles, the estimated energy savings contained in this Chapter may be exceeded.

C. Impact of Initiatives on Energy Demand

The package of initiatives is designed to reduce energy consumption in all end-use sectors. Figure 6.1 illustrates the projected distribution of energy savings, by major end-use, for the year 2000.

Figure 6.1

ENERGY SAVINGS BY CATEGORY OF INITIATIVE IN THE YEAR 2000



Total Savings = 500 - 700 PJ

The **equipment initiatives** are expected to account for about 25 per cent of total energy savings in the year 2000. Most of these savings would result from improvements in the energy efficiency of new equipment purchases. The largest single impact on energy use, within the equipment initiatives, is projected to result from an increase in the energy efficiency of residential and commercial lighting. Significant energy efficiency improvements are also expected for the six residential white goods, residential water heaters, and space heating and cooling systems. These improvements would result largely from the expansion of the ENERGUIDE labelling program and the introduction of national minimum energy efficiency standards.

The **buildings initiatives** are expected to result in energy savings of about 20 per cent by the year 2000. The energy savings would come largely from new buildings being constructed to the efficiency standards contained in the updated Building Measures as compared to those in evidence in current building practices. Some modest energy savings are also expected in the buildings retrofit market in response to improvements in information about the efficiency levels of existing buildings.

It is estimated that about 27 per cent of energy savings could be achieved through the **industry initiatives** by the year 2000. The largest contribution is expected to come through the adoption of process changes, controls and instrumentation, which would account for about 60 per cent of the total. Energy savings from waste heat recovery and energy cascading would account for most of the remaining 40 per cent.

The **transportation initiatives** are estimated to make up nearly 28 per cent of total energy savings in the year 2000, with improved vehicle operation expected to account for the largest component of the savings. There would also be a further modest improvement in the average energy efficiency of new vehicles (over and above that which would occur in the absence of government involvement) in response to higher government/industry negotiated Company Average Fuel Consumption (CAFC) standards and the associated adoption of more energy efficient "on the shelf" technologies.

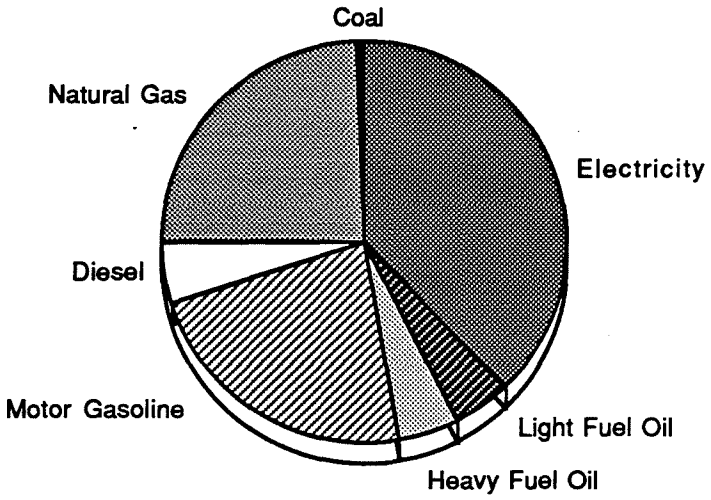
The **alternative energy initiatives** would have a negligible effect on the level of energy demand but would reduce the consumption of some of the higher carbon fossil fuels. The biomass and alternative transportation fuels initiatives have the potential to displace about 15 to 20 PJ of conventional fossil fuel consumption in the year 2000. The initiatives to increase biomass consumption would reduce net CO_2 emissions providing they did not result in a net depletion of our forests. The initiatives to encourage alternative transportation fuels would have their largest impact in terms of reduced emissions of NOx and VOCs, which are major contributors to urban smog.

The potential impact of the initiatives would be relatively broad in

terms of their effect on fuel mix, as shown in Figure 6.2.

Figure 6.2

ENERGY SAVINGS BY FUEL IN THE YEAR 2000



Total Savings = 500 - 700 PJ

The largest potential impact of the initiatives is the reduction in electricity consumption, in part reflecting the predominant electricity impact of the equipment initiatives. Motor gasoline is the second largest in terms of energy saved, followed by natural gas, the majority of which would be saved in the industrial sector.

