CLIMATE OF CHANGE

Canadian Solutions

Practical and Affordable Steps to Fight Climate Change

David Suzuki Foundation

Finding solutions

Pembina Institute
for Appropriate Development

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Canadian Solutions:

Practical and Affordable Steps to Fight Climate Change

The global climate is changing, regional weather is changing and the negative effects upon our environment and upon human activities, including our economy, are likely to grow in severity and scale. Now is the time to take affordable, practical and effective action to restore climate stability by using energy more efficiently and using cleaner energy.

Here's what we can achieve by implementing the actions recommended in this report:

- improved public health: reduced fossil fuel emissions means fewer premature deaths, less respiratory illness and reduced risks of diseases associated with a warmer climate;
- new job creation opportunities as more emphasis is placed upon labour-intensive energy efficiency and energy conservation efforts; expert studies show four times as many jobs are produced compared to new energy production projects;
- improved environmental standards mean a cleaner environment and more livable communities, adding to the quality of life today and for future generations;
- new industries for Canada: by moving forward now we can benefit from the growing global demand for energy efficiency products and services and keep our industries competitive;
- meeting our international obligations: Canada is respected for our commitments to global peace and global development – a failure to act on this issue risks our international reputation.

Moving forward now reduces the costs of inaction, brings immediate benefits and allows Canada to play a positive role in restoring climate stability. Continuing to do nothing is is the most costly option.

How to use this report

This book tells what our governments can do to begin the task of preventing global warming. Its format is essentially a "recipe book" of how Canada could meet the commitment made in Kyoto in December, 1997 to reduce emissions of greenhouse gases six per cent by the years 2008-2012. This plan may not be the only one Canada could take to meet that goal. However, this array of measures would be effective and affordable, and so presents a practical path into the 21st century for policy makers, governments, journalists, business leaders and all concerned Canadians.

Accordingly, the bulk of the report is a detailed explanation of 17 steps which would each lead to significant reductions in emissions. The actions are grouped into the ten sectors of the economy where emissions need to be reduced. The description of each step includes an estimate of the size of the reductions that would be achieved, the economic costs and benefits, other environmental benefits that would be gained, and the recommended policy measures needed to implement it.

Canadian Solutions

Our atmosphere is heating up, weather patterns are shifting, and the climate is changing. We are just now beginning to see and understand the damage climate change can inflict upon our economy and our well being.

Human activities, particularly our use of fossil fuels like coal, oil and natural gas to supply world energy demands, are largely responsible. Symptoms of a changing climate, including increased temperatures, changes in established weather patterns, and more intense extreme weather events like floods and droughts are already appearing in Canada and around the world. These symptoms are likely to increase in magnitude and frequency unless greenhouse gas emissions are substantially reduced. *Canadian Solutions* outlines which initial actions Canada's federal, provincial and municipal governments can take to address climate change. If adopted, the practical set of measures described here will allow Canada to meet its obligations to reduce greenhouse gas emissions under the Kyoto Protocol to the United Nations Framework Convention on Climate Change.

It is now widely accepted by the scientific community that increasing concentrations of greenhouse gases in our atmosphere – due to human activity – have begun to change our climate. Gases such as carbon dioxide, methane, and nitrous oxide are 'heat-trapping' gases that produce a natural greenhouse effect and keep the earth warm enough to sustain life. The combustion of fossil fuels, however, is dramatically increasing the atmospheric concentration of these gases. This is magnifying the greenhouse effect, and the result is climate change.

These complementary emission reductions will substantially reduce costs on our health care system and help save lives, since current estimates indicate that up to 16,000 Canadian die prematurely as a result of air pollution each year.

One of the key elements of climate change is global warming. While global temperatures have always fluctuated according to natural activities, temperature records show an historically unprecedented upward trend in average global temperatures from 1860 to 1998. Based on direct measurements, the world's average temperature has risen by almost 1°C during the past 135 years. Globally, the 11 hottest years on record have occurred since 1982, and 1998 is likely to be the hottest year ever recorded.

In fact, by late August 1998, Environment Canada was already projecting that 1998 would be the warmest year in Canadian history. For example, parts of the Northwest Territories experienced average temperatures 5°C above normal in 1998. This is consistent with the findings of the Mackenzie Basin Impact study, which found that average temperatures in the Northwest Territories have increased by 1.5°C this century.[1] Another recent study now indicates that spring is arriving a week earlier in the Arctic than it did a decade ago.[2] While these changes may sound like good news to many Canadians, the Arctic's fragile ecosystems and permafrost base are seriously threatened by such dramatic climatic shifts.

But temperature is only one element of climate change. Changes in temperature will produce changes in other weather elements like precipitation and wind patterns. While individual weather events like a drought cannot yet be directly attributed to climate change, there is increasing evidence that we are seeing an increase in the frequency and severity of extreme weather events and their impact, consistent with what is projected to occur as a result of climate change. Dr. James Bruce, the former director of meteorology for Environment Canada notes that "[I]n Canada, forest fires, insects, and diseases have affected twice as much area of the boreal zone in the 1980s and 1990s, as in previous decades. And in Calgary, the average frequency of large hail storms (hail stones greater than 20 mm) has increased from one every four years in the 1980s to two every year in the 1990s."[3]

Continued climate change could have drastic consequences in many parts of Canada. In low-lying coastal areas, rising sea levels could mean relocation for thousands of families, or huge expenditures to build protective dykes and other structures. Government and academic research indicates increased ocean temperatures due to climate change may also change movements of Pacific salmon stocks, forcing a northern migration away from Canadian waters.[4] In the Prairie provinces, scientific analysis predicts altered rainfall patterns that may produce a potentially significant reduction in groundwater tables, affecting water availability for humans, as well as for birds, fish and other animals. As a result, the Prairie grain harvest could fall by 10 to 30 percent.[5] In Toronto, the average annual number of days when temperatures exceed 30°C is expected to increase from about 10 to more than 50, with important implications for human health.[6]

Such temperature will worsen air pollution in and around Canadian cities because temperature is a critical factor in the formation of ground level ozone.[7]

These are just some of the changes that we are likely to face in Canada as a result of climate change. Fully detailing the potential effects on ecosystems, flora and fauna, local weather patterns, water systems and human activities (including economic activity) is beyond the scope of this report. Nevertheless, there is every indication, from existing scientific research, that the effects will be substantial, and could be devastating.[8]

Now that there is a broad scientific consensus that climate change is occurring, the debate in Canada has shifted to a narrow focus on the financial costs of taking action to reduce fossil fuel combustion and mitigate climate change. This discussion, however, has usually failed to consider the benefits of taking action, and the costs of not taking action.

For example, action to reduce greenhouse gas emissions through more efficient use of fossil fuels and increased use of renewable energy resources will reduce emissions of a host of hazardous air pollutants, including those that contribute to urban smog and acid rain. These complementary emission reductions will substantially reduce costs on our health care system and help save lives, since current estimates indicate that up to 16,000 Canadian die prematurely as a result of air pollution each year.[9] There are also a number of environmental impacts associated with the production and distribution of fossil fuels that will be reduced through action to protect the climate.

In addition, investments in renewable energy and energy efficiency will bring net economic benefits. For example, energy efficiency investments have been found to produce four times as many jobs as equivalent investments in new energy supply.[10] Reduced energy bills will improve industrial competitiveness and provide more disposable income to individuals and small businesses. If Canada is to succeed and prosper in a future low-carbon, energy-efficient global economy, steps must be taken now to encourage the development of energy efficient and renewable energy technologies and industries in Canada.

Finally, the current debate has often ignored the financial costs that will be incurred as a result of climate change. These include public health costs, crop losses, ecological damage, infrastructure replacement and upgrading, the costs of violent weather episodes, and social dislocation costs. It is essential that debates in Canada about how to implement the Kyoto Protocol consider the rising costs and risks of 'business as usual' in any assessment of the costs of emission reduction strategies.

In spite of opposition from a number of fossil fuel producers, the federal government has made a commitment to address climate change. In 1990, the federal government pledged to return Canada's greenhouse gas emissions to 1990 levels by the year 2000. This commitment was reaffirmed at the 1992 United

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Nations-sponsored Earth Summit in Rio de Janeiro and in the official platform of the Liberal government in the 1993 and 1997 federal elections. In 1998, Canada signed the Kyoto Protocol to the United Nations Framework Convention on Climate Change. When the Protocol is ratified and enters into force, it will require Canada to reduce greenhouse gas emissions to 6 percent below 1990 levels averaged over the 2008-2012 period.

These commitments are important because Canada is a major contributor to climate change. Canadians consume more energy per capita than any other country and more total energy than the 700 million inhabitants of Africa.[11] Canada is also the second largest per capita emitter of greenhouse gases in the world.[12]

While commitments have been made, Canada's federal and provincial governments have failed to take action to protect the global climate. Words have spoken more loudly than deeds. Aside from the establishment of some new energy efficiency standards for domestic appliances, Canada has done little more than make a plea for industry to voluntarily take action to reduce greenhouse gas emissions. With the exception of a small number of companies, this plea has not generated any new action by industry to protect the climate.[13] As a result, greenhouse gas emissions in Canada are moving rapidly in the wrong direction. In 1990, Canada's total greenhouse gas emissions were 599 megatonnes (Mt).[14] In 1996, emissions rose to 670 Mt – an increase of 12 percent. These trends have led the Canadian government to formally abandon its commitment to stabilize greenhouse gas emissions at 1990 levels by the year 2000.

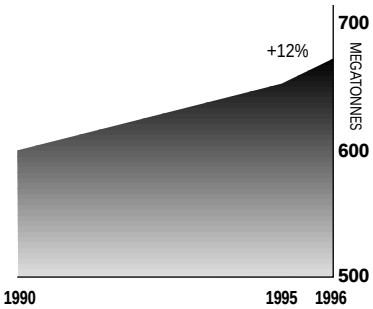

FIGURE 1. CANADA'S GREENHOUSE GAS EMISSIONS 1990-1996

SOURCE: Environment Canada

If Canada is serious about complying with its more stringent commitments under the Kyoto Protocol, it will have to move from rhetoric to action, and it will have to do so quickly. *Canadian Solutions* demonstrates how this can be done in an economically sound and practical way.

Canada and the Kyoto Protocol

The Kyoto Protocol was negotiated in December 1997. Under the Protocol, industrialized countries have committed to reduce their total greenhouse gas emissions to, on average, approximately 5% below 1990 levels in the 2008-2012 period. However, the Protocol represents only a small first step on the road to the 60%-80% reduction in global greenhouse gas emissions that are required to stabilize the atmospheric concentration of greenhouse gases at a level less than a doubling of pre-industrial levels.[15]

The Kyoto Protocol will require Canada to reduce greenhouse gas emissions to, on average, 563 Mt a year in the 2008-2012 period (6% below 1990 levels). The most recent official projection from Natural Resources Canada indicates that Canada's greenhouse gas emissions are projected to be 19%-20% above 1990 levels in the year 2010. In other words, Canada's greenhouse gas emissions

in the year 2010 are projected to be 140 Mt above the level required under the Kyoto Protocol.[16] This represents Canada's emissions 'gap'.

What is Canada doing to reduce the 'gap'? In early 1998, Canada's federal, provincial and territorial Energy and Environment Ministers agreed to launch an 18 month process to examine measures Canada could take to implement the Kyoto Protocol. This process, which finally got started in June 1998, is likely to cover a lot of old ground. After all, a similar 18-month process in 1993-94 identified more than 80 actions Canada could take to reduce greenhouse gas emissions.[18] The Climate Action Network's Rational Energy Program demonstrated that it is possible to meet a Kyoto-type target with a package of measures that would create 1.5 million net jobs.[19]

At the same time, the new process has rapidly become unmanageable. Fourteen "Issue Tables", each with 25-40 participants, are now examining potential mechanisms to reduce greenhouse gas emissions. At this time, there is no clear process for integrating this work into a single package, and it remains unclear what process will be used to analyze and assess whatever package of measures is finally developed. After several months of operation, the process has produced little more than work plans, budgets, and a schedule for future work. It is currently difficult to imagine this process delivering an action plan by the end of 1999 that governments will implement to meet Canada's commitments under the Kyoto Protocol.

Action is needed now to reduce greenhouse gas emissions. Substantial early action is important for several reasons:

- Acting now to reduce greenhouse gas emissions will start us on the road to meeting our Kyoto commitment in a low-cost, predictable, staged and easily achievable manner. By delaying action, Canada will be forced to meet its Kyoto obligations in a shorter time frame, increasing costs for all Canadians.
- Acting now to reduce greenhouse gas emissions can have an immediate impact on emissions of gases that contribute to the formation of urban smog and other pollutants. Canadians are increasingly concerned about the health impacts of urban air quality.
- Acting now to reduce greenhouse gas emissions can bring immediate economic benefits to Canadians and Canadian industry by improving the efficiency with which we use energy. Doing more with less will put money in the pockets of individuals and businesses that can be reinvested in the economy – creating new economic activity and jobs.
- Acting now to reduce greenhouse gas emissions will provide Canadian industry with a clear incentive to become more energy and resource efficient and less carbon-intensive. This will help to better position these industries to compete in the global economy. Failing to act means coun-

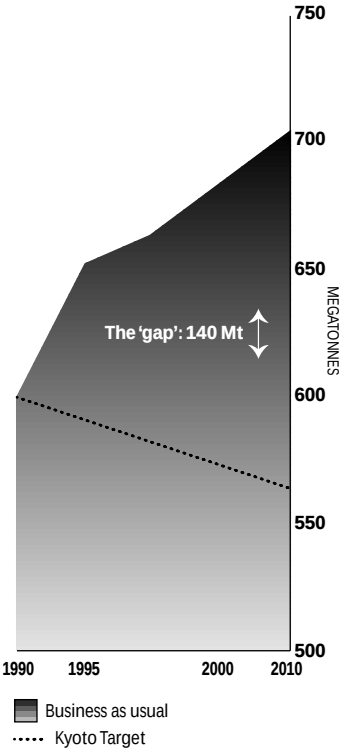

FIGURE 2. CANADA'S MOST RECENT OFFICIAL PROJECTION OF GREENHOUSE GAS EMISSIONS TRENDS[17]

SOURCE: Natural Resources Canada

Canada's greenhouse gas emissions in the year 2010 are projected to be 140 Mt above the level required under the Kyoto Protocol.

If Canada is to implement the Kyoto Protocol, the federal and provincial governments must demonstrate political will and leadership by taking immediate and significant actions to reduce greenhouse gas emissions.

tries that are taking action now to reduce greenhouse gas emissions will gain a competitive advantage over Canada. Meeting tough environmental targets, including greenhouse gas emission reductions, is an important part of industrial competitiveness strategies for a growing number of countries because such targets drive efficiency and innovation.

- Acting now will demonstrate to the global community, particularly the developing nations, that Canada is willing to lead and that will encourage them to act as well.

If Canada is to implement the Kyoto Protocol, the federal and provincial governments must demonstrate political will and leadership by taking immediate and significant actions to reduce greenhouse gas emissions. This action must move beyond voluntary initiatives. While voluntary programs have a role to play in Canada's climate change strategy, they will only work if they are complemented by strong regulations that establish minimum levels of performance and fiscal measures that provide clear incentives for greenhouse gas emissions reduction.

Government, however, does not bear all responsibility for addressing the climate change issue. Industry must move from denial of climate change to constructive implementation of solutions. Only a handful of Canadian companies have made this shift and are seriously tackling the climate protection challenge. And individual Canadians must accept responsibility for their own contribution to the problem and begin to take action. While many of the initial actions Canada can take to reduce greenhouse gas emissions will not require radical lifestyle changes, Canadians need to start examining how lifestyle changes can improve environmental and economic sustainability as well as the attractiveness and livability of our communities.

Why *Canadian Solutions*?

The Pembina Institute and the David Suzuki Foundation have produced *Canadian Solutions* to meet the following objectives:

- provide Canadian citizens with advice on specific policy changes they should demand be implemented by their elected officials,
- educate Canadian individuals, institutions, and businesses about practical opportunities to reduce greenhouse gas emissions,
- inform those who are participating in national and provincial processes to design action plans to implement the Kyoto Protocol about key greenhouse gas emission reduction "opportunity areas" and the scope of those opportunities, and
- provide governments with a set of practical, affordable and effective actions, and an implementation strategy, that will allow Canada to meet the reductions set out in the Kyoto Protocol.

Published in April 1998, the initial outline of *Canadian Solutions* briefly described 15 actions Canada could take that would allow it to implement the Kyoto Protocol. In this comprehensive version, some 17 actions are discussed, defined and analyzed in more detail. In addition, a proposed implementation strategy is provided for each action.

The action plan set out in this publication is not the only package of actions that would allow Canada to implement the Kyoto Protocol. Indeed, we reference a number of additional actions that could be taken to reduce greenhouse gas emissions. Nonetheless, most of the actions presented here are likely to be an integral component of Canada's climate protection action plan, and Canadians need to get moving on implementation for the sake of protecting our ecosystem and our economy.

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Summary of the results produced by *Canadian Solutions*

Canadian Solutions describes 17 initiatives Canada should take to reduce greenhouse gas emissions. Taken together, these measures would reduce Canada's greenhouse gas emissions by 143.6 Mt from what they would have been in the year 2010 without *Canadian Solutions*. These emission reductions are more than enough to fill Canada's 140 Mt emissions 'gap' and thereby meet its commitment under the Kyoto Protocol to reduce its greenhouse gas emissions to six per cent below 1990 levels in the period 2008-2012. Table 1 lists the greenhouse gas emission reductions generated by each of the 17 initiatives. Appendix B provides a description of the methodology used to make each of these estimates.

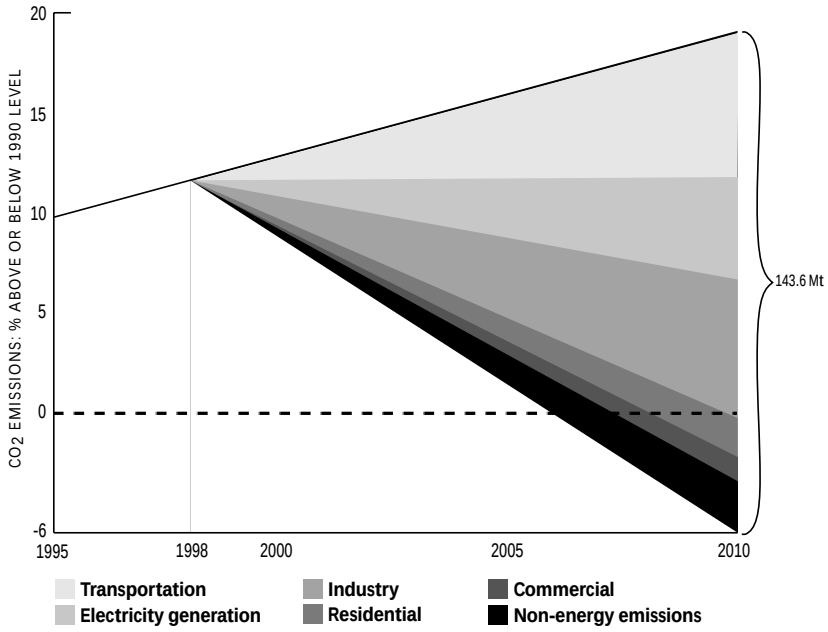

FIGURE 1. FILLING CANADA'S EMISSIONS GAP

The role these 17 measures can play in helping Canada to meet its Kyoto commitment is illustrated graphically in Figure 1.

It must be noted that the 17 measures described above are not the only initiatives described in *Canadian Solutions*. Adoption of a number of the additional measures listed at the end of each chapter can produce additional emission reductions that will provide a "safety margin" if Canada's emission gap exceeds 140 Mt and will also move Canada toward the much larger emission reductions that are ultimately required to address the climate change issue.

TABLE 1. **ESTIMATES FOR GREENHOUSE GAS EMISSIONS REDUCTIONS FROM THE ACTIONS PROPOSED IN CANADIAN SOLUTIONS**

	Policy	GHG Emission Reduction (Mt)
TRANSPORTATION		
1	Improved and mandatory fuel economy standards for vehicles	25.8
2	Phased increases in gasoline and diesel taxes	7.5
3	Actions to increase the use of alternative modes of transportation	4.7
4	Mandatory 5% renewable energy content in gasoline	3.1
5	Stricter enforcement of reduced speed limits	2.2
	Sub-total	**43.3**
ELECTRICITY GENERATION		
6	Net metering policies	1.1
7	Level playing field for low-carbon energy sources	19.2
8	Producing electricity from waste solution gas	0.9
9	Adopting a 10% renewable energy portfolio standard by 2010	7.8
	Sub-total	**29.0**
INDUSTRY		
10	Cap and allowance emissions trading (domestic)	26.0
11	Using the Kyoto Protocol's flexibility mechanisms	14.0
	Sub-total	**40.0**
RESIDENTIAL		
12	Mandating an R-2000 building code for new homes	3.7
13	Cost-effective energy efficient retrofits of Canadian homes	7.2
	Sub-total	**10.9**
COMMERCIAL		
14	Cost-effective energy efficient retrofits of commercial buildings	4.4
15	Providing support for district energy	2.0
	Sub-total	**6.4**
NON-ENERGY EMISSIONS		
16	Mandating the capture of landfill methane gas	11.0
17	Reducing methane emissions from livestock manure management	3.0
	Sub-total	**14.0**
	Total	**143.6**

Responsibility for limiting greenhouse gas emissions during the 2008-2012 period must therefore be allocated clearly to all sectors and all Canadians.

THE DISTRIBUTION OF RESPONSIBILITY FOR GREENHOUSE GAS EMISSIONS REDUCTION

Canada's commitment under the Kyoto Protocol is a national commitment. But the sources of greenhouse gas emissions covered by the commitment are so numerous and diverse that the commitment can only be met if all governments and all sectors of society act to reduce their emissions. Responsibility for limiting greenhouse gas emissions during the 2008-2012 period must therefore be allocated clearly to all sectors and all Canadians.

The federal government has stated that "all sectors and regions should do their share [to help Canada meet its climate protection commitment], but no region or sector should be asked to bear an unreasonable share of the burden of mitigation actions such that actions would prevent economic growth". It is only through an explicit allocation of responsibilities that it will be possible to assess whether all sectors and regions have been asked to bear a reasonable share of the burden.

The national process developing an implementation strategy for the Kyoto Protocol in Canada is avoiding the allocation issue, despite its fundamental importance. This report demonstrates that we can allocate responsibility in a manner that is fair, equitable and manageable for all Canadians.

For example, Table 2 provides a summary of the projected growth rates in emissions in different sectors according to *Canada's Energy Outlook: 1996-2020*.

Table 3 illustrates how the actions described in *Canadian Solutions* affect greenhouse gas emissions from different sectors in the year 2010. It also presents three different ways to assess the relative contribution of each sector to the total emission reductions generated:

- final emissions in each sector relative to 1990 levels
- percentage reduction in emissions in each sector relative to projected 2010 levels in Canada's Energy Outlook, and
- percentage contribution to the total emission reductions generated.

TABLE 2. CANADA'S ENERGY OUTLOOK: 1996-2020

SECTOR	1990 EMISSIONS (Mt)	PROJECTED 2010 EMISSIONS (Mt)	PROJECTED % CHANGE IN EMISSIONS, 1990-2010
Transportation	149	188	+26%
Electricity generation	95	110	+16%
Industry*	201	245	+22%
Residential	44	38	-13%
Commercial	26	33	+26%
Non-energy**	48	54	+13%

*Fossil fuel production, other industry and 37% of non-energy emissions
**Landfills, agriculture

TABLE 3. SECTORAL EMISSION REDUCTIONS UNDER *CANADIAN SOLUTIONS*

SECTOR	PROJECTED EMISSIONS IN 2010 AS A RESULT OF *CANADIAN SOLUTIONS* (Mt)	FINAL EMISSIONS RELATIVE TO 1990 LEVELS	FINAL EMISSIONS AS A REDUCTION FROM PROJECTED 2010 LEVELS	PERCENTAGE CONTRIBUTION TO CLOSING CANADA'S 140 Mt EMISSIONS GAP
Transportation	145	-3%	-22%	29%
Electricity generation	81	-15%	-26%	20%
Industry*	205	+2%	-16%	28%
Residential	27	-39%	-24%	8%
Commercial	27	+4%	-18%	5%
Non-energy**	40	-17%	-26%	10%

*Fossil fuel production, other industry and 37% of non-energy emissions
**Landfills, agriculture

Greenhouse gas emission reductions for all sectors range from 16% to 26% below projected 2010 levels as a result of the implementation of *Canadian Solutions*.

As Table 3 illustrates, greenhouse gas emissions in different sectors vary widely relative to 1990 levels after the implementation of *Canadian Solutions*. Emissions in the commercial and industrial sectors remain above 1990 levels in 2010, but emissions in the residential sector fall to 39% below 1990 levels in that year. This does not sound very equitable.

A different story emerges, however, when the impact of *Canadian Solutions* on projected emission levels is considered. As demonstrated in Table 3, greenhouse gas emission reductions for all sectors range from 16% to 26% below projected 2010 levels as a result of the implementation of *Canadian Solutions*. When viewed this way, responsibility for greenhouse gas emission reductions appears to be shared much more equitably across different sectors.

Finally, the contribution of each sector to the total greenhouse gas emission reductions generated by *Canadian Solutions* roughly parallels the contribution made by each sector to Canada's current greenhouse gas emissions. In 1995, for example, Canada's greenhouse gas emissions came from: transportation (27%), electricity generation (17%), industry (37%), residential (7%), commercial (4%), and non-energy related emissions (8%). Once again, it would appear that responsibility for emission reductions has been fairly shared when assessed against this yardstick.

OTHER ENVIRONMENTAL AND ECONOMIC BENEFITS

Most of the actions outlined in *Canadian Solutions* reduce our use of carbon-intensive fossil fuels by either:

- improving the efficiency with which fossil fuels are used,
- substituting low-carbon fossil fuels for high-carbon fossil fuels, or
- substituting no-carbon renewable energy sources for fossil fuels.

Any action to reduce fossil fuels produces a host of other environmental benefits. These include:

- reduced emissions of gases that lead to acid precipitation (e.g., SO_x),
- reduced emission of gases that lead to ground level ozone and urban smog (e.g., NO_x, VOCs),
- reduced emissions of respirable particulate matter, and
- reduced damage to ecosystems associated with the production and transmission of fossil fuels (e.g., oil spills).

These additional environmental benefits are important and must be factored into any analysis about the costs and benefits of taking action to address climate change. Indeed, *Canadian Solutions* can produce significant improvements in public health through reduced production of ground level ozone, respirable particulate matter and acid gases.

For example, it has been estimated that on average, every tonne of CO_2 reduced by decreasing gasoline use in automobiles results in a 0.5 kg reduction in SO_2 and a 9 kg reduction in NO_x.[20] The measures presented in *Canadian Solutions* reduce greenhouse gas emissions from gasoline use by almost 41,700,000 tonnes. As a result, these measures also reduce emissions of sulphur dioxide by almost 21,000 tonnes and emissions of nitrogen oxides by 375,000 tonnes.

