TURNING THE CORNER

March 2008

Detailed Emissions and Economic Modelling

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

In recent years, all governments in Canada have taken steps to reduce greenhouse gas emissions, and have committed to further actions in the years to come. At the federal level, Canada's government has committed to a national goal of achieving absolute emissions levels in 2020 that are 20 per cent below those of 2006 levels by 2020. This is equivalent to an integrated emissions level of about 610 megatonnes in 2020, requiring a reduction of about 330 megatonnes relative to Environment Canada's reference case forecast of 2020 emissions. Independently, provincial and territorial governments have announced greenhouse gas emissions reduction targets, that taken together and extrapolated to 2020, imply some 300 megatonnes of reductions by 2020. To date, some 200 measures under these provincial/territorial plans have been announced, and most governments indicate that there will be more to come.

Environment Canada has prepared an analysis of the policies underlying these targets to identify the likely impacts that their implementation implies.

Our analysis has determined that under reasonable assumptions of their future evolution, federal measures alone will reduce emissions in 2020 by approximately 230 megatonnes below forecasted levels, with 165 megatonnes of that reduction being attributable to the federal *Regulatory Framework for Industrial Greenhouse Gas Emissions*. When provincial/territorial measures under their respective targets are also taken into account, total reductions in 2020 are forecast to at least meet the total reductions required to put Canadian emissions at 20 per cent below 2006 levels.

Our analysis of the economics of the federal *Regulatory Framework* further indicates that there will be real economic costs associated with these emissions reductions, particularly for some of Canada's industrial sectors like oil and gas and electricity generation, as well as for individual consumers. While our analysis also indicates that these costs can be expected to be substantially mitigated by improved energy efficiency savings for both business and consumers, we conclude that there will inevitably be real, but manageable, adjustments required to achieve significant absolute reductions in greenhouse gas emissions by 2020.

This analysis was undertaken on the basis of an updated Environment Canada long-term greenhouse gas emissions reference case that incorporates the latest available economic and energy information for Canada. Economic projections were developed by Informetrica Limited and were the subject of extensive consultations in the summer of 2007 among key federal departments and industry. The core economic assumptions were calibrated to the latest long-term economic forecast put forward by Finance Canada.

Similarly, forecasts of major energy supply projects (i.e., oil sands production, large hydro capacity expansions, nuclear refurbishment and additions) were derived, with some adjustments to better reflect recent developments, from the National Energy Board's "Continuing Trends" forecast, presented in their November 15, 2007 report entitled *Canada's Energy Future - Reference Case and Scenarios to 2030.* As a result, the main economic and energy demand-supply underpinnings of the Environment Canada reference case are consistent with those of other governmental and non-governmental institutions. This reference case yields an emissions growth trajectory that will require effective government policies, leading-edge industry innovation, and society-wide engagement in order to be addressed.

The emissions and economic impacts presented here were estimated through Environment Canada's economic model (the Energy-Economy-Environment Model for Canada, or E3MC). E3MC permits integrated energy-economy policy simulations in a manner that fully addresses the challenges of additionality, free-

riders, rebound effects, and policy interaction effects that commonly arise in this type of complex analysis. The assumptions governing our modelling of government measures are based on conservative and economically realistic assessments of the responsiveness of sectors to price and other signals created by the policy package.

INTRODUCTION

The Government of Canada has set a national goal of reducing greenhouse gas emissions, relative to 2006 levels, by 20 per cent by 2020, and by 60 to 70 per cent by 2050. The purpose of this paper is to describe the analysis undertaken by Environment Canada to estimate the greenhouse gas emissions reductions and economic impacts of federal and provincial measures to meet the first of those commitments.

To this end, we provide the results of a modelled analysis of the response of the Canadian economy to a number of different policy measures, including regulation, product standards and producer and consumer incentives. These responses are expressed in relation to a reference case, developed by Environment Canada, to reflect a "business-as-usual" scenario for Canada's greenhouse gas emissions and its economic growth prospects to 2020.

Without prejudging their future evolution, we have used the current suite of federal and provincial-territorial government policies as the basis of a scenario for Canada's emissions pathway to 2020. This scenario makes the assumption that governments will extend and, in some areas, deepen their interventions in support of climate change mitigation along the lines of the approaches they have taken to date. This scenario must therefore be viewed as illustrative.

The analysis in this paper is divided into three sections:

- section one provides a summary of the federal and provincial/territorial measures that form the basis of our modelling scenario;
- section two provides details on the estimated greenhouse gas emission reductions resulting from the implementation of federal and provincial/territorial greenhouse gas reduction measures under our scenario; and,
- section three provides details on the estimated economic impacts resulting from the key regulatory underpinnings of the suite of federal and provincial/territorial greenhouse gas reduction measures we have modelled.

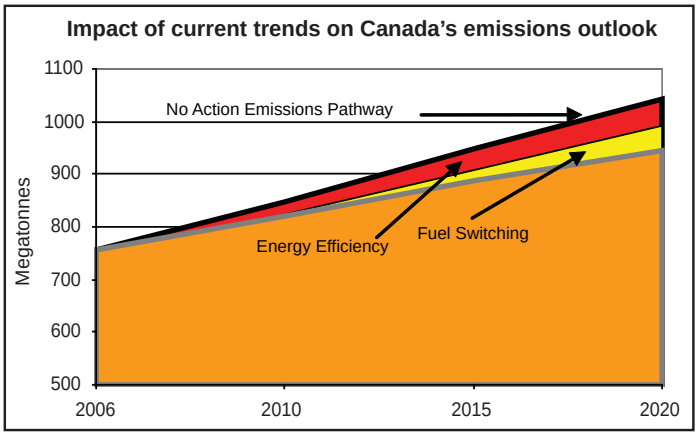
1. CLIMATE CHANGE POLICY MEASURES

Federal, provincial and territorial governments have proposed a range of measures designed to reduce greenhouse gases. When considering measures for inclusion in the modelled policy package, Environment Canada examined a range of relevant federal and provincial/territorial regulations, product standards, building codes and various types of spending measures.

Not all of these measures were amenable to incorporation into our modelled scenario. Some government announcements, while promising, simply did not contain enough detail to be adequately modelled, while others, such as education and engagement initiatives, do not permit the estimation of concrete and attributable greenhouse gas reductions. However, the Department has included in its modelled policy package all those announced and signalled measures that could be practically analysed (see Annex 2 of this document).

1.1 Existing Climate Change Mitigation Measures

Based on a simple extrapolation of 2006 energy efficiency and emissions intensity levels, we estimate that greenhouse gas emissions in Canada, if left unchecked, could reach some 1,040 megatonnes by 2020. That said, it is important to note that governments, business, and consumers are already committed to a range of greenhouse gas emissions reduction measures. In fact, through initiatives such as the closure of all of Ontario's coal-fired electricity generation units by 2014 as promised by the Ontario Government, Canada's greenhouse gas emissions are already coming under a greater degree of control as a result of ongoing improvements to energy efficiency and a switch to cleaner fuels.



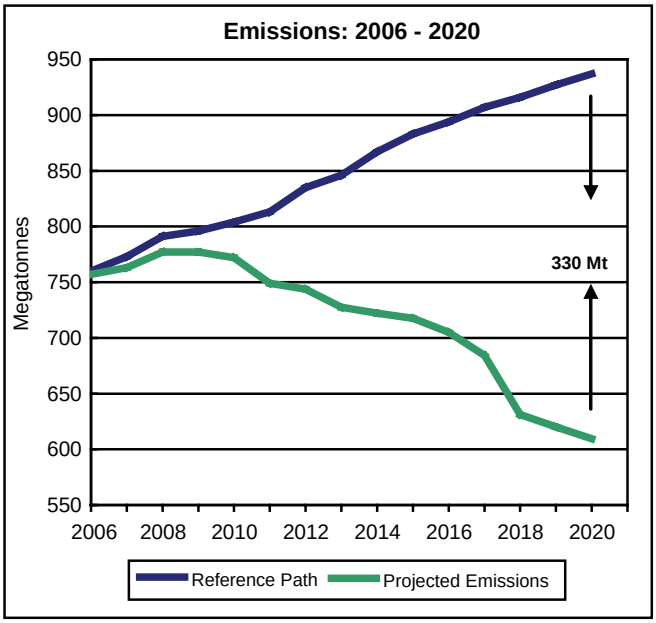
As the basis for assessing the scope of the challenge that remains, we have therefore constructed a reference case forecast of greenhouse gas emissions that already incorporates many of the measures and trends currently underway across Canada. In this respect, we have applied the date of January 1, 2006 as the cut-off point for defining existing measures that are to be included in our reference case forecast of "business as usual" emissions growth. In this reference case, while it is clear that current trends will deliver real and tangible reductions by 2020, overall growth in Canada's greenhouse gas emissions will continue in the absence of further measures. Indeed, our reference case forecast indicates that, in the absence of further actions, annual emissions will reach approximately 940 megatonnes by 2020, which is almost 25 per cent greater than 2006 levels (further detail on Environment Canada's reference case is available at Annex 4).

The challenge for Canada clearly remains significant, and substantially more effort on the part of governments and all sectors of the economy and Canadian society will be required.

1.2 Policy Measures to Achieve Canada's 2020 Target

The national target of a 20 per cent reduction in absolute greenhouse gas emissions from 2006 levels by 2020 implies a 2020 emissions level in Canada of approximately 610 megatonnes.[1] This requires a 330 megatonne reduction from the reference case projected emissions level of 940 megatonnes in 2020.

At the same time, while announced provincial/territorial targets collectively amount to approximately a 300 megatonne reduction target when extrapolated to 2020, these targets cannot be viewed as necessarily incremental to the federal objective. While there are clearly areas where provinces and territories are best positioned to act in a complementary manner to federal measures, there is also a strong potential for overlap.



Indeed, our analysis suggests that this is already happening to a considerable degree. Of the reductions under specific announced provincial/territorial measures to date that we have been able to examine, our review concludes that only a little over 50 per cent can be considered incremental to federal reductions already announced or in place. It is therefore evident that in moving to close the considerable gap that remains to be addressed under provincial/territorial targets, there is a need for improved focus by all governments on key areas where incremental reductions are most likely to be achieved.

In this context, our modelled policy package incorporates a wide range of federal and provincial/territorial measures announced after January 1, 2006 (prior announcements have been incorporated into our "business-as-usual" reference case), as well as related enhancements where focused action could yield significant additional reductions.

1.2.1 Federal Regulatory Framework for Industrial Greenhouse Gas Emissions

Federal industrial regulations call for an 18 per cent emissions intensity improvement from regulated sectors by 2010 from a 2006 base year, and improvements of 2 per cent per year thereafter. Other key features of the Framework include a requirement for oil sands upgraders, in-situ plants and coal-fired electricity plants that come into operation in 2012 or later to meet a stringent target based on the use of carbon capture and storage by 2018. In addition, regulated codes of conduct will be developed to ensure the use of best practices for the capture of unintentional fugitive emissions and HFCs (details at Annex 2.1).

1.2.2 Federal ecoACTION and Related Measures

The federal ecoACTION package focuses on a series of measures to complement reductions from the *Regulatory Framework for Industrial Greenhouse Gas Emissions*. These include measures under the ecoENERGY and ecoFREIGHT initiatives, regulations covering motor vehicle fuel consumption, renewable

1 Under the Environment Canada Reference Case, 2006 emissions are assumed to be approximately 760 megatonnes, increasing to 940 megatonnes by 2020. 20% below 2006 emissions levels by 2020 is therefore equal to about 610 megatonnes

fuels, and energy efficiency standards for appliances and equipment, as well as other measures to improve energy efficiency and the use of renewable energy sources (details at Annex 2.2).

1.2.3 Announced Provincial/Territorial Measures

Announced provincial/territorial measures focus to a great extent on improving the efficiency of homes and commercial, municipal and institutional buildings as well as on mandating the use of renewable fuels. Among the more important of these actions are Alberta's greenhouse gas regulations, a measure to reduce flaring and fugitive emissions in the oil and gas sector in British Columbia and Saskatchewan, the encouragement of agricultural and forestry "sinks" in Quebec, Ontario, and Saskatchewan, Quebec's carbon levy, British Columbia's carbon tax, and transportation fuel efficiency measures in these and several other provinces (details at Annex 2.3).

1.2.4 Additional Opportunities

In light of the key policy levers that rest under provincial/territorial jurisdictions with respect to, for example, electricity generation and regulation of secondary emissions sources in the natural resources and manufacturing sectors, we have undertaken an analysis of the largely as yet untapped potential for further reductions towards both provincial/territorial and national targets that lie in these and other areas. This includes initiatives to expand clean electricity generation in Canada, incorporating, for example, an expansion of the east-west power grid, which would allow greater transmission of power between Manitoba and Ontario and Quebec and Ontario, as well as development of major hydro projects at Peace River C and Lower Churchill (as assumed in the November, 2007 National Energy Board "Continuing Trends" scenario). We have also examined the emissions reduction potential of provincial/territorial action to address emissions in the mining and manufacturing sectors, as well as further steps to improve building energy efficiency (details at Annex 2.4). It should be noted, however, that these additional reduction opportunities have not been included in the core policy package that we have modelled.

1.3 Summary of Federal and Provincial Measures

The nature of integrated economic modelling, such as that undertaken here, precludes the presentation of separate results for individual measures because of the widespread interactions among them. The table below though, presents the current federal and provincial/territorial targets that the individual measures would need to collectively reach.

E3MC's detailed sectoral dimension does, however, allow for the analysis of the expected greenhouse gas emission impacts of the integrated modelled policy measures on key sectors of the Canadian economy. The following section focuses on a presentation of emissions reduction results for major sectors of the Canadian economy (more detail on Environment Canada's model is available in Annex 1).

FEDERAL, PROVINCIAL, AND TERRITORIAL GREENHOUSE GAS REDUCTION TARGETS		
	Target	**Announced**
Federal	Reduce GHGs by 20%, relative to 2006 levels, by 2020.	April, 2007
Alberta	Reduce emissions by 50% relative to business-as-usual by 2050 or 14% relative to 2005	January 2008
BC	Reduce GHGs to 33% below 2007 levels by 2020	February 2007
Manitoba	Reduce GHGs to 6% below 1990 levels by 2012. First step is to reduce GHG emissions to below 2000 levels by 2010 (resulting in more than 3 Mt reduction)	October 2002
New Brunswick	Reduce GHGs to 10% below 1990 levels by 2020	June 2007
Newfoundland and Labrador	Reduce GHGs to 10% below 1990 levels by 2020	June 2007
Nova Scotia	Reduce GHGs to 10% below 1990 levels by 2020	March 2007
Nunavut	No explicit target	
Northwest Territories	No explicit target	
Ontario	Reduce GHGs by 15% below 1990 levels by 2020	June 2007
Prince Edward Island	Reduce GHGs to 1990 levels by 2010, 10% below 1990 levels by 2020	August 2001
Quebec	Reduce GHGs to 6% below 1990 levels by 2012	June 2006
Saskatchewan	Reduce GHGs by 32% below 2004 levels by 2020	June 2007
Yukon	No explicit target	

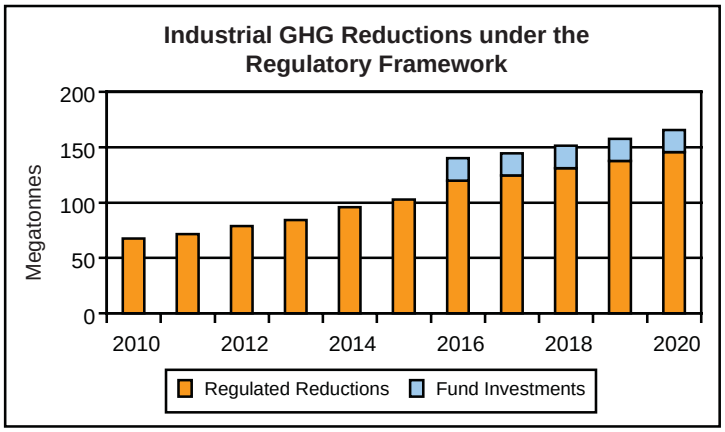
2. GREENHOUSE GAS EMISSIONS REDUCTIONS FROM POLICY MEASURES

2.1 Action on Industrial Greenhouse Gas Emissions

Industry accounts for about half of Canada's greenhouse gas emissions. The Government of Canada is mandating the reduction of industrial greenhouse gas emissions through the introduction of a regulatory framework for major industrial sectors.

