climate leadership, economic prosperity

FINAL REPORT ON AN ECONOMIC STUDY OF GREENHOUSE GAS TARGETS AND POLICIES FOR CANADA

the PEMBINA institute
Sustainable Energy Solutions

David Suzuki Foundation
SOLUTIONS ARE IN OUR NATURE

Climate Leadership, Economic Prosperity: Final report on an economic study of greenhouse gas targets and policies for Canada

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The Pembina Institute and the David Suzuki Foundation remain solely responsible for the contents of this report.

Notice – Position of the David Suzuki Foundation

In many instances the technology choices exhibited in this report reflect the outcomes produced by the CIMS model in response to the application of a stringent, economy-wide carbon price. Likewise, some of the policy choices have been constrained by the model. Accordingly, it should be noted that the technology and policy choices in this report only represent some of the potential scenarios for achieving a GHG emission reduction target in 2020, and should not be construed as a specific endorsement of each of these technologies and policies by the David Suzuki Foundation.

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CONTENTS

Executive Summary

There is now a broad scientific consensus that more than 2°C of average global warming above the pre-industrial level would constitute a dangerous level of climate change. The Intergovernmental Panel on Climate Change, the world's leading climate science body, has shown that to have a chance of not exceeding the 2°C limit, industrialized countries need to reduce their combined emissions of greenhouse gases (GHGs) to 25–40 per cent below the 1990 level by 2020, if they are to make a fair contribution to the necessary cuts in global emissions.

The Government of Canada's current GHG target of 20 per cent below the 2006 level by 2020 is a much more modest reduction of just three percent relative to the 1990 level. However, as it is the government's current commitment, it is important to understand what policies would be needed to achieve this target.

The Pembina Institute and the David Suzuki Foundation therefore commissioned the leading economic modelling firm M.K. Jaccard and Associates Inc. to conduct an in-depth study of federal and provincial government policies to allow Canada to meet a "2°C target" to reduce GHG emissions to 25 per cent below the 1990 level by 2020, based on the science outlined above, as well as the federal government's current target.

The analysis shows that with strong federal and provincial government policies, Canada can meet the 2°C emissions target in 2020 and still have a strong growing economy, a quality of life higher than Canadians enjoy today, and continued steady job creation across the country.[1] The analysis also shows that the federal government needs to implement far stronger policies than it has proposed to date to meet its current GHG target.

Meeting either target requires governments to put a significant price on GHG emissions (a "carbon price") broadly across the economy, and to back it up with strong complementary regulations and public investments. In this analysis, to meet the 2°C target, a carbon price starting at $50 per tonne[2] in 2010 needs to rise to $200 per tonne by 2020. To meet the government's target, a carbon price starting at $40 per tonne in 2011 needs to rise to $100 per tonne by 2020.

Canada's GDP is projected to grow 23 per cent between 2010 and 2020, or an average of 2.1 per cent annually, while meeting the 2°C emissions target. By comparison, under business as usual

conditions, Canada's GDP is projected to grow 27 per cent between 2010 and 2020, or an average of 2.4 per cent annually, with GHG emissions in 2020 rising to 47 per cent above the 1990 level. GDP growth rates vary significantly among regions, as is the case under business as usual. The urgent need to address the enormous GHG emissions from the coal-fired electricity and petroleum sectors in Alberta and Saskatchewan accounts for reductions in the projected rates of growth in these provinces. Under the government's target, Canada's GDP is projected to grow 25 per cent between 2010 and 2020, or an average of 2.2 per cent annually.

It is important to note that business as usual involves extraordinary costs. In his 2006 review of the economics of climate change, former World Bank chief economist Sir Nicholas Stern estimated that the "costs and risks" of uncontrolled climate change are equivalent to a loss in global GDP of at least 5 per cent and up to 20 per cent or more, "now and forever."[3]

The total number of jobs in Canada is projected to grow 10.7 per cent between 2010 and 2020, with almost 1.86 million net new jobs created over this period, while meeting the 2°C emissions target. Under the government's target, the total number of jobs is projected to grow 11.0 per cent between 2010 and 2020, with almost 1.91 million net new jobs created over this period. By comparison, under business as usual conditions, 1.80 million net new jobs are projected to be created over the same period. The robust rate of job creation when meeting the GHG reduction targets is a result of using carbon pricing revenue to reduce the rate of personal income tax.

The analysis shows that the most important technological approaches needed to achieve major reductions in Canada's GHG emissions are

- capture and storage of carbon dioxide from the oil and gas industry and power plants
- reduction of "fugitive" emissions from the oil and gas industry and from landfills
- increased energy efficiency throughout the economy (e.g., in vehicles and buildings)
- increased production of renewable energy (e.g., wind power accounts for 18 per cent of electricity generated in 2020 when meeting the 2°C target)
- replacement of fossil fuels by cleaner electricity (e.g., for heating buildings).

