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Investing in GHG Emissions-Reduction Technology.

Assessing the Economic Impact

At a Glance

- The study quantifies the economic impact of investments in greenhouse gas-reducing technologies that include some funding from Alberta's Climate Change and Emissions Management Corporation.
- Between 2011 and 2016, this investment is expected to amount to just over $1.3 billion (2007 $).
- It is expected to have a total economic impact (including direct, indirect, and induced effects) of more than $2.4 billion (2007 $) and to add 15,017 person-years of full-time-equivalent employment.

BRIEFING FEBRUARY 2015

Executive Summary

In 2009, as part of Alberta's climate change strategy, the Climate Change and Emissions Management Corporation (CCEMC) was established as an independent organization with a mandate to reduce greenhouse gas (GHG) emissions and help Alberta adapt to climate change through the discovery, development, and deployment of technology. The CCEMC receives money from the Climate Change and Emissions Management Fund, and, in turn, directs this money to support technology development at all stages of the innovation chain, from R&D to commercialization and deployment of emissions-reducing technologies.

The goal of this study is to quantify the economic impact of investments in transformative technologies that include some CCEMC funding and that are aimed at reducing GHG emissions. The wider repercussions on the overall economy of an investment in new technology can be estimated by using economic models. The economic impact analysis does not consider the operations of the CCEMC but, rather, the benefits of direct and leveraged investments. Moreover, this study does not consider the effect of CCEMC and related investments on reducing GHG emissions.

The CCEMC provided the investment data necessary to assess the economic impacts. This information included the value of projects undertaken or planned by various companies and organizations in which the CCEMC contributed a portion of the funding. Between

2011 and 2016, this investment is expected to amount to just over $1.3 billion (2007 $).

The Conference Board of Canada estimates that the total economic impact (including direct, indirect, and induced effects) of CCEMC and related investments from 2011 to 2016 will be more than $2.4 billion (2007 $), indicating that for each dollar invested, economic activity is lifted by nearly $1.90. In terms of the impact on jobs, we estimate that an additional 15,017 person-years of full-time-equivalent (FTE) employment will be added over the six-year period.

The impact on real gross domestic product (GDP) for Alberta is forecast to be $1.95 billion. This amounts to a multiplier of 1.5. In other words, for every dollar of investment through the CCEMC program, Alberta's economy will be lifted by $1.50. Additionally, total employment will rise by 12,244 FTE person-years from 2011 to 2016. At its peak, in 2014, total employment was up by roughly 5,200 jobs. This will also boost household income and retail sales—the latter up by a cumulative $790 million from 2011 to 2016. In turn, a lift to income will add $226 million to general government coffers.

Investments leveraged through the CCEMC program will result in additional supply-chain impacts in other provinces, as well.[1] Ontario will benefit the most, with real GDP expected to rise by $240 million, while 1,231 person-years of FTE employment will be added to payrolls over the 2011 to 2016 period. British Columbia, Quebec, Manitoba, and Saskatchewan will also benefit from sizable lifts to economic activity and employment. The real GDP gains range from a forecast $22 million in Manitoba to $106 million in British Columbia, while the increases in person-years of FTE employment range from 134 to 696, respectively.

1 There will be some direct spending in other provinces, but it will be very small compared with the Alberta investments. Indeed, 98.3 per cent of CCEMC and related investments from 2011 to 2016 will be made in Alberta.

Introduction

In 2009, as part of Alberta's climate change strategy, the Alberta Climate Change and Emissions Management Corporation (CCEMC) was established as an independent organization with a mandate to reduce greenhouse gas (GHG) emissions and help Alberta adapt to climate change through the discovery, development, and deployment of technology. The CCEMC receives money from the Climate Change and Emissions Management Fund, and, in turn, directs this money to support technology development at all stages of the innovation chain, from R&D to commercialization and deployment of emissions-reducing technologies.

Table 1
CCEMC and Related Investments in New Technologies to Reduce Greenhouse Gases, Canada
(2007 $ millions)

	2011	2012	2013	2014	2015	2016	Total
Wages and salaries, and other current spending	65.9	130.6	224.5	223.4	64.8	33.2	742.4
Non-residential construction investment	23.9	52.7	143.2	153.7	25.4	8.6	407.5
Machinery and equipment investment	9.5	21.7	59.4	63.1	10.7	3.7	168.1
Total	99.4	205.1	427.1	440.2	100.8	45.5	1,318.1

Sources: CCEMC; The Conference Board of Canada.

