

C.D. Howe Institute
Working Paper

www.cdhowe.org

June 2007

Estimating the Effect
of the Canadian
Government's 2006–2007
Greenhouse Gas Policies

Mark Jaccard and Nic Rivers

Inside...

Current policy proposals for reducing greenhouse gas emissions will fall short of federal targets for 2020 by almost 200 megatonnes; because of this gap it is unlikely that a future government would be able to meet the current reductions target for 2050.

The Study in Brief

Mounting public concern about climate change has prompted the Canadian government to respond with a major policy effort to reduce greenhouse gas emissions. Since early 2006, the government has launched a series of initiatives under the “ecoACTION” banner, culminating in the release in April 2007 of its “regulatory framework for air emissions,” which is currently under consultative review.

This working paper reports on estimates of the effects of the current slate of federal greenhouse gas policies, using an energy-economy simulation model and other analytical tools. Current policies are likely to reduce emissions substantially compared to their business-as-usual evolution. By 2020, emissions would be 120 megatonnes below projected levels and by 2050 the reduction would be almost 400 megatonnes below the business-as-usual projection. However, the results also indicate that overall emissions in Canada are unlikely to fall below current levels. The government is likely to miss its 2020 emissions target by almost 200 megatonnes. Moreover, because of this gap in 2020 between target and reality, it is unlikely that a future government would be able to achieve the ambitious 2050 target.

The Authors of This Working Paper

Mark Jaccard is Professor, School of Resource and Environmental Management, Simon Fraser University and a Fellow-in-Residence at the C.D. Howe Institute.

Nic Rivers is a graduate student in the School of Resource and Environmental Management at Simon Fraser University.

Executive Summary

Mounting public concern about climate change has prompted the Canadian government to respond with a major policy effort to reduce greenhouse gas (GHG) emissions. Since early 2006, the Conservative government has launched a series of initiatives under its “ecoACTION” banner, culminating in the release in April 2007 of its “regulatory framework for air emissions,” which is currently under consultative review.

The government maintains that the combined effect of its policies will reduce Canadian GHG emissions to a target 20 percent below today’s levels by 2020.¹ The government also says that this initiative moves Canada toward its emission target for 2050 — a 65 percent reduction from current levels. If achieved, this four-decade target represents a profound transformation of our energy-economy system.

While these initiatives and commitments are undoubtedly taken in earnest, Canadian governments have an unfortunate record on GHG targets and policies. Since 1988, Canadian governments have, on several occasions, set targets for reduced GHG emissions and implemented policy initiatives to achieve those targets. However, five major policy initiatives have failed to stem the steady growth of Canadian GHG emissions, as shown in Figure 1 of the Working Paper. Emissions actually rose faster during the period of policy initiatives, from 1990 to 2006, than during the previous decade, from 1980 to 1990, even though this earlier period had no GHG reduction policies.

To estimate the effects of the current slate of federal greenhouse gas policies, we apply an energy-economy simulation model and other analytical tools at our research group at Simon Fraser University.² Our analysis depends in part on the CIMS energy-economy policy simulation model, which is typical of the leading models used by governments and researchers for this type of analysis.³ CIMS is an integrated energy supply, energy demand and macro-economy model, meaning that it simultaneously simulates the effect of all policies intended to reduce GHG emissions — thereby ensuring that the effects of overlapping policies are not double-counted. The model is technologically explicit, in that it keeps track of energy producing and using

¹ Emissions in 2020 would be about 150 megatonnes (Mt) below current levels (750 Mt) and a full 300 Mt below the levels they were projected to reach by 2020 in the absence of new reduction policies.

² The Energy and Materials Research Group in the School of Resource and Environmental Management at Simon Fraser University has been simulating energy-economy policies for over two decades as independent research, but also under contract to government, industry, and non-government organizations in Canada and abroad.

³ In terms of its technological detail and portrayal of firm and household decision-making, CIMS has similarities with the NEMS model of the US government, the Maple-C model of Natural Resources Canada and the Energy 2020 model of Environment Canada.

technologies. And its firm and household behavioural parameters are estimated using standard statistical methods from past market data and, in some cases, from surveys of consumer receptivity to new and emerging technologies — thereby reducing the risk of biased assumptions about the responsiveness of consumers and businesses to GHG policies. The value of this approach is well recognized by applied researchers assisting governments in forecasting policy effectiveness.⁴

We provide in this paper the results of our simulation of the government's GHG policies to the years 2020 and 2050. Since the government has not yet clarified all aspects of the policies over both of these timeframes, or resolved all of its long-run expectations for each policy, we made certain assumptions and asked Environment Canada for clarifications, which it provided where possible. Of particular importance, we assumed that the government would continue the 2 percent per year emission intensity reduction for large final emitters from 2015 all the way through to 2050, even though it has not announced this. We also assumed that the government would adopt the California vehicle GHG emissions regulations and continue to tighten these aggressively, even though it has not announced this. These two policy assumptions play the biggest role in the substantial emissions reductions in our simulation.

We tried to be true to the government's assumptions about policies. But for the response of firms and households to these policies, we relied on the empirically estimated behavioural parameters of the CIMS model and on policy effectiveness estimates from studies of similar policies in other jurisdictions — policies designed to stimulate greater energy efficiency, fuel switching, emissions control and land-use changes. Finally, an additional challenge was to sort out the net effect of policies that overlap. For example, the "offsets" allowed large industrial emitters could fund energy efficiency in residential dwellings, which might also occur because of provincial policies from the "climate change trust fund." Research shows that even with a very large bureaucracy scrutinizing all potentially relevant expenditures, it is impossible to prevent a certain amount of redundancy when policies allow for overlap such as this.

⁴ See the recent special issue of *The Energy Journal*, the leading international energy economics journal: Hourcade, J.-C., Jaccard, M., Bataille, C. and F. Ghersi, "Hybrid Modeling, New Answers to Old Challenges: Introduction to the Special Issue of the Energy Journal," *The Energy Journal*, Special Issue, 2006, 1-12. We note that the CIMS model was one of two models selected by a Canada-wide panel of experts and government representatives in Canada's National Climate Change Process, in 1998, to simulate policies for meeting Canada's 2010 Kyoto target. The model indicated that a GHG tax of \$120–\$150 per tonne of CO₂ needed to be implemented in 2000 if Canada was to meet its Kyoto target. The rising emissions of the past seven years suggest that a tax of this magnitude may indeed have been required. No tax or economy-wide emissions caps were implemented and emissions in 2006 were 31 percent above the target. For the explanation of the 1998 analysis and forecast, see Jaccard, M., Nyboer, J. and B. Sadownik, 2002, *The Cost of Climate Policy*, Vancouver: UBC Press.