Additional reductions are also generated from reductions in the use of fossil fuels at stationary sources. It has been estimated that reducing carbon dioxide emissions by one tonne at a stationary source will reduce emissions of sulphur dioxide by 20 kg and nitrogen oxides by 8 kg. The measures presented in *Canadian Solutions* reduce greenhouse gas emissions from the stationary combustion of fossil fuels in Canada (electricity generation, industry, residential and commercial) by 72,300,000 tonnes. Such a reduction would therefore produce complementary emission reductions of approximately 1.4 million tonnes of sulphur dioxide and 578,000 tonnes of nitrogen oxides.

The measures outlined in *Canadian Solutions* will also provide a number of additional environmental benefits, including:

- improved urban growth management and reduced urban sprawl as less land is needed to meet transportation needs,
- reduced emission of hazardous air pollutants through reduced flaring in oil and gas production,
- improved indoor air quality through energy retrofits of homes and buildings,
- reduced emissions of hydrochlorofluorocarbons and hydrofluorocarbons through increased use of district energy systems to cool buildings,
- reduced stress on vegetation and reduced risk of explosions and fires through reductions in emissions of methane from landfills, and
- reduced surface and groundwater pollution and reduced need for fertilizers through imporved agricultural manure management systems.

We are confident that these measures will result in net economic benefits for

Canada. This is particularly the case when calculations consider life-cycle costs and the multiple environmental benefits of action. Energy efficiency saves money and creates jobs. Fuel switching imposes minimal costs relative to the environmental benefits in many cases. Renewable energy represents an investment in future energy markets. Eco-efficient technologies accelerate competitiveness and open up enormous export opportunities.

In 1996, the Rational Energy Program, a package of measures developed by the Climate Action Network, was found to create 1.5 million net jobs and have an insignificant impact on the economy when a full macroeconomic analysis was conducted. In fact, most macroeconomic studies have shown that the costs of taking action to reduce greenhouse gas emissions in 2010 are small when compared to expected economic growth between now and that date. Indeed many studies have shown that such action will bring economic benefits in the formof new jobs and economic growth. Some of the more recent of these studies include:

- "The Costs of Climate Protection: A Guide for the Perplexed" – World Resources Institute, 1997
- "Scenarios of US Carbon Reductions: Potential Impacts of Energy Technologies by 2010 and Beyond" – US Department of Energy 1997
- "Energy Inovations: A Prospectus Path to a Clean Environment" – Alliance to Save Energy, American Council for an Energy Efficient Economy, Natural Resources Defence Council, Tellus Institute, Union of Concerned Scientists, 1997.
- "Approaching the Kyoto Targets: Five Key Strategies for the United States – American Council for an Energy Efficient Economy, 1998

Pembina Institute and the David Suzuki Foundation hope to further quantify the multiple environmental and economic benefits associated with the full package of measures presented in *Canadian Solutions*.

AN IMPLEMENTATION STRATEGY FOR CANADA – RECOMMENDATIONS

Canadian Solutions outlines a number of steps federal, provincial and municipal governments must take if they are to implement the actions identified to meet our commitment. These steps are diverse. There is a need for new regulation, new program spending, changes to the tax system, and additional education and voluntary programs. The following text summarizes the actions governments must take to make *Canadian Solutions* a reality.

Federal Government

- The Prime Minister should clearly state that Canada will meet the overwhelming majority of its emission reduction obligations under the Kyoto Protocol through actions at home.

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- The federal government should mandate:
  - new fuel economy standards for vehicles of 5.0 L/100km for passenger vehicles and 7.0 L/100km for light trucks to enter into force in 2005,
  - that all gasoline sold in Canada have a minimum 5 per cent renewable energy content by the year 2010, with interim targets for intervening years such as 2005 and 2008,
  - a cap and allowance emissions trading system that includes large industrial emitters – key design features should be agreed by 2003 for implementation by no later than 2008 (any preceding voluntary credit trading system should recognize this), and
  - greenhouse gas emissions reporting under the National Pollutant Release Inventory.
- The federal government should make the following adjustments to the tax system:
  - include waste solution gas from fossil fuel production as a qualifying fuel in Class 43.1 of the Income Tax Act,
  - extend the accelerated capital cost allowance treatment provided in Section 43.1 of the Income Tax Act to investments in district energy systems,
  - change the tax treatment of employer subsidized transit passes and allow them to be a non-taxable benefit,
  - maintain the current excise tax exemption for ethanol fuels through the year 2010 and extend it to all biomass-based transportation fuels,
  - provide tax credits for investments in home and building energy retrofits if it can be clearly demonstrated that such a retrofit has taken place and is delivering results, and
  - increase the federal excise tax on gasoline and diesel fuels by 2 cents a litre (beyond the rate of inflation) in 1999, 2002, 2004, 2006 and 2008, and offset this increased revenue through an equivalent decrease in other taxes (e.g., sales taxes, payroll taxes, income taxes).
- The federal government should launch the following initiatives:
  - a $1.5 billion Public Transit Improvement Fund that would, on a cost-sharing basis, upgrade and expand public transit infrastructure and support investments in alternative transportation infrastructure (e.g., bicycle paths),
  - a program to offer and promote low-interest loans for energy retrofits in the residential sector, delivered by utilities and financial institutions,
  - a revolving fund for investments in commercial building energy retrofits that would partner with other funding sources to provide loans to building operators seeking to either design or implement an energy retrofit program,
  - a program for large district energy demonstration projects in Canada – the federal government would only participate on a cost-shared basis with provincial/municipal governments and/or the private sector,
  - a Canadian counterpart to the U.S. AgStar program – the federal government would cooperate with provincial agriculture departments in widespread delivery,
  - a significant increase in funding for initiatives like the Green Communities Initiative to help ensure they exist across Canada,

  - additional research, development and commercialization support for transportation biofuel production technologies, including loan guarantees for the construction of production facilities that meet appropriate environmental criteria, and
  - an expanded Federal Buildings Initiative to demonstrate leadership in the use of on-site renewable energy and micro natural gas co-generation technologies.
- The federal government should study:
  - the life-cycle costs and benefits imposed by government (i.e., taxation and subsidies) on competing non-renewable energy options – from resource extraction through to the production of useful energy – and take steps to level the playing field, and
  - design options for ecological tax reform.
- Finally, the federal government should take steps to ensure the environmental effectiveness of the Kyoto Protocol's flexibility mechanisms in ongoing international negotiations

Provincial Governments

- All provincial governments should mandate:
  - retailers of electricity within their jurisdiction to offer a net metering tariff to all retail consumers – residential, commercial, agricultural and industrial,
  - all fossil-fuel fired electricity generation to meet the most stringent emission standard with respect to local and regional air pollutants applied within that jurisdiction,
  - strict and short time limits for the recovery of stranded costs to ensure a rapid transition to a truly competitive marketplace when restructuring the electricity market.
  - a Renewable Energy Portfolio Standard for electricity retailers in the province – the standard should be phased in so that it starts at 3% in 2003, 6% in 2005 and 10% in 2010,
  - an R-2000 building code for new residential construction to enter into effect in the year 2000,
  - all home and building owners to demonstrate that they have implemented a clearly identified basic set of cost-effective energy retrofit measures before a home can be sold, inspected or renovated,
  - reductions in speed limits of 5 km/h on all highways where the speed limit is currently above 90 km/h, and
  - all landfills with a capacity of 1 million tonnes or more to install systems to capture and combust methane gas,
- All provincial government should also:
  - adjust energy resource royalties to ensure a level playing field among all energy resources such that no single energy resource gains an unfair competitive advantage in the marketplace, and
  - increase resources for speed limit enforcement through either increased use of automated equipment (e.g., photo radar) or increased personnel for enforcement purposes, on a cost-recovery basis.

3

Reducing greenhouse gas emissions from transportation **(43.3 Mt reduction)**

In 1995, transportation was responsible for 165 megatonnes (Mt) of greenhouse gas emissions, 27 per cent of Canada's total.[21] This represented an 11 per cent increase over 1990 levels. Greenhouse gas emissions from transportation are projected to increase to 26 per cent above 1990 levels by the year 2010.

Greenhouse gas emissions in the transportation sector arise from the use and combustion of fossil fuels such as gasoline, diesel, and aviation fuels. For example, the combustion of one litre of gasoline produces 2.36 kg of carbon dioxide at the tailpipe. In 1995, Canadians used 32.5 billion litres of gasoline to meet their road transportation needs.[22]

To date, Canadian governments and the auto industry have totally ignored the consideration of greenhouse gas emissions in the development of transportation policies. The substantial shift since the 1960s of passengers from transit to single occupancy vehicles, and of freight from rail to trucks, has been responsible for massive increases in greenhouse gas emissions in the transportation sector. These mode changes are magnified by continuing population increases, falling fuel efficiency in passenger vehicles, increases in the per capita rate of vehicle ownership, increases in the per capita level of distance traveled, and the switch from inventory storage to just-in-time-delivery within the retail industry.

The single biggest contributor to greenhouse gas emissions in the transportation sector is passenger transportation in automobiles and light-duty trucks. In 1995, these emission sources accounted for 55 per cent of total greenhouse gas emissions from the transportation sector. It is also clear that passenger transportation is a major contributor to regional air pollution with attendant mortality and illness.[23] The following are ways to reduce greenhouse gas emissions from passenger road transportation:

- reducing demand for transportation (e.g., walking, cycling, modifications in urban and suburban development patterns, increased telecommuting),

- using transportation fuels more efficiently (e.g., more fuel-efficient vehicles and more fuel-efficient driving practices),
- switching to less carbon-intensive modes of transportation (e.g., public transit, carpooling), and to rail freight, and
- using less carbon-intensive transportation fuels (e.g., ethanol and natural gas).

The measures proposed in Canadian Solutions to address greenhouse gas emissions from passenger road transportation cover all of these emission reduction possibilities. Taken together, it is projected that they will reduce greenhouse gas emissions by 43.3 Mt relative to projected emission levels in 2010. This would reduce greenhouse gas emissions in the transportation sector to 3% below 1990 levels.

While the policies proposed in Canadian Solutions focus on passenger road transportation, additional actions are required to address greenhouse gas emissions from air travel, railways and freight transportation by road. Rail freight is between five and six times more fuel efficient (and therefore CO_2 efficient) than average truck freight. Moving a significant portion of long distance freight haulage back onto railroads is a major opportunity to reduce greenhouse gas emissions as well as to reduce highway congestion, increase passenger safety and solve other environmental problems. Canada's final strategy for implementing the Kyoto Protocol must ensure that air, rail, and heavy truck emission sources are addressed.

The substantial shift since the 1960s of passengers from transit to single occupancy vehicles, and of freight from rail to trucks, has been responsible for massive increases in greenhouse gas emissions in the transportation sector.

Improved mandatory fuel economy standards for vehicles (25.8 Mt reduction)

In 1978 Canada began a vehicle fuel efficiency program in collaboration with the automobile industry that included voluntary targets based on corporate fleet average fuel efficiencies. These were identical to legislated fuel economy standards in the United States (CAFE). Motor vehicle manufacturers agreed to meet these voluntary targets, and this led the federal government to refrain from implementing its 1981 Motor Vehicle Fuel Consumption Act. In Canada, the average target is expressed as litres consumed per 100 kilometres driven.

The current voluntary target for passenger vehicles is 8.6 L/100km, which is equivalent to the U.S. standard of 27.5 miles per U.S. gallon. This standard has been in place in Canada since 1985. Between 1990 and 1997, the average fuel efficiency of new automobiles sold (not including vans and small trucks) was essentially stable, continuing a trend that has existed since 1982.[24] According to Natural Resources Canada, the average fuel economy of new automobiles is expected to improve by only seven per cent between 1995 and 2010, unless new initiatives to improve fuel economy are implemented.

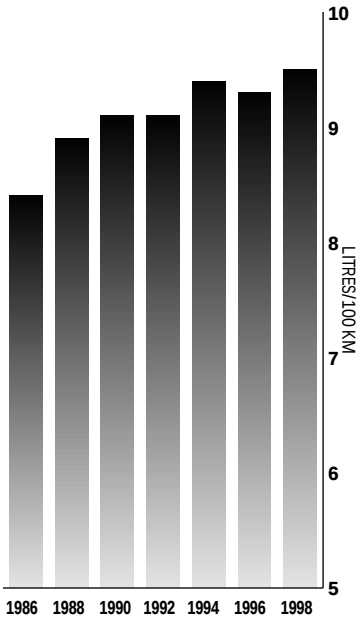

FIGURE 3. COMPANY AVERAGE FUEL CONSUMPTION IN L/100KM – TOTAL CANADIAN NEW VEHICLE FLEET SUMMARY

SOURCE: Transport Canada

As a result of increased sales of sport utility vehicles, trucks and minivans, the overall efficiency of new vehicles (cars and trucks) sold in Canada has been declining rapidly.

In 1990, the Canadian program began including a separate voluntary target for light duty trucks, which includes minivans and sport utility vehicles. Under the program, manufacturers agreed to produce trucks that achieve an average fuel consumption of 11.8 litres for every 100 kilometres driven. Between 1986 and 1998, the average fuel economy of new light-duty trucks has significantly worsened, moving from 10 L/100km to 11.4 L/100km.[25] This is in part a reflection of the boom in sales of sport utility vehicles (SUV's) and minivans in Canada. Between 1982 and 1994, annual sales of these vehicles increased from 9,000 to 190,000 and SUVs and vans now comprise 28 per cent of all new vehicle sales.

As a result of increased sales of SUV's, trucks and minivans, the overall efficiency of new vehicles (cars and trucks) sold in Canada has been declining rapidly. In 1986, the average new vehicle had a fuel efficiency of 8.4 L/100km. By 1998, this had slipped to 9.5 L/100km.[26]

It is possible to do much better. Multivalve engines, lean burn engine technology, improved transmissions, and new lightweight, high-strength materials are all available fuel technologies that could help make the average car meet a 5.0 L/100km standard. In its discussion of readily available fuel efficient technologies, the U.S. National Academy of Sciences pointed out that "most of these technologies have reached only a fraction of their potential application in vehicles sold in the U.S. The adoption of a standard now, with full phase-in not occurring until 2005, would provide manufacturers with the lead time to implement these technologies."

In reality, a number of cars will soon be available that can do better than this proposed standard. Volkswagen's TDI diesel engine in a mid-size Jetta car, already available on the market, now uses less than 4.5 L/100km. Hybrid automobiles like the Toyota Prius, which uses a gasoline engine supplemented with an electric motor for low speeds, are already in production and are capable of driving 28 kilometres per litre of gas (3.6 L/100km). New fuel injection technology by Mitsubishi motors has led to the development of a conventional gasoline engine that is capable of driving 32 kilometres on a litre of gasoline. The Mitsubishi Galant, which is not available in North America because of the high sulphur content in our fuel, is capable of driving 100 kilometres on 3.15 litres of gasoline at a constant speed of 60 kilometres per hour.

Elsewhere, automobile manufacturers appear ready to move forward and improve fuel economy. For example, the European Union has recently accepted a proposal from the European Automobile Manufacturers Association (EAMA) to voluntarily improve the average fuel economy of new cars to 6 L/100 km by 2008. The EAMA is also promising efficiency gains in the truck sector. It should be noted that Ford and General Motors are members of the EAMA.

DESCRIPTION OF THE MEASURE

The federal government must implement mandatory fuel economy standards for new automobile fuel efficiency in the year 2000, utilizing the 1981 Motor Vehicle Fuel Consumption Act. These new standards should require an average achievement in model year 2005, of 5 L/100km for automobiles and 7 L/100km for light trucks. Large vehicles that are primarily used as passenger vehicles, such as sport utility vehicles and minivans, should be included in the standard for cars.[27]

GREENHOUSE GAS EMISSION REDUCTION BENEFITS

Implementing these new mandatory fuel economy standards for vehicles, beginning in 2005, will reduce greenhouse gas emissions 25.8 Mt from projected levels in the year 2010.

The impact of this measure is also significant at the level of the individual automobile owner. In Canada, the average distance traveled per vehicle each year is 21,500 km. The average car on the road today uses 11.8 L/100km and therefore generates 5.57 tonnes of CO_2 each year. Under the proposed standard of 5 L/100km, a car would emit only 2.36 tonnes of CO_2 each year.

MULTIPLE ENVIRONMENTAL BENEFITS

Like all measures that reduce fossil fuel use, this measure will also reduce local and regional air pollutants including SOx, VOCs, particulate matter and NOx. Regional air quality problems in urban areas from Vancouver to Montreal are costing billions of dollars a year.. New mandatory fuel economy standards can help address these problems at no additional cost.

For example, it has been estimated that on average, every tonne of CO_2 reduced by decreasing gasoline use in automobiles results in a 0.5 kg reduction in SO_2 and a 9 kg reduction in NO_x.[28] These reductions produce very significant improvements in public health due to reduced production of ground level ozone, respirable particulate matter and acid gases.

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ECONOMIC COSTS AND BENEFITS

The American Council for an Energy Efficient Economy estimates that an 80 per cent improvement in automobile energy efficiency is technically achievable at a cost of $1,200 (CDN) per vehicle.[29] Consumer savings on fuel bills would return the $1,200. For example, at an average driving distance of 20,000 kilometres per year the fuel savings attributable to this measure, if gasoline is $.50 per litre, would amount to $360 per year for a car. This means that there is a three to four year payback on the original investment, well within the lifespan of the average vehicle.

Furthermore, analysis presented to the U.S. Congress has concluded that

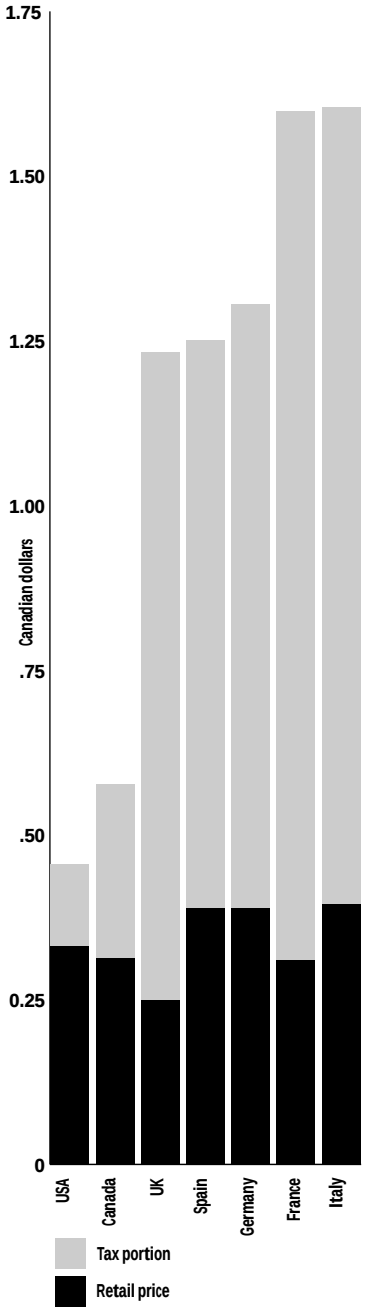

FIGURE 4. RETAIL PRICE OF GASOLINE IN SELECTED COUNTRIES ($CDN/L)[32], AND PERCENTAGE OF RETAIL GASOLINE PRICE REPRESENTED BY TAXES, MAY 1996[35]

improving American CAFE standards to 5.25 L/100km. (45 mpg) for cars and 6.9L/100km.(34 mpg) for trucks by 2008 would save Americans more than $200 billion in gasoline costs, or $2,160 per family, over the next ten years.[30]

AN IMPLEMENTATION STRATEGY FOR CANADA – RECOMMENDATIONS

1. The federal government should mandate new fuel economy standards for vehicles of 5.0 L/100km for cars and 7.0 L/100km for light trucks to enter into force in 2005. In these negotiations, sport utility vehicles and mini vans should be classified as passenger vehicles since this is their primary function. This measure would simply require the federal government to proclaim the existing 1981 Motor Vehicle Fuel Consumption Act and mandate the new fuel economy standards.
2. Canada should make an effort to implement such standards in a coordinated manner with the United States, but if need be, Canada must act unilaterally to implement fuel economy standards for all cars sold in Canada. It is clear that a standard that applies in both Canada and the United States will have a stronger impact on new technology development in the North American car market. In March 1996, Natural Resources Canada (NRCan) signed a Memorandum of Understanding (MOU) on road transportation energy efficiency and alternative fuels with the United States Department of Energy that provides a formal mechanism to negotiate and harmonize North American policy regarding fuel efficiency. No action, however, has been taken to pursue this opening with regard to fuel economy standards.

Phased increases in gasoline and diesel taxes

(7.5 Mt reduction)

One of the basic principles of economics is that demand for a good or service will decrease as the price of that good or service increases. In the area of transportation fuels, Canadians have received little in the way of market signals to encourage decreased consumption of transportation fuels.

For example, Figure 4 illustrates the fact that Canadians pay significantly less for transportation fuels than citizens of many other major industrialized countries. In fact, the price of transportation fuels is typically two to three times higher in the European Union than in North America, and per capita fuel consumption is approximately one-third that of North America.[31]

Just as important as a comparison of prices between countries, however, is a comparison of the price Canadians have paid for transportation fuels over time. In reality, the real price Canadians pay for transportation fuels (adjusted for

inflation) has changed little over time. Table 2 illustrates that Canadians paid essentially the same price for gasoline in 1996 as they did in 1957.

Federal and provincial governments can influence market signals in this area and already play a significant role in determining the price of transportation fuels like gasoline and diesel. In fact, taxes accounted for 48% of the cost of gasoline purchased in Canada in May 1996.[34] While this is a significant proportion of the total price, Figure 4 illustrates that it is much less than the taxes charged by other major industrialized countries on transportation fuels.

It should be noted that the federal government has not increased its excise taxes on diesel fuel (currently 4 cents a litre) since 1987. Federal excise taxes on gasoline (currently 10 cents a litre) have increased only once since 1990. This stands in stark contrast to the position taken by a number of other major industrialized countries in the wake of international agreements to protect the global climate.

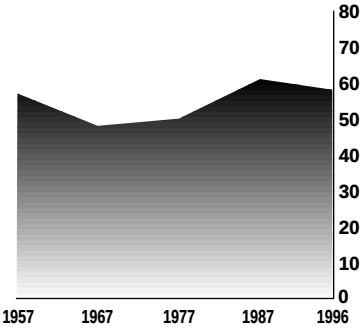

FIGURE 5. **REAL PRICE OF GASOLINE IN CANADA ($1995 /L)**[33]

For example:

- In Norway, taxation is the main instrument being used to limit carbon dioxide emissions from the transportation sector. From 1990 to 1997 gasoline taxes in Norway were increased by 70%. This contributed to a reduction in the consumption of gasoline in the transportation sector of more than 8% between 1990 and 1995.[36]
- In the United Kingdom, duties on transportation fuels were increased by 7 cents per litre in the 1993 Budget (an 8%-10% increase). A further commitment was made to increase duties on transportation fuels by, on average, at least 5% a year above the rate of inflation.[37] In fact, taxes on transportation fuels have been increasing at a more rapid rate since 1993.

Low transportation fuel prices in Canada not only provide little incentive to reduce greenhouse gas emissions, they also unfairly subsidize travel by automobile because car owners are not required to cover the full environmental, health and other costs associated with the development, maintenance and use of transportation infrastructure. Clearly, Canadian governments have an opportunity to reduce greenhouse gas emissions through increased taxes on gasoline and diesel fuels.

Low transportation fuel prices in Canada not only provide little incentive to reduce greenhouse gas emissions, they also unfairly subsidize travel by automobile because car owners are not required to cover the full environmental, health and other costs.

DESCRIPTION OF THE MEASURE

The federal government should make a commitment to increase the federal excise tax on gasoline and diesel fuels by 2 cents a litre in the 1999 Budget. It should also indicate that as part of Canada's efforts to implement the Kyoto Protocol and improve the urban environment, Canada's National Action Program on Climate Change will call for further increases in the federal excise tax on gasoline and diesel fuels of 2 cents a litre beyond the rate of inflation in each of the years 2002, 2004, 2006 and 2008.

Revenue generated through these fuel tax increases should be offset by equivalent reductions in tax revenue from other sources, consistent with the principles of ecological tax reform.

Revenue generated through these tax increases should be offset by equivalent reductions in tax revenue from other sources (e.g., income taxes, payroll taxes, sales taxes), consistent with the principles of ecological tax reform (see Appendix A). The federal government should attempt to implement such changes in a harmonized fashion with the United States, but should move alone if the United States is unwilling to participate.

A single increase of 2 cents a litre in the price of gasoline is unlikely to have a large impact on greenhouse gas emissions. After all, the retail price of transportation fuels fluctuates much more significantly in the course of the year. Accordingly, this measure seeks to send a clear market signal that increases gasoline and diesel prices, but more importantly indicates that these prices *are expected to continue increasing at a steady rate throughout the next decade*.

This long-term signal will be much more effective at encouraging consumers to reduce vehicle usage, engage in more fuel-efficient driving behaviour, and shift towards more fuel efficient vehicles and less carbon-intensive fuels. It also signals a shift to ensure that the car user begins to pay more of the full environmental, health and municipal land use costs of transportation and thereby reduces public subsidization of the automobile.

GREENHOUSE GAS EMISSION REDUCTION BENEFITS

It is estimated that the proposed increases in federal excise taxes applied to gasoline and diesel fuels will reduce Canada's greenhouse gas emissions by 7.5 Mt from projected levels in the year 2010.

ECONOMIC COSTS AND BENEFITS

A 2 cent increase in the federal excise tax on gasoline and diesel fuels would raise $963 million at 1995 consumption levels. This increased tax revenue will be offset by an equivalent reduction in other taxes (e.g., income taxes, sales taxes, payroll taxes and premiums) consistent with the principles of ecological tax reform.

There is some concern that increasing the gap between gasoline and diesel fuel prices between Canada and the United States will increase "cross-border" shopping for transportation fuels. However, the "cross-border" shopping issue is overstated as there is already a significant gap between the prices of transportation fuels in the two countries yet most people continue to shop at home.

AN IMPLEMENTATION STRATEGY FOR CANADA – RECOMMENDATIONS

1. In the 1999 Federal Budget, the federal government should increase the federal excise tax on gasoline and diesel fuels by 2 cents a litre. This tax increase should be accompanied by an equivalent decrease in other taxes

(e.g., sales taxes, payroll taxes, income taxes) consistent with the principles of ecological tax reform.

2. In the 1999 Federal Budget, the federal government should clearly indicate that as part of Canada's strategy to implement the Kyoto Protocol, further increases in the federal excise tax for gasoline and diesel fuels of 2 cents a litre beyond the rate of inflation are planned for the years 2002, 2004, 2006, and 2008. Once again, the revenue generated by these tax increases should be offset by reductions in other taxes.
3. The federal government should work with the United States in an effort to have them implement similar fuel tax increases in a harmonized manner, but if these discussions fail to produce results, the federal government must act to implement such tax increases in Canada unilaterally.

