The Conference Board of Canada
Insights You Can Count On

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The Economic and Employment Impacts of Climate-Related Technology Investments

ENERGY, ENVIRONMENT AND TRANSPORTATION POLICY

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The Economic and Employment Impacts of Climate-Related Technology Investments
by *The Conference Board of Canada*

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Preface

This study was initiated to consider two basic issues: where technology funds fit on the climate change agenda and the value that technology funds contribute to the economy. Canada and each of its provinces and territories have announced long-term programs to reduce greenhouse gas emissions. Their strategies include a broad range of market instruments, one of which is technology investments. This report considers the potential role of technology investments—and more specifically, technology funds—within the range of instruments being considered. It also investigates the economic and employment impacts of technology investments that will be made between 2010 and 2014.

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Acknowledgements

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EXECUTIVE SUMMARY

The Economic and Employment Impacts of Climate-Related Technology Investments

At a Glance

- This report examines the economic and employment impacts of climate-related technology investments in Canada.
- Identified spending between 2010 and 2014 totals $11.8 billion.
- All provinces have developed climate action plans that make use of a range of tax measures, regulatory approaches, performance standards, and technology investments.
- An analysis of the economic and employment impacts of climate-friendly technology investments will help position these investments relative to other elements of climate action plans.

This report examines the economic and employment impacts of climate-related technology investments in Canada. The analysis begins with a general working definition of technology and then places technology investments within the broad context of innovation strategies and climate action plans. Next, we profile a range of technology investments and technology funds that are currently implemented in Canada, including their interplay with other market instruments, and describe various governance models associated with these investments and funds. Finally, we quantify the potential economic impacts of technology investments based on anticipated government investments and matching private sector investments from 2010 through 2014. At this early stage of the investment period, it is not possible to quantify the impact of technology investments on greenhouse gas (GHG) emissions, particularly for investments in technologies such as carbon capture and storage that have yet to be commercially demonstrated.

Each province has an established emissions reduction target, although the targets and timing vary among provinces.

The economic impacts are expected to be significant. Identified spending over the five-year period will total $11.8 billion, the bulk of which will be in Alberta ($6.1 billion) and Ontario ($1.97 billion), the two provinces with the largest GHG emissions. Ontario has the strongest manufacturing industry, and as such, every $100 million invested in Ontario is estimated to result in $107 million in real gross domestic product (GDP). The results are not as strong for other provinces. Alberta, for example, would see only $70 million in increased real GDP per $100 million invested. The lower return on investment in Alberta is due to the higher dependence on out-of-province suppliers (as compared with Ontario).

The projects available for technology investments primarily involve industrial implementation, which accounts for 72 per cent of the total spending. Another 5 per cent goes toward residential implementation. Some 12 per cent flows to research and development, while the remaining 11 per cent goes to industrial construction.

Climate-related technology investments are also expected to generate federal and provincial income and indirect taxes. For each $100 million invested in Manitoba, tax revenues will increase by $27 million. For Ontario, the growth in tax revenues is estimated at $25 million, and for Alberta, just $8 million per $100 million invested. These fiscal impacts are a combination of the GDP generated and varying provincial tax rates.

The anticipated levels of climate-related technology investment are based on a review of provincial climate action plans and investment programs, as well as core federal government climate technology investments. For our analysis, we differentiated between technology investments and technology funds in terms of the sources of funds (whether general government revenue, fuel taxes, or compliance penalties), the stage of innovation that forms their primary focus (technology development, commercialization, or implementation), and the governance model applied (the decision process for allocating funds and selecting projects). All provinces have developed climate action plans that make use of a range of tax measures, regulatory approaches, performance standards, and technology investments. Each province has an established emissions reduction target, although the targets and timing vary among provinces. Most provinces have also implemented at least one technology fund, although the structures vary widely. Those provinces that have technology funds are using them in combination with other market and policy instruments to contribute to meeting their GHG emissions reduction targets.

The fund structure and governance models vary widely. British Columbia's Innovative Clean Energy (ICE) Fund derives revenue from a tax on delivered fuels, rather than from the revenue-neutral carbon tax. Quebec funds climate technology from a tax on delivered fuels as well, but uses the revenues more broadly, such as investing in technology funds as well as in a range of climate action programs. Manitoba's Sustainable Development Innovations Fund is approximately matched to revenues from environmental levies such as recycling fees, and is much smaller in value than most other funds, with only a portion earmarked for climate technologies. Alberta is the only province with regulatory limits on GHG emissions intensity, with payment into a technology fund as one compliance option. The fund is reinvested in climate technologies. The revenues are therefore not dependent on general taxation or subject to the budgeting process. A board of directors with the requisite expertise makes the investment decisions.

Technology funds are expected to generate and implement emissions-reducing technologies that will contribute to reaching targets and provide sales opportunities on international markets.

The Alberta model appears to be working, based on the revenues generated to date and the fact that emitters are making use of all compliance options. They are reducing emissions, purchasing offsets, and trading in credits, as well as contributing to the technology fund. The flexibility inherent in this system allows emitters to select the mix of options that best suits their circumstances. Although it is still too early in the investment cycle to quantify the emissions impact, technology funds are expected to generate and implement emissions-reducing technologies that will contribute to reaching targets and provide sales opportunities on international markets.

CHAPTER 1

Introduction

Chapter Summary

- This report examines the contribution that investments in technology are expected to make in reducing greenhouse gas emissions in Canada.
- A broad definition of technology includes all practical applications of science to social and economic goals.
- An analysis of the economic and employment impacts of climate-friendly technology investments will help position these investments relative to other elements of climate action plans.

Climate change has potentially become one of the defining challenges of this century. Although it is a global issue that requires global solutions, those solutions will be composed of myriad smaller actions. The expression "think globally but act locally" describes the best approach for all interested parties—countries, provinces, cities, and individuals—to address the challenge. In Canada, for example, the federal government has established reduction targets and put programs in place to encourage and fund investments that will reduce emissions. Similarly, at the provincial level, each province has set a target for emissions reductions and developed a climate action plan that reflects the risks and opportunities in that province. There are many tools available to encourage emissions reductions. These tools include carbon taxes, emissions caps, emissions intensity caps, offsets, voluntary carbon markets, exchange-based emissions trading, performance standards, and a multitude of programs to contribute to the development and commercialization of technologies and the cost of investments that will reduce emissions.

The tools can be sorted into four main categories:

- those that use price signals to change behaviour;
- those that mandate performance or emissions standards;
- those that develop low-emitting technologies; and
- those that implement or commercialize low-emitting technologies.

In this report, climate technology funds are distinguished from climate technology investments.

This report summarizes the findings of a review of the economic impacts of a selected group of technology investments whose objective is to reduce greenhouse gas (GHG) emissions. The review focuses primarily on the investments made and their impact on gross domestic product (GDP) and employment. Many of the investments, particularly those intended to create new technologies, are difficult to assess in terms of their potential impact on GHG emissions. In addition to looking at the economic impacts of the investments, we also review the various funding models used to fund the investments.

In this report, climate technology funds are distinguished from climate technology investments by their focus on technology development rather than implementation. (See box "Technology Investments and Technology Funds.") Climate technology funds are focused on creating new technologies or making significant improvements to existing technologies, always with a goal of reducing emissions. Climate technology investments, however, focus more on the implementation aspect of the technology. The differentiation is important because technology funds focus more on the reduction of emissions that is owed to the improvement of existing technology or the creation of new technology rather than to its implementation.

(Before going any further, we need to define "technology." See box "What Is Technology?")

This research was undertaken to respond to two questions:

- How are technology funds best used to contribute to reducing greenhouse gas emissions?
- What is the economic contribution or impact of technology funds?

The response to the first question is largely qualitative. It is based on the premise that there is not a single best approach to reducing GHG emissions, and that a combination of measures will be required. This follows the approach that all levels of government have taken to date. Our analysis focuses on the mix of tools currently in use, as well as the intended outcomes of technology investments.

The economic analysis was performed for each province to quantify the direct, indirect, and induced impact of technology investments.

The response to the second question is more quantitative, and is based on The Conference Board of Canada's economic models. Using current annual spending plans for the identified technology investments over the coming five years, we developed multipliers and applied them to measure the direct and indirect economic and employment impacts of these investments.

The economic analysis was performed for each province to quantify the direct, indirect, and induced impacts of technology investments. *Direct impacts* measure the value added in the economy that is directly associated with

Technology Investments and Technology Funds

The climate action plans adopted by the provinces include quite a broad range of initiatives and expenditures, most of which include activities that fall under our working definition of technology and involve expenditures whose benefits will last beyond the period in which the expenditure is made. (This essentially is a working definition of *technology investment*.) Technology investments would therefore include the full range of expenditures described in chapters 2 and 4 of this report.

Technology funds are distinguished by their structure and perhaps their purpose, and form a subset of technology investments. Technology funds have specific and ongoing sources of revenue, a clearly defined mandate to focus primarily on technology development and demonstration, a process for allocating funds, and, in some cases, a governance model that includes a measure of independence.

What Is Technology?

This report uses a broad working definition of *technology*. The definition includes both the development and implementation of technology, and allows us to add "emissions reduction," "climate-friendly," and other modifiers to narrow the analysis as appropriate. The definition we have chosen is from the American Heritage Dictionary[1]:

"TECHNOLOGY

1. a. The application of science, especially to industrial or commercial objectives.
   b. The scientific method and material used to achieve a commercial or industrial objective."

This definition is broad enough to include the typical activities described in the provincial climate action plans. It includes support of science research, academic programs, public education initiatives, programs to improve existing devices or create new devices, investments to broaden the use and implementation of devices, revisions to standards or codes, and more.

1 *The American Heritage Dictionary of the English Language, Fourth Edition.*

the investment spending or jobs created by technology investments. *Indirect impacts* measure the value added that the direct impact firms generate in the economy through their demand for intermediate inputs or support services. *Induced effects* include those that arise from spending the income associated with employment and/or the profits created by the direct investment. The Conference Board of Canada's provincial forecasting models were used to estimate the economic impact of anticipated investments on each of the provincial economies over the period 2010 to 2014.

This report presents the potential economic impacts of anticipated technology investments directed at reducing greenhouse gas emissions. In Chapter 2, we summarize the policy frameworks and the provinces' emissions reduction targets. This provides a general context within which to place technology investments. Chapter 3 presents an overall innovation framework and describes the approaches to innovation that the provinces have taken. An understanding of the innovation framework provides a key link between technology investments that target emissions reductions and overall policies that govern investments in science, technology, and innovation. Chapter 4 describes the range of technology investments currently being made across Canada, with particular attention paid to technology funds. The description includes the funding source, policy objectives, decision-making process, and general governance and business models used. Chapter 5 presents the methodology employed and the results of the economic impact analysis. The final chapter focuses on conclusions based on the research.

CHAPTER 2

Climate Change Policy Frameworks and Reduction Targets

Chapter Summary

- Canada's provinces and territories face very different challenges in terms of the quantity and sources of greenhouse gas emissions.
- Emissions reduction targets and timing are not coordinated among the provinces.
- Technology investments play a key role in each of the climate action plans reviewed for this study.
- Alberta's climate action plan places the strongest emphasis on technology to reduce emissions.

Greenhouse gases are emitted as a result of a broad range of human activities. In most cases, the emissions are related to the ways we produce and use energy. (See box "Major Sources of GHG Emissions.") Energy-related emissions account for just over 82 per cent of Canada's total; the remaining emissions result from agriculture and waste management. Energy-related emissions include energy production (46.3 per cent), stationary energy consumption (12.9 per cent), goods production (8.4 per cent), and transportation (32.4 per cent). Each of these emissions-producing sectors employs a range of technologies and displays a unique set of cost characteristics. Therefore, determining or implementing a single approach to reducing emissions across all sectors would be virtually impossible. A combination of measures is required.