Our aggregate estimate of the effect of the Canadian government's 2006-2007 GHG policies on future emissions is presented in Figure 2 of the Working Paper. We estimate that these policies are likely to reduce emissions substantially compared to their business-as-usual evolution. By 2020, emissions would be 120 megatonnes below projected levels and by 2050 the reduction would be almost 400 megatonnes below the business-as-usual projection. However, the results also indicate that overall emissions in Canada are unlikely to fall below current levels. The government is likely to miss its 2020 emissions target by almost 200 megatonnes. Moreover, because of this gap in 2020 between target and reality, it is unlikely that a future government would be able to achieve the ambitious 2050 target.

Some of the uncertainty in our study is due to unresolved policy decisions by government. But significant uncertainty also results from the imperfect knowledge of energy-economy researchers about the responsiveness of businesses and households to policies that affect the information, costs and/or regulatory constraints of emitting GHGs. We accordingly adjusted key parameters to reflect this uncertainty and then executed multiple model runs. These are reflected in the grey band around our central forecast in the figure, showing that emissions in 2050 could range from 1,000 to 800 megatonnes.

We summarize the salient points from our research.

(i) Our assessment shows that the 2006-2007 policies of the current government of Canada will not be effective in meeting its stated targets. Leading independent research indicates that the principal reason for policy failure — in Canada especially, but elsewhere as well — is the unwillingness of government to place a value on the atmosphere. Setting a value on the atmosphere is essential since fossil fuels, the dominant source of human GHG emissions, will remain competitive with other energy sources for at least several decades and perhaps centuries. Such value-setting can only occur (1) directly via a GHG tax, the most economically efficient approach, or (2) indirectly by regulations that set a cap on emissions (perhaps with tradable permits), or control the carbon content of energy supplies, or control the emission characteristics of the technologies available in the market (vehicles, buildings, equipment). Policy reliance on information programs and subsidies to reduce GHGs may have a small effect, but cannot cause dramatic reductions in the short or long run.⁵ Only with a cost to emitting GHGs (directly via tax or indirectly via regulation on emissions or technologies) will the economy see significant technological change over the next decades from the four major actions to reduce GHG emissions: greater energy efficiency, fuel switching to low or zero emission fuels, capture and storage of carbon, and changes in forestry and agricultural land use and management practices.

⁵ A more detailed explanation and evidence is provided in Jaccard et al., 2006.

(ii) The government's 2006-2007 policies are an apparent improvement on previous policies in that the intensity reductions on industrial emissions are potentially greater (depending on the flexibility provisions) and there is an expectation of fully regulating vehicle GHG emissions. However, the regulation on industrial emissions allows industries to forego emissions reductions and instead pay subsidies to firms and households in the unregulated sectors of the economy. These subsidies will have a significantly weakened effect, as evidenced with past subsidy programs, because it is impossible to prevent free-riders — people receiving the subsidy for GHG reductions they would have undertaken anyway — and the subsidy budget can never be large enough to influence more than a small percentage of market activity.

(iii) We estimated GHG emissions reductions by 2020 and 2050, based on the individual policies introduced by the government in 2006/2007. The total of 116.5 megatonnes of CO₂ equivalent in 2020 is far less than the 300-megatonne reduction required for the government to reach its 20 percent reduction target (See Table 1 of the Working Paper).

(iv) This study is limited to assessing policy effectiveness and thus does not include an estimation of costs to the economy. In future analyses, we expect to assess the costs of the government's policies alongside alternative policies. The challenge for policymakers is to design policies that are effective at the lowest possible costs. Preliminary analysis suggests that the government's current policies — which will fail to meet its 2020 and 2050 targets — will incur costs to the GDP comparable to those of more effective policies that would actually achieve its targets. Costs imposed by an economy-wide GHG tax, or an economy-wide emissions cap, would not be substantially different.

Working Paper: Estimating the Effect of the Canadian Government's 2006-2007 Greenhouse Gas Policies

Mark Jaccard and Nic Rivers

Mounting public concern about climate change has prompted the Canadian government to intensify its policy effort to reduce greenhouse gas (GHG) emissions. Since early 2006 the Conservative government has launched a series of initiatives under its "ecoACTION" banner, culminating in the release in April 2007 of its "regulatory framework for air emissions" from large industry.

In a "background" document, the government maintains that the combined effect of its policies will reduce Canadian GHG emissions to a target 20 percent below today's levels by 2020.⁶ The government also claims that this initiative moves Canada toward its emission target for 2050 – a 65 percent reduction from current levels. If achieved, this four-decade target represents a profound transformation of our energy-economy system.

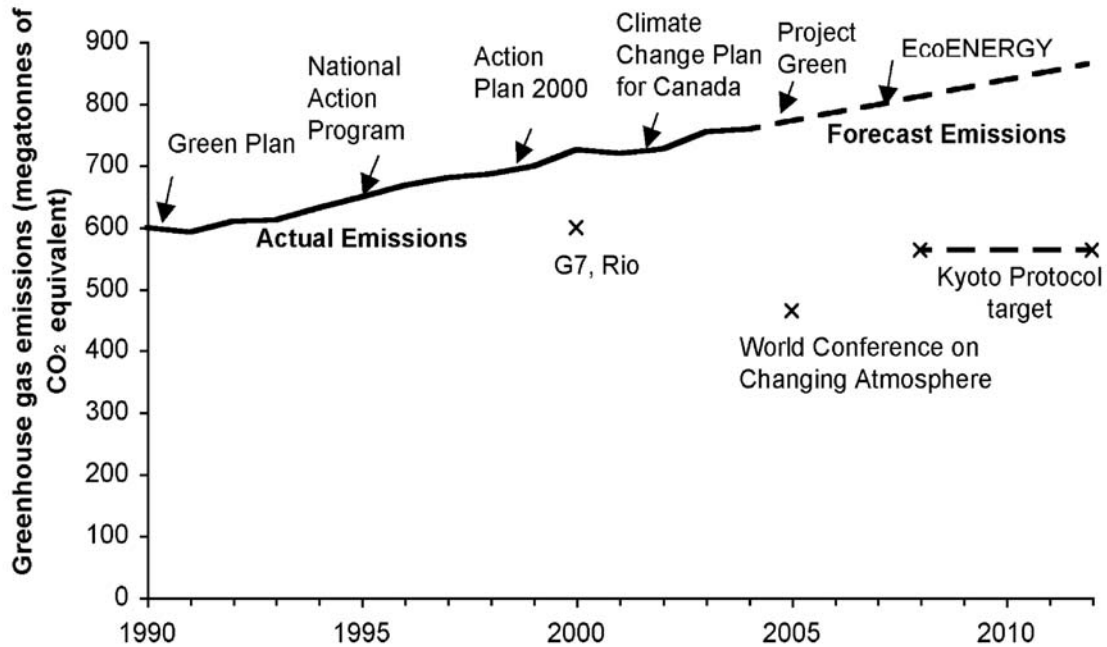
While these initiatives and commitments appear to have been taken in earnest, Canadian governments have an unfortunate record on GHG targets and policies. Since 1988, Canadian governments have, on several occasions, set targets for reduced GHG emissions and implemented policy initiatives to achieve those targets. However, five major policy initiatives have failed to stem the steady growth of Canadian GHG emissions, as shown in Figure 1. Emissions actually rose faster during the period of policy initiatives, 1990 to 2006, than during the previous decade, from 1980 to 1990, even though this earlier period had no GHG reduction policies.