Actions to increase the use of alternative modes of transportation (4.7 Mt reduction)

There are many modes of transportation that are more carbon friendly than traveling alone in an automobile. For example, walking and bicycling produce virtually no greenhouse gas emissions. Car pooling spreads the emissions produced among a larger number of passengers. Finally, it has been estimated that a passenger traveling on a fully occupied diesel bus uses 1/3 of the amount of fuel used by a passenger in a single occupant vehicle.[38]

Unfortunately, public transit usage has decreased by 13 per cent since 1990.[39] Simultaneously, between 1990 and 1995 the number of light duty vehicles (LDVs) on the road has increased from 14.74 million to 16.1 million (9 per cent) and the average distance driven in LDVs increased by 6 per cent.[40] As a result of these trends, greenhouse gas emissions from LDVs increased by 10 Mt (12 per cent) between 1990 and 1995.[41]

Unfortunately, public transit usage has decreased by 13 percent since 1990.

Commuting to and from work currently accounts for approximately 30 per cent of LDV usage. As a result, it is estimated that commuting by LDV produced 27 megatonnes of CO_2 emissions in 1995. Data from the 1996 Census indicates that 8.9 million people, 73 per cent of the Canadian workforce, drove to work as the single occupant of a vehicle while only 10 per cent commuted by public transit, 7 per cent carpooled, another 7 per cent walked and 2 per cent bicycled. Clearly, there is an opportunity to use a mix of initiatives to promote and increase the use of alternative modes of transportation.

While such action will reduce greenhouse gas emissions, it will also improve regional and local air quality, ease road congestion, and reduce both unproductive commuting time and municipal infrastructure costs. These additional benefits alone justify action in this area.

DESCRIPTION OF THE MEASURE

By providing transit funding, removing tax penalties against employee sponsored transit passes, and supporting alternative modes of transportation, government can reverse the trend towards single passenger vehicle use. Initiatives which can lead to mode shifting include the following:

Improving the Attractiveness, Frequency and Convenience of Transit Services

By modernizing bus fleets and adopting transit prioritization technologies, local transit companies can improve the attractiveness of commuter bus travel. New information technologies can be used to provide better co-ordination of bus fleets, road networks and high priority routes, delivering greater reliability and convenience to transit users.

Currently local and provincial governments spend nearly $3 billion per year on transit, while the federal government provides no funding. In fact Canada is the only OECD country in which the national government provides no funding for transit.[42] Nonetheless, Ottawa collects $4 billion per year in fuel taxes. In order to revitalize transit in Canada the federal government should establish a Public Transit Improvement Fund aimed at upgrading and expanding transit infrastructure and offsetting operating deficits for local transit companies. The fund should be equivalent to 25 per cent ($1.5 billion) of the annual fuel tax revenue. It should be provided to projects on a cost-shared basis with provincial and municipal governments. The objective of the fund is to increase transit use from 10% to 25% of all commutes by the year 2010.

In Canada, it is estimated that removing the tax penalty for transit passes will result in 5 percent of single occupant vehicle travelers changing their mode of transportation for commuting by 2010.

Support for Alternative Modes of Transportation

A portion of the fund should also be set aside to invest in alternative transportation infrastructure such as intraurban bicycle routes and support for commuter ride matching services. In addition, these funds could support the development of High Occupancy Vehicle (HOV) lanes which would be dedicated to buses and car pools. The objective of this measure is to make car pooling and bicycle commuting more feasible so that these transportation modes can, by 2010, attract a further 5 per cent of commuters now traveling alone in automobiles.

Allow Employer Subsidized Transit Passes to be a Non-Taxable Benefit

Employees who receive free parking rights from employers currently do not have to declare this benefit as income, creating a tax subsidy for parking. At the same time, if an employee receives a transit pass it must be declared as income, creating a transit tax penalty. In Canada, it is estimated that removing the tax penalty

for transit passes will result in a further 5 per cent of single occupant vehicle travelers changing their mode of transportation for commuting by 2010.[43]

GREENHOUSE GAS EMISSION REDUCTION BENEFITS

Implementing alternative transportation initiatives aimed at reducing single occupant automobile use from 73 per cent to 50 per cent of commuter trips will reduce greenhouse gas emissions by 4.7 Mt from projected levels in the year 2010.

MULTIPLE ENVIRONMENTAL BENEFITS

Increasing public transit usage and infrastructure will contribute toward improvements in urban growth management, thereby reducing the cumulative impacts of urban sprawl. As commercial centres and more compact residential developments occur along transit lines, the amount of land dedicated to urban areas is reduced. Additionally, as fewer cars are on the road and congestion decreases, less land is needed for new roads.

In cities which practice compact growth management the amount of land needed for urban areas decreases dramatically, as do municipal infrastructure costs. For example, the city of Portland, Oregon has grown by 50 per cent over the last 20 years while the urban area has expanded by only 2 per cent, while Chicago's population grew by 4 per cent and used 46 per cent more land over the same period.[44]

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ECONOMIC COSTS AND BENEFITS

For every $1 million invested in public transit 21.4 full-time jobs are created.[45] In addition, property values increase due to increased opportunities for higher density development and revitalization of previously abandoned areas.

AN IMPLEMENTATION STRATEGY FOR CANADA – RECOMMENDATIONS

1. The federal government should change the tax treatment of employer subsidized transit passes and allow them to be a non-taxable benefit.
2. The federal government should establish a $1.5 billion Public Transit Improvement Fund that would, on a cost-sharing basis, aim to upgrade and expand public transit infrastructure and offset operating deficits for local transit companies. A portion of the funds should be made available, on a cost-shared basis, to support investments in alternative transportation infrastructure such as intraurban bicycle routes and support for commuter ride matching services.

Although Canada is one of the world's most important agricultural and forest fibre producers, it is not one of the world's 10 leading producers of ethanol.

Mandatory renewable energy content in gasoline
(3.1 Mt reduction)

Canadians use a variety of transportation fuels, but gasoline is by far the most dominant in the market place. Gasoline provided 73 per cent of the energy used by Canadians for road transportation in 1995. Other fuels that contribute to Canada's road transportation energy needs are diesel (24 per cent) and propane (2 per cent), with minor contributions from natural gas, electricity, and ethanol.[46]

Each of these fuels has a different greenhouse gas emission profile. Ethanol fuels and other biofuels (e.g., biodiesels) are produced from biomass sources like corn, grain, wood waste, and agricultural waste. If the biomass used to produce the fuel is harvested in a sustainable manner, there will be no net increase of carbon dioxide into the atmosphere when these fuels are combusted. Carbon released through combustion will be offset by carbon sequestered by growing biomass.

This does not mean, however, that all biomass-based fuels provide equal benefits. After all, it is also important to consider the greenhouse gas emissions associated with the production, and not just the combustion, of these fuels. These emissions differ from biomass source to biomass source and production process to production process. Even on a life-cycle basis, however, most of these fuels are significantly less greenhouse gas intensive than gasoline.

There has been some effort in Canada to promote the use of ethanol as a transportation fuel. For example, the federal government currently provides an excise tax exemption for alternative transportation fuels like ethanol, methanol, natural gas and propane. In addition, the federal government has provided some loan guarantees to ethanol producers that have allowed them to secure financing for production facilities from commercial sources.

The result is that Canada now produces 212 million litres of ethanol each year, of which 70% is from one world-scale corn ethanol plant.[47] This, however, is far short of potential biomass-based fuel production in Canada. Although Canada is one of the world's most important agricultural and forest fibre producers, it is not one of the world's 10 leading producers of ethanol. Indeed, it has been conservatively estimated that Canada has the potential to easily produce over 5 billion litres of ethanol from grain and lignocellulose feedstocks each year.[48]

Biomass-based fuels will not wholly replace gasoline. After all, Canadians used approximately 32.5 billion litres of gasoline in 1995. Nonetheless, it is possible to create ethanol/gasoline blends, and increasing the production and consumption of biomass-based fuel to replace a portion of gasoline consumption is an attractive greenhouse gas emissions reduction opportunity for Canada.

It is also relatively straightforward because technology and infrastructure for the production of ethanol fuels are already available in Canada.

DESCRIPTION OF THE MEASURE

The federal government should pass a regulation requiring all transportation fuels sold in Canada to have a minimum 5 per cent renewable energy content by the year 2010. Already in Canada, some gasoline retailers (e.g., Sunoco, Mohawk) offer ethanol-blended gasoline. This measure would require all gasoline sold in Canada to have a similar composition.

As large scale ethanol production technologies that use low cost feedstocks are just now emerging, it is more expensive to produce ethanol and other biomass-based transportation fuels than to produce gasoline. While this is true, it is also true that the price of gasoline does not incorporate and reflect the environmental impacts associated with its production and consumption. Nonetheless, to ensure that the standard is met, the following complementary measures would also be put in place:

- federal and provincial governments would agree to impose no excise taxes on biomass-based fuels through 2010,
- the federal government would agree to provide loan guarantees for the construction of biomass-based transportation fuel production facilities over the next decade,
- the federal government would support additional research and development into the production of biomass-based transportation fuels, and
- Canada's Environmental Choice program would differentiate among different types of biomass-based fuels on the basis of their life-cycle emissions impacts.

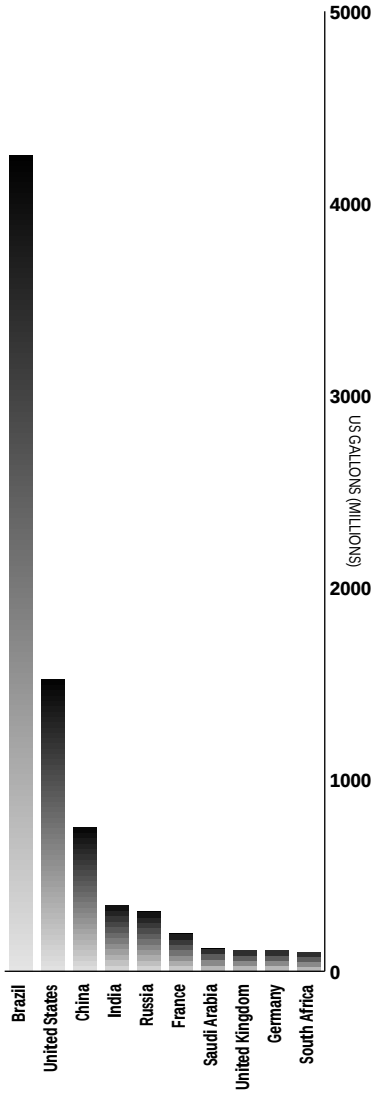

FIGURE 6. LEADING ETHANOL PRODUCERS BY COUNTRY (MILLIONS OF US GALLONS)[49]

GREENHOUSE GAS EMISSION REDUCTION BENEFITS

The implementation of a mandatory 5 per cent renewable energy content standard for gasoline in the year 2010 would reduce Canada's greenhouse gas emissions by 3.1 Mt from projected levels in that year.

MULTIPLE ENVIRONMENTAL BENEFITS

There are a number of local and regional environmental benefits of utilizing biomass-based transportation fuels as opposed to conventional gasoline. For example, studies have shown that a 10 per cent ethanol blend will[50]:

- have a greater octane rating than conventional gasoline, providing greater resistance to "knock" and therefore allowing new vehicles to attain greater fuel efficiency,
- reduce carbon monoxide emissions by 20 per cent for older vehicles on the road today,

- reduce emissions of Volatile Organic Compounds (contributors to urban smog) by 7 per cent, and
- reduce emissions of aromatics like benzene, toluene and other hydrocarbons.

It should be noted that 10 per cent ethanol blended gasoline does produce a slight increase (approximately 3 per cent) in tailpipe NOx emissions.[51] On a life-cycle basis, however, these emission increases are more than offset by reductions in production-related emissions for most sources of ethanol relative to gasoline.

ECONOMIC COSTS AND BENEFITS

Clearly, enhanced biomass-based transportation fuel production in Canada does offer some interesting possibilities for Canada's agriculture industry. Further work is needed, however, to assess the economic costs and benefits of this measure. This analysis will need to consider a number of factors, including potential changes in the value of feedstocks for biomass fuels and the market for co-products from biomass-based fuel production (e.g., cattle feed supplement is a by-product of corn based ethanol production).

AN IMPLEMENTATION STRATEGY FOR CANADA – RECOMMENDATIONS

1. The federal government should maintain its current excise tax exemption for ethanol fuels through the year 2010 and extend it to all biomass-based transportation fuels and provincial governments should provide a similar exemption.
2. The federal government should establish a mechanism that will provide producers of biomass-based ethanol fuels with loan guarantees for the construction of production facilities that meet appropriate environmental and greenhouse gas emissions reduction criteria. This measure should be in place until 2008.
3. The federal government should implement legislation that would mandate that all gasoline sold in Canada would have to have a minimum 5 per cent renewable energy content by the year 2010. Such legislation might include interim targets for intervening years such as 2005 and 2008.
4. The federal government should provide additional research and development support for the commercialization of transportation biofuel production technologies in Canada.
5. Canada's Environmental Choice program should differentiate among different types of biomass-based fuels on the basis of their life-cycle emissions impacts.

Stricter enforcement of reduced speed limits

(2.2 Mt reduction)

The efficiency of fuel consumption in automobiles varies dramatically with speed. Most automobiles are designed to reach maximum fuel efficiency at a speed of approximately 90 km/h. Fuel use increases rapidly with additional increases in speed. For example, a car traveling at 100 km/h requires approximately 20 per cent more fuel than the same car traveling at 90 km/h.

In Canada, speed limits on highways vary from province to province and from primary highway to secondary highway. They can be as high as 110 km/h and as low as 80 km/h. Given the enormous increase in the use of transportation fuels at higher speeds, there is clear scope for significant greenhouse gas emissions reduction in Canada simply through a lowering of speed limits and an increase in enforcement. While it is perhaps unrealistic to imagine a situation where all Canadians would always drive at the speed limit, it is possible to imagine a scenario where the average speed driven on Canada's highways declines from current levels.

DESCRIPTION OF THE MEASURE

Provincial governments would pass legislation reducing the speed limit by 5 km/h on all highways where the speed limit is currently above 90 km/h. This reduction in speed limits would be accompanied by an increase in speed limit enforcement capacity (either through automated or manual means) by both the federal and provincial governments to ensure that the average speed on Canada's highways did indeed fall by 5%. Increased enforcement costs can easily be designed to achieve cost recovery.

GREENHOUSE GAS EMISSION REDUCTION BENEFITS

If the average speed on Canada's highways fell by 5 km/h, greenhouse gas emissions would be reduced by 2.2 Mt relative to projected levels in 2010.

MULTIPLE ENVIRONMENTAL BENEFITS

This measure would provide a number of multiple environmental benefits associated with a reduction in the combustion of fossil fuels, including reductions in emissions of local and regional air pollutants like sulphur oxides, volatile organic compounds, particulate matter and oxides of nitrogen. Lower speeds on Canada's highways are also likely to reduce the frequency and severity of automobile accidents.

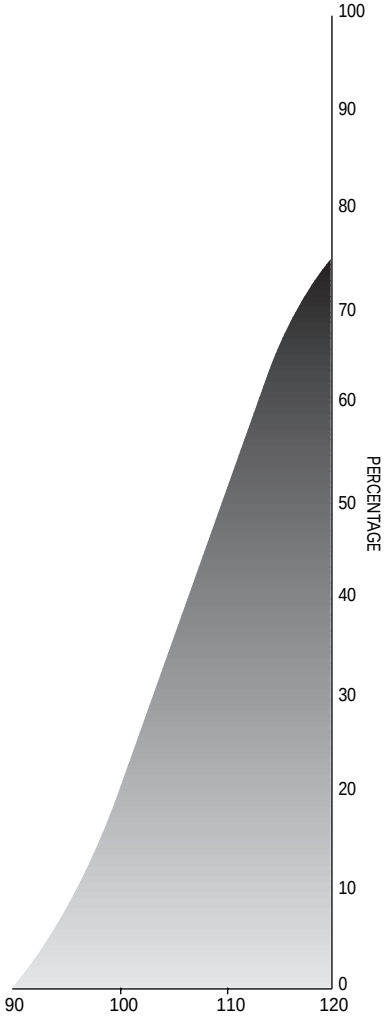

FIGURE 7. INCREASE IN FUEL REQUIRED TO EXCEED SPEEDS OF 90 KM/H RELATIVE TO TRAVEL AT 90 KM/H[52]

If the average speed on Canada's highways fell by 5 km/h, greenhouse gas emissions would be reduced by 2.2 Mt relative to projected levels in 2010.

ECONOMIC COSTS AND BENEFITS

This measure would impose some economic costs on Canada because it would increase the time required to move people and goods across the country by road. It must be noted, however, that the per centage increase in time is minor, particularly when compared to the per centage decrease in greenhouse gas emissions that would result. In addition, reduced health care costs associated with vehicle accidents would have to be considered in any cost-benefit analysis.

AN IMPLEMENTATION STRATEGY FOR CANADA – RECOMMENDATIONS

1. All provincial governments should pass legislation reducing speed limits by 5 km/h on all highways where the speed limit is currently above 90 km/h.
2. All governments should increase resources for speed limit enforcement through either increased use of automated equipment (e.g., photo radar) or increased personnel for enforcement purposes, on a cost-recovery basis.

Other potential actions to address greenhouse gas emissions from passenger transportation

While the five measures presented above represent important initiatives that can help Canada meet its Kyoto commitment, they do not represent all that can be done to reduce greenhouse gas emissions from passenger transportation. Some other options that governments should pursue further to promote climate protection in passenger transportation include:

Feebate Programs: Provincial governments could build on the Ontario example and institute a system that would provide rebates to people who purchase fuel efficient cars while charging additional fees to people who buy inefficient vehicles. Such a program should be designed in a revenue-neutral manner.

Vehicle Inspection and Maintenance Programs: Provincial governments could follow the lead of British Columbia and institute vehicle inspection and maintenance programs in major urban centres. By making cars run more efficiently, such programs can contribute to greenhouse gas emissions reduction.

Scrappage Programs: Provincial governments could provide a bounty for older polluting and less fuel- efficient vehicles to encourage owners to take them off the road and assist in upgrading to cleaner vehicles.

Low-Emission and Zero-Emission Vehicles: Federal or provincial governments could follow the lead of California and establish regulations requiring auto manufacturers to ensure that a specific percentage of their sales within a jurisdiction are made up of low-emission or zero-emission vehicles.

Improved Municipal Land Use and Transportation Planning: Municipal governments should take steps now to promote more dense and mixed use developments that would be more readily accessible to modes of transportation other than the automobile. This is clearly critical if Canada is to address the climate change problem over the long-term.

Modal Shifts and Improved Efficiencies for Freight: Any national climate change action plan must include actions to reduce greenhouse gas emissions from air transport, rail transport, and freight transport on roads. In particular, there is a need to develop multi-modal freight transportation systems that allow maximal use of rail transportation and minimal use of truck transport.

Municipal governments should take steps now to promote more dense and mixed use developments that would be more readily accessible to modes of transportation other than the automobile.

4

Reducing greenhouse gas emissions from electricity generation **(29 Mt reduction)**

In 1995, greenhouse gas emissions from electricity generation in Canada amounted to 103 Mt, 16.6 per cent of Canada's total greenhouse gas emissions in that year.[53] This represented an 8.6 per cent increase above 1990 levels. In the year 2010, it is projected that greenhouse gas emissions from electricity generation will increase to 15.8 per cent above 1990 levels.

The primary source of greenhouse gas emissions in electricity generation is the combustion of fossil fuels to produce electricity.[54] These fuels include coal, natural gas, fuel oil, and diesel fuel. Within Canada, the fuel mix used to generate electricity (and subsequently the greenhouse gas emissions associated with electricity generation) vary significantly from one part of the country to another. For example, coal is the primary energy source for electricity in Alberta, Saskatchewan and Nova Scotia, and a substantial source in Ontario. Hydroelectricity, however, accounts for the vast majority of electricity produced in British Columbia, Manitoba, Quebec and Newfoundland.

When fossil fuels are used to generate electricity, it is important to remember that not all fossil fuels are equal from a climate change perspective. Not only do fossil fuels differ in their carbon intensity per unit of energy produced (natural gas produces only 40 per cent to 65 per cent of the greenhouse gas emissions of coal, depending on the type of coal used), they also differ in the efficiency with which they produce energy. For instance, a coal-fired electric power station is likely to operate at 30 per cent to 40 per cent efficiency. Natural gas combined cycle co-generation facilities, however, can transform up to 80 per cent or 90 per cent of the energy contained in natural gas into electricity and useful heat energy.

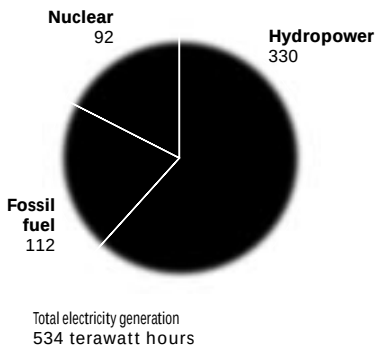

FIGURE 9. ELECTRICITY GENERATION IN CANADA, 1995 (TERAWATT HOURS)

SOURCE: *Electric Power in Canada*, CEA

Several types of "supply side" initiatives can be taken to reduce greenhouse gas emissions from electricity generation. They fall into three general types:

- actions that improve the efficiency with which energy sources are used to generate electricity (e.g., increased use of co-generation),

- actions that reduce the carbon intensity of electricity generation (e.g., switching from coal-fired power to electricity produced from natural gas), and
- actions that increase the share of electricity produced from renewable energy sources (e.g., wind, small scale hydro, solar power).

Throughout Canada there is growing pressure to break up electricity monopolies in the provinces and to open up the electricity market to increased competition. Provincial governments are creating new rules for the operation of the electricity marketplace. This restructuring process is well underway in Alberta and is just beginning in Ontario.

The need to rewrite the rules to facilitate restructuring of the industry presents an incredible opportunity for Canada to protect the climate. It is possible to design the electricity marketplace to reward decisions that decrease the carbon intensity of electricity generation in Canada. At the same time, it is important to ensure that a focus on climate protection does not encourage the expanded use of other forms of environmentally damaging electricity generation such as nuclear power and large hydro dams.

If these rules are designed poorly and the opportunity is squandered, there is a very real possibility that increased competition in the electricity market will lead to an increase in greenhouse gas emissions and other environmental stresses from this sector. This must not be allowed to happen if Canada is to meet its obligations under the Kyoto Protocol.

The measures proposed here would reduce greenhouse gas emissions in the electricity generation sector by 29 Mt from projected 2010 levels. These measures do not, however, represent a comprehensive list of all actions that could be taken to reduce greenhouse gas emissions in this sector. While it is important to reduce emissions from the supply of electricity, it is also essential to look at policies that reduce the demand for electricity. A number of these are discussed in later sections on the industrial, residential, and commercial sectors.

It is possible to design the electricity marketplace to reward decisions that decrease the carbon intensity of electricity generation in Canada.

Implement net metering polices to promote the adoption of customer-based co-generation and renewable energy technologies (1.1 Mt reduction)

There is significant potential in Canada to generate electricity on a small scale at a multitude of dispersed sites through the use of renewable energy (wind, solar and environmentally-benign small hydro) and natural gas micro-co-generation technologies. Most of these technologies produce electricity at the site of customer demand, and they are therefore often referred to as “distributed” technologies or resources because they are distributed throughout the utility electricity grid.

Under net metering, when the customer produces electricity in excess of their consumption, the utility receives that electricity and the customer's meter runs backwards.

For various regulatory and financial reasons, the potential for these resources and technologies is virtually untapped in Canada. The development of the electricity sector in Canada has instead focused on developing and maintaining large-scale, centralized power sources that are usually distant from the site of electricity demand.

One way of tapping the potential of distributed electricity generation technologies is to develop a provincially-legislated net metering policy for the electricity sector. Such policies have already been applied in many jurisdictions in the U.S. and other locations.

Net metering allows electric utility customers to install small scale co-generation and renewable energy technologies to generate electricity for their own use. When the customer produces electricity in excess of their consumption, the utility receives that electricity and the customer's meter runs backwards. When customers cannot generate enough electricity for their own needs, the utility supplies the shortfall and the meter measures it, running in a forward direction.

At the end of the billing period the utility sends out a bill for the net electricity consumed as specified by the meter, equivalent to the total amount of power supplied by the utility minus the excess power provided by the customer to the utility. If the production meets or exceeds consumption within a billing period, the customer's energy bill will be zero, or the customer may even receive some compensation for excess production. Any component of the bill that charges for the capacity of the power connection remains untouched.

Net metering is ideally suited to co-generation technologies since they are distributed energy supplies and often the customer's heat and electricity demand do not coincide. For example, a hotel may need hot water during the morning for showers and during the day to do laundry, but the peak power demand is in the evening and at night when guests are using electricity for lighting. With net metering, a co-generation technology could run the electric meter backwards during the day when the laundry facilities are operating and the meter would only run forward again when the hotel was required to take out utility power during the evening.

Net metering benefits individual customers and electric systems because it allows customers who invest their private capital in small-scale electricity generating technologies to produce direct financial benefits for themselves as well as additional environmental, technical, and social benefits such as those listed below:

- Improving the capacity factor of distributed generation technologies with high capital costs so that they maximize the generation of electricity and associated financial benefits. This is particularly important when the peak power demand of on-site consumption is much higher than the average demand. With net metering, the generator can partly serve the consump-

tion during peak periods and "bank" power in the utility grid during off-peak periods.
- Improving the utility load factors if the net-metered resource is producing power during periods of peak electricity demand.
- Eliminating the need for expensive storage and/or power conditioning and transforming equipment for technologies that generate power from intermittent resources such as water, wind and the sun. In many cases, new meters will not be required because existing meters are often capable of operating in both directions.

Net metering has been adopted in 24 states in the U.S. and by two electric utilities in Canada. In the U.S., the programs have been initiated in three different ways: (1) state-legislated requirements on all electricity transmission and distribution companies; (2) utility commission orders; and (3) voluntary electric utility initiatives such as those established in Canada on a pilot basis by Ontario Hydro and Toronto Hydro. In Japan, 9,400 solar home systems were installed in 1997 under a government supported net metering program.

Many of the net metering initiatives that have been established in other jurisdictions have focused on small-scale renewable energy technologies such as solar photovoltaics, wind generators and micro-hydro generators. However, most have also enabled commercial, institutional and small industrial customers with heat and electricity co-generation facilities to net meter, many allowing a capacity of up to 100kW.

Net metering has been adopted in 24 states in the U.S. and by two electric utilities in Canada.

DESCRIPTION OF THE MEASURE

This measure involves the development of a national net metering program in Canada, made possible through legislation implemented in all provinces and territories in the year 2000. The program and associated legislation should:
- Require all retailers of electricity within the jurisdiction to offer a net metering tariff to all retail consumers – residential, commercial, agricultural and industrial – with enforcement by the regulator (e.g., B.C. Utilities Commission) or a government entity. The tariff would enable customers to connect distributed electricity supply technologies into their existing electrical system and would apply a standard residential, commercial or industrial rate for the "net" power consumption. If the "net" power consumption is negative, the tariff specifies the rate at which excess power is paid, ranging between zero and the avoided cost of power supply to the utility.
- Identify the following eligible technologies and resources: environmentally-benign small-scale hydroelectricity, wind, photovoltaic solar, biomass, small-scale natural gas co-generation with full heat utilization, hydrogen fuel cells or other low greenhouse gas emission resources which are suitable for distributed application.