Emissions levels and sources vary significantly among provinces, as illustrated in Chart 1. In 2007 (the most recent year for which a full National Inventory Report[1] is available), Alberta and Ontario together accounted for almost 60 per cent of Canada's total emissions, with Quebec, Saskatchewan, and British Columbia combining for an additional 30 per cent. The other eight provinces and territories contributed the remaining 10 per cent.[2]

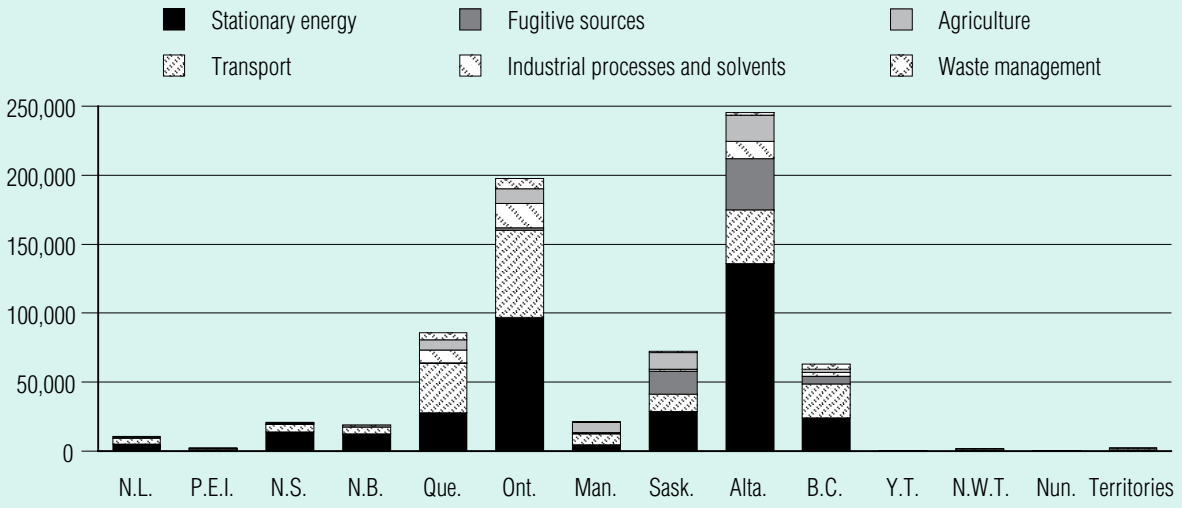
Some provinces and territories face larger challenges than others in reducing greenhouse gas emissions, and the mix of emissions sources varies significantly among the jurisdictions.

Not only do the quantities of emissions differ among the provinces and territories, but the primary sources of emissions vary widely as well. For example, stationary energy emissions range from a low of 8 per cent of total emissions in Nunavut to a high of 55 per cent in Alberta; transportation emissions range from a low of 17 per cent of total emissions in Saskatchewan to a high of almost

1 As part of the United Nations Framework Convention on Climate Change (UNFCCC), annual greenhouse gas (GHG) inventory reports are submitted to the UN. "The inventory uses an internationally agreed upon reporting format that groups emissions into the following six sectors: Energy; Industrial Processes; Solvent and Other Product Use; Agriculture; Land Use, Land-Use Change and Forestry; and Waste." Environment Canada. Reports and Publications.

2 Environment Canada, *National Inventory Report 1990–2007*.

Chart 1
Sources of Emission, by Province and Territory, 2007
(thousand tonnes $CO2_e$)



Sources: The Conference Board of Canada; Environment Canada.

90 per cent in Nunavut. The point here is that some provinces and territories face larger challenges than others in reducing greenhouse gas emissions, and the mix of emissions sources varies significantly among the jurisdictions. Clearly, the challenges and approaches are very different for a fossil fuel–producing province that also relies on coal for a large share of its electricity production (such as Alberta or Saskatchewan) than they are for a province that relies on hydro power and has a relatively higher share of emissions from transportation (such as Quebec or Manitoba).

Each of Canada's provinces and territories has established a climate action plan and set emissions reduction targets, although the reference point, percentage reduction, and timing varies from one to the other. Table 1 lists the key sources that articulate those targets, as well as the corresponding targets themselves. Chart 2 shows past and present emissions levels for each province, as well as those that will result if all targets are met. This comparison is possible only for the provinces, since the three territories have set targets that relate to government operations only.

As the table shows, the provinces are acting independently of each other (i.e., with respect to base year, reduction targets, and the timelines within which they intend to meet their targets). The Atlantic provinces are all signatories to a joint strategy with the New England states,

Major Sources of GHG Emissions

The data presented in the National Inventory Report can be organized into six major source categories, as shown in Chart 1. Stationary energy includes emissions related to energy production and retail energy consumption in the residential, commercial, and industrial sectors. Energy production emissions include those associated with oil and gas production, coal mining, and electricity generation. The transportation category includes emissions related to transporting people and goods, whether in private, public, or various modes of freight transport. Fugitive sources primarily include activities related to oil and gas production or other mining activities. Industrial process emissions relate to minerals processing, chemicals production, and other non-energy industrial use of hydrocarbons and solvents. Agricultural emissions include farm-based emissions related to land and manure management but exclude land-use changes. Waste management emissions include solid waste handling, incineration, and wastewater processing.

Source: The Conference Board of Canada.

Table 1
Provincial Emissions Reduction Programs and Targets

Province/territory	Key documents	Reduction targets
British Columbia	*Greenhouse Gas Reduction Targets Act* (GGRTA), *Climate Action Plan* (2008), Progress and Timelines (livesmart website), *Meeting British Columbia's Targets—A Report From the B.C. Climate Action Team*	6% below 2007 levels by 2012, 18% below by 2016, 33% below by 2020, 80% below by 2050
Alberta	*Alberta's 2008 Climate Change Strategy*, 2008 Greenhouse Gas Emissions Reduction Program Results (website), Climate Change and Emissions Management Fund (website), *Alberta Environment Report on 2007 Greenhouse Gas Emissions*	Reduce emissions by 20 Mt by 2010, 50 Mt by 2020, and 200 Mt by 2050
Saskatchewan	GO Green—Climate Change (website), Bill 95—The Management and Reduction of Greenhouse Gases (has not been passed), *Management and Reduction of Greenhouse Gases and Adaptation to Climate Change Technical Briefing Package*	20% below 2006 levels by 2020
Manitoba	*The Climate Change and Emissions Reduction Act*, Climate Change Action—A Priority for Manitobans (website), *Manitoba Sustainable Development Innovations Fund—Annual Report 2006–2007*	6% below 1990 levels by end of 2012
Ontario	Climate Change—Our Climate Change Action Plan (website), *Bill 150—An Act to Enact the Green Energy Act, 2009, and to build a green economy, to repeal the Energy Conservation Leadership Act, 2006, and the Energy Efficiency Act and to amend other Statutes*, *Climate Change Action Plan 2008–2009 Annual Report*	6% below 1990 levels by 2014, 15% below by 2020, 80% below by 2050
Quebec	*Cible de réduction des émissions des GES*—press release Nov. 23, 2009, Plan d'action 2006–2012 sur les changements climatiques (website), *Troisième bilan de la mise en œuvre du plan d'action 2006–2012 sur les changements climatiques—juin 2009*	20% below 1990 levels by 2020
Nova Scotia	*Environmental Goals and Sustainable Prosperity Act of 2007*, *Greenhouse Gas Emissions Regulations*, ecoNova Scotia for Clean Air and Climate Change website, *Nova Scotia Department of Energy Renewable Energy Standard*, *Toward a Greener Future—Nova Scotia's Climate Change Action Plan*, 2009	10% below 1990 levels by 2020
New Brunswick	*Climate Change Action Plan 2007–2012*, *Climate Change Action Plan 2007–2008 Progress Report*, *Climate Change Action Plan 2008–2009 Progress Report*	10% below 1990 levels by 2020, 5.5 Mt reduction from 2007 levels by 2012
Prince Edward Island	*Energy Framework and Renewable Energy Strategy 2004*, *A Strategy for Reducing the Impacts of Global Warming 2008*, *Securing Our Future: Energy Conservation and Efficiency*	10% below 1990 levels by 2020

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Table 1 ***(cont'd)***
Provincial Emissions Reduction Programs and Targets

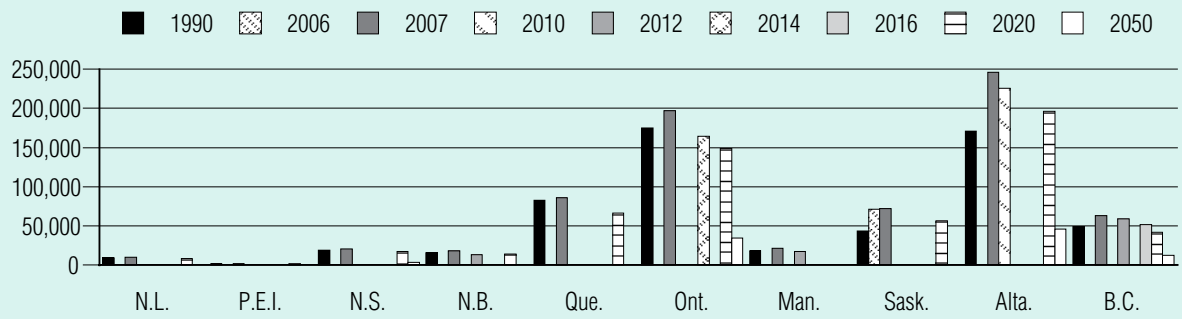
Province/territory	Key documents	Reduction targets
Newfoundland and Labrador	*Climate Change Action Plan 2005*, *Climate Action Plan Update 2007*, *Focusing Our Energy—Newfoundland and Labrador Energy Plan*	10% below 1990 levels by 2020
Yukon	*Yukon Government Climate Change Action Plan* (February 2009)	Cap GHG emissions in 2010, reduce GHG emissions by 20% by 2015, and become carbon neutral by 2020 (note that this applies to government operations only—no general target for the territory)
Northwest Territories	*NWT Greenhouse Gas Strategy 2007–2011*	10% below 2001 levels by 2012, with targets to be reviewed in 2010 (note that this applies to government operations only—no general target for the territory)
Nunavut	*Nunavut Climate Change Strategy*, October 2003	Control and reduce GHG emissions. This goal applies to the 10-year period 2003–13

Sources: The Conference Board of Canada; provincial climate action plans.

hence the common initial target; however, they have each set their own action plan. Some provinces have formalized their reduction targets through legislation, while others have passed regulations for certain sectors or emitter classes, with some relying on programs and policy statements.

The targets set out in Table 1 are presented visually in Chart 2. This is done by starting with the 2007 emissions level reported in the National Inventory Report and then applying the reduction targets (a specific percentage) published by each province. Most provinces have explicit targets for at least one year in the near term (2010 through 2015); almost all provinces have explicit targets for 2020, and four have very long-term targets for 2050. In 2007, all provinces reported emissions that were above the 1990 level. New Brunswick, Ontario, and Manitoba have set targets at or below 1990 emissions levels for the 2012–14 period. Newfoundland and Labrador, Prince Edward Island, Nova Scotia, Quebec, and British Columbia

Chart 2
Provincial Emissions and Reduction Targets, Select Years, 1990 to 2050
(thousand tonnes $CO2_e$)



Sources: The Conference Board of Canada; Environment Canada; provincial climate action plans.

plan to reduce emissions equal to or below 1990 levels by 2020. Alberta's target is set to be reached between 2020 and 2050, and Saskatchewan does not have an explicit target that would see emissions reduced below the 1990 level.

Potentially, there is a very complex interaction among initiatives.

Notwithstanding the range of emissions levels, sources, and reduction targets, a relatively uniform set of tools has been developed and is being implemented to help reduce greenhouse gas emissions. Table 2 lists some of the relevant initiatives and indicates which jurisdictions have adopted these tools. Each initiative utilizes a range of approaches that differ in terms of implementation (e.g., how, when, level of aggression) and that will address the pertinent challenges and priorities of the province or territory.

As stated in the introduction to this report, the tools to encourage emissions reduction can be sorted into four main categories. Of the 38 initiatives listed in Table 2, half are related to mandating performance or setting emissions standards, 13 encourage commercialization or implementation of low-emitting technologies, 10 support development of low-emitting technologies, and only 6 relate to price signals (most of the latter having yet to be fully implemented). Based simply on the number of initiatives in each province or territory, governments in Canada expect technology development and implementation to contribute significantly to our future progress toward a low-carbon economy. Chapter 4 explores this theme more carefully by profiling the technology investments currently being made. A final observation based on Table 2: potentially, there is a very complex interaction among initiatives.

