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# Shedding Light on the Economic Impact of Investing in Electricity Infrastructure

**ECONOMIC PERFORMANCE AND TRENDS**

The Conference Board of Canada
**Insights You Can Count On**

Shedding Light on the Economic Impact of Investing in Electricity Infrastructure
by *Len Coad*, *Todd Crawford*, and *Alicia Macdonald*

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## Preface

This research was undertaken by The Conference Board of Canada for the Canadian Electricity Association (CEA). In keeping with Conference Board guidelines for financed research, the design method of research and the content of this study were determined by the Conference Board. The research was conducted by Todd Crawford and Alicia Macdonald, economists in the Board's Economic Forecasting and Analysis Division, under the direction of Pedro Antunes, Director of the Board's National and Provincial Forecasting group; and Len Coad, Director, Energy, Environment, and Transportation Policy.

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## Acknowledgements

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## EXECUTIVE SUMMARY

# Shedding Light on the Economic Impact of Investing in Electricity Infrastructure

### At a Glance

- Investment in electricity infrastructure in Canada from 2011 to 2030 will total an estimated $347.5 billion, in current dollars.
- The direct, indirect, and induced impacts of that investment will add an average of $10.9 billion per year to real GDP and create an average of 156,000 jobs per year.
- In other words, for every $100 million (inflation adjusted) invested in electricity generation, transmission, and distribution infrastructure, real GDP will be boosted by $85.6 million and 1,200 jobs will be created.

Electricity generation, transmission, and distribution are a ubiquitous and integral part of any modern economy. Aside from providing households with all the conveniences of electric power, a modern and reliable electricity sector contributes to efficient overall economic production and plays an important role in determining Canada's competitive advantage. But in addition to its role of providing a source of energy, the electricity sector also contributes to lifting overall Canadian economic activity and employment through its capital investments in electricity infrastructure.

This report assesses the economic impact of potential future investment in electricity infrastructure in Canada. The methodology used allowed us to calculate economic multipliers—rules of thumb that link new investment in the sector to overall economic activity. The economic multipliers are valuable for planning because they link each dollar of additional investment by the industry to a given dollar value of overall economic output, job creation, and tax revenues. Moreover, this report links the occupational requirements of these increases to capital spending—highlighting the number of workers and skills needed to put in place future electricity generation, transmission, and distribution capacity.

**A modern and reliable electricity sector contributes to efficient overall economic production.**

The investment data used for this analysis were compiled in an earlier Conference Board report that examined capital investment in generation, transmission, and distribution capacity in each of Canada's provinces and territories. To determine the generation investments between now and 2030, a thorough search was performed to identify all generation units that are operational, under construction, planned, or proposed. Based on our estimates of retirements and refurbishments, we estimated the new construction required to ensure that future capacity increases align with future North American market requirements. Transmission investment estimates were based on company long-term plans, system operator long-term plans, and regulatory filings, but a lack of information suggests that transmission investments identified in this report are likely to be underestimated. Estimates for capital investment in distribution were based on sustaining existing infrastructure and meeting the requirements of expanding generation capacity. These capital investment estimates do not include increases to incorporate new technology, such as smart grids, or new uses of distributed electricity, such as electric cars.

**Increased economic activity will lift household income and profits, boosting GDP in current dollars by an annual average of $21.3 billion from 2011 to 2030.**

The analysis relied on results from Statistics Canada's national input-output model as well as simulations of the Conference Board's proprietary model of the national economy to determine the total economic impact resulting from new investment in electricity infrastructure from 2011 to 2030.

Cumulative investment in electricity infrastructure from 2011 to 2030 will total an estimated $347.5 billion, in current dollars. In real 2002 dollars, the total value of the projected investment will be $259.5 billion, an average of $13 billion per year. Not surprisingly, such a large increase in investment will have a widespread impact on the national economy. From 2011 to 2030, the average annual contribution to real gross domestic product (GDP), including direct, indirect, and induced impacts, will be $10.9 billion, and the contribution to employment will average 156,000 jobs per year. The impact would be even greater where it not for the sizable share of machinery and equipment investment that is expected to be imported from outside Canada.

The increased economic activity will lift household income and profits, helping to boost GDP in current dollars by an average of $21.3 billion per year from 2011 to 2030. A sizable benefit also accrues to the federal and provincial governments. In current dollar terms, the federal government balance will benefit from the increased economic activity by an average of $4.2 billion per year, while the aggregate provincial and territorial governments' balance will improve by an average of $1.9 billion per year from 2011 to 2030.

The labour requirements to accommodate the investment in electricity infrastructure will undoubtedly exert pressure on an already tight labour market. Employment in electric power engineering construction is expected to increase by an average of 49,000 jobs per year from 2011 to 2030. Since most of the investment is front-end loaded, the lift to employment will be most important over 2011 to 2016, when, on average, 75,359 jobs per year will be created in the electric power engineering construction sector.

# Shedding Light on the Economic Impact of Investing in Electricity Infrastructure

## INTRODUCTION

Electricity generation, transmission, and distribution are a ubiquitous and integral part of any modern economy. Aside from providing households with all the conveniences of electric power, a modern and reliable electricity sector contributes to efficient overall economic production and plays an important role in determining Canada's competitive advantage. But in addition to its role of providing a source of energy, the electricity sector also contributes to lifting overall Canadian economic activity and employment through its capital investments in electricity infrastructure.

This report assesses the economic impact of potential future investment in electricity infrastructure in Canada. The methodology used allowed us to calculate economic multipliers—rules of thumb that link new investment in the sector to overall economic activity. Under not too stringent conditions, the multipliers remain relatively stable under different capital investment scenarios. In other words, the economic multipliers are valuable for planning because they allow us to link each dollar of capital investment to a given dollar value of output, job creation, or tax revenues. In addition, census occupational databases were used to quantify future labour market requirements for electric power generation construction workers on an occupational basis.

An extensive nationwide survey on planned electricity infrastructure was conducted, allowing us to build estimates of capital investment spending on electricity generation, transmission, and distribution over the next two decades to 2030. Survey results provided planned additions to generation capacity, but these were also compared with anticipated future demand requirements to ensure that capacity increases aligned with future North American demand. Statistics Canada's input-output model was used to determine the first round, supply-chain impacts of this investment. The Conference Board of Canada's national forecasting model was then used to quantify the full economic impact on key indicators such as gross domestic product (GDP), employment, income, and government revenues.

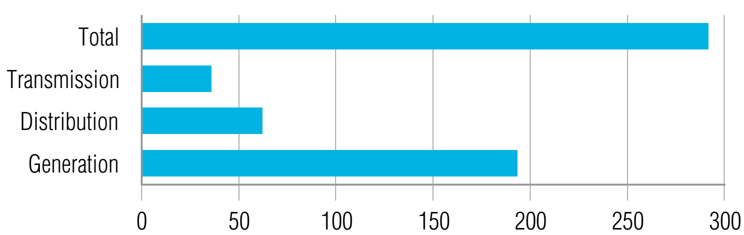
## INVESTMENT DATA AND METHODOLOGY

The investment data used for this analysis were compiled in an earlier Conference Board report that examined capital investment in generation, transmission, and distribution capacity in each of Canada's provinces and territories.[1] To determine the generation investments between now and 2030, a thorough search was performed to identify all generation units that are operational, under construction, planned, or proposed. Based on our estimates of retirements and refurbishments, we estimated the new construction required to ensure that future capacity increases align with future North American market requirements. Transmission investment estimates were based on company long-term

1 Baker and others, *Canada's Electricity Infrastructure: Building a Case for Investment.*

plans, system operator long-term plans, and regulatory filings, but a lack of information suggests that transmission investments identified in this report are likely to be underestimated. Estimates for capital investment in distribution were based on sustaining existing infrastructure and for meeting the requirements of expanding generation capacity. These capital investment estimates do not include increases to incorporate new technology, such as smart grids, or new uses of distributed electricity, such as electric cars. The total investment in electricity infrastructure over 2010 to 2030 will be nearly $300 billion (in 2010 dollars), with the majority of the investment occurring in generation capacity. (See Chart 1.)

**Chart 1**
Electricity Infrastructure Investment from 2010 to 2030
(2010 $ billions)




Source: The Conference Board of Canada.

## GENERATION INVESTMENT

Each province and territory faces different future needs with regard to installed generation capacity, the mix of generation technologies, the timing of new investments, the governing policy framework, and whether the capacity additions will be funded by private or public organizations.

The starting point for generation investments in each jurisdiction is the level and age distribution of currently installed capacity for each generation technology. Assumptions about asset life and retirement or refurbishment options were applied to existing capacity to determine the investments required in those categories. In addition, pending federal regulations for coal-fired generation would require each unit to meet a "clean as natural gas" emissions standard at the end of the economic life of the unit or the end of its power purchase agreement, whichever comes first. New coal units coming into service after 2015 would be required to meet the same standard.[2] The working assumption for this analysis is that coal-fired units that have not been scheduled for retirement will be repowered with some form of clean coal technology.[3] All other units are assumed to be repowered with the same energy source they currently use. For units that are to be retired, the required investments are included.

**Estimates for capital investment in distribution were based on sustaining existing infrastructure and meeting the requirements of expanding generation capacity.**

The next tranche of generation investment is for projects that are under construction or are at an advanced planning stage—that is, they have been approved by the appropriate regulator or planning authority. These projects are not all guaranteed to be built but carry a high probability of completion. For these projects, the capital cost estimates were based on published data for each generation technology, together with the announced target for installed capacity for each project.

The final tranche of generation investment relates to projects that have been proposed or announced. This category includes thousands of projects, many of which are highly uncertain. Considerable judgment must be applied to determine the level of investment that might occur in this group of projects. For each technology, the capital cost per megawatt of installed capacity was estimated, based on recently completed projects.

2 According to Environment Canada, the proposed regulation requires all existing coal-fired electricity generation units, upon reaching end of economic life, to meet a carbon dioxide ($CO_2$) emission standard of 375 tonnes per gigawatt-hour (GWh). If a unit cannot meet the Natural Gas Combined Cycle (NGCC) standard, it will be required to shut down. New units will be also required to meet the NGCC standard. However, the standard will not apply to new generation until the year 2025, provided it is carbon capture and storage (CCS) ready. The proposed regulations will be promulgated under the *Canadian Environmental Protection Act* (CEPA) and will come into effect on July 1, 2015. Details of the program announcement can be found at www.ec.gc.ca/default.asp?lang=En&n=714D9AAE-1&news=2E5D45F6-E0A4-45C4-A49D-A3514E740296.

3 In building the investment assumptions, we have assumed, based on previous research, that clean coal technologies will improve sufficiently to meet the standard at a cost that is roughly 10 per cent lower than that of new nuclear facilities.

These capital costs were applied to the estimated installed capacity for each technology to determine the overall investment in new generation capacity.

The level of projected future demand for energy was based on the potential for growth in domestic and export markets for each of the provinces and territories. However, because market requirements are for energy, not capacity, an assumed capacity factor was applied to determine the installed capacity required to meet future demands. The capacity factors were estimated by technology for each province and territory, and were based on historical performance.

**The level of projected future demand for energy was based on the potential for growth in domestic and export markets for each of the provinces and territories.**

The overall level of capacity from new construction was then estimated based on the balance between required capacity and the sum of installed capacity (including retirements, refurbishments, and repowering) plus capacity under construction or at advanced planning stages. The mix of technologies differed in each province, based on installed capacity, technology-related policy frameworks, the mix of technologies within the set of announced projects, and a general understanding of the ability of the transmission grid to integrate additional renewable energy in particular.

The mix of generation technologies and capacities included in the investment profile for each province and territory is shown in Table 1. These investments reflect the best available information, plus some necessary assumptions. For example, the investment data are based on the Lower Churchill hydroelectric project in Labrador proceeding as currently planned. Also, any coal stations with announced retirement dates are assumed to be replaced by clean coal technologies, and all future coal retirements are based on an assumed service life applied to the original plant commissioning date.

The required generation investments by province are shown in Table 2.

### TRANSMISSION INVESTMENT

The level of future investment in transmission capacity was based on announced projects in each province or territory. Planning horizons differ widely in each, with very few investment streams covering the entire period through 2030. Because transmission investments are project-specific, this report did not estimate investments beyond identified projects through the rest of the period. This means the $35.8-billion estimate of transmission investment understates the level of future investment that will likely be required. (See Table 3.)

There is also the potential for a mismatch between the generation investments assumed and the transmission investments that will be required to integrate long-term future generation projects into the grid. This mismatch would likely be greatest in jurisdictions where a significant portion of future generation investments is in wind and solar and the existing grid is designed primarily around thermal generation sources. The cost of integrating these variable sources is subject to uncertainty.

**The $35.8-billion estimate of transmission investment likely understates the future investment required.**

The transmission investments in this report do not include the impact of smart grid programs[4] unless those programs are included in published investment plans. Given the very early stage of smart grid development and the focus to date on downstream investments (mainly smart meters in homes and workplaces), we do not believe the numbers in Table 3 reflect the smart grid investments that will eventually be made.

4 The Canadian Electricity Association defines the smart grid as "a suite of information-based applications made possible by increased automation of the electricity grid, as well as the underlying automation itself; this suite of technologies integrates the behaviour and actions of all connected supplies and loads through dispersed communication capabilities to deliver sustainable, economic and secure power supplies." McCarthy, *The Smart Grid: A Pragmatic Approach*, 5.

**Table 1**
Generation Capacity Included in Investments
(MW)

| | B.C. | Alta. | Sask. | Man. | Ont. | Que. | N.S. | N.B. | N.L. | P.E.I. | Y.T. | N.W.T. | Nun. | Canada |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Coal | 0 | 1,376 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,376 |
| Nuclear | 0 | 0 | 0 | 0 | 3,500 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 3,540 |
| Large hydro | 3,223 | 147 | 250 | 2,380 | 862 | 3,350 | 0 | 0 | 3,153 | 0 | 10 | 10 | 0 | 13,385 |
| Natural gas | 72 | 4,163 | 346 | 0 | 4,243 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 8,874 |
| Biomass | 138 | 0 | 182 | 0 | 77 | 0 | 180 | 0 | 0 | 0 | 0 | 0 | 0 | 577 |
| Landfill or biogas | 0 | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| Diesel | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fuel oil | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Off-grid hydro | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Small