In Japan, 9,400 solar home systems were installed in 1997 under a government supported net metering program.

- Specify that projects eligible for the net metering tariff must be sized in similar proportion to the electricity demand at the site where they are developed such that annual electricity production will not greatly exceed consumption.
- Limit participation to projects of 2MW of electricity generating capacity or less (this represents the electricity demand of a medium-sized university).
- Limit the total capacity within the jurisdiction to 5 per cent of the peak capacity within the jurisdiction to ensure that utility system integrity is maintained[55].
- Use existing meters, and consumers should be credited only for that production up to and including their energy consumption on an annual basis, banking any surpluses or deficits between billing periods within the year, thus limiting administrative costs.
- Require connections to include a distribution utility accessible lock-out switch to guarantee utility lineworker safety by ensuring that the technology is not producing electricity while work is underway.
- Prohibit utilities from requiring net-metered customers to: acquire liability insurance or property easements, implement over-engineered safety equipment, undertake expensive utility inspections, or to pay standby or interconnect charges.

The customers most likely to adopt this initially would be universities, hospitals, hotels and apartments for natural gas micro-co-generation, farmers and rural homeowners for wind power and micro-hydro, home owners for solar energy, and some industrial consumers for biomass, wind, hydro, or co-generation. In the long run, fuel cells may also be used as well. Federal and provincial governments could make an important contribution by expanding the scope of programs like the Federal Buildings Initiative to encourage the use of small scale electricity generating technologies.

GREENHOUSE GAS EMISSION REDUCTION BENEFITS

Implementation of this measure would reduce greenhouse gas emissions by 1.1 Mt from projected levels in 2010.[56]

MULTIPLE ENVIRONMENTAL BENEFITS

If net-metered power offsets electric power production from more carbon-intensive or less efficiently used fossil fuels (e.g., coal), it will have a positive impact on local air quality and public health through reduced emissions of sulphur dioxide, nitrous oxides, particulate matter, carbon monoxide, and volatile organic compounds.

ECONOMIC COSTS AND BENEFITS

A potential cost may be a subsidy from utility ratepayers to net-metered customers because the power produced may not be coincident with the peak demand periods when most of the consumption takes place. Also, residential customers' contribution to capacity assets will be stranded as their retail rates do not have a capacity charge. Both of these subsidies could be compensated for, by allowing the utility to market excess net-metered supplies as "green power" at a price premium.

There will also be economic benefits. The sale and installation of distributed electricity generation technologies will foster economic development in local communities. In addition, studies have shown that a million dollar investment in new renewable electricity generation will create 33% more jobs than equivalent investments in new conventional energy supply.[57] Finally, increased domestic demand for renewable energy technologies can significantly reduce unit costs and position Canadian suppliers to compete in the rapidly growing global market for renewable energy sources.

Studies have shown that a million dollar investment in new renewable electricity generation will create 33% more jobs than equivalent investments in new conventional energy supply.

AN IMPLEMENTATION STRATEGY FOR CANADA – RECOMMENDATIONS

1. Provincial governments should pass legislation requiring all retailers of electricity within the jurisdiction to offer a net metering tariff to all retail consumers – residential, commercial, agricultural and industrial. This legislation should have the additional characteristics described in the detailed discussion of the measure above.
2. Federal and provincial governments should expand in-house initiatives like the Federal Buildings Initiative to demonstrate leadership in the use of on-site renewable energy and micro natural gas co-generation technologies.

Leveling the playing field for low carbon energy sources **(19.2 Mt reduction)**

Provincial governments are under increasing pressure to break up utility monopolies and to allow competition in the electricity marketplace. The implications of such electric utility market restructuring for greenhouse gas emissions depend on the new rules established to govern the electricity market. To be climate-friendly, these rules must ensure that carbon-intensive electricity sources (i.e., coal) are not given an unfair competitive advantage in the new marketplace.

To be climate-friendly, these rules must ensure that carbon-intensive electricity sources (i.e., coal) are not given an unfair competitive advantage in the new marketplace.

There are a number of ways in which coal-fired electricity generation can be given an unfair competitive advantage in a new competitive marketplace. For example, in Alberta:

- Provincial energy resource royalty structures require producers of natural gas to pay six times the rate of coal producers of coal on a unit of electricity produced basis.
- Provincial emission standards for local and regional air pollutants are less stringent for existing coal-fired electricity generation than for new natural gas-fired electricity generation.
- Restructuring of the provincial electricity market has provided a mechanism that subsidizes the capital costs of existing coal-fired electricity generators. This means that new entrants in the market, who must recover both capital and operating costs, are forced to compete with an electricity price from existing generators that only reflects operating costs.

Similar unfair subsidies to coal over natural gas exist in most other provinces.

If the playing field is not truly level, coal-fired electric power generation could have a competitive advantage when there is a demand for new electric generating capacity. More importantly, shielding existing coal-fired power plants from fair competition in a competitive marketplace may allow these plants to exist for longer than would otherwise be the case. It may even result in an extension of the life of such plants as new opportunities arise for increased electricity trade with other jurisdictions.

This scenario must be avoided. Numerous industrial developments in Canada that produce or use process heat provide excellent low-cost opportunities to replace coal or oil-fired electricity generation with high efficiency natural gas co-generation that produces heat and electricity at competitive prices. Industrial-scale natural gas co-generation technologies must be able to compete on a level playing field with coal-fired electric generation. Another measure described in this report, net metering, has the benefit of fostering developments of micro-co-generation technologies in the commercial and institutional sectors.

In provinces that are not currently restructuring their electricity markets, a level playing field can be promoted through equivalent fiscal and regulatory treatment of different fossil fuels used for electricity generation and the use of a competitive bidding process for new power plant additions. This would expand opportunities for independent power producers to provide industrial sized co-generation facilities as a means of meeting new growth in electricity demand, or to replace plants that have been retired. This is particularly important in Saskatchewan and Atlantic Canada where coal or oil are used extensively to generate electricity.

In Ontario and Alberta, electricity market restructuring is proceeding with a goal of opening up the retail markets early in the 21st century. Almost 80 per cent of Canada's coal-fired generating capacity is in Ontario and Alberta. As part of electricity market restructuring, Alberta and Ontario must take steps to ensure that all forms of fossil fuel-fired electricity generation compete on a level playing field.

DESCRIPTION OF THE MEASURE

This measure includes the following components to help level the playing field in the electricity market:

- The federal government should assess the life-cycle[58] costs and benefits imposed by government (i.e., taxation and subsidies) on competing non-renewable energy options – from resource extraction through to the production of useful electricity – and work with the provinces to level the playing field.[59]
- Provincial governments should adjust energy resource royalties to ensure a level playing field among all energy resources such that no single energy resource gains an unfair competitive advantage in the marketplace.
- Provincial governments should pass legislation requiring all fossil fuel-fired electricity generation to meet the most stringent air pollution emission or technology standard applied within that jurisdiction with respect to local and regional air pollutants.
- Provincial governments restructuring their electricity markets should set a strict and short time limit for the recovery of stranded costs to ensure a rapid transition to a truly competitive marketplace and a timely replacement of old polluting facilities.

GREENHOUSE GAS EMISSION REDUCTION BENEFITS

The implementation of a level playing field in the electricity sector is expected to reduce greenhouse gas emissions 19.2 Mt from projected levels in 2010. This is a conservative estimate. It does not assume the early retirement of any coal-fired electric generating capacity.

Instead, it assumes that the implementation of these measures will eliminate all projected growth in electricity generated from coal between now and 2010. This is mostly due to the fact that on a level playing field, new coal-fired electricity generation stations are more costly to build than new natural-gas fired co-generation stations when external sales of heat and steam for the latter are factored into the financial analysis. For example, coal-fired stations that meet current air quality standards[60] are expected to have electricity production costs of about 4.5 cents/kWh in 2010 (in real 1995 dollars), compared with natural gas fired plants at between 3.6 and 4.2 cents/kWh[61].

The implementation of these measures will eliminate all projected growth in electricity generated from coal between now and 2010.

The reduction of coal-fired electricity and its replacement with natural gas co-generation will also have a very substantial positive impact on local air quality and public health.

It is also assumed that natural gas co-generation will replace all existing and planned generation of electricity from heavy fuel oil and light fuel oil in regions of Canada (predominantly Atlantic Canada) where natural gas will be available by the year 2010. This is because natural gas co-generation is much more cost-competitive than electricity generated from oil.

MULTIPLE ENVIRONMENTAL BENEFITS

The reduction of coal-fired electricity and its replacement with natural gas co-generation will also have a very substantial positive impact on local air quality and public health through reduced emissions of sulphur dioxide, nitrous oxide, particulate matter, carbon monoxide, and volatile organic compounds.

ECONOMIC COSTS AND BENEFITS

As noted above, in a purely competitive marketplace with a level playing field for new investment in electricity generation, a new natural gas-fired efficient co-generation facility will be cheaper to construct and operate than a coal-fired power plant. It is also assumed that the natural gas co-generation facilities developed under this measure will have a lower levelized cost than a new coal plant or the continued operation of an existing oil plant. This should produce a financial saving for the ratepayer.

AN IMPLEMENTATION STRATEGY FOR CANADA – RECOMMENDATIONS

1. The federal government should begin immediately to study the life-cycle costs and benefits imposed by government (i.e., taxation and subsidies) on competing non-renewable energy options – from resource extraction through to the production of useful energy. If the playing field is found not to be level, steps should be taken to level it immediately.
2. Provincial governments should adjust energy resource royalties to ensure a level playing field among all energy resources such that no single energy resource gains an unfair competitive advantage in the electricity marketplace.
3. Provincial governments should pass legislation requiring all fossil-fuel fired electricity generation to meet the most stringent emission standard with respect to local and regional air pollutants applied within that jurisdiction.
4. Provincial governments restructuring their electricity markets (currently Alberta and Ontario) should set a strict and short time limit for the recovery of stranded costs to ensure a rapid transition to a truly competitive marketplace.

Providing incentives to produce electricity from waste solution gas in fossil fuel production[62]

(0.9 Mt reduction)

In 1995, the production and distribution of oil and natural gas in Canada resulted in 101.6 Mt of greenhouse gas emissions, 16 per cent of Canada's total greenhouse gas emissions in that year. When drilling for oil, a mix of gaseous hydrocarbons (including methane) is often brought to the surface along with the oil. This mix is called solution gas.

In Alberta, about 92 per cent of solution gas is conserved or used in some manner and the remaining 8 per cent is combusted (flared). Flaring of solution gas produces carbon dioxide emissions. But flaring does not result in 100 per cent combustion of solution gas. Tests in Alberta found flares in which the combustion efficiency ranged from only 66 per cent to 84 per cent. As a result, methane and up to 250 other compounds, many with serious local environmental impacts, are also released into the atmosphere.

In many cases, this solution gas could be captured and used to generate electricity. It has been estimated that about 50 percent of currently flared solution gas could be captured and used to produce enough electricity to meet 5 per cent of the total currently installed electrical generation capacity in Alberta.[63]

Taking such action would reduce the emission of methane from oil and gas production facilities. Moreover, the electricity produced by such actions could be used to replace electricity generated at coal-fired electrical power stations in Alberta. As the electricity produced at the flare site would be generated more efficiently and with lower carbon intensity than electricity produced at a coal-fired generating station, additional greenhouse gas emission reductions would occur.

Clearly, Canada has an opportunity to reduce greenhouse gas emissions from the oil and gas industry and the electricity sector at the same time, but at the moment, investments in the micro-turbines required to produce electricity from solution gas are only marginally economic. A few simple policy changes could, however, make such investments viable.

In 1995, the production and distribution of oil and natural gas in Canada resulted in 101.6 Mt of greenhouse gas emissions, 16 percent of Canada's total greenhouse gas emissions in that year.

DESCRIPTION OF THE MEASURE

The federal government should include solution gas as a qualifying fuel in Class 43.1 of the Income Tax Act.

Currently, some non-traditional fuels for electricity generation (e.g., landfill methane) qualify under Class 43.1. This means that investments in technologies used to generate electricity from these sources are eligible for a 30 per cent capital cost allowance write off. The micro-turbines that would be used to produce electricity from solution gas, however, are currently only eligible for a 6 per cent

As many as 250 compounds can be released into the atmosphere through flaring. Many of these are hazardous air pollutants.

capital cost allowance write-off. This is not high enough to encourage investment because the economic life of such a turbine is likely to be only 4.5 years. Allowing investments in these small micro-turbines to qualify under Class 43.1 would significantly aid their entry into the marketplace.[64]

GREENHOUSE GAS EMISSION REDUCTION BENEFITS

If electricity produced from solution gas met 5 per cent of Alberta's projected electric power needs in the year 2010, greenhouse gas emissions would be 0.9 Mt lower than currently projected for that year.

This emission reduction total does not includes:

- elimination of methane emissions associated with flaring.

MULTIPLE ENVIRONMENTAL BENEFITS

In Alberta, considerable concern has been raised about the potential environmental and health effects of flaring on humans and livestock. As noted earlier, as many as 250 compounds can be released into the atmosphere through flaring. Many of these are hazardous air pollutants. This measure would reduce the release of these substances into the environment.

ECONOMIC COSTS AND BENEFITS

Solution gas is currently wasted and provides no economic value to oil and gas producers. Capturing the gas and using it to produce electricity would require investments in micro-turbines to generate electricity, but it would also reduce the costs of purchased electricity for oil and gas producers and could even produce revenues if excess electricity was sold to the grid.

AN IMPLEMENTATION STRATEGY FOR CANADA – RECOMMENDATIONS

1. The federal government should include solution gas as a qualifying fuel in Class 43.1 of the Income Tax Act.

Adopting a 10% renewable portfolio standard by 2010

(7.8 Mt reduction)

If the world is to successfully address the climate change issue in the long-term as well as protect regional air quality, it will be necessary to find alternatives to fossil fuels for electricity generation. While highly efficient natural gas co-generation can be an important tool in the transition to a more sustainable energy future, we will ultimately need to dramatically increase our reliance on renewable energy sources.

Some of the renewable energy sources that can be used to generate electricity include:

- wind electricity-generating technologies, including wind farms,
- solar energy conversion technologies, such as photovoltaic modules and solar thermal technologies that offset electric loads (e.g., solar water preheating for electric boilers),
- biomass electricity production technologies, although attention must be paid to the full range of environmental impacts that might accompany a major increase in demand for biomass fuels,[66]
- geothermal electricity generation projects that utilize energy from the earth in the form of heat,
- freestream tidal and wave power technologies, and
- environmentally-benign hydroelectric systems that: (a) do not affect aquatic organisms, (b) have minimal water storage requirements (i.e. run-of-river) or represent expansion at existing facilities with no reservoir expansions, and (c) cause no or little alteration of water flow patterns.

Over the last few decades, the costs of electricity generating technologies based on renewable energy have fallen rapidly. This is despite the fact that the overwhelming majority of energy research and development spending from governments has historically been directed to either nuclear power or fossil fuels. These advances in technology have led to advances in the marketplace. For example, while wind power still produces less than 1% of the world's electricity, global wind energy generating capacity increased by almost 600% between 1985 and 1996.[67] It is the world's fastest growing source of electricity – but this growth is not occurring in Canada. In 1996, the following five countries saw the biggest increase in wind power generating capacity: Germany, India, Denmark, Spain and the United Kingdom.[68]

Global wind energy generating capacity increased by almost 600% between 1985 and 1996. It is the world's fastest growing source of electricity – but this growth is not occurring in Canada.

While more than 60% of Canada's electricity comes from hydro power, much of that power has been produced at large facilities that have had a massive impact on the environment. Non-hydro renewable energy technologies, however, make up only a minuscule portion (less than 1%) of Canada's electricity supply.

There is a clear opportunity for Canada to take action to increase the portion of its electricity supplied from renewable energy sources that produce no greenhouse gas emissions. One of the most effective ways to ensure progress is the use of renewable energy portfolio standards (REPS).

A renewable energy portfolio standard is a legislated requirement for all electricity producers to ensure that a specific percentage of the electricity they produce is created from renewable energy sources. This tool has already been used in Vermont, Maine, Massachusetts, Nevada, and Arizona, and President Clinton has proposed that the United States adopt a 5.5 per cent non-hydro renewable energy portfolio standard in the year 2010.

Renewable technologies will play an increasingly important role in the global energy economy and offer significant export potential – particularly to satisfy the needs of developing countries where more than 2 billion people still do not have access to electricity.

DESCRIPTION OF THE MEASURE

As part of electricity market restructuring, Alberta and Ontario should require electricity retailers to demonstrate that 10 per cent of the electricity they are selling is produced from renewable energy resources by the year 2010. Similar renewable energy portfolio requirements should also be mandated by regulators of monopoly utilities in the other provinces and territories for implementation in 2010.[69] This renewable portfolio requirement would be phased in with interim targets in preceding years.

Both monopoly and market retailers would have the opportunity to meet this standard through a system of tradable "renewable energy credits", (REC) to provide for least-cost and maximum flexibility. An REC is created for each kilowatt-hour of electricity generated from renewable energy. Power retailers (i.e., electric utilities or marketers) could generate renewable power with their own facilities or purchase it from separate companies in the form of an REC that is tradable within the jurisdiction's power pool.

GREENHOUSE GAS EMISSION REDUCTION BENEFITS

Implementing a 10% renewable energy portfolio standard for all provinces and territories in Canada would reduce greenhouse gas emissions 7.8 Mt below projected levels in 2010.

While earlier measures eliminated the projected growth in coal-fired electricity and replaced it with increased electricity production from natural gas cogeneration, this measure would eliminate some of the growth that had been projected for natural gas-fired electricity and replace it with electricity from renewable energy sources.

The largest emission reductions occur in British Columbia, Alberta and Ontario where the growth in natural gas supplied electricity is the largest. In Québec and Newfoundland, hydroelectricity is assumed to make up most of the mix, with a zero emission rate, so the REPS does not offset as many emissions there. In Manitoba, the emission reduction benefits are assumed to be zero because the provincial electricity system will comply with the REPS under Natural Resources Canada's projected business as usual scenario due to the presence of significant environmentally-desirable hydroelectricity supplies.[70]

MULTIPLE ENVIRONMENTAL BENEFITS

As with any other policy that reduces fossil fuel consumption, the REPS provides local air quality and public health benefits through reduced emissions of sulphur dioxide, nitrous oxides, particulate matter, carbon monoxide, and volatile organic compounds.

ECONOMIC COSTS AND BENEFITS

The economic costs of the REPS are listed below. These are ratepayer impacts, specified in dollars per kilowatt-hour.

TABLE 3. THE ECONOMIC COSTS OF RENEWABLE ENERGY PORTFOLIO STANDARDS (REPS)

PROVINCE	RESIDENTIAL RATE IMPACT $/kWh	COMMERCIAL RATE IMPACT $/kWh	INDUSTRIAL RATE IMPACT $/kWh
British Columbia	0.0020	0.0014	0.0011
Alberta	0.0042	0.0032	0.0030
Saskatchewan	0.0026	0.0024	0.0015
Manitoba	–	–	–
Ontario	0.0002	0.0002	0.0002
Quebec	(0.0003)	(0.0003)	(0.0003)
Atlantic Canada	0.0003	0.0003	0.0002
Total	0.0003	0.0010	0.0008

The average rate impacts are approximately one-tenth of a cent per kilowatt-hour. For a residential customer, the rate impact translates to about $1.30 per month. Certain industrial customers may require some form of rate relief with these additional costs, although it is expected that an REPS will be applied in the U.S., making such a measure competitively neutral across Canada and the U.S.

The largest rate impact is in Alberta because of the very low existing supply of renewable energy technologies. Also, the conventional marginal supply technology in Alberta – combined-cycle natural gas turbines – is very cheap to build and operate. In contrast, the REPS has an economic benefit in Québec where the conventional supply resource is a combination of large hydroelectricity and natural gas, both more expensive than the renewable energy resources that are developed under the REPS.

It should be noted that the rate impacts generated by the imposition of the REPS are short-term and front end loaded. As the cost of renewable energy continues to decline, and pollution costs associated with fossil-fuel fired electricity are reflected in electricity prices, renewables will become fully competitive and ultimately cheaper than most fossil fuel based electricity.

An important economic benefit associated with the REPS measure is the potential it offers for Canadians to become more engaged in the development, production, installation and use of renewable energy technologies. These technologies will play an increasingly important role in the global energy economy and offer significant export potential – particularly to satisfy the needs of developing countries where more than 2 billion people still do not have access to electricity.[71]

The average rate impacts are approximately one-tenth of a cent per kilowatt-hour. For a residential customer, the rate impact translates to about $1.30 per month.

AN IMPLEMENTATION STRATEGY FOR CANADA – RECOMMENDATIONS

1. Each province should enact legislation that establishes a Renewable Energy Portfolio Standard for electricity retailers in the province. The standard should be phased in so that it starts at 3% in 2003, 6% in 2005 and 10% in 2010. It should allow the use of tradable renewable energy credits among electricity producers within regulated jurisdictions. The legislation should also identify a specific body (e.g., a government department or a non-profit society) to coordinate all aspects of the REPS, including: certification of renewable energy supplies, definition of market standards, and regulation of compliance with the standard.

Other potential actions to reduce greenhouse gas emissions from the electricity generator sector

While the measures presented in *Canadian Solutions* represent important steps in climate protection, they do not reflect the full range of actions that could be taken in Canada to reduce greenhouse gas emissions from the electricity generation sector. As noted earlier, the current move to increased competition in electricity markets offers a real opportunity for policy-makers to take action to protect the climate. Some of the specific actions that should be considered include:

Provincial governments could require electricity providers to disclose the energy sources used to produce the electricity sold and the associated environmental impacts.

Green Power Procurement: Provincial governments, private corporations and individual Canadians should follow the lead of the federal government and companies like Suncor and demand and purchase 'green' power that is produced from renewable energy sources. Both the federal government and large industries participating in Canada's Voluntary Challenge and Registry Program should increase their purchases of 'green' power.

Emission Caps: Provincial governments could cap emissions of non-greenhouse gases from electricity generators within their jurisdiction. For example, the Ontario Clean Air Alliance has suggested that Ontario cap emissions of acid gases emitted during fossil fuel-fired electricity production at 175 kilotonnes for sulphur dioxide and 38 kilotonnes for oxides of nitrogen.

Environmental Adders: Provincial governments could pass legislation requiring utilities to incorporate environmental adders into electricity prices in an effort to reflect the environmental impact of different forms of electricity generation in the price paid by consumers. This would complement the measures designed to level the playing field among competing sources for electricity generation, and would shift the environmental and health care costs of pollution onto the polluters and the user.

Labeling: Provincial governments could require electricity providers to disclose the energy sources used to produce the electricity sold and the associated

environmental impacts. Such action would facilitate and inform consumer choice in the marketplace and help to build support for the Renewable Energy Portfolio Standard and green power procurement.

Research and Development Spending: The cost of electricity generated by renewable energy technologies has fallen sharply over the years, but electricity generated by renewable energy is still not competitive in all electricity markets. Additional spending on research and development and technology commercialization can help to bring these costs down and ensure development of a Canadian industry able to compete and prosper in the huge global renewables marketplace.

Taxation Treatment of Renewable Energy. The federal government has established special tax expense and depreciation categories for renewable energy, including capital cost allowance provisions under Class 43.1 of the Income Tax Act. The provisions of Class 43.1 only benefit industrial investors in renewable energy. This special tax treatment should be extended to commercial and residential customers so they can recover some of their investments in renewable energy projects through reduced taxes on their income.

Demand Side Management: By providing direct financial incentives and creative financing packages to customers, and working with trade associations, private and public utilities can encourage the efficient use of electricity and reduce the need for new power supply. Regulators and governments should work to ensure that demand side management is actively pursued in monopolistic and competitive electricity markets.

Regulators and governments should work to ensure that demand side management is actively pursued in monopolistic and competitive electricity markets.

5

Reducing greenhouse gas emissions from industry (40 Mt reduction)

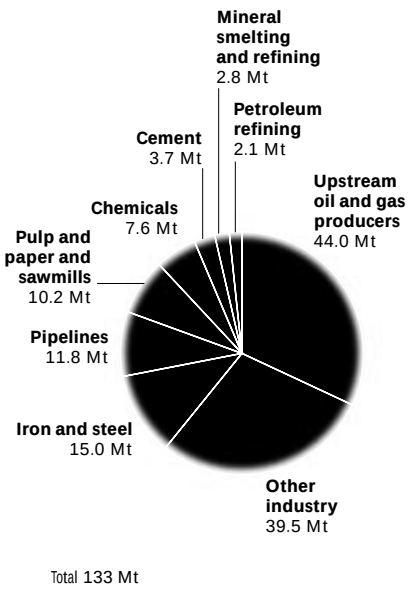

FIGURE 10. ENERGY-RELATED GREENHOUSE GAS EMISSIONS FOR INDUSTRY

In 1995, industry produced 228 Mt of greenhouse gas emissions, or 37 per cent of Canada's total greenhouse gas emissions in that year.[72] This represented a 13 per cent increase above 1990 levels. Much of the increase came from increased production in Canada's oil and gas industry. Greenhouse gas emissions associated with the use of electricity and fossil fuels to produce oil and natural gas for export accounted for more than 30% of the total increase in Canada's greenhouse gas emissions in the 1990-1995 period.[73]

Greenhouse gas emissions in the industry sector come from a variety of sources. There are, however, three significant categories of emissions in the industry sector: energy-related emissions, fugitive emissions, and process-related emissions.

ENERGY-RELATED EMISSIONS

Energy-related emissions accounted for 58% (133 Mt) of greenhouse gas emissions from the industry sector in 1995. Eight different industries accounted for more than 70% of the entire industry sector's energy-related greenhouse gas emissions.

In the year 2010, energy-related greenhouse gas emissions from upstream oil and gas producers are projected to be 27% above 1990 levels.[74] For the balance of the industry sector, energy-related greenhouse gas emissions are projected to be 20% above 1990 levels in the year 2010.

FUGITIVE EMISSIONS

The production and distribution of fossil fuels also releases fugitive emissions of greenhouse gases (carbon dioxide and methane) into the atmosphere. In 1995, these fugitive emissions represented 21% of total industry emissions and contributed 48.5 Mt to Canada's greenhouse gas emissions inventory.

PROCESS-RELATED EMISSIONS

Specific industrial processes also release greenhouse gas emissions into the atmosphere even though no combustion of fossil fuels has taken place. These process-related emissions account for 21% (47 Mt) of all greenhouse gas emissions from the industrial sector. Some examples include:

- The chemical process that produces cement releases carbon dioxide to the atmosphere.
- The production of some chemical products, like adipic acid, releases nitrous oxide emissions to the atmosphere.
- The production of aluminum releases perfluorocarbons into the atmosphere.