Table 2
Summary of Climate Initiatives in Canada

Measure	N.L.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Y.T.	N.W.T.	Nun.	Cda.
Corporate Tax Incentives		F				√	√	√		√				√
Carbon Tax					√					√				
Fuel Tax					√					√				
Capital Subsidies—Businesses			√	√	√	√	√	√	√	√	√	√		√
Capital Subsidies—Consumers	√	√	√		√	√	√	√	√	√	√	√		√
Technology R&D Delivery	√					√		F	√			√		√
Technology R&D Funding	√	F	√		√	√	√	F	√			√		√
Technology Implementation Funding	√	F	√	√	√	√	√	F	√			√		√
Cap on Emissions			√		F	F	F	F		F	F			F
Cap on Emissions Intensity									√					
Mandatory Emissions Reporting			√		√				√	F	F			√
Voluntary Emissions Reporting									√					√
Emissions Trading in Place			F		F	F	F	F	√	F				F
Renewable Electricity Program	√	√	√	√	√	√			√	√	√	√		√
Renewable Fuel Standards—Gasoline		F		F	√	√	√	√	√	F				√
Renewable Fuel Standards—Diesel		F		F	√		√	√	√	√				√
Vehicle Efficiency Standards		F	2010	F	√	F				√	F	F		F
Building Efficiency Standards	√	F	√	√	√	√	√	√	√	√	√	√		√
Updated Building Code		F	F	√	F	√	√	F	F	√	F	F		F
Energy Efficiency Funding	√	√	√	√	√	√	√	√	√	√	√	√		√

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Table 2 ***(cont'd)***
Summary of Climate Initiatives in Canada

Measure	N.L.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Y.T.	N.W.T.	Nun.	Cda.
Renewable Energy Funding	√	√	√	√	√	√	√	√	√	√	√	√		√
Renewable Energy Targets	√	√	√	√	√	√	√	√	√	√	√	√		√
Offsets Program	F					F	√	√	√	√	F			F
Public Transit Plan and Funding	F	F	F	√	√	√	√	√	F	√				
Vehicle Rebates for Low or Zero Emissions	F	√			√	√		√		√	F	√		√
Greening Government Fleet	√	√	√	√			√	√	√	√	F	√		
Greening Government Buildings	√	F	√	√	√	F	√		√	√	F	√		√
Public Education Campaigns	F	F	√	√	√	√	√	√	√	√	√	√		√
Support for Municipalities	√		√	√	√	√	√	√	√	√	√	√		
Industry GHG Reduction Programs and Funding	F	F	√	√	√	√	√	√	√	√	√	√		√
Green Procurement	√	√	√	√		F	√		F	√	F	√		
Vehicle Idling Restrictions			GOVT	F		F				F	F	F		
Vehicle Idling Information Campaigns	√		√	√	√	√		√	F	√	√	√		
Management of GHGs From Waste	F	F		√	√	√	√		√	√	√	√		
Agriculture Emissions Management Program		F		√	√	F	√	F	√	√	F			
Land-Use Plans That Reflect CC Action		F							F	F	F			
Vehicle Emissions Standards			2010	F		F	√			F	F			√
Forest Strategy That Reflects CC Action			F	F		√	√	F	√	√	F	√		

Legend:
√ = measure in place
GOVT = applies to the government fleet only
F = planned for the future
Source: The Conference Board of Canada.

CHAPTER 3

Policy Objectives, Innovation, and Technology

Chapter Summary

- Federal and provincial governments have put forward innovation strategies that include clean-energy development.
- Innovation plays a key role in meeting the climate change challenge and turning clean-energy technologies into commercial opportunities.
- Each provincial innovation strategy focuses on areas of perceived competitive advantage and opportunity.

CONTEXT

Current GHG emissions reduction targets described in the previous chapter will be difficult to meet, given that the Canadian economy and population will grow over the target period. The current targets cannot be met without significant additional investments in more energy-efficient and cleaner-energy technologies. Some of these technologies currently exist, while others will need to be developed, commercialized, and implemented. The significant investments required to reduce Canada's GHG emissions can lead to the development and growth of homegrown clean-energy technology suppliers. In order to succeed, however, these Canadian companies will need sufficient financial and human resources capacity, access to world-class science and technology, and a business environment conducive to the development and commercialization of their technologies.

Canada is not alone in wanting to significantly reduce its emissions and seeking innovative solutions to achieve its climate change objectives. Countries around the world are also looking at the development and implementation of clean-energy technologies to reduce emissions. As such, there are two possible outcomes: either we become a leader in the development and commercialization of these technologies, or we rely on others to sell them to us. If the latter occurs, we will have missed an important opportunity to develop globally competitive, highly innovative clean-energy technology industries.

Will our governments succeed in supporting the development of our major clean-energy technology industries?

Governments across Canada recognize the need for continued investments in clean-energy technologies. And some of them have incorporated this view not only in their climate change policies but also as part of their innovation strategies aimed at developing and commercializing new or significantly improved technologies. Will they succeed in supporting the development of major clean-energy technology industries in Canada?

The following section describes the innovation process and the various federal, provincial, and territorial innovation strategies.

INNOVATION

Innovation is all about turning knowledge and creativity into value.[1] It is "a process through which economic or social value is extracted from knowledge through the generation, development, and implementation of ideas to produce new or significantly improved products, processes, and services."[2] This process of innovation is non-linear and includes four key components:

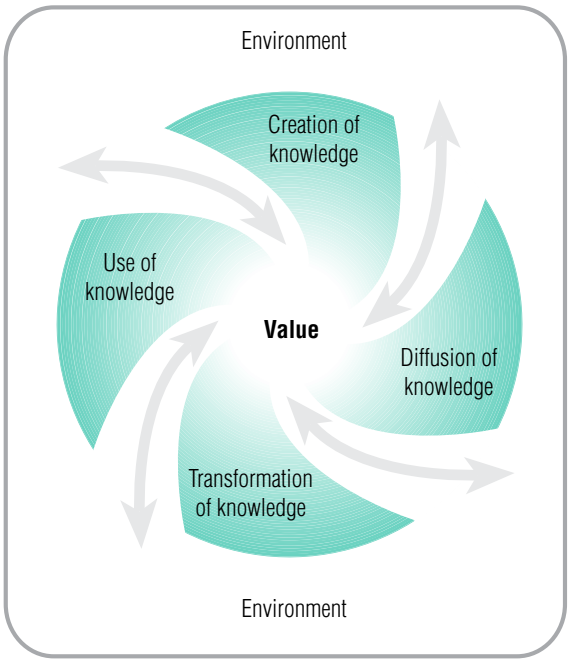
- The **creation of knowledge** includes research and development and the formation of new ideas.
- The **diffusion of knowledge** is the sharing of the output of that creativity and includes academic articles and patents.
- The **transformation of knowledge** takes these outputs to develop new or significantly improved products, processes, and services.
- The **use of knowledge** is the implementation and selling of these new and significantly improved products, processes, and services. (See Exhibit 1.)

This innovation process ultimately generates economic and social value by creating wealth and jobs, improving competitiveness, enhancing the well-being of individuals, and addressing environmental issues.

Innovation does not occur in a vacuum. It requires the right environment, comprising the following elements[3]:

- markets for innovative products, processes, and services;
- highly qualified people to work in all four components of innovation;

Exhibit 1
The Conference Board of Canada Innovation Model



Source: The Conference Board of Canada.

- access to financial capital to fund all of these components;
- regulations that are conducive to innovation;
- collaboration between academia, business, and government, and
- public and private sector leadership commitment to innovation.

Overall, governments must demonstrate to others their leadership commitment to innovation.

Governments play a major role in supporting innovation. They can create markets for innovative products, processes, and services through strategic procurement, regulations that mandate their use, and fiscal incentives to purchase them. They can support the attraction and development of highly qualified people through immigration policy and post-secondary education and training. They can provide research and development funding and

1 The Conference Board of Canada, *Annual Innovation Report 2002*, p. 1.

2 Ibid., p 1.

3 These elements have been discussed in several Conference Board publications, including the following: Guthrie and Warda, *The Road to Global Best: Leadership, Innovation, and Corporate Culture*; Guthrie and Warda, *The Road to Global Best: Leading Innovation Through R&D*; Stanley, *Canada's Pathways Toward Global Innovation Success: Report of the Leaders' Panel on Innovation-Based Commerce*; and The Conference Board of Canada, *Annual Innovation Report 2002*.

access to risk capital for the development and commercialization of innovations. They can institute effective regulations that support the development, commercialization, and use of new products and technologies while also meeting other public policy objectives (e.g., environmental protection, public safety).

If the innovation process is to achieve its full potential, governments need to collaborate with one another and with academia and business. Overall, they must demonstrate to others their leadership commitment to innovation.

The federal government has committed to "bolster" its science and technology strategy.

FEDERAL AND PROVINCIAL INNOVATION STRATEGIES

Canada's governments recognize the important role innovation can play in our economy. In 2007, the federal government released its innovation strategy, *Mobilizing Science and Technology to Canada's Advantage*. It asserts that "we must improve our productivity and competitiveness through innovation."[4] To this end, the strategy strives to create an innovation- and commercialization-friendly environment by supporting strong private sector commitment to science and technology, strengthening the knowledge base, and helping Canada become a magnet for talent.[5]

This strategy cites four core driving principles:

- promoting world-class excellence in science and technology;
- focusing on key priorities in research areas where Canada is strong;
- encouraging partnerships between academia, business, and government in Canada and abroad; and
- enhancing accountability to deliver and demonstrate results from the science and technology efforts.[6]

In keeping with the second core principle, the federal government has identified four areas of priority: environmental science and technology; natural resources and energy; health and related life sciences and technology; and information and communications technologies.[7] It is important to note that clean-energy technologies fall under at least two of these four focus areas. In the latest Speech From the Throne, the federal government has committed to "bolster" its science and technology strategy. Part of its commitment relates to continuing to invest in clean-energy technologies.

In addition to the federal government's strategy, all of the provinces and one territory (Yukon) have their own innovation strategy as well. A brief description of these strategies appears below.

BRITISH COLUMBIA

The Government of British Columbia has developed the B.C. Research and Innovation Strategy. It was designed to encourage increased commercialization of research and adoption of innovative processes. One key trait of this strategy is that it focuses on key areas in which the province excels: life sciences (health and biotechnology); technology (information and communication, new media, wireless and emerging technologies); clean technology (alternative energy and sustainable technologies); and natural resources (forestry, agriculture, fishing, mining, oil and gas).

The B.C. strategy aims to strengthen emerging clusters, leverage support from the private sector, increase collaboration between industry and academia, and work to help B.C. companies grow and stay in the province. One of the ways it will attempt to do this is by focusing on people—investing in education and developing research chairs. There will also be commercialization support, including a $25 million per year Clean Energy Fund.

B.C.'s government is clearly interested in promoting an innovation-friendly climate while strategically focusing on areas in which the province can compete internationally, including clean technologies that will result in reduced GHG production.