If Canadian policymakers are to break this pattern of failure, they need to understand why previous policies failed and to replace these with effective substitutes. In a previous C.D. Howe Institute *Commentary* (Jaccard et al., 2006), we surveyed the findings of international researchers that explain why certain GHG emissions reduction policies are ineffective. In general, policies that continue to allow use of the atmosphere as a free waste receptacle for GHG emissions fail. Thus, information programs (appliance labels) and subsidies (insulation grants to homeowners) are found to be mostly ineffective when applied on their own, while policies that tax GHG emissions (carbon tax) or

⁶ Emissions in 2020 would be about 150 megatonnes (Mt) below current levels (780 Mt) and a full 300 Mt below the levels they were projected to reach by 2020 in the absence of new reduction policies.

regulate emissions (emission cap and permit trading) are found to be much more effective. Given the compulsory nature of these latter policies and the voluntary nature of the former policies, this finding is not particularly surprising. What is surprising perhaps is that some governments have been so slow to acknowledge this evidence and to re-orient their policies accordingly.

Figure 1: Canadian Targets, Policies and Emissions



Source: Authors' calculations.

Independent researchers, including our research team in the School of Resource and Environmental Management at Simon Fraser University, have applied the results of this research to the construction of energy-economy simulation models that forecast the effect of government policies on GHG emissions. In this report, we provide the results of our simulation of the government's 2006-2007 GHG policies to the years 2020 and 2050. We calculated the effect of the policy package using a variety of accepted modeling methods and estimated parameters.

In a project of this nature, there is considerable uncertainty about the effects of various policies as these depend on assumptions about how businesses and households will respond to changes in costs, regulations and information. We asked Environment Canada for information on the energy-economy

modeling tools it used and the major assumptions it applied in concluding that its policies would reduce emissions by 20 percent by 2020, as well as in concluding that its policies would set the country on the trajectory needed to achieve its 2050 target of a 65 percent reduction. While the government provided aggregate results for individual policies, we are still unclear about the key assumptions the government used in estimating how businesses and consumers would respond to its 2006-2007 policy initiatives and also unclear about how the government ensured that the effects of overlapping policies were not double counted.

Understanding and Forecasting Greenhouse Gas Reduction Actions and Policies

In popular discourse, and even in political speeches, there is often confusion between the actions that reduce GHG emissions, on the one hand, and the policies that are needed to cause these actions, on the other. Politicians might be heard to say, “We should improve energy efficiency first.” But politicians do not improve energy efficiency. Businesses and households determine collectively the rate at which energy efficiency improves through their decisions when acquiring and operating energy-using devices or in fact acquiring any object that requires energy for its production, transportation, and disposal. All politicians can do is try to influence these decisions with the imperfect policy levers at their disposal.

This distinction between policies and actions is critical when predicting the future effectiveness of public policies. First, the actions may be more difficult to achieve than a simplistic cost analysis might suggest. Second, the policy itself might be inherently flawed or simply inappropriate for the actions that the policy maker is trying to induce. Research into the effectiveness of GHG reduction policy has found that both of these considerations are critical in explaining past policy failures. We explain below the challenges for assessing actions and then policies.

There are four major categories of actions that reduce GHG emissions: changes in forest and agricultural land use or waste management (including urban waste management); energy substitution away from fossil fuel combustion to renewables or nuclear;⁷

⁷ This includes the less important, but nonetheless significant, substitution between industrial processes that can reduce GHG emissions even though fossil fuel consumption is not reduced.

increased energy efficiency where fossil fuels are used (including changes in urban form that reduce transportation needs); and capture and storage of GHG emissions.

Actions within each of these categories have varying levels of estimated costs, but to these apparent costs should be added intangible factors that may increase or decrease the ability of government policy to realize the action. An efficient compact fluorescent light bulb might appear to have lower overall costs because its low electricity costs appear to offset its high capital costs. But when the risk of accidental breakage is factored in, its expected capital costs can be too high for the investment to be profitable. Moreover, when consumer preferences are included, its advantage may be further diminished – many consumers do not see compact fluorescent light bulbs and incandescent light bulbs as perfect substitutes. Likewise, public transit is not a perfect substitute for a car. And a small car is not a perfect substitute for a big car. Researchers have found, therefore, that energy efficiency can be much more difficult to induce when all tangible and intangible decision factors are included. Detailed evidence and a literature survey are presented in Jaccard (2006, 79-100).

Researchers have also found that actions need to be characterized in terms of the likelihood of their endurance, especially given that rising GHG concentrations in the atmosphere is a long-term problem. An obvious example is the action of planting trees in order to capture and store carbon on the earth's surface. The likely permanence of storage of carbon in the trees, roots, and soil needs to be carefully included in any estimate of GHG levels many decades and even a century into the future.

Rigorous research is required to estimate the long-run effect of every GHG emissions reduction action. Similarly, careful research is also required when assessing the likely effectiveness of the policies intended to induce these actions. Policy options for inducing GHG emissions reduction actions can be characterized as falling into one of the following categories:

- command-and-control regulations;
- information programs;
- subsidies (tax credits, grants);
- financial penalties (taxes and charges); and
- market-oriented regulations.