In this study the federal government invests in substantial volumes of international emissions reductions to meet either of the two targets, thereby lowering the cost of meeting them. For example, if Canada purchased no international reductions, the carbon price would need to reach $145 per tonne by 2020 to meet the government's target. It is important to recognize that genuine GHG reductions have the same global environmental benefit wherever they occur. It is also noteworthy that the U.S. is currently contemplating a massive reliance on international emission reductions under the American Clean Energy and Security Act of 2009 ("Waxman-Markey"), passed by the House of Representatives in June.

Under the carbon pricing policy modelled in this study, emitters pay for every tonne they emit, either by purchasing emission allowances auctioned by government in a cap-and-trade system, or by paying an emissions tax. Almost half of this revenue is returned to Canadians in the form of reductions in the rate of personal income tax. Smaller portions are used to fund public investments to reduce GHG emissions, to make payments to individuals to compensate regional variations in household energy cost increases, and to protect the international competitiveness of the most vulnerable manufacturing sectors. The resources available for this project unfortunately did not allow us to model explicit measures for low income earners, although they receive significant protection from the payments to individuals.

Introduction

There is now a broad scientific consensus that more than 2°C of average global warming above the pre-industrial level would constitute a dangerous level of climate change. The Intergovernmental Panel on Climate Change, the world's leading climate science body, has shown that to have a chance of not exceeding the 2°C limit, industrialized countries need to reduce their combined emissions of greenhouse gases (GHGs) to 25–40 per cent below the 1990 level by 2020, if they are to make a fair contribution to the necessary cuts in global emissions.

In Canada, achieving emission reductions on this scale is a major national task: it means that a decade from now we need to be well on the way to a transformation in the ways we produce and use energy. It is critical that we understand the policies needed to get there because the business as usual scenario of uncontrolled global warming will involve extraordinary costs for people, the environment and the economy.

The Government of Canada's current GHG target of 20 per cent below the 2006 level by 2020 is a much more modest reduction of just three percent relative to the 1990 level.[4] However, as it is the government's current commitment, it is important to understand what policies would be needed to achieve this target.

The Pembina Institute and the David Suzuki Foundation therefore commissioned the leading economic modelling firm M.K. Jaccard and Associates Inc. (MKJA) to conduct an in-depth study of federal and provincial government policies to allow Canada to meet one of two GHG targets:

- a "2°C target" of 25 per cent below the 1990 level by 2020, based on the science outlined above
- the federal government's current target of three per cent below the 1990 level by 2020

There is now a broad scientific consensus that more than 2°C of average global warming above the pre-industrial level would constitute a dangerous level of climate change.

The two packages of policies that we chose to model, one for each target, reflect the expert consensus that an effective and economically efficient national plan to achieve substantial GHG reductions must combine

- a policy that puts a significant price on GHG emissions (a "carbon price") broadly across the economy – this can be a cap-and-trade system or an emissions tax
- complementary regulations and public investments to expand green infrastructure and the use of clean technology.

Our policy packages also address several commonly expressed concerns by using revenue from carbon pricing to compensate disproportionate increases in household energy costs in targeted regions, limit inter-regional financial flows, and protect the international competitiveness of vulnerable manufacturing sectors. In addition, domestic action is complemented by significant government investments in international emission reductions to meet either target.

Our policy packages also address several commonly expressed concerns by using revenue from carbon pricing to compensate disproportionate increases in household energy costs in targeted regions, limit inter-regional financial flows, and protect the international competitiveness of vulnerable manufacturing sectors.

The study uses two economic models known as CIMS and R-GEEM. CIMS contains a detailed database of technologies relevant to GHG emissions, and simulates firms' and individuals' choices of technologies based on studies of real-world behaviour. CIMS has been widely used by the governments of Canada, Alberta and other provinces. R-GEEM is used to study "macroeconomic" quantities such as GDP and employment.

This summary report presents the most significant findings from the study; the full technical report by MKJA is available separately.[5] We also published preliminary results for the 2°C target only in December 2008.[6] The final study described here takes account of the extra year's delay in initiating policies, and adds: new public investment programs; regional results; details of the contribution of individual policies and technologies; refinements to the economic models; and the federal government's target.

Section 1 presents key projected economic effects of meeting the targets. Section 2 describes in more detail the federal and provincial policies required to meet the targets. Section 3 outlines what climate science indicates is necessary in setting Canadian and international GHG targets.

1. Economic Modelling Results

The analysis by M.K. Jaccard and Associates shows that with strong federal and provincial government policies, Canada can meet the 2°C emissions target in 2020 and still have a strong growing economy, a quality of life higher than Canadians enjoy today, and continued steady job creation across the country.

The analysis shows that a significant price on GHG emissions applied across the entire economy, combined with strong complementary regulations and public investments, will enable Canada to reduce its net[7] emissions to 25 per cent below the 1990 level by 2020. We assume the carbon price starts at $50 per tonne[8] in 2010; it then needs to rise to $125 per tonne by 2015 and $200 per tonne by 2020. (The anticipated carbon price also affects decisions taken earlier; in the analysis the price continues to rise after 2020.)