In 2010, regulated industries will be required to meet challenging greenhouse gas emissions targets - 18 per cent below their respective 2006 emission intensity levels. These intensity targets will be stringent and tightened on an annual basis at a rate of 2 percent per year. New facilities, which are those whose first year of operation is 2004 or later, would be granted a three-year commissioning period before they would face an emission-intensity reduction target. After the third year, new facilities would face a target based on a cleaner fuel standard. New facilities would also be required to improve their emission intensity each year by 2 per cent. The regime will incent companies to incorporate carbon capture into new facilities and will require oil sands upgraders, in-situ plants and coal-fired electricity plants that come into operation in 2012 or later to meet a carbon capture and storage standard by 2018.

To determine the impact of the regulations, emissions intensities for covered sectors were calculated and from those, targeted emissions levels for each sector for each year were determined, taking into account expected output growth. In other words, emissions intensities were converted into absolute emissions reductions.

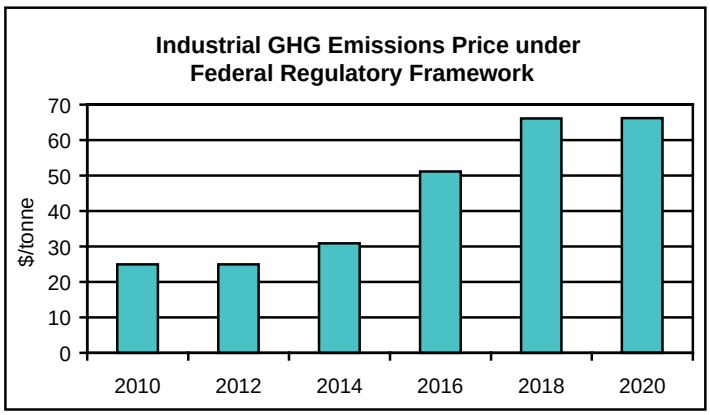


Emission reductions under the regulatory system are projected to reach 125 megatonnes by 2020. Reductions generated by the Technology Fund are expected to account for another 20 megatonnes, while action on unintentional fugitive emissions and hydrofluorocarbons is expected to result in an additional 20 megatonnes by 2020. On its own, the industrial regulatory package is therefore estimated to result in reductions of 165 megatonnes below reference case levels by 2020.

To understand how emissions reductions are achieved under the *Regulatory Framework*, it is important to note that firms are offered several different options to meet their emissions intensity targets. In the first instance, they can simply undertake in-house abatement. Where that would prove more costly than the alternatives, however, they can contribute to the Technology Fund, acquire emission credits from other regulated industries domestically, purchase offset credits from domestic sources outside of the regulated sectors, or make use of the Clean Development Mechanism (CDM) under the Kyoto Protocol.

In our modelling, the choice of compliance option, and the magnitude of each option's respective contribution to achieving the industrial target, is a function of the price signal arising from the regulatory system. As the lowest cost option, the starting Technology Fund contribution rate of $15/tonne has the effect of moderating the price in the early years of the regime (with the price steadily rising as the mandated Fund contribution

rate increases beyond $15). However, as the maximum allowed Fund contributions decline (to disappear totally by 2018), and the required emissions intensity improvements grow at a rate of 2 per cent per year, the overall price signal to industry steadily increases over time. As a result, by 2015 or so, the Fund is beginning to play a relatively marginal role in setting that price signal for industrial reductions, and it is instead the market price of emissions that drives the selection of a specific compliance option in the model. By 2018, firms are responding to carbon prices in the range of $65 per tonne, making in-house reductions and purchase of offsets from outside the regulated sectors among the more cost-competitive options. This price signal is sufficient not only to incent change within the regulated sectors, but also, through the offset system and related price changes in the outputs of regulated sectors, to encourage significant emissions reductions throughout the Canadian economy.

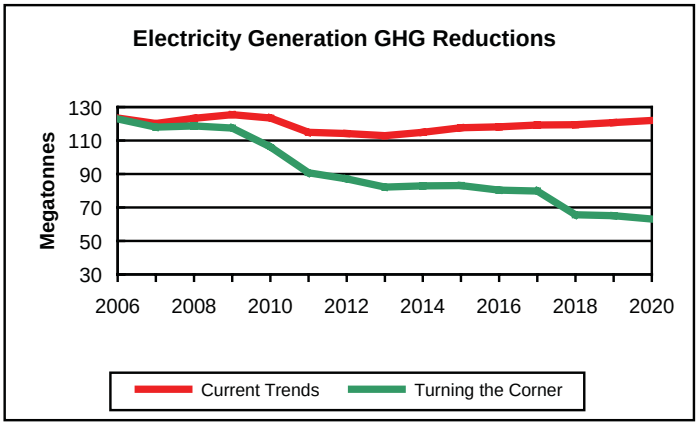


2.2 Sectoral Emissions Reduction Impacts

The *Regulatory Framework for Industrial Greenhouse Gas Emissions* is significant to the extent that it touches upon activities in many different sectors of the economy. However, the level of emissions reductions in each sector is also impacted by the interaction of the *Regulatory Framework* with the range of other federal and provincial/territorial measures introduced into the model. Our analysis has, therefore, focussed on identifying these integrated impacts, and presents the cumulative total reductions by sector of all modelled federal and provincial/territorial measures assumed under our scenario to be in place between 2006 and 2020.

2.2.1 Electricity Generation

In addition to the requirements of the *Regulatory Framework for Industrial Greenhouse Gas Emissions*, there are a number of other significant federal and provincial/territorial measures introduced into the model that influence the emission reduction path for electricity generation. Among these are measures that encourage the production of cleaner energy, such as the Government of Canada commitment to provide $1.48 billion to increase the supply of clean electricity from renewable sources such as wind, biomass, low-impact hydro, geothermal, solar photovoltaic and ocean energy. In this respect, the model also simulates the increased penetration of solar electricity and solar thermal power in the commercial sector. In total, there is an assumption that 40 per cent of all new electricity capacity, relative to the reference case, would be built from renewable sources including hydro. This is expected to yield 14.3 terawatt-hours of renewable electricity by 2012. A complementary measure for renewable heat also contributes to emissions reductions in this sector by encouraging the adoption by firms of renewable thermal energy equipment.



The provinces are proposing various measures aimed at the electricity generation sector. For example, all electricity in British Columbia

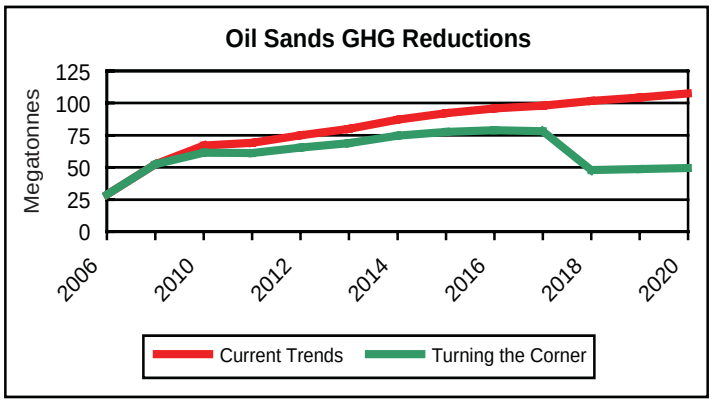
will be required to have net zero GHG emissions by 2016. Several provinces including British Columbia, Saskatchewan, Ontario and Quebec are establishing incentive programs for encouraging the further adoption of renewables.

Under the combined federal, provincial and territorial package, electricity generation is projected to increase from about 625 TWh in 2006 to 730 TWh in 2020 (about a 17 per cent increase). At the same time, there is a fundamental shift to low-carbon electricity generation. The contribution of hydro, wind, and biomass to overall electricity generation is expected to grow significantly, while coal-fired generation falls dramatically and natural gas remains close to 2006 levels.

We estimate that the federal Regulatory Framework will reduce projected emissions from the electricity sector by about 30 megatonnes. This reduction is over and above those included in the current trends scenario (e.g. closure of Ontario coal-fired generation stations by 2014). A further 30 megatonnes of reductions are estimated to result from future provincial actions aimed at “greening” their electricity systems.

2.2.2 Oil sands

Oil sands activities are among the most responsive to the *Regulatory Framework for Industrial Greenhouse Gas Emissions*. It is anticipated that the requirement to improve emissions intensity will lead to significant in-house reductions by 2020 and this is reflected in the estimated emissions reductions for this sector. Under the basic intensity improvement requirements (18 per cent in 2010 and 2 per cent each thereafter) under the *Regulatory Framework*, oil sands emissions are projected to be some 30 megatonnes below the current trends level.



Oil sands emissions reductions are also driven by a target introduced into the modelled policy package that would, under the federal *Regulatory Framework*, have all new in-situ and upgrader facilities coming on stream in 2012 or later meet a target that is equivalent in stringency to carbon capture and storage. The Government of Alberta has announced its own carbon capture and storage strategy in January, 2008, with expected reductions of up to 50 megatonnes from oil sands operations by 2020. The combined effect of all measures, including carbon capture and storage are estimated to lead to emission reductions of up to 60 megatonnes by 2020.

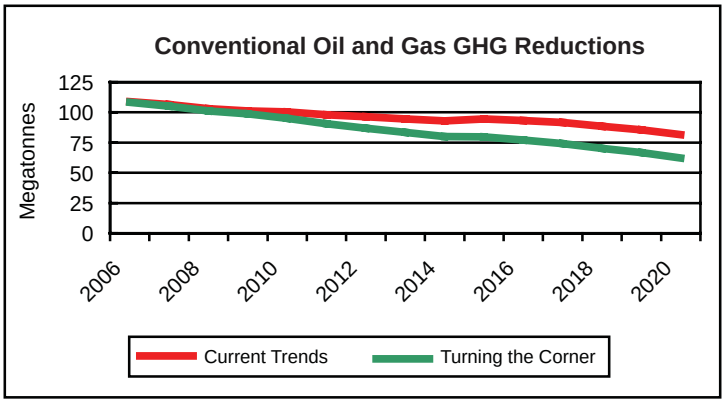
In Environment Canada’s reference case, the long-term world oil price is assumed to be about $50 per barrel, and at that price there is expected to be a small impact on planned oil sands expansion plans. Under the modelled simulation, production of mined bitumen and in-situ bitumen falls by about 100,000 barrels per day (i.e. from 3.6 to 3.5 million barrels per day) in 2020.[2]

2.2.3 Conventional oil and gas

As with firms in the regulated industrial sector, firms involved in the production of conventional oil and gas and pipeline transportation are subject to the new *Regulatory Framework for Industrial Greenhouse Gas Emissions.*

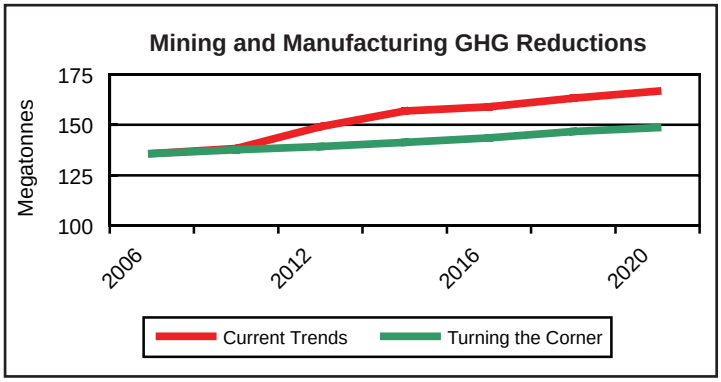
2 Oil Sands production is exogenously set to the National Energy Board’s Continuing Trends level. To simulate an output response to changing production costs, it is assumed that a one percent increase in production costs will reduce output by one-and-a half percent.

The *Regulatory Framework* is responsible for driving the bulk of the greenhouse gas emission reductions in this sector. In addition, we have modelled the introduction of regulated codes of practice to deal with unintentional fugitive emissions, assuming that this would result in a 50 per cent decrease by 2020 in such emissions. At a more specific level, we have also included an assumption in the modelled policy package that would have flaring and related emissions fall by 20 per cent in British Columbia and Saskatchewan by 2016, as announced under BC's climate change plan and as signalled in the past in Saskatchewan. The estimated impact of these actions is to reduce greenhouse gas emissions by more than 20 megatonnes from the 2020 reference case level.



2.2.4 Mining and manufacturing

As with firms in the conventional oil and gas sector, manufacturing and some mining firms are also subject to the new *Regulatory Framework for Industrial Greenhouse Gas Emissions.* In addition, we have modelled the introduction of regulated codes of practice to deal with the capture of hydrofluorocarbon emissions. We have assumed that this would result in a 50 per cent decrease by 2020 in hydrofluorocarbon emissions. The estimated impact of these actions is to reduce greenhouse gas emissions by more than 20 megatonnes from the 2020 reference case level.



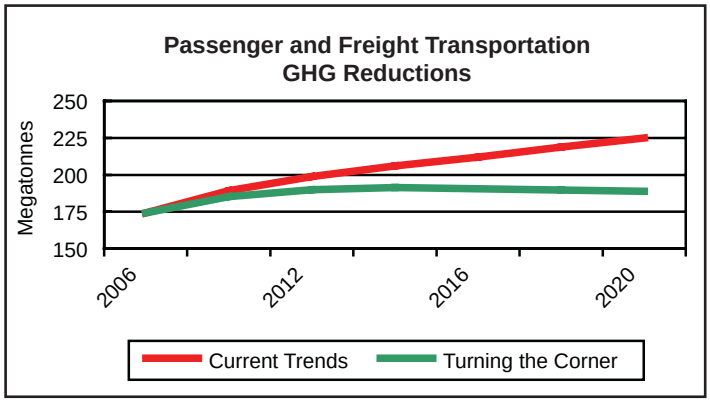
2.2.5 Transportation

Modelled emission reductions in the transportation sector reflect the impact of new regulatory actions. The federal government has announced that Canada will regulate the fuel consumption of new cars and light trucks, beginning with the 2011 model year. By 2020, we assume that the average new vehicle sold in Canada will have fuel consumption levels better than some of today's hybrid cars, and produce fewer GHG emissions than approximately 93 per cent of all vehicle entries listed in the 2008 Fuel Consumption Guide.

Emissions from the transportation sector are also expected to be reduced through a new federal regulation of renewable fuel content. This has been modelled by assuming that 2 per cent of diesel fuel and home heating oil is bio-diesel and that 5 per cent of gasoline is ethanol. There is also an assumption in the model to account for programs that will remove older more polluting cars from the overall vehicle fleet. For that measure, the model assumes that the lifetime of passenger cars and light trucks will decrease by 2 per cent over 2 years starting in 2008.

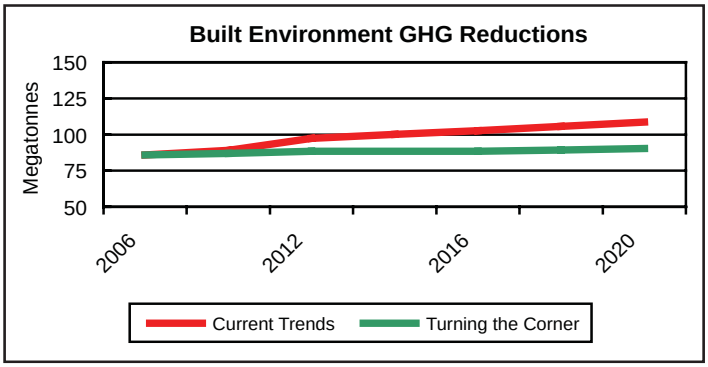
For freight transport a number of measures have been announced, including provisions to harmonize the treatment of trucking across all provinces and territories, to share best practices on fleet management, to demonstrate freight technologies, to cost-share the purchase of proven emissions reducing technologies,

to promote voluntary actions that lead to emissions reductions, and to demonstrate the use of shore-based power systems for marine vessels. In modelling these measures it was assumed that the effects would both increase the fuel efficiency for road vehicles and change the modal share of different kinds of transport. Certain other specific measures such as potential provincial/territorial government measures to require activation of speed limiters in trucks have been assumed for the modelled policy package. The estimated impact of all of these actions is to reduce greenhouse gas emissions from the transportation sector by more than 35 megatonnes from the reference case forecast.