From 2011 to 2016, it is expected that the CCEMC will help fund just over $1.3 billion (2007 $) in projects in Canada aimed at reducing GHG emissions. (See Table 1.) These investments have increased substantially in recent years and have been largely undertaken in Alberta. However, five other provinces—Quebec, Ontario, Manitoba, Saskatchewan, and British Columbia—have also received direct funding for projects.

This research study assesses the economic impact of these investments on Alberta's economy, and on the other provincial economies where investment has taken place or where there have been spillover effects from the Alberta investments. The economic impact analysis does not

consider the operations of the CCEMC but, rather, the benefits of direct and leveraged investments. Moreover, this study does not consider the effect of CCEMC and related investments on reducing GHG emissions.

While we are assessing the impact of CCEMC and related investment projects on the economy only, projects aimed at reducing GHG emissions have wider benefits. Indeed, reducing GHG emissions has become a priority for many countries, including Canada. Over the past century, an increase in GHG emissions has had a significant impact on the global climate. GHGs are being released into the atmosphere from a variety of sources, including industrial production, forestry, and agriculture processes, as well as the burning of fossil fuels—the latter being the biggest source of GHG emissions in Canada. As GHGs crowd the atmosphere globally, less heat is able to escape and the planet becomes warmer. Estimates from the United States Environmental Protection Agency suggest that the average temperature of the Earth has risen by 0.8°C in the past 100 years, and it is expected to rise by another 1.1°C to 6.4°C over the next century.[1] Data from Environment Canada suggest that average annual temperatures in Canada have warmed by 1.7°C over the last 65 years.[2]

One of the damaging effects of this climate change has been more severe weather patterns, such as stronger hurricanes, and more frequent tornadoes, forest fires, flooding, and droughts. Ecosystems have been affected as well, as have humans. In fact, a recent study by scientists from Harvard University, Boston University, Syracuse University, and Sonoma Technology Inc. noted that reducing pollutants—and, in turn, GHG emissions—from power plants by between 22 and 27 per cent annually could save up to 3,500 lives and prevent 1,000 hospitalizations

1 United States Environmental Protection Agency, *Climate Change: Basic Information*.

2 Environment Canada, *Climate Trends and Variations Bulletin—Annual 2012*.

in the United States each year, by reducing the number and severity of several health issues, including respiratory ailments and heart attacks.[3]

Controlling GHG emissions will continue to be an important policy priority in Canada and around the world. Promoting investments in new technologies that curb emissions can help slow global warming, generate new industries, and diversify Alberta's economy. This study does not address these additional benefits of CCEMC and related investment.

Section 2 of this report discusses the methodology used in this study, while section 3 describes the findings resulting from our analysis. A brief conclusion is provided in section 4.

Methodology

The goal of this study was to quantify the economic impact of CCEMC and related investments in transformative technologies to reduce GHG emissions. The wider repercussions on the overall economy of an investment in a new technology can be estimated by using economic models. The most apparent impact is the economic activity directly attributed to the investment (direct impact), largely associated with the wages of those directly employed in the project and any other current spending, as well as the investment in non-residential capital, and in machinery and equipment. In addition, new technologies generate demand for inputs from other areas (defined as indirect or supply-chain impact), while the income generated by this activity leads to additional spending in the economy (induced impacts). Each of these impacts is described in this section.

The Conference Board relied on its proprietary model of provincial economies, as well as Statistics Canada's input-output model, to obtain the direct, indirect (supply chain), and induced effects of CCEMC and related investments on a wide range of economic indicators—including real GDP, employment, and income—over recent history. While Alberta

3 Joel Schwartz and others, *Health Co-Benefits of Carbon Standards for Existing Power Plants*, 3.

was the focus, the study also addressed impacts on other provinces, including direct effects (although these are small), and supply-chain effects that cross provincial boundaries.

The CCEMC provided the investment data necessary to assess the economic impacts. This information included the nominal dollar value of projects undertaken or planned by various companies and organizations, in which the CCEMC contributed a portion of the funding. In other words, the data included direct investment/funding, and total investments generated by the funding. These projects took place or are scheduled to take place between 2010 and 2019. However, this impact analysis assessed only investments from 2011 to 2016, since most of the planned funding will be provided within this date range. The data were broken down by major category, including wages and salaries, other current spending, construction, and investment in machinery and equipment. These data were also spread out annually over the life of the projects.