The analysis also shows that the federal government needs to implement far stronger policies than it has proposed to date, even to meet its current target to reduce Canada's emissions to three per cent below the 1990 level by 2020. The analysis of the government's target assumes complementary regulations and public investments that are, for the most part, equally strong as for the 2°C target. Despite this, to meet the government's target, a carbon price starting at $40 per tonne in 2011 needs to rise to $67 per tonne by 2015 and $100 per tonne by 2020.

In this study the federal government purchases international emission reductions to meet both targets (see Section 1.4). If Canada purchased fewer or no international reductions, the carbon prices would need to be higher to compensate. For example, to meet the government's target with no use of international reductions, the carbon price would need to reach $145 per tonne by 2020.

It should be noted that the starting point for the analysis is a business as usual scenario that is merely one plausible view of a future in which governments do not implement policies to cut emissions. If the business as usual scenario were changed, the rates of economic and employment growth reported below would also change, both for the business as usual scenario and the scenarios in which the GHG targets are met.

1.1 Continued economic growth

The analysis shows that Canada's economy is projected to continue growing steadily under the policies needed to meet the 2°C target. With the implementation of our policy package, Canada's GDP is projected to grow 23 per cent between 2010 and 2020, or an average of 2.1 per cent annually, while meeting the 2°C emisssions target. By comparison, under business as usual conditions, Canada's GDP is projected to grow 27 per cent between 2010 and 2020, or an average of 2.4 per cent annually, with GHG emissions in 2020 rising to 47 per cent above the 1990 level. This means that when meeting the 2°C target, Canada's economy in 2020 is 3.2 per cent smaller than under business as usual.

It is important to reiterate that business as usual is very far from cost-free. In his 2006 review of the economics of climate change, former World Bank chief economist Sir Nicholas Stern estimated that the "costs and risks" of uncontrolled climate change are equivalent to a loss in global GDP of at least 5 per cent and up to 20 per cent or more, "now and forever."[9] Governments and business organizations agree that business as usual is not an option when it comes to GHG emissions. Even those reluctant to take action generally acknowledge that Canada must at least follow the U.S. on climate policy.

GDP results, 2°C target

	BC	AB	SK	MB	ON	QC	ATL[10]	CANADA
GDP growth 2010–20	24%	38%	16%	22%	21%	14%	30%	**23%**
Average GDP growth per year	2.2%	3.3%	1.5%	2.0%	1.9%	1.3%	2.7%	**2.1%**
GDP in 2020, relative to business as usual	–4.8%	–12.1%	–7.5%	+2.1%	0.0%	–1.3%	–1.9%	**–3.2%**

Growth rates vary significantly among regions, as is the case under business as usual. The urgent need to address the enormous GHG emissions from the coal-fired electricity and petroleum sectors in Alberta and Saskatchewan accounts for the reductions in the projected rates of growth in these provinces. There is, however, continued expansion of oil sands operations in Alberta, but it occurs with large-scale use of carbon capture and storage. It should also be noted that Alberta's per capita GDP continues to be much higher than that of any other region, and Saskatchewan's per capita GDP stays close to the Canadian average.

GDP per capita in 2020 (2005 dollars), 2°C target

BC	AB	SK	MB	ON	QC	ATL	CANADA
$42,400	$65,200	$45,100	$42,200	$47,100	$39,500	$39,300	**$45,900**

Under the policies modelled all economic sectors experience an increase in output between 2005 and 2020, except for petroleum refining and natural gas extraction.

The analysis of the federal government's target for 2020 shows that Canada's economy would continue to grow only slightly more quickly than under the 2°C target. With the implementation of our policy package, Canada's GDP is projected to grow 25 per cent

between 2010 and 2020, or an average of 2.2 per cent annually. This means that when meeting the government's target, Canada's economy in 2020 is 1.5 per cent smaller than under business as usual. At the regional level, Alberta has faster growth under the government's target, with more rapid oil sands development and less use of expensive carbon capture, relative to the 2°C target. However, petroleum refining and natural gas extraction still experience an absolute decline in output under the government's target.

GDP results, government target

	BC	AB	SK	MB	ON	QC	ATL	CANADA
GDP growth 2010–20	27%	44%	22%	22%	22%	15%	33%	**25%**
Average GDP growth per year	2.4%	3.7%	2.0%	2.0%	2.0%	1.4%	2.9%	**2.2%**
GDP in 2020, relative to business as usual	–2.5%	–8.5%	–2.8%	+2.1%	+0.9%	–0.3%	–0.1%	**–1.5%**

1.2 Continued employment growth

Substantial employment growth continues in all regions and nearly all sectors of the Canadian economy under the policies needed to meet the 2°C target. With the implementation of our policy package, Canada's total number of jobs is projected to grow 10.7 per cent between 2010 and 2020. In absolute terms, almost 1.86 million net new jobs are created over this period while meeting the 2°C emissions target. By comparison, under business as usual conditions, 1.80 million net new jobs are projected to be created between 2010 and 2020. This means that when meeting the 2°C target, Canada's net job creation by 2020 is essentially the same as under business as usual. This is a result of using carbon pricing revenue to reduce the rate of personal income tax, which provides a boost to job creation (see Section 1.6).