When all the different sources are combined together, it is clear that the upstream oil and gas industry is the largest single contributor to greenhouse gas emissions from the industry sector. In 1995, this industry produced 87.6 Mt of greenhouse gas emissions, 38% of total industry emissions in that year. A number of other sectors are important contributors to the overall total because they are responsible for both energy-related emissions and process-related emissions. These sectors include: cement, iron and steel, chemicals, and aluminum production.

It is clear that there is a great deal of diversity of greenhouse gas emission sources in the industrial sector. On the other hand, it is also clear that the vast majority of greenhouse gas emissions in the industry sector are produced by only a small handful of different industries. What is the best way to proceed?

It would be challenging to identify a specific package of measures to reduce greenhouse gas emissions for each sector of industry and each source of emissions (energy-related, process-related, fugitive). Accordingly, it is most appropriate within the industry sector to use broad-based economic instruments that send clear market signals to reduce greenhouse gas emissions but also provide individual firms with the flexibility to decide on their most cost-effective way to respond to those signals.

The measures proposed in this section only address a subset of industry, but still reduce greenhouse gas emissions by 40 Mt from projected levels in 2010. Clearly, additional measures will be required to ensure that all industry sectors and firms contribute to Canada's efforts to meet its commitments under the Kyoto Protocol.

Greenhouse gas emissions associated with the use of electricity and fossil fuels to produce oil and natural gas for export accounted for more than 30% of the total increase in Canada's greenhouse gas emissions in the 1990-1995 period.

Domestic action: implementing a cap and allowance emissions trading system for industry (26 Mt reduction)

The industry sector is extremely diverse. Emission sources, and emission reduction opportunities and costs, vary widely from industry to industry and from

It is most appropriate within the industry sector to use broad-based economic instruments that send clear market signals to reduce greenhouse gas emissions but also provide individual firms with the flexibility to decide on their most cost-effective way to respond to those signals.

company to company within an industry. Thus, it is recommended that governments use a "cap and allowance" emissions trading system to reduce emissions in this sector.

Under a cap and allowance emissions trading system[75], a regulated emissions cap is established for total emissions from all participants in the system. Rights to emit a portion of the emissions within the cap are then allocated to the participants in the system in the form of allowances that permit the holder to emit a unit of carbon dioxide equivalent greenhouse gas emissions. At the end of each year all participants must hold allowances equivalent to their actual emission levels. Participants who hold surplus allowances (i.e., they emitted less than they were permitted) can sell them to participants who do not have enough allowances to cover their actual emission levels. Stiff penalties are required for participants who do not have enough allowances to cover their actual emission levels.

The use of such a cap and allowance system guarantees that an environmental objective will be met because total emissions are regulated under the cap. It also makes it likely that low-cost emission reduction options will be implemented before high-cost emission reduction options are. A firm is unlikely to invest in an emission reduction in its own facilities if it can purchase allowances more cheaply from another company that has made an equivalent reduction in emissions. This reduces the overall cost of compliance for all emitters regulated under the regulated cap.

DESCRIPTION OF THE MEASURE

There are potentially many different types of cap and allowance emission trading systems for greenhouse gases and the full range of these systems should continue to be explored, assessed and analyzed. It is recommended, however, that the federal government implement some form of cap and allowance emissions trading system, to become effective by no later than the year 2008, to address greenhouse gas emissions from the industry sector. Phasing in a cap and allowance trading system prior to 2008 may ensure a smoother transition for Canadian industries.

The system proposed here would cover energy-related greenhouse gas emissions, fugitive emissions, and industrial process emissions.[76] For the purposes of this analysis, we will assume that the regulated cap would be consistent with the Kyoto Protocol and would require total emissions from all industry sector participants to be no higher than 94% of 1990 levels in each of the years 2008, 2009, 2010, 2011 and 2012.

To provide increased flexibility, participants would also be able to purchase a limited number of allowances or greenhouse gas emission reduction credits internationally through the flexibility mechanisms included in the Kyoto Protocol (see the measure: Using the Kyoto Protocol's Flexibility Mechanisms).

Participants could also make use of greenhouse gas emission reduction credits from incremental reduction activities achieved within Canada by other emitters not regulated by the cap (e.g., municipalities) to help them meet their regulatory requirements. If this is to be allowed, however, strong and effective criteria must be in place to ensure that offsets or emission reduction credits are "additional" and not simply the result of actions that would have been taken in any event.

Participants in the system would include the following:

- upstream oil and gas production,
- pulp and paper,
- iron and steel,
- pipelines,
- smelting and refining,
- petroleum refining,
- chemicals, and
- cement.

These industries account for close to 85% of all emissions (energy-related, fugitive and process-related) from the industry sector.[77] Furthermore, it has been estimated that a total of about 200 companies produce more than 85% of the total emissions within these industry sectors.[78] Therefore, it should be possible to cover approximately 72% of total industry emissions through these 200 companies.

A larger number of companies should be involved in the cap and allowance trading system. However, more analysis is required to determine precisely how many additional firms should be brought into the system from large-scale manufacturing and smaller resource sector companies without adding significantly to administrative costs.

It is also important to include electric utilities in such a system. If electric utilities were left outside the system, it could potentially provide an incentive for industry to substitute the use of electricity for the direct use of fossil fuels. Moreover, including electric utilities in the regulated cap would increase the quantity of emissions covered by the program by almost 50% through the addition of no more than 10-15 firms.[79]

Most of the actions described in the earlier chapter on the electricity generation sector are clearly complementary to a cap and allowance emissions trading system. Measures that level the playing field and provide equal access to the market for electricity generated from co-generation, waste solution gas, and small scale renewable energy projects are complementary because they increase the range of cost-effective emission reduction opportunities to participants from the electricity generation sector. As noted earlier, the package of measures proposed in the electricity generation sector would reduce greenhouse gas emissions

Including electric utilities in the regulated cap would increase the quantity of emissions covered by the program by almost 50% through the addition of no more than 10-15 firms.

The adoption of a cap and allowance emissions trading system in the industrial sector will allow participating firms and society as a whole to reduce emissions more cheaply than would be the case under conventional regulatory approaches.

in the electricity sector to 15 per cent below 1990 levels in the year 2010. Accordingly, the cap on emissions from the electric utility sector under this cap and allowance trading program should be no less stringent than this.

GREENHOUSE GAS EMISSION REDUCTION BENEFITS

If we assume that the cap and allowance trading system would require industry emitters that represent 72% of total industrial emissions to reduce their greenhouse gas emissions to 6% below 1990 levels by 2010, it would reduce greenhouse gas emissions in this sector by 40 Mt from projected levels in 2010.

It is clearly desirable and cost-effective to design the program so that a larger percentage of emissions from the industry sector is included. As a result, this should be considered the minimum emission reductions from this measure. It should also be noted that no additional emission reductions are recorded here for electric utility sector participants because it is assumed that the level of their regulated cap will reflect the impact of actions described in the chapter on emissions from the electric utility sector.

All participants in the system would, however, have access to the Kyoto Protocol's "flexibility mechanisms" to obtain a maximum 14 Mt of emission reductions. Accordingly, these firms would only be required to reduce emissions within Canada by 26 Mt.

ECONOMIC COSTS AND BENEFITS

The adoption of a cap and allowance emissions trading system in the industrial sector will allow participating firms and society as a whole to reduce emissions more cheaply than would be the case under conventional regulatory approaches.

Nonetheless, many industrial firms claim that energy represents a significant portion of their total costs and therefore they are already highly energy efficient and have fewer opportunities to reduce greenhouse gas emissions. They might then argue that an 11% reduction from projected domestic emission levels in 2010 cannot be done without the imposition of significant costs on industry. Several studies, however, indicate this is not the case.

For example, the Energy Research Group at Simon Fraser University has estimated that carbon dioxide emissions in Canadian industry could be reduced below projected levels in 2010 if the energy end-use technology with lowest life-cycle cost, evaluated at a 7% discount rate, captured 100% of the market. Emissions would fall by the following amounts below projected levels: pulp and paper (33%), iron and steel (10%), and metal smelting (40%).[80]

Another study, by MK Jaccard and Associates and Willis Energy Service Ltd., concludes that if industry adopted the most energy efficient technologies, emissions would be reduced below projected 2010 levels by the following amounts: pulp and paper (25%), petroleum refining (7%), mining (3%), iron and steel (14%), chemicals (8%), and industrial minerals (11%).[81]

Naturally, the implementation of a cap and allowance emissions trading system would also send a price signal that would make greenhouse gas emission reductions more attractive and increase the range of cost-effective opportunities available to industry to reduce emissions.

It is important to note that it will be absolutely essential to implement complementary measures that produce emission reductions in firms that are within the industry sector but fall outside the scope of a cap and allowance trading program. If this is not the case, the burden of emission reductions is being unfairly borne by a subset of larger emitters in this sector. Potential additional measures to address greenhouse gas emissions from the industry sector are discussed later in this document.

AN IMPLEMENTATION STRATEGY FOR CANADA – RECOMMENDATIONS

1. The federal government should announce that a cap and allowance emissions trading system that includes large industrial emitters will form part of Canada's strategy for implementing the Kyoto Protocol. Detailed design work for such a system should begin immediately. Key design features such as system rules and participants, the level of the emissions cap, and the procedure to be used for allocating allowances should be confirmed and specified by 2003 so that industry has a chance to prepare for implementation of the system in 2008. Phasing in a cap and allowance trading system prior to 2008 may ensure a smooth transition for Canadian industries.
2. Any government design for a voluntary emission reduction credit trading scheme or a related 'credit for early action' system for industrial emitters should be based on the assumption that a broad industry cap and allowance emissions trading system will be implemented by 2008.
3. To prepare for the implementation of a cap and allowance emissions trading system, the National Pollutant Release Inventory (NPRI) program should be expanded to require mandatory reporting of greenhouse gas emissions for all emitters above a specific threshold of emissions per year and the Canadian Environmental Protection Act should be amended to provide legislative authority for the NPRI program.

International action: using the Kyoto Protocol's "flexibility mechanisms" (14 Mt reduction)

The Kyoto Protocol includes two types of "flexibility mechanisms" to help industrialized countries achieve emission reduction commitments under the Protocol. These are emissions trading, and joint implementation and the Clean Development Mechanism.

Emissions Trading

The Kyoto Protocol sets a cap on the total greenhouse gas emissions that can be emitted by industrialized countries and it is expected that each country will receive international "allowances" to emit a specific amount under the cap. For example, Canada would receive allowances to emit, on average, 94% of 1990 greenhouse gas emission levels in each year of the 2008-2012 period. At the end of the compliance period, all countries will have to hold allowances equal to their emissions level. Under international emissions trading, countries that exceed their emissions limit will be allowed to purchase surplus allowances from countries that do not use all of their allowances because their emissions are below their emissions limit.

The Canadian government has made it clear that it wants the private sector to be able to participate in international emissions trading. To do so, Canada will have to allocate a portion of its total allowances to potential participants in the emissions trading program. The establishment of a domestic cap and allowance emissions trading system would provide a mechanism for distributing these allowances to industry – the most likely participants in an emissions trading program.

Joint Implementation/Clean Development Mechanism

These mechanisms under the Kyoto Protocol allow a country to exceed its emissions limit if it takes actions to reduce emissions in another industrialized country (Joint Implementation) or developing country (Clean Development Mechanism). In essence, governments or members of the private sector would invest in specific projects that reduce greenhouse gas emissions in another country to offset their own emissions. A "credit" would be awarded for the difference between the level of greenhouse gas emissions before the project was implemented and the level of greenhouse gas emissions after the project was implemented. Canada would then be allowed to exceed its emissions limit under the Protocol by the amount of emissions represented by the credit. Again, it is expected that primarily private companies in the industrial sector would take advantage of these flexibility mechanisms.

These flexibility mechanisms and the rules under which they will operate continue to be the subject of ongoing international negotiations. These negotiations are not expected to conclude until late 1999 at the earliest.

No matter when these negotiations are completed, however, Canadian industry will be unable to take advantage of these flexibility mechanisms until federal and provincial governments determine how responsibility for meeting Canada's Kyoto commitments will be allocated among emitters in society. As a result, Canadian industry's ability to benefit from the flexibility mechanisms will be linked to decisions by federal and provincial governments on the allocation question.

DESCRIPTION OF THE MEASURE

Assuming that the flexibility mechanisms ultimately negotiated under the Kyoto Protocol are credible and effective, the federal government would establish procedures to allow Canada's private sector to take advantage of them. However, the federal government must also clearly indicate that Canada will meet the vast majority of its emission reduction obligations under the Kyoto Protocol at home. To move from rhetoric to reality, the federal government would establish a firm limit on the extent to which the private sector could make use of these provisions. We have suggested that this limit be 14 Mt, or 10 per cent of the total emission reductions Canada is projected to require to meet its Kyoto Protocol commitment. Canada should also push for an equally strict limit or cap on the use of "flexibility mechanisms" for all industrialized countries in the ongoing negotiations to elaborate the Protocol.

There are several reasons why it is important for Canada to meet the vast majority of its emission reduction commitments through domestic actions:

- The Kyoto Protocol is very clear in its intent: international trading of emissions is to be "supplemental to domestic emission reductions."
- While taking action to reduce greenhouse gas emissions will make a similar contribution to climate protection no matter where it occurs, many of these actions (e.g., reducing the combustion of fossil fuels) produce additional environmental and health benefits (e.g., decreased emissions of gases that lead to urban smog and acid rain). Taking action in Canada ensures that Canadians receive these multiple benefits.
- Actions that reduce greenhouse gas emissions often produce economic benefits as well, such as increased employment and investment as well as savings generated by reduced energy use. Making investments in climate protection in Canada will create jobs and economic activity in Canada and will help to make Canadian industry more competitive and efficient. Making similar investments overseas will draw investment out of the country and result in Canadian dollars creating foreign jobs and supporting foreign technology development.
- The Kyoto Protocol is only the first step in international climate protection. Stabilizing the atmospheric concentration of carbon dioxide at double pre-industrial levels will require cuts in global greenhouse gas emissions of 60% or more. Additional, much more substantial, emission reductions will be needed. Meeting such an objective will require the development of new technologies and significant investment in research and development. Ensuring that Canada will meet most of its emission reduction commitments at home will provide a strong incentive for research and development spending and technology development in Canada. Additional fiscal incentives should also be provided to ensure that Canada is well positioned to provide the world with climate protection technologies for the future.

The federal government must also clearly indicate that Canada will meet the vast majority of its emission reduction obligations under the Kyoto Protocol at home.

Ensuring that Canada will meet most of its emission reduction commitments under the Kyoto Protocol at home would send a strong signal to developing countries that Canada is serious about climate protection.

- If the world is to deal successfully with climate change, all countries will have to contribute to greenhouse gas emissions reduction. Under the United Nations Framework Convention on Climate Change (UNFCCC), industrialized countries agreed to take the lead in this international effort. Unfortunately, the overwhelming majority of these countries will fail to meet their goal under the UNFCCC of stabilizing greenhouse gas emissions at 1990 levels by the year 2000. This has led developing countries to argue that they will not adopt their own emission reduction commitments until industrialized countries make demonstrable progress in climate protection. Ensuring that Canada will meet most of its emission reduction commitments under the Kyoto Protocol at home would send a strong signal to developing countries that Canada is serious about climate protection – increasing the likelihood that developing countries will agree to limits on the future growth of their own emissions of greenhouse gases.

GREENHOUSE GAS EMISSION REDUCTION BENEFITS

The use of the Kyoto Protocol's flexibility mechanisms in this manner would contribute up to 14 Mt of greenhouse gas emission reductions to Canada's Kyoto commitment as part of the total contribution of 40 Mt of reductions projected from the industry sector under the cap and allowance trading program.

To ensure that greenhouse gas emission reductions really do occur in other countries through the use of these flexibility mechanisms, Canada will have to ensure that the final rules negotiated for these mechanisms include:

- A provision that allowances purchased through emissions trading must come from countries that can demonstrate they have actually taken specific incremental actions to reduce emissions by that much. Some countries (e.g., Russia) may end up with surplus allowances simply because their emissions limit was set far too high and actual emissions will fall below the limit even if no actions are taken to reduce emissions. Trading of these paper emission reductions (hot air) is unacceptable.
- A provision that reductions obtained through credit trading programs like joint implementation or the Clean Development Mechanism are "additional" and would not simply have happened anyway.[82] This is important to ensure that incremental greenhouse gas emissions reductions actually occur in developing countries that face no obligation to limit emissions. It is also important to ensure that private sector companies cannot simply shift the obligation of finding "additional" emission reductions onto other actors (e.g., other companies, governments, and private citizens).

ECONOMIC COSTS AND BENEFITS

If the Kyoto Protocol's flexibility mechanisms are environmentally credible and effective, they will reduce the costs for Canada of complying with its obligations under the Protocol if emissions can be reduced more cheaply outside Canada than within Canada.

It has been argued that unfettered access to the flexibility mechanisms would allow Canada to meet its obligations at the lowest possible cost. Such arguments ignore the short-term economic benefits generated by investment in emission reduction actions in Canada and the long-term benefits to Canada that will result from actions (including technology development) that will make Canada more competitive in an energy-efficient, less carbon-intensive world of the future.

AN IMPLEMENTATION STRATEGY FOR CANADA – RECOMMENDATIONS

1. As part of the Canadian approach for the fourth meeting of the Conference of the Parties to the UNFCCC in Buenos Aires (November 1998) the Prime Minister should clearly state that Canada will meet the overwhelming majority of its emission reduction obligations under the Kyoto Protocol through actions at home.
2. Canada must participate actively in the ongoing international negotiations establishing the rules for the Kyoto Protocol's flexibility mechanisms. The first priority in these negotiations must be to ensure the environmental effectiveness of these measures by including the following goals:

- actions to prevent 'hot air' emissions trading,
- actions to ensure the "additionality" of emission reductions generated through joint implementation and the Clean Development Mechanism, and
- actions to ensure that activities to enhance greenhouse gas sinks do not produce emission reduction 'credits' until the Intergovernmental Panel on Climate Change has developed broadly accepted methodologies for monitoring and measuring carbon sequestration in biomass.

3. The federal government should take steps to acknowledge and design the linkages required between a domestic emissions trading system and use of the Kyoto Protocol's flexibility mechanisms.

Other potential actions to reduce greenhouse gas emissions from the industrial sector

Even with a cap and allowance emissions trading system in place, additional measures in the industrial sector will be needed to protect the climate. First, emissions trading will not address all industrial sources of greenhouse gas emissions – smaller sources are likely to be excluded from the program. Second, while an emissions trading system may increase the range of cost-effective measures available to firms seeking to decrease greenhouse gas emissions, it may not address many of the key barriers that prevent firms from taking advantage of cost-effective emission reduction opportunities. Some examples include:

- subsidies that provide incentives that contradict and counteract the price signals generated through emissions trading,
- a lack of information about greenhouse gas emission reduction opportunities in the industrial sector,
- financial barriers such as a lack of access to investment capital or very high rate of return requirements on investments, and
- the failure of prices to reflect environmental externalities associated with fossil fuels but unrelated to climate change.

Accordingly, there is a need for complementary measures such as:

- *Improved regulated energy efficiency standards for industrial motors and equipment*
- *Financial incentives for investments in energy efficiency improvements and climate friendly technologies and practices.* (Finance Canada and Natural Resources Canada have concluded that investments in energy efficiency are actually penalized under the current tax system relative to a 'neutral' tax system)
- *Access to electricity markets for electricity produced with co-generation technologies* (as noted earlier, many provinces remain a long way from competitive electricity markets).
- *Revenue-Neutral Shifts in Royalty Structures:* Currently, upstream petroleum producers do not pay royalties on the energy used to produce oil and gas. A decrease in provincial royalty payments on the final product, accompanied by the imposition of royalties on the use of energy to produce oil and natural gas, would provide increased incentives to reduce greenhouse gas emissions in the production process.
- *Increased Performance-Based Research and Development Tax Credits:* These should be linked to the development of technologies that significantly reduce greenhouse gas emissions and other environmental stresses.

6

Reducing greenhouse gas emissions from the residential sector **(10.9 Mt reduction)**

In 1995, the residential sector accounted for 42 Mt of Canada's greenhouse gas emissions, 7% of Canada's total emissions in that year.[83] This represented a 3% increase over 1990 levels. According to the most recent government projection of Canada's future greenhouse gas emissions, emissions from the residential sector are projected to be 13% below 1990 levels in the year 2010. This decline in emissions stands in stark contrast to projected emission trends in all other sectors. It appears to be the product of very positive assumptions with respect to energy efficiency of equipment and appliances used in the home that use fossil fuels.[84]

The main sources of greenhouse gas emissions in the residential sector are the use of fossil fuels (primarily fuel oil and natural gas) to meet space heating and water heating needs and to power appliances. As in other sectors, the opportunities for greenhouse gas emissions reduction in the residential sector fall into four broad categories:

- reducing the demand for fossil fuels (e.g., improved home insulation and better home design),
- improving the efficiency of fossil fuel use (e.g., buying a more efficient furnace),
- switching to less carbon-intensive fuels (e.g., switching from an oil furnace to natural gas), and
- making greater use of renewable energy sources (e.g., active solar heating, voluntary green power purchases)

The residential sector also uses electricity to provide for needs such as lighting, cooking, heating, cooling, and entertainment. In all aspects of residential energy consumption there are opportunities for greater efficiencies and energy conservation. Clearly, actions will also be required in this sector to reduce the demand for electricity.

Mandating an R-2000 building code for new homes
(3.7 Mt reduction)

A new home built to R-2000 standards would reduce energy use by 26% from average levels in new homes built in 1994.

The federal government's R-2000 program has promoted energy efficient construction in residential housing since it was first established in 1982. It uses the "House as a System" approach, addressing all areas of energy usage within the home, as well as indoor air quality and occupant health. For 17 years, the program has provided Canada's housing industry with information and guidelines for the construction of more energy efficient, environmentally friendly and healthy homes.

The R-2000 home is clearly a good product. A comprehensive study completed in August of 1998 by Natural Resources Canada's Policy and Analysis Division provides a comparison of Canadian household energy consumption for new houses constructed in 1994 and homes built to the National Energy Code for Housing (NECH) and R-2000 standards.[85] The study concludes that:

- The average total annual energy consumption of new houses in 1994 was found to be 131 GJ/year.
- A new home built to the proposed "National Energy Codes for Houses" (NECH) would reduce energy use by 11.5% from that 1994 benchmark.
- A new home built to R-2000 standards would reduce energy use by 26% from average levels in new homes built in 1994.[86]

Between 1982 and 1997 thousands of builders across Canada took R-2000 Builders Courses and millions of dollars were spent on public promotion of the R-2000 program and program delivery. While these efforts have helped to make new homes in Canada more energy efficient, the average new home built in Canada today still uses significantly more energy than an R-2000 home. In fact, only about 7,000 R-2000 homes have been built in Canada since 1982 and R-2000 housing starts accounted for only 0.6% of all new housing starts in Canada in 1995.[87]

Clearly, there is significant scope for governments to take action that will increase the construction of R-2000 homes in Canada.

DESCRIPTION OF THE MEASURE

Provincial governments should mandate the R-2000 standard as the minimum building code for all new residential construction starting in the year 2000. R-2000 technology is proven, available and cost-effective.

GHG EMISSION REDUCTION BENEFITS

The adoption of an R-2000 building code for new residential construction in the year 2000 would decrease greenhouse gas emissions by 3.7 Mt relative to projected levels for the year 2010.

MULTIPLE ENVIRONMENTAL BENEFITS

While R-2000 homes provide significant benefits in terms of reduced energy use, they are also designed to have a lower overall environmental impact compared to a conventional home. New homeowners will also benefit from the improved indoor air quality found in R-2000 homes.

ECONOMIC COSTS AND BENEFITS

While an R-2000 home uses 26% less energy than the average new home built in Canada in 1994, they are 4% to 6% more expensive to construct. For the homebuyer, it will take between 15 to 20 years to payback these additional costs through reduced energy bills at current utility prices.[88] This modest increase should be put in the context of the addition of many other non-economic luxury features to new homes that have helped to increase the average price of new homes in Canada.

This assessment, however, does not take into account the fact that construction costs are likely to decline with widespread adoption of R-2000 building techniques and technologies. At the same time, R-2000 construction will also reduce long-term repair and maintenance costs through improved building shell construction, and can potentially add to the re-sale value of the home.

Even so, the key attribute differentiating R-2000 homes from conventional homes is energy performance – and currently most homebuyers and financial institutions do not fully consider the cost of energy over the life of a home when assessing ability to buy a new home and qualify for a mortgage. This presents an opportunity and challenge to educate homebuyers and financial institutions about the environmental and economic benefits associated with this measure.

AN IMPLEMENTATION STRATEGY FOR CANADA – RECOMMENDATIONS

The 17-year history of the R-2000 program has proven that a non-regulatory approach will not result in the construction of R-2000 homes, no matter how much money is applied to marketing, information and education. Accordingly:

1. Provincial governments should mandate an R-2000 building code for new residential construction to enter into effect in the year 2000. For this deadline to be met, work needs to begin immediately on the development of new R-2000 compliance requirements that would be based on climatic regions (heating and cooling degree-days). While there will be some additional up-front costs for training services and regional inspectors, most of the basic tools and infrastructure required to implement an R-2000 building standard already exist.

Cost-effective energy efficient retrofits of Canadian homes (7.2 Mt REDUCTION)

In 1996, there were approximately 11,500,000 residences in Canada. More than 60% of these were built prior to 1977.[89] Over the last 20 years, however, numerous cost-effective opportunities to improve energy efficiency in the home through actions that reduce the demand for space heating and cooling, electrical usage and water heating have been clearly identified.

For example, the Energy Matters database originally developed by the Alberta Department of Energy identified the following actions as having significant potential to reduce energy demand for space heating in existing homes[90]:

- weather stripping and caulking: 5%-25% reduction,
- improved roof insulation: 10%-25% reduction,
- floor and basement insulation: 10%-15% reduction,
- storm windows/doors: 8%-15% reduction,
- high efficiency furnaces: 10%-15% reduction, and
- setback thermostats 5%-10% reduction.

It is estimated that between 5% and 7% of homeowners perform some energy retrofit improvements to their home each year and there have been a number of efforts in Canada to try and ensure that these retrofits capture available energy efficiency potential. Funding programs and grant programs such as the federal government's 1979 "Canadian Home Insulation Program" had some level of success, but current government programs that focus solely on educating and motivating homeowners to undertake energy efficiency retrofits have not produced the desired results. In fact, a July 1998 report from Natural Resources Canada concluded that energy retrofit activity in Canadian homes in 1995 reduced average energy consumption by only 0.50 %.[91]

One bright spot in recent years, however, has been the development of local community based energy efficiency programs. For example, the Ontario Green Communities Initiative (GCI) has been able to increase awareness and complete simple energy efficiency and environmental audits on 85,000 Ontario homes. The program has a 75% success rate for voluntary uptake of audit recommendations with an average expenditure of $1,300 per household on energy efficiency improvements. Water conservation procedures have produced natural gas savings of between 0.4% to 2.4%, while savings on space heating loads have been between 4% and 9%. Estimated annual carbon dioxide emission reductions have ranged from 0.39 tonnes to 1.4 tonnes per home.