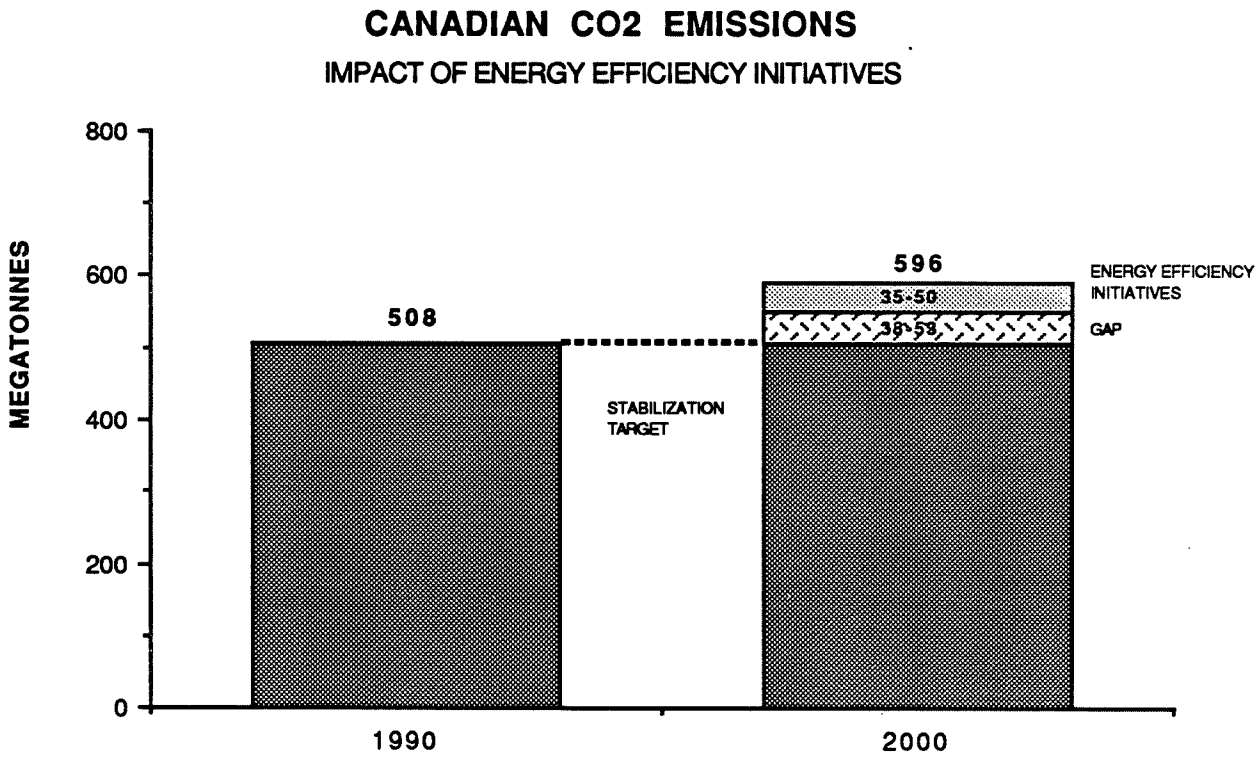
D. Impact of Initiatives on Carbon Dioxide Emissions

It is estimated that the initiatives package would reduce CO_2 emissions by 35 to 50 megatonnes in the year 2000. This assumes that the electricity saved in the year 2000 would otherwise have been generated on the basis of the average regional mix of fuels forecast for that year. Thus, some of the savings in end-use electricity demand are projected to displace nuclear and hydro power and hence have no impact on CO_2 emissions. A greater reduction in CO_2 emissions would be possible if each provincial utility, in response to the savings in demand, were to adjust its generation mix to displace the higher carbon-content fuels. In

Ontario, this would mean displacing more coal and less nuclear. In Quebec, hydro electricity would still be the major fuel displaced.

The reduction in CO_2 emissions of 35 to 50 megatonnes in the year 2000 would not stabilize emissions at the 1990 level (see figure 6.3). An additional reduction of 38 to 53 megatonnes of CO_2 annually would need to be achieved by 2000 to meet a stabilization target.

Figure 6.3



CHAPTER 7: THE CHALLENGE

A. Introduction

The need for action to limit Canada's emissions of greenhouse gases has been widely acknowledged. There is little doubt that more efficient use of energy in the Canadian economy should be the major element of an initial response, and that the energy sector will have a continuing and evolving role over the coming decade, and beyond, in addressing issues of atmospheric change. The challenge that governments and all sectors of society face is to find the most effective approach to achieve our objectives, an approach that minimizes the economic and social costs of adjustment.

B. Possible Federal Role

Economic efficiency will generally be maximized to the extent that those being required to change their energy use practices are provided with the maximum flexibility to choose how best to respond. To the extent that individuals and organizations can decide for themselves how to contribute to the overall objectives of energy efficiency and CO_2 reductions, the country will unequivocally be better off. Against this understanding is set the urgency for achieving results.

The process of allocating the need for action to the various elements in society, and assuring that the required action is undertaken is a difficult one. Increased assurance of realizing the objectives can be attained by the use of centralized, national policy instruments, but often at a higher cost of adjustment as flexibility and choice -- reflecting local capacities and opportunities -- are restricted. Balancing commitment against flexibility, a participatory approach against central authority, and ultimately environmental imperatives against other economic and social objectives, will require careful consideration.

Energy use is ultimately a very disaggregated activity that is significantly affected by local factors (e.g. the way our communities are built, the way our transportation systems are devised, the type of

industries we foster). The best role for the federal government in this area is a guiding role. One that establishes a national foundation and framework for action but which recognizes that many of the most effective measures are those that can only be implemented and carried out at a more local level. Establishing this guiding role would require, as an important first step, the introduction of the types of initiatives described in this paper. Beyond that, the federal government can play an important role in setting objectives for industry, other levels of government and private citizens to do their part in realizing our longer-term energy policy goal of significantly reducing the negative impacts of energy use on our atmosphere.