To ensure the data were comparable over time and compatible with the economic models, each category of spending was adjusted for inflation. Essentially, each category of spending was deflated by a respective price index available from Statistics Canada (over history) and forecast by the Conference Board. For non-residential construction, we used the implicit price deflator for business gross fixed capital formation, non-residential construction, while the machinery and equipment deflator was the implicit price deflator for business gross fixed capital formation, machinery and equipment. Wages and salaries and other current spending data were deflated by the implicit price deflator for final consumption expenditure. Once the data were converted to 2007 dollars, the annual totals were summed to get the overall level of spending in each category.

The aggregate data were then used to determine the overall economic impact on Alberta and other provinces. To do so, we first identified key supply-chain linkages from the investments, then quantified their impact on key economic indicators, such as GDP, employment, and income.

This impact analysis assessed only investments from 2011 to 2016, since most of the planned funding will be provided within this date range.

The analysis in this study evaluates the combined direct, indirect, and induced economic impacts, defined as follows.

Direct impact measures the value-added[4] to the economy of the investments in transformative technologies related directly to the amounts spent on wages and salaries, other current spending, non-residential construction, and machinery and equipment.

Indirect impact measures the value-added that "direct impact firms" generate in the economy through their demand for intermediate inputs or other support services. For example, research and development activity would create demand for materials needed to build or create new technologies. These effects often cross provincial boundaries.

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

To derive the indirect impact (supply-chain linkages) of CCEMC and related investments on Alberta and other provincial economies, the Conference Board first relied on simulation results from Statistics Canada's interprovincial input-output (IO) model. The IO model assesses more finely detailed supply-chain linkages within Alberta and between provincial economies. Statistics Canada produced the IO simulations by increasing or decreasing demand output in a particular industry to get the total direct and supply-chain linkages associated with that industry. Results from the IO simulations were used to establish economic impacts outside Alberta and to guide the simulation results of the Conference Board's more aggregate model of Alberta's economy.

While the IO estimates provide a very detailed account of the supply-chain linkages, the Conference Board's provincial model assesses

4 Value-added or net output is the difference between total revenue and the sum of expenses for 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.

the impact of the increased investment over time, on a wider range of economic indicators.

Findings

The CCEMC program is assumed to have generated capital investment and other spending activity that may or may not have occurred without the program. To estimate the economic impact, however, we assumed that all activity arising from direct lending and leveraged funds is new activity. Thus, the economic impact analysis was based on the effect of increasing capital investment spending and other current spending by annual amounts equivalent to the sum of direct and leveraged funds invested by the CCEMC program. The overall economic impacts were assessed using Statistics Canada's input-output model and the Conference Board's econometric model of Alberta's economy.

As mentioned, from 2011 to 2016, the CCEMC is expected to help fund just over $1.3 billion (2007 $) in Canadian research projects and new technologies aimed at reducing GHG emissions. While nearly all of these investments (98.3 per cent) are in Alberta, some direct investments are occurring in Quebec, Ontario, Manitoba, Saskatchewan,

and British Columbia. Table 2 breaks down total investment spending (2007 $ millions) by province and spending category from 2011 to 2016.

Table 2
CCEMC and Related Investments in New Technologies to Reduce Greenhouse Gases, Six Provinces, 2011 to 2016
(2007 $ millions)

	Alberta	Quebec	Ontario	Manitoba	Sask.	British Columbia
Wages and salaries, and other current spending	729.70	1.70	2.00	0.10	6.90	1.90
Non-residential construction investment	400.40	0.00	0.10	0.00	6.60	0.40
Machinery and equipment investment	165.20	0.00	0.00	0.00	2.70	0.20
Total	1,295.40	1.70	2.10	0.10	16.30	2.40
% of total	98.30	0.13	0.16	0.01	1.20	0.18

Sources: CCEMC; The Conference Board of Canada.

As shown in Table 2, nearly $730 million or 56 per cent of total CCEMC and related investment in Alberta is related to wages and salaries and other current spending, while the remaining amount ($566 million) is spending on non-residential construction, machinery, and equipment. These are the direct economic contributions to Alberta's economy. However, the full economic benefit of the investment is much larger when the indirect impacts and induced effects are included.