Employment results, 2°C target

	BC	AB	SK	MB	ON	QC	ATL	CANADA
Increase in number of jobs, 2010–20	11%	6%	8%	9%	16%	7%	3%	11%
Number of net new jobs, 2010–20	253,000	133,000	43,000	58,000	1,052,000	281,000	37,000	1,857,000
Number of jobs in 2020, relative to business as usual	+0.2%	–3.1%	–0.8%	+1.4%	+1.0%	+1.0%	–0.2%	+0.3%

The analysis of the federal government's target for 2020 shows that employment would again grow at essentially the same rate as under business as usual. With the implementation of our policy package, Canada's total number of jobs is projected to grow 11.0 per cent between 2010 and 2020. In absolute terms, almost 1.91 million net new jobs are created over this period while meeting the government's GHG reduction target.

Employment results, government target

	BC	AB	SK	MB	ON	QC	ATL	CANADA
Increase in number of jobs, 2010–20	11%	8%	10%	9%	16%	7%	3%	11%
Number of net new jobs, 2010–20	264,000	163,000	49,000	58,000	1,049,000	282,000	40,000	1,906,000
Number of jobs in 2020, relative to business as usual	+0.6%	−1.7%	+0.3%	+1.4%	+0.9%	+1.0%	0.0%	+0.5%

1.3 Key emission reduction opportunities

This study reveals the key technological approaches needed to achieve major reductions in Canada's GHG emissions. The most important of these are

- capture and storage of carbon dioxide from the oil and gas industry and power plants
- reduction of "fugitive" emissions from the oil and gas industry and from landfills
- increased energy efficiency throughout the economy (e.g., in vehicles and buildings)
- increased production of renewable energy (e.g., wind power accounts for 18 per cent of electricity generated in 2020 when meeting either of the two targets, compared to less than two per cent now)
- replacement of fossil fuels by cleaner electricity (e.g., for heating buildings).

In the full technical report, tables 26 and 42 show the volume of emission reductions obtained from each of these key technological approaches when meeting each of the two targets; the appendix entitled "Technology Penetration in CIMS" shows the increasing market shares of specific technologies like wind power, public transit or heat pumps between 2010 and 2020.

Substantial employment growth continues in all regions and nearly all sectors of the Canadian economy under the policies needed to meet the 2°C target.

Besides the price on GHG emissions, our policy packages include a series of regulations in areas where overall economic costs are expected to be lower when using mandatory measures rather than carbon pricing alone. For instance, substantial emission reductions are achieved through regulations to require the capture of methane, a potent GHG, from landfills. In our analysis, this simple yet effective measure eliminates the vast majority of Canada's landfill emissions.

Another example is tailpipe GHG regulations to accelerate the application of fuel efficient vehicle technology in the cars Canadians drive. As a result, Canadians will experience a considerable reduction in the amount of money they spend on personal transportation. In this analysis, under the 2°C target, by 2020 Canadians pay $6.7 billion less each year for personal transportation compared to business as usual, despite fuel prices being higher under our policy package. Under the government's target, the figure is $6.5 billion. (This is also due in part to greater use of public transit and shorter commutes.)

The complete set of regulations and public investments is outlined in Section 2. In the full technical report, table 54 shows the volume of emission reductions attributable to each individual regulation or investment when meeting each of the two emissions targets.

1.4 International emission reduction opportunities

Investments by the federal government in emission reduction projects in less wealthy countries can help lower the cost of meeting a national GHG target, while simultaneously helping those countries address climate change. This can be done through the purchase of international emission credits, such as those currently available under the UN's Clean Development Mechanism.

In this study the federal government purchases 80 million tonnes[11] of international reductions annually by 2020 to meet the 2°C target. This means that Canada's *domestic* GHG emissions are reduced to 11 per cent below the 1990 level in 2020, with international reductions used to achieve the remainder of the 25 per cent target. In our analysis the government purchases 56 million tonnes of international reductions annually by 2020 to meet its own current target, which means Canada's domestic emissions are reduced to eight per cent above the 1990 level. Looked at another way, international reductions close one-fifth of the gap between business as usual and the target, for both targets.

To ensure Canada is acquiring credits that are of high environmental quality and represent real emission reductions,[12] we have assumed a relatively high price for them: $75 per tonne by 2020 for the 2°C target and $50 by 2020 for the government's target. These prices are nonetheless lower than the cost of additional domestic emisssion reductions, as indicated by the domestic carbon price.

To ensure Canada is acquiring credits that are of high environmental quality and represent real emission reductions, we have assumed a relatively high price for them: $75 per tonne by 2020 for the 2°C target and $50 by 2020 for the government's target.