Such a role would require continuous involvement by the federal government in monitoring energy use patterns, in consulting with parties and coordinating activities as needed, and in clearly identifying the goals and objectives that must be realized by all parties to achieve our national and international commitments to reduce greenhouse gas and other atmospheric emissions. The federal government would also need to be prepared to consider additional actions at the federal level in the event it became clear that the collective measures of all relevant actors would be insufficient to address the problem of atmospheric emissions in a full and satisfactory manner.

The implementation of a package of initiatives based on the suggestions in Chapter 5 could lead, of itself, to changes in decisions and behaviour in Canada which could significantly reduce the expected levels of energy use in all sectors. With the active cooperation of other governments, corporations and individuals, these measures could trigger potential savings of up to 8 to 9 per cent of expected demand in the year 2000. The resulting reduction in CO_2 emissions could be as high as 10 per cent.

Although such achievements would be impressive, they may not, in the end, be sufficient to meet the objectives ultimately adopted by Canada. It is therefore important to note that these initiatives would also lay the foundation for responsive policy evolution over the 1990s, by:

- establishing a new legislative base for national

energy efficiency regulations;

- establishing new processes for the continuing review and improvement of national energy efficiency standards;

- establishing new consultative mechanisms that will facilitate greater cooperation on energy demand-side issues among the various levels of government;

- through a variety of information and demonstration programs, enhancing permanently the level of industry and public awareness of energy efficiency and alternative energy opportunities and their linkages to the environment;

- through the development of a national energy use data base, providing for more informed decision-making in both the public and private sectors; and

- through enhanced R&D, expanding the range of technical solutions available for implementation.

By establishing such a framework for action and by providing the consultative mechanisms to adjust that framework effectively and co-operatively over time, the federal government would be initiating the development of a process to ensure the ultimate achievement of our objectives in the most flexible and responsive manner. Nevertheless, that achievement cannot be accomplished without the full and enthusiastic participation of all sectors of Canadian society: provincial and municipal governments; corporations; communities and other interested groups; and individual Canadians.

C. Potential Areas For Achieving Further Reductions in CO_2 Emissions

How might Canadians all work together to build upon current and proposed federal and provincial measures to stabilize or reduce further energy-related atmospheric emissions? An illustrative list of possible areas for further action, for each level of decision-making, is provided

below.

1. Federal Level

The federal government can play an important role in the further development of national standards for energy efficiency and alternative energy. In some cases, however, it may be more efficient and effective for the enforcement of such standards (to the extent it is required) to be carried out at the provincial or municipal level.

The federal government can also play a key role in developing and testing new technologies and in ensuring that technical and marketing successes are communicated to all regions of the country. There are also areas where broad cross-Canada information programs are the most cost effective approach to persuading consumers to be more energy efficient. In this context, we must develop public information programs which are convincing and which influence consumer behaviour.

To the extent there is a need for changes in the economic signals received by energy users or by purchasers of energy using equipment, the federal government can be most effective where broad, uniform changes are required (as opposed to changes that are regional or product specific).

2. Provincial Level

A number of Canadian electrical utilities have initiated Demand Side Management (DSM) programs to reduce or alter the demand for electricity. Such programs can be very effective in inducing changes in consumer behaviour and there would appear to be room for utilities to be more aggressive in this area. Some Canadian utilities are significantly less active than others in pursuing demand-side options and even the most active utilities in Canada are less aggressive than some of the U.S. utilities.

In addition, it is ultimately the role of utilities to determine the optimal mix -- coal, hydro, nuclear, natural gas or alternative energy -- for electricity generation. Whether reductions in end-use electricity demand translate into reductions in atmospheric emissions will depend to

a large extent on how utilities adjust this mix over time.

Provincial governments establish the regulatory environment within which utilities operate. Provincial regulation has a significant impact on the rates that customers are charged for energy, on the incentives for utilities (natural gas as well as electricity) to pursue demand-side options, and on the ability for small power producers to access the utility distribution system.

Provincial governments also have considerable influence over building practices within the province, inter-city transport and over sales of energy-using equipment.

3. Local Level

Municipal governments have a significant influence over building practices through local laws and regulations and through the city planning process. They have the prime responsibility for urban transport, a rapidly growing source of atmospheric pollution. Municipal governments are also a key element in energy options, such as district heating, which require the participation of a number of different institutions to be economically attractive.

4. The Private Economy

To the extent industry and individual consumers are more or less active in pursuing energy efficiency opportunities than expected, the need for government intervention will be reduced or increased.

Industry cannot be expected to focus on energy efficiency to the detriment of their financial operation. Nevertheless, industry can do more to ensure that economic opportunities for energy efficiency are indeed being realized, thereby meeting the dual objective of helping the environment and improving their own international competitiveness.

Collectively, individual consumers represent a very powerful force. There is room for significant efficiency gains in the way energy is consumed in the home and in personal transportation. We must inform