2.2.6 Buildings

Greenhouse gas emissions reductions in the built environment sector are stimulated by a number of regulatory- or standards-based measures that improve the energy efficiency of related goods and equipment. The proposed phase-out of inefficient incandescent light bulbs, new federal energy efficiency standards for currently unregulated products such as commercial clothes washers and boilers, as well assumed increases to the stringency of the efficiency standards of currently regulated products, such as dishwashers and dehumidifiers, have also been incorporated into our modelled policy package for this sector.



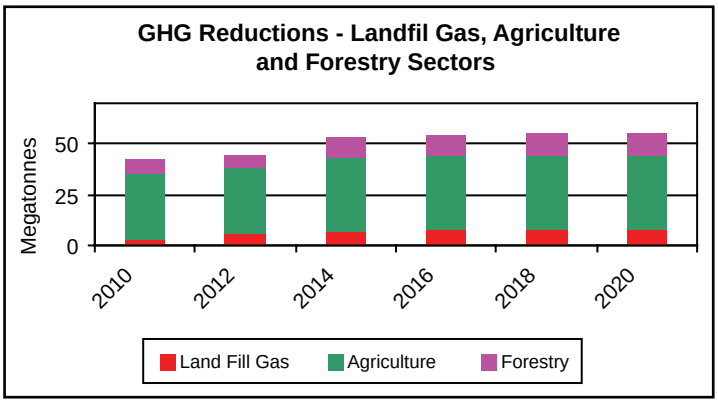
The modelled policy package driving the emissions reductions in this sector also includes several province-specific assumptions based on announced provincial measures, including provisions that would have solar thermal units for water and space heating installed in approximately 2 per cent of housing units in Ontario, and another related measure that would reduce the capital cost of such equipment in Saskatchewan, for both residential and commercial use, by 25 per cent.

Emissions reductions in this sector are also driven by the assumed extension of existing government programs which encourage more energy efficient building practices in both the residential and commercial markets. The home retrofit program, for example, for detached, semi-detached and low-rise multi-unit residential dwellings provides grants to improve the energy efficiency of residential dwellings. The estimated impact of all of these actions is to reduce greenhouse gas emissions by about 20 megatonnes from the 2020 forecasted levels.

2.2.7 Landfill, Agriculture and Forestry

It is anticipated that landfill gas capture, forestry and agricultural industries will be a major source of offsets as part of the federal industrial regulatory regime, and supplementary provincial regulations already announced but not yet elaborated (e.g. under the regional cap and trade regimes currently under examination by British Columbia and Manitoba). In addition, provinces such as Saskatchewan, Ontario and Quebec are also

considering putting in-place support systems to encourage emissions reductions by agriculture and forestry operations. The emissions reduction estimates for these activities and sectors capture the reductions attributable to all of these federal and provincial/territorial measures assumed in our forecast policy scenario. In total, our analysis indicates that some 55 megatonnes of reductions will be generated through the price signal for offsets under greenhouse gas regulations, improvements in emissions management, and energy cost-driven changes in energy consumption and operational practices.



2.2.8 Clean Electricity

The federal government has announced its intention to explore, with provinces and industry, options for the further reduction of greenhouse gas emitting electricity generation by 2020. This could include:

- development of an East-West transmission grid and sub-sea cable on the Atlantic coast;
- development of further major hydroelectric projects, such as Peace River C and Lower Churchill
- introduction of new nuclear reactors;
- retirement of fossil-fuel electricity generation facilities at the end of their expected life; and
- all-province adoption of the British Columbia commitment to net zero-emissions new electricity generating capacity.

Our analysis indicates that in total these actions could reduce Canada's greenhouse gas emissions by up to 25 megatonnes by 2020.

2.3 Opportunities for Further Reductions

Environment Canada has also examined a number of other potential greenhouse gas reduction measures. In particular, our review indicates that more aggressive options to lower further the demand for electricity and other energy products overall could significantly deepen greenhouse gas reductions within the forecast period. Our review of the standalone potential of these opportunities indicates that, cumulatively, reductions in the range of 35 megatonnes by 2020 are plausible.

2.3.1 Enhancement of Green Buildings

Enhancements to provincial/territorial residential and commercial building codes represent an effective way of reducing energy costs and increasing building energy efficiency. While requiring very focussed action, an enhancement of the assumed mandatory 30 per cent improvement in building efficiency under provincial/territorial building codes to reach the range of 50 per cent from 2010 onwards could yield significant reductions by 2020.

2.3.2 Non-Regulated Industrial Emissions

Our analysis indicates that steps to address secondary industrial and manufacturing sources of emissions not covered by the *Regulatory Framework for Industrial Greenhouse Gas Emissions,* or current provincial regulation, could reasonably target an improvement in emissions intensity at a rate of 1 per cent per year beginning in 2010 or so. This could add appreciably to the level of national reductions by 2020. Such an initiative could be accomplished through the setting of industrial standards or regulated codes of practice.

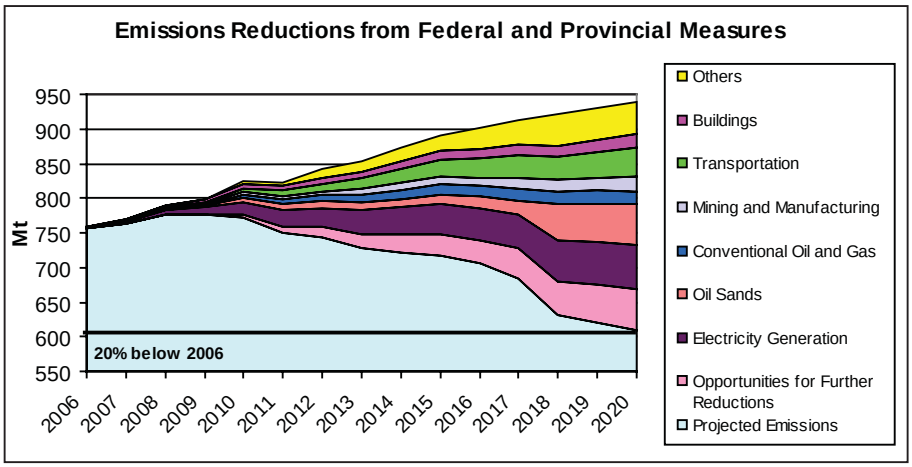
2.3.3 Smart Urban Growth

Provinces and municipalities have an important role to play in promoting the smart growth of our cities. Smart urban growth reduces dependence on the automobile while simultaneously supporting the development of a more energy efficient built environment. Higher density development that incorporates a mix of uses such as housing, employment, retail, and recreation in relatively close proximities makes transit less emissions-intensive, increasingly cost effective, and enables better transit service. In addition, higher urban density frequently includes a greater amount of attached housing which require less energy to heat than a detached home. Through land use planning with a focus on mixed use and walkable communities, Canadian municipalities can therefore significantly reduce housing and transportation-related greenhouse gas emissions.

2.4 Overall Emissions Reductions

When all measures are taken into account, our analysis indicates that the combination of existing and reasonably anticipated federal and provincial/territorial measures that we have assumed in our scenario will be capable of lowering Canada's greenhouse gas emissions by approximately 330 megatonnes in 2020, or 20 per cent below 2006 levels. Furthermore, the reductions trajectory generated by E3MC indicates that absolute reductions in Canada's greenhouse gas emissions will occur in the 2010 to 2012 period. Given the potential for additional reductions under provincial/territorial climate change targets, and the high commitment by all Canadians to the goal of decisively addressing our greenhouse gas emissions challenge, Canada's national target of a 20 per cent reduction in emissions from current levels by 2020 is both realistic and, with reasonable adjustments going forward, within reach of the current policy approach.

As the federal government moves forward on implementation of its *Turning the Corner* plan, it will take the opportunities presented by the five-year review periods specified under the *Regulatory Framework* to assess and, as appropriate, adjust certain of its measures. This will ensure that the solid policy foundation of this emissions reduction scenario will remain on track to realize the year over year reductions that Canada can achieve, while adjusting policies and measures to reflect both improvements in technologies and industrial processes, and changes in the North American and global climate change context.



3. ESTIMATED ECONOMIC IMPACTS

The full policy package examined under the emissions reduction part of this analysis includes a wide variety of federal-provincial-territorial regulations, programs, subsidies, taxes, and other measures that can contribute to achieving Canada's 2020 emissions reduction target.

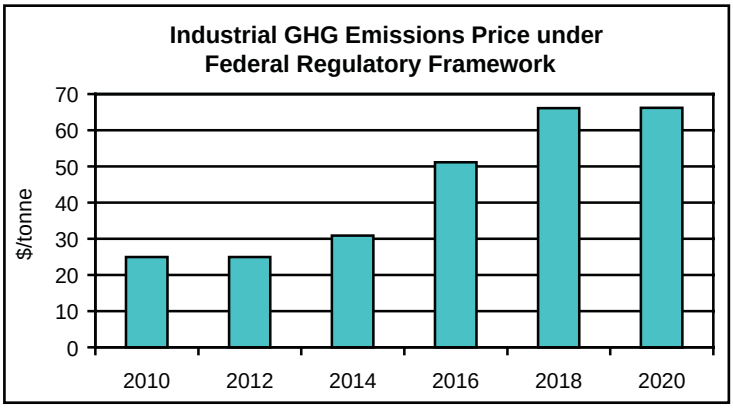
While there are undoubtedly economic costs and benefits associated with all these measures, these are difficult to quantify at this juncture given the variations in design they could assume going forward. We therefore believe that it is prudent and transparent to focus our analysis of economic impacts on those measures where there exists certainty in design over the full forecast period from 2010 to 2020. In this regard, only the federal *Regulatory Framework for Industrial Greenhouse Gas Emissions* provides sufficient detail on targets, parameters, and mechanisms for the full period from 2010 to 2020 necessary to provide a relatively definitive economic assessment.

The following analysis therefore presents an assessment of the economic impacts of the *Regulatory Framework*, which will be the principal policy and economic driver of progress on Canada's 2020 greenhouse gas emissions goal. A short discussion on the potential economic impacts of the full suite of federal-provincial-territorial actions on climate change that we have incorporated in our scenario is presented at the end of this section.

Analysis of the economic impact of the *Regulatory Framework* is complex. The results presented here are based on an economic modeling structure that has a longstanding track record in Canada and the United States with respect to impact analysis of climate change measures. This gives us high confidence in our conclusions, but it must be recognized that no single economic model can claim absolute certainty in its results. As with complex policy analysis, application of alternate modelling approaches to generate a range of estimates is desirable. To this end, Environment Canada is working with other government departments and external experts to support Canada's environmental agenda on the basis of a robust and comprehensive analytical capacity.

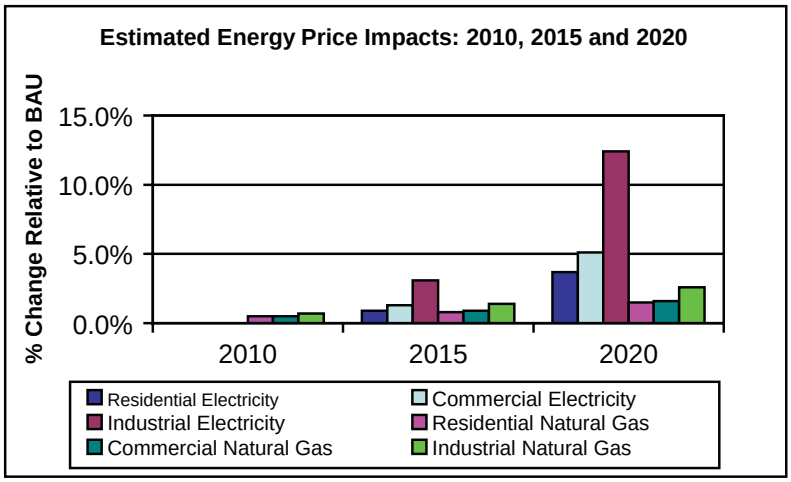
3.1 Emissions and Energy Price Impacts of the federal *Regulatory Framework for Industrial Greenhouse Gas Emissions*

The federal *Regulatory Framework for Industrial Greenhouse Gas Emissions* provides the core economic signal for change in Canada's energy-economy profile. As noted earlier in this paper, the effect of regulatory measures is to send a strong price signal to Canada's industrial sectors, derived from the incremental costs they will face in complying with the regulations. This provides an economic incentive for improved energy efficiency, a switch to cleaner energy sources where possible, and improved management of non-combustion greenhouse gas emissions



(such as accidental spills and leaks). In many cases, new technology and other investments will be required as well.

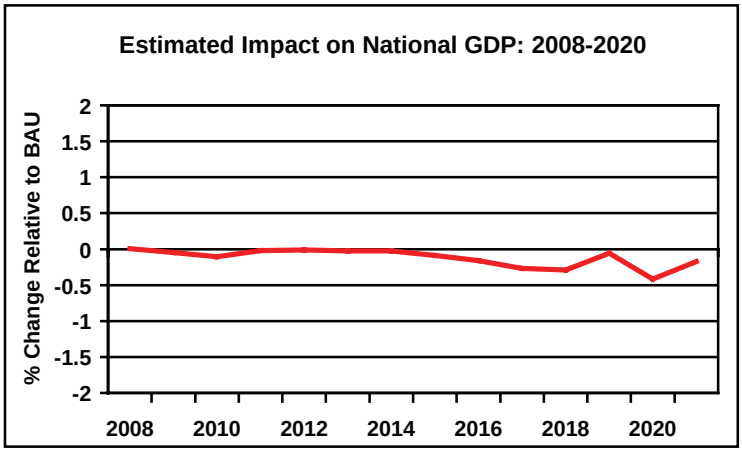
A portion of the costs associated with these investments and changes in operations will be passed on to consumers in the form of higher prices, thereby changing the relative price signals to the rest of the economy and favouring low-emitting investment and consumption choices. By 2018, regulated firms are facing an average greenhouse gas emissions cost of about $65 per tonne, as a result of the *Regulatory Framework*. The results of our economic modelling of the *Regulatory Framework* are primarily driven by these greenhouse gas emissions prices originating in the regulated sectors of the economy.



Our modelling suggests that Canadians can expect to bear real costs under the *Regulatory Framework*. For the majority of individual Canadians and for businesses outside the regulated sectors, these costs will be most evident in the form of higher energy prices, particularly with respect to electricity and natural gas (although increased energy conservation and efficiency are expected to limit those increases). On average, national residential electricity prices can be expected to be about 4.0 per cent higher than otherwise forecast in 2020, while natural gas prices will be about 2.0 per cent above those in the business-as-usual case. The *Regulatory Framework* itself is not expected to have a significant impact on motor fuel prices, given international competitiveness constraints.