Although the GCI program has had some success, the energy efficiency improvements generated have clearly not captured the full potential that exists for energy efficiency improvements and associated greenhouse gas emission reductions in the residential sector. Capturing this potential will require increased

funding for programs like GCI, as well as the implementation of a package of complementary regulatory and fiscal measures that provide increased incentives for energy efficiency improvements in the residential sector.

DESCRIPTION OF THE MEASURE

A package of initiatives is proposed to increase both the number of homes undertaking energy retrofits as well as the energy efficiency improvements generated by those retrofits. The objective of these measures is to produce, on average, a 20% energy efficiency improvement in 50% of currently existing homes by the year 2010. These measures would:

- mandate minimum energy efficiency retrofits in existing homes,
- provide increased support to programs that identify energy-efficiency opportunities for homeowners,
- provide financial incentives for homeowners to undertake energy retrofits, and
- provide increased training for homeowners and professionals in residential energy retrofits.

The specific measures being proposed include:

- *Provincial Regulations Requiring Energy Retrofits:* Provincial and/or municipal governments have a number of opportunities to mandate energy efficiency retrofits of homes through building codes, land use planning and permit approval processes. For example, prescriptive codes should be developed and implemented that require homeowners to undertake a number of cost-effective energy efficiency measures (e.g., caulking and weather stripping, installation of low flow water equipment, minor insulation upgrades) any time a house is to be sold, inspected, or renovated. This has been done in San Francisco, where the 1981 "Residential Energy Conservation Ordinance" (RECO) has reduced the amount of energy the average home uses in the city by more than 15%.
- *Increased Support for initiatives like the Green Communities Initiative:* These programs have demonstrated results. Additional funding should be provided to such programs to support the implementation of more retrofits. Complementary incentives would improve the quality of the retrofits and increase the energy and greenhouse gas emission reductions.
- *Low Interest Energy Retrofit Loans for Energy Retrofits:* Such loans provide a direct economic incentive to homeowners to undertake energy efficiency retrofits. The federal government should be a catalyst for the provision of such loans by making a minimal financial commitment and forming partnerships with financial institutions, utilities, building supply companies or equipment manufacturers. For example, Fannie Mae is a congres-

In San Francisco, the 1981 "Residential Energy Conservation Ordinance" (RECO) has reduced the amount of energy the average home uses in the city by more than 15%.

sionally charted, shareholder-owned company that is the largest source of home mortgage funds in the United States. It is working with utility companies to provide customers with a low-cost source of funds that allows homeowners to finance energy-efficiency improvements. Eligible upgrades include the replacement of central heating and cooling systems, water heating systems, replacement windows and doors, insulation, ductwork upgrades, and lighting replacement. Loans are made available for less than market rates for terms up to 10 years and amounts up to $15,000. Interest is fixed for the term of the loan based upon market conditions.

- *Tax Incentives for Energy Retrofits*: The federal government should provide a tax credit for investments by homeowners in energy retrofits. Homeowners who have completed an energy efficiency upgrade would contact their utility suppliers for total energy consumption figures for the year prior to retrofitting and the year after retrofitting. The seasonally adjusted reductions in energy usage would then qualify for a pro-rated, time limited, tax credit. The larger the energy savings, the larger the tax benefit. Other possible incentives would be to provide tax credits to homeowners who undertake energy audits or to allow the withdrawal of Registered Retirement Savings Plan funds with no penalty for the purposes of investing in an energy efficiency retrofit.
- *Government Sponsored Training In Energy Retrofits*: Federal and provincial governments should combine their efforts and resources to provide ongoing mandatory training programs and educational materials for residential energy retrofits to renovation contractors, code and building officials and organizations involved in residential energy retrofits. Training program delivery could be handled through existing infrastructure such as Canada Mortgage and Housing Corporation, Natural Resources Canada, provincial energy departments, or regional educational institutes. Homeowner do-it-yourself training and education programs could also be delivered through educational institutes or through a joint venture with national and regional hardware and building supply outlets.

GREENHOUSE GAS EMISSION REDUCTION BENEFITS

Improving the energy efficiency of 50% of existing homes by, on average, 20% by the year 2010 would reduce greenhouse gas emissions by 7.2 Mt relative to projected levels for the year 2010.

ECONOMIC COSTS AND BENEFITS

Currently, homeowners do not undertake energy efficiency retrofits for a number of reasons. First, many lack information about low-cost energy efficiency opportunities. Programs like the Green Communities Initiative, however, have

demonstrated that providing this information directly to homeowners will produce investment in cost-effective energy efficiency improvements.

Nonetheless, low energy costs, combined with the project and borrowing costs for energy efficiency retrofits, result in a number of energy efficiency actions yielding fairly long-term paybacks that most homeowners do not regard as sufficient incentive. This package of measures will require homeowners to implement a specific set of low-cost actions to improve energy efficiency in the home whenever a home is sold, inspected or renovated. In addition, however, this package of measures then provides information, training and incentives to facilitate voluntary adoption of more aggressive energy efficiency measures.

Generating new investment in energy efficiency will create jobs and local economic development opportunities. Investments in energy efficiency create four times as many jobs as equivalent investments in new conventional energy supply.[92] This is because energy efficiency improvements are both labour intensive (using local labour), and they reduce energy costs, thereby providing homeowners with money that will then be spent locally in labour-intensive sectors of the economy (e.g., the service sector).

Investments in energy efficiency create four times as many jobs as equivalent investments in new conventional energy supply.

AN IMPLEMENTATION STRATEGY FOR CANADA – RECOMMENDATIONS

A pro-active approach is now needed to stimulate residential energy retrofits. Relying simply on education and awareness campaigns that seek to inform and motivate homeowners to pursue energy retrofits will not be enough to deliver results. While government grant programs can have an effect, they are usually very costly, difficult to administer, and often yield results which are hard to verify. Accordingly, a mix of regulatory and fiscal measures is required.

The following steps should be taken:

1. The federal government should significantly increase the funding made available to initiatives like the Green Communities Initiative to help ensure they exist and flourish across Canada.
2. The federal government should provide Canadians with an opportunity to obtain a tax credit for investments in home energy retrofits if it can be clearly demonstrated that such a retrofit has taken place and is delivering results.
3. The federal government should establish a program to offer and promote low-interest loans for energy retrofits in the residential sector, delivered by utilities and financial institutions.
4. Provincial governments should pass regulations that require all homeowners to demonstrate that they have implemented a clearly identified basic set of cost-effective energy retrofit measures before a home can be sold, inspected or renovated.

Other potential actions to reduce greenhouse gas emissions from the residential sector

The single action taken by Canada since 1990 that is likely to make the most significant contribution to greenhouse gas emissions reduction has been the development and implementation of energy efficiency standards for residential equipment and appliances.[93] While the impact of these actions has been small to this point, they will make a more significant difference by 2010 as homeowners and renters retire their old appliances (e.g., refrigerators, washing machines, dishwashers, ranges) and purchase new ones.

Nonetheless, technology continues to evolve and energy efficiency standards must also evolve to reflect new developments in technology. Accordingly, the federal government should commit to strengthening these standards and initiating a new round of standard improvements for implementation in 2005.

7

Reducing greenhouse gas emissions from the commercial sector (6.4 Mt reduction)

In 1995, the commercial sector accounted for 27.2 Mt of Canada's greenhouse gas emissions, 4.3 per cent of Canada's total emissions in that year.[94] This represented a 13 per cent increase over 1990 levels. According to the most recent government projection of Canada's future greenhouse gas emissions, emissions from the commercial sector are projected to be 26% above 1990 levels in the year 2010.

As in the residential sector, the main sources of greenhouse gas emissions in the commercial sector are the use of fossil fuels (primarily fuel oil and natural gas) to meet space heating and water heating needs and to power appliances and equipment. Once again, the opportunities for greenhouse gas emissions reduction fall into four broad categories:

- reducing the demand for fossil fuels (e.g., improved building shells),
- improving the efficiency of fossil fuel use (e.g., buying a more efficient furnace),
- switching to less carbon-intensive fuels (e.g., switching from oil-powered heating to natural gas), and
- making greater use of renewable energy sources (e.g., active solar heating, voluntary purchases of green power).

The commercial sector also is a significant user of electricity and it is clear that actions will also be required in this sector to reduce the demand for electricity.

Cost-effective energy efficient retrofits of commercial buildings (4.4 Mt reduction)

Energy efficiency improvements in the commercial building sector offer one of the key cost-effective opportunities to reduce greenhouse gas emissions in Canada. Current studies and results from energy upgrades indicate that the potential for

Energy efficiency improvements in the commercial building sector offer one of the key cost-effective opportunities to reduce greenhouse gas emissions in Canada.

energy efficiency improvements in existing commercial buildings is[95]:

- space heating and cooling – 10% to 25%
- office and computer equipment – 30% to 50%
- energy management systems – 15% to 50%
- lighting upgrades – 30% to 75%
- building shells – 30% to 60%.

There are a number of successful case studies in Canada that demonstrate that significant energy savings potential exists and can be achieved cost-effectively through commercial building energy retrofits.[96] Nonetheless, these case studies remain isolated examples within the entire Canadian commercial building stock. There are several reasons for this:

- Energy costs are often a small percentage of the total costs faced by commercial enterprises and, as a result, energy efficiency improvements are not a high priority when looking for ways to reduce costs.
- Many commercial building owners remain unaware of the energy efficiency potential that exists within their buildings.
- Many commercial building owners are unwilling to pay the up-front costs of an energy audit that can identify cost-effective energy efficiency opportunities. Once this up-front analysis and design work is completed, however, many commercial building owners are willing to invest in energy retrofits.
- While some commercial building owners may be willing to make investments in energy efficiency measures with a rapid payback (e.g., lighting), they are often unwilling to accept the up-front costs required to invest in energy efficiency improvements with a longer payback period (e.g., building shell).
- Commercial building owners that rent out their facilities have little incentive to invest in energy efficiency improvements because their tenants pay the majority of the energy costs.

There have been some efforts to overcome these barriers in Canada. Since the early 1980's, a wide variety of ongoing information and promotional campaigns, combined with limited funding programs at both federal and provincial levels, have had some effect. Even so, much more could and must be done.

DESCRIPTION OF THE MEASURE

As in the residential sector, *Canadian Solutions* proposes a package of measures to encourage more aggressive energy retrofits in the commercial sector. The package includes: more aggressive and effective education and awareness campaigns, training for building professionals, changes to building codes and regulatory procedures, and financial assistance (to cover up-front costs or energy retrofits themselves) provided through tax incentives and revolving funds. Most of these

measures are described in some detail in the measure related to cost-effective retrofits of Canadian homes, and will not be detailed again here. The exceptions are more aggressive and effective education and awareness campaigns and the concept of a revolving fund.

Education and Awareness: Natural Resources Canada's Energy Innovators Plus initiatives and "Dollars to $ense" energy master plan workshops should be expanded and delivered to a much wider base of commercial and institutional building operators. A wider promotion through joint efforts with provincial governments, local Chambers of Commerce, and all commercial sector associations is needed. Partnerships should be formed with local and regional initiatives (e.g., the Pembina Institute's Eco-Efficient Communities Initiative) to ensure that energy information services are better promoted on a more regional and local basis to increase usage and information transfer.

Energy Efficiency Revolving Funds: Federal, provincial and municipal governments should combine forces to set up revolving energy efficiency funds. These funds could be established as independent entities or could be a portion of a larger municipal environmental infrastructure investment program. Public sector institutional building owners would draw interest-free loans for energy audits or energy retrofits from a revolving fund. Private sector commercial building owners would be charged less than market interest rates. These loans could also be used as leverage loans to help secure additional financing from conventional sources.

Energy retrofits will reduce energy bills, and the building owner can repay the loans from the energy bill savings generated – resulting in no increase in total costs for the commercial operation. Once the loan is paid off, all subsequent savings would be retained by the building owner. This is the same concept that is currently being offered by many Energy Service Companies (ESCOs). The shortcoming of the ESCOs, however, is that they are still a small (but rapidly growing) industry and they are not usually interested in small commercial operations or rural facilities. Once set-up, a revolving fund is self-perpetuating with ongoing long-term benefits.

Provincial Regulations Requiring Energy Retrofits: Provincial and/or municipal governments should develop and implement prescriptive codes that require commercial and institutional building owners to undertake a number of cost-effective energy efficiency measures (e.g., caulking and weather stripping, installation of low flow water equipment, minor insulation upgrades) any time a building is to be sold, inspected, or renovated.

Low Interest Loans for Energy Retrofits:. The federal government should be a catalyst for the provision of such loans by making a minimal financial commitment and forming partnerships with financial institutions, utilities, building supply companies or equipment manufacturers.

It is our objective that the package of measures being proposed would result in 80% of commercial buildings improving their energy efficiency by 30% by the year 2010.

Tax Incentives for Energy Retrofits: The federal government should provide a tax credit for investments by commercial and institutional building owners in energy retrofits that have produced demonstrable energy savings.

Government Sponsored Training In Energy Retrofits: Federal and provincial governments should combine their efforts and resources to provide ongoing mandatory training programs and educational materials for building energy retrofits to renovation contractors, code and building officials and organizations involved in energy retrofits.

Natural Resources Canada has assumed that current initiatives will allow 50% of Canada's commercial buildings to experience gains of 15%-20% in energy efficiency by the year 2010.[97] It is our objective that the package of measures being proposed would result in 80% of commercial buildings improving their energy efficiency by 30% by the year 2010.

GREENHOUSE GAS EMISSION REDUCTION BENEFITS

Using a package of measures to meet the objective outlined above would reduce greenhouse gas emissions by 4.4 Mt relative to projected levels for the year 2010.

ECONOMIC COSTS AND BENEFITS

This package of measures should significantly enhance the voluntary adoption of cost-effective energy retrofit measures in the commercial sector. They are designed to remove information and up-front financing barriers that have limited the extent of commercial energy retrofits in Canada.

While governments will be required to invest seed capital in these measures, the investments are solid. Loans provided through mechanisms like revolving funds will be repaid through energy bill savings. Investment in energy retrofits will also generate enormous economic activity and job creation. It has been estimated that investments in energy efficiency at the municipal level in Canada would create 66 jobs per million dollars invested.[98] This compares to a figure of seven new jobs created per million dollars invested in various conventional energy supply options (hydro, oil, gas, coal, nuclear).[99] This package of measures can generate enough economic activity to produce new tax revenues to more than offset those lost through the provision of a tax incentive, and other program costs.

AN IMPLEMENTATION STRATEGY FOR CANADA – RECOMMENDATIONS

1. The federal government should establish a revolving fund for investments in commercial building energy retrofits that would partner with other funding sources (provincial and municipal governments, private lending institutions) to provide loans to commercial building operators

seeking to either design or implement an energy retrofit program. Such a fund could be a component of a broader program to upgrade municipal infrastructure in an environmentally sensitive manner in Canada.
2. The federal government should provide tax credits to commercial building owners who can clearly demonstrate expenses undertaken to pursue energy retrofits as well as results in terms of less energy use.
3. Provincial governments should establish regulations requiring that a simple, cost-effective package of energy retrofits be undertaken in any commercial building before it can be approved for sale, inspection, or major retrofit.

Providing federal support for district energy

(2.0 Mt reduction)

District energy systems distribute thermal energy from a central, highly efficient source to buildings in the form of chilled water, hot water and/or steam, to provide: space heating, air conditioning, hot water or industrial process energy. By using one central energy source and a system of pipes to provide heating and cooling needs to a large number of buildings, district energy systems are much more energy efficient than the normal situation where individual units are used to provide heating and cooling needs in each building. District energy systems can also operate on a wide range of low-carbon energy sources (e.g., natural gas, biomass, waste heat from industrial facilities). They can use a dedicated thermal facility, or for even greater efficiency, they can use a co-generation source that supplies both electricity and heat.

Some effort has been made in Canada to install district energy systems. There are major district energy systems in six Canadian municipalities. There are also about 60 district energy systems owned and operated by the Department of National Defence, and an additional 60 systems in hospitals and universities.[100] Technical support, and some financial support for feasibility studies, is available from Natural Resources Canada and the Federation of Canadian Municipalities.

Even so, the use of district energy systems in Canada is minimal when compared to the widespread adoption of such systems in many countries with climate similar to Canada. In Denmark, Sweden, and Finland, for example, district heating meets the needs of between 30% and 45% of the heating market, and this figure rises to 80% in major urban areas. Even the United States has approximately 5,800 district energy systems, mainly serving downtown areas, universities, military bases, hospital complexes and other groups of buildings.[101]

In Denmark, Sweden, and Finland, for example, district heating meets the needs of between 30% and 45% of the heating market, and this figure rises to 80% in major urban areas.

Canada's current approach to district energy systems will not produce any significant increase in the use of such systems in Canada. Other countries, however, are taking a much more aggressive approach. The European Union, for example, provides support to district energy projects in a number of ways, including: loans, loan guarantees, and direct investment in projects.[102]

The reality is that district energy systems often require significant capital investments with payback periods that are too long for private investors. Accordingly, governments must play a key role in the development of district energy systems in Canada. Municipal governments are well placed to do this but will require some forms of financial assistance from the federal government if a much broader adoption of district energy is to become a reality.

DESCRIPTION OF THE MEASURE

District energy systems significantly increase the efficiency with which energy is used to provide heating and cooling needs. Even so, Section 43.1 of the Income Tax Act, which provides accelerated capital cost allowance treatment for energy conservation initiatives, does not include district energy systems. As an immediate first step, the federal government should correct this error and provide similar treatment for investments in the infrastructure required for district energy systems (e.g., pipes). The Federation of Canadian Municipalities (FCM) believes that such action will assist municipal governments in their efforts to attract private partners for the development of such projects.[103]

Additional action is, however, required to significantly increase the use of district energy systems in Canada. As a second step, the federal government, in cooperation with municipal governments and the private sector, should initiate a program of demonstration projects to document and illustrate the economic and environmental benefits of district energy systems. The Canadian District Energy Association identified 23 specific projects in 1996 that were considered to be borderline economical that might serve as a starting point for the selection of demonstration projects.[104]

Ultimately, the federal government should provide financing assistance for the development of district energy systems over the longer term. This could take the form of low interest loans, loan guarantees, or seed money for new projects and is a key component of municipal infrastructure improvements that will reduce operating costs and reduce greenhouse gas emissions.

GREENHOUSE GAS EMISSION REDUCTION BENEFITS

It is difficult to assess the full potential impact of this measure on projected greenhouse gas emission levels in the year 2010. The Canadian District Energy

Association has estimated that the 23 potential projects it identified would reduce Canada's greenhouse gas emissions by 0.4 Mt annually. However, these 23 projects represent a small fraction of the full potential for district energy in Canada.

It has been assumed that this measure will reduce greenhouse gas emissions to 2.0 Mt below projected levels in 2010.

MULTIPLE ENVIRONMENTAL BENEFITS

In addition to the multiple environmental benefits generated through the more efficient use of fossil fuels, district energy used for cooling purposes will provide opportunities to decrease the use of hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs). These are extremely potent greenhouse gases that can be several thousand times more potent as a greenhouse gas than carbon dioxide over a 100-year time frame.

ECONOMIC COSTS AND BENEFITS

As noted earlier, district energy systems require a large up-front capital investment and have relatively long payback periods. Approximately 60% of the up-front cost of establishing a district energy system is, however, labour. As a result, investments in district energy systems are investments in job creation. For example, the 23 projects identified by the Canadian District Energy Association would, if implemented, create 7,000 construction jobs and 2,500 permanent jobs.[105]

The FCM notes that district energy systems provide the following benefits to local communities[106]:

- use of local energy resources such as biomass and waste heat,
- retention of energy expenditures in the community,
- revitalization of urban core areas,
- local job creation and economic development.

AN IMPLEMENTATION STRATEGY FOR CANADA – RECOMMENDATIONS

1. The federal government should extend the accelerated capital cost allowance treatment provided in Section 43.1 of the Income Tax Act to investments in district energy systems.
2. The federal government should announce the creation of a program for large district energy demonstration projects in Canada. The funds would only be made available if the project was cost shared with provincial/municipal governments and/or the private sector.

Investments in district energy systems are investments in job creation. For example, the 23 projects identified by the Canadian District Energy Association would, if implemented, create 7,000 construction jobs and 2,500 permanent jobs.

The federal government's C-2000 building standard will result in buildings that use only half of the energy of a building built to the not yet implemented National Energy Code for Buildings.

Other potential actions to reduce greenhouse gas emissions from the commercial sector

A more aggressive building standard for new commercial buildings has been developed. The federal government's C-2000 building standard will result in buildings that use only half of the energy of a building built to the not yet implemented National Energy Code for Buildings. To this point, the C-2000 standard has only been presented in a few demonstration projects. More resources must be committed to this effort if the C-2000 standard is to have any chance of being adopted in at least a few jurisdictions prior to the 2008-2012 commitment period of the Kyoto Protocol.

It should also be noted that Natural Resources Canada's projection of greenhouse gas emissions assumes that the National Energy Code for Buildings will be implemented around the year 2000. At this point, the code has not been formally adopted by any province, and the prospects for adoption do not look good. Provincial governments should make it a priority to immediately implement the National Energy Code for Buildings.

8

Reducing greenhouse gas emissions from non-energy sources (14.0 Mt reduction)

Reducing greenhouse gas emissions from waste: mandating the capture of methane gas

(11.0 Mt reduction)

It has been estimated that methane emissions from landfills are roughly equivalent to the greenhouse gas emissions generated by 5 million automobiles.

Waste is an important contributor to Canada's greenhouse gas emissions. While wastewater handling, waste incineration, and composting all produce greenhouse gas emissions, more than 90% of all greenhouse gas emissions associated with solid waste in Canada comes from landfills.

In 1995, methane emissions from landfills accounted for 18 Mt (2.9%) of Canada's total greenhouse gas emissions.[107] It has been estimated that this is roughly equivalent to the greenhouse gas emissions generated by 5 million automobiles.[108] This represents a 6% increase above 1990 levels. In the year 2010, greenhouse gas emissions from landfills are projected to be 25% above 1990 levels.

Solid waste landfills are an important contributor to Canada's greenhouse gas emissions because the anaerobic decomposition of organic material produces methane. Waste in the municipal waste stream that produces methane includes food, yard waste, diapers, paper and cardboard. It has been estimated that up to 70% of municipal solid waste in landfills is capable of generating methane gas despite recycling and other waste diversion programs.[109]

Methane is 21 times more potent than carbon dioxide as a greenhouse gas over a 100-year time frame and methane emissions from landfills can be eliminated by capturing and combusting the methane. While the combustion process produces carbon dioxide and water, these carbon dioxide emissions do not have a net impact on the atmosphere because it is assumed that they are offset by growing organic material that draws carbon dioxide out of the atmosphere. Even better, the combusted methane can also be used directly as an energy source for heating or simply as an energy source to produce electricity. It has been esti-

It has been estimated that all the methane currently emitted from landfills in Canada can produce enough energy to heat over half a million homes.

mated that all the methane currently emitted from landfills in Canada can produce enough energy to heat over half a million homes.[110] If the energy source replaced by landfill methane is a fossil-fuel, additional emission reduction benefits will occur.

There has already been some effort to capture landfill methane in Canada. For example, 33 landfills in Canada captured approximately 24 per cent of Canada's landfill methane gas in 1997. Of these landfills, 20 simply flared the gas and 13 utilized the gas as an energy source.[111] These efforts have been spurred in part by landfill gas recovery guidelines in British Columbia, Ontario and Quebec. For example, Ontario's new landfill regulation came into effect in August 1998 and requires the collection of landfill gas for new or expanding sites with a capacity larger than 2.5 million tonnes.[112]

The United States, however, has been much more aggressive in this area. In March 1996, the Clean Air Act's *New Source Performance Standards and Emissions Guidelines* (Landfill Rule) required all landfills with a capacity of more than 2.5 million tonnes, or those that release more than 50 tonnes of non-methane organic compounds a year, to install a gas collection system to capture and combust their landfill gas emissions. This regulation was accompanied by measures to enhance tax treatment for the utilization of landfill methane as a motivation to complete projects. As a result of these initiatives, the United States projects that 58 per cent of all landfill methane generated will be captured by the year 2000 and that 91 per cent of this methane will be used for energy purposes.[113]

There is still significant potential in Canada to reduce greenhouse gas emissions through the capture and flaring or use of landfill methane gas. Indeed, Environment Canada has estimated that installing methane capture systems at approximately 40-50 more landfill sites would double Canada's current landfill gas capture rate of approximately 24% to 50%.[114]

DESCRIPTION OF THE MEASURE

Canada's provincial governments should establish regulations requiring all landfills with a capacity of 1 million tonnes or more to install systems to capture and combust methane gas.

As noted earlier, the potential greenhouse gas emission reduction benefits associated with the capture of landfill methane can often be increased if the methane is used as an energy source. As competition is introduced into electricity markets across Canada, provincial governments must take steps to ensure that facilities that recover landfill methane have fair access to the electricity grid. In addition, steps must be taken to recognize and promote landfill methane as "green" power.

GREENHOUSE GAS EMISSION REDUCTION BENEFITS OF THE MEASURE

It is assumed that Canada, like the United States, can recover 60% of the methane emissions generated in its landfills and that the implementation of this regulation by provincial governments across Canada will do this. Under these circumstances, it is expected that this measure will reduce greenhouse gas emissions by 11 Mt from projected levels in the year 2010.

MULTIPLE ENVIRONMENTAL BENEFITS OF THE MEASURE

The capture and combustion of landfill gas produces a number of additional environmental benefits, including reduced:

- emissions of non-methane organic compounds that contribute to the formation of ground level ozone,
- stress on vegetation on or near landfills by decreasing landfill gas migration below the surface,
- odours from landfills as well as the risk of explosions and fires, and
- releases of trace quantities of toxic and carcinogenic chemicals like hydrogen sulfide and vinyl chloride.

ECONOMIC COSTS AND BENEFITS

The capital costs for landfill gas collection (including the collection field, the piping, the extraction plant and the flare) represent a small (1% to 5%) percentage of the total costs of managing a landfill site of greater than 1 million tonnes with landfill tipping fees of $40 to $60/tonne.[115] Nonetheless, it appears clear that some additional regulatory or economic incentives will be required to spur significant new investment in landfill gas recovery.

One of the biggest incentives for increased investment in landfill gas recovery would be access to electricity markets for this energy source. The energy produced by landfill methane can be a significant source of income. For example, the city of Toronto receives royalties of $2.5 million per year from landfill gas to electricity projects.

An additional incentive for landfill owners is the fact that capturing and combusting methane will reduce liability concerns around the release of methane and other gases from landfill sites.

The City of Toronto receives royalties of $2.5 million per year from landfill gas to electricity projects.