While none of the general types of policies listed above is necessarily ideal, some policies have performed better than others when it comes to influencing the energy-using and GHG-emitting technology choices of businesses and consumers. Indeed, thanks to almost three decades of policies by governments and energy utilities promoting energy efficiency, fuel switching and pollution

control, researchers have a rich empirical record to study from and draw conclusions. They have found, in particular, that information and subsidy programs are by themselves insufficient to cause substantial changes in the energy-use and energy-related emissions of modern economies. In contrast, pollution taxes and pollution regulations, preferably regulations with considerable market flexibility (like a cap and trade system), have been shown to be much more cost-effective when it comes to reducing undesirable emissions from energy use. Detailed evidence and a literature survey are presented in Jaccard (2006, pp.259-314), but we summarize some of the key lessons below.

Governments have used information programs to try to inform businesses and consumers of the financial and social benefits of their energy efficiency and fuel switching investments as a way of reducing energy use and GHG emissions. But, as noted, businesses and consumers seem to be aware that these efforts can be costlier and that the technologies in question are often not perfect substitutes. Finally, information programs encouraging reduced energy use must compete with modern mass advertising and its efforts to convince people that their lives will improve by acquiring new devices – some of which require energy to operate, all of which require energy to manufacture, deliver and dispose of.

Subsidies include grants, tax credits, and other inducements that improve the economics of an investment that reduces energy use and/or GHG emissions from what they otherwise would be. When someone accepts a subsidy to acquire a more energy efficient device, like a relatively efficient fridge, it appears to be intuitively obvious that the subsidy has reduced energy use and therefore GHG emissions. However, the consistent finding of leading independent researchers is that subsidies to encourage energy efficiency are not nearly as effective as they appear on the surface. A key reason is that the energy efficiency of most devices in the economy is naturally improving over time, even in the absence of policy. At any given time, a percentage of the population is acquiring devices that are more efficient than existing equipment. Because it is impossible to exclude these people from a subsidy program, these “free riders” receive the subsidy but the trajectory of their emissions does not change. While it is difficult to accurately estimate the number of free riders, researchers have developed various statistical methods to distinguish the incremental effects of subsidy programs – i.e., to net out the effects of free riders. This research shows that in many subsidy programs, free riders are in the neighbourhood of 50 percent of subsidy recipients.

An additional problem is that subsidy programs for say efficient fridges are unable to influence the entire set of decisions affecting the evolution of energy use for cooling food. At the same time that a household acquires a more efficient fridge it might also acquire a water cooler or a wine cooler, two cooling devices whose sales are growing. The new fridge it acquires might be larger than

the old one (efficiency is measured per unit volume), and the old one might even continue to be used for secondary purposes (the basement beer fridge). Finally, the acceleration of energy efficiency innovations fosters the invention of related energy-using devices such as desktop refrigerators for offices and portable fridges for outdoor leisure. The evidence suggests that subsidy programs for energy efficiency (as a way of reducing GHG emissions) have little long-term effect if the subsidies are not accompanied by other price or regulatory mechanisms.

The effective policies, not surprisingly, are compulsory ones that either penalize GHG emissions with a tax or other kind of financial levy, or set inescapable regulations that require declining emissions from firms and households, or apply some combination of these two approaches. These kinds of compulsory policies directly or implicitly put a value on the use of the atmosphere as a waste receptacle for dumping GHGs. A GHG tax puts a direct value on the atmosphere by charging for its use. With a GHG regulation, the value is indirect – resulting from the price for tradable emission permits or the cost of fines for non-compliance. Another indirect approach to valuing the atmosphere is a regulation directed at particular technologies, such as a prohibition on high emission vehicles.

In terms of policy effectiveness then, the most important conclusion of independent research is that without a value on the atmosphere, GHG emissions will not fall. The challenge, however, is that the only effective policies are also the most difficult for finding political acceptance. This explains why politicians have been reluctant to implement them, and it explains the policy failures of the last decade and a half. Canadian politicians have largely opted for politically painless policies that were also ineffective. These policies were implemented, but emissions kept rising. Policies in many other OECD countries have not been much better than Canadian policies. But some countries have had success in implementing carbon taxes and emission caps applying to at least some of their economies, and these countries have controlled their GHG emissions more effectively.

Individual Assessment of the GHG Emissions Reduction Policies

In forecasting policy effectiveness, it is important that the rich experiences of the last two decades inform the key assumptions of whatever energy-economy modeling tool is used by government or independent analysts such as us. In numerous publications in refereed academic journals, we have explained how parameters are estimated in our model, which is called CIMS. In terms of its technological detail and portrayal of firm and household decision-making, CIMS

is similar to the NEMS model used by the US government to assess energy policies, the Energy 2020 model used by Environment Canada, and the Maple-C model used by Natural Resources Canada. CIMS is among the world's leading models when it comes to the empirical estimation of its long-run behavioural parameters.⁸ To assess the new government's policies, we therefore used a combination of the CIMS model and ancillary models and calculations as needed.

In our analysis, we distinguish three phases in the policies implemented by the Conservative federal government. The first phase encompasses two policies implemented with the government's first budget in early 2006. The second phase occurred early in 2007, as the government re-instigated with slight changes several policies that had been introduced by the previous Liberal government and then cancelled by the Conservatives after taking office. The third phase is the release of the "regulatory framework for air emissions" in April 2007.

Phase I – Post-Election Conservative Climate Policies

Public Transit Tax Credit: Announced in the 2006 budget, the public transit tax credit provides a tax credit to monthly or annual transit pass holders. The policy allows commuters to write off the value of transit passes at the lowest federal tax bracket (15.5 percent), and so is worth about \$150 annually to a regular commuter. The Prime Minister suggested that the tax rebate could cause a 25 to 50 percent increase in transit ridership (CBC, 2005). However, based on studies of transportation demand, this seems very unlikely. Most research shows that (1) the own-price elasticity for public transit is fairly small, with most estimates about -0.15 to -0.2, (2) the demand for public transit is much more sensitive to increases in prices than to decreases in prices, and (3) the cross-price elasticity of passenger vehicle use with respect to transit price is much less than 0.1 (Cervero, 1990; Elgar and Kennedy, 2005).

These "price elasticity" values mean that decreases in the price of public transit are unlikely to stimulate increases in public transit use by regular public transit users or mode switching from private vehicles to public transit. Based on these elasticity estimates and on travel data from Statistics Canada, we estimate that the transit credit is likely to reduce emissions by only about 70 kt CO₂ equivalent (CO₂e) in 2006 and 145 kt CO₂e in 2007 and subsequent years, at a cost (in terms of lost government revenue) of over \$100 million per year. This means

⁸ The most recent summary of this modeling approach is provided in a special issue of *The Energy Journal*, the top international energy-economy journal. For an overview, see Hourcade et al., 2006.

that the cost per unit of emissions reduction would exceed \$1,000 per tonne CO₂e. The high cost and limited environmental impact of the policy result from the fact that almost all of the tax credit is provided to those who were already regular transit users (“free riders”), with very limited shifting from private vehicles to public transit resulting from policy implementation.