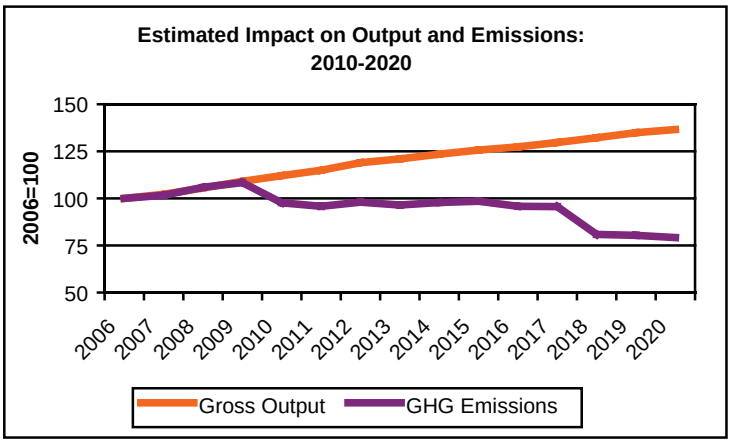
3.2 Macroeconomic Impacts of the federal *Regulatory Framework for Industrial Greenhouse Gas Emissions*

Overall, our modelled results indicate that the *Regulatory Framework* will set in motion a transformation of Canada's energy-economy. As consumers and industry respond to the "push" of higher energy prices and the "pull" of an offset market for emissions reductions, significant improvements in energy efficiency are foreseen as a result of the adoption of emerging technologies such as carbon capture and storage, as well as changes in production process and consumer habits. These improvements reduce energy requirements in the production of goods and services, and in the homes, places of work, and vehicles of Canadians. In turn, this moderation and improved efficiency in greenhouse gas emitting energy consumption acts as the principal driver of emissions reductions across the economy.



However, these changes will come at a cost for Canadians. Negative impacts from the *Regulatory Framework* on Canada's real GDP level will be small

over the next 5 years but will gradually increase, reaching about 0.4 per cent in 2020 (see chart) below the forecast level of GDP for that year. Real GDP will thus be modestly affected by the policy but it will continue to grow at a robust pace.



These impacts reflect the cost of mandatory business and other investments, as well as energy price increases motivated by the policy package.

Some industrial sectors, particularly those that are more carbon intensive, will be more affected than others. In the short- and medium-term, costs for these industries are primarily driven by the requirement for accelerated investments in more energy efficient, less carbon-intensive capital and technologies, with some loss in output possible.

Overall, our modelled results indicate that the transformative change unleashed by the *Regulatory Framework* will help break the link between greenhouse gas emissions from Canada's industrial sector and sustained economic growth for these key industries. While greenhouse gas emissions for the regulated sectors in 2020 are projected to be some 21 per cent below 2006 levels, economic output for the industrial sector is projected to deviate only slightly from its "business as usual" trajectory, and continue to rise to a 2020 level that is some 35 per cent higher relative to 2006.

3.3 Potential Economic Implications of Canada's National Greenhouse Gas Reduction Goal

The above analysis suggests that the economy will be modestly affected by the *Regulatory Framework*, with the level of GDP about 0.4 per cent below its forecast level in 2020. For the other actions on climate change, assessing their full economic costs will need further analysis and the development of specialised tools. For some programs and regulations, we will be in a better position to provide estimates of the economic impact when details are finalized, while others will likely evolve over time from their current form, making estimates of their long-term economic impacts a questionable proposition.

Nevertheless, given our above analysis of the impact of the regulatory framework and our knowledge of the other measures, the federal government is confident that the economic impacts of the full suite of actions required to achieve a reduction in 2020 emissions to 20 per cent below 2006 levels will be manageable for Canada.

Actions implied by the current suite of federal and provincial policies will require business investments in new technologies to improve energy efficiency and switching to less-carbon intensive energy sources, which will in turn raise the cost of production somewhat. As a consequence, households and firms purchasing energy will face higher prices. However, the regulatory and other measures being put in place by governments and included in the *Turning the Corner* plan provide industry and Canadians with the necessary incentives, and time, to adjust and align investments and lifestyles in a manner that is manageable for the economy.

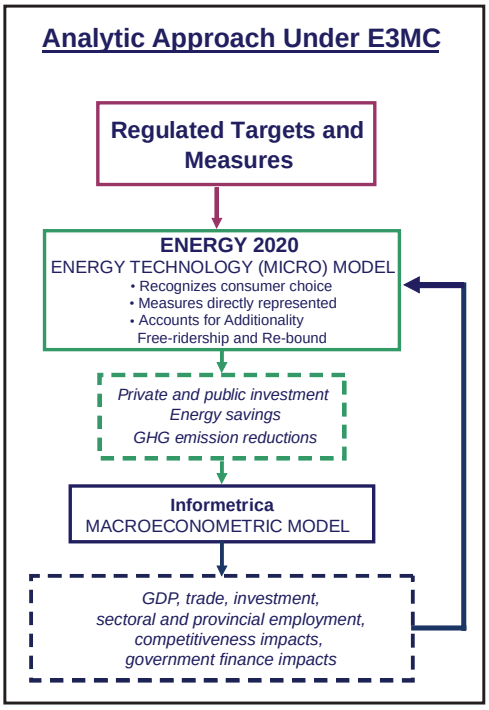
While there will therefore be some short-term costs, longer-term gains arising from improved energy efficiency, and in some cases increasing access to international markets for Canada's "green" technology, can be beneficial for the economy. This will help ensure the continued competitiveness of Canada's industrial and manufacturing sectors, all the while delivering reduced greenhouse gas emissions.

ANNEX 1: ENVIRONMENT CANADA'S MODELLING FRAMEWORK

1.1 Environment Canada's E3MC Model

Environment Canada's E3MC has two components: Energy 2020, which incorporates Canada's energy supply and demand structure, and TIM, Informetrica's macroeconomic model of the Canadian economy.

Energy 2020 is an integrated multi-region, multi-sector North American model that simulates the supply, price and demand for all fuels. The model can determine energy output and prices for each sector, both in regulated and unregulated markets. It simulates how factors like energy prices and government policies affect the choices that consumers and businesses make in the purchase and use of energy. The model's outputs, which include changes in energy use, energy prices, GHG emissions, investment costs and possible cost savings from policies, are used to identify the direct effects stemming from GHG reduction measures. The resulting savings and investments from Energy 2020 are then used as inputs into TIM.



TIM is used to examine consumption, investment, production, and trade decisions in the whole economy. It captures not only the interaction among industries, but also the implications for changes in producer prices, relative final prices and income. It also factors in government fiscal balances, monetary flows, interest and exchange rates.

More specifically, TIM incorporates 133 industries at a provincial and territorial level. It also has an international component to account for exports and imports, covering approximately 100 commodities. The model projects the direct impacts on the economy's final demand, output, employment, price formation and sectoral income that result from various policy choices. These, in turn, permit an estimation of the effect of climate change policy and related impacts on the national economy.

1.1.1 Treatment of Interaction Effects

The analytical approach permitted by E3MC addresses several key modelling challenges, namely additionality, free ridership, rebound effects, and policy-interaction effects.

The additionality issue refers to the question of what would have happened without the initiative in question. Problems of additionality arise when the stated emissions reductions do not reflect the difference in emissions between equivalent scenarios with and without the initiative in question. This will be the case if stated emissions reductions from an initiative have already been included in the reference case – emissions reductions will effectively be double-counted in the absence of appropriate adjustments. In the E3MC model,

additionality is controlled for by the fact that model structure is based on incremental or marginal decision making. The E3MC model assumes a specific energy efficiency or emission intensity profile at the sector and end-use point (e.g., space heating, lighting, auxiliary power, etc). Under the E3MC modelling philosophy, if the initiative in question was to increase the efficiency of a furnace, only the efficiency of a new furnace would be changed. The efficiency of older furnaces would not change unless those furnaces are retired and replaced with higher efficiency ones. As such, any change in the model is incremental to what is reflected in the business-as-usual assumptions.

A related problem, that of free ridership, arises when stated reductions include the results of behaviour that would happen regardless of the policy. This can occur when subsidies are paid to all purchasers of an item (e.g., a high efficiency furnace), regardless of whether they purchased the item because of the subsidy. Those who would have purchased the product regardless are termed free riders. In our model, the behaviour of free-riders has already been accounted for in the reference case. Their emissions are not counted, therefore, toward the impact of the policy. Instead, it is only the incremental take-up of the emissions-reducing technology that is counted.

The rebound effect describes the increased use of a more efficient product resulting from the implied decrease in the price of its use. For example, a more efficient car is cheaper to drive and so people may drive more. Emissions reductions will generally be overestimated by between 5 per cent and 20 per cent, if estimates do not account for increased consumption due to the rebound effect. Within the model, we have mechanisms for fuel choice, process efficiency, device efficiency, short-term budget constraints and cogeneration, which all react to changes in energy and emissions costs in different time frames.[3] All these structures work to simulate the rebound effect – in the example above, the impact of extra kilometres that may be driven as a result of improved fuel efficiency are automatically netted out of the associated emissions reduction estimates.

Finally, emissions-reduction policies such as the ones defined in the Government's plan interact with each other, with a resulting impact on their overall effectiveness. A policy package containing more than one measure or policy would ideally take into account this impact to understand the true contribution the policy package is making (in this case to emission reductions). This impact is described through what are known as policy interaction effects.

E3MC is a comprehensive and integrated model focusing on the interactions between sectors and policies. In the demand sectors, the fuel choice, process efficiency, device efficiency, and level of self-generation are all integrally combined in a consistent manner. The model has detailed equations to ensure that all the interactions between these structures are simulated with no loss of energy or efficiency. For example, the electric generation sector responds to the demand for electricity from the energy demand sectors, so any policy to reduce electricity demand in the consumer sectors will impact the electric generation sector. The model accounts for the emission in the electric generation sector as well as the consumer demand sectors. As the electric sector reduces its emissions intensity, policies designed to reduce electric demand in the consumer sectors will cause less of an emissions reduction. The natural gas and oil supply sectors similarly respond to the demands from the consumer sectors, including the demands for refined petroleum products for transportation. As well, the export by supply sectors of their products is also simulated.

Taken as a whole, the E3MC model provides a detailed representation of technologies that produce goods and services throughout the economy and can realistically simulate capital stock turnover and choices among technologies. It also includes a representation of equilibrium feedbacks, such that supply and demand for goods and services adjust to reflect policy. Given its comprehensiveness, E3MC covers all the greenhouse gas emissions sources, including those unrelated to energy use.

3 A shift in energy prices will cause cogeneration to shift in the short to medium term, device efficiency to adjust over the short to mid-term, process efficiency to adjust in the mid term, and fuel choice to react in the mid- to long-term. The actual adjustment times depend on the particular sector.

1.1.2 Simulation of capital stock turnover

As a technology vintage model, E3MC tracks the evolution of capital stocks over time through retirements, retrofits, and new purchases, in which consumers and businesses make sequential acquisitions with limited foresight about the future. This is particularly important for understanding the implications of alternative time paths for emissions reductions. The model calculates energy costs (and emissions) for each energy service in the economy, such as heated commercial floor space or person kilometre traveled. In each time period, capital stocks are retired according to an age-dependent function (although the retrofitting of un-retired stocks is possible, if warranted by changing economic conditions). Demand for new stocks grows or declines depending on the initial exogenous forecast of economic output (i.e., a forecast that is external to the model and not explained by it) and the subsequent interplay of energy supply-demand with the macroeconomic module. A model simulation iterates between energy supply-demand and the macroeconomic module until there is a convergence. The global convergence criterion is set at 0.1 per cent between iterations. This convergence procedure is repeated for each year over the simulation period.[4]

E3MC simulates the competition of technologies at each energy service node in the economy based on a comparison of their cost and some technology-specific controls, such as a maximum market share limit in cases where a technology is constrained by physical, technical or regulatory means from capturing all of a market. The technology choice simulation reflects the financial costs as well as the consumer and business preferences, revealed by real-world technology acquisition behaviour.

1.1.3 Model Challenges and Limitations

While very sophisticated analytical tools, no model can fully capture the complicated interactions associated with given policy measures between and within markets or between firms and consumers. Unlike computable general equilibrium models, however, the E3MC model does not fully equilibrate government budgets and the markets for employment and investment. That is, the modelling results reflect rigidities such as unemployment and government surpluses/deficits. Furthermore, the model, as used by Environment Canada, does not generate changes in nominal interest rates and exchange rates, as would occur under a monetary policy response to a major economic event.

4 The energy technology simulation component of the E3MC model (i.e., Energy 2020) does not have an explicit test for convergence because of the algorithm used for in the model. The macroeconomic component of the E3MC model (i.e. The Informetrica Model or TIM) is used to test for convergence between the two models because logically if one model continues to send the identical information to the other model then necessarily the other model should find the exact same solution as before. As the initial testing showed that after about 3 iterations most of the variables in TIM were very close to convergence, the maximum iteration for convergence is set to 5.

ANNEX 2: POLICY MEASURES AND MODELLING ASSUMPTIONS

For the purposes of this modelling exercise, we have looked at the range of existing federal and provincial measures as a “real-world” source of modelling parameters. In order to assess the effectiveness of the current policy mix that underlies government targets, we have made the theoretical assumption that government intervention would take the form of an extension of the existing package of federal and provincial measures up to 2020. This should not be construed as implying, or advocating for, a policy decision to extend or otherwise alter these programs. In the case of the federal government, and also with respect to provincial/territorial governments, the extension of individual measures currently in place will continue to be based on a careful assessment of their individual efficiency and effectiveness. Moreover, while our analytical scenario is based on the assumption that the current mix of government measures is representative of public policy interventions going forward, it must be recognized that there may well be a very different mix of policy measures in place by 2020 than we have assumed in this analysis.

2.1 Regulatory Framework for Air Emissions

Industrial Greenhouse Gas Regulations

In 2010, regulated industries will be required to meet challenging greenhouse gas emissions targets - 18 percent below their respective 2006 emission intensity levels. These intensity targets will tightened on an annual basis at a rate of 2 per cent per year. New facilities, which are those whose first year of operation is 2004 or later, would be granted a three-year commissioning period before they would face an emission-intensity reduction target. After the third year, new facilities would face a target based on a cleaner fuel standard. New facilities would also be required to improve their emission intensity each year by 2 per cent. A flexible approach would be taken in special cases where the equipment or technology used in a new plant facilitates carbon capture and storage or otherwise offers a significant and imminent potential for emission reductions. In those sectors in which carbon capture and storage is a viable option for reducing emissions, new facilities that do not meet the cleaner fuel standard but are built capture-ready will see the standard apply to the facility’s actual emission intensity. The incentive for carbon capture and storage would apply to the oil sands, electricity, petroleum refining, chemicals and fertilizer sectors. For upgraders and in-situ facilities in the oil sands sectors, and for new coal-fired electricity generating facilities that begin operations in 2012 or later, a target based on carbon capture and storage would apply in 2018.

Emissions for 2006 are available in the reference case for most of the covered industrial sectors. GHG emissions are disaggregated in three broad categories: combustion-related, process and non-energy. For each of those categories, the share of what is fixed process emissions has been estimated. Those shares have been applied to the reference case GHG emissions in 2006 to produce a net figure for covered GHG emissions by covered sectors.

In order to calculate emissions per unit of production, different measures of production were used. For the electricity sector, total electricity generated by fossil fuel was used. In the oil and gas sector, it was total production in the gas sector and oil sub-sectors. Gross Output was used for all the other covered sectors. Once the targeted intensities were defined, they were translated into targeted emission levels for each year.

The model then takes into account the available compliance options for firms:

- Access to the Technology Fund (TF). For the purpose of the analysis, the maximum contribution to the TF fund was calculated as follow:

  Maximum (Mt) = (reference case emissions (Mt) – Targeted Emissions (Mt)) * TF (%) + access to R&D
  where:

  reference case emissions (Mt) = total GHG emissions from the covered sectors
  Targeted Emissions (Mt) = total targeted emissions from the covered sectors
  TF (%) = Access as % of total target over 2010 – 2017 period: 70%, 65%, 60%, 55%, 50%, 40%, 10%, 10%

- Access to R&D = access to 5 Mt annually to research and development fund. The contribution rate to the funds (in terms of $/tonne over the 2010 - 2017 period) were $15, $15, $15, $20, $20, and then escalating at the rate of GDP growth. The contribution to the TF is assumed to be the cheapest option available to the industry. As such, the TF contribution is maximized before other compliance options are pursued by the industry.