As explained in the methodology, indirect benefits comprise the supply-chain demand created by new investment in goods and services required as inputs. Induced impacts are created when employees researching new technologies, and people linked to that research through the company's supply chain, use the money they earn to buy goods and services. This spending creates additional economic benefits in the form of new jobs and activity generated in other sectors of the economy. The

The model simulations show that the total impact of this new investment on Alberta's real GDP will be $1.95 billion between 2011 and 2016.

sum of the direct, indirect, and induced effects represents the overall contribution to the economy.

The model simulations show that the total impact of this new investment on Alberta's real GDP—including direct, indirect, and induced impacts—will be $1.95 billion between 2011 and 2016. This amounts to a multiplier of 1.5. In other words, for every dollar of investment, output in the Alberta economy increased by $1.50. Meanwhile, the number of FTE jobs is expected to rise by 12,244 person-years.

Chart 1 shows how Alberta's real GDP and employment will be affected over time. Both real GDP and employment rise through 2016, as investments in new technology have increased significantly. In 2011, real GDP rose by $99.6 million. In 2014, that impact peaked at nearly $660 million.

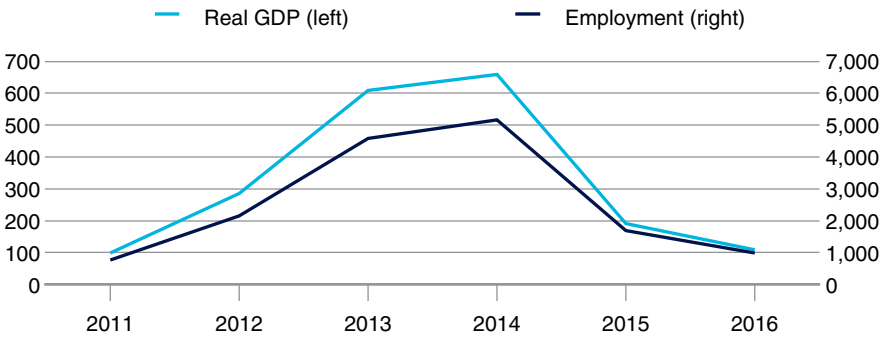
Even though 12,244 person-years of FTE jobs will be added over the six-year period, the increase in actual employment is even higher when part time jobs are included. Cumulatively, employment will have increased by 15,362 between 2011 and 2016. At its peak in 2014, employment was up by roughly 5,200 jobs.

Table 3 presents the results of the CBoC model simulation for Alberta between 2011 and 2016, showing the economic impact of the increased investment not only on real GDP and employment, but also on a host of other key economic indicators. For instance, growing demand for workers has helped attract migrants and labour force entrants. Thus, the labour force will make gains, with more than 11,500 new entrants expected in total between 2011 and 2016. Additional workforce entrants have dampened the downward trend in the unemployment rate, which was reduced by just under 0.1 percentage points at peak impact in 2014.

Chart 1

Impact of CCEMC and Related Investment in Transformative Technologies on Alberta's Real GDP and Employment

(total direct, indirect, and induced impacts; GDP, 2007 $ millions; jobs)



Sources: CCEMC; The Conference Board of Canada; Statistics Canada.

Table 3
Impact of CCEMC and Related Investments in Transformative Technologies on Key Indicators, Alberta
(total direct, indirect, and induced impacts)

	2011	2012	2013	2014	2015	2016	Total
Real GDP at market prices (2007 $ millions)	99.6	285.3	608.7	659.1	191.8	108.4	1,952.8
Personal income ($ millions)	49.5	151.9	338.1	401.4	158.7	105.2	1,204.7
Personal disposable income ($ millions)	43.2	129.0	284.4	325.0	104.9	76.0	962.6
General government transfers paid ($ millions)	5.7	21.1	50.0	72.3	49.9	26.8	225.8
Personal income tax ($ millions)	5.1	18.1	42.2	58.4	35.3	15.7	174.7
Other current transfer paid ($ millions)	0.7	3.0	7.9	13.9	14.6	11.2	51.2
Population of labour force age	17	88	248	490	68	46	958
Labour force	568	1,612	3,403	3,849	1,294	774	11,502
Employment	762	2,161	4,580	5,163	1,700	996	15,362
Unemployment rate (level difference)	–	–	(0.1)	(0.1)	(0.0)	(0.0)	(0.9)
Retail sales ($ millions)	26.3	96.2	221.7	248.7	126.5	70.8	790.2
Housing starts	10.0	73.0	124.0	136.0	34.0	22.0	398.0
Net operating surplus: Corporations ($ millions)	28.5	57.6	98.8	48.7	20.3	23.7	277.5

Sources: CCEMC; The Conference Board of Canada; Statistics Canada.