Renewable Fuel Standard: Like the public transit tax credit, the renewable fuel standard was a campaign promise to mandate a minimum renewable fuel content in gasoline (minimum 5 percent renewable content by 2010) and diesel (minimum 2 percent renewable content by 2012). The environmental impact of renewable fuels like ethanol and biodiesel depends on how they are produced – the source of biomass as well as the refining process that turns the biomass into fuel. For grain-based ethanol, which is likely to make up most of the renewable fuel volume for the near future, significant amounts of both natural gas (for fertilizer production) and diesel (for farm machinery) are used to grow the feedstock. To turn the grain into fuel, a large amount of energy is required for fermentation and heating. The energy required in biofuel refineries can come from several sources. Electricity can be used, but electricity is generally more costly than most other fuels. Natural gas can also be used, but gas prices are high and have been extremely volatile recently, discouraging their use.

It is quite possible that industry will turn to coal to provide power for biofuel refineries, as is being done in the US, where most of the new biofuel refineries being planned for development will burn coal (Clayton, 2006). Coal releases about twice the GHGs as natural gas to produce a similar amount of energy. Farrell et al. (2006) show that grain ethanol refined using coal actually produces more GHGs than gasoline, even when the emissions required to extract and process the gasoline are accounted for. As a result, the net impact on GHG emissions from the renewable fuels mandate is likely to be limited, at least until new processes for producing biofuels are developed and widely applied. Using the EBAMM model developed at the University of California, Berkeley (Farrell et al., 2006), we estimate that the renewable fuel standard will reduce emissions by about 1 Mt CO₂e relative to business-as-usual by 2010. We assume that the same standard is maintained to 2050, so that the emissions reductions increase to about 2 Mt annually over the period. This policy directly overlaps with the forthcoming vehicle efficiency regulations (described below), which reduces the effectiveness of each policy on its own.

Phase II – The EcoENERGY Policies

EcoENERGY Technology Initiative: This research and development program provides about \$57 million annually over four years to stimulate basic research and development of clean energy technologies. Although some public research effort is probably warranted in a serious climate change plan, it is unlikely that

this amount of funding will lead to significant GHG reductions. Most energy R&D is global in nature (products of innovation spill easily between borders), and this initiative represents much less than one percent in global public R&D investment for energy (Stern et al., 2006, p.353). In addition, most of the funding is not “new” money, but is reallocated from existing public technology funding, so that the total increase in global public energy R&D funding represented by this initiative is likely on the order of one tenth of one percent or less.

Yet another consideration is that there are already technologies available to reduce GHGs. Thus, it is highly unlikely that R&D alone will produce market-ready technologies that will be profitable even when fossil fuel users can still use the atmosphere as a free dumping ground for CO₂. It is our view that a prudent assessment would only accord a negligible amount of GHG emissions reduction to this program. In our assessment, we assume that the funding is maintained at the current level through 2050, and that one Mt of emissions is reduced for every \$50 million spent. This is based on our work on the cost of emissions reductions in Canada (using CIMS), and may overstate significantly the effectiveness of an R&D program.

EcoENERGY Efficiency Initiative: This is primarily a subsidy program built on previous government programs that provide grants and rebates to home and small business owners who retrofit their buildings for improved energy efficiency. The total program funding is \$300 million over four years, with \$220 million earmarked for building retrofit incentives. As with any subsidy program, a substantial share of the recipients will be free riders. As a result, this policy is likely to be quite costly compared to the amount of GHG emissions reduced. Notably, the Commissioner on the Environment and Sustainable Development estimated that the very similar Liberal policy called EnerGuide for Houses spent \$104 million for GHG reductions of only 0.7 Mt CO₂ (Canada, 2006b, ch.3, p. 15-18). Much of the money spent on the program went to program administration (25 percent was spent on government administration, a further 40 percent was spent on audits, only 35 percent was spent on energy efficiency grants). Other EcoENERGY Efficiency Initiatives primarily involve information programs for buildings and fleet operators, with the usual problems of effectiveness when emitting to the atmosphere is still free in a market economy. Assuming a similar cost effectiveness as for the previous EnerGuide for Houses program, we calculate that the EcoENERGY Initiative will reduce emissions by about 0.5 Mt CO₂e relative to the business-as-usual scenario in 2010. With continued funding, we calculate that the program will result in annual reductions of about 4.5 Mt by 2050.

EcoENERGY Renewable Initiative: This is a continuation of the previous government’s policy which provides a 1¢/kWh subsidy for 10 years for

renewable power projects, with a total program budget of \$1,480 million over four years (although funds will continue to be disbursed following the program completion). As a subsidy program, it is vulnerable to free-riders, which are likely to be quite prevalent in this case since renewable power is aggressively pursued by both electricity agencies (Hydro-Quebec aims to develop 3,500 MW of wind power, and the Ontario Power Authority has a “standard offer” for renewable electricity projects) and by the provinces (British Columbia requires that 90 percent of electricity generation be clean or renewable). As a result, developers that would have built the projects even in the absence of the subsidy likely capture much of the federal subsidy. A much smaller component of the Renewable Initiative is a \$36 million (over four years) program to provide grants for installation of commercial renewable heating systems. Using the CIMS model, we calculate that the EcoENERGY Renewable Initiative will reduce emissions by about 3 Mt CO₂e in 2010 relative to the business-as-usual scenario. With continued funding, we calculate that the program will result in annual emissions reductions of about 10 Mt by 2050.

EcoTRANSPORT Initiatives: One new program is a feebate program for passenger vehicles, called the EcoAUTO program. The feebate consists of a fee on inefficient vehicles, coupled with a rebate on efficient vehicles, and is designed to encourage buyers to choose vehicles that are more efficient. In general, feebates have been supported by researchers because they can change the real costs facing decision makers and hence their technology choices, just like a GHG tax or a regulation (Greene et al., 2005). However, the EcoAUTO policy does not apply to the majority of vehicle models. Of the 1,040 vehicle models available in 2007, only 17 would qualify for a rebate of \$1,000 or \$2,000, and about 150 models will be assessed a green levy ranging from \$1,000 to \$4,000 (trucks and sport utility vehicles are exempt from the green levy). The other EcoTRANSPORT policies are information programs that largely existed before the current government. Based on analysis that was conducted for the National Round Table on the Environment and the Economy (Marbek Resource Consultants et al., 2006), we estimate that this policy will reduce emissions by at most 1 Mt CO₂e relative to the business-as-usual scenario in 2010. The effectiveness of this policy is limited in part because the federal government has also announced minimum efficiency standards for vehicles (to be discussed in the following section), as well as a renewable fuels standard (discussed above). Since all of these policies overlap, their combined effectiveness is less than the sum of what each might attain on its own.