- Access to Pre-Certified Investment Projects: For the purpose of the analysis, firms/sectors were able to invest directly in pre-certified investment projects.

- Access to Clean Development Mechanism (CDM). For the purpose of the analysis, the maximum contribution to the CDM is set at 10 per cent of the total target, calculated as follows:

  Maximum CDM (Mt) = (reference case emissions (Mt) – Targeted Emissions (Mt)) * 10%

- Access to Credit for Early Action. For the purpose of the analysis, eligible firms/sectors were allocated a share of one-time credit for early action. A maximum of 15 Mt worth of credits were allocated, with no more than 5 Mt allocated in one year. The credits were allocated between 2010 and 2012.

- The price of CDM is assumed to be $25 per tonne. As other compliance options are expected be less expensive than the CDM (e.g. internal reductions or offsets), industries will not necessarily buy all the CDM credits that are available to them.

- Access to Domestic Offsets. In the model, cost curves are used to determine how many tonnes of domestic offset would be available to the industry. As the price of permits increases, the availability of offsets will increase. The price of the domestic offset is the domestic trading price.

- Domestic Trading. Industrial facilities would have the option of trading emission credits amongst themselves. An industry performing better than its target (its level of emissions being lower than the targeted level) would have the option to sell the “extra tonnes” on the market to a facility that would not otherwise meet their target. For modelling purposes, an initial price of $15 per tonne was implemented in the model (same level as the TF price). The cost of domestic credits is calculated endogenously by the model every year. As long as the covered industries meet their overall target, the price will remain at $15. As soon as a facility fails to meet the overall industrial target, the price of permits will start rising and will continue until the emissions-target reaches an equilibrium. If the emissions fall under the target, the price of the credits will decrease.

- Internal reductions. Although several compliance options are available to the industry to reach its target, it might be more cost effective for them to make internal reductions such as investing

in new capital stock with greater efficiency or switching from one type of fuel to the other. Each industry has a cost curve which defines the potential reductions and their associated cost. The initial reduction is usually achieved at a very low cost, which might be lower than the cost of the different compliance mechanisms. For the purpose of the analysis, it is assumed that the industries will always go to the "cheapest option". For example, they will generate internal reductions until the price of those reductions get higher than the CDM price. If the CDM price gets lower than their internal reduction price, they will buy CDM credits.

Best Practices for the Capture of Unintentional Fugitive Emissions and HFCs

The *Regulatory Framework* mandates the application of best practices with respect to the control of unintentional fugitive emissions and HFCs.

- Fugitive emission reductions: In this analysis, it was assumed that emissions from unintentional fugitives, accounting for about 46 per cent of total fugitives emissions, would decrease by 50 per cent by 2020. This represents an average reduction of fugitives of about 3.5 per cent per year starting in year 2010.
- HFC emission reductions: In the model, it was assumed that HFC emissions would decrease by 50 per cent between 2010 and 2020.

2.2 ecoACTION Measures

Phase Out of Inefficient Lighting

The Government is developing regulations that will phase out the use of inefficient incandescent light bulbs in most areas of regular use by 2012. The ban on inefficient bulbs will include allowances for applications where incandescent bulbs are still the only practical alternative, such as in some medical lighting situations, oven lights and others.

- Inefficient incandescent lighting is to be phased out by 2012, with new compact fluorescent bulbs used instead. Energy-star certified compact fluorescent bulbs (CFL) are assumed to use only 25 per cent of the energy required by equivalent incandescent bulbs.

- It was assumed that 2 per cent of the residential energy requirement dedicated to lighting was already met through CFLs. The remaining 98 per cent was assumed to be from incandescent lighting and all of it was assumed to be replaceable by CFLs. The energy intensity of incandescent lighting was assumed to be improved by 25 per cent through the 2007 – 2012 period.

- For the commercial sector, it was assumed that 50 per cent of the energy requirement for lighting was already met through CFLs. It was also assumed that all light bulbs could be replaced.

Energy Efficiency Standards for Products

To reduce emissions from consumer and commercial products, the government will amend the Energy Efficiency Regulations to strengthen energy efficiency standards for those products. The amendments will include: new energy performance standards for 20 currently unregulated products, such as commercial clothes washers and commercial boilers; and more stringent requirements for 10 currently regulated products, such as dishwashers and dehumidifiers.

This policy was assessed separately for the commercial and the residential sectors.

Residential Sector:

- In the model, there are seven distinct classes of end-uses in the residential sector. The efficiency standard was implemented in three end-use categories: refrigeration, substitutable and non-substitutable. Space heating, water heating, lighting, and space conditioning were all excluded from the analysis. It was assumed that the capital cost of the targeted equipment would be 5 per cent higher than it would have otherwise been without the implementation of the more stringent standard.

- For the refrigeration class, based on available historical data, it was assumed that about 75 per cent of the energy use was from refrigerators and that the best in class refrigerator is about 20 per cent more efficient than the average refrigerator sold on the market. The remaining 25 per cent of the energy use is attributed to freezers with the best in class assumed to be 10 per cent more efficient than the average freezer.

- The substitutable end-use class includes equipment such as ranges and clothes dryers. These appliances are part of the substitutable category as they do not necessarily use electricity (unlike televisions or dishwashers); they can use other forms of energy (such as natural gas). For the substitutable category, it was assumed that the best in class equipment was 20 per cent more efficient than the average equipment sold in the market.

- The other non-substitutable end-use class includes all electrical equipment used by households and not specified in the other classes (from dishwashers to alarm clocks). For this category, it was assumed that the application of a best in class standard would be 25 per cent more efficient than the average new equipment.

- The improvement was held constant through time, i.e. all new equipment purchased in any given year is more efficient than it would otherwise have been. For example, a new refrigerator bought in 2020 in the policy case will be 20 per cent more efficient that a new refrigerator bought in 2020 under the reference case. Thus, the improvement is built “on-top” of the autonomous improvement assumed in the reference case.

Commercial Sector:

- In the commercial sector, it was assumed that the commercial device efficiency of all end-use classes, excluding lighting (as modelled under the initiative to phase-out inefficient incandescent light bulbs) would be 25 per cent more efficient than what it would have otherwise been in the reference case, starting in 2010 and ending at 2020. As with the residential sector, it was assumed that the capital cost of the targeted equipment is 5 per cent higher than it would have otherwise been without the implementation of the more stringent standard. Again, the improvement is built “on-top” of the autonomous improvement assumed under the reference case.

ecoENERGY for Renewable Heat

The ecoENERGY for Renewable Heat program is a four-year, $36 million investment to:

- increase the use of renewable thermal energy by industry, commercial businesses and institutions;

- boost the amount of renewable thermal energy created for these sectors; and

- contribute to cleaner air by helping Canadian businesses use less fossil fuel-based energy for space heating and cooling and water heating in buildings across Canada.

The penetration of solar energy in the commercial and industrial sectors was increased in the model. This was triggered by a non-price factor variable that changes the behavioural pattern of consumers in the model. The increase of the factor induces more penetration of solar energy to a segment of the market even though the cost to the commercial or industrial sector is higher than the cost of other energy sources.

ecoENERGY Home Retrofit

The ecoENERGY Retrofit is available to owners of single family homes including detached, semi-detached and low rise multi-unit residential buildings. Property owners can qualify for federal grants by improving the energy efficiency of their homes, and reducing their home's impact on the environment.

- Based on an average incentive of $1,100 per house retrofitted, about 140 000 homes over the four years of the program would undergo retrofits with savings of 35 per cent of energy use. This translates into 35 000 homes per year undergoing retrofits, or about 0.35 per cent of the total housing stock in Canada. In the model, it was assumed that 0.35 per cent of the houses continuously improved their energy efficiency by 35 per cent in each year. It was also assumed that the interest rate for the investments required was 2 per cent lower than the reference case interest rate.

Motor Vehicle Fuel Consumption Regulations (under the Motor Vehicle Fuel Consumption Standards Act (New Fuel Economy Standard))

This measure involves incorporating a New Vehicle Fuel Consumption Regulation to come into effect in 2011, which establishes a new standard benchmarked against a stringent, North American Standard.

- For the purposes of the analysis, we assumed that Canada's new vehicle fuel consumption regulations would be aligned to the new vehicle fuel consumption standards outlined in the United States' *Energy Independence and Security Act*. The Energy Act amends the US CAFE legislation by requiring standards to be set from model year 2011, sufficient to achieve an average among new vehicles in 2020 of 35 miles per gallon (6.7 litres per 100 kilometre). The 35 miles per gallon (6.7 litres per 100 kilometre) was assumed to be the minimum stringency for Canada's motor vehicle fuel consumption regulations. Given the fleet average sales in 2006, achieving the 35 miles per gallon standard would require an improvement of about 20 percent.

Renewable Fuel Content Regulation (Under CEPA 1999)

The government announced a regulation requiring fuel producers and importers to have an average annual renewable fuel content of at least 5 per cent of the volume of gasoline produced or imported to Canada, starting in 2010. In addition, the government intends to put in place a requirement for an average 2 per cent renewable fuel content in diesel fuel and heating oil, such as bio-diesel, by 2012.

- For the mandatory content in gasoline, it was assumed that 5 per cent of the motor gasoline consumed for each year starting in 2010, was replaced with ethanol. In order to assess the GHG impact of the regulations, it was assumed that ethanol is 37 per cent less GHG intensive than the motor gasoline used.

- The mandatory content of renewable fuel in diesel was implemented and assumed that 2 per cent of all diesel fuel used in the transportation sector and 2 per cent of the heating oil used in

the residential sector, starting in 2012, is from bio-diesel. It was also assumed that bio-diesel is 65 per cent less GHG intensive. No use of bio-diesel is modelled in the reference case.

Vehicle Scrappage Program

Scrappage incentives lead to older, more highly polluting cars being taken off the road earlier than they otherwise would, which could result in an increased use of public transit or the purchase of newer, lower-polluting vehicles.

- Starting in 2008, the lifetime of passenger cars and light trucks is assumed to decrease by 2 per cent over 2 years.

ecoFREIGHT Program

The ecoFREIGHT program consists of six initiatives expected to enhance freight transportation efficiency:

- National Harmonization Initiative for the trucking industry: identification of regulatory barriers and solutions in collaboration with provinces and territories, so the Canadian trucking industry can embrace emissions-reducing technologies.
- ecoENERGY for Fleets: reduction of fuel use and emissions in commercial and institutional fleets via training, sharing of best practices, anti-idling campaigns, technical analysis to look for potential improvements and other technology opportunities.
- Freight Technology Demonstration Fund: establishment of cost- shared demonstrations to test and measure new and underused freight transportation technologies in real-world conditions.
- Freight Technology Incentives Program: establishment of cost-shared funding to companies and non-profit organizations in freight transportation to help them to purchase and install proven emission-reducing technologies.
- ecoFREIGHT Partnerships: the building and maintaining of partnerships within the transportation sector to reduce emissions from freight transportation through fast and flexible voluntary actions that can support the regulatory framework.
- Marine Shore Power: demonstrating the use of shore-based power for marine vessels in Canadian ports to reduce air pollution from idling ship engines in some of Canada's largest urban centers.

In this analysis, it was assumed that the above actions would lead to improvements in the fuel efficiency for road freight and off-road vehicles and to a shift in which more efficient means of freight transportation were employed.

ecoENERGY for Renewable Power

The ecoENERGY for Renewable Power will invest $1.48 billion to increase Canada's supply of clean electricity from renewable sources such as wind, biomass, low-impact hydro, geothermal, solar photovoltaic and ocean energy. It will encourage the production of 14.3 terawatts hours of new electricity from renewable energy sources, which is enough electricity to power about one million homes. It will provide an incentive of one cent per kilowatt-hour for up to 10 years to eligible low-impact, renewable electricity projects constructed between April 1, 2007 and March 31, 2011.

- For the purpose of the analysis, it was assumed that geothermal, tidal and fuel cells were not ready for deployment within the timeframe. Electricity generated from wind, biomass, low-impact hydro, solar and wastes were taken into account.

- In the model, a larger share of renewable was assumed to penetrate the market. For example, the assumption was that 40 per cent of all the capacity to be built would be from targeted renewable sources. It is important to note that if new capacity is not required to meet the electricity demand, it was not forced into the capacity mix. The percentage of the "green power market share" was determined by the program target of 14.3 terawatt hours of new electricity. In order to determine which of the renewable sources would be used to generate this green power, the model takes into account the capital cost (net of the 1 cent per kilowatt-hour grant) of building and maintaining the capacity, and the renewable source with the lowest cost comes on-line first.

2.3 Provincial/Territorial Measures

There is significant variability in the type of measures being introduced at the provincial/territorial level as well as in the specific targets that each province/territory sets for those measures. Moreover, changes to government policy in recent months mean that it is challenging to describe a list of provincial/territorial measures with specificity. Below, however, are general descriptions of the types of measures introduced into the model (i.e., in which variable parameters account for provincial differences). A more detailed overview of provincial climate change announcements is presented at Annex 3.

Residential, Commercial and Industrial Solar (Thermal) Equipment Programs

Residential: Some provinces see an increase in the number of solar thermal units for water and space heating installed in residential housing units.

Commercial: The capital cost of solar thermal units declines in some provinces.

Residential and Commercial Building Code Improvements

Residential and Commercial Building codes and energy efficiency standards implemented provincially across Canada represent an effective way of reducing energy costs and increasing building and energy efficiency. The model presents the situation in which all provinces experience similar efficiency improvements to new residential and commercial buildings, due to the implementation of improved building code standards.

Vehicle Efficiency Standards

Vehicle efficiency standards are designed to stimulate improvements in transportation fuel technologies. Many provincial governments have expressed a commitment to establishing such standards. These are reflected in the model by improvements to device efficiency standards in some provinces beyond those anticipated by federal action in this area.

Emission Free Electricity Generation

The model assumes that certain provinces require all new fossil fuel electricity generation be GHG emission free starting in 2010, consistent with announced provincial government intentions.

Bio-fuel Portfolio Requirements

Many provinces have announced plans to implement bio-diesel and ethanol fuel content standards. Such action represents an important way to decrease carbon dioxide emissions from the transportation sector and increase the renewable fuel content of gasoline and fuel products, as well as enhancing provincial ethanol and alternative fuel research and production.

Carbon Levy (i.e. in Quebec)

The Government of Quebec has developed a fee on hydrocarbons, which is imposed on greenhouse gas emitting companies in the energy sector. The plan is based on the 'polluter pays' principle, and the Government, to ensure funding for the plan, is imposing new fees rather than using existing funding. Furthermore, the Government has requested that fees not be passed onto consumers. Royalties from the fee are to be set aside in a Green Fund to be used to finance the Government of Quebec's Climate Change Plan. The amount of the charge varies per fuel, and is based on the amount of carbon dioxide each fuel produces. These charges have been incorporated into the model.

Carbon Tax (i.e. in British Columbia)

The Government of British Columbia has announced that on July 1, 2008 it will begin to phase in a fully revenue-neutral carbon tax. The carbon tax will apply to virtually all fossil fuels, including gasoline, diesel, natural gas, coal, propane, and home heating fuel. The carbon tax starts at a rate based on $10 per tonne of associated carbon, or carbon-equivalent, emissions and will rise by $5 a year for the next four years – reaching $30 per tonne by 2012. All revenue generated by the carbon tax will be returned to individuals and businesses through reductions to other taxes.

Reduction of Fugitive Emissions Requirements from the Oil and Gas Sector

British Columbia and Saskatchewan are proposing to regulate the intensity of both flaring and fugitive emissions from their respective oil and gas sector. The model assumes reductions of fugitive emissions in those provinces.

Agricultural and Forestry Offsets

Several provinces (e.g., Saskatchewan, Ontario and Quebec) are planning to introduce programs aimed at developing forest and agricultural offsets.

2.4 Assumed Policy Evolution

The measures elaborated above summarize Environment Canada's review of the current suite of climate change policy measures announced by all levels of government in Canada. For analytical purposes, we have assumed that this "policy package" is representative of the collective approach of governments in Canada going forward.