4 Industry Canada, *Mobilizing Science and Technology to Canada's Advantage*, p. 2.

5 Ibid., p. 2.

6 Ibid.

7 Ibid., p. 13.

ALBERTA

The Government of Alberta has established an innovation strategy, Alberta Innovates, which focuses on four areas: high-tech firms that use technology platforms (e.g., nanotechnology, information and communication technologies); bio-products; health technologies; and energy and environment. There are agencies to support research and development in each of these areas and relevant firms that can commercialize and implement the products, services, and technologies. One agency—Alberta Innovates, Energy and Environment Solutions (formerly Alberta Energy Research Institute, or AERI)—has developed an energy-specific innovation strategy, Alberta Energy Innovation Strategy. It recognizes that "we need technology more than ever today to keep our energy industry competitive and sustainable."[8]

Alberta Innovates, Energy and Environment Solutions is tasked with developing and implementing its innovation strategy, becoming an inter-mediator, serving the energy innovation community as the energy and environmental technological arm of the government, and investing in research and technology. The agency is working to create an innovation-friendly climate using its annual base budget of $16 million plus other monies, potentially, from funding envelopes put in place by the Government of Alberta to advance sustainable development.[9]

One key innovation-friendly initiative is the Energy Innovation Platform Agenda, designed to promote and facilitate knowledge and technology transfer between researchers in government, academia, and industry.[10]

SASKATCHEWAN

The mission of Enterprise Saskatchewan—a newly created economic development agency—is to advance "a transformative sustainable economic growth agenda and (develop) a culture of innovation and entrepreneurship."[11] Part of its 2009–10 plan is to enhance the economic impact of innovation by creating a governmental department—Innovation Saskatchewan—and developing an innovation strategy for the province. Furthermore, this plan focuses on the need to grow sustainable energy industries by developing a carbon capture and storage research strategy, positioning the bio-fuels sector for growth, and looking at ways to increase the value-added of its uranium resource.

MANITOBA

Manitoba's Innovation Framework is based on "the importance of innovation and is creating an environment to sustain economic growth and job creation for Manitobans by expanding the innovative capacity of all participants in the economy."[12] Similar to other provincial strategies, Manitoba's plan focuses on both the existing innovation infrastructure and selected key industries. In Manitoba's case, the key industries include advanced manufacturing, aerospace, cultural and new media industries, hydro and alternative energy developments, electricity and natural gas, information and communications technologies, and life sciences.

The Manitoba Innovation Framework sets out a series of six steps to foster further innovation in the province. They include planned investments in research and investment in technology commercialization.

ONTARIO

The Ontario Ministry of Research and Innovation released Ontario's Strategic Plan in November 2006. This plan sets high-level future goals for the year 2020. These goals include:

> . . . building stronger links and greater interactions between research institutions and the commercial sector; integrating and coordinating all provincial innovation efforts; ensuring maximum returns on public investment in research; creating a culture of innovation and a commerce friendly environment across the province and within the provincial government; and recognizing and responding to the significant time, enterprise and effort needed to achieve optimal returns on investments in research.[13]

8 Alberta Energy Research Institute (AERI). *2009–14 Strategic Business Plan.*

9 Ibid., p. 9.

10 Alberta Innovates, Energy and Environment Solutions: Energy Innovation Platform of Alberta.

11 Enterprise Saskatchewan, *Plan for 2009–10.*

12 Government of Manitoba, Manitoba Innovation Framework: Executive Summary.

13 Quote from Premier Dalton McGuinty, in Ontario Ministry of Research & Innovation, *Strategic Plan*, p. 26.

In an updated innovation agenda, Ontario emphasized its commitment to focusing on commercialization opportunities from public research and targeting investments in areas where Ontario can be a global leader, such as the bio-economy and clean technologies.[14] Within these areas, the government is looking at clean automobiles and technologies that will help achieve its overall climate change plan.

Provincial investments in innovation include $205 million for the Ontario Venture Capital Fund (limited partnership between the Ontario government and investors); $250 million over five years for the Ontario Emerging Technologies Fund (2009); and $50 million over four years in additional funds (as of 2009) to the Innovation Demonstration Fund, a program that helps companies commercialize their innovations by providing support at the pilot or project demonstration stage.[15] Overall, the Ontario Innovation Agenda has a budget of $3.2 billion over eight years. Its focus is on supporting innovation and growth in sectors where Ontario has research and business strengths. This Agenda is global market-oriented.[16]

QUEBEC

The Quebec Research and Innovation Strategy echoes the sentiment that forms the basis of all the strategies described here: innovation is key to the economic and social growth of the province. Quebec's strategy stresses the need for an environment that is conducive to research and innovation and identifies three main types of action that will yield such an environment:

- improve excellence of public sector research;
- provide greater support for industrial research and business innovation; and
- strengthen mechanisms to develop and transfer research findings.[17]

This strategy takes into account the need to focus in areas of competitive advantage and technologies that will provide the greatest opportunities for economic development. It also clearly recognizes not only the need for an innovation-friendly climate but also the challenges of commercializing new innovations.

All strategies emphasize that innovation is key to the economic and social growth of the province or territory.

The Government of Quebec has allocated $888 million in additional investments through the Quebec Research and Innovation Strategy, of which $400 million will go to public research, $420 million will help to increase the research infrastructure, and $80 million will support business expenditures on research and development through tax credits.[18] These investments are supplementary to the $83 million that had already been granted in the aeronautics field and the $195 million invested in research this year alone.[19]

NOVA SCOTIA

The province's strategic direction on innovation is imbedded within the Nova Scotia economic growth strategy, Opportunities for Prosperity. This strategy identifies five issues surrounding innovation in the province and puts forward a series of next steps. Starting with the issue of federal investment, the province plans to work collaboratively with federal bodies and initiatives for research and innovation.[20] Nova Scotia's plan for the second issue identified—the challenge of technology adoption—is to encourage businesses to make investments in the use of new technologies and to adopt best practices.[21] To address the third issue, the action plan establishes a strategy to identify and increase research and

14 Ontario Ministry of Research & Innovation, *Seizing Global Opportunities*.

15 Ontario Ministry of Research & Innovation, Support for Emerging Green Technology Companies.

16 Ibid.

17 Ministère du Développement économique, de l'Innovation et de l'Exportation, *Québec Research and Innovation Strategy:*.

18 Ministère du Développement économique, de l'Innovation et de l'Exportation, *An Innovative, Prosperous Québec*, p. 18. Note that the numbers in the original text do not add to $888 million.

19 Ibid.

20 Province of Nova Scotia, *Opportunities for Prosperity*.

21 Ibid.

development among businesses.[22] For the issue of commercialization, the plan includes steps to establish a "direct link between business need and support for academic research."[23] The fifth issue is demonstration projects.

PRINCE EDWARD ISLAND

P.E.I.'s strategy, Island Prosperity—A Focus for Change, 2009–2014, sets goals that include becoming nationally recognized as a centre of biotechnology excellence and increasing the focus on environmentally friendly energy sources. This series of goals is industry-focused and features areas in which the province has decided that its limited resources will pack a punch.

P.E.I.'s goals feature areas in which the province has decided that its limited resources will pack a punch.

P.E.I. will be investing $200 million in innovation through three major tracts:

- $40 million will be devoted to people in the province, to be divided among various awards, scholarships, research chairs, and investing in skilled workers.
- $60 million has been earmarked for the economic infrastructure needed for innovation, with particular focus on the Island Biocommons Research Park and the renewable energy sector.
- $100 million will be devoted to innovation and distributed through a series of programs, funds, and tax incentives. One example of the funds available is the Pilot Fund, which will provide assistance in the testing phase of high-risk projects with commercial potential.

NEWFOUNDLAND AND LABRADOR

Here, the government has developed Innovation Newfoundland and Labrador: A Blueprint for Prosperity. This strategy includes a series of innovation-focused programs that support commercialization through funding and through intellectual property and technology transfer support.[24]

The Innovation Enhancement Fund is one of the more developed funding programs in Newfoundland and Labrador. It looks at increasing research and development with the following tools: innovation awards, a federal and provincial innovation team, incentives and bursaries, and the establishment of an Advisory Council on Innovation.[25]

The Blueprint identifies four strategic goals to expand the province's innovation capacity, including positioning the province as a competitive economy with internationally recognized strengths and advantages.[26]

NEW BRUNSWICK

New Brunswick's strategy, Innovation and New Brunswick: Greater Opportunity—An Innovation Agenda for New Brunswick 2002–2012, was developed in 2002. It focuses on building clusters and capacity as well as on creating partnerships. Like other provinces, New Brunswick has identified four specific technology areas of strength, where its focused efforts can help the province become globally competitive: knowledge industries, life sciences, advanced manufacturing, and value-added natural resources.[27]

New Brunswick has also developed an Innovation Fund program with $20 million. This fund can be used to leverage additional investments. Also, the province works with the federal government to support innovation in New Brunswick at the National Research Council's Institute for Information Technology. This institute is funded through both the federal government ($8.4 million) and the provincial government ($3.6 million).

YUKON

The Government of Yukon has included innovation and technology in its economic development plan. One of the most important parts of Yukon's current innovation strategy is the Yukon Cold Climate Innovation Research Centre at Yukon College. This research centre capitalizes on Yukon's unique environment to develop a world-recognized centre for specific cold climate technologies in construction and infrastructure.[28]

22 Ibid.

23 Ibid., p. 16.

24 Government of Newfoundland and Labrador, *Innovation Newfoundland and Labrador.*

25 Ibid., p. 8.

26 Ibid.

27 Province of New Brunswick, *Innovation and New Brunswick.*

28 Yukon Economic Development. Innovation and Technology.

CHAPTER 4

Technology Funds and Related Investments

Chapter Summary

- This chapter features an overview of the technology investments and funds that have been developed by provincial governments and agencies.
- Existing programs focus on eligibility criteria, financial measures, matching investments from project sponsors, and to a lesser extent, the impact that projects will have on emissions.
- Technology investments vary widely in terms of sources of funds, selection criteria, and governance models.
- A subset of technology funds directly link funding sources to emissions and link investments to anticipated emissions reductions.

Chapter 2 presented the climate action plans and policies of provincial and territorial governments, as well as a subset of related federal programs. Each jurisdiction's plan includes technology investments. These investments fit within and contribute to the provincial strategies to promote innovation that are described in Chapter 3. Some programs fund academic research, research and development (R&D), technology development, technology commercialization, or technology implementation. The collective impact is difficult to measure for two reasons: many of the investments are recent or a work in progress, and there is a diversity of investments and approaches. This chapter focuses on the latter issue, leaving the economic impact analysis to Chapter 5.

Almost all of the programs funded by government include some form of matching investment from other levels of government, private sector investors, and/or the project proponents.

Climate change technology investments include the full range of expenditures on programs and initiatives intended to produce, improve, commercialize, or implement technologies that reduce greenhouse gas emissions, whether the investments are made by government, the private sector, or individuals. In fact, almost all of the programs funded by government include some form of matching investment from other levels of government, private sector investors, and/or the project proponents. Projects that are developed in the private sector and have substantial investment by the project proponents are expected to be more likely to succeed. Table 3 lists many of the technology investment programs currently in place.

Table 4 summarizes the more important federal funding programs for climate change technology investments. Most of the federal programs listed were developed or restructured between 2007 and 2009 and are time-limited.

Table 3
Provincial Climate Change Technology Investment Programs

Province	Fund name	Amount/timing/source	Matching funds	Purpose/description
B.C.	Innovative Clean Energy Fund (ICE)	$25 million per year, approximately, based on a 0.4% fee on energy utility deliveries.	No more than 1/3 of total project funding can come from ICE, and no more than 75% can come from government sources, including ICE. In 2008 and 2009, matching funds were 4.8:1.	Encourage new technologies and sources of clean energy.
B.C.	Renaissance Capital Fund	$35 million announced in 2008–09, although only $7 million was placed with fund managers; $90 million announced in 2009–10, although only $9 million has been placed to date.	The venture capital firms are to commit their own managed capital as well. The $9 million placed in 2009–10 has generated a total investment of $37 million.	This fund commits government monies to co-invest with venture capital firms in clean energy, information technology, life sciences, and digital media. It funds B.C. startup companies. The amount allocated to clean energy varies with opportunities.
B.C.	Pacific Institute for Climate Solutions	A one-time $94.5 million endowment to University of Victoria to establish the Institute in 2008.	Not identified.	A one-time endowment to establish an institute focused on actions that will reduce greenhouse gas emissions.
Alta.	Climate Change and Emissions Management Fund (CCEMF)	$120 million will be available for investment in 2010 based on 2007 and 2008 payments into the Fund. This is expected to remain in the range of $70 million per year longer term. The Fund receives revenue from the $15/tonne compliance penalty for large emitters that don't meet their intensity target.	CCEMF can pay a maximum 50% of project cost.	The CCEMF was created to fund technology development and deployment related to GHG mitigation and adaptation.
Alta.	Innovative Energy Technology Program	$200 million over 5 years, initiated in April 2005. Projects are no longer being accepted, although royalty reductions continue until March 2014. Funded by royalty reductions.	The government share can be a maximum of 30% of the total cost.	The program grants royalty reductions for pilot projects and demonstration projects in the upstream oil and gas sector. The projects must show potential to improve recovery rates.
Alta.	Carbon Capture and Storage Fund	$2 billion total; 4 projects have been announced for a total of $1.961 billion provincial funding. The Alberta funding is allocated 40% during design and construction (2010–15), 20% on startup (2015), and the remaining 40% over the first 10 years of operation.	The provincial funds have been supplemented by $526 million in federal funding. Total cost of the 4 projects is estimated to be in excess of $4.6 billion, although project cost details are not public.	This Fund's purpose is to develop and demonstrate technologies for Carbon Capture and Storage in Alberta. The 4 projects selected target total GHG reductions in excess of 25 million tonnes/year.