EcoAGRICULTURE Initiatives: The EcoAGRICULTURE Initiative consists of several agricultural subsidies and information programs with a total value of about \$125 million annually over four years. Most of the funding is designed to stimulate new supply of biofuel feedstock for renewable fuels like ethanol and

biodiesel, and so the policy complements the Renewable Fuels Standard announced in 2006. Greenhouse gas reductions resulting from the use of ethanol and biodiesel are accounted for under that policy, so we do not allocate any GHG reductions to this policy.

Canada EcoTrust: The EcoTrust policy reincarnates the previous Opportunities Envelope program and the Partnership Fund, and represents about \$500 million of funding annually over three years (Canada, 2007b, 136). The policy is designed to subsidize climate change efforts in the provinces and territories. To the extent that the subsidies are directed to initiatives that improve the prospects for GHG reduction actions, it may have some long-term effect. For example, it may contribute to the development of additional hydrogen refueling stations in B.C. or a high voltage electricity transmission line that would enable Ontario to access hydropower generated electricity in neighbouring provinces. But to assess the net effect of these zero-emission energy supply initiatives it is necessary to estimate the amount by which they reduce or prevent GHG-emitting activities. This depends on estimating the net impact of several interactive effects. The production of hydrogen for fuel cell cars could actually increase GHG emissions if the hydrogen is produced from fossil fuels without carbon capture and storage, and this is likely if there is not a significant charge on GHG emissions. The production of zero-emission electricity for Ontario (from hydropower projects in Manitoba and/or Quebec) might be good news for inter-provincial trade, but might not have a significant effect on electricity generation emissions if other policies are already pushing Ontario to reduce its GHG emissions from this sector. We estimate the effectiveness of the EcoTrust policy using CIMS, and assume that 50 percent of the subsidy is captured by free-riders. This leads us to estimate that the EcoTrust program will likely reduce emissions by around 5 Mt CO₂e annually by 2010. With continued funding at current levels, we anticipate that this program could reduce annual emissions by about 30 Mt by 2050 compared to the business-as-usual scenario.

Phase III – New Regulatory Framework for Air Emissions

Passenger Cars and Trucks: The federal government's April regulatory agenda stated that new regulations would be forthcoming for passenger cars and trucks in 2011. The specific level of the regulations is not clear, although they will be "benchmarked against a stringent, dominant North American standard" (Canada, 2007, 5). The most stringent North American standard for new vehicles, which was recently announced by California, requires a 22 percent improvement in GHG intensity of new vehicles by 2012 and a 30 percent improvement by 2016. Because the government has not stated explicitly that it will adopt the California standard, it is difficult to know which standard to assume for Canada. Usually governments have done less than promised when it

comes to GHG policy. Nonetheless, in this case we have decided to assume that Canada will adopt the California standard, and will continually tighten vehicle efficiency regulations by 2 percent per year after 2015, such that by 2050 new vehicles are required to be more than twice as efficient as today's new vehicles. This policy, which is regulatory in nature, is likely to reduce emissions significantly. Our estimate shows that emissions in 2015 will be 9 Mt CO₂e below business-as-usual emissions because of the policy. By 2050, we calculate that the policy will have reduced emissions by almost 45 Mt relative to business-as-usual levels.

Energy-Using Products: The government's regulatory agenda also promised several new regulations governing the energy consumption of equipment used in houses and buildings. Included in the promised regulations are updates to 10 currently regulated products and new regulations for 18 currently unregulated products. The federal government has developed and updated energy efficiency regulations for dozens of products since 1992 (when the *Energy Efficiency Act* was introduced). While the past regulations have undoubtedly reduced energy consumption and GHG emissions in the commercial and residential sectors, overall growth has swamped improvements in efficiency, so that energy use has grown by about 1 percent per year in the residential sector, and 3 percent per year in the commercial sector (Canada, 2006, pp. 23 and 49). In the absence of detailed information from government, we assume that this relationship between regulations and overall energy demand growth will continue. We estimate that the total incremental emissions reductions as a result of this policy will be about 1.5 Mt CO₂e in 2010, increasing to about 3 Mt in 2050. While this policy will likely reduce electricity consumption by a significant amount, at least 75 percent of the electricity generated in Canada (hydro, nuclear, and wind) produces no greenhouse gas emissions.

Large Industrial Emitters: The most important policy in the new regulatory framework targets the large industrial emitters – about 700 firms in the oil and gas, manufacturing, electricity generation, and mining sectors that produce about half of the country's GHG emissions. The policy, which is similar but somewhat more aggressive than a policy that the Liberals had been negotiating since about 2000, requires reductions in the GHG intensity of production from each industrial sector of 18 percent by 2010 and a further 2 percent per year until 2015 (all with reference to 2006 levels).

If it is aggressive enough, an intensity target can reduce absolute emissions. If GHG per tonne of steel must fall by 2 percent per year and steel production only grows by 1 percent per year, then emissions from this sector will fall by 1 percent per year. Given historic and projected growth rates for the large final emitters in Canada, it appears that absolute emissions will fall for the next

four years with the requirements in this policy. However, while the government links this policy to its 2020 target of a 20 percent reduction throughout the economy, the policy is silent on the intensity reductions for industry after 2015. For the purposes of this study, we have assumed that the 2 percent rate of intensity reduction would be maintained indefinitely. As with vehicles, we may be overestimating the future stringency of government policy, and thus our estimates of emissions reductions may be too high.

In any case, the long-run effect of the large final emitters policy is difficult to assess because of several flexibility conditions. Depending on their attractiveness relative to the alternatives, Canadian industry may undertake little or no in-house emissions reductions. We describe below the assumptions we made about each of these flexibility conditions in order to generate our simulation of the government's complete slate of GHG emissions reduction policies.

First, large final emitters can claim credit for total reductions of 15 million tonnes between 1992 and 2006 ("early action"), as verified by an independent review. We assume that all of this amount will be allocated, meaning that industrial emissions intensity from 2008 will not actually fall by the percentages announced in the policy.