This, of course, is a highly simplified assumption made necessary by the requirements of our modelling exercise. In reality, all of these policy measures will be subject to periodic review and evaluation by the respective governments responsible for them. Some measures will come to an end before 2020, perhaps, but not necessarily, to be replaced by alternative initiatives. Other measures will continue on in their present form, or continue but in a modified form. Furthermore, in the context of shared federal-provincial-territorial jurisdiction over environmental matters, some approaches currently resting with one level of government may be adopted or deepened by another.

From an analytical standpoint, this has meant that Environment Canada has had to make assumptions about the evolution of this complex policy environment, particularly with respect to the future of those policies and programs that are currently in place. In the sections below, we articulate the areas where we have assumed sustained action by both federal and provincial/territorial governments, as well as the general parameters that we have changed in the model to reflect the impact of those actions.

Buildings

Many provinces have announced their intention to improve upon existing residential and building codes. The actual percentage improvement to energy efficiency from those improvements varies by province but tends to fall in the range of 15 per to 25 per cent. In the model we have elected to assume a 30 per cent improvement over the forecast period, capturing we believe the likely enhancement to the policy that would occur over time. Moreover, for simplicity we have assumed the same improvement across all provinces – that is, that there is an eventual equilibration of the impact on efficiency of building codes among all provinces and territories.

Transportation

As it stands, Quebec, Ontario and New Brunswick have introduced measures to place speed limiters in trucks that keep velocities below 105 km/h. In the model we assume that this measure is eventually adopted by all provinces. We also assume that the shared federal-provincial policy support for renewable fuels continues and that a pan-Canadian standard of 10 per cent ethanol in gasoline and 5 per cent bio-diesel in diesel and heating oil develops, without making a distinction as to which governmental level, federal or provincial/territorial, introduces the enhancement. There also exist many opportunities to reduce freight truck energy use and improving technical energy efficiency through improved technology and operations. We've assumed that governments provide market signals which will support actions aimed at increased aerodynamics, weight reductions, reduced engine friction, improved engine and transmission designs, more efficient tires, and more efficient accessories.

Electricity Generation

Some provinces, notably Saskatchewan and Alberta, have discussed the possibility of building, or have announced plans to build, clean coal power plants. To capture the potential reductions from this policy option, we have assumed the construction of four 500 MW plants, two in Alberta and two in Saskatchewan, within the forecast period. This new capacity is modelled as replacing more emissions intensive plants within those provinces.

Industry

In recent years, both the federal government and the provinces have introduced a variety of programs and policies to encourage firms to acquire more energy efficient and environmentally friendly machinery and equipment. We assume in the model that this trend continues and augments as a result of new government initiatives such that the turnover of capital stock accelerates over the forecast period.

Potential Opportunities for the Future That Were Not Modelled

It should be noted that there were a number of promising options for reducing greenhouse gases that were identified, having been discussed by one or more levels of government, but which were not modelled by Environment Canada for this analysis because of the lack of detail on policy and program design. These provide meaningful examples of measures that could become part of the national climate change mitigation effort as both federal and provincial/territorial governments, separately and collaboratively, adjust their policy mixes over time.

Clean Electricity

East-West Grid Expansion

Manitoba and Quebec, as well as Newfoundland and Labrador and British Columbia, have tremendous hydroelectric resources that could be developed if appropriate infrastructure were in place. There have been discussions at the provincial level about reinforcing and expanding the interconnections among provinces as a first step in creating a national east-west power grid (e.g., between Ontario and Quebec and Ontario and Manitoba).

Peace River "C" and Lower Churchill Hydro Projects Development

An expansion of the Peace River "C" hydro project in British Columbia and an expansion of the Lower Churchill Hydro project in Newfoundland could provide additional emissions reductions in the future (this is consistent with the Fall, 2007 National Energy Board "Continuing Trends" forecast).

Non-Regulated Mining and Manufacturing

Many mining and manufacturing operations are outside of the coverage of current and planned greenhouse gas regulatory regimes. Additional regulations to improve the process efficiency of secondary mining and manufacturing could be considered as an enhancement to the current approach by governments in this area.

Enhancement of Building Code Improvements

A further efficiency improvement for all new residential buildings, both single and multi-family units, beyond the current 30 per cent improvement assumed in our analysis could be pursued. Given the pace of improvement in materials and building construction practices, it may be possible to achieve improvements in building efficiency in the range of 50 per cent by 2020.

Similarly, there remains scope for an even more aggressive process efficiency standard for commercial buildings.

Smart Urban Growth

There exist many opportunities at the municipal level for emissions reductions based on land use planning aimed at:

- replacing low-density detached and semi-detached houses with high- and medium- density housing;
- controlling urban sprawl; and,
- improving access to alternative forms of transportation.

ANNEX 3: PROVINCIAL/TERRITORIAL TARGETS AND ACTIONS

In Budget 2007, the Government of Canada provided $1.52 billion in funding to the provinces through the Clean Air and Climate Change Trust Fund for initiatives to reduce greenhouse gases and air pollution.

This contribution is in addition to the extensive measures that provinces have announced to date to respond to climate change. The list below, while not exhaustive, is intended to reflect the broad areas of provincial action.

British Columbia

Provincial target of reducing GHG emissions 33 per cent below 2007 levels by 2020, and at least 80 per cent below 2007 levels by 2050.

Carbon Tax: On July 1, 2008, subject to approval by the legislature, British Columbia will begin to phase in a fully revenue-neutral carbon tax. The carbon tax will apply to virtually all fossil fuels, including gasoline, diesel, natural gas, coal, propane, and home heating fuel. The carbon tax starts at a rate based on $10 per tonne of associated carbon, or carbon-equivalent, emissions and will rise by $5 a year for the next four years – reaching $30 per tonne by 2012. All revenue generated by the carbon tax will be returned to individuals and businesses through reductions to other taxes.

Energy: In The 2007 BC Energy Plan, the government required that all electricity in B.C, connected to the integrated grid, must have net zero GHG emissions by 2016. In addition, the government directed B.C Hydro to develop a program to purchase electricity from renewable projects which have a capacity of 10 MW or less.

Transportation: New tailpipe emission standards are required for all new vehicles sold in B.C. and will be phased in over the period 2009 to 2016. This is expected to reduce carbon dioxide emissions from automobiles by 30 per cent by 2016. The government has committed to adopt a low carbon fuel standard. In addition, a federal-provincial partnership has been established and an investment of $89 million is expected to support fuelling stations and the world's first fleet of 20 fuel cell buses. Furthermore, the province has committed to 5 per cent ethanol content in gasoline/diesel by 2010. Budget 2008 proposes $370 million for capital and operating expenses to improve and expand public transportation.

Commercial and Residential: Implementation of building standards by 2010: Includes energy efficiency targets for 12.5 per cent of existing single family dwellings to reduce energy use by 17 per cent, all newly constructed single family dwellings to reduce energy use by 32 per cent, 9 per cent of existing multi-unit residential dwellings to reduce energy use by 16 per cent, all newly constructed multi-unit residential dwellings to reduce energy use by 37 per cent, 20 per cent of existing commercial and industrial buildings to reduce energy use by 14 per cent and all new commercial and industrial buildings to reduce energy use by 20 per cent. Budget 2008 announced LiveSmartBC, an energy efficiency incentive program, as well as other initiatives, to encourage individuals and communities to make more energy efficient choices. A provincial sales tax exemption was also announced for some products such as energy star qualified residential refrigerators, clothes washers and freezers.

Renewable Fuels: British Columbia will require a 10 per cent carbon reduction in fuels by 2020 and 5 per cent renewable fuel standard for diesel by 2010.

Oil and Gas: The government of British Columbia has committed to reducing greenhouse gas emissions from the oil and gas industry to 2000 levels by 2016.

Electricity: 90 per cent of electricity to be generated from renewables. B.C has contracts for the development of 300 MW of wind energy, with the first scheduled for completion in 2008.

Government: The government has committed to becoming carbon neutral by 2010, and for Government travel to be carbon neutral.

Partnerships: B.C has agreed to join the Western Regional Climate Action Initiative which currently consists of Arizona, California, New Mexico, Oregon, Utah, Washington and Manitoba. Under the agreement, the five states, with B.C. and Manitoba jointly set a regional GHG emissions reduction target of 15 per cent below 2005 levels by 2020. The provincial government is providing funding for community and municipal conservation efforts.

Housing retrofit: Program in operation.

Public awareness/ education: Program in operation.

Alberta

Alberta's Climate Change Plan calls for a 50 per cent reduction in GHG emissions from its projected 2050 business as usual levels, or a 14 per cent reduction in GHG emissions relative to 2005 levels.

GHG legislation: Alberta's Bill 3, Climate Change and Emissions Management Amendment Act and its accompanying Specified Gas Emitters Regulation came into force in July, 2007. It represents the first provincial GHG reduction legislation in Canada. In it, companies that emit more than 100 Kilotonnes of GHGs per year are required, by regulation, to reduce their emissions intensity by 12 per cent starting July 1, 2007. There are three ways in which companies can meet their target: through in house reductions, by contributing to the Alberta-based technology fund at a rate of $15/tonne, for every tonne above the 12 per cent target, or by investing in Alberta based, in-province offset projects. According to the plan, this represents a reduction from the provincial business as usual levels of 20 megatonnes CO_2e by 2010 and 60 megatonnes CO_2e by 2020.

Alberta's Climate Change Plan, released in January, 2008, states that greenhouse gas emissions will be cut in half from its projected 2050 business as usual levels. Carbon capture and storage, consumer incentives and greener energy production are keys to achieve this reduction of about 200 megatonnes by 2050. The long-term goal of the plan corresponds to a 14 per cent reduction from 2005 levels by the year 2050 (or 30 megatonnes from 2005 levels).

Renewable energy: By 2008, 12.5 per cent of Alberta's total electricity will be generated from renewable and alternative sources, primarily wind and biomass, and 20 per cent of its energy needs from renewable or alternative sources by 2020. Furthermore, the government announced that a Renewable Energy and Energy Efficiency Revolving Fund will be created. The target of the fund is to achieve a 25 per cent reduction in energy consumption from fossil fuels through the use of energy efficiency measures and increase the use of renewable energy within a five year period.

Energy: All new coal fired facilities must have GHG emission levels equal to those of combined cycle gas turbine.

Transportation: The province has committed to 5 per cent ethanol content in gasoline/diesel by 2010.

Government: A commitment to the continued purchase of 90 per cent green electricity for all government buildings.

Housing retrofit: Program in operation.

Public awareness/ education: Program in operation.

Saskatchewan

Target: The government committed to a stabilization of GHG emissions at 2004 levels by 2010, a 32 per cent reduction in GHGs from 2004 levels by 2020 and an 80 per cent reduction by 2050.[5]

Energy: The Province will ensure that all of SaskPower's new and replacement electricity generation facilities are either GHG free or fully offset by emission credits. In addition, the province will develop a conservation program to reduce SaskPower's electricity load by 300 megawatts by 2017.

Transportation: On November 1, 2005, Saskatchewan became the first province to implement legislation requiring all fuel distributors in the province to distribute an average blend of 1% per cent ethanol in unleaded gasoline; in January, 2007, the requirement increased to 7.5 per cent. Furthermore, the province intends to work with industry to develop E-85 (fuel blends of 85 per cent ethanol and 15 per cent gasoline) corridors in the Province.

Agriculture and Forestry: The government will encourage the establishment of agricultural soil sinks, which is expected to provide reductions of 25 megatonnes CO_2e by 2012 and 37 megatonnes by 2050. In addition, the reforestation of 20, 000 hectares by 2017 is expected to contribute 4.9 megatonnes reductions of CO_2e.

Education: Climate change education is set to receive approximately $2 million, green technology commercialization approximately $1 million and the energy conservation initiative $2.8 million.

Government: The provincial government has committed to 30 per cent greater energy efficiency in new government buildings.

Housing retrofit: Program in operation.

Public awareness/ education: Program in operation.

Manitoba

Target: The Government agreed to match the Kyoto Protocol targets, and in 2002, Manitoba's Climate Change report "Kyoto and Beyond- A Plan of Action to Meet and Exceed Manitoba's Kyoto Targets" stated that by 2010, Manitoba could reduce GHGs by 18 per cent from 1990 levels, and by 2012, the province could achieve a 23 per cent reduction in GHGs from 1990 levels, provided the right conditions are in place.

In the November, 2007, Speech from the Throne, the government committed to introduce legislation detailing Manitoba's Kyoto target and the measures for its achievement. As of January, 2008, no details had been provided. However, the government pledged that by 2010, the province would reduce its GHG emissions to below 2000 levels. By 2012, Manitoba has pledged to cut GHG emissions by more than 3 megatonnes.

Energy: The government has announced a new provincial energy saving target of 842 MW of electricity by 2017. In addition, the government has committed to developing 1000 megawatts of wind power over the next

5 Saskatchewan's newly elected Government has indicated that it remains committed to these targets. However, the measures described in this document reflect the climate change plan announced by the previous government in 2007.

decade. The Speech from the Throne outlined the provincial government's plan to phase down the Brandon coal plant and make electrical generation in Manitoba coal-free, following the conversion of the Selkirk coal plant to natural gas. It will also require the capture of methane emissions from large landfills.

Transportation: The government has passed biofuels legislation which mandates the use of 8.5 per cent ethanol in gasoline products. The mandate is currently pending and will take effect once local production grows to meet the demand. It is expected to generate an annual reduction of 150 kilotonnes of GHGs. An average of 8.5 per cent ethanol means some pumps will sell gasoline without any ethanol and others may have a blend as high as 15 per cent. The ethanol mandate is intended to cut tailpipe emissions and should reduce Manitoba's overall GHG emissions by 135 kilotonnes. Additionally, a $2000 rebate is offered for hybrid vehicle purchase.

Housing retrofit: Program in operation.

Partnerships: The Manitoba-California MOU came into force December, 2006. Its central feature is support from California for Manitoba's planned GHG reduction legislation. In addition, Manitoba joined the Western Regional Climate Action Initiative which currently consists of Arizona, California, New Mexico, Oregon, Utah, Washington and British Columbia. Under the agreement, all parties jointly set a regional GHG emissions reduction target of 15 per cent below 2005 levels by 2020. Additionally, Manitoba signed the Midwestern Regional Greenhouse Gas Reduction Accord in mid November, 2007 along with the U.S states of Illinois, Ohio, Michigan, Wisconsin, Minnesota, Indiana, Iowa, Kansas and South Dakota. Within the next year, targets for greenhouse gas emission reductions and complete development of a proposed cap-and-trade system are to be established. Targets will be consistent with the 60 to 80 per cent recommended by the Intergovernmental Panel on Climate Change (IPCC). Full implementation of the accord is to be completed within 30 months.

Government: Buildings that receive government funding must meet the Silver LEED Standard.

Public awareness/ education: Program in operation.

Ontario

Target: The government of Ontario recently announced a greenhouse gas reduction strategy that aims to cut emissions 6 per cent below 1990 levels by 2014 (61 megatonnes), 15 per cent below 1990 levels by 2020 (99 megatonnes), and 80 per cent below 1990 levels by 2050. The provincial 2014 GHG emissions reductions are forecast to come from the closure of coal fired plants (50 per cent), research & innovation (17 per cent); the federal plan for industrial reductions (11 per cent); transportation (10 per cent); municipal measures (8 per cent); and homes (3 per cent).

Energy efficiency: Ontario has set targets to achieve a total of 6,300 MW of electricity demand reduction through conservation by 2025. Of this, 2,700 MW of savings are to be realized by 2010.

Renewable energy: The province has set targets to obtain 10% per cent of energy from renewable sources by 2010. By 2025, Ontario wants to increase its clean, renewable energy capacity by 50 per cent. Currently, Ontario has over 1000MW of wind energy under development.