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Table 3 ***(cont'd)***
Provincial Climate Change Technology Investment Programs

Province	Fund name	Amount/timing/source	Matching funds	Purpose/description
Sask.	Go Green Fund	No stated annual funding level or limit. In 2009, $45.45 million was allocated under the fund. Projects are identified by Requests for Proposals.	For the projects that identified matching funds, the ratio was 17% government funding share of total, which would translate into a total of $267 million spending.	Go Green includes a broad range of technology investments, energy-efficiency programs, water research, etc.
Sask.	Petroleum Technology Research Centre	Receives about $7 million per year from federal and provincial governments.	One project, Joint Implementation of Vapour Extraction, is $40 million over 4 years; another (Weyburn) is $80 million over 8 years.	A technology research initiative that is jointly funded by federal and provincial governments, plus project-specific industry contributions.
Man.	Sustainable Development Innovations Fund	$3.4 million per year, although the total includes programs not related to climate change. In 2006–07 the allocation for the Climate Action Fund was only $399,000. There was an additional $1.35 million in the open fund category. It is funded to match (approximately) provincial environmental levies.	Partner funding must be identified in the application, but no target is set and partner contributions are not quantified.	Supports research, technology demonstration, community projects, and educational projects.
Ont.	Climate Change Action Plan	$50 million over 5 years.	Not identified.	To fund investments related to the development of an electricity Smart Grid. .
Ont.	Climate Change Action Plan	$150 million through 2020.	Not identified.	To support homeowners in reducing GHG emissions.
Ont.	Climate Change Action Plan	$15 million over 4 years, beginning in 2009.	Not identified.	To subsidize purchase of alternative fueled medium-duty vehicles.
Ont.	Emerging Technologies Fund	$250 million over 5 years.	Unspecified. Will co-invest with venture capital.	Venture capital for clean tech, life sciences, health, digital media, and ICT.
Ont.	Innovation Demonstration Fund	$50 million over 4 years.	Must be at least 50% partner funding.	To help commercialize innovative technologies.
Que.	Cellulosic Ethanol Research	$25 million over 5 years.	Not specified.	Cellulosic ethanol technology research.
Que.	Inter-modal Freight	$60 million over 5 years.	Not specified.	Encourage intermodal freight.

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Table 3 ***(cont'd)***
Provincial Climate Change Technology Investment Programs

Province	Fund name	Amount/timing/source	Matching funds	Purpose/description
Que.	Waste Treatment	$38 million 2007–09. Program continues through 2012.	Not specified.	Methanization of organic waste at landfills.
Que.	Energy R&D	$20 million 2006–12, of which $5 million goes to carbon capture and storage (CCS).	Not specified.	To support R&D into clean-energy technologies.
Que.	Industrial Development Strategy for Green Technologies	$281.4 million identified for 2006–12.	Not specified.	Green technology development and deployment.
Que.	Climate Action Plan	$1.55 billion for 2006–12, of which $780 million had been spent as of June 2009. Program extends through 2012.	Not specified.	Includes most of the initiatives listed for Quebec, above, plus more.
Que.	Carbon Tax	$200 million per year, based on a levy on energy sales (primarily oil products and natural gas).	None.	Revenue source for the green fund initiatives listed above.
N.B.	Climate Action Fund	$34 million over 3 years, beginning October 2007.	Not specified.	To implement GHG mitigation and adaptation measures in New Brunswick.
N.S.	EcoNova Scotia	$42.5 million, of which $9.5 was set aside for environmental technology program.	Unspecified. Will co-invest with venture capital.	One-time allocation following federal program guidelines. As of end of 2008, $15.5 million had been allocated.
N.L.	ecoAction	$23 million from federal ecoACTION program 2007–12.	None.	To implement GHG mitigation and adaptation measures in Newfoundland and Labrador.

Note: This table summarizes the technology investment programs in each province, where such programs are ongoing and have climate change mitigation as a significant objective.
Source: The Conference Board of Canada.

The Sustainable Development Technology Canada (SDTC) funds listed are limited by the total funds available rather than by timing. Investments in programs such as the ecoENERGY Technology Initiative and the ecoACTION Trust Fund for Clean Energy will wind down between 2012 and 2015 unless further funds are allocated. For the ecoENERGY Technology Initiative, eight projects were chosen for carbon capture and storage technologies: one in British Columbia, two in Saskatchewan, and five in Alberta. The provincial distribution of funds for the ecoACTION Trust Fund for Clean energy appears in the table. These funds were distributed to provincial agencies and are largely administered by the provincial governments.

Sustainable Development Technology Canada was created by the federal government to bridge the gap between technology development and commercialization. SDTC funds are allocated based on program criteria; the resulting provincial allocation is shown in Table 5. Partner funding is a requirement of both the NextGen Fund and the SDTC Tech Fund; the breakdown is presented in the table.

Table 4
Federal Climate Change Technology Investment Programs

Fund name	Amount/timing/source	Matching funds	Purpose/description
ecoENERGY Technology Initiative	$230 million. Timing of projects differs. Funds committed in 2007, projects announced in March 2009, investments complete between 2012 and 2015. Funds awarded total $140 million.	Yes, but details not reported.	A technology development and demonstration fund.
Trust Fund for Clean Energy	$1.5 billion in total. Allocations to provinces as follows (in millions): Nun. $5 N.W.T. $5 Y.T. $5 N.L. $23 P.E.I. $15 N.B. $34 N.S. $42.5 Que. $349.9 Ont. $586.2 Man. $53.8 Sask. $44.4 Alta. $155.9 B.C. $199.3	Details not reported.	Established in 2007 as one-time fund for allocation through 2012. Some provinces detail how much has been spent already (see provincial table).
Clean Energy Fund	Mostly already counted for carbon capture and storage (CCS) projects above. Totals $1 billion over 5 years, with $650 million to CCS (see provincial table), $150 million to R&D, and $200 million to demonstration projects.	Yes, but not detailed.	Supports technology development.
SDTC NextGen Fund and SDTC Tech Fund	See Table 5.	Yes.	Supports commercial scale demonstration facilities.

Source: The Conference Board of Canada.

Table 5
Cumulative SDTC* Leveraged Funding 2002–09
($ millions)

Province	SDTC investment	Partner investment	Total
N.L.	0.7	1.2	1.9
P.E.I.	9	18	27
N.B.	2	5	7
N.S.	8	15	23
Que.	67	156	223
Ont.	182	429	611
Man.	11	22	33
Sask.	26	71	97
Alta.	53	125	178
B.C.	111	250	361
Total	469.7	1,092.2	1,561.9

*Sustainable Development Technology Canada
Sources: SDTC; The Conference Board of Canada.

CLIMATE TECHNOLOGY INVESTMENTS VERSUS CLIMATE TECHNOLOGY FUNDS

For the purposes of this report, there is a useful distinction between climate technology investments and its subset, which we refer to as "climate technology funds." The distinction rests upon three basic criteria:

- the source of capital that is used;
- the level of focus on technology development or demonstration; and
- the decision-making model.

The capital provided to technology funds would ideally support ongoing investments and be linked, both in its source and its allocation, to climate change mitigation outcomes. An ongoing commitment of funds is essential because innovation and technology development should be viewed as an ongoing process rather than an event. Also, because it is difficult to predict both the results and expenditures that will eventually be required, an ongoing commitment to invest based on project milestones and measured outcomes may be preferred to one-time or short-term programs. The linkage between climate change and funding is important for the sources of funds and their uses. All governments have chosen a definition of climate change mitigation actions that is broad enough to include all sources of GHG emissions.

Clean-energy technologies are prominent in each province's climate action plan.

When considering the policy instruments they will use to reduce GHG emissions, governments should also consider the proportion of the resulting revenues, if any, that will be reinvested in technologies. In doing so, they will create a direct link between the emissions that cause climate change and mitigation technologies. There are four such examples. British Columbia's Innovative Clean Energy Fund (ICE) and Quebec's Green Energy Fund are supported by a tax on fuels as delivered to end customers within the respective province.[1] This provides a clear link between the level of energy consumption (a major contributor to GHG emissions) and the funds available for investment. Manitoba's Sustainable Development Innovation Fund (SDIF) receives funding that is determined by the government to at least approximately match revenues from environmental protection taxes, recycling fees, etc. Although SDIF targets a broad range of sustainability issues, climate change is listed among the fund's priorities. The strongest link between the source of funds and climate change exists in Alberta's Climate Change and Emissions Management Fund (CCEMF). In this case, the supporting funds are generated by a $15 per tonne technology payment from large final emitters that are unable to meet their regulated emissions intensity levels. This direct link follows strongly "the polluter pays" principle, providing all stakeholders the assurance that the revenues generated will be redirected to solving the problem.

1 In British Columbia, the tax is imposed on deliveries by utilities. A separate carbon tax is levied on all fuels, including transportation fuels, which does not support ICE. In Quebec, the carbon tax is based on the emissions from each fuel, so the largest share comes from refined products, then natural gas deliveries, with only a small contribution from electricity.

Most of the climate technology investments described in tables 3 through 5 support both technology development and deployment. Clean-energy technologies are prominent in each province's climate action plan. At a broad scale, investments must be made in all four components of the innovation process described in Chapter 3. Many of the specific investments made by the programs or initiatives listed in tables 3 through 5 relate to technology implementation, while others relate to technology development. Such investments are often characterized as "technology push versus market pull."

Many of the technologies and investments included are not yet sufficiently developed to provide reliable estimates of the contribution they will actually make in reducing emissions.

Many of the technologies that we use today were not initially considered useful or have been adopted more broadly than anticipated. Such technologies were developed first, and then a demand cultivated. The personal computer provides one of the more commonly cited examples of *technology push*. On the other hand, some technologies are developed because the market is looking for a better way to accomplish a task or provide a service. The current generation of smartphones provides an example of *market pull* technology development.

In our context, part of the distinction between climate technology investments and climate technology funds is the level of emphasis placed on technology development versus technology commercialization or implementation. This is not an easy distinction to trace, since many of the specific projects funded by the programs listed are geared toward technology implementation with adaptations of a commercially available technology. However, a distinction is possible. At the federal level, both of the funds administered by SDTC focus on the pre-implementation stages, whereas the ecoACTION and ecoENERGY programs tend to focus more on implementation. As for the provinces, many of the programs examined place emphasis on applying existing technologies to improve energy efficiency or support energy conservation. Some examples of technology funds with a strong focus on technology development are the venture capital funds in British Columbia and Ontario, the Carbon Capture and Storage Fund, the CCEMF, Alberta's Innovative Energy Technology Program (IETP), and Ontario's Innovation Demonstration Fund (IDF).

In this report, *climate technology funds* are distinguished from *climate technology investments* by their focus on technology development rather than implementation. This delineation makes sense because many of the technologies that are expected to contribute to reducing GHG emissions will be either significant improvements over existing technologies or entirely new technologies. Carbon capture and storage provides an example of one of the potential game-changing technologies. Several of the technology components already exist, although some remain to be developed and others will require significant cost reductions. Should this technology succeed, retrofits to existing facilities could greatly reduce emissions resulting from energy production or transformation. Climate technology funds are focused on creating new technologies or making significant improvements to existing technologies, always with a goal of reducing emissions. Another difference is that climate technology investments include a broader range of implementation investments.