The boost to population has helped lift household income. From 2011 to 2016, total personal income is forecast to rise by $1.2 billion as a result of the investments, while personal disposable income will be up by a cumulative $963 million. More people, rising incomes, and increased employment are lifting retail sales and housing activity as well. Retail sales are expected to rise by a cumulative $790 million through the six-year period. At the same time, a total of 398 extra housing starts are expected over the 2011 to 2016 period. The increased economic activity also benefits businesses in Alberta—corporate profits are expected to rise by a cumulative $278 million.

Higher personal income and corporate profits are also a notable source of increased tax revenue for governments. On the household side, general government transfers will rise by an extra $226 million between

2011 and 2016, of which $175 million will be attributable to personal income taxes. The remaining $51-million increase in revenues is due to other current transfers paid, which includes contributions to social insurance plans.

Table 4
Impact of CCEMC and Related Investment in Transformative Technologies on Real GDP and Employment, by Industry, Alberta
(total direct, indirect, and induced impacts)

	2011	2012	2013	2014	2015	2016
Real GDP at basic prices (2007 $ millions)	101.4	288.9	615.2	663.4	186.6	104.9
Agriculture and other primary	13.0	34.8	72.7	74.7	16.5	10.3
Manufacturing	12.3	33.2	71.2	76.6	24.5	19.0
Construction	37.0	97.7	199.1	197.8	29.6	7.2
Utilities	1.4	4.4	9.7	10.8	4.3	2.6
Information and cultural industries	2.3	7.1	15.1	15.9	4.3	2.1
Transportation and warehousing	3.4	9.3	19.7	20.4	5.0	3.7
Wholesale and retail trade	8.2	25.5	56.9	67.2	34.4	24.9
Finance, insurance, and real estate	15.5	49.5	107.9	117.9	44.4	23.8
Community, business, and personal services	10.8	32.0	68.5	74.1	21.9	11.0
Government services	–2.5	–4.4	–5.7	8.0	1.8	0.3
Total employment	762.0	2.2	4,580.0	5,163.0	1,700.0	996.0
Agriculture and other primary	38.0	113.0	226.0	238.0	64.0	45.0
Manufacturing	88.0	241.0	509.0	549.0	206.0	144.0
Construction	288.0	770.0	1,509.0	1,599.0	337.0	112.0
Utilities	4.0	18.0	35.0	44.0	20.0	12.0
Transportation and warehousing	32.0	92.0	191.0	199.0	58.0	42.0

(continued …)

Table 4 (cont'd)

Impact of CCEMC and Related Investment in Transformative Technologies on Real GDP and Employment, by Industry, Alberta

(total direct, indirect, and induced impacts)

	2011	2012	2013	2014	2015	2016
Wholesale and retail trade	105.0	313.0	693.0	820.0	444.0	330.0
Finance, insurance, and real estate	47.0	141.0	301.0	309.0	105.0	54.0
Other commercial service industries	185.0	514.0	1,161.0	1,296.0	427.0	239.0
Government services	–26.0	–42.0	–45.0	109.0	39.0	17.0
Unemployment	–193.0	–549.0	–1,176.0	–1,313.0	–407.0	–221.0

Sources: CCEMC; The Conference Board of Canada; Statistics Canada.

Table 4 looks at the changes to Alberta's industries. The largest impacts are expected to occur in the construction industry, partly because of direct investment in structures but also due to the spinoffs created by the overall rise in economic activity, especially demand for new housing and other non-residential structures. Other notable increases in economic activity are occurring in the manufacturing and commercial services sectors. The manufacturing sector is benefiting from an overall rise in demand. Meanwhile, the commercial services sector is benefiting from stronger demand for management, scientific, and consulting services, as well as computer system design and related services.

Not all of the supply-chain demand is being met within the province and, as a result, a number of additional impacts are accruing to other provinces. And while Alberta will receive modest benefits from investments in other provinces, the lion's share of the impact in Alberta is driven by domestic investments. In the remaining provinces, the indirect

and induced impacts are much larger relative to direct investment, due to spillover effects from Alberta.

