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Burning Our Money to Warm the Planet

Canada's Ineffective Efforts to Reduce Greenhouse Gas Emissions

Mark Jaccard, Nic Rivers, Christopher Bataille, Rose Murphy, John Nyboer and Bryn Sadownik

In this issue...

Since 1990 Canada's efforts to reduce greenhouse gas emissions have not stopped them from rising by 25 percent. As long as the government relies primarily on information and subsidies to encourage voluntary action and fails to establish emission charges or aggressive regulatory controls, emissions will continue to rise.

The Study in Brief

For 15 years Canadian governments have layered one greenhouse gas (GHG) policy over another — the 1990 Green Plan, the 1995 National Action Program on Climate Change, Action Plan 2000 on Climate Change, the 2002 Climate Change Plan for Canada and Project Green in 2005. The names changed, but the policy approach did not: it consisted primarily of offering information and subsidies to encourage voluntary reductions in emissions. Without substantial restrictions or charges for emitting GHGs, Canadian emissions have grown by 25 percent since 1990, outstripping the emission targets and commitments set by the government.

As a result of investments in energy supply, infrastructure, buildings and energy-using devices, we continue on the GHG-intensive path, and the cost of diverting from it in future keeps rising. This is to be expected in a market economy where there are many benefits to businesses and individuals from burning fossil fuels, and these actions overwhelm the effect of voluntary efforts to reduce GHGs. This explains why the evidence from international experience with energy efficiency and climate policy suggests that emission charges or regulations are necessary if the GHG intensity of the economy is to be reduced over the next several decades.

In spite of the mounting evidence that Canada's policies were not working, the government's last major policy initiative, Project Green, represented an intensification of the information and subsidy approach. A forecast based on a continuation of this approach suggests that Canadian emissions would increase by 50 percent within 35 years. Even the anticipated regulation of industrial emissions in its present form would be swamped by growth in key sectors, such as oil sands production and fossil-fuel-based electricity generation. If this policy approach continues, we will spend at least $80 billion over the next 35 years — but without reducing GHG emissions.

Many Canadians believe we have been taking action on climate change when we have actually been doing little. In fact, it could be argued that without a substantial shift in policy, we will be burning our money to warm the planet.

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Over the past 15 years, the Canadian government has made several commitments to reduce domestic greenhouse gas (GHG) emissions. Its goal has been to help the international effort to stabilize atmospheric concentrations of GHGs at levels that will reduce the risk of unacceptable climate change.

To meet these commitments, the government's main policy approach has been to provide information and subsidies for businesses and consumers to encourage them to shift voluntarily to technologies and lifestyles that will reduce GHG emissions. A key emphasis has been on controlling emissions of carbon dioxide (CO_2) from the production and consumption of energy.

During this period, however, the country's GHG emissions have continued to rise, and they show no sign of falling. In fact, domestic emissions have risen more rapidly since 1990 than in the preceding decade, when the federal government had no GHG policy. Nevertheless, the latest plan for reducing GHG emissions, announced in 2005 as Project Green, was an intensification of the information and subsidy approach. Although the newly elected federal government has cut significantly the funding for Project Green, it is uncertain what, if anything, it will do to reduce GHG emissions.

The past 15 years of policies for reducing GHG emissions, in addition to 25 years of programs by electric utilities to reduce or shift electricity demand, provide a large body of evidence for assessing the effectiveness of subsidies and information policies in influencing energy use and associated GHG emissions. This study uses this information to calculate the likely effect on Canadian GHG emissions of a long-term continuation of the policy approach represented by Project Green. The first part of the study recounts the Canadian policy approach to GHG emission reduction of the past 15 years and assesses the past and likely future effectiveness of this approach. The second part presents a 35-year (2005–2040) simulation of what would happen to Canadian GHG emissions if the government were to continue the approach epitomized by Project Green. Not surprisingly, emissions continue to grow at a rate that, if matched in the rest of the world, would lead to much higher atmospheric GHG concentrations within a few decades.

Not only does the information and subsidy approach allow GHG emissions to continue growing, it is also expensive. Estimates in this report suggest that a continuation of this approach to controlling GHG emissions would cost over $80 billion by 2040, much of that money being spent outside of Canada.

The third part discusses the lessons for policy design and then suggests alternative policy approaches for GHG emission control. In particular, there is strong evidence that while some firms and households may voluntarily make expenditures to reduce GHG emissions in response to moral arguments or to information about the financial advantages of energy efficiency, many more may choose energy-intensive, pollution-intensive options if those offer a competitive advantage or a benefit to their lifestyles. From a policy perspective, this means that if domestic GHG emissions are to be reduced substantially over the next few decades, firms and households must be prevented from freely emitting wastes into

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the atmosphere — by financial penalties or legal requirements or both. Fortunately, experience controlling different pollutants in various jurisdictions offers examples of politically acceptable policies that can effectively control GHG emissions without causing severe economic disruption in the short term.

The Canadian Policy Approach to Reducing Greenhouse Gas Emissions

International Commitments and Domestic Policies

The growing consensus of scientists and governments around the world is that to reduce the damage from climate change to an acceptable level, the atmospheric concentration of CO_2 should be stabilized at 450 to 550 ppm, which is about one and a half to two times the pre-industrial concentration. Since global energy demand is projected to grow at least threefold over the next 100 years, stabilization at this level implies that energy-related CO_2 emissions must fall by 75 percent to 90 percent from current levels in the course of this century. Given the inertia of long-lived capital stocks (transportation infrastructure, energy distribution networks, buildings, electricity generating stations, large industrial plants, petroleum refineries and mines), GHG emissions must be reduced during the next three decades if the longer-term goal is to be reached.

Recognition of this necessity has led Canada to make several commitments to reduce its GHG emissions over one or two decades. In 1988, Canada hosted the World Conference on the Changing Atmosphere, in which delegates and the Canadian government called for a reduction of global CO_2 emissions of 20 percent from 1988 levels by 2005. Later that year, at a meeting of the G7 countries, Prime Minister Mulroney made a commitment to stabilize national GHG emissions at 1990 levels by the year 2000. These commitments were echoed in national policy documents in 1990, and were made again at the 1992 Earth Summit in Rio de Janeiro, when Canada ratified the United Nations Framework Convention on Climate Change. This agreement was superseded in 1997 by the Kyoto Protocol, under which Canada agreed to reduce its emissions from 2008 to 2012 to 6 percent below their 1990 level. Canada ratified the Kyoto Protocol in 2002.

To meet its international commitments, the Canadian government has launched numerous policies over the last two decades. Its omnibus Green Plan of 1990, which involved over 200 environmental policy initiatives and a budget of $3 billion over five years, included $175 million for 24 GHG reduction policies, mostly focused on energy efficiency and alternative energy. Independent researchers noted that virtually all policies in the Green Plan emphasized the provision of information to businesses and consumers to persuade them to take voluntary actions for environmental improvement (Hoberg and Harrison 1994; Gale 1997). In 1990, the government also established the National Action Strategy on Global Warming, with the aim of information sharing between municipalities, provinces and industry to foster GHG reduction.

In 1995, the federal government launched the National Action Program on Climate Change, comprising information programs and some modest subsidies; the government estimated that this program would reduce GHG emissions by 66

Mt by 2010 (Canada 1995a). The main element in the program was the Voluntary Challenge and Registry, under which companies would submit plans for reducing GHG emissions and make regular progress reports, all voluntarily. The program also incorporated the Federal Buildings Initiative, which supported the retrofitting of federal government buildings to higher energy efficiency standards; and the National Communication Program, which sought to educate Canadians about climate change.

After signing the Kyoto Protocol, the government in 1998 launched its Action Plan 2000 on Climate Change, a set of policies designed to reduce annual domestic emissions of GHGs by 49 Mt CO_2e by 2010 (Canada 1998).[1] This program included modest subsidies for renewable energy as well as a host of energy information programs for consumers and businesses, such as free energy efficiency audits of small businesses.

Before ratifying the Kyoto Protocol in 2002, the Canadian government released the Climate Change Plan for Canada, a composite of policies projected to reduce total emissions by 100 Mt CO_2e by 2010 (Canada 2002a). A key component, accounting for 55 Mt of emission reductions, was a system of negotiated covenants with large point-source GHG emitters to set emission intensity caps for each sector and then allocate tradable permits on this basis. Other elements of the plan were a combination of information and modest subsidies to encourage voluntary actions by firms and households. These programs included financial support for public transit coupled with voluntary targets for increased transit use, high-efficiency insulation in commercial buildings, 10 percent renewables for new electricity generation and improved vehicle efficiency. The government estimated that through these programs as well as education, each Canadian would reduce his or her average annual CO_2 emissions by one tonne.

Most recently, in 2005, the government launched Project Green, yet another plan for reducing GHGs. This program is described in detail later in this study.

Table 1 shows the key components of each of the last three major policy initiatives before Project Green. (Not all policies were implemented.) Like their predecessors, these three programs rely almost entirely on voluntary policies — asking businesses and consumers to reduce their GHG emissions out of financial self-interest or an ethical concern for climate change.

In spite of Canada's international commitments and the numerous domestic GHG policies described above, the country's GHG emissions have continued to rise during the last 15 years. Figure 1 compares Canada's commitments with its actual emissions from 1990 to 2003, along with the policy initiatives intended to reduce domestic emissions. With emissions rising by 24 percent over this time, Canada missed by a substantial amount each of the targets set at the 1988 World Conference on the Changing Atmosphere, the 1988 G7 meeting and the 1992 Earth Summit in Rio. According to the latest government estimates, Canada's domestic emissions remain on a path that would miss its Kyoto target by at least 270 Mt in 2010, or by almost 30 percent (Canada 2005b). This is shown in the figure as the business-as-usual forecast.