The significant reliance on international reductions to meet either target by 2020 is a consequence of the longstanding failure by Canada to take serious action to control its GHG emissions since first committing to do so nearly two decades ago. However, we believe that the responsible solution is not to weaken Canada's targets but rather to recognize that genuine GHG reductions have the same global environmental benefit wherever they occur, and that in the near term Canada can cost-effectively take responsibility for its past domestic failures through international investments. These investments can also create opportunities for Canadian exporters of clean technologies.

It is noteworthy that the U.S. is currently contemplating a massive use of international emission reductions to meet its GHG targets. The American Clean Energy and Security Act of 2009 ("Waxman-Markey"), passed by the House of Representatives in June, mandates the U.S. government to invest, by 2020, in a volume of emission reductions in developing countries equivalent to 12 per cent of U.S. emissions in 1990.[13]

1.5 International competitiveness

This study examined two different scenarios under which Canada could achieve either emissions target in 2020. In the first scenario, "OECD acts together," Canada's OECD trading partners implement GHG emission reduction policies at least as strong as Canada's. If Canada's major trading partners implement similar policies, their costs of production will change by a similar amount to Canada's, reducing the likelihood that customers of Canadian goods will replace their purchases with foreign equivalents.

In the second scenario, "Canada goes further," other OECD countries (including the U.S.) do implement a price on GHG emissions, but Canada's GHG reduction policies are

sufficiently stronger that the country can be considered to be "acting alone." In this scenario the analysis shows some shifting of GHG-intensive activities to other jurisdictions. However, we ensure that no manufacturing sector experiences a decline in output relative to 2008 levels by returning some carbon pricing revenue to producers in proportion to production levels. With the 2°C target, the industrial minerals and metal smelting sectors receive this protection; while with the government's target only the metal smelting sector needs to be protected.

In both international scenarios, developing countries such as China, India and Brazil are assumed to have considerably less stringent GHG reduction policies than OECD countries between now and 2020.

It is noteworthy that the carbon prices required in our analysis to meet either the 2°C target or the government's target are much higher than those currently expected in the U.S. The Waxman-Markey bill (see Section 1.4) is projected to generate a carbon price of just US$16–32 per tonne[14] by 2020.[15, 16] Accordingly, we have chosen to present results in this summary report only for the "Canada goes further" scenario. Results for "OECD acts together" can be found in the full technical report. The differences in results between the two scenarios are generally small, with the notable exception of the two manufacturing sectors mentioned above. Under "OECD acts together," these sectors do not need to receive any carbon pricing revenue to avoid a decline in output.

We ensure that no manufacturing sector experiences a decline in output relative to 2008 levels by returning some carbon pricing revenue to producers in proportion to production levels.

Since the models we have used do not contain an explicit representation of the U.S. economy, the conclusions regarding trade effects should be treated with caution. However, the results in Sections 1.2 and 1.3 above do lend support to the notion that Canada can feasibly implement much stronger GHG reduction policies than the U.S. This study shows that Canada must do so whether it is aiming for the government's target or a more ambitious one.

1.6 Revenue from carbon pricing

Under the carbon pricing policy modelled in this study, emitters would have to pay for every tonne they emit, either by purchasing emission allowances auctioned by government in a cap-and-trade system, or by paying an emissions tax. This would generate considerable government revenue. The analysis shows that the revenue from carbon pricing would be more than $70 billion per year by 2020 under the 2°C target, and over $45 billion per year by 2020 under the government's target.

It is important to note that in our approach, almost half of this revenue is returned to Canadians in the form of reductions in the rate of personal income tax, which provides a boost to job creation and take-home pay. Smaller portions are used to fund public investments to reduce GHG emissions, to make payments to individuals to compensate regional variations in household energy cost increases, and to protect the international competitiveness of the most vulnerable manufacturing sectors (see Section 1.5).

Use of carbon pricing revenue, 2020 (2005 dollars)

	2°C TARGET	GOVERNMENT TARGET
Investments in domestic emission reductions	$10.1 billion	$9.4 billion
Investments in international emission reductions	$6.0 billion	$2.8 billion
Payments to individuals to compensate regional variations in household energy cost increases	$7.1 billion	$4.5 billion
Payments to targeted manufacturing sectors to ensure there are no absolute declines in output	$1.8 billion	$0.1 billion
Expenditure to maintain public services and government transfers to households at business as usual levels[17]	$13.7 billion	$7.5 billion
Reduction in the rate of personal income tax	$33.2 billion	$21.2 billion
Total	**$71.9 billion**	**$45.5 billion**

The payments to individuals fully compensate the projected increases in household energy costs relative to business as usual, which are considerably higher in regions like Alberta and Saskatchewan because they rely most heavily on fossil fuels. The payments also serve to limit the net outflows of carbon pricing revenue from those regions. Payment of a fixed amount per person provides compensation without diluting the incentive to conserve energy, and provides significant protection for low income earners.