The decision model of a fund often differs from that of a simple investment. A simple investment decision often relates to the specific costs, revenues, and timing of a particular expenditure or series of expenditures. These criteria may or may not include GHG emissions but will always include capital costs, operating costs, cost savings, revenue potential (if any), and the resulting return on the investment made or payout period required. For the programs in tables 3 through 5, the criteria often include matching funds. A climate technology fund might also include the broader technology opportunities to which a particular investment might lead.

Based on the three criteria noted earlier, the following list represents the existing climate technology funds, with the participating government in parentheses:

- Innovative Clean Energy Fund (B.C.);
- Renaissance Capital Fund (B.C.);
- Climate Change and Emissions Management Fund (Alberta);
- Innovative Clean Energy Technology Program (Alberta);
- Carbon Capture and Storage Fund (Alberta);
- Go Green Fund (Saskatchewan);
- Sustainable Development Innovations Fund (Manitoba);
- Emerging Technologies Fund (Ontario);
- Innovation Demonstration Fund (Ontario);
- Carbon Tax Green Fund (Quebec);
- New Brunswick Climate Action Fund (New Brunswick);
- ecoENERGY Technology Initiative (federal);
- ecoENERGY Trust fund for Clean Energy (federal); and
- SDTC NextGen Fund and SDTC Tech Fund (federal).

The challenge is to find an optimal or near-optimal combination of instruments.

Although it would be desirable to include a criterion related to the focus on climate change mitigation, or the reductions in GHG emissions anticipated from the investments profiled, it is not possible to do so. In the first instance, not all programs are linked directly to emissions outcomes. Many of the programs are linked to criteria that establish the quality of the investment being made and ensure that specific financial and reporting requirements are met. Not all of the investments are judged on their ability to reduce emissions, and the expected contribution is not always published, even where it is identified. In the second instance, many of the technologies and investments included are not yet sufficiently developed to provide reliable estimates of the contribution they will actually make in reducing emissions.

ONE TOOL AMONG MANY

Before concluding the discussion of technology investments, it is important to place them in the context of overall GHG mitigation policies and instruments. Chapter 2 presented a list of climate action plan elements that are being used or proposed in Canada. These measures fall into a number of broad categories:

- emissions caps;
- taxation;
- mandated standards;
- investment subsidies;
- technology investments; and
- information programs.

The analysis presented here is based on the view that no single approach will provide the best answer, and that technology investments or technology funds are one of the many tools that will be required. The challenge is to find an optimal or near-optimal combination of instruments.

CAP AND TRADE

North America appears to be moving toward an emissions cap with broadly based emissions trading and supporting offsets programs. The cap element of this "cap and trade" approach provides a clear boundary for acceptable emissions levels and a penalty for emissions above these levels. The trade element allows the market to find an allocation of emissions that is, in at least some manner, economically more efficient than a simple cap. Where emissions trading is permitted, those who can easily reduce their emissions below the required level are free to do so, with an incentive that the reduction can be sold to another party. However, the transaction costs associated with cap and trade often become more important as the emissions from any one party become smaller. For example, the emissions of a fossil fuel power-generating station are often equivalent to those of thousands of households or vehicles. Placing an individual cap on smaller emissions sources is difficult to do, and expensive per unit of emissions, particularly as compared to a larger source.

CARBON TAX

A carbon tax is often touted as a way to extend the reach of carbon pricing mechanisms to smaller emitters. Carbon taxes are usually applied to energy deliveries, since energy use is one of the larger sources of GHG emissions. Carbon taxes can be applied to energy producers based on the carbon content of the fuel and the level of production. They can also be applied to energy consumers in the form of fuel taxes, as has been done in British Columbia and Quebec. Applying carbon taxes to fuel purchases is administratively efficient because in most cases, fuel taxes already exist. The carbon tax is an additional calculation, but the mechanisms for tracking fuel deliveries, calculating the basic tax, and remitting the proceeds already exist.

One of the drawbacks of this type of carbon tax, however, is that both energy supply and energy demand are price inelastic. This means simply that our ability to respond to price changes by adjusting our demand for or supply of the product is limited. In the near term, we are unable to substitute other goods for energy, so our response to price comes primarily from changing behaviour. In the longer term, we can also invest in more efficient energy technologies. As a result, the level of carbon tax required to reduce emissions enough to meet the provincial targets set out in Chapter 2 might be significant. Subsidies aimed at energy production or energy consumption equipment can help reduce the capital cost of the required investment and shorten the transition from short-term to longer-term price responses.

MANDATED STANDARDS

Mandated standards may provide a useful tool in achieving emissions reductions without significant price dislocations. A simple example of this is the transition from incandescent light bulbs to compact fluorescents. Energy consumption is reduced to less than a quarter of that associated with the incandescent bulb, although the cost per bulb is higher. Eliminating the sale of incandescent bulbs requires the consumer to adopt a new technology as the old bulbs burn out. The higher cost of the new bulb is often paid out in energy savings long before it burns out.

INVESTMENT SUBSIDIES

A more complex example of mandated standards arises from low carbon fuel standards or renewable fuel standards for automobiles. Both presume an available supply of fuel or technology to meet the standard, leaving the market to determine the resulting financial consequences. In the case of renewable fuel standards, capital cost subsidies and operating margin subsidies have also been applied to ensure that enough fuel is available to meet the standard. In the case of low carbon fuel standards, California was the first to act. It simply mandated that fuel imports must be equal to or less than the carbon content of fuels consumed in California. This type of standard sets a potentially aggressive goal, leaving fuel suppliers to meet it. The hazard arises if the goal is so aggressive that it can't be met.

Technology funds provide a more focused approach than do broader technology investments.

TECHNOLOGY INVESTMENTS

Technology investments and technology funds can be applied in connection with each of the instruments described above and in Chapter 2. Under an emissions cap system, emitters that cannot meet the regulated target must either purchase emissions rights from others or pay a penalty. This additional cost impairs their competitiveness, but the cap on emissions protects the environment. If the cap regulation includes the opportunity to purchase an offset, the cost can potentially be reduced. Including a technology payment in the emissions cap approach, as is the case in Alberta, potentially addresses the competitiveness issue more directly through technology development. If the funds are set aside for technology investments rather than being returned to energy consumers or taxpayers, those investments can contribute to cost reductions for existing technologies, or support the development, commercialization, and implementation of new, lower emissions technologies. This path has the potential to restore competitiveness more rapidly and may even make companies more competitive. It can also produce innovations that are marketable worldwide, thereby creating new business opportunities for Canadian companies.

Properly targeted technology investments can reduce the level of carbon taxes required to achieve emissions reduction targets. Emissions reductions are directly linked to energy conservation or efficiency, both of which are directly linked to technologies. Investments that result in low emissions technologies being made available sooner or at lower cost will contribute to reducing emissions at lower levels of tax. Similarly, technology investments can contribute to the ability to meet tighter mandated standards than would otherwise be possible.

Technology investments are likely to be more effective when combined with other instruments. They improve the effectiveness of the policy instruments they are combined with. Technology funds provide a more focused approach than do broader technology investments and can, therefore, contribute more effectively. Linking the base revenues for technology funds to emissions provides a direct and useful link between the sources of emissions and potential solutions. This link can be used to supplement the other measures described above and to reduce the economic dislocations that might otherwise accompany long-term emissions reductions.

CHAPTER 5

The Economic Impact of Technology Funds

Chapter Summary

- Alberta and Ontario will make the largest investments in climate-friendly technologies over the period 2010–14.
- The technology investments examined will total $11.8 billion.
- Economic impact multipliers are highest in provinces that can source materials and services locally. Ontario's investment multiplier exceeds 1, suggesting that each dollar of technology investment will generate slightly more than one dollar of GDP.
- Each $100 million of investment will yield between 600 and 1,500 person years of employment.

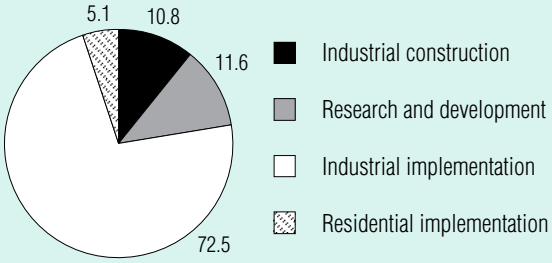
This chapter summarizes the research methods and results of the Conference Board's assessment of the potential economic impact of technology funds investment on the Canadian economy and its regions. The analysis quantifies the economic impact of estimated capital acquisitions and spending on research and development. It does not attempt to measure the additional beneficial aspects of reducing energy consumption or GHG emissions, nor does it capture the potential benefits of commercializing new technology.

The economic impacts reviewed here are based on estimates of the capital investment and R&D funds made available by the various federal and provincial technology fund programs described in chapters 3 and 4. Estimates of spending were collected on a fund-by-fund basis, including partner funding. Moreover, because different types of spending have varied economic impacts on the economy, the investments were broken out by type of spending: implementation of new technology (residential and non-residential); construction of new structures; and research and development. For the purposes of the economic impact analysis, the spending estimates were cumulated over a five-year period, spanning 2010 to 2014 inclusively. Overall, our research suggests that a total of $11.8 billion in spending will be leveraged by technology funds over the next five years. The lion's share of the funding is expected to take the form of implementation of new technology by industrial sectors—essentially, investment in new machinery and equipment. (See Chart 3.)

Economic multipliers are valuable for planning because they allow us to link each dollar of spending to a given dollar value of GDP, job creation, or tax revenues.

The Conference Board's macroeconomic models of the provincial economies were used to quantify the effect of these estimated investments on a wide range of economic variables. The methodology allows for the calculation

Chart 3
Estimates of Technology Fund Spending, by Category, 2010–14
(percentage change; average annual compound growth rate)



Source: The Conference Board of Canada.

of economic multipliers—rules of thumb that link technology funds investment to economic activity—that, under not too stringent assumptions, remain relatively stable under different investment scenarios. In other words, the economic multipliers are valuable for planning because they allow us to link each dollar of spending to a given dollar value of GDP, job creation, or tax revenues.

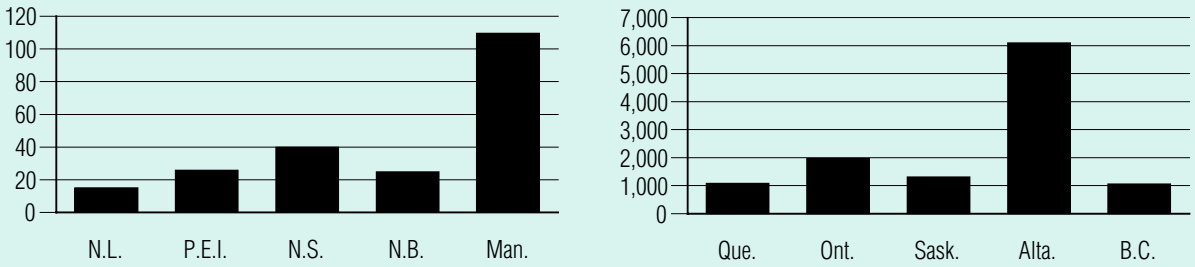
In addition to the amount of spending leveraged regionally, the varied mix of investment by region results in different economic impacts and multipliers. For instance, if a high portion of the investment is in industrial construction, the economic multiplier for this type of spending tends to be large, since a greater proportion of the inputs can be sourced locally. If a large portion is spent on machinery and equipment, the economic multiplier is not as large because machinery and equipment is often imported. As can be expected, larger or more diverse economies stand to benefit more; smaller provinces, whose industrial structure is not as diverse, tend to have smaller economic multipliers. Overall, the economic impact by region depends greatly on the overall amount of spending as well as on the mix of investment.

Investment in technology funds will generate many jobs in all of the provinces.

The level of cumulative investment in technology funds over the next five years (2010–14) varies widely from province to province. Alberta will have the greatest amount of investment, topping $6.1 billion in current dollars. Ontario will spend nearly $2 billion, with Saskatchewan, Quebec, and British Columbia following behind with investments all over $1 billion. Manitoba will spend nearly $110 million, while the Atlantic provinces are expected to invest under $100 million over the next five years. (See Chart 4.)