Transportation: A $17.5 billion investment has been earmarked for the development of rapid transit over the next 12 years. In addition, the government announced a $650M fund, geared towards innovation, including an emphasis on new clean energy technologies and building the next-generation of "green" cars. Additionally, a $2000 rebate is offered for hybrid vehicle purchase. Finally, the government has committed to 5 per cent ethanol content in gasoline and diesel and a 10 per cent reduction in the carbon content of gasoline and diesel fuel by 2020. Transportation sector actions are expected to contribute to 10 per cent of Ontario's 2014 emissions reduction target.

Coal fired plants: The government has committed to phasing out Ontario's coal-fired power stations by 2014. Coal closure is expected to reduce Ontario's emissions by up to 30 megatonnes of carbon dioxide a year. Ontario is the first jurisdiction in North America to commit to phasing out all coal-fired generation. The closure of coal fired plants is expected to contribute to 50 per cent of Ontario's 2014 emissions reduction target. To achieve the phase-out, Ontario has been developing a long-term strategy to diversify electricity supply and reduce electricity demand, which includes doubling renewables and conservation, and modernizing Ontario's nuclear capacity.

Government: Currently, the government has committed to reducing its GHG emissions by 10 per cent.

Research and innovation: Actions are expected to contribute to 20 per cent of Ontario's 2014 emissions reduction target.

Housing Retrofits: Home retrofit program in operation.

Public awareness/ education: Program in operation.

Quebec

Target: Reduction of GHG emissions to 6 per cent below 1990 levels by 2012. This is expected to result in a 13.8 megatonnes reduction below the anticipated 2012 emission levels. The government of Quebec envisions a joint Federal /Provincial partnership in realizing the target of a 6 per cent reductions in GHG from 1990 levels by 2012 (13.8 megatonnes) , where the province commits to a reduction of 10 megatonnes, with the expectation that federal measures will reduce a further 3.8 megatonnes in order to reach the target.

Quebec's 1990 GHG emissions were 85.3 megatonnes, and the Quebec government has estimated the 2012 GHG emissions to be 94 megatonnes, necessitating a 13.8 megatonnes reduction in GHGs in order to reach the target. The actions in the provincial plan equate to 10 megatonnes worth of reductions, and require the remaining 3.8 megatonnes of reductions to be achieved with Federal support, as provided through the Clean Air and Climate Change Trust Fund in Budget 2007.

Introduction of a Carbon Tax: A carbon tax has been established and has come into force on Oct 1, 2007. It is expected to raise $200 million a year and will finance Quebec's plan to reduce greenhouse gas emissions and favour public transit.

The actual amount of the carbon tax varies according to the amount of carbon dioxide each fuel produces. For gasoline, the tax is 0.8 cents a litre, diesel is 0.9 cents and propane is 0.5 cents a litre. The tax for light heating oil is 0.96 cents, heavy heating oil is 1 cent a litre, and the tax for coke used in steel making at 1.3 cents a litre. The tax associated with coal use is confirmed at $8 a tonne.

Energy: Quebec intends to add 4,000 MW of wind power by 2015: however only 500 MW of this power is new to the most recent climate change plan. In addition, 4500 MW of hydro-electricity projects are expected to be announced in the next three years. Beyond 2015, the development of wind energy will be dependant upon the development of hydroelectric power: for every segment of hydroelectric power developed, a wind energy project of 10 per cent of hydroelectric project value must also be developed.

Energy efficiency: All new commercial and industrial buildings are to use 25 per cent less energy by 2008.

Transportation: $120 million of the $200 million in raised revenue from the Carbon tax will be used to develop public transportation, with the intention of increasing transit use 8 per cent by 2012. In addition, the Quebec government has committed to requiring 5 per cent ethanol in all its gasoline by 2012 and a 20 per cent improvement in fuel efficiency by 2012. The provincial government has approved new regulations to adopt

California-level standards to reduce pollution from new cars. Manufacturers will have to ensure that the average level of emissions from their cars in the target period does not exceed the California standard to reduce emissions by 30 per cent. The standards will come into effect between 2010 and 2016 and are expected by Quebec to reduce emissions by nearly 2 megatonnes. Finally, a tax exemption of up to $1000 is available on the purchase of new hybrid vehicles.

Together, energy and transportation measures are expected by Quebec to yield GHG reductions of 4.8 megatonnes.

Industry: Voluntary agreements and regulation regarding halocarbons are expected to achieve a reduction in GHG emissions of 1.6 megatonnes by 2012. The government announced new programs to replace industrial and institutional hot-air generators and cooling systems.

*Residual mate*rials: The implementation of regulation for landfills and the incineration of residual material and biogas capture in existing landfills are expected by Quebec to achieve 3.0 megatonnes worth of GHG emission reductions.

Agriculture: The combination of waste treatment and recovery of agriculture biomass is expected by Quebec to generate 0.3 megatonnes of GHG emission reductions.

Research and Development: Funding of $100 million dollars from federal transfer payments has been earmarked for the research and development of new techniques to store CO_2.

Government: Existing government buildings, including universities and hospitals, are required to improve their energy efficiency by 10 to 14 per cent, and new government buildings by 20 per cent. Government leadership is expected by Quebec to achieve a reduction of 0.2 megatonnes of greenhouse gas emissions. Additionally, public awareness actions are expected to supply 0.1 megatonnes of GHG emission reductions.

Partnerships: Provincial commitment to action on climate change through participation in the conference of New England Governors/ Eastern Canadian Premiers to reduce GHG emissions to 1990 levels by 2010, and 10 per cent below 1990 levels by 2020.

Public awareness/ education: Program in operation.

New Brunswick

Target: To reduce greenhouse gas emissions to 1990 levels by 2012. Furthermore, by 2020, emissions must be reduced by 10 per cent below 1990 levels. The government of New Brunswick announced measures expected to reduce GHG emissions 5.5 megatonnes by 2012, assuming that GHG emissions in 2012 are equal to 2004 levels.

Energy: The government has committed to a standard requiring that 10 per cent of electricity sales must come from new renewable sources by 2016. In addition, it announced $15.3 million of funding be provided to the New Brunswick Energy Efficiency and Conservation Agency for comprehensive home energy conservation initiatives. Finally, the Province is moving forward with the refurbishment of the Point Lepreau nuclear station. If the refurbishment goes through it would result in approximately 0.6 megatonnes per year of CO_2 emission reduction by 2010. New Brunswick is expected to add 100 MW of wind energy to the grid in 2008. Energy efficiency and renewable energy actions are expected to reduce GHG emissions by 2.2 megatonnes by 2012.

Government: The Government will lead by example and reduce GHG emissions from public operations by 25 per cent by 2012, measured from 2001 levels. Government leadership actions and public awareness programs are expected to yield 0.2 megatonnes of GHG emission reductions by 2012.

Transportation: The province anticipates implementing energy consumption vehicle standards similar to low emission vehicle standards in California, provide incentives to switch to alternative fuel and to fuel efficient vehicles, implement vehicle emissions standards and emissions testing and encourage research in biofuels. Measures undertaken to reduce GHG emissions from transportation are expected to achieve 1.2 megatonnes in reductions. Furthermore, New Brunswick is requiring 5 per cent ethanol content in gasoline and diesel by 2010.

Waste management: projects to increase waste diversion and recycling and encourage the capture of methane gases from landfills to produce energy are expected to translate into GHG emission reductions of 1.2 megatonnes by 2012.

Industrial sources: GHG reduction actions are expected to provide 0.7 megatonnes of GHG emission reductions. The province recognizes that potential for further reductions exists with partnership from the federal government.

The above measures are expected to reduce New Brunswick's GHG emissions 5.5 megatonnes by 2012.

Housing Retrofits: Housing retrofit program in operation.

Partnerships: Provincial commitment to action on climate change through participation in the conference of New England Governors/ Eastern Canadian Premiers to reduce GHG emissions to 1990 levels by 2010, and 10 per cent below 1990 levels by 2020.

Public awareness/ education: Program in operation.

Nova Scotia

The government has committed to reducing GHG emissions to ten per cent below 1990 levels by 2020.

Energy: 18.5 per cent of the total electricity needs of the Province will be obtained from renewable energy sources by 2013.

Transportation: The province will adopt emissions standards for greenhouse gases and air pollutants from new motor vehicles, similar to those of California by 2010.

Education: Conserve Nova Scotia will be given a $10.2 million budget to help educate the public on reducing their energy use. Programs will focus on residential, commercial, industrial, and transportation sectors.

Partnerships: Provincial commitment to action on climate change through participation in the conference of New England Governors/ Eastern Canadian Premiers to reduce GHG emissions to 1990 levels by 2010, and 10 per cent below 1990 levels by 2020.

Public awareness/ education: Program in operation.

Prince Edward Island

The government has committed to reducing GHG emissions to ten per cent below 1990 levels by 2020.

Renewable energy: Adoption of a 15 per cent renewable portfolio standard by 2010.

Transportation: Hybrid vehicle rebate program in operation.

Partnerships: Provincial commitment to action on climate change through participation in the conference of New England Governors/ Eastern Canadian Premiers to reduce GHG emissions to 1990 levels by 2010, and 10 per cent below 1990 levels by 2020.

Public awareness/ education: Program in operation.

Newfoundland and Labrador

Target: Reduction GHG emissions by 1.5 megatonnes annually, however, this is not an official provincial objective. There was no mention of climate change action plans in the 2007 Throne Speech nor was there any direct funding. The budget allocates $12 million towards the energy plan initiatives but this does not include any GHG reduction activities or targets. However, the province is a member of New England Governors/ Eastern Canadian Premiers, and together agreed to reduce GHG emissions to 1990 levels by 2010, and 10 per cent below 1990 levels by 2020.

Renewable energy: The Energy Plan states that 98 per cent of provincial electricity needs will be derived by renewable sources by 2016.

Electricity: Increase of 25 MW of electricity generated from wind power by December, 2008.

Housing retrofit: Program in operation.

Partnerships: Provincial commitment to action on climate change through participation in the conference of New England Governors/ Eastern Canadian Premiers to reduce GHG emissions to 1990 levels by 2010, and 10 per cent below 1990 levels by 2020.

Public awareness/ education: Program in operation.

Yukon

Target: There are no specified GHG reduction targets

No climate change action plan to date however the 2007 budget allocated $145,000 for climate change. The government released a climate change strategy in September, 2006 with the intention of reducing GHG emissions, developing adaptation strategies, enhancing public awareness of climate change, and supporting research and innovation on climate change. However, minimal steps have been taken in this direction.

Carmacks-Steward Transmission Project: $10 million dollar project to connect the mine to the grid rather than rely on diesel. Stage one is expected to reduce GHGs by 24.1 kilotonnes/year.

Public awareness/ education: Program in operation.

Northwest Territories

Target: No specified target

The Greenhouse gas strategy 2007-2011 was released in March 2007 but did not set out any specific provincial targets, although it stated it will support Canada in meeting its obligations under the Kyoto Protocol; however, there was no direct funding allocated to climate change issues in the 2007 budget.

Government: The greenhouse gas strategy 2007-2011 commits the provincial government to lead through example by adopting a target to reduce greenhouse gas emissions from its own operations to 10 per cent below 2001 levels by 2011.

Housing Retrofits: There are several operational programs that focus on retrofitting existing homes for energy efficiency.

Public awareness/ education: Program in operation.

Nunavut

Target: There is no specific greenhouse gas reduction target. Nunavut's climate change activities are directed towards monitoring, documenting, and adapting to the impacts from climate change, as their GHG emission statistics are currently combined with those of the Northwest Territories.

Public awareness/ education: Program in operation.

ANNEX 4: THE ENVIRONMENT CANADA REFERENCE CASE TO 2020

The reference case developed by Environment Canada is designed to incorporate the best available information about economic growth as well as energy demand and supply into the future. It captures how future production and consumption of goods and services in Canada will impact on greenhouse gas emissions. Economic projections were developed by Informetrica Limited and were the subject of extensive consultations in the summer of 2007 among key federal departments and industry. Moreover, the economic assumptions were calibrated to the long-term economic forecast put forward by Finance Canada.

Similarly, forecasts of major energy supply projects (i.e., oil sands production, large hydro capacity expansions, nuclear refurbishment and additions) were derived from the National Energy Board's "Continuing Trends" forecast, presented in their *Canada's Energy Future - Reference Case and Scenarios to 2030.* As a result, the main economic and energy supply underpinnings of the Environment Canada reference case are consistent with those of other governmental and non-governmental institutions.

In describing the reference case, we begin by examining the macroeconomic context in Canada and continue with the economic prospects and greenhouse gas emissions profiles of key sectors of our economy as we anticipate them evolving over time.

Macroeconomic Outlook

Canadian real GDP in 2006 was approximately $1,100 billion ($1997). This represents an average annual real GDP growth rate of approximately 2.8 per cent over the 16 previous years. This growth is expected to continue at a slightly slower pace into the future, as real GDP increases by approximately 25 per cent by 2015 and 37 per cent by 2020, relative to 2006 levels. On average, real GDP is expected to grow by about 2.3 per cent per year over the 2006-2020 period.

Key Macroeconomic Indicators – 2006 to 2020

	2006	2010	2015	2020
Gross Domestic Product at Basic Prices ($1997 Billion)	1,100	1,230	1,375	1,506
Goods ($1997 Billion)	335	374	420	455
Services ($1997 Billion)	765	855	955	1,050
Gross Output - All Industries ($1997 Billion)	2,237	2,510	2,814	3,073
Exchange Rate ($Can per $U.S.)	1.13	1.12	1.10	1.08
Inflation Rate (Consumer Price Index)	1.9	0.9	2.0	2.1
Exports - Total Goods & Services ($1997 Billions)	483	557	639	693
Imports - Total Goods & Services ($1997 Billions)	507	602	670	726
Population (000,000's)	32.5	33.6	35.1	36.4
Households (000,000's)	12.9	13.7	14.5	15.3
Labour Force (000,000's)	17.6	18.4	19.0	19.2
Disposable Personal Income ($1997 Billions)	716	806	893	974
Unemployment Rate (%)	6.3	6.1	6.1	6.3

Gross Output, which is a proxy for industrial shipments, is also projected to show significant growth. It is expected to increase by approximately 26 per cent by 2015 and 37 per cent by 2020, relative to 2006 levels. Imports and exports are both projected to increase by 32 per cent by 2015 and 43 per cent by 2020, relative to their respective 2006 levels.

Energy Demand

Demand for energy up to 2020 is expected to be driven mostly by increased energy needs by the energy sector itself more so than by the end use sectors. By 2020, energy used in the production, transformation and distribution of energy is expected to increase by 34 per cent relative to 2006 levels.

Energy Demand By the Energy Sector				
(PJ/Yr)	**2006**	**2010**	**2015**	**2020**
Total	5,962	6,609	7,575	7,988
Conventional Oil and Gas	741	678	643	547
Oil Sands	468	1,099	1,523	1,781
Utility Electric Generation	3,824	3,887	4,178	4,437
Petroleum Refining	711	734	1,016	1,028
Pipelines	218	211	215	195

Within the energy production sector, energy demand for oil sands production is notable - by 2006 the oil sands sector had more than doubled its demand over a sixteen year period and is projected in the reference case to triple it by 2020. Moreover, the oil sands share of total energy sector energy demand rises from about 7.9 per cent in 2006 to 22.3 per cent by 2020.

In contrast to the demand for energy by the energy sector, energy demand by the end-use sector is expected to be more stable. Historical demand increased appreciably by 2006 but the fuel mix remained relatively constant. In the reference case, overall energy demand by the end-use sector continues to increase, albeit by less than the 34 percent increase for the energy sector. Overall end-use demand increases 22 per cent by 2020 relative to 2006 levels.