Table 5 outlines the total economic impact on each province, including real GDP at market prices and FTE person-years of employment.

Table 5
Impact of CCEMC and Related Investment in New Technologies to Reduce Greenhouse Gases, Five Provinces, 2011 to 2016

	Quebec	Ontario	Manitoba	Sask.	British Columbia
Real GDP, market prices (2007 $ millions)	75.7	240.5	21.9	47.4	105.7
FTE jobs	438.0	1,231.0	134.0	275.0	696.0

Sources: CCEMC; The Conference Board of Canada; Statistics Canada.

Taking into account the direct investments in all six provinces, plus the indirect and induced impacts across the provinces, the Conference Board estimates that the total economic impact (including direct, indirect, and induced effects) of CCEMC and related investments from 2011 to 2016 will be just over $2.4 billion (2007 $), suggesting that each dollar invested lifts economic activity by nearly $1.90. In terms of the impact on jobs, 15,017 person-years of FTE employment will be added over the six-year period.

In dollar terms, Ontario is forecast to see the next-largest impact on its economy, after Alberta. In total, Ontario's real GDP will increase by $240 million and the number of FTE jobs will rise by 1,231 person-years. Even allowing for a multiplier similar to Alberta's on the original Ontario investment, we can see that about 90 per cent of the impact in Ontario is due to the investment in Alberta. Ontario benefits from many indirect and induced effects—when, for instance, its companies supply materials

to Alberta firms, those Ontario companies hire workers, and those employees spend money and pay taxes.

At the same time, the increased investments are expected to boost British Columbia's economy by $106 million between 2011 and 2016. The number of FTE jobs will rise by 696 person-years. Next up are Quebec, with an increase in real GDP of $76 million and 438 additional person-years of FTE jobs; Saskatchewan, with a $47-million impact on the economy and 275 new person-years of FTE jobs; and Manitoba, with $22 million and 134 person-years of FTE work. As in Ontario, most of the impact on these provinces' economies comes from the supply-chain and induced impacts of the Alberta investments.

Conclusion

The CCEMC has invested in and helped leverage additional funds for many new projects since its inception in 2009. These new investments are expected to total more than $1.3 billion (2007 $) in Alberta alone from 2011 to 2016. This direct contribution to the Alberta economy will lead to a $1.95-billion (2007 $) increase in the province's real GDP, through supply-chain and induced effects—a multiplier of 1.5. It will also result in the addition of more than 15,300 jobs, or 12,244 FTE person-years of employment.

The rise in output and employment will help generate a cumulative $1.2-billion increase in personal income in Alberta, as well as a $278-million cumulative increase in net operating surplus for corporations. Additional household tax revenues collected will amount to a total of $226 million over the six-year period.

Within the province, some of the largest supply-chain and induced impacts are occurring in the construction, manufacturing, and commercial services industries. However, not all of the supply-chain impacts are occurring in Alberta. Other provinces—Quebec, Ontario, Manitoba, Saskatchewan and British Columbia—are benefiting from Alberta's investments, and CCEMC and related investments of their own. Taking into account the impacts on these provinces, the total

direct, indirect, and induced effects of CCEMC and related investments will amount to over $2.4 billion (2007 $), making the overall multiplier 1.9—almost a doubling of the total investment. Across all the provinces, including Alberta, 15,017 FTE person-years of employment will be created over the six-year period.

APPENDIX A

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Acknowledgements

This research was undertaken by The Conference Board of Canada with funding and support from the Alberta Climate Change and Emissions Management Corporation (CCEMC). In keeping with Conference Board guidelines for financed research, the design and method of the research, as well as the content of this study, were determined solely by the Conference Board.

Pedro Antunes, Deputy Chief Economist and Executive Director, and Jane McIntyre, Senior Economist with the Conference Board's Economic Forecasting and Analysis division, were the lead writers and researchers on the project. Many thanks are due to Ray Luchkow and Kirk Andries from the CCEMC for their valuable comments and insights throughout the production of this research project.

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To cite this document: McIntyre, Jane and Pedro Antunes. *Investing in GHG Emissions-Reduction Technology: Assessing the Economic Impact*. Ottawa: The Conference Board of Canada, 2015.

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PUBLICATION: 6861
PRICE: Complimentary