AN IMPLEMENTATION STRATEGY FOR CANADA – RECOMMENDATIONS

1. Canada's provincial governments should establish regulations requiring all landfills with a capacity of 1 million tonnes or more to install systems to capture and combust methane gas.

2. Provincial governments should ensure that efforts to restructure electricity markets allow for a fair price and preferred access to electricity power pools for generators using landfill gas.

Other potential actions to reduce greenhouse gas emissions from waste

The measure proposed above focuses on reducing greenhouse gas emissions once waste has been deposited in a landfill. Naturally, it is also possible to address the problem by reducing the amount of organic material that enters the landfill. There are two main routes to doing this: composting of food wastes and recycling of other organic materials like boxboard and cardboard.

While both recycling and composting have made significant strides in Canada in the last decade much more could be done. For example, recycling programs still only recover a percentage of newspaper and cardboard. At the same time, composting is still generally limited to small scale backyard composting programs, although TransAlta Utilities' municipal composting project in Edmonton makes composting a truly city-scale activity. Larger scale initiatives such as that need additional support from governments and industry to become a reality.

These additional measures are especially important because landfill gas capture and combustion systems are not viable in all landfills, and many small landfills will be unable to afford such systems.

Reducing greenhouse gas emissions from agriculture – action to reduce methane emissions from livestock manure management

(3.0 Mt reduction)

In 1995, Canada's agriculture sector contributed 27.6 Mt (4.5%) to Canada's total greenhouse gas emissions.[116] This represented a 6% decline from 1990 levels.

There are four main sources of greenhouse gas emissions from Canada's agriculture sector:

- methane emissions from enteric fermentation (digestion) in ruminant animals like cattle,
- methane and nitrous oxide emissions from animal wastes,
- nitrous oxide emissions from fertilizer use, and
- carbon dioxide and nitrous oxide emissions from agricultural soils.[117]

Methane emissions alone are projected to increase to 37% above 1990 levels by the year 2010.

This measure focuses on greenhouse gas emissions from animal wastes. In 1995, approximately 7 Mt (1%) of Canada's greenhouse gas emissions were released from agricultural manure management systems. Approximately 50% of these emissions were methane emissions and 50% were nitrous oxide emissions. If animal manure decomposes anaerobically (under low oxygen conditions), methane is produced. This occurs in the liquid and slurry storage manure systems that are typically used in large modern swine and dairy farms. These systems produce a large amount of methane, particularly when compared to alternative systems that manage manure in a dry form (e.g., spreading it on a field).

These methane emissions can be controlled through the use of anaerobic methane digesters that can capture the methane. This methane is a biogas (60%-70% methane and 30%-40% carbon dioxide) that can then be used as an energy source. It has been demonstrated that such systems can be used successfully in the United States in livestock operations with more than 300 milking cows or more than 500 sows.[118] Indeed, the U.S. Environmental Protection Agency estimates that at least 4,000 American farms could profitably reduce methane emissions through the use of such technology by the year 2000 (approximately 20% of swine and dairy farms). Over a longer time frame, they believe that 50% of these methane emissions can be eliminated at a profit in the U.S.[119]

The U.S. Environmental Protection Agency estimates that at least 4,000 American farms could profitably reduce methane emissions by the year 2000.

Investments in on-farm energy systems require upfront capital, and access to that capital is a barrier to implementation. Another barrier to the widespread use of such systems is the difficulty farmers face in obtaining reliable information on methane recovery systems that is relevant to site-specific technical and economic evaluations. Under the U.S. AgStar program, the federal government provides farmers with the information and technical expertise required to determine the potential profitability of methane recovery on the farm. Participants in the program sign a Memorandum of Understanding where they commit to install such a system within three years if the analysis indicates that such a system would meet an agreed definition of profitability.

Canada has no program similar to the US AgStar program. This is a shortcoming that must be corrected.

DESCRIPTION OF THE MEASURE

The federal government should, through Agriculture Canada, launch a Canadian counterpart to the U.S. AgStar program and cooperate with provincial agriculture departments in widespread delivery.

GREENHOUSE GAS EMISSION REDUCTION BENEFITS

If these actions resulted in a 50% reduction of methane emissions from animal wastes on Canada's farms, greenhouse gas emissions would be reduced by 3.0 Mt relative to projected emission levels in 2010.

The energy generated through the use of 'green' power from livestock manure can be used on the farm to provide heat, hot water, electricity, and refrigeration – reducing existing power bills.

MULTIPLE ENVIRONMENTAL BENEFITS

The use of methane recovery systems in manure management systems will also produce a number of additional environmental benefits:

- reduced surface and groundwater pollution,
- improved odour management and reduced conflict with neighbouring land uses, and
- reduced fertilizer costs.

ECONOMIC COSTS AND BENEFITS

This measure will be profitable in many large livestock operations if the captured methane is used to generate energy. This energy generated through the use of 'green' power from livestock manure can be used on the farm to provide heat, hot water, electricity, and refrigeration – reducing existing power bills.

AN IMPLEMENTATION STRATEGY FOR CANADA – RECOMMENDATIONS

1. The federal government should, through Agriculture Canada, launch a Canadian counterpart to the U.S. AgStar program and cooperate with provincial agriculture departments in widespread delivery.

Other potential actions to reduce greenhouse gas emissions from agriculture

There are a number of other agricultural sources of greenhouse gas emissions. Canada's Kyoto Protocol implementation strategy should include actions that address all of these emission sources. Some of the actions that could be taken include:

- education and outreach programs related to animal nutrition,
- increased taxes or regulatory restrictions on nitrogen based fertilizers, and
- increased promotion and education regarding organic agricultural production methods and less energy-intensive sustainable forms of agriculture.

CARBON SEQUESTRATION

One set of actions that are not part of our proposals to help Canada meet its obligations under the Kyoto Protocol are actions to increase carbon sequestration in Canada's agricultural soils. This is not to say that such actions are a bad thing. Indeed, taking action to improve tillage practices and ensure more carbon stays in our agricultural soils will provide a host of environmental benefits. These actions should be encouraged. They should not, however, be considered in the context of Canada's efforts to implement the Kyoto Protocol for very important technical reasons.

This is because the Kyoto Protocol does not include carbon sequestration in soils in Canada's (or any other industrialized country's) emission reduction commitment. The main reason it was not included was the lack of international agreement and comfort on any methodology to estimate carbon sequestration in agricultural soils. This issue is now being reviewed by the Intergovernmental Panel on Climate Change (IPCC). Hopefully, the IPCC will be able to assist in the development of an international consensus in this area that will allow such activities to be considered in the future.

We have also excluded consideration of forestry-related projects in this report. While the Kyoto Protocol is concerned with afforestation, reforestation and deforestation, there is as of yet no common definition of these terms within the ongoing Kyoto Protocol negotiations. As a result, it is not clear exactly what is included in the Protocol and what is not. Once again, Canada should not plunge forward with activity regarding carbon sequestration until the IPCC has determined clear definitions and measurement protocols.

Canada should not plunge forward with activity regarding carbon sequestration until the IPCC has determined clear definitions and measurement protocols.

9

Conclusion

The concrete actions outlined in this report are specifically designed to allow Canada to meet the targets accepted in the Kyoto Protocol and to do so in a manner that will facilitate further reductions beyond the objectives set for the 2008-2012 period. These actions rely almost entirely upon policies and technologies that have been employed in other countries, and often within Canada, but in a more a limited context. They have been demonstrated to be affordable, practical and effective.

Canada has accepted a legally binding obligation to act and it must do so. If climate change is not moderated and halted, the severity of the projected impacts upon the environment, upon human settlements, and upon the economy would be incalculable. Any efforts to restore climate stability are doomed to failure unless Canada joins with the rest of the world community and reduces greenhouse gas emissions, primarily through reduced consumption of fossil fuels.

Deciding upon the best means of achieving the necessary emission reductions has become a highly politicized deadlock. Moving forward means looking beyond vested interests. We must accept the consensus of scientists on the damage caused by the continual overuse of fossil fuel energy. And we must recognize the successes of proven alternatives.

Canada has proven itself capable of meeting formidable challenges in the past. Our country has the technical and engineering skills, and the capital necessary to change direction. We have the democratic cultures and institutions that will support the structural changes necessary to shift energy use and production patterns over time.

What is required now is the will and the commitment to move Canada beyond discussion to concrete actions. It is in that vein that Canadian Solutions is presented to governments, to industry and to the public. Further delay is not necessary. We can move forward on the basis of these policies and start to build a solid foundation for Canada's contribution to global climate stability.

APPENDIX A. REDUCING GREENHOUSE GAS EMISSIONS THROUGH THE USE OF REVENUE NEUTRAL ECOLOGICAL TAX REFORM

Canada has generally advocated a voluntary approach to greenhouse gas emissions reduction. For a voluntary approach to be effective, however, it must produce emission reductions that go beyond "business as usual" and actually help to close the gap between Canada's projected greenhouse gas emissions in the year 2010 and our 6% reduction commitment under the Kyoto Protocol. Voluntary action will remain insignificant unless it is accompanied by strong incentives for action and disincentives to inaction.[120]

The strongest and most effective incentives to encourage greenhouse gas emission reductions are market price signals that make it clear that producing greenhouse gas emissions is bad and reducing greenhouse gas emissions is good.

Despite our extremely low energy prices relative to most industrialized countries, however, Canadians are never keen to discuss new taxes – especially carbon taxes. There is, however, an ongoing discussion in Canada about tax reform. Ecological tax reform involves making adjustments to the tax system that shift the burden of taxes away from taxing things we want (e.g. value-added production , labour and income) to taxing things we do not want (e.g. pollution and waste). If done in a revenue neutral manner, ecological tax reform can result in significant changes to the market signals provided by the tax system while producing no new revenue for government (i.e., no tax grab) and strengthening the economy.

These changes to market signals can do two things:

- provide a clear incentive to reduce greenhouse gas emissions, and
- stimulate economic development and job creation by reducing tax and price barriers to employment, investment and consumer spending.

While the concept of ecological tax reform is still in its infancy in Canada, it is already being adopted in European countries. For example, all five European countries that have implemented carbon taxes (Norway, Sweden, Denmark, Finland, Netherlands) have implemented these taxes as part of a broader ecological tax reform that saw other taxes reduced at the same time. The concept of ecological tax reform also has a number of high profile supporters including the World Business Council for Sustainable Development and its more than 50 large corporate members.

Description of the measure

The federal government would apply a minimum energy tax to all non-renewable energy sources in Canada. An additional tax would be imposed on fossil fuels in relation to their carbon content.

These tax increases would be offset by equivalent reductions in other taxes (e.g., payroll taxes, sales taxes, income taxes). A schedule would be established whereby the energy and carbon taxes would be increased on a regular basis over time.

An implementation strategy for Canada – recommendations

Despite claims that the national process to develop a strategy through which Canada can implement the Kyoto Protocol is examining all the options available to Canada, there is no space in the process for an assessment and analysis of the contribution ecological tax reform could make to climate protection.

Yet many economists and policy analysts agree that ecological tax reform represents the single most cost-effective, broad-based, and administratively simple measure to drive greenhouse gas emission reductions throughout society while not prescribing how these reductions should be achieved.

Accordingly, it is imperative that governments support a major research initiative to:

- catalogue examples of ecological tax reform in other countries,
- design proposals for ecological tax reform in Canada, and
- conduct socio-economic analyses of the proposals, including greenhouse gas emission reduction benefits, industry and business competitiveness benefits, and job creation benefits.

APPENDIX B. ESTIMATING GREENHOUSE GAS EMISSION REDUCTIONS GENERATED BY *CANADIAN SOLUTIONS*

TRANSPORTATION

Improved Mandatory Fuel Economy Standards for Vehicles (25.8 Mt reduction)

The impact of this measure on greenhouse gas emissions relative to projected levels in the year 2010 was modelled by the Energy Forecasting Division of Natural Resources Canada on the basis of the measure description contained in *Canadian Solutions* that was provided by the Pembina Institute and the David Suzuki Foundation. This measure does not necessarily reflect Natural Resources Canada's views on appropriate policy initiatives to address climate change.

As a result of this measure, demand for gasoline in the year 2010 is reduced by 380 petajoules, producing a 25.8 Mt reduction in greenhouse gas emissions. It should be noted that only carbon dioxide emissions are considered here and that additional reductions in nitrous oxide emissions would also be expected to occur.

Phased Increases in Gasoline and Diesel Taxes (7.5 Mt reduction)

The impact of this measure on greenhouse gas emissions relative to projected levels in the year 2010 was modelled by the Energy Forecasting Division of Natural Resources Canada on the basis of the measure description contained in *Canadian Solutions* that was provided by the Pembina Institute and the David Suzuki Foundation. This measure does not necessarily reflect Natural Resources Canada's views on appropriate policy initiatives to address climate change.

As a result of this measure, demand for gasoline and diesel transportation fuels declines by 108 petajoules in the year 2010, producing a 7.5 Mt reduction in greenhouse gas emissions. It should be noted that only carbon dioxide emissions are considered here and that additional reductions in nitrous oxide emissions would also be expected to occur.

Finally, the modelling work that was undertaken assumed that Canada implemented these phased increases in gasoline and diesel taxes on a unilateral basis. The emission reductions generated would be higher if these tax increases were implemented in a harmonized manner with the United States.

Actions to Increase the Use of Alternative Modes of Transportation (4.7 Mt reduction)

According to the modelling results from Natural Resources Canada, the major measure directed at the transportation sector (fuel economy standards) will reduce the demand for gasoline by 380 petajoules from its projected levels in 2010 of 1,377 petajoules. We assume that urban commuting will be responsible for approximately 30% of the remaining demand for 1,000 petajoules of gasoline in 2010. Combusting 1,000 petajoules of gasoline will produce 67.9 Mt of carbon dioxide emissions. As a result, we assume that urban commuting will be responsible for 20.4 Mt of greenhouse gas emissions in that year.

Currently, 73% of commuting trips are made by a single passenger in an automobile. As a result of the measures proposed, we assume that single passenger trips will be reduced by approximately a third, so that these trips will account for only 50% of total commuting trips in 2010. People switching out of single occupant vehicle travel will shift to: public transit (60%), carpooling (20%), and bicycling/walking (10%).

Accordingly, emission reductions have been calculated as follows:

- reduction in single occupant vehicle use by one third -6.8 Mt
- increase resulting from more public transit use (⅓ as carbon-intensive) +1.4 Mt
- increase resulting from more car pooling (½ as carbon-intensive) +0.7 Mt
- increase resulting from increased walking/cycling 0 Mt
- Total Emission Reduction -4.7 Mt

As a result, this measure will reduce greenhouse gas emissions by 4.7 Mt from projected levels in the year 2010.

Mandatory 5% Renewable Energy Content in Gasoline (3.1 Mt reduction)

The impact of this measure on greenhouse gas emissions relative to projected levels in the year 2010 was modelled by the Energy Forecasting Division of Natural Resources Canada on the basis of the measure description contained in *Canadian Solutions* that was provided by the Pembina Institute and the David Suzuki Foundation. This measure does not necessarily reflect Natural Resources Canada's views on appropriate policy initiatives to address climate change.

As a result of this measure, demand for gasoline falls by 46 petajoules in the year 2010, producing a 3.1 Mt reduction in greenhouse gas emissions. It should be noted that only carbon dioxide emissions are considered here.

Finally, it was assumed that the production of the renewable fuel and the production of gasoline are equally carbon-intensive. This need not be the case. In fact, many forms of biomass-based fuels will produce significantly fewer greenhouse gas emissions in the production stage than gasoline. Accordingly, the emission reductions generated by such an initiative could be significantly higher.

Stricter Enforcement of Reduced Speed Limits (2.2 Mt reduction)

The impact of this measure on greenhouse gas emissions relative to projected levels in the year 2010 was modelled by the Office of Energy Efficiency at Natural Resources Canada on the basis of the measure description contained in *Canadian Solutions* that was provided by the Pembina Institute and the David Suzuki Foundation. This measure does not necessarily reflect Natural Resources Canada's views on appropriate policy initiatives to address climate change.

To estimate the greenhouse gas emission reductions associated with this measure, Natural Resources Canada made assumptions about highway driving speeds (i.e., what percentage of drivers move at what speed) and the fuel use associated with different driving speeds. It was then assumed that all drivers would move 5 km/h slower as a result of changes to speed limits and that there would be increased enforcement of these new speed limits (resulting in a further reduction in fuel consumption).

As a result, demand for gasoline was found to decline by 32.8 petajoules in the year 2010. Using standard greenhouse gas emission conversion factors, it was found that this would result in a 2.2 Mt decline in carbon dioxide emissions relative to projected levels in 2010.

ELECTRICITY GENERATION

Implement Net Metering Polices to Promote the Adoption of Customer-Based Co-generation and Renewable Energy Technologies (1.1 Mt reduction)

It is assumed that a variety of existing greenhouse gas producing resources will be offset by this measure. When a customer owns and operates a distributed supply technology, they offset the average demand for electricity within a jurisdiction. Thus,

EMISSION REDUCTION BENEFITS OF NET METERING

REDUCE EXISTING ELECTRICITY SUPPLY BY 1%	ELECTRICITY (Mt)	AVERAGE SYSTEM EMISSIONS FACTOR (t/GWh)	NET METERED EMISSIONS FACTOR (t/GWh)*	NET EMISSION REDUCTION (tonnes)
British Columbia	786	66.1	50	12,655
Alberta	563	825.3	50	436,494
Saskatchewan	186	716.2	50	123,913
Manitoba	279	50**	50	0
Ontario	1654	300***	50	413,500
Quebec	1823	50**	50	0
Atlantic	714	257.6	50	148,266
Total				1,134,788

* assuming 50 tonnes CO_2 per GWh of cogen/renewable generation.
** different from NRCan's 1996-2020 Outlook – estimate made by the author to reflect a diversity of resources beyond hydroelectricity in the future (e.g., natural gas).
*** different from NRCan's 1996-2020 Outlook – estimate made by the author to reflect the early retirement of nuclear facilities.

the average emission factor for the electricity sector in each province should be applied for the application of emission reductions. The average emission factors provided by NRCan for the year 2010 are used, along with an assumption that 1% of the customer demand (GWh) will be met through net-metered resources, less than the provincial limit of 5% of peak capacity.

It should be noted that there may be some double counting between this measure and the measure on a Renewable Energy Portfolio Standard. This double counting is likely to be very small, however, because net metering produces only 1.1 Mt of greenhouse gas emission reductions from projected levels in 2010, and renewable energy sources are only expected to account for 10% - 20% of all the electricity produced through the net metering initiative.

Levelling the Playing Field for Low Carbon Energy Sources (19.2 Mt reduction)

Canada's Energy Outlook: 1996-2020 forecasts an increase in coal-fired electricity generation of about 180 petajoules between 2000 and 2010. The greenhouse gas emissions emissions associated with this increase are about 16 Mt. It has been assumed that levelling the playing field for low-carbon energy sources will eliminate all of this growth and replace it with electricity produced from natural gas co-generation technologies.

It has also been assumed that this measure will lead to the early retirement of existing non-cost competitive grid-intertied oil facilities. The Outlook projects that 75.4 PJ and 1.3 PJ of heavy fuel oil and light fuel oil respectively will be consumed in 2010 to produce electricity. This is equivalent to about 7,029 GWh of electricity a year with associated emissions of 5.37 megatonnes. It is assumed that all of that will be retired by the year 2000 under a level playing field. For non-grid integated areas, diesel fuel consumption of 26.1 PJ is assumed to remain active.

The net GHG emissions for generating electricity from a cogenerator is equivalent to the difference between the total emissions for producing heat and electricity with the natural gas cogenerator and the emissions from the production of heat using the displaced coal-fired or oil-fired technology. An assumption is made that the average emission factor of the power that will replace the coal or oil is 100 tonnes of CO2 per GWh of electricity produced. The vast majority of this power is expected to be generated with natural gas co-generation technologies but some zero-emission hydroelectricity is also assumed to contribute toward that low emission factor.

As a result, the incremental impact of this measure is to reduce Canada's greenhouse gas emissions by 19.2 Mt from what they would have been in the year 2010.

EMISSION REDUCTION BENEFITS OF LEVELING THE PLAYING FIELD

EMISSION REDUCTION BENEFITS	ENERGY (PJ)	ELECTRICITY (GWh)	EMISSIONS (Mt)
Eliminate all growth of coal-fired power	179.29	16,427.98	-16.13
Retire all grid-integrated oil plants	76.7	7,028.86	-5.37
Replace with natural gas fired cogeneration and hydroelectricity		23,456.84	2.35
Net emissions reductions			19.15

Assuming:
1. 0.09 megatonnes CO2 per PJ of coal combustion
2. 0.07 megatonnes CO2 per PJ of oil combustion
3. 100 tonnes CO2 per GWh of new cogen/hydro generation
4. 33% conversion efficiency for coal and oil fired power plants

Providing Incentives to Produce Electricity from Waste Solution Gas in Fossil Fuel Production (0.9Mt reduction)

It has been estimated that captured solution gas could produce 200 MW of electricity in Alberta year round. We have assumed that 60% of this potential is brought to life as a result of this initiative.

Sixty percent of this capacity would produce 1.04 million Mwh of electricity. If we use a greenhouse gas emission conversion factor of 825.3 tonnes per Gwh for Alberta's electricity, this measure would offset 0.9Mt of greenhouse gas emissions. Of course, the combustion of waste solution gas to produce electricity also produces carbon dioxide emissions, but we assume that these are more than offset by the reduced methane emissions that occur when flared solution gas is captured and combusted at a higher efficiency than occurs through simple flaring.

It should be noted that there may be some double counting between this initiative and the initiative on levelling the playing field for low-carbon energy sources. Within the context of Canada's emissions gap (140 Mt), however, this potential double counting is likely to be small.

Adopting a 10% Renewable Energy Portfolio Standard by 2010 (7.8 Mt reduction)

It is assumed that the electricity generated from renewable energy sources as a result of this initiative offsets the marginal baseload resource. The marginal resource is that which would have been built in absence of this measure. It is unlikely that this measure will shut down existing technologies, but will rather avoid the development of certain new technologies. The emission reduction benefits are linked directly to the marginal resource. In most provinces, the marginal resource is assumed to be electricity produced from natural gas-fired co-generation, although in some

EMISSION REDUCTION BENEFITS OF A 10% RENEWABLE ENERGY PORTFOLIO STANDARD

PROVINCE	GHG REDUCTIONS (tonnes)
British Columbia	1,435,102.15
Alberta	1,590,748.71
Saskatchewan	436,073.01
Manitoba	–
Ontario	3,560,890.86
Québec	287,183.10
Atlantic Canada	489,045.67
Total	7,799,043.50

provinces a mix of hydroelectricity and natural gas-fired power is assumed.

In order to assess the environmental benefits and the economic costs of this measure, a simulation model was developed. The model specifies the specific technologies that would be supported by the measure, the marginal resources that will be offset by the measure, the economic impacts of the measure, and the emission reduction benefits. The model compares the characteristics of a "business-as-usual" scenario (the projection in *Canada's Energy Outlook: 1996-2020*) versus a renewable energy portfolio standard scenario.

The assumptions that were applied to the model are as follows:

- Electricity demand remains the same under this measure.
- The seven markets that are modeled include: BC, Alberta, Saskatchewan, Manitoba, Ontario, Québec, Atlantic.
- All prices are in 1995 real Canadian dollars.
- The levelized cost of renewable energy technologies is determined with an 11% real (1995) discount rate and a financing term over the life of the project. This assumes that new developments are financed and undertaken by independent power producers which are taxable.
- The marginal baseload resource in all jurisdictions except for Newfoundland and Québec is combined-cycle gas turbines, a combination of utility and industry developments, depending on the jurisdiction. In Newfoundland it is 30% large hydroelectricity (at 5 cents/kWh) and 70% oil fired combined cycle turbines. In Quebec it is assumed to be 90% large hydroelectricity (at 5 cents/kWh), and 10% natural gas. The marginal price of new supply is that of purchasing and operating those technologies / resources.
- Emission reduction benefits are assumed to be equivalent to the avoidance of the marginal electricity supply resource, not the average emission factor of the jurisdiction.
- Price impacts of this initiative are measured against the marginal price of supply, and individual customer rates are scaled-up in proportion to the percentage increase in the marginal price resulting from this initiative.

As a result, the largest emission reductions occur in British Columbia, Alberta and Ontario where the growth in natural gas supplied electricity is the largest. In Québec and Newfoundland, hydroelectricity is assumed to make up a part of the mix, with a zero emission rate, so the renewable energy portfolio standard does not offset as many emissions there. In Manitoba, the emission reduction benefits are assumed to be zero because the provincial electricity system will comply with the renewable energy portfolio standard under *Canada's Energy Outlook: 1996-2020* because of significant environmentally-desirable hydroelectricity supplies.

INDUSTRY

Domestic Action: Implementing a Cap and Allowance Emissions Trading System for Industry (26 Mt reduction)

In 1990, greenhouse gas emissions in the industry sector (201 Mt) were distributed as follows: fossil fuel combustion (123 Mt), fugitive emissions (33.8 Mt), and process-related emissions (44.2 Mt). *Canada's Energy Outlook: 1996-2020* assumes that total greenhouse gas emissions from the industry sector will be 245 Mt in the year 2010.

The cap and allowance trading program involves the following industries: upstream oil and gas production, pulp and paper, iron and steel, pipelines, smelting and refining, petroleum refining, chemicals, and cement. These industries account for approximately 73% of all energy-related emissions in the industry sector, and close to 100% of all fugitive and process-related emissions. As a result, these sectors produce approximately 85% of all industry related greenhouse gas emissions. Work conducted for the National Round Table on the Environment and the Economy by the Pembina Institute and Margaree Consultants indicates that 200 companies are probably responsible for roughly 85% of the greenhouse gas emissions from these industry sectors. As a result, this cap and allowance trading system would address 72% of total industrial emissions.

If these firms are responsible for 72% of industry-related emissions, they would have produced 145 Mt of greenhouse gas emissions in 1990. We have assumed that the total cap on firms participating in this program would reduce greenhouse gas emissions from these firms to 6% below 1990 levels by the year 2010. As a result, the 'cap' on these firms would restrict emissions to 136 Mt in the year 2010.

In the year 2010, these firms are currently projected to produce 176 Mt of greenhouse gas emissions. Accordingly, they will be required to reduce emissions by 40 Mt to stay within their cap. We have assumed (see next measure) that these firms will use the Kyoto Protocol's flexibility mechanisms to produce 14 Mt of the 40 Mt in greenhouse gas emission reductions required. As a result, the incremental impact of this measure is to reduce Canada's domestic greenhouse gas emissions by 26 Mt from what they would have been in the year 2010.

It should be noted that the firms participating in this cap and allowance emissions trading system would not be responsible for the emissions associated with the production of electricity they use. As discussed in the measure description, these emissions would be the responsibility of electric utilities, who also would participate in the cap and allowance trading program.

Nonetheless, it is true that many of the measures industrial firms could take to reduce their own use of fossil fuels may also lead to a reduction in their demand for electricity, further reducing Canada's greenhouse gas emissions. No attempt has been made to quantify the potential electricity savings generated by industry participants in the cap and allowance trading program and no emission reductions have been claimed for such savings.