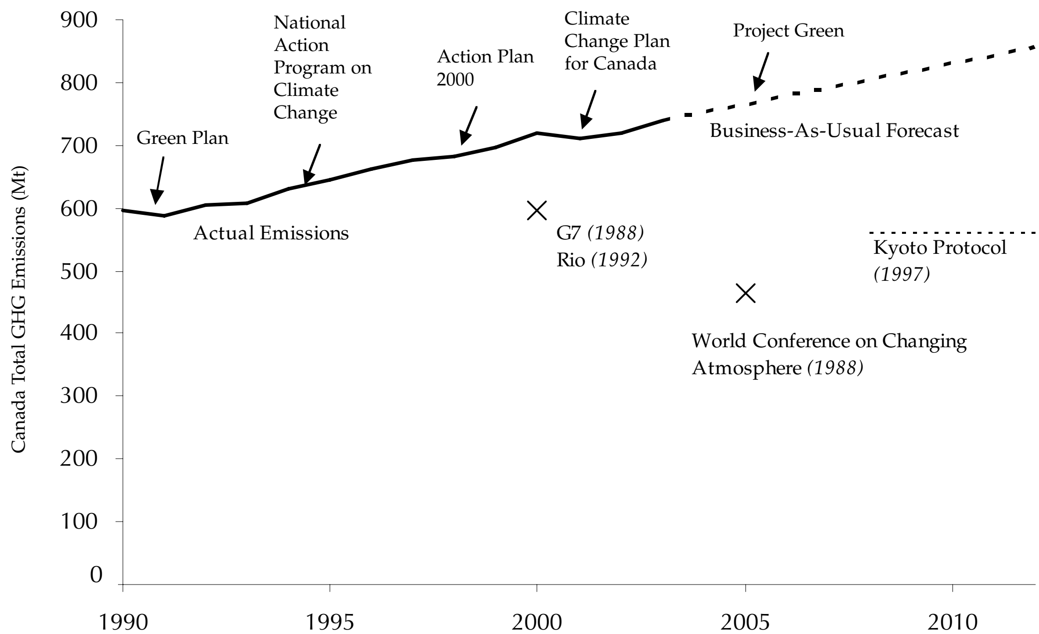
1 CO_2e stands for CO_2 equivalent. Other GHG emissions have been added to the CO_2 total after being converted into their equivalent global warming potential.

Table 1: *Primary Canadian Programs for GHG Reduction*

Sector	Elements of Program	Policy Type
	National Action Program on Climate Change	
Industry	Voluntary Challenge and Initiative	Voluntary
	Industrial Energy Innovators Initiative	Voluntary
	Industrial Energy Efficiency Technology Program	Information
	Industrial Energy Efficiency Targets (CIPEC)	Voluntary
Buildings	Federal buildings initiative	Direct government action
	Model National Energy Codes	Information
	EnerGuide (for appliances, etc.)	Information
All	National Communication Program	Information
	Energy Efficiency Standards	Regulation
Transportation	Fleetwise	Direct government action
	Auto$mart	Information
	Action Plan 2000 on Climate Change	
Transportation	Partnerships with automotive manufacturers and ethanol producers	Subsidy and information
	Information provision through EnerGuide for Vehicles	Information
	Demonstration projects for hydrogen distribution infrastructure and efficient urban transportation	Information
Energy Supply	Demonstration project for carbon sequestration	Information
	Information provision and moral suasion through Canadian Industry Program for Energy Conservation	Information
	Voluntary agreements with industry	Voluntary
	Financial incentive for renewable energy	Subsidy
	Purchase of green power by government	Subsidy
Industry	Information gathering and benchmarking	Information
	Energy-efficiency audits for small and medium-sized enterprises	Subsidy and information
Buildings	Information provision to encourage retrofits in commercial sector	Information
	Information provision through EnerGuide for Houses	Information
	Climate Change Plan for Canada	
Transportation	Increased ethanol and biodiesel blending in fuels through excise tax exemption and agreements with provinces	Subsidy
	Labelling of consumer vehicles	Information
	Increased use of public transit	Subsidy and funding
	Increased freight transportation efficiency	Voluntary
	Improved new-vehicle efficiency by 25% by 2010	Voluntary
Energy Supply	Negotiated covenants and regulations with large final emitters	Cap and trade
	Targeting of renewables for 10% of new supply	Subsidy
	Building of a CO_2 pipeline	Subsidy
	Demonstration coal plant with CO_2 capture and storage	Subsidy
Industry	Negotiated covenants and regulations with large final emitters	Cap and trade
	Cost-shared investments in innovative technologies	Subsidy
Buildings	Energy efficiency retrofits for houses	Information and subsidy
	Increased new-house efficiency (R-2000)	Voluntary
	Increased new commercial building efficiency (MNECB + 25%)	Voluntary
	Energy efficiency retrofits for commercial buildings	Voluntary

Source: Adapted from Canada (1995a; 1998; 2002a; 2002a).

Figure 1: *GHG Emissions in Canada, 1990–2003, and International Commitments to Reduce GHG Emissions*



Source: Canada (2005a).

This discrepancy between government commitments to reduce GHGs and the continuing growth of the emissions raises questions about the effectiveness of the information and subsidy policy approach. As yet, the federal government has not emphasized the other options available to it, namely regulations and fiscal disincentives. This is somewhat surprising given the evidence for the effectiveness of different types of policies in achieving environmental objectives cost-effectively. Some of this research is summarized in the next section.

Evidence for the Effectiveness of Information and Subsidies

Although program managers and businesses offer anecdotal evidence of voluntary actions to improve the environment, the effectiveness of voluntary programs is difficult to determine because one cannot be certain how the economy would have evolved without such policies. That is especially the case with efforts to stimulate energy efficiency. Since the 1950s, most OECD economies have seen steady improvements in energy efficiency because new technologies are often more efficient than those they replace. But it is difficult to know if a particular policy has hastened the uptake of more efficient technologies.

In a recent survey of voluntary policies for environmental protection, Khanna (2001) noted that the few empirical studies which have tried to estimate the actual environmental impact have found such policies to have a negligible effect. In another review, the OECD concluded that the "environmental effectiveness of voluntary approaches is still questionable" (OECD 2003, 14). Harrison (1999) and Harrison and Antweiler (2003) also found little environmental improvement from voluntary policies in Canada. Finally, some studies of Canada's voluntary GHG reduction programs found them to be almost entirely ineffective (Takahashi et al. 2001; Bramley 2002).

These discouraging results nonetheless confirm standard research findings on motivation in a market economy. Whereas some firms and households may voluntarily invest in energy efficiency or pollution reduction in response to moral arguments or new information about the financial advantages, many others may make an energy-intensive, pollution-intensive choice if it provides a competitive advantage or benefit to their lifestyle, especially if free discharge of GHG emissions into the atmosphere is still permitted. One need only think of the rapid spread of outdoor patio heaters, driveway heaters, roof de-icers, desktop refrigerators, deluxe air conditioners and various industrial energy-using devices. But these will go largely unnoticed if government, industry, environmental organizations and the media highlight only the cases where new GHG reduction actions appear to have been taken. This can create the misconception that voluntary policies are successful — until one looks at the expanding gap between the government's commitments to reduce emissions and the country's actual emissions.

Over time, however, the growing awareness of this widening gap between Canada's commitments and its actual emissions appears to have led to new subsidies in support of the existing information programs. This trend culminated in the significant budget commitments of the latest GHG reduction policy, launched in 2005 under the name Project Green. (The details of the subsidy mechanisms in this policy are presented in the next section.) Independent evaluation of past government and utility subsidy programs can help policy makers foresee the likely effectiveness of this kind of policy.

Since the first energy price shocks in the 1970s, governments and electric utilities have subsidized businesses and consumers to invest in greater energy efficiency or to switch fuels. Although some evaluations of policy effectiveness have been conducted on past government programs in North America and Europe, the richest sources of information are the numerous evaluations of U.S. electric utility demand-side management programs by independent, academic researchers. From the early 1980s through the 1990s, electric utilities in the U.S. invested over US$20 billion in information and subsidy programs to encourage greater electricity efficiency, as well as some load shifting and fuel switching, by their industrial, commercial and residential customers. Because these programs were established by utilities whose investments are assessed for their prudence in a quasi-judicial regulatory process, many have since been subjected to extensive evaluation by some of the most respected researchers in the energy field.

In general, this research shows the need to lower significantly the initial assumptions about the effectiveness of information and subsidy programs. One reason is the impossibility of stopping free riders from benefiting from subsidy programs. Free riders are firms and households who receive financial support for making energy-efficiency investments they would have made anyway — thus adding to program cost without having any effect. Their investments are part of the general efficiency trend, observed since the 1950s, that drives the economy toward less energy intensity. But at the aggregate level of energy use and GHG emissions, this trend toward improvement in energy efficiency has been swamped by a greater demand for the same and new energy services, most of which result in GHG emissions, either at the point of end use or in the production of electricity, natural gas and refined petroleum products. When governments or utilities offer subsidies to anyone who can claim to be improving their energy efficiency, they have no way of ensuring that the money is given only to those firms and households that would otherwise not have made such investments. Those who receive the subsidy but would have made the investment anyway are free riders.

It is impossible to know exactly the number of free riders for any program. But independent researchers have developed various estimation mechanisms, which usually involve a control group that was not subject to the policy but otherwise faced similar conditions. This is possible if some jurisdictions or utilities have subsidy and information programs while others do not.

Regardless of the scope or location of the comparison groups, independent researchers have consistently found that many free riders benefit from subsidy programs. Joskow and Maron (1992) noted the inadequate estimation of free riders by utilities. Train (1988) and Train and Atherton (1995) in some U.S. jurisdictions and Farla and Blok (1998) in the Netherlands estimated free-ridership rates to be in excess of 60 percent. Sutherland (2000), who also estimated high free-ridership rates, noted that such rates considerably reduce the cost-effectiveness of subsidies, implying that the bulk of government or utility expenditure is actually a wealth transfer from taxpayers to subsidy recipients with no resulting behavioural changes or environmental improvement.[2]

From a broader point of view, Loughran and Kulick (2004) conducted an aggregate statistical analysis of 324 U.S. electric utilities during the period 1989-1999, when the active utilities in their sample spent $15 billion on demand-side management programs — essentially subsidies and information. They found that the programs did not reduce utility sales nearly as much as expected, again because of free-ridership rates above 60 percent. Wirl (2000), who made a crude comparison of OECD countries that did little or no demand-side management investment in electricity with the U.S., found that the difference in the change in electricity intensity between the U.S. and other countries was imperceptible.