Results from our model simulations suggest that a $100-million investment (inflation-adjusted) in technology funds in Ontario will yield a $107-million impact to real GDP, based on the mix of investment. This differs from Alberta's $70-million impact on GDP from a $100-million investment because most of Alberta's investment goes

Chart 4
Estimates of Technology Fund Spending, by Province, 2010–14
(current $ millions)



Source: The Conference Board of Canada.

toward carbon capture and storage, which is intensive in machinery and equipment and imports. Investment in technology funds will generate many jobs in all of the provinces, ranging from construction workers and researchers to machinery operators and engineers. A real $100-million investment in Ontario or Manitoba will create over 1,400 jobs in those regions. Given the mix of investment and provincial industrial structure, New Brunswick, Quebec, and British Columbia will also create over 1,000 jobs for every $100 million invested.

Provincial and federal government revenues will also receive a boost from technology investment. Because of all the jobs created, personal income and indirect tax revenues alone will boost government coffers by as much as $27 million (in nominal terms) in Manitoba for every $100 million invested. At the other end of the spectrum, revenues will increase by just $8 million for a $100 million investment made in Alberta.

METHODOLOGY AND KEY ASSUMPTIONS

The primary objective of this study is to quantify the impact of technology funds investments on key economic indicators such as GDP, employment, income, and government revenues for each of the 10 provinces. The analysis evaluates the combined direct, indirect, and induced economic impacts, defined as follows:

Direct impact measures the value added[1] to the economy of the increased capital spending on those directly involved in the construction or implementation of GHG-reducing technology. The R&D portion of the spending is captured through increased wages attributed to the region where the spending occurs.

Indirect impact measures the value added that the "direct impact firms" generate economically through their demand for intermediate inputs or other support services. For example, increased demand for machinery and equipment has elevated import content, muting the direct effect on the Canadian economy. Nonetheless, the increased demand will generate domestic activity in the transportation sector.

Induced impacts are derived when employees of the aforementioned industries spend their earnings and owners spend their profits. These purchases lead to more employment, wages, income, and tax revenues, and can be felt across a wide range of industries.

Industrial implementation of GHG-reducing technologies will result in, for most regions, high levels of imported machinery and equipment.

Thus, increased demand for a specific industry will not only have direct impacts on the economy but will spread through the economy through a series of multiplier effects. Indirect effects are first felt on the demand for industries that are direct suppliers. Second-round induced effects produce a widespread impact (albeit usually smaller) on all sectors of the economy, largely through a general increase in consumer spending. The overall economic multiplier is calculated as the sum of all value-added impacts (direct, indirect and induced) divided by the initial constant dollar spending leveraged by technology funds.

The Conference Board of Canada's provincial forecasting models capture the sum of the direct, indirect, and induced impacts on each of the provincial economies, based on estimated historical relationships. The models incorporate a detailed modelling of prices, households, and businesses, and provide economic impact results for a wide range of economic indicators. It is important to note that the initial constant dollar value of the capital investment does not necessarily result in a one-to-one increase in real GDP. This is because the lion's share of investment is assumed to go toward the purchase of machinery and equipment, much of which is imported from abroad or from other provinces. Depending on the industrial makeup of each of the regions, the economic multipliers can vary significantly. In particular, industrial implementation of GHG-reducing technologies will result in, for most

1 Value added or net output is the difference between total revenue and the sum of expenses on parts, materials, and services used in the production process. Summing the value added across all industries in a region will yield the GDP in that region.

regions, high levels of imported machinery and equipment. Provinces that have a larger and more diversified manufacturing base, such as Ontario, have greater capacity to benefit from the increased demand for machinery and equipment as well as from other economic stimulus, such as increased demand for transportation and other services.

NOTABLE NOTES

Some key points and assumptions about the methodology are important to mention. Most important is that the information available to break out investment by type of spending and over time is limited, as many of these programs are just getting started and there is incomplete information about these factors. Nevertheless, care was taken to estimate annual amounts of spending over the 2010–14 period, as well as to examine the probable breakout of spending based on the type of investments targeted by each of the specific initiatives. Estimates of the capital investment and R&D funds made available by the various federal and provincial technology funds, and the breakdown of investment by type of spending—implementation of new technology (residential and non-residential), construction of new structures, and research and development—are based on the programs and incentives described in chapters 3 and 4. Still, because of the uncertainties associated with the data, the economic impact results are presented as an average over the five-year period rather than on an annual basis. This helps disperse the uncertainties associated with the lack of information about timing and type of spending.

The technology fund spending estimates are reported by various federal and provincial governments on a current dollar basis. In order to feed the econometric models, these data need to be converted into constant dollar (inflation-adjusted) estimates. The provincial economic accounts, on which the econometric models are based, are produced by Statistics Canada on a constant 2002 dollar basis. As such, appropriate deflators have been used to adjust the current dollar estimates into real 2002 dollar spending. This methodology ensures that the economic impact and multiplier results reported are stable, but the constant dollar spending estimates reported in the following sections differ from the current dollar estimates reported in Chart 4.

In producing the model simulations, we assume that technology investment funds are available, such that there are no direct effects on government accounts. Implicitly, this suggests that new funding is debt-financed and does not result in reduced spending on other government programs. This avoids the complications of allocating the financing, not only at the federal level but also at the regional level. As such, only the beneficial effects of the model simulation are recorded on the government accounts, through increases in personal income taxes generated by the simulations. The Conference Board's provincial forecasting models contain only a partial accounting of government revenues (including federal and provincial direct income taxes). In addition, government accounts in the Conference Board's national and regional models are based on national accounts data and not on public accounts data. In principle, one can assume that the impact of the simulation on a national account and public account basis would be similar.[2]

Finally, although the simulation has only small effects on costs and prices, these variables do move in response to the lift in economic activity and have a modest dampening effect on the economic impact results. Price effects are too small to have a measurable impact on monetary policy or on the value of the currency.

ECONOMIC IMPACT RESULTS

Table 6 provides a summary of the overall economic impact of the technology fund spending by region. The first two columns present the estimated direct spending levels for each of the regions in millions of current and constant dollars.[3] The latter column presents the cumulative impacts on real GDP and employment over the five

2 An additional assumption about the availability of technical funds is that these funds do not impact the availability of funds for any other government program.

3 Data are converted to constant dollars using appropriate deflators applied to the estimated breakdown of spending on residential and industrial construction, machinery and equipment, and wages—the latter applied to R&D spending. Because the deflator for machinery and equipment, as reported by Statistics Canada, is lower today than it was in 2002, this offsets increased prices for other spending categories. The result is that the overall spending estimates are very similar, and in many cases larger, in constant dollars than in current dollars.

years from 2010 to 2014. Even though the economic multiplier is not as robust in Alberta as in Ontario (as we will see in subsequent sections), the overall economic impact of technology funds will be largest in Alberta. A total of nearly $6.9 billion in real spending generated by technology funds is estimated to boost Alberta's real GDP by roughly $4.8 billion and create close to 50,500 person-years of employment.

Alberta will create 50,500 person-years of employment in the period 2010 to 2014.

Ontario's economy will also benefit from robust technology fund investment as well as strong multiplier effects, helping to lift real GDP by $2.1 billion over the five-year period and create just over 29,000 person-years of employment. British Columbia and Quebec will benefit from strong employment gains with over 12,000 person-years of employment created. Saskatchewan and Manitoba follow suit while the Atlantic provinces are expected to experience smaller impacts.

Considering the relative size of each province, results are slightly different across the regions. Chart 5 displays the average potential job creation in any one year from the increased technology fund spending (over the period 2010–14) as a share of total employment in each region.[4]

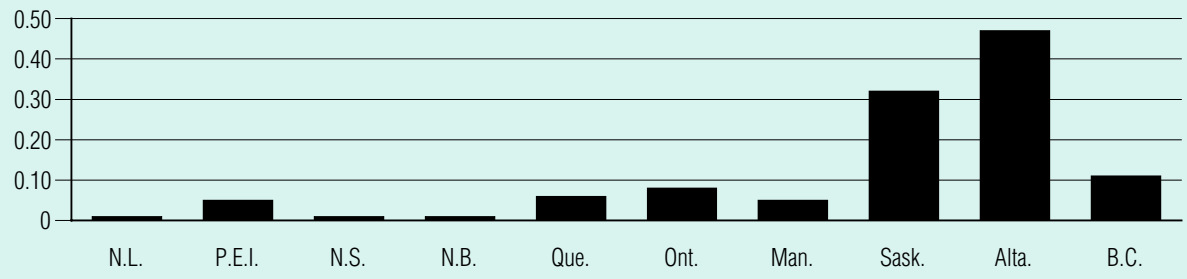
Table 6
Technology Fund Spending: Five-Year Impacts on Real GDP and Employment

	Technology fund spending 2010–14 ($ millions)	Technology fund spending 2010–14 (2002 $ millions)	Total real GDP impact (2002 $ millions)	Person-years of employment
N.L.	15	14	7	99
P.E.I.	26	27	9	195
N.S.	40	41	20	330
N.B.	25	25	16	264
Que.	1,082	1,123	838	12,287
Ont.	1,970	1,986	2,132	29,022
Man.	110	112	107	1,642
Sask.	1,317	1,415	697	8,568
Alta.	6,103	6,865	4,815	50,497
B.C.	1,063	1,030	866	13,317

Source: The Conference Board of Canada.

Alberta's relatively large funding suggests that the province would add, on average, about 0.5 per cent to total employment over the five-year period examined. Saskatchewan comes in second, with funding potentially adding more than 0.3 per cent to employment. Quebec and the provinces west of Quebec are also expected to experience relatively significant increases from technology

Chart 5
Potential Employment Impacts in Any One Year From Increased Technology Fund Spending (Over 2010–14)
(per cent; as a share of total employment in each region)



Source: The Conference Board of Canada.

4 Total provincial employment levels forecast over the 2010–14 period are based on the Conference Board's latest medium-term provincial forecast, completed in January 2010.

fund programs now in place. Currently, the level of spending through technology funds is smaller for the Atlantic provinces (with the exception of Prince Edward Island). This, coupled with more modest economic multipliers, suggests that employment impacts would be less important over the next five years.

Another way to interpret the results of the econometric model simulations is to examine the multiplier impacts that technology funds produce. The exercise allows us to estimate the impact that an additional $100 million in funding would have on various economic indicators for each of the provinces. A summary of multiplier impacts is presented in Table 7. The first column, for example, suggests that for each $100 million in real spending by region, real GDP would be lifted by as much as $107 million in Ontario but only $34 million in Prince Edward Island. Recall the earlier discussion that the multipliers are affected by the type of spending and the industry structure of the regions. As such, Ontario benefits relatively more from the impact of new spending because more of the increased demand can be met through local production. Manitoba also registers a relatively robust multiplier, in this case, due to the fact that a greater proportion of the province's technology funds are targeted toward R&D, which is assumed to be performed within the province.

Alberta's planned investment in carbon capture and storage is much larger than amounts put forth in other provinces, and the province will benefit from the largest absolute and relative impacts on its economy.

The mix of spending and industry structure also results in varied employment impacts, ranging from just 605 jobs for $100 million in real spending in Saskatchewan to over 1,400 in Ontario and Manitoba. These multiplier impacts would remain relatively constant, assuming that the relative mix of spending generated by the technology funds is stable.

In addition to real GDP and employment impacts, Table 7 presents the estimated economic impacts on federal and provincial income and indirect tax revenues. For the most part, indirect taxes are provincial and federal sales taxes levied on consumption. These estimates are based on average impacts resulting from the model simulations over the 2010–14 period. Given the number of R&D jobs and income generated in Manitoba, it stands to add the most to provincial and national coffers in income and sales taxes for every $100 million in technology funds spending. Alberta will add the least amount, given that a higher proportion of its investment will be in industrial implementation, but also because it has lower income and sales tax rates.