Energy demand by end use sector				
PJ/Yr	**2006**	**2010**	**2015**	**2020**
Total	11,719	12,375	13,402	14,285
Residential	1,483	1,604	1,722	1,832
Commercial	1,227	1,372	1,533	1,669
Industrial	3,220	3,302	3,531	3,734
Industrial - Energy Related	2,661	2,710	2,861	3,016
Industrial - Non-Energy	559	594	670	718
Transportation	2,569	2,793	3,085	3,316

Energy Prices

The world oil prices (i.e., West Texas Intermediate (WTI) crude oil price) and the natural gas price (i.e., Henry Hub price of natural gas) used in this analysis are based on the National Energy Board's Continuing Trends case. The last decade saw a steep increase in the world price for energy products. Prices for crude oil and for natural gas, in particular, were over US $60 per barrel and US$ 7.32 per thousand cubic feet respectively in 2006. However, that trend is not expected to continue. Under the National Energy Board's Continuing Trends case, the global price of crude oil is expected to fall to $50 per barrel (in 2005$) by 2010 and remain constant, while natural gas prices are forecasted to remain at an average of US $7.14 per thousand cubic feet (in $2005). This is consistent with the current views of other energy forecasters, such as the United States' Energy Information Agency.[6]

Energy Production

Historically, growth has occurred in all areas of oil and gas production, with over half the growth coming from natural gas production. In the reference case, however, natural gas and conventional oil production both decrease over time, but the increase in production from oil sands operations more than makes up for this decline. As such, it is projected oil sands in situ and oil sands mining production will increase by 353 per cent and 122 per cent, respectively, from 2006 to 2020, while gas production will decline by 24 per cent and light oil production by 48 per cent, over the same period.

Growth in oil and gas production				
	2006	**2010**	**2015**	**2020**
Light Oil (000's bbl/day)	666	570	451	348
Heavy Oil (000's bbl/day)	517	472	399	337
Frontier Oil (000's bbl/day)	324	308	423	309
Oil Sands In-Situ (000's bbl/day)	393	1,016	1,502	1,780
Oil Sands Mining (000's bbl/day)	816	1,136	1,535	1,812
Oil Sands Upgraders (000's bbl/day)	572	1,443	1,868	2,154
Gas (BCF)	6,839	6,286	6,002	5,230

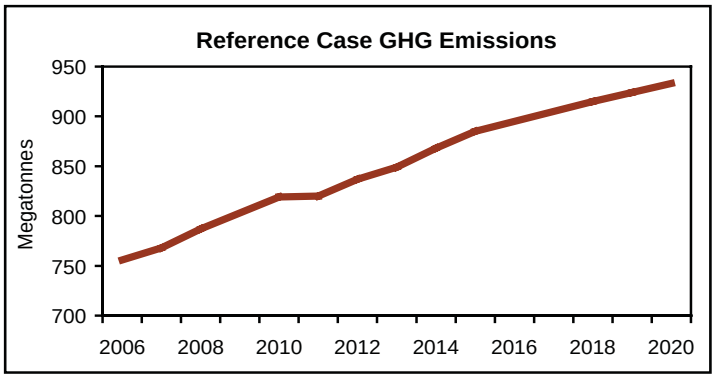
Aggregate electricity generation is also expected to increase substantially in the reference case, by about 25 per cent from 2006 to 2020, with fuel mix changes as generation increases. It should be noted that the proportion of generation coming from wind power and other renewable sources increases in the 2006 to 2020 period. As well, hydro-electric generation increases throughout this period and provides more than half of Canada's generation by 2020. Importantly though, natural gas-fired generation increases about two and a half times its 2006 levels and provides almost 40 per cent of the growth in total electricity generation.

6 http://www.eia.doe.gov/oiaf/ieo/oil.html. (Accessed on February 11, 2008.)

Electricity generation by fuel type				
Electricity Generation by Source (TWh/Yr)	**2006**	**2010**	**2015**	**2020**
Total	623.0	678.9	733.2	780.4
Biomass	9.0	10.4	13.4	14.9
Coal	85.6	80.9	66.4	65.7
Hydro	361.3	374.1	385.6	397.8
Landfill Gases/Waste	0.2	0.2	0.2	0.2
Natural Gas	54.4	79.9	103.4	115.3
Nuclear	93.1	88.6	104.7	113.0
Petroleum Coke	1.7	1.8	1.8	1.8
Refined Petroleum Products	16.1	25.8	25.7	28.3
Wind	1.6	17.2	32.0	43.4

Greenhouse Gas Emissions

Historically, the growth in energy production and energy demand has been a key factor influencing Canada's GHG emissions. That is expected to continue to be the case in Environment Canada's reference case. However, changes in other fundamental factors such as population growth and personal income will also contribute to the growth in GHG emissions. As it stands, emissions in 2005 were 749 megatonnes; emissions for 2006 are estimated at 760 megatonnes. In the reference case these are expected to grow to about 940 megatonnes by 2020.



In terms of sector specific changes, GHG emissions from oil sands production will almost triple between 2006 and 2020, making it the largest single contributor to Canada's medium-term emissions growth. Emissions growth in other sectors is within the 17 to 39 per cent range. Moreover, the 2020 emissions levels for conventional oil as well as for natural gas production and distribution are projected to be lower than the 2006 level because of declining production, and emissions for electricity and heat generation are projected to be lower than 2006 because of changes to the fuel mix of electricity generation.

Emission Growth By Sector				
	2006 Mt	2020 Mt	2020 Relative to 2006	
			Mt	%
Residential and Commercial	86	109	23	27%
Mining and Manufacturing - Regulated	77	90	13	17%
Mining and Manufacturing - Non-Regulated	28	38	11	39%
Conventional Oil and Gas Production and Distribution and Refining	132	114	-18	-14%
Oil Sands	29	108	79	271%
Electricity and Heat Generation	123	122	-2	-1%
Transportation	177	232	55	31%
Others	104	124	20	20%
Total	756	937	181	24%

There will also be substantial growth in GHG emissions from other sectors of the economy, particularly transportation. By 2020, the projected emissions increase for the transportation sector is 31 per cent, relative to 2006. While this increase in emissions is substantial, the growth rate in transportation emissions is well below that for the economy as a whole, indicative of the efficiency improvements that are expected for this sector even under business-as-usual assumptions.

Within the transportation sector, passenger transport is expected to continue to be the dominant emissions category, accounting for some 55 per cent of the sector's total emissions. This increase in emissions will be driven by increases in population and personal income, and the tendency of Canadians to rely on emission intensive forms of transport – personal vehicles (e.g., light trucks and sport utility vehicles). Nevertheless, freight transport will also represent a sizeable fraction of growth in the sector's emissions, driven by rising domestic and international trade.

In the electricity and heat generation sector[7], emissions are expected to decrease by 2 per cent over the 2006 to 2020 period. While emissions here increased up to 2006, in the future, ongoing changes to the fuel mix of electricity generation between carbon intensive coal-fired electricity and zero-carbon electricity, including hydroelectricity, nuclear and low impact renewables (e.g. wind) will tend to limit the growth of emissions for this sector.

Provincial Outlook

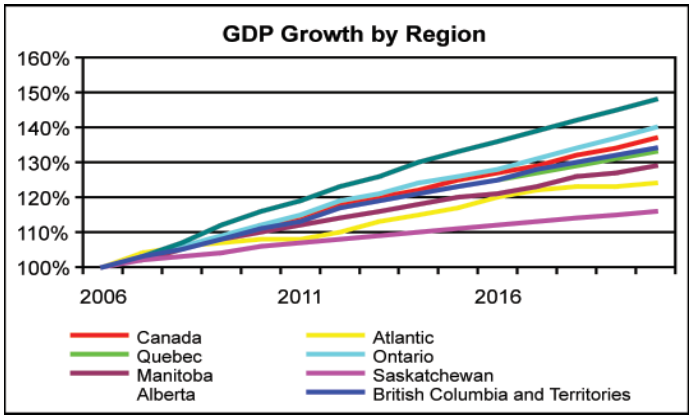
Economic trends by province

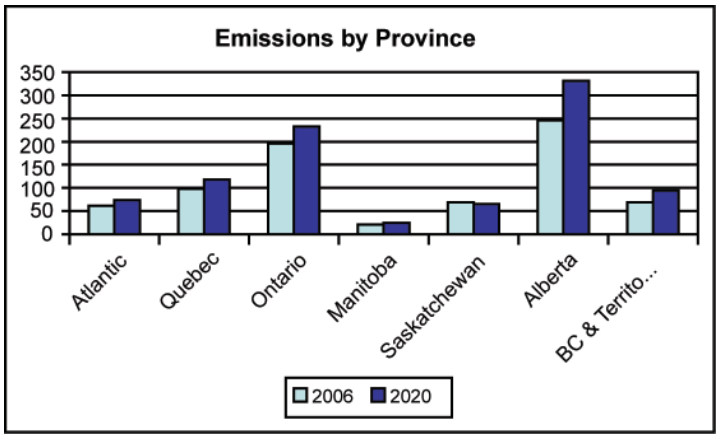
While all provinces enjoyed economic growth in recent years, Ontario, Alberta, British Columbia and the Territories each grew faster than Canada as a whole, in the period leading up to 2006. This distribution of economic growth is expected to continue, with growth between 2006 and 2020 varying significantly from region to region, with Alberta and Ontario forecast to each grow faster than Canada as a whole.

7 Includes co-generation of electricity and heat by industrial and energy sectors, such as pulp & paper and oil sands operations.

Greenhouse gas emissions trends by province

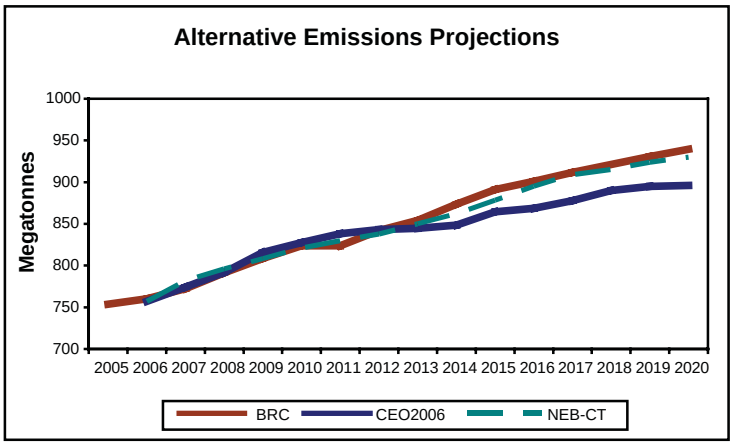
Alberta and Ontario had the highest emissions of all provinces in 2006 at 246 megatonnes and 196 megatonnes respectively. In the reference case, most provinces are expected to continue to report increases in GHG emissions, but more than half of the overall national increase will come from Alberta and Ontario. The largest proportional growth is forecast to occur in British Columbia and the Territories, followed by Alberta.





Comparison to Other Forecasts

The reference case developed by Environment Canada represents the department's view of the most likely GHG emissions profile of Canada to 2020. It is based on up-to-date economic growth projections, the most current knowledge available of medium-term developments in key sectors such as electricity generation and oil and gas, and a rigorous approach to estimating emissions associated with energy production, industrial, and transportation activities. In this respect, the Environment Canada forecast is somewhat more aggressive in terms of Canada's emissions growth to 2020 than other current estimates, such as that put forward by Natural Resources Canada in, *Canada's Energy Outlook: The Reference Case 2006* and in the Continuing Trends scenario published by the National Energy Board in, *Canada's Energy Future - Reference Case and Scenarios to 2030*.



Natural Resources Canada's *Canada's Energy Outlook: The Reference Case 2006*, which was developed during the 2004 to 2005 period, and was released in October 2006. The principal assumptions used to develop the NRCan Outlook were:

- Population will grow at about 0.7 percent annually and Real Gross Domestic Product (GDP) at about 2.4 percent per year to 2020. GDP for large greenhouse gas industrial emitters is projected to grow at about 1.6 percent per year, while the services sector is projected to grow by about 2.4 percent per year.

- Crude oil prices, in 2003 dollars, will decline to US$45 per barrel by 2010 and will remain constant thereafter. Although lower than today's high level, this is much higher than the oil prices prevailing through most of the last two decades.

- All but two of Canada's nuclear power plants will stay in service for at least eight more years, or will be refurbished and returned to service. The two units at Pickering A, which are currently out of service, will remain so indefinitely.

- Conventional oil production will decline, but the oil sands are expected to show a significant rise to 2.9 million barrels per day.

- Total natural gas production is projected to peak in 2011 at 6.6 trillion cubic feet (Tcf), and then decline.

- Growing energy demand and a changing energy production mix lead to growth in GHG emissions from 758 megatonnes (Mt) in 2004 to 828 Mt in 2010 and 897 Mt in 2020.

National Energy Board's *Canada's Energy Future - Reference Case and Scenarios to 2030* was published in November 2007. The report examines different possible energy futures that may unfold for Canadians up to the year 2030. This includes a baseline projection, called the Reference Case, which is the Board's view of the most likely outcome up to the year 2015. Three different scenarios, each with its own internally consistent set of assumptions, such as economic growth, action on environmental issues and energy prices, are then used to examine Canada's energy future to 2030:

- Continuing Trends Scenario: Trends that are apparent at the beginning of the outlook period are maintained throughout the entire forecast and extend the Reference Case over the long-term.

- Triple E Scenario: A balancing of economic, environmental and energy objectives means this scenario has well-functioning energy markets, cooperative international agreements and the most rigorous energy demand management policies of the three scenarios.

- Fortified Islands Scenario: Security concerns dominate this scenario with geopolitical unrest, a lack of international cooperation and trust, and protectionist government policies.

The principal assumptions underlying the National Energy Board Continuing Trends Scenario are:

- Population growth of 0.7 percent per year. GDP is projected to grow at 2.5 percent per year. GDP for large greenhouse gas industrial emitters is projected to grow at about 2.0 percent per year, while the services sector is projected to grow by about 2.8 percent per year.

- The global price of crude oil is expected to fall to $50 per barrel (in 2005$) by 2010 and remain constant, while natural gas prices are forecasted to remain at an average of US$ 7.14 per thousand cubic feet (in $2005).

- Oil sands in situ and mining production will increase to 1.8 million barrels per day respectively by 2020 and synthetic crude oil production will increase to 2.2 million barrel per day by 2020, while natural gas productions declines to 5230 Billion Cubic Feet and conventional light and heavy oil production to 995,000 barrels per day by 2020.

- Canada's electricity generation sector is projected to see significant expansion of hydro, nuclear and wind energy under the National Energy Board Continuing Trends scenario.
    - Between 2016 and 2030, several hydro facilities will be constructed, including the Peace River Site C (900 MW) in British Columbia, Conawapa (1 380 MW) and Gull/Keeyask (600 MW) in Manitoba, and 1 125 MW of new hydroelectric generation in Quebec.
    - Nuclear additions occur in Ontario and New Brunswick. In Ontario, a 1,000 MW Advanced Canadian Deuterium (CANDU) Reactor (ACR) is added in 2016 to replace retiring coal units, and two 1,000 MW units are added in 2028 and 2030 when the units at Pickering Station A are retired. In New Brunswick, a 1,000 MW ACR is added in 2024 to replace retiring oil-fired and Orimulsion-fired steam units.
    - Wind power almost doubles its share of the total generation mix, increasing from just over nine percent in 2016 to 20 percent in 2030. Total wind power increases from 11 400 MW in 2016 to 24 000 MW in 2030.

- Canadian total GHG emissions grow at a rate of 1.5 percent over the 2004 to 2015 period and 0.9 percent over the 2015 to 2030. By 2020, greenhouse gas emissions reach about 925 Mt.

Key differences from the National Energy Board *Continuing Trends* projection and those found in Environment Canada's forecast include:

- A slightly higher growth rate for goods producing industries relative to the service sector, along with a lower overall economic growth rate (2.3% vs 2.8% per year);

- A higher level of bitumen production from oil sands operations (3.6 mbpd vs 3.4 mbpd), and a different methodology for the calculation of oil sands emissions;

- The assumption that new coal-fired electricity generation in Saskatchewan will not use carbon capture and storage;

- The assumption that Peace River C and Churchill hydro development projects will not be constructed before 2020.