Second, industries whose emissions are deemed unavoidable because there is currently no technological means of reducing them will be exempted from the reduction obligations. This group represents about 10 percent of industrial emissions. We assume that this will stay approximately the same.

Third, over the next decade large final emitters have the option of simply paying government for any emissions that exceed their intensity reduction requirements. This money goes into a "technology fund," which will be spent on projects that may reduce the costs of future emissions reductions, say by building a CO₂ pipeline for carbon capture and storage or a long distance electricity transmission line for accessing hydropower and other renewables in neighbouring provinces. In 2010, firms can meet 70 percent of their regulatory obligation in this way, but this adjusts gradually downward to 0 in 2018. At the same time, the payment per tonne starts at \$15 in 2010, climbs to \$20 by 2013 and rises at the rate of inflation after that. In effect, this is short-term relief for large final emitters, which allows them to pay taxes instead of cutting emissions, with the idea that the government revenue will be used to provide infrastructure that lowers the costs of future emissions reductions. But these are not current emission reductions. They are potential future emission reductions. There is no way of knowing if \$15 per tonne for 100 tonnes of excess emissions in 2010 will result in 100 tonnes of emissions reductions in 2020. We have assumed that only 50 percent of the permits bought by industry actually result in emissions

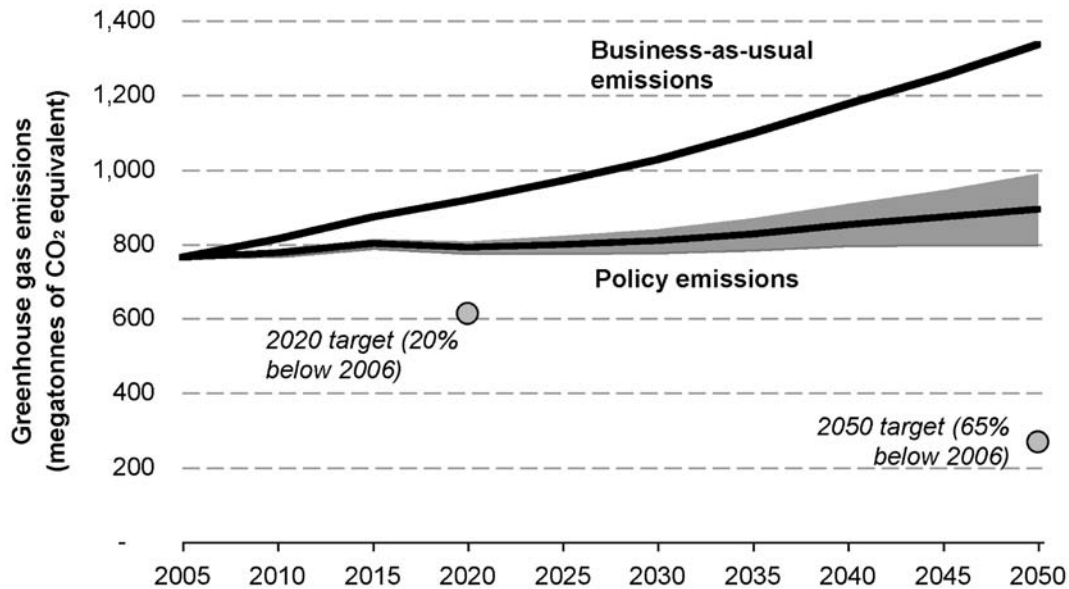
reductions. Given the burden of administration and free-ridership, this is likely a generous estimate.

Fourth, large final emitters can instead subsidize others to reduce emissions, in Canada or abroad. This is by far the most significant of the flexibility provisions in that it could potentially result in industry achieving almost no emissions reductions itself while instead paying for apparent reductions elsewhere in Canada and to a minor extent abroad (10 percent of payments can go to other countries through what is called the Clean Development Mechanism of the Kyoto Protocol). These payments would be in the form of subsidies from Canadian industries to others who appear to be reducing their emissions through changes in behaviour or technology. But this means that this policy is encumbered with the very flaws that have rendered past subsidy programs so ineffective at reducing GHG emissions. It is virtually impossible to separate free-riders from legitimate reductions in GHG emissions. Moreover, there is no negative incentive to slow or arrest the development of new GHG-emitting technologies in the sectors whose GHG emissions are not capped by regulation or penalized by financial penalty. These include to some extent residences, institutions, office buildings, light industry, personal transportation, freight transportation, agriculture, and forestry. Based on the structure of the regulatory framework, and based on our assumptions, we use the CIMS model to calculate that the policy would likely reduce emissions by about 16.5 Mt CO₂e by 2010 and by about 285 Mt CO₂e by 2050, relative to the business as usual scenario.

Estimating Total Emissions

Figure 2 shows our best estimate of the likely evolution of Canadian GHG emissions under the slate of policies introduced by the Canadian government during the period 2006-2007. As noted throughout, this estimate reflects considerable uncertainty over the 2020 timeframe and even greater uncertainty over the 2050 timeframe. Significantly, we assumed that the government would continue the 2 percent per year emission intensity reduction for large final emitters from 2015 all the way through to 2050, even though it has not announced this. We also assumed that the government would adopt the California vehicle regulations and continue to tighten these aggressively, even though it has not announced this.

Figure 2: Forecast of Canada's Greenhouse Gases Under Federal Government Policies



Source: Authors' calculations.

Some of our other assumptions are uncertain by virtue of the imperfect knowledge that energy-economy modelers have about the responsiveness of businesses and households to policies that affect the cost of emitting GHGs, but do not physically set a total limit on emissions (the outcome of an economy-wide emissions cap, in contrast, is easy to model). As is standard practice among modelers, we adjusted the key parameters of the model to reflect this uncertainty and executed multiple runs in order to generate a probability distribution of outcomes. The grey band around our central forecast in Figure 2 reflects this probability distribution. It shows that emissions in 2050 could range from 800 to 1,000 Mt of CO₂, given the policy assumptions and uncertainties in our modeling exercise.

We summarize the salient points from our research.

(i) Our assessment shows that the 2006-2007 policies of the Canadian government will not reach its stated emissions targets for 2020 and 2050. The total of 116.5 megatonnes of CO₂ equivalent in 2020 is far less than the 300 megatonne reduction required for the government to reach its 20 percent reduction target (Table 1).