Payments to individuals to compensate projected increases in household energy costs, per person in 2020

	BC	AB	SK	MB	ON	QC	ATL	CANADA[18]
2°C target	$68	$940	$737	$42	$93	$30	$196	$191
Government target	$38	$501	$372	$22	$57	$21	$154	$109

2. Federal and provincial government policies required

There is a strong consensus among experts that an effective and economically efficient national plan to achieve substantial GHG reductions must combine

- a policy that puts a significant price on GHG emissions broadly across the economy – this can be a cap-and-trade system or an emissions tax
- regulations and public investments in sectors where the response to the emissions price is hampered by market barriers or market failures, or where it is administratively difficult to implement emissions pricing
- measures to protect people on low incomes from increases in energy costs
- measures to protect industry sectors where a significant portion of production and associated emissions would otherwise relocate to countries with weaker policies.[19]

We believe there is also a need for

- regulations and/or public investments to stimulate more rapid emission reductions during the transitional period when the emissions price is rising to the necessary level.[20]

The packages of policies that we modelled were designed to meet all of these criteria. The resources available for this project unfortunately did not allow us to model explicit measures for low income earners, although they receive significant protection from the fixed payments to individuals to compensate household energy cost increases.

In the following table we provide a complete list of the policies modelled, with brief rationales for each one. Except where noted, all of the policies start in 2011. In part this reflects lead times for implemention, and in part the fact that the CIMS model uses fixed five-year periods for investments, with the next such period being 2011–2015. Carbon pricing is an exception: given the urgency of initiating progress towards the 2°C target, the carbon price is announced and immediately implemented at the beginning of 2010. For the government's target, the carbon price is announced at the beginning of 2010 but only implemented starting in 2011.

Most of these policies could be either federal or provincial. However, we believe that the federal government has a responsibility to take a strong lead on climate change, in which case most of the policies should be implemented at the federal level. For policies that fall under exclusive provincial jurisdiction, we believe the federal government should make their implementation a condition for the transfer of carbon pricing revenue to provinces.

In the full technical report, table 54 shows the volume of emission reductions attributable to each individual policy when meeting the two emissions targets.

Policies modelled in this study

POLICY	RATIONALE
Carbon price: An emissions pricing policy (cap-and-trade system or emissions tax)[21] covering about 80 per cent of national emissions. In the case of cap-and-trade, emitters would have to pay for every tonne they emit, by purchasing emission allowances auctioned by government. (See "public investments of carbon pricing revenue" below for the detailed use of the revenue.) The stringency of the policy increases steadily over time and is announced in advance so that firms and households can plan ahead.	Experts agree that an emissions price is the most important policy to achieve substantial GHG reductions. Auctioning all permits reflects the polluter-pays principle and generates revenues that can be used to finance the public investments outlined later in this table. A steadily rising price allows the economy to adjust.
REGULATIONS:	
Vehicle emission standards: GHG emission regulations for cars and light trucks initially in line with California standards and then gradually tightened.	Increased vehicle efficiency is hampered by significant market barriers. California's are the strongest standards that have been proposed by governments in North America, and they have now been endorsed by the Obama administration.
Building codes: Stronger energy efficiency requirements in building codes for new houses and commercial buildings: new houses 50 per cent more energy efficient than current norms; new commercial buildings built to LEED Gold standard; mandatory electric heating in BC, Manitoba and Québec.	Energy efficiency in buildings is hampered by significant market barriers/failures. BC, Manitoba and Québec produce electricity that is nearly emissions-free and is already routinely used to heat buildings using electric heating including the option of heat pumps.
Appliance efficiency standards: Energy efficiency regulations for major appliances set at the level of the most efficient commercially available models.	Appliance efficiency is hampered by significant market barriers.
Regulations to require the capture of landfill gas	These emissions are difficult to include in a carbon pricing policy because they are difficult to measure. Targeted regulations are therefore preferred.

The federal government has a responsibility to take a strong lead on climate change, in which case most of the policies should be implemented at the federal level.

For policies that fall under exclusive provincial jurisdiction, we believe the federal government should make their implementation a condition for the transfer of carbon pricing revenue to provinces.