International Action: Using the Kyoto Protocol's "Flexibility Mechanisms" (14 Mt reduction)

For a number of reasons outlined in the report, it is absolutely essential that Canada produce the vast majority of the emission reductions required to meet commitments under the Kyoto Protocol at home. Accordingly, we have limited the use of the Kyoto Protocol's flexibility mechanisms to 10% of Canada's current emissions 'gap' (the difference between where emissions are expected to be in the year 2010 and where emissions are supposed to be in 2010 under the Kyoto Protocol).

Canada's Energy Outlook: 1996-2020 indicates that Canada's emissions gap will be 140 Mt. As a result, the incremental impact of this measure will be to allow Canada to claim 14 Mt of greenhouse gas emission reductions through the use of the Kyoto Protocol's flexibility mechanisms.

RESIDENTIAL

Mandating an R-2000 Building Code for New Homes (3.7 Mt reduction)

In *Canada's Energy Outlook: 1996-2020*, Natural Resources Canada assumes that 2% of new homes are built to R-2000 standards in 1998 and 95% of new homes are built to R-2000 standards by 2020. If we assume that this is a linear progression, approximately 52% of new homes in the year 2010 would be built to R-2000 standards. In the period 2000-2010, a total of 32% of all new homes would have been constructed to the R-2000 standard.

The Office of Energy Efficiency at Natural Resources Canada (NRCan) provided the Pembina Institute with data on the energy savings that would result if an R-2000 standard was applied for all new home construction starting in the year 2000. It should be noted that this measure does not necessarily reflect Natural Resources Canada's views on appropriate policy initiatives to address climate change.

According to the data from NRCan, application of the R-2000 standard for new home construction beginning in the year 2000 would reduce demand for natural gas by 91.5 petajoules, and the demand for heating oil by 12.5 petajoules, in the year 2010.

If we assume that 32% of these reductions are already included in *Canada's Energy Outlook*, the incremental impact of this measure would be to reduce demand for natural gas by 62.2 petajoules, and the demand for heating oil by 8.5 petajoules in the year 2010. Using standard conversion factors, this is equivalent to a 3.7 Mt reduction in greenhouse gas emissions.

It should be noted that demand for electricity is also decreased by 33.7 petajoules in the year 2010 as a result of this initiative. Between 1990 and 2010, Natural Resources Canada has assumed that total demand for electricity will increase by 1,016 petajoules. Accordingly, this measure would reduce projected growth in electricity demand between 1990 and 2010 by approximately 3%. No emission reductions are claimed for this decrease in electricity demand to ensure that there is no double counting with the initiatives described in the section on electricity generation.

Cost –Effective Energy Retrofits of Residences (7.2 Mt reduction)

In *Canada's Energy Outlook: 1996-2020*, it is assumed that only 5% of existing homes are retrofitted by the year 2020. The energy savings generated by these retrofits are not specified.

The Office of Energy Efficiency at Natural Resources Canada provided the Pembina Institute with data indicating that if 50% of homes improved their energy efficiency by 20% by the year 2010, it would reduce energy demand in the residential sector by 267.12 petajoules from the levels projected in *Canada's Energy Outlook*. It should be noted that this measure does not necessarily reflect Natural Resources Canada's views on appropriate policy initiatives to address climate change.

In the year 2010, Natural Resources Canada assumes that residential energy needs will be primarily met by natural gas (44%), electricity (40%), and refined petroleum products (7%). Applying this distribution to the energy savings generated by this measure, we would expect demand for natural gas to be 117.5 petajoules lower than projected in 2010 and the demand for refined petroleum products would be 18.7 petajoules lower than projected. Using standard greenhouse gas emission conversion factors, this translates into a greenhouse gas emissions reduction of 7.2 Mt.

It should be noted that demand for electricity is also decreased by 107 petajoules in the year 2010 as a result of this initiative. Between 1990 and 2010, Natural Resources Canada has assumed that total demand for electricity will increase by 1,016 petajoules. Accordingly, this measure would reduce projected growth in electricity demand between 1990 and 2010 by approximately 11%. No emission reductions are claimed for this decrease in electricity demand to ensure that there is no double counting with the initiatives described in the section on electricity generation.

COMMERCIAL

Cost-Effective Energy Retrofits of Commercial Buildings (4.4 Mt reduction)

In *Canada's Energy Outlook: 1996-2020*, it is assumed that 50% of commercial buildings will have energy retrofits by 2010 that will improve energy efficiency by 15%-20%. Even with these improvements, however, total energy demand in the commercial sector increases 107 petajoules between 1995 and the year 2010.

We have assumed that the package of measures contained in *Canadian Solutions* produces a 30% improvement in energy efficiency in 80% of commercial buildings by the year 2010. In other words, we assume an additional 10% improvement in efficiency from projected levels in 50% of commercial buildings, and a 30% improvement in projected levels in 30% of commercial buildings by the year 2010.

Canada's Energy Outlook assumes that energy demand in the commercial sector will be 1113 petajoules in the year 2010. The measures proposed would reduce energy demand by 56 petajoules (10% improvement in 50% of buildings) and 100 petajoules (30% improvement in 30% of buildings) for a total reduction of 156 petajoules.

In the year 2010, Natural Resources Canada has assumed that natural gas will account for 44% of commercial energy demand and refined petroleum products will account for 8.3% of commercial energy demand. If reductions occurred equally across all fuels, this would lead to a 69 petajoule reduction in demand for natural gas and a 13 petajoule reduction in demand for refined petroleum products. Using standard greenhouse gas emission conversion factors, the total impact of this measure would be to reduce greenhouse gas emissions by 4.4 Mt relative to projected levels in 2010.

It should be noted that demand for electricity is also decreased by 66 petajoules in the year 2010 as a result of this initiative. Between 1990 and 2010, Natural Resources Canada has assumed that total demand for electricity will increase by 1,016 petajoules. Accordingly, this measure would reduce projected growth in electricity demand between 1990 and 2010 by approximately 6%. No emission reductions are claimed for this decrease in electricity demand to ensure that there is no double counting with the initiatives described in the section on electricity generation.

Providing Support for District Energy (2.0 Mt reduction)

The Canadian District Energy Association has estimated that greenhouse gas emissions would be reduced by 0.4 Mt annually if 23 near-economic projects it has identified were to be implemented. Clearly, there is much more scope for the use of district energy in Canada. Accordingly, we have conservatively assumed that the initiatives presented in *Canadian Solutions* will create enough district energy projects to reduce greenhouse gas emissions by 5 times this amount in the year 2010 (2 Mt).

NON-ENERGY SOURCES

Reducing Greenhouse Gas Emissions from Waste – Mandating the Capture of Landfill Methane Gas (11 Mt reduction)

In 1995, Canada's landfills emitted 24 Mt (carbon dioxide equivalent) of methane. Of these 24 MT, approximately one quarter (6 Mt) was captured and combusted, while the remaining three quarters (18 Mt) was released into the atmosphere.

In 1990, Canada's landfills released 17 Mt (carbon dioxide equivalent) of methane into the atmosphere. We will assume that this represented three quarters of total methane emissions in that year (22.7 Mt). *Canada's Energy Outlook*: 1996-2020 assumes that methane emissions from landfills will increase by 25% between 1990 and 2010, and that there will be no increase in the capture and combustion of landfill methane emissions.

Accordingly, we assume that total methane emissions from landfills will be 28.4 Mt in the year 2010. We have assumed that the measures proposed will result in 60% of this landfill methane being captured and combusted (17 Mt). Of this 17 Mt, 6 Mt are already being captured and combusted. As a result, the incremental impact of this measure is to reduce Canada's greenhouse gas emissions by 11 Mt from what they would have been in the year 2010.

Reducing Greenhouse Gas Emissions from Agriculture – Action to Reduce Methane Emissions from Livestock Manure Management (3 Mt reduction)

In 1995, greenhouse gas emissions from livestock and agricultural manure management accounted for 21 Mt of Canada's greenhouse gas emissions. Of this total, approximately two-thirds was released through enteric fermentation (14 Mt) and one-third from agricultural manure management. Emissions from manure management were approximately 50% methane (3.5 Mt) emissions and 50% nitrous oxide emissions (3.5 Mt).

Canada's Energy Outlook: 1996-2020 assumes that methane emissions from the agricultural sector will increase by 37% between 1995 and 2010 with no new actions to reduce emissions from this sector. Accordingly, methane emissions in the year 2010 are projected to be 24 Mt, with 18 Mt coming from enteric fermentation and 6 Mt coming from manure management.

We have assumed that the measures proposed in this area will reduce methane emissions from manure management by 50% by the year 2010. As a result, the incremental impact of this measure is to reduce Canada's greenhouse gas emissions by 3 Mt from what they would have been in the year 2010.

NOTES

1. Stewart J. Cohen, *Mackenzie Basin Impact Study Final Report* (Environment Canada and University of British Columbia, 1997), p. 1.
2. R. Myneni *et al*., "Increased plant growth in the northern high latitudes from 1981 to 1991." *Nature* 396 (1997): p. 698.
3. J. Bruce, *Montreal Gazette*, 29 August 1998, p. B-6.
4. Eric Taylor and Bill Taylor, Responding to Global Climate Change in British Columbia and Yukon, eds.,Vol I Canada Country Study, Environment Canada, p 12-6, 1997
   and Terry Glavin, Last Call: The Will to Save Pacific Salmon, David Suzuki Foundation, p 8, 1998
5. Responding to Global Climate Change in the Prairies, Ross Herrington, Brian Johnson and Fraser Hunter, eds.,Vol III of the Canada Country Study, Environment Canada, 1998, p ii
6. Henry Hengeveld, Environmental Adaptation Research Group, Environment Canada, 1996
7. John Last, Konia Trouton and David Pengelly, Taking Our Breath Away: The Health Effects of Air Pollution and Climate Change, David Suzuki Foundation, October, 1998
8. For example, the Intergovernmental Panel on Climate Change has summarized research on the potential global impacts of climate change if the atmospheric concentration of greenhouse gas emissions doubles from pre-industrial levels. Some of the summary's conclusions are that this could significantly affect one-third of the world's forests, melt one-third to one-half of existing mountain glacier mass, and could produce a rise in sea level that would submerge 6% of the Netherlands, 17% of Bangladesh and 80% of the Marshall Islands.
9. Canada's Response to U.S. EPA Proposal on Transboundary Air Pollution, Government of Canada, March 16, 1998
10. Comparative Analysis of Employment from Air Emission Reduction Measures, Pembina Institute, 1997.
11. M. Keating et al., Canada and the State of the Planet: Canadian Global Change Program, (Oxford: Oxford University Press, 1997), p.29
12. James P. Bruce, Hoesung Lee, Erik Haites, eds., *Climate Change 1995 – Economic and Social Dimensions of Climate Change*, IPCC, Cambridge University Press, 1996, p 95
13. Corporate participation in Canada's Voluntary Challenge and Registry Program (VCR) has been reviewed in the Pembina Institute's Corporate Action on Climate Change – 1997: An Independent Review.
14. This is a new figure released by Environment Canada in 1998. Canada's 1990 greenhouse gas emissions had previously been estimated to be 564 Mt.
15. Most models that have examined the potential impacts of climate change have assessed what those impacts would be when the atmospheric concentration of carbon dioxide emissions or greenhouse gas emissions increases to double pre-industrial levels.
16. Natural Resources Canada has recently produced an "events-based" update of Canada's official greenhouse gas emissions projection that indicates that this emissions gap may be as high as 185 Mt. This projected increase reflects new

assumptions about investment in oilsands development, the closure of nuclear power plants in Ontario, and more rapid economic growth. Canadian Solutions has focused on the 140Mt emissions gap because this remains Canada's official projection and will be the foundation for Canada's analytical work in the national process to design a strategy to implement the Kyoto Protocol. It should be noted, however, that Canadian Solutions describes a number of additional measures that could be used to reduce greenhouse gas emissions further.

17. These figures are taken from a presentation made by Sue Kirby of Natural Resources Canada to the Climate Change Economic Modelling and Analysis Forum on October 5, 1998.
18. Several packages of measures were developed by the multi-stakeholder Measures Working Group of the federal-provincial National Air Issues Coordinating Committee in 1993-1994.
19. The Rational Energy Program. Sierra Club of Canada. 1996.
20. These figures, and the figures in the following paragraph, are drawn from: *Climate Change Fact Sheet 235*. Information Unit of Climate Change (IUCC) 1993. United Nations Environment Program.
21. According to Environment Canada, greenhouse gas emissions from transportation grew a further 3.6% above 1995 levels in 1996.
22. Art Jaques *et al.*, Trends in Canada's Greenhouse Gas Emissions: 1990-1995. Environment Canada. 1997.
23. For more information, see Taking Our Breath Away. David Suzuki Foundation. 1998.
24. SOE Bulletin No. 98-5 on Canadian Passenger Transportation. Environment Canada.
25. Data obtained from Transport Canada's Road Safety Branch.
26. *Ibid.*
27. There may be other ways to set these standards that would achieve the same environmental objective. For example, it may be possible to have a single standard (at a different level) that would cover cars, SUVs, minivans and trucks together. This would remove the incentive for auto manufacturers to try and encourage buyers to move out of cars and into trucks.
28. Senes Consulting Ltd., Background Report on the Effects of Weather, Climate Variability and Climate Change on Air Issues Great Lakes Basin-Toronto-Niagara Region, May 1998, p. 5-15
29. In a report prepared for the Society of Automotive Engineers, Dr. Amory Lovins of the Rocky Mountain Institute goes further and states that 90% efficiency improvements are available at no incremental cost.
30. This study can be found at [http://www.ewg.org/pub/home/reports/blindspot/blindhome.html]
31. Backgrounder – Sustainable Transportation in Canada. National Round Table on the Environment and the Economy, 1996, p.51.
32. Gasoline Price Report, Petroleum Communication Foundation, 1997.
33. Marc Prud'homme and Klaus Kostenbauer, 'Forty Years of Gasoline Prices' in The Consumer Price Index – December 1996, Statistics Canada.
34. Gasoline Price Report., op.cit.
35. *Ibid.*
36. Norway's Second National Communication to the UN Framework Convention on Climate Change, April, 1997.

37. Climate Change: The UK Program. February 1997.
38. Energy Sourcebook, American Institute of Physics, 1991
39. John Pucher, "Back on Track – Eight Steps to Rejuvenate Public Transport in Canada" Alternatives Journal Vol. 24:1 Winter, 1998, p27
40. A.P. Jaques *et al., op cit.*, Table 2.134, p 26
41. *Ibid* Appendix A-2
42. Submission by the National Task Force to Promote Employer Provided Tax Exempt Transit Passes to the House of Commons Standing Committee on Finance. Members of the Task Force include: Amalgamated Transit Union Canadian Council, Canadian Labour Congress, Canadian Urban Transit Association, Federation of Canadian Municipalities, Ontario Lung Association, and Pollution Probe.
43. *Ibid.*
44. Molly O'Meara, "How Mid-Sized Cities Can Avoid Strangulation" World Watch, September/October 1998
45. Todd Litman and Felix Laube, "Automobile Dependence and Economic Development", Presented to the Transportation Research Board 1999 Annual Meeting.
46. Canada's Energy Outlook: 1996-2020. Natural Resources Canada. 1997.
47. Personal communication with representatives of the Canadian Renewable Fuels Association.
48. Personal communication with officials at Agriculture Canada.
49. 'Growing World Ethanol Production'. Presentation by Philip Madson, President of Raphael Katzen Associates International at a conference on Ethanol into the 21st Century in Sacramento, California on April 2-3, 1998. It should be noted that only approximately 70% of the production represented here is for transportation fuels.
50. It should be noted that the benefits resulting from the use of a 5 percent blend are proportional (i.e., approximately one-half) of the benefits described here.
51. This information was drawn from: Black, Frank. 'An Overview of the Technical Implications of Ethanol and Methanol as Highway Motor Vehicle Fuels' in Alternate Fuels: A Decade of Success and Promise (SAE, 1995), and Harris, J.M. 'Economic Policies and Their Effect on Transportation Choices', NorthEast Sustainability Energy Association, 1993 Sustainable Transportation Symposium, Boston.
52. Foundation Paper on Climate Change – Transportation Sector (Draft). Marbek Consultants, June 1998.
53. According to Environment Canada, greenhouse gas emissions from electricity generation increased by 1% over 1995 levels in 1996.
54. There are other emission sources in this sector. For example, reservoirs at large hydroelectric facilities are a source of methane emissions, although the quantity of these emissions is unclear. There are also emissions that need to be considered from a life-cycle perspective, for example, greenhouse gas emissions associated with the extraction of coal.
55. Andrew Pape *et al.* Implementing Sustainable Energy in Competitive Electricity Markets. Simon Fraser University Masters Research Project. 1997. This report references a study which states that as much as 30% of the system peak can be met by intermittent, non-dispatchable resources without affecting overall power quality, provided that there is a diversity of supply in the system, some energy storage (e.g., hydro reservoirs), and sophisticated system control infrastructure in place.

56. It should be noted that there is the possibility of some double counting between this measure and the later measure mandating renewable energy portfolio standards. This is likely to be small, however, as renewable energy sources are likely to only account for 10%-20% of the energy produced through this net metering initiative.
57. Comparative Analysis of Employment from Air Emission Reduction Measures, Pembina Institute, 1997.
58. For example, coal power should include coal mining, transport, processing, and combustion.
59. A previous attempt to assess the fairness of the taxation system by Natural Resources Canada and Finance Canada fell short of considering the full life-cycle of all competing resources and excluded coal and nuclear power from the analysis.
60. This data refers to a fluidized-bed combustion coal-fired plant.
61. Pape *et. al.*, *op cit.*
62. Much of the information presented for this measure is drawn from the following report: Management of Routine Solution Gas Flaring in Alberta – Report and Recommendations of the Flaring Project Team. Clean Air Strategic Alliance. Edmonton, 1998.
63. It is believed that 50% of the total volume of solution gas that is flared comes from only 6% of the flares. These flares are large enough to cost-effectively support electricity generation.
64. It should be noted that this measure has a broad range of support from both the industrial and environmental communities in Alberta.
65. There is some potential for double counting emission reductions here because earlier measures to level the playing field eliminated the need for new coal-fired electrical generating capacity in Alberta. Nonetheless, the implementation of a cap and allowance emissions trading system that involves utilities increases the likelihood of at least some early retirement of coal-fired electrical generation, which would open space in the market for electricity produced from waste solution gas.
66. In cases where the wood residue from a pulp and paper mill or sawmill was previously disposed of in open air burners, the diversion of the wood residue to a biomass plant will improve local air quality by reducing pollutants such as NO_x, VOCs, PM-10, and CO. Also, where previously landfilled wood residue is utilized in a biomass plant, landfill gas emissions (e.g. methane – a greenhouse gas) are reduced.
67. Lester Brown, Michael Renner, Christopher Flavin, eds., Vital Signs 1997. Worldwatch Institute, 1997.
68. *Ibid.*
69. It should be noted that in several provinces a portion of the electricity market supply already complies with the definition of renewable energy sources provided earlier. For example, in British Columbia, almost 6% of the existing supply in 1998 fits the definition, and only an additional 4% of the overall supply needs to be met with new renewable energy technologies.
70. Although the measure allows for the use of tradable renewable energy credits within a regulated jurisdiction, this estimate of the effects of the measure assumes that no trading has taken place.
71. Lester Brown *et al.*, *op cit.*
72. Greenhouse gas emissions from the industry sector were 2.3% above 1995 levels in 1996.

73. National Air Issues Coordinating Committee. 1996 Review of Canada's National Action Program on Climate Change. 1996. It should be noted that this figure includes the emissions associated with the production of electricity used by the oil and gas sector.
74. Natural Resources Canada's 'events-based' update indicates that recent announcements about future investment in oilsands development would increase the growth in greenhouse gas emissions in this sector by approximately 20 Mt by 2010. If correct, this would mean that emissions in this sector would be almost 40% above 1990 levels in the year 2010.
75. See Erik Haites and Robert Hornung. Possible Designs for a Domestic Emissions Trading Program for Greenhouse Gases. National Round Table on the Environment and the Economy. July 1998.
76. A recent report prepared by Cheminfo for the National Round Table on the Environment and the Economy (Potential of Including Non-Combustion Sources of Greenhouse Gas Emissions in a Domestic Emissions Trading Program) concluded that virtually all of these emission sources could be addressed in a cap and allowance emissions trading system. Exceptions noted included magnesium smelting and potentially the use of fossil fuels used as non-energy feedstocks.
77. This estimate was developed from a review of data contained in Environment Canada's "Trends in Canada's Greenhouse Gas Emissions: 1990-1995," published in April 1997.
78. Barbara Campbell, Robert Hornung and Erik Haites. "Description of Different Potential Allowance Trading Programs for Canada." National Round Table on the Environment and the Economy. September 1998.
79. *Ibid.*
80. Personal communication with staff at Simon Fraser University's Energy Research Group.
81. Industrial Energy End-Use Analysis and Conservation Potential in Six Major Industries in Canada, March 1996.
82. The Pembina Institute has recently developed a methodology to operationalize the 'additionality' concept. It will soon be released in Greenhouse Gas Offsets and Emission Reduction Credits: Eligibility and Selection Criteria, Pembina Institute, 1998.
83. According to Environment Canada, greenhouse gas emissions from the residential sector in 1996 were 10% above 1995 levels.
84. Personal communication with officials from Natural Resources Canada.
85. Household Energy Consumption Benchmarks for 1994 Newly Constructed Houses and its Associated Potential Energy Savings for both National Energy Code for Housing (NECH) and R-2000 Standard Upgrades. Policy Development and Analysis Division, Efficiency and Alternative Energy Branch, Natural Resources Canada, August 1998.
86. The report explained that only the thermal envelope characteristics and ventilation requirements were considered in the analyses. The actual savings analysis shown is a minimum energy savings potential. This also does not include the health benefits associated with improved indoor air quality available with R-2000 homes.
87. Influencing Energy Use in Canada. Natural Resources Canada. 1996.
88. Personal communication with R-2000 staff in Alberta.
89. Energy Efficiency Trends in Canada: 1990-1996. Natural Resources Canada. 1998.

90. These numbers are presented as a range because energy savings potential will vary from home to home.
91. Energy Retrofit Activity for Canadian Homes in 1995. Policy Development and Analysis Division, Efficiency and Alternative Energy Branch, Natural Resources Canada, July 1998.
92. Comparative Analysis of Employment from Air Emission Reduction Measures. Pembina Institute., 1997.
93. Canada's Second National Report on Climate Change. Government of Canada. 1997.
94. According to Environment Canada, greenhouse gas emissions from the commercial sector were essentially unchanged from 1995 levels in 1996.
95. These figures are drawn from a variety of sources including: databases developed in the Alberta Department of Energy's now defunct Energy Efficiency Branch, actual experience with energy retrofits, and B.C. Hydro's Guides to Energy Management. The figures are consistent with those found in a number of reports published by the U.S. Department of Energy's Energy Information Administration.
96. For example, the city of Edmonton established a $1 million revolving energy efficiency fund for retrofitting city buildings in 1995. First year savings were over $190,000, and estimated savings over the next 10 years are expected to be in the $5 million range. On a larger scale, The Federal Government, Canada's largest owner of commercial and institutional buildings, has determined that a $1 billion investment in energy efficiency improvements would reduce its energy bills by $160 million per year.
97. Personal communication with officials at Natural Resources Canada.
98. Feasibility Study for the Federation of Canadian Municipalities – the Municipal Energy Efficiency Initiative. Federation of Canadian Municipalities. 1994. This is one of the few studies that has attempted to address this question on a nation-wide basis in Canada.
99. This is an average figure drawn from a review of numerous studies by the Pembina Institute in Comparative Analysis of Employment from Air Emission Reduction Measures. 1997.
100. Personal conversation with Ms. Nicole Richer, Federation of Canadian Municipalities.
101. District Energy / Co-generation Systems in US Climate Change Strategy. Presentation by Mark Spurr, International District Energy Association at the Climate Change Analysis Workshop, Springfield, Virginia, 1996.
102. Conclusion drawn from a review of national communications submitted by a number of EU member states to the UNFCCC.
103. Presentation by FCM to the House of Commons Standing Committee on Environment and Sustainable Development, February 4, 1998.
104. Energy Efficiency and Heating/Cooling From Renewable Energy Sources Consultation Process Canadian District Energy Association.. 1996.
105. *Ibid.*
106. FCM presentation. *Op. cit.*
107. In 1996, greenhouse gas emissions from landfills were essentially unchanged from 1995 levels.
108. Presentation by Alain David of Environment Canada to the Air & Waste Management Association Meeting & Exhibition, Toronto, June 8-13, 1997.

109. Canadian Institute for Environmental Law and Policy. Methane, Climate Change and Waste. 1996.
110. Personal communication with Alain David, Environment Canada.
111. Personal communication with Mary Ellen Perkin, Environment Canada.
112. Draft – Municipalities Table Proposals for Early Action, 1998.
113. U.S. Government. U.S. Climate Action Report – 1997.
114. Presentation by Alain David. Op cit.
115. Presentation by Alain David, Op.cit.
116. A recent update to Canada's greenhouse gas emissions inventory significantly increases this figure to 63 Mt. It appears that estimates of emissions from each of the four main sources of agricultural emissions has been revised upward. That same update from Environment Canada indicates that greenhouse gas emissions from agriculture grew 2% between 1995 and 1996.
117. It should be noted that Canada is the only country to report on carbon sequestration in agricultural soils. At this point in time, this form of carbon sequestration is not recognized to be part of the Kyoto Protocol's commitments.
118. Inventory of Technologies to Reduce GHG emissions from Agriculture. Symbiotics Environmental Research and Consulting. Dec. 1996, p. 14.
119. US Climate Action Report – 1997.US Government.
120. The need for incentives to support voluntary initiatives in Canada is highlighted in: Corporate Action on Climate Change – 1997: An Independent Review. Pembina Institute. 1997., and in recent work by the New Directions Group outlining the minimum requirements for effective voluntary programs.

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We welcome your comments on this paper and the specific policy measures proposed. If you have suggestions for additional actions to reduce greenhouse gas emissions, we would like to hear about them.

The Pembina Institute

The Pembina Institute is an independent, citizen based research organization that develops and promotes environmentally sound and socially just public policy in the areas of energy and environment, environmental economics, and sustainable resource management. The Institute's Climate Change Program, based in Ottawa, provides a wide range of climate protection services that includes:

- public policy advice and the development and analysis of specific policy measures to address climate change,
- broad public education and the development of curriculum material for schools related to climate change,
- assessment and review of corporate climate change action plans,
- private sector strategic planning on climate change,
- evaluation of greenhouse gas emission reduction offsets, and
- corporate employee education and training on climate change.

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Research: The David Suzuki Foundation seeks out and commissions the best, most up-to-date research to help reveal ways we can live with nature.

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Advocacy: We urge decision makers to adopt policies which encourage and guide individuals and businesses, so their daily decisions reflect the need to act within nature's constraints.

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