Table 1: Estimated Emissions Reductions by Policy

	Estimated Domestic GHG Reduction in 2020 Compared to BAU ^a	Estimated Domestic GHG Reduction in 2050 Compared to BAU
<i>Phase I</i>		
Public Transit Tax Credit	0.1 Mt	0.1 Mt
Renewable Fuel Standard	0.8 Mt	1.7 Mt
<i>Phase II</i>		
EcoENERGY Technology	1.1 Mt	8.0 Mt
EcoENERGY Efficiency	1.5 Mt	4.5 Mt
EcoENERGY Renewable	5.6 Mt	10.0 Mt
EcoTRANSPORT	1.2 Mt	2.2 Mt
EcoAGRICULTURE ^b	-	-
EcoTRUST	15.0 Mt	30.0 Mt
<i>Phase III</i>		
Large Industrial Emitters ^c	74.7 Mt	283.9 Mt
Passenger Vehicles	14.8 Mt	44.6 Mt
Energy-using Products	1.7 Mt	2.6 Mt
Total	116.5 Mt	387.6 Mt

a BAU stands for business-as-usual

b No GHG reductions are assigned to EcoAGRICULTURE policies that encourage renewable fuel production. Reductions are accounted for under Renewable Fuel Standard.

c GHG reductions for Large Industrial Emitter policy include domestic offset credits.

(ii) The government's 2006-2007 policies are an apparent improvement on previous policies in that the intensity reductions on industrial emissions are potentially greater (depending on the flexibility provisions) and there is an expectation of fully regulating vehicle GHG emissions. However, the regulation on industrial emissions allows industries to forego emissions reductions and instead pay subsidies to firms and households in the unregulated sectors of the economy. These subsidies will have a significantly weakened effect, as evidenced by past subsidy programs, because it is impossible to prevent free-riders — people receiving the subsidy for GHG reductions they would have undertaken anyway — and the subsidy budget can never be large enough to influence more than a small percentage of GHG emitting market activity.

(iii) This study is limited to assessing policy effectiveness and thus does not include an estimation of costs to the economy. In future analyses, we expect to assess the costs of the government's policies alongside alternative policies. The challenge for policymakers is to design policies that are effective at the lowest possible costs. Preliminary analysis suggests that the government's current policies — which will fail to meet its 2020 and 2050 targets — will incur costs to the GDP comparable to those of more effective policies that would actually achieve its targets. Costs imposed by an economy-wide GHG tax, or an economy-wide emissions cap, would not be substantially different.

References

- Bataille, C., Jaccard, M., Nyboer, J., and Rivers, N. 2006. "Towards General Equilibrium in a Technology-rich Model with Estimated Behavioural Parameters." *The Energy Journal*, Special Issue on Hybrid Modeling of Energy-Environment Policies: 93-112.
- Canada, 2006. "Energy Use Data Handbook: 1990 and 1998 to 2004." Ottawa: Natural Resources Canada.
- Canada. 2006b. "Report of the Commissioner of the Environment and Sustainable Development to the House of Commons," Ottawa: Office of the Auditor General of Canada.
- Canada. 2006c. "National Inventory Report: 1990-2004." Ottawa: Environment Canada.
- Canada. 2007. "Regulatory Framework for Air Emissions." Ottawa: Environment Canada.
- Canada. 2007b. "Budget 2007: Aspire to a Stronger, Safer, Better Canada." Ottawa: Department of Finance Canada.
- Canada. 2007c. "Clean Air Regulatory Agenda: Regulatory Framework for Industrial Air Emissions." Ottawa: Environment Canada, In-depth Technical Briefing, April 30th, May 1st, and 2nd, 2007.
- Canadian Broadcasting Corporation [CBC]. 2005. "Harper Promises Public Transit Tax Break," Thursday, December 29, 2005. Accessed at

- http://www.cbc.ca/news/story/2005/12/29/elxn_tory_transit051229.html on May 10, 2007.
- Cervero, R. 1990. "Transit Pricing Research: A review and synthesis." *Transportation* 17: 117-139.
- Clayton, M. 2006. "Carbon Cloud Over a Green Fuel." *Christian Science Monitor*, March 23, 2006.
- Elgar, I., Kennedy, C. 2005. "Review of Optimal Transit Subsidies: Comparison Between Models." *Journal of Urban Planning and Development*, 131(2): 71-78.
- Farrel, A., Plevin, R., Turner, B., Jones, A., O'Hare, M., Kammen, D. 2006. "Ethanol Can Contribute to Energy and Environmental Goals." *Science*, 311: 506-508.
- Fischer, C. and Newell, R. 2004. "Environmental and Technology Policies for Climate Change and Renewable Energy." Resources for the Future Discussion Paper, 04-05.
- Greene, D., Patterson, P., Singh, M., and Li, J. 2005. "Feebates, Rebates, and Gas Guzzler Taxes: A Study of Incentives for Increased Fuel Economy." *Energy Policy*, 33: 757-775.
- Hourcade, J-C., Jaccard, M., Bataille, C. and Gherzi, F. 2006. "Hybrid Modeling, New Answers to Old Challenges: Introduction to the Special Issue of the Energy Journal." *The Energy Journal*, Special Issue, 1-12.
- Intergovernmental Panel on Climate Change [IPCC]. 2007. "Working Group III Contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report: Mitigation of Climate Change. Summary for Policy Makers." Geneva: World Meteorological Organization/United Nations Environment Program.
- Jaccard, M. 2006. *Sustainable Fossil Fuels: The Unusual Suspect in the Quest for Clean and Enduring Energy*. Cambridge, UK: Cambridge University Press.
- Jaccard, M., Rivers, N., and Horne, M. 2004. *The Morning After: Optimal Greenhouse Gas Policies for Canada's Kyoto Obligations and Beyond*. C.D. Howe Institute Commentary 197.
- Jaccard, M., Rivers, N., Bataille, C., Murphy, R., Nyboer, J., and Sadownik, B. 2006. *Burning our Money to Warm the Planet: Canada's Ineffective Efforts to Reduce Greenhouse Gas Emissions*. C.D. Howe Institute Commentary 234.
- Loughran, D. and Kulick, J. 2004. "Demand Side Management and Energy Efficiency in the United States." *The Energy Journal*, 25(1), 19-43.
- Marbek Resource Consultants, Resources for the Future, and DesRosiers Automotive Consultants. 2005. "Development of Options for a Vehicle Feebate in Canada," Report Prepared for the National Roundtable on the Environment and the Economy.
- Stavins, R. N. 2001. "Experience with Market-based Environmental Policy Instruments." in Maler, K.-G. and Vincent, J. (eds.), *The Handbook of Environmental Economics*. Amsterdam: North-Holland/Elsevier Science.
- Stern, N. et al. 2006. "Stern Review on the Economics of Climate Change." HM Treasury, London.