Policies modelled in this study *(continued)*

POLICY	RATIONALE
Venting and flaring regulations: Regulations to limit unnecessary venting and flaring emissions from oil and gas production.	These emissions are difficult to include in a carbon pricing policy because they are difficult to measure. Targeted regulations are therefore preferred.
Carbon capture requirement *(2°C target only):* Requirement to capture and permanently store carbon dioxide from all new natural gas processors, coal-fired power plants and oil sands operations, starting in 2016.	In the context of an ambitious GHG reduction target, we consider new fossil fuel developments to be acceptable only if they use carbon capture. Several years' lead time is provided to allow plans for new facilities to be adjusted. Without this regulation, the cost of reducing emissions from new oil sands facilities would lead to an even higher domestic carbon price for other sectors.
Full cost pricing for nuclear power: Requirement that nuclear power producers pay the full estimated cost of waste management, decommissioning and insurance.	Major costs are not currently taken into account in decisions to invest in nuclear power, leading to economic inefficiency in addition to serious environmental and security issues. This measure requires nuclear power to compete fairly with other sources of electricity.
PUBLIC INVESTMENTS OF CARBON PRICING REVENUE:	
Investments in electricity transmission infrastructure: Conversion to smart grids across Canada, new transmission lines within provinces and increased transmission capacity between Québec and Ontario; total investment of $14 billion between 2010 and 2020.	Although the carbon price is high enough to spur a massive increase in the deployment of low-impact renewable electricity production, notably wind power, market failures prevent adequate private investment in the transmission infrastructure needed to capture the full potential of these technologies.
Investments in public transit infrastructure: Expansion of urban transit, mostly rail, across Canada; plus new high speed intercity train systems for Québec City–Windsor, Edmonton–Calgary and Vancouver–Seattle; total investment of $77 billion between 2010 and 2020.	The level of transit investments is not expected to respond efficiently to an emissions price. More convenient transit services can significantly reduce emissions from transportation.
Government purchase of agricultural offsets: Purchase by the federal government of "offset credits" representing emission reductions in the agriculture sector; the government pays a price per tonne equal to the carbon price.	Agricultural emissions are administratively difficult to cover under a cap-and-trade system or emissions tax; purchase of credits is an alternative way to effectively price these emissions. Purchase by government, not the private sector, prevents any weakening of the carbon price applying to other emissions.

Policies modelled in this study *(continued)*

POLICY	RATIONALE
Investments in international emission reductions: Investment by the federal government in emission reduction projects in less wealthy countries.[22] See Section 1.4.	Carefully chosen international investments can have the same environmental benefit as domestic action, while being more cost-effective in the near term; they are also important in helping less wealthy countries address climate change.
Payments to individuals to compensate regional variations in household energy cost increases See Section 1.6.	These payments effectively remove regional variations in household energy cost increases, relative to business as usual, and limit net outflows of carbon pricing revenue in regions like Alberta and Saskatchewan that rely most heavily on fossil fuels.
Payments to targeted manufacturing sectors: Payments proportional to production levels to ensure no manufacturing sector experiences a decline in output relative to 2008 levels. See Section 1.5.	There will be little or no environmental benefit if production and associated emissions relocate to other countries with weaker GHG reduction policies.
Reductions in the rate of personal income tax: Recycling of the remaining carbon pricing revenue to reduce personal income taxes. See section 1.6.	This will offset the increased cost of pollution and stimulate job creation.

It should be noted that emission or absorption of carbon dioxide by forests has not been considered in this project. Reducing emissions from forests through conservation and, where appropriate, enhancing "sinks" (absorption of carbon dioxide from the air), could be important ways for Canada to reinforce its action on climate change or reduce the cost of meeting a given GHG target, as the potential volumes of carbon dioxide involved are large.[23] However, the economic models we have used are not yet capable of including forests.

3. Climate science and GHG targets for Canada and the industrialized world

The ultimate objective of the UN Framework Convention on Climate Change (UNFCCC), which has been ratified by virtually all countries in the world, is to "avoid dangerous anthropogenic interference with the climate system" – in other words, to avoid dangerous climate change. This objective should be the primary consideration for any country, Canada included, in setting targets for reducing GHG emissions.

There is now a broad consensus that more than 2°C of average global warming above the pre-industrial level would constitute dangerous climate change. The Bali Climate Declaration by Scientists, signed in 2007 by over 200 of the world's leading climate scientists, states that staying within 2°C must be "the prime goal" of the next global climate agreement.[24] The governments of all the world's top GHG-emitting countries, including Canada, now "recognize the scientific view that the increase in global average temperature above pre-industrial levels ought not to exceed 2°C."[25]

Prominent U.S. climate scientist James Hansen says that global warming above this threshold would be "exceedingly dangerous,"[26] given that the last time the world crossed it for a sustained period (3 million years ago), melting ice raised the sea level at least 15 metres higher than where it is now.[27] Scientists are now projecting sea levels to rise by as much as a metre or more this century alone if there is no action to cut GHG emissions[28] – enough to make tens of millions of people homeless.[29] Impacts like these would clearly be extraordinarily costly to people, the environment and the economy – but these costs are not included in our economic modelling results.

The Intergovernmental Panel on Climate Change (IPCC), the world's leading climate science body, has shown that to have a chance of not exceeding the 2°C limit, industrialized countries' combined GHG emissions must fall to 25–40 per cent below the 1990 level by 2020, if they are to make a fair contribution to the necessary cuts in global emissions.[30] Although industrialized countries as a whole could, in principle, meet a target within the

25–40 per cent range even if Canada met only a weaker target, there are at least four reasons why Canada's target should be at least a 25 per cent reduction below the 1990 level:

- An analysis of various formulas for determining individual countries' fair share of emission reductions shows that under most formulas, Canada's percentage reduction target for 2020, relative to the 1990 level, should be close to the percentage reduction target for the industrialized world as a whole.[31]
- A formula that apportions the global emission reduction effort based on the key principles of countries' financial capacity to act and their historical responsibility for GHG emissions indicates that Canada should reduce its net emissions by fully 50 per cent below the 1990 level by 2020.[32]
- Emission reductions by industrialized countries in the 25–40 per cent range, accompanied by a fair share of reductions by developing countries, correspond to only about a 50 per cent chance of keeping warming below 2°C.[30]
- The international climate science community is now suggesting that the scale of emission reductions needed may have been underestimated: "Recent observations show that greenhouse gas emissions and many aspects of the climate are changing near the upper boundary of the IPCC range of projections."[33]

Countries that are parties to the Kyoto Protocol, including Canada, agreed in 2007 that the IPCC's range of a 25–40 per cent emission reduction by industrialized countries should guide the current negotiations on a new global treaty for GHG reductions post-2012,[34] which countries have agreed to finalize at the UN climate conference in Copenhagen, in December 2009.