Chart 6 summarizes the economic impact that current technology funds investment will have on each of the provincial economies over the next five years. The total (inflation-adjusted) spending on implementation of new technology (residential and non-residential), construction of new structures, and research and development is presented alongside the overall economic impact that all

Table 7
Economic Multipliers—Economic Impacts of $100 Million in Real Technology Fund Spending

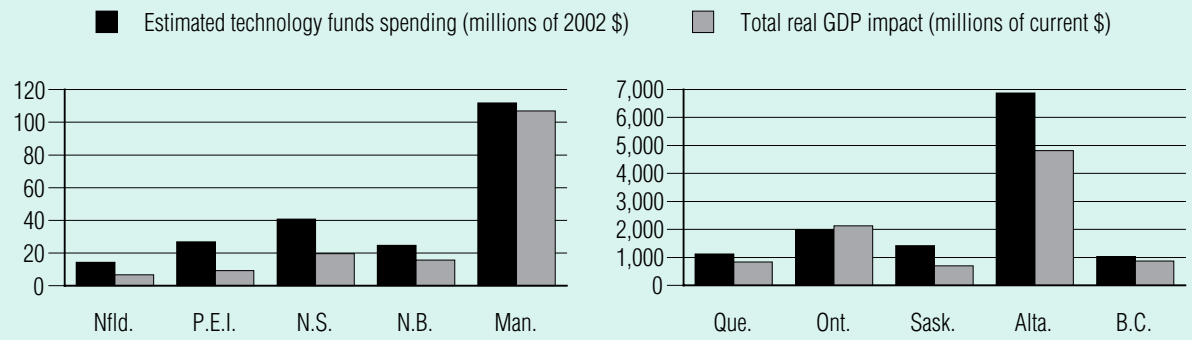
For every $100 million investment in technology funds:

	Real GDP (2002 $ millions)	**Employment** (number of additional jobs)	**Nominal GDP** ($ millions)	**Federal and provincial income and indirect taxes** (current $ millions)
N.L.	47	697	68	10
P.E.I.	34	730	48	11
N.S.	48	808	69	14
N.B.	64	1,072	69	13
Que.	75	1,094	97	23
Ont.	107	1,461	137	25
Man.	96	1,468	132	27
Sask.	49	605	54	12
Alta.	70	736	85	8
B.C.	84	1,293	128	19

Source: The Conference Board of Canada.

of these programs will have over the 2010–14 period. The impacts are, of course, very much dependent on the initial spending estimates but also on the type of spending as well as the industrial structure of each region. Alberta's planned investment in carbon capture and storage is much larger than amounts put forth by other provinces, and the province will benefit from the largest absolute and relative impacts on its economy. Still, all provinces benefit from the increased spending generated by technology funds.

Chart 6
Economic Impacts of Estimated Technology Fund Spending, by Province
(spending estimates 2010–14)



Source: The Conference Board of Canada.

CHAPTER 6

Conclusions

Chapter Summary

- Although most provinces are pursuing technology investments as a tool to reduce greenhouse gas emissions, the history is too short to evaluate the effectiveness of these tools.
- Alberta and Ontario have both the highest levels of GHG emissions and the highest levels of technology investments.
- Technology investments will produce greater benefits than estimated in this report to the extent that those technologies are exported.

This report has examined the potential economic and employment impacts of climate-based technology investments in Canada. The investigation is based on each province's stated goals to reduce GHG emissions, as well as on a review of current technology investment programs, both provincially and federally. The federal, provincial, and territorial governments have recognized the importance of innovation and have developed plans and strategies for fields where they feel that they have an advantage in science and technology. Most provinces have a range of programs and initiatives that fund technology and innovation. Although many of these programs do not directly target GHG emissions, the federal and many provincial governments focus on clean-energy technologies as one area of innovation and commercialization.

It is important to recognize that not all regions of Canada have a comparative advantage in clean-energy technology development. Furthermore, provinces have different GHG emissions challenges that can be turned into opportunities. For example, the environmental challenge of Alberta's oil sands production is leading to research and development that will likely provide commercial solutions to reduce its ecological footprint. Ontario's automotive sector is a significant contributor to its economy, so the strategic innovation focus on clean automobiles can provide avenues for the province's future prosperity while also responding to the climate change challenge.

Not all regions of Canada have a comparative advantage in clean-energy technology development.

Overall, Canada will require significant private and public sector investments to meet aggressive GHG emissions targets. A considerable part of these investments must be devoted to the research, development, implementation, and commercialization of clean-energy technologies. In other words, innovation will play a major role in achieving climate change mitigation goals. It will also offer economic opportunities of turning these innovative solutions into commercial applications and technologies that can be sold not only in Canada but internationally. But to achieve both environmental and full economic benefits, Canadian governments need to properly support homegrown commercialization of technologies and help develop Canadian clean-energy technology companies.

Chapter 2 of this report identifies the range of emissions levels, compositions, reduction targets, and policies across Canada. Alberta and Ontario face the largest challenge in terms of the current level of emissions. Alberta, Ontario, and Saskatchewan have seen the largest percentage of growth in emissions over the past 20 years. Notwithstanding the diversity of emissions levels, emissions sources, emissions reduction targets, and climate action plans, there are two common themes:

- all provinces are implementing climate action plans that rely heavily on developing and implementing technologies that reduce GHG emissions; and
- most of the programs have a limited track record of investments and are more focused on expenditures than on emissions reductions, making it impossible to measure their contribution to meeting provincial targets.

Investments are being made where the emissions reduction challenge is greatest.

As outlined in Chapter 4, the provinces are each pursing independent paths in establishing programs and promoting technology investments to reduce GHG emissions. The funding levels, funding models, governance models, and investment targets vary from program to program. In most cases, the funding levels, investment criteria, requirements for matching funds, and financial reporting requirements are much more clearly stated than the emissions reductions targets. Only a limited number of technology investments include project-specific GHG emissions reductions.

Alberta and Ontario, the two provinces with the largest GHG emissions, are also the provinces leading the way in technology investments. In fact, at more than $6.1 billion, climate-friendly technology investments in Alberta over the period studied are expected to be larger than those in all other provinces combined. Ontario ranks second at just under $2 billion, and Saskatchewan third at just over $1.3 billion. The finding is simply that geographically, and on a per capita or GDP basis, investments are being made where the emissions reduction challenge is greatest.

Our multiplier analysis indicates that technology investments in Ontario generate the highest in-province GDP impacts, primarily because of greater manufacturing diversity in that province. Quebec, British Columbia, and Alberta all see up to 30 per cent of the impacts leaking to other provinces or outside of Canada. Saskatchewan and the Atlantic region see even greater leakages.

The greatest impact of technology investments appears to be on employment. The benefits in job creation, particularly when measured against current employment, appear to be greatest in Alberta, Saskatchewan, and British Columbia. These provinces are the largest investors in climate-friendly technologies, and they are also the largest producers of hydrocarbons, an industry that is broadly expected to face economic hardship from carbon taxes, cap and trade, or other measures to reduce GHG emissions. The observation is that technology investments are currently acting to offset at least the employment impacts of emissions regulation. The challenge is to further understand whether more targeted technology investments can contribute more effectively in that regard.

To the extent that they result in new or significantly improved technologies, technology investments will generate economic benefits that are not captured in this analysis. These impacts will come through export sales. An obvious example is carbon capture and storage technologies. The federal and Alberta governments, in particular, are investing billions of dollars to develop, demonstrate, and commercialize technologies to capture and store GHG emissions, including retrofit technologies. Commercial success could lead to very large market opportunities in the United States and around the world. These potential impacts have not been included in this report, primarily because at the current state of development, it is impossible to predict the timing, cost, and impacts with any degree of certainty.

Technology investments in Canada also show a diversity of decision models. Only a subset of the investments we examined have specific sources of funds that link directly to GHG emissions. Many of the investments are based on government program spending that is funded through budget allocations. Most of the investments that we have

considered to be technology funds have sources of funding that are linked directly to either fuel levies (ICE in British Columbia and the Green Fund in Quebec, for example) or environmental levies (the SDIF in Manitoba or the CCEMF in Alberta, for example). Technology funds that are directly linked to emissions levies have the potential to reduce the burden of emissions reductions by advancing the development of new technologies that are more climate-friendly.

The impacts measured suggest that technology investments will contribute positively to both GDP and employment over the five-year period examined. They also point to potential benefits from export markets.

Technology investments raise questions around technology neutrality. Some of the programs studied are generic in that any investment that reduces GHG emissions is considered. Others, such as the Carbon Capture and Storage Fund in Alberta, are very technology-specific. An important element of the governance model for technology funds is whether, or to what extent, they should be technology-neutral. Funds such as ICE and SDIF that are technology-neutral often allocate funds based on application timing rather than on expected outcomes. The venture capital funds rely on venture capitalists to recognize good investment potential, and place government investments accordingly. The most climate-targeted fund, in terms of both revenue sources and investment criteria, is the CCEMF in Alberta. The funds come entirely from GHG emitters; the investments wholly contribute to GHG-reducing technologies. A board of directors with strong technology and financial competencies must be in place to ensure that the investments made are directed to developing and implementing technologies that will contribute effectively and efficiently to reducing GHG emissions.

The analysis presented in this report indicates that technology investments play an effective role in reducing GHG emissions. They can be used in combination with other policy and market instruments to improve their effectiveness and reduce the economic dislocations that might otherwise result. Many technology investment and technology fund models are being used in Canada. Their eventual impact is difficult to measure, particularly with regard to emissions reductions, because many of these technologies are still being developed or have only a limited track record. The impacts measured suggest that technology investments will contribute positively to both GDP and employment over the five-year period examined. They also point to potential benefits from export markets. Technology investments will continue to play a useful role in creating clean-energy opportunities, reducing GHG emissions, and strengthening Canada's economy. There is an opportunity to make these investments more focused and perhaps more effective as a result.

The climate action plans reviewed in Chapter 2 are in the early stages of implementation. Governments across Canada are at various stages of evaluating or implementing initiatives to reduce GHG emissions, such as carbon taxes, cap and trade, performance standards, communications projects, and capital subsidies. The technology funds model is evolving as well. Several provinces have chosen to use technology funds in combination with other instruments. A properly coordinated climate action plan that uses each instrument efficiently and effectively can contribute to economic growth by responding to opportunities as well as risks. The Alberta model that allocates revenues from compliance penalties directly and entirely to technology development and implementation appears to be headed in the right direction. Large emitters are reducing emissions intensity, purchasing offsets, trading emissions credits, and investing in technology well beyond the compliance penalties. Other provinces have similar funds, although the link between compliance revenues and technology investments is less direct.

APPENDIX A

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APPENDIX B

Related Products and Services

Council on Climate Change Adaptation

This network is a knowledge-sharing forum for leaders grappling with the challenges of uncertain climate change. The primary goal is to strengthen the capacity of member institutions (and, by extension, Canada as a whole) to act proactively, effectively, and in partnership with one another. A secondary goal is to raise broader awareness of the need for climate change adaptation policies. The network does this by getting insights into the hands of key decision makers, disseminating relevant decision-support tools, and commenting on Canada's progress.

Business Council for Sustainability

The role of this cross-industry network is to help you:

- discover, by presentation and hands-on learning, cutting-edge practices in environmental management and corporate sustainability;
- exchange insights and experiences with peers across a diverse range of Canadian organizations; and
- leverage emerging research, public policy insights, and global best/next practice experiences for the benefit of your organization.

This network is for operating executives—the most senior person of an operating unit, president or vice-president of a medium or large-sized organization—and senior executives whose responsibilities include environmental management and sustainability performance.

Global Climate-Friendly Trade: Canada's Chance to Clean Up

This report assesses Canada's trade performance and areas of relative strength in climate-friendly technologies.

Freight Trucks and Climate Change Policy: Mitigating CO2 Emissions

This briefing looks at ways of formulating effective, equitable, and feasible responses by business leaders and policy makers to the challenge of reducing freight truck–related greenhouse gas emissions.

U.S. Climate Legislation Implications and Prospects: Challenges for Canada

This briefing looks at the shape and prospects for climate change legislation currently being contemplated by the United States and its implications for Canada.

How Canada Performs 2009: A Report Card on Canada

This website assesses Canada's quality of life compared with that of its peer countries. We measure performances in six categories: Economy, Innovation, Environment, Education and Skills, Health, and Society.

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