Free-ridership might be acceptable if it encouraged people to acquire efficient equipment and buildings more rapidly than they otherwise would and thus made others more aware of the economic benefits of efficiency, thereby hastening the adoption of efficient equipment. However, independent research has also revealed that energy efficiency is often more costly than it originally appears, and this will slow the adoption of more efficient devices. Pindyck (1991) and Jaffe and Stavins (1994) are among several researchers who have analyzed the importance of differences in risk and quality between more energy-efficient devices and the conventional devices they might replace. New technologies almost always have a higher risk of failure. Long-payback technologies pose higher risks if the

2 An extreme example is the transit pass tax credit announced in the spring 2006 budget by the Canadian government. Because the tax credit would only slightly increase transit use, it is almost entirely a transfer from taxpayers to existing transit users. If the policy is intended to reduce GHGs, its cost could be as high as $2,000 per tonne of CO_2 reduced.

probability of accidental damage is the same in each year as it is for competing technologies that cost less to buy.

Moreover, some efficient technologies do not provide the same quality of service. For example, in the late 1980s high-efficiency light bulbs cost much more than incandescent bulbs, although they were expected to use much less electricity. As a new technology, however, they had a higher risk of premature failure and, therefore, a different financial risk. Their higher up-front cost also meant that many years of efficient operation were needed before the initial investment was paid off, and yet the risks of accidental breakage in each year were about the same as for an incandescent bulb, so that again there was a different financial risk. In terms of quality, the lights looked different, did not fit into all fixtures, did not work well with dimmer switches, took longer to reach full intensity and gave a light with a less attractive hue. Many consumers saw the quality of service as distinctly lower. This combination of differential risk and quality helps explain why compact fluorescents did not achieve the market transformation in a few years that had been predicted by many utility programs. Their share of the market grew only slightly through the period of steady subsidies.

But even when more efficient equipment like light bulbs save money, other research has shown that forecasts of the effect of efficiency programs on energy use (or GHG emissions) must also take into account the increase in the demand for an energy service, like lighting, that occurs when the price falls. So, for example, more efficient outdoor Christmas lights encourage the development of additional decorative lighting and perhaps decorative lighting at different times of year, such as Hallowe’en. Similarly, hybrid electric-gasoline vehicles encourage the development of vehicles with greater horsepower, offsetting some of the fuel savings. Although this “rebound effect“ is likely to be small for many end uses, researchers suggest that in some cases, it can be as high as 10 to 35 percent (Greening, Greene, and Difiglio 2000).

These independent evaluations of subsidy and information programs that promoted energy efficiency help to explain why Canadian GHG reduction policies have not stopped the rise of GHG emissions. They also provide crucial information for estimating the future effect of continuing with this policy approach. This study uses those findings to simulate in an energy-economy model a continuation of the Project Green policies over the next 35 years. In other words, it predicts what is likely to happen if the government continues to rely primarily on the subsidy and information policy approach.

Simulating Canada’s Policy Approach As Represented by Project Green

In 2005, the federal government launched Project Green, which continued some previous GHG emissions-reduction programs but combined them with greater funding for information and subsidies and an intention to regulate emissions from major point sources. Since an assessment of the approach typified by Project Green should consider both its short- and long-term effects on domestic GHG emissions, this study used five- and 35-year time frames. The five-year time frame corresponds to the Kyoto commitment for substantial emissions reductions by 2010. However, policies implemented today determine the evolution of technologies for several decades; and that in turn determines the character of the new long-lived equipment, buildings and infrastructure that are installed during these decades. If Canada is to meet its commitment to help reverse the global rise of GHG emissions, it needs policies that substantially influence the character of technological change so that by 2040 domestic emissions fall significantly.

The immediate and long-term effectiveness of Project Green can be calculated in the following way. First, assuming that Project Green is not implemented, a business-as-usual (BAU) forecast is developed for GHG emissions through to 2040. Second, each part of Project Green is examined to determine its specific function, including the level of funding and the sectors of the economy to which it applies. It is then assumed that each of those elements will remain generally unchanged for 35 years. Third, the best research on policy effectiveness is used to help set the parameters for simulating Project Green policies in an energy-economy model, with the impact of each component of the policy indicated over both the 5-year and 35-year time frames. This forecast is compared to the BAU to assess the effectiveness of Project Green.

For simulating the effect of Project Green on domestic GHG emissions, the CIMS model was used (see Box 1). This model has been used for over a decade to assess the cost and effectiveness of policies on energy, air pollution and climate change in Canada and other countries. CIMS contains a detailed database representing most of the technologies in Canada that use energy and emit GHGs. It also simulates the manner in which consumers and businesses choose between different technologies — using behavioural parameters estimated from real-world evidence. CIMS is an integrated model in that energy supply and demand interact to reach an equilibrium of energy prices and quantities. It also includes macroeconomic feedbacks that adjust the demands for products and services according to their prices, and that simulate the trade in energy and other products between Canada and other countries. A general description of the model is provided in Jaccard et al. (2003) and a more detailed description in Bataille (2005).

Business-As-Usual Forecast

In the Project Green policy document, the Canadian government recognizes that its BAU forecast in 2002 has already proved to be too low in terms of both total growth and the growth of GHG-intensive sectors.

> In 2002, our emissions gap was estimated at 240 Mt. This estimate has now increased — Canada's economy is performing better than had been projected, and economic growth in emissions-intensive sectors is now expected to be greater than had previously been projected. (Canada 2005b, 12.)

This recent underestimation by government of GHG emissions growth is not a unique event. Over the past decade the government has generated several forecasts, all of which have required upward correction. In 1997, the government projected that total GHG emissions would reach 669 Mt by 2010. In 1999, its new prediction was 764 Mt. Its 2002 forecast was 810 Mt. The 2005 Project Green document reports that this forecast is also being revised upward.

Box 1: *The CIMS Model*

The CIMS model, developed by the Energy and Materials Research Group at Simon Fraser University, simulates the technological evolution of fixed capital stocks (mostly equipment and buildings) and the resulting effect on costs, energy use, emissions, and other material flows. The stock of capital is tracked in terms of energy service provided (in square metres for lighting or space heating) or units of physical product (metric tons for market pulp or steel). New capital stocks are acquired as a result of time-dependent retirement of existing stocks and growth in stock demand. Market shares of technologies competing to meet new stock demands are determined by standard financial factors as well as behavioural parameters from empirical research on consumer and business technology preferences. CIMS has three modules — energy supply, energy demand and macroeconomy — which can be simulated as an integrated model or individually. A model simulation comprises the following basic steps.

1. A base-case macroeconomic forecast initiates model runs. If the forecast output is in monetary units, these must be translated into forecasts of physical product and energy services.
2. In each time period, some portion of existing capital stock is retired according to stock lifespan data. Retirement is time-dependent, but sectoral decline can also trigger retirement of some stocks before the end of their natural lifespans. The output of the remaining capital stocks is subtracted from the forecast energy service or product demand to determine the demand for new stocks in each time period.
3. Prospective technologies compete for new capital stock requirements on the basis of financial considerations (capital cost, operating cost), technological considerations (fuel consumption, lifespan), and consumer preferences (perception of risk, status, comfort), as revealed by behavioural-preference research. Market shares are a probabilistic consequence of these various attributes.
4. A competition also occurs to determine whether technologies will be retrofitted or prematurely retired. This is based on the same type of consideration as the competition for new technologies.
5. The model iterates between the macroeconomy, energy-supply and energy-demand modules in each time period until equilibrium is attained, meaning that energy prices, energy demand and product demand are no longer adjusting to changes in each other. Once the final stocks are determined, the model calculates energy use, changes in costs, emissions, capital stocks and other relevant outputs.

The key market-share competition in CIMS can be modified by various features depending on the evidence about factors that influence technology choices. Technologies can be included or excluded at different time periods. Minimum and maximum market shares can be set. The financial costs of new technologies can decline as a function of market penetration, reflecting economies of learning and economies of scale. Intangible factors in consumer preferences for new technologies can change to reflect growing familiarity and lower risks as a function of market penetration. Output levels of technologies can be linked to reflect complementarities.

This record of consistent under-forecasting of the growth of GHG emissions is problematic for an independent assessment of Canada's future emissions in a world with and without Project Green. One could simply use the latest government BAU emissions forecast. However, as the Project Green document states, the government is in the process of raising its forecast — for the third time. This is in part driven by the ever faster expansion of Alberta's GHG-intensive oil sands production in response to high international oil prices, a development that also has a buoyant effect on overall Canadian economic growth.

The forecast used in this report, therefore, has a slightly higher rate of economic growth and oil sands production than the government's 2002 forecast. Specifically, the BAU forecast developed here assumes a 2.6 percent annual rate of real economic growth throughout the period under analysis. This rate is consistent with recent history (Canada's economy has grown at an average rate of 2.8 percent since 1987) and with other projections. The BAU forecast developed for this study also assumes continuing population growth in Canada, both as a result of fairly constant immigration levels and natural increase. This growth rate is consistent with those estimated for Canada by both the United Nations and the U.S. Census Bureau. Production of synthetic oil from oil sands is also forecast to increase substantially, from about 1 million barrels per day in 2003 to over 5 million in 2030. This is consistent with projections by the CAPP (2005) and the Alberta Chamber of Resources (2004). The BAU forecast developed here also assumes maintenance of most key trends, such as an increase in air travel, improvements in efficiency of electricity generation and in manufacturing, and an increase in air conditioning load. (More details about the assumptions used in this forecast are shown in the appendix.)

This study's BAU forecast of GHG emissions is higher than the government's previous three forecasts in 1997, 1999 and 2002 (see Figure 2). (In the figure, CEO is Canada's Emissions Outlook and CEOU is Canada's Emissions Outlook — An Update.) However, it maintains the upward trend of each subsequent forecast, and given some of the conservative estimates for growth in key sectors, it may require further upward revision in future.

In order to simulate the likely effect of Project Green, the study assumes that its policies, including full funding, are fully implemented by 2008. It is also assumed that the Project Green policies are maintained at roughly the same magnitude and character until 2040, thereby providing an indication of the effect on the long-run evolution of Canadian GHG emissions if the federal government continued with a policy approach dominated by information and subsidies. The key components of Project Green are evaluated next.

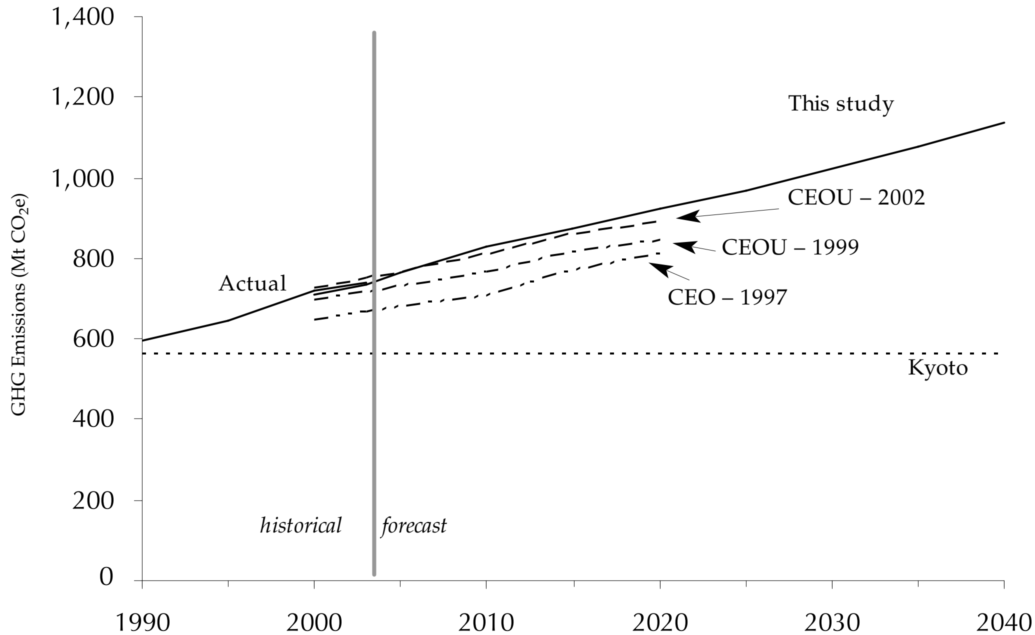
An Emission Cap and Permit Trading System for Large Final Emitters

Nearly 50 percent of GHG emissions in Canada are generated by relatively few firms, known as the large final emitters (LFEs).[3] Project Green proposes that GHG intensity targets be set for each LFE sector, requiring firms to reduce their GHG emissions intensity to about 12 percent below a BAU level, yet to be defined.[4] LFEs have several options for compliance with the proposed legislation. They can reduce their in-house emissions, buy permits from government at \$15/tCO_2e, buy

3 LFEs are mining and manufacturing firms, thermal electricity generators, and upstream oil and gas companies.

4 In addition, emissions are separated into two categories: fixed process emissions and other emissions. Fixed process emissions receive a 0 percent target, while other emissions receive a 15 percent target. For example, cement production emits about 0.9 t CO_2e / t cement, of which about 0.5 t / t is fixed and 0.4 t / t is from combustion. The target for the cement industry would be 0.5 t / t + (0.85 * 0.4 t / t) = 0.84 t CO_2e / t cement. Overall (fixed process plus other) emissions target for any sector will not exceed 12 percent. Emissions are allocated to new firms based on a "best available technology economically achievable" (BATEA) system.

Figure 2: *Business-As-Usual Forecasts of GHG Emissions*



Note: CEO is *Canada's Emissions Outlook*.
CEOU is *Canada's Emissions Outlook — An Update*.

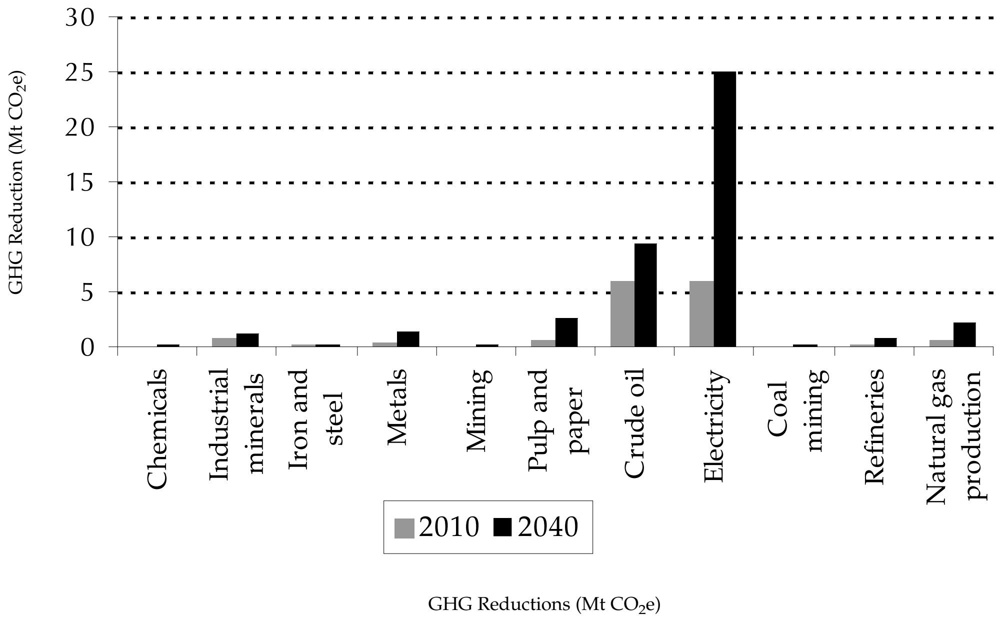
Source: Analysis and Modeling Group (1999); Canada (1997; 2002; 2005).

permits from other LFEs, buy offset credits from recognized domestic sources outside the LFE system, buy GHG reduction credits from recognized international sources, or invest the money they would have had to pay in permits in a GHG fund established for investing in new, clean technologies. Because the government is offering an unlimited number of permits at $15/t, LFEs are assured that any emissions over their allocated permits will not cost more than that in the Kyoto target period of 2008–2012.

There are some difficulties and uncertainties with the LFE policy. It is not clear how cogeneration or clean (non-thermal) energy will be treated. As currently designed, the LFE policy may provide a disincentive for firms to cogenerate heat and electricity, because only direct emissions are counted. Cogeneration of heat and power consumes more fuel directly, but it reduces emissions from distant electricity generation plants. It is also unclear how demand-side management efforts by electricity and natural gas companies will be treated in the LFE policy, since a reduction of electricity or natural gas demand reduces the GHG intensity target for the utility. Because the LFE policy is based on intensity of each sector rather than on a sector's absolute emissions, if firms grow faster than forecasted, the LFE policy will reduce emissions less than forecasted.

Simulation of the LFE policy with CIMS indicates that with permit prices capped at $15/t, LFEs will reduce their own GHG emissions by about 15 Mt in the Kyoto time frame. LFEs meet the total requirement of 45 Mt by (1) obtaining 9 Mt of credits from investing in the GHG Technology Fund (which causes no

Figure 3: *GHG Emissions Reductions from Implementation of LFE Policy*



Source: Authors' calculations.

immediate reductions but may lower the future cost of GHG reduction) and (2) obtaining the remaining 21 Mt from the purchase of international permits — since these are likely to cost less than $15/t.

The small domestic reductions in the Kyoto period correspond to the short time available for capital stock turnover before 2012. Continuing the LFE policy in its current form over a longer period would lead to larger reductions, since firms would make new investments if that produced domestic reductions that were less expensive than buying international credits or other domestic offsets. By 2040, according to the simulation, the LFE policy would decrease industrial GHG emissions by about 43 Mt from the BAU. With the LFE, the electricity and oil production sectors achieve most of the industrial-sector emissions reductions (see Figure 3).

Voluntary Commitment by Vehicle Manufacturers

In 2005, the government signed a memorandum of understanding with the automotive industry to reduce GHG emissions from passenger vehicles. The reductions are voluntary, with the automotive industry expected to achieve a 5.3 Mt GHG reduction in 2010 relative to a BAU forecast for automobile emissions.[5] The 5.3 Mt target corresponds roughly to a 25 percent improvement in new-vehicle fuel efficiency by 2010 compared to BAU.

5 The BAU is based on the 1999 *Canada's Emissions Outlook — An Update* (Analysis and Modeling Group 1999), with further updates made to factors beyond the control of the automotive industry by an oversight committee.

It is difficult to simulate the short- and long-run effect of a voluntary policy such as this. One has to assume that the target may not be achieved, given that voluntary policies have a poorer record than mandatory ones. If the government was confident that industry could reach the target, it could have responded to environmentalist concerns by making the reduction mandatory, with penalties for non-compliance, as was done in California and New York. Instead, the memorandum of understanding allows automobile manufacturers to terminate the agreement on 90 days' notice, which is presumably what they would do if emissions did not decline according to the memorandum of understanding. In 1998 the European Union negotiated a similar voluntary agreement with European, Korean and Japanese auto manufacturers, which are now falling short of their commitment (OECD/IEA 2005).

While compliance in the Kyoto time period is of concern, a much greater issue is the long-term effect of the policy. Without financial penalties or regulation of emissions, vehicle manufacturers have no incentive to make vehicles with zero- or near-zero emissions or to make marketing efforts that might stem the trend toward larger vehicles, greater horsepower, greater rates of vehicle ownership and use, and more on-board devices that increase fuel consumption.

The vehicle emission reductions in the memorandum of understanding are relative to an earlier BAU forecast, the *Canada's Emissions Outlook* update of 1999. However, partly in response to higher fuel prices, the actual fuel efficiency of vehicles sold from 2000 to 2004 was significantly better than predicted in the 1999 forecast. These improvements make up almost one-quarter of the GHG reductions required under the memorandum of understanding (Lutsey 2006). Since the BAU forecast developed for this report already includes the fuel efficiency improvements made from 2000 to 2004, they cannot be counted again in determining the effectiveness of the policy. With this correction of the forecast, this study assumes that most of the reductions in the policy will be achieved during the 2008–2012 period; these reductions are therefore included in the policy simulation.

At the same time, new forecasts, including the one in this simulation, suggest that Canadians will acquire and use vehicles more than ever, meaning that emissions from the sector as a whole will continue to climb in a BAU forecast. Therefore, to project the effect of the policy through 2040, it was assumed that the memorandum of understanding continues to require a 25 percent improvement in new-vehicle fuel efficiency relative to the BAU forecast. If the policy were additive to BAU fuel efficiency improvements, and if industry complied fully with it, total GHG reductions would be about 23 Mt relative to the BAU forecast in 2040. However, in view of the unwillingness to make the policy mandatory, the historical record of voluntary programs missing targets, and the recent experiences of the European voluntary program, the projected reduction from BAU is decreased by about 10 percent — to 20 Mt by 2040.

Subsidies to Cleaner Energy Sources and More Efficient Energy Conversion

Project Green includes policies to support renewable energy sources and cogeneration. Both the Wind Power Production Incentive (WPPI) and the Renewable Power Production Incentive (RPPI) give a subsidy of 1¢/kWh to qualifying facilities. Some of these projects may also receive offset credits, which they could sell in the Offsets System policy described below.[6] Changes to the tax rules in 2005 allow faster depreciation of capital costs for renewable-energy generation equipment and highly efficient cogeneration equipment, and previous changes allow full deduction of the costs of resource assessment and feasibility studies.

The government expects that these policies, in conjunction with provincial policies, will reduce GHG emissions by 15 Mt annually during the 2008-to-2012 period. Project Green contains no details on how these reductions will be achieved. However, discussions with the staff at Natural Resources Canada and Environment Canada revealed that about 3 Mt of reductions are expected from wind generation stimulated by the WPPI, and a further 3 Mt from biomass and small hydro generation stimulated by the RPPI.[7] In addition, the government forecasts that about 9 Mt of GHG will be displaced by cogeneration, mostly in the commercial and residential sectors, as a result of the changes to the accelerated capital cost depreciation.

In order for the WPPI policy to reduce GHG emissions by 3 Mt, according to the Project Green documents, about 4,000 MW of wind power needs to be operational between 2008 and 2012. Recently, wind power capacity has grown quickly in Canada: from 120 MW of installed capacity in 2000 to almost 700 MW by the end of 2005 (Canada 2005b). If Canada is able to maintain this high rate of growth, it will be on track to have about 4,000 MW of wind power operational between 2008 and 2012.

For the period after Kyoto, the WPPI is not likely to have much further effect if it is the dominant policy for continuing the growth of wind power in Canada — for two reasons. First, the growth in recent years is a result not only of the WPPI, but also of other subsidies from utilities, governments, environmentalists and even private citizens. Hydro Quebec, for example, made a decision to acquire wind resources, a decision that was not conditional on the existence of the WPPI and that will involve substantial subsidies from electricity consumers in that province. Since some wind power projects would have taken place anyway (and are therefore not attributable to the WPPI), they would in fact be free-rider recipients of the WPPI.

Second, at 1 ¢/kWh, the WPPI subsidy is too small to offset the special costs caused by the variability of wind. Because wind is not reliable for timely dispatch, its cost must include the costs of storing the energy. This is true even when wind

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6 It is proposed that the value of an offset credit be based on displacing GHG emissions from a new natural gas combined-cycle turbine. These facilities produce about 0.00036 t CO_2/MWh of electricity, and so offsets would provide renewable energy facilities with approximately 0.54 ¢/kWh in additional to the WPPI and RPPI incentive.

7 Communication with Environment Canada staff, February 2006.

has only a small share of the electricity system (DeCarolis and Keith 2005). Experts add at least 2¢ to 3¢/kWh to the cost of wind power to account for the cost of storage, whether this is contracted from another source, such as a large hydroelectric facility with a storage reservoir, or obtained by investing in backup combustion or energy storage equipment. With this higher cost, wind power is in most cases unable to compete with coal-fired electricity generation, given that the latter faces minimal constraints or costs associated with GHG emissions. (If a new coal-fired plant under the LFE had to buy all its permits at the government's permit price ceiling of $15/tCO_2e$, the cost of its electricity would rise by only about 1 to 1.5¢/kWh.). The WPPI does not oblige electricity providers to accept wind power; it simply tries to increase the competitive position of wind with a subsidy.

If the tax credits and the WPPI were maintained at 1¢/kWh, or even increased to 2¢/kWh, it is unlikely that wind power would expand substantially. Canada has access to relatively low-cost coal and the cost of coal generation of electricity in North America should continue to fall with ongoing technological change. For wind power to gain significantly more market share over the 30-year time frame, it would need greater support, or coal-based electricity would need to be constrained by regulation or emission charges. In the simulation of WPPI to 2040, the output of wind power therefore grows only to 10,000 MW by 2040. As discussed earlier, much of this growth would likely happen even in the absence of the WPPI policy, for the rapid expansion of wind power has mostly been driven by implicit subsidies from electric utilities and provincial governments. The forecast adopted in this study shows that 8,000 MW would be installed in the BAU case and that the WPPI policy would stimulate only an additional 2,000 MW.

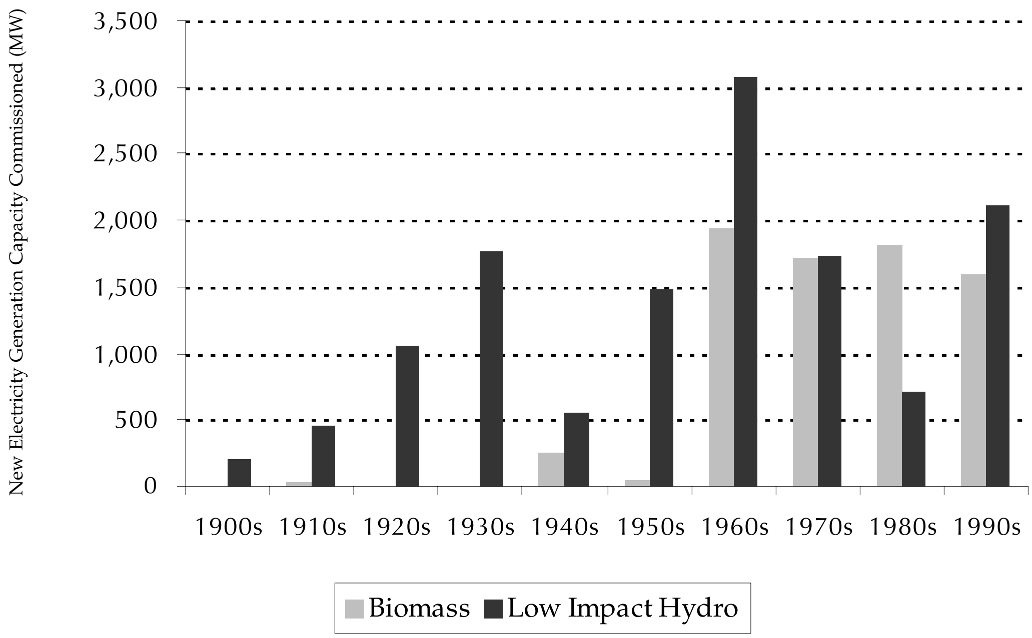
Project Green expects that the RPPI policy will lead to an incremental 1,500 MW of new renewable energy capacity (excluding wind), resulting in displacement of 3 Mt of GHG emissions.[8] Other sources of renewable energy, in particular, biomass (from combustion of wood residues in the pulp and paper sector) and small hydro, already account for some of the electricity generated in Canada, and have been installed in large numbers throughout the country for over a century (see Figure 4). In each decade since 1950, Canada has installed at least 1,500 MW of new biomass and small hydro capacity.

Discussion papers on the RPPI admit that policy administrators will have a challenge in distinguishing truly incremental generation from small hydro and biomass generation that would have been built anyway.[9] This difficulty is similar to the free-rider problem with energy efficiency programs. As a result, a considerable amount of the subsidy is likely to go to electricity generators who would have installed the hydropower and biomass capacity without the subsidy. Using the behavioural data on other subsidy programs, this report estimates that only about half of new capacity would be attributable to the RPPI program.

8 However, at this point the RPPI policy is still in the "discussion paper" phase and is not likely to be in effect before 2007 (at the earliest), leaving little time for the installation of the required capacity.

9 Natural Resources Canada states, "Where a renewable electricity generation project is developed at a site where no previous generation existed, it would clearly be considered incremental." http://www2.nrcan.gc.ca/es/erb/erb/english/View.asp?x=682. Accessed January 2006.

Figure 4: *Historic Installation of Biomass and Small Hydroelectricity Generation in Canada Since 1900*



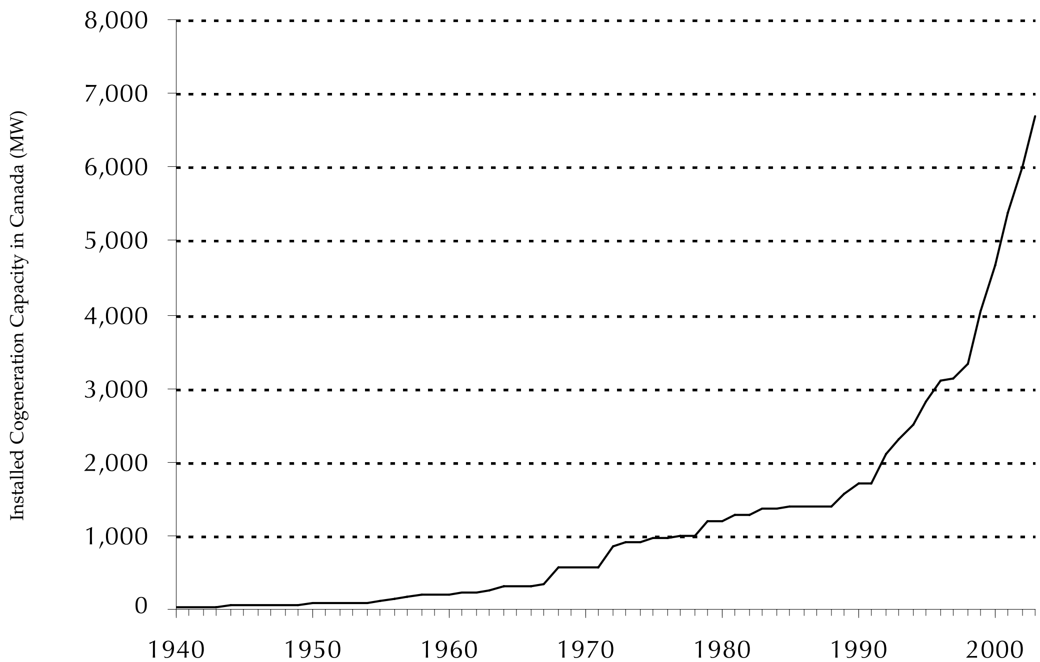
Source: CIEEDAC (2005a).

The RPPI policy would be unlikely to stimulate significant growth in alternative energy capacity over the long term, even if the currently proposed level of support were somewhat increased. Cost-effective biomass electricity generation in the pulp and paper sector is limited by the availability of wood residue and spent pulping liquor, and it will not increase dramatically in response to a small subsidy. Small hydro generation is limited by the availability of sites close to transmission lines and by public opposition to new facilities, although the subsidy will foster the development of some additional projects. Other sources of renewable energy, like tidal power, are unlikely to be competitive with coal-fired generation even with the LFE System and the RPPI subsidy. In the long term, the modelling suggests annual capacity increases of non-wind renewable energy of about 500 MW per year, most of which would occur even without the RPPI policy — i.e., as part of the BAU forecast.

Project Green assumes that incremental new cogeneration facilities built in response to the accelerated depreciation allowance policy will offset 9 Mt of GHG emissions by 2010. Assuming that natural-gas-fired cogeneration has a heat-to-power ratio of 4.3, to offset 9 Mt of GHG would require about 16,500 MWe of new cogeneration facilities by 2010.[10] In order to be attributable to the policy, these facilities would need to be in addition to what would have been installed in the absence of the policy.

10 Renewable energy generators may also qualify for the accelerated capital depreciation allowance, but all capacity increases for these sources have been discussed in previous paragraphs.

Figure 5: *Cogeneration Capacity in Canada Since 1940*



Source: CIEEDAC (2005b).

Cogeneration is a decades-old technology that has long been competitive in some cases with conventional centralized generation of heat and power. So far Canada has about 7,000 MWe of cogeneration capacity (see Figure 5). Since cogeneration has grown especially quickly over the past decade, even without the new capital cost depreciation policy, it would likely continue growing in the absence of the policy. It is unlikely that the accelerated depreciation policy could cause much expansion above that which would have occurred, because this change to tax rates will not dramatically change the financial prospects of cogeneration investments.[11] Optimistically, Canada might install 2,000 MWe of cogeneration capacity by 2010 above that which would have been installed in the absence of the policy; that would reduce GHG emissions by 1.1 t from the BAU scenario. Over the long term, if the policy is maintained at current levels, the modelling suggests that Canada might install an incremental 8,000 MWe of cogeneration capacity by 2040 as a result of the policy's continuance, given the fact that cogeneration is competitive in several cases if there is enough time for capital stock turnover.

11 A recent survey of operators of combined heat and power facilities in Canada conducted by CIEEDAC revealed that only about one-third of existing facilities are actually taking advantage of the accelerated capital cost allowance because of restrictions on the allowance and lack of knowledge. It is therefore unlikely that the new policy will stimulate a dramatic uptake of combined heat and power in the short term.

Climate Fund

The Project Green documents state: "The purpose of the Climate Fund is to create a permanent institution for the purchase of emissions reduction and removal credits on behalf of the Government of Canada, which will be one of the primary tools for Canada's approach to climate change" (Canada 2005b, 20). This initiative was announced in Budget 2005 with funding of $1 billion over five years although the government's projection of GHG emission reductions in the range of 75 to 115 Mt annually over the period 2008 to 2012 is based on total funding of $4–$5 billion over five years. The Climate Fund would be available to purchase domestic emission reductions — both through a domestic offsets program and through funding reductions in other countries — for which Canada can receive credit towards its Kyoto commitment.

The Project Green documents do not specify the likely allocation of purchases between domestic and international sources; a competitive process will be used to make purchases, but the Climate Fund's primary mandate is to promote domestic reductions. The domestic offsets program is discussed in detail in the following section.

International credits purchased by the Climate Fund may include project-based credits from both developing countries and industrialized countries that have ratified the Kyoto Protocol. Assigned Amount Units, generated when a country exceeds its emission reduction target, can also be purchased by Canada under Kyoto. These credits may be the result of emission reductions caused by economic decline in Central and Eastern Europe rather than by any deliberate GHG reducing activity; these are commonly known as "hot air."

The impact of the Climate Fund on Canada's GHG emissions depends on future funding levels, prices for international and domestic credits, political decisions about how many of each type of credit to buy and international agreements after Kyoto. The impact of the Climate Fund in 2010 and 2040 was estimated on the basis of the following assumptions.

- The budget is assumed to be $1 billion per year over the period 2008 to 2012 (total of $5 billion allocated to the Climate Fund). This amount is within the range of government funding expectations but is much greater than the $1 billion committed so far. To extrapolate the impact of the Climate Fund to 2040, the funding of $1 billion per year is assumed to continue. This is in line with the Climate Fund's mandate to become a permanent institution.
- A domestic offset price of $17 per tonne CO_2e is assumed during the Kyoto time frame. This is based on the supply curve derived in the following section.
- There is a great deal of uncertainty surrounding future prices for international credits recognized under the Kyoto Protocol. The World Bank reports that between January 2004 and April 2005, prices for Certified Emission Reductions issued under the Clean Development Mechanism were in the range of US$3 to $7.15/$tCO_2e$, with a weighted average of US$5.63 (Lecocq and Capoor 2005). It is expected that Assigned Amount Units from Russia, Ukraine and other transition economies will sell at

lower prices than the other types of international credits owing to doubts about their legitimacy. In this study the average price for international credits purchased using the Climate Fund is assumed to be C$8/t$CO_2$ between 2008 and 2012.

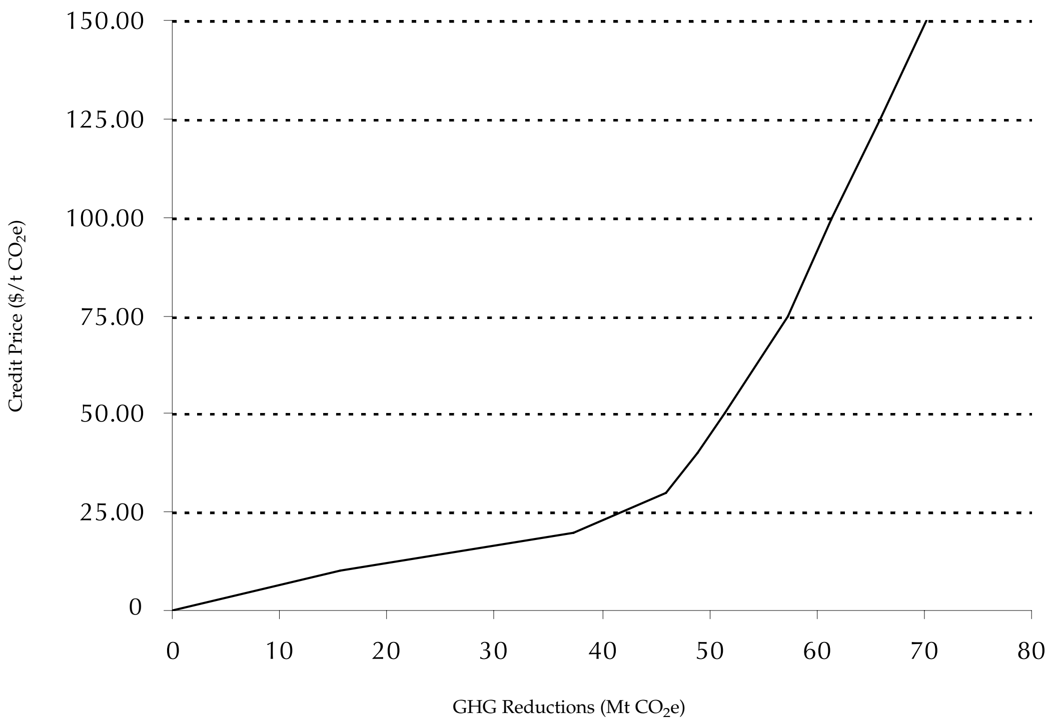
- Assuming that the goal for the post-Kyoto phase will be to include more countries (especially the U.S., China and India) and much more ambitious targets over a longer period, the international credit prices are likely to reflect the long-run cost of investments that move toward a zero-emission energy system. Over the past several years, a near-consensus has emerged among researchers and policy advisers about these costs, especially in the case of electricity generation. Globally, zero-emission sources of electricity are likely to cost about US$50–$70 per tonne of carbon dioxide emissions abated, increasing electricity generation costs by 30 to 60 percent compared to conventional coal and natural gas electricity generation (Sims, Rogner, and Gregory 2003). It is assumed that an international credit price of C$80 will be reached in the post-Kyoto time frame. In this analysis, international credit prices increase gradually from $8 in 2012 to $40 in 2020 and to $80 by 2040. Domestic credit prices are projected to reach $40 per tonne by 2020 and $80 per tonne by 2040.
- International credit prices are expected to be lower than domestic credit prices during almost all of the 30-year period analyzed in this study, with international and domestic offset prices converging by 2040. As a result, a significant number of credits will be purchased from international sources during the Kyoto time frame, despite the political preference for buying domestically. In this simulation of Project Green, it is assumed that only 30 percent of credit purchases by number (50 percent by budget) in 2008 are domestic GHG reductions but that this portion rises to 40 percent by 2012, and then to 85 percent by 2040.

On the basis of these assumptions, the impact of the Climate Fund on domestic GHG emissions is an annual reduction of 28.9 Mt from BAU levels in the Kyoto time frame. The reduction potential of the fund's annual budget, which is eroded over time by rising credit prices, is an annual reduction of only 10.6 Mt in 2040. Reductions from domestic and international credit purchases together are estimated at 92.5 Mt in 2010 and 12.5 Mt in 2040. The Climate Fund therefore achieves its target reduction of 75 to 115 Mt annually between 2008 and 2012, but the majority of this contribution is from international credit purchases. The free-rider problem with the Climate Fund is discussed in the following section.

Offset System

The Offset System seeks to create a market for GHG emission reductions in which individuals, businesses and organizations can sell credits for their GHG reductions to LFEs, the federal government and potentially other domestic buyers. The program, which would be phased in during 2006, would make any actions since January 1, 2000, eligible for offset credits (Canada 2005c). Currently, any emission reduction or removal activity that is not subject to the LFE regulations would be eligible to generate offset credits.

Figure 6: *Offset Credit Supply Curve in 2010*



Source: Authors' calculations.

There are considerable difficulties in establishing what effect, if any, offset systems may have. The credits issued are based on an estimate of the proponent's BAU emissions, and emissions reductions must be shown to be in addition to those resulting from other federal incentives and regulation. In practice, considerable uncertainty and judgment are involved in determining whether a particular project would have been undertaken without the offset subsidy (Mascher 2000). If credits are awarded for reductions that would have been made without the credit incentive, actual GHG emission reductions will be less than credited under this program. Again, this is because of the ubiquitous free-ridership problem facing all subsidy programs in a world in which there are always some BAU investments that increase energy efficiency and reduce GHG intensity. The free-ridership problem is particularly serious for the Offset System, which proposes allocating retroactive offset credits to projects completed since 2000.

Because of this identification problem, a significant portion of the offset credits are assumed in this study to be captured by free riders. This is reflected in Figure 6, where the offset credit supply curve eliminates actions induced by other government programs and assumes 50 percent free-ridership. It is therefore a residual supply curve for GHG abatement in Canada, calculated by subtracting other programs from abatement curves estimated previously with the CIMS model.

Partnership Fund

Some actions related to reducing GHG emissions are at least partly under provincial jurisdiction. The Partnership Fund is designed to allow the federal, provincial and territorial governments to work together on strategic projects to reduce GHG emissions. Potential projects include investments in a carbon dioxide pipeline (for capture and storage projects), cellulosic ethanol plants, enhanced transmission grids between Manitoba and Ontario and between Prince Edward Island and New Brunswick, and development of regional climate change centres.

The 2005 Budget provided funding for the Partnership Fund of at least $50 million per year from 2005 to 2010, with amounts to be added as projects are identified and developed. Project Green envisioned total Partnership Fund spending of $2 to $3 billion over the next decade and expected 55 to 85 Mt of GHG reductions annually from 2008 to 2012 as a result of such spending.

The Partnership Fund is essentially a continuation of the existing Opportunities Envelope program, which was announced in 2003. Like the Partnership Fund, the Opportunities Envelope was aimed at fostering cooperation with the provinces on climate change issues; it was allocated about $50 million a year ($160 over three years), about the same as currently allocated to the Partnership Fund. The Opportunities Envelope operated for only two years before being subsumed by the Partnership Fund, but a review of its operation over these two years provides a starting point for evaluating the potential effect of the Partnership Fund. During its two-year operation, the Opportunities Envelope provided funding to 29 projects at a cost to the federal government of about $54 million. In total, according to Project Green documents, it is expected that the 29 funded Opportunities Envelope programs will reduce GHG emissions by about 2 Mt annually.[12]

As in other subsidy programs, it is likely that many of the GHG reductions that are allocated to the Partnership Fund would have been made in the absence of the policy. For example, if the government invests in a CO_2 pipeline for enhanced oil recovery, it cannot be sure if such an investment would have gone ahead anyway, for the oil industry has been building CO_2 pipelines for enhanced oil recovery for years, and this kind of activity is bound to increase as conventional oil supplies dwindle and if the price of oil remains high. Indeed, some of these investments are already included in the BAU scenario used in this paper. The evidence that was outlined earlier suggests that a prudent assumption is that at least 50 percent of the actions under subsidy programs such as the Partnership Fund would have been taken anyway.

At the current level of funding, there are likely to be only minimal real GHG reductions from the Partnership Fund (less than 1 Mt annually). Even if funding is increased to about $250 million annually by 2007, as Project Green documents suggest might be possible, a maximum incremental GHG reduction of only about 16 Mt annually during the Kyoto time frame is projected, far short of the 55–85 Mt envisioned in Project Green. The modelling conducted for this project shows that if funding were maintained constant at $250 million annually through 2040,

12 This projection is based on *ex ante* estimates from project proponents and Natural Resources Canada, and it may be optimistic.

annual GHG reductions would increase to about 21 Mt in 2020 before declining to about 14 Mt in 2040 as a result of the rising cost of domestic GHG reductions. This analysis assumes a 50 percent free-rider rate of projects funded by the Partnership Fund. It also assumes that GHG reductions instigated by the Partnership Fund last an average of eight years.

Other Programs

As noted, the federal government has used information programs to encourage energy efficiency and GHG emissions reduction for almost two decades. These policies include moral suasion, like the recently terminated One Tonne Challenge, and similar advertising and public involvement campaigns to raise awareness of opportunities to reduce GHG emissions. The government has also provided information on energy savings and GHG emission reductions with labelling programs like EnerGuide and Energy Star. Some policies foster research and development on innovative technologies that could reduce emissions, like new industrial catalysts and improved house energy efficiency. Some policies, like the house retrofit incentive and the Commercial Buildings Incentive Program, offer modest subsidies to stimulate investment in energy efficiency. Finally, the government intends to continue retrofitting its own buildings and improving the efficiency of its vehicle fleet. In Project Green, the federal government estimated that its continuation and intensification of these efforts would reduce GHG emissions by 46 Mt during the Kyoto time frame.

As discussed above, research into demand-side management programs run by electric and natural gas utilities has found that information programs on their own have had little effect. Similar studies have found that subsidies to encourage energy efficiency have a smaller effect than initially assumed because of free-ridership. In this study, therefore, these other subsidy programs are also assumed to have 50 percent free-ridership when their effect on GHG emissions is calculated. In the case of pure information programs, like the One Tonne Challenge, the best estimate is that they have only a negligible effect on technology choices and behaviour. Nonetheless, in this study information programs are assumed to have some effect, but only about half of that claimed by the government. In total, the likely effect of other Project Green domestic policies is a reduction in emissions of 21.1 Mt in the Kyoto Protocol time frame and a further 3.5 Mt through international projects. By 2040, this increases to 27 Mt as the residential and commercial building stock and the industrial sector increase in size.

The Effect on Canada's GHG Emissions

In its Project Green documentation, the government predicted that during the Kyoto time frame this program would reduce GHG emissions by 230 to 300 Mt relative to a BAU trajectory. This study estimates that the policy of relying on information and subsidies to encourage voluntary action would more likely reduce emissions by only 175 Mt and that only half of these reductions would be in Canada (see Table 2). This estimate is based on funding levels and policies for Project Green in the period 2006–2012 that were committed to but not allocated by

Table 2: *Assessment of GHG Reductions Attributable to Project Green*

	GHG Reductions in 2010 (Mt)				GHG Reductions in 2040 (Mt)		
	Projection in	Estimate in This Study			Estimate in This Study		
Policy	Project Green	*Domestic*	*International*	*Total*	*Domestic*	*International*	*Total*
Large Final Emitter System	36.0	15.0	21.0	36.0	43.0	—	43.0
Climate Fund	75–115	28.9	63.6	92.5	10.6	1.9	12.5
Offset System	—	—	—	—	—	—	—
Partnership Fund	55-85	16.0	—		14.0	—	14.0
Renewable Energy Policies							
Wind Power Production Incentive	3.0	3.0	—	3.0	7.5	—	7.5
Renewable Power Production Incentive	3.0	1.5	—	1.5	7.5	—	7.5
Class 43.1 Accelerated Depreciation Allowance	3.0	1.1	—	1.1	4.4	—	4.4
Total	15.0	5.6	—	5.6	19.4	—	19.4
Memorandum of Understanding with Automakers	5.3	3.5	—	3.5	20.0	—	20.0
Other Policies and Programs							
One Tonne Challenge	5.0	2.5	—	2.5	3.0	—	3.0
Federal House in Order	1.0	1.0	—	1.0	1.2	—	1.2
Pre-existing Programs	40.0	15.1	3.5	18.6	18.2	5.0	23.2
Houses		1.4	—	1.4	1.6	—	1.6
Buildings		0.1	—	0.1	0.2	—	0.2
Industry		3.2	3.5	6.7	3.8	—	3.8
Transportation		2.2	—	2.2	2.6	—	2.6
Renewable Energy		2.3	—	2.3	2.7	—	2.7
Green Municipal Funds		1.0	—	1.0	1.2	—	1.2
Agriculture		5.0	—	5.0	6.0	—	6.0
Total	46.0	18.6	3.5	22.1	22.4	5.0	27.4
Total	230–300	87.6	88.1	175.7	129.4	6.9	136.3

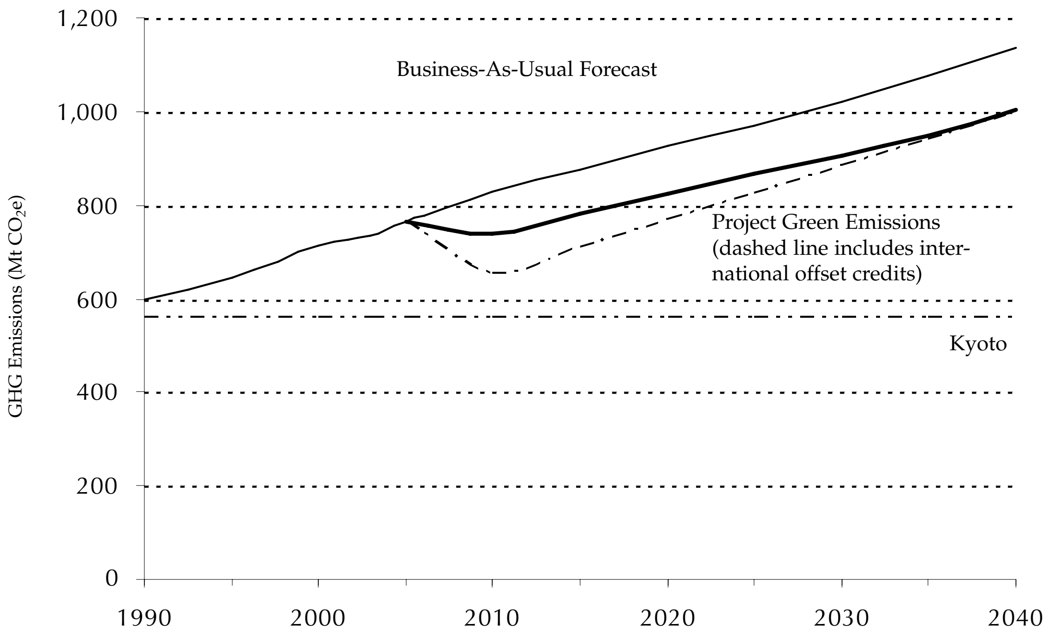
Source: Project Green projections from Canada (2005b); authors' calculations.

the previous federal government, namely, a 500 percent increase in funding for the Climate Fund and the Partnership Fund, implementation of the Large Final Emitter system, funding for the Renewable Power Production Incentive and increased funding for the Wind Power Production Incentive.

The Project Green documents also say it "is a plan that makes sense for Canada's future" (Canada 2005b, 33). Since the purpose of all GHG emissions reduction policy is to stabilize atmospheric concentrations of GHGs, today's policy approaches should be evaluated for their ability over a longer period to cause the dramatic emission reductions that are required for stabilization. However, when the policy approach represented by Project Green is projected over a 35-year time frame to 2040, Canadian GHG emissions will continue their upward trend, reaching 1,000 Mt by the final year (see Figure 7). This would be about 135 Mt below the projected BAU level but far above the 2005 level of emissions and even farther above Canada's commitment under the Kyoto Protocol.

The Intergovernmental Panel on Climate Change says that if GHG emissions throughout the world continue to rise at the BAU rate, CO_2 emissions would rise

Figure 7: *Projected Impact of Project Green on GHG Emissions*



Source: Authors' calculations.

from their current annual rate of 20 gigatonnes up to 50–60 gigatonnes by 2040 and 75–110 gigatonnes by 2100 (IPCC 2001). This implies an atmospheric CO_2 concentration of 700–850 ppm by 2100, which, according to the IPCC, will cause substantial temperature increases by the latter part of the century.

Not only is a continuation of Project Green unlikely to contribute much to the achievement of Canada's policy objective, but it will cost a great deal. If this policy were maintained roughly as it is until 2040, the total cost to Canadian taxpayers would be $12 billion by 2012 and $83 billion by 2040. The total costs over the 35 years would be equal to $32 billion in present value (using a discount rate of 6 percent for the time value of money).

Alternative Policy Approaches

If Canada is serious about its GHG objective, it must consider alternative policy approaches. The policies that seem to be more successful are ones that legally or financially impede GHG emissions. One such policy would be a gradually increasing tax on GHG emissions. Decades of experiments with environmental taxes — including CO_2 taxes in several jurisdictions — have shown that a properly designed tax can achieve its goals at reasonable cost. Governments could reduce other taxes, so that there was no net tax increase. Industries whose exports were threatened could be given some tax exemption and assistance with emissions reduction. Lowering taxes that inhibit new investments could make industry better able to adapt to the new circumstances. Tax payments could be returned to provincial governments to prevent the policy from causing transfers between regions. The tax could be set at a modest level at first but could be scheduled to rise gradually, so that it affected new investment decisions but not the profitability of old equipment.

If the public is not yet ready for complete reliance on the taxation approach, this policy could be combined with, or replaced by, market-oriented regulations that required the development and adoption of non-GHG-emitting technologies (Jaccard et al. 2003). California, for example, requires vehicle manufacturers to achieve a growing market share for vehicles with zero and near-zero GHG emissions. The manufacturers can trade among themselves to meet their obligations, and the long time frame allows for development and market testing of options like battery-electric, plug-in hybrid, hydrogen fuel cell and bio-fuel. Penalties for non-compliance ensure that manufacturers are motivated to refocus their R&D and marketing to promote cleaner cars.

In the case of energy production, Canada's nascent emission cap and trade regulation for large industrial emitters would provide greater confidence about environmental effectiveness if it included gradually tightening caps or even an absolute cap. Its industry-specific emission caps must be tightened; otherwise, the rapid growth of a high-emissions activity like oil sands production will drive national emissions higher.

Another market-oriented regulation would be to shift the burden for emission management back to the fossil fuel industry, which would be required to take responsibility for the fate of the carbon it handles, just as industries must do with other potentially harmful substances. This carbon management standard would require anyone extracting carbon from the earth's crust to ensure that it did not end up in the atmosphere (Jaccard 2005). At first the obligation would apply to only a small percentage of carbon extracted, but the percentage would be scheduled to gradually rise. This phase-in approach would allow time for industry to gain experience without large increases in production costs, for the cost of GHG control to fall and for the government see if other countries imposed equivalent constraints on their industries. To minimize compliance costs, all activities engaged in carbon extraction and processing (oil sands production, oil refineries, coal mines, electricity generators, pipelines, gas processors) would be allowed to form consortia in order to meet the total requirement as cheaply as possible. Over time, some adjustment to the schedule could be allowed in response to new information about compliance costs and the seriousness of the risk of climate change.

While evidence suggests that these policies are likely to be more effective, they are not without substantial costs. It remains to be seen if Canadians are willing to make these expenditures as part of an international effort to address the climate change risk.

Conclusion

For 15 years Canadian governments have layered one GHG policy over another — the 1990 Green Plan, the 1995 National Action Program on Climate Change, Action

Plan 2000 on Climate Change, the 2002 Climate Change Plan for Canada, and Project Green in 2005. The names changed, but not the policy approach, which consisted primarily of offering information and subsidies to encourage voluntary emission reductions. But without substantial restrictions or charges for emitting GHGs, Canadian emissions have continued to grow, outstripping the emission targets and commitments set by the government. Investments in energy supply, infrastructure, buildings and energy-using devices continue the GHG-intensive path and increase the costs of diverting from it in future. This is to be expected in a market economy where there are many benefits to businesses and individuals from burning fossil fuels, which is a high-quality form of energy, and these actions overwhelm the effect of voluntary GHG reduction efforts.

In spite of mounting evidence that its policies are not effective, Canada's latest major policy initiative, Project Green, represented an intensification of the information and subsidy approach. A forecast based on continuing this policy approach suggests that Canadian emissions would increase by 50 percent within 35 years. As designed, even the anticipated regulation of industrial emissions would be swamped by growth in key sectors such as oil sands production and fossil-fuel-based electricity generation. If this policy approach continues, we will spend at least $80 billion over the next 35 years — but without reducing GHG emissions.

Many Canadians believe we have been taking action on climate change when we have actually been doing little. In fact, it could be argued that without a substantial shift in policy, we will be burning our money to warm the planet.

Appendix

The table below delineates the key assumptions that were used to develop the BAU scenario (and sensitivity scenarios) used in this study. Many other assumptions were also required, but the ones shown have the greatest effect on overall GHG emissions, as well as the most uncertainty.

Appendix Table: *Key Assumptions in the Business-As-Usual (BAU) Forecast*

	BAU	Justification
Population	37.9 million by 2030. Based on maintenance of overall immigration quota, 1%/year decrease in birth rate, 0.85% per year increase in death rate.	UN forecasts show Canada's population growing to 37.5 million by 2035. U.S. Census Bureau forecasts growth to 40 million.[a]
GDP	Grows at 2.6% per year.	Canada's GDP has grown by 2.8% annually from 1987 to 2004, Conference Board of Canada projects growth at 2.6% per year to 2020.[b]
Autonomous energy efficiency improvement	Industry and oil and gas = 0.6% per year; electricity generation = 0.25-0.3% per year; transportation = 0.25% per year	Energy intensity improved in several industrial sectors by about 1% per year from 1997 to 2002.[c]
Increase in demand	2% per year growth in air conditioning demand; 1% per year growth in residential and commercial energy service demand	
Oil sands production	Oil sands production grows at 4% per year to 6.14 mbd by 2030	Forecast based on Canadian Association of Petroleum Producers and Government of Canada estimates.
Increase in transportation demand	0.6% per year increase in per capita light-duty vehicle travel	

[a] http://www.sustainableworld.com/data/population/prop_proj_samp.htm.

[b] Historic GDP growth in constant 1997 dollars from Statistics Canada; Conference Board of Canada report available at www.conferenceboard.ca.

[c] Canada (2004).

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