Although industrialized countries as a whole could, in principle, meet a target within the 25–40 per cent range even if Canada met only a weaker target, there are at least four reasons why Canada's target should be at least a 25 per cent reduction below the 1990 level.

NOTES

1 It should be noted that the starting point for the analysis is a business as usual scenario that is merely one plausible view of a future in which governments do not implement policies to cut emissions. If the business-as-usual scenario were changed, the rates of economic and employment growth reported here would also change, both for the business as usual scenario and the scenarios in which the GHG targets are met.

2 Of carbon dioxide equivalent.

3 See the short Executive Summary, available online at http://www.hm-treasury.gov.uk/sternreview_summary.htm.

4 We have used data from Environment Canada's latest *National Inventory Report* on GHG emissions to re-express this target relative to the 1990 level.

5 MKJA, *Final Report – Exploration of two Canadian greenhouse gas emissions targets: 25% below 1990 and 20% below 2006 levels by 2020, October 18th, 2009* (Vancouver, BC: MKJA, 2009). Available online at http://climate.pembina.org.

6 *Deep Reductions, Strong Growth: An economic analysis showing that Canada can prosper economically while doing its share to prevent dangerous climate change* (Drayton Valley, AB and Vancouver, BC: The Pembina Institute and David Suzuki Foundation, 2008). Available online at http://climate.pembina.org/pub/1740.

7 "Net" emissions are physical domestic emissions minus international emission credits purchased by Canada.

8 Of carbon dioxide equivalent.

9 See the short Executive Summary, available online at http://www.hm-treasury.gov.uk/sternreview_summary.htm.

10 In this and other tables, "ATL" means the four Atlantic provinces, plus the territories.

11 Of carbon dioxide equivalent.

12 For example, the Pembina Institute and the David Suzuki Foundation endorse credits from developing countries that are registered to the Gold Standard. See http://www.cdmgoldstandard.org/.

13 The bill mandates the purchase of 720 million tonnes of reductions in 2020 from reduced deforestation, which compares to U.S. emissions in 1990 of 5,975 million tonnes (see *Climate Analysis Indicators Tool Version 6.0* (Washington, DC: World Resources Institute, 2009), http://cait.wri.org).

14 Of carbon dioxide equivalent.

15 *EPA Analysis of the American Clean Energy and Security Act of 2009* (Washington, DC: U.S. Environmental Protection Agency, 2009), 3. Available online at http://www.epa.gov/climatechange/economics/pdfs/HR2454_Analysis.pdf.

16 *Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009* (Washington, DC: U.S. Department of Energy, 2009), xi. Available online at http://www.eia.doe.gov/oiaf/servicerpt/hr2454/pdf/sroiaf(2009)05.pdf.

17 This item compensates for lower government revenue from corporate and sales taxes and royalties when meeting either target.

18 National average payment.

19 Clare Demerse and Matthew Bramley, *Choosing Greenhouse Gas Emission Reduction Policies in Canada* (Drayton Valley, AB: The Pembina Foundation, 2008). Available online at http://climate.pembina.org/pub/1720.

20 Ibid.

21 In the full technical report, the emissions pricing policy is referred to as a "carbon charge."

22 In the full technical report, this is referred to as "purchases of international emissions permits."

23 See Canadian Forest Service, *Is Canada's Forest a Carbon Sink or Source?* (Ottawa, ON: Natural Resources Canada, 2007). Available online at http://warehouse.pfc.forestry.ca/HQ/27501.pdf.

24 Available online at http://www.ccrc.unsw.edu.au/news/2007/Bali.html.

25 *Declaration of the Leaders of the Major Economies Forum on Energy and Climate* (2009). Available online at http://www.g8italia2009.it/static/G8_Allegato/MEF_Declarationl.pdf. The signatories are Australia, Brazil, Canada, China, the European Union, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, South Africa, South Korea, the U.K. and the U.S.

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28 See, for example, Stefan Rahmstorf, "A Semi-Empirical Approach to Projecting Future Sea-Level Rise," *Science* 315: 368 (2007). Available online at http://www.pik-potsdam.de/~stefan/Publications/Nature/rahmstorf_science_2007.pdf. See also W. T. Pfeffer et al., "Kinematic Constraints on Glacier Contributions to 21st-Century Sea-Level Rise," *Science* 321: 1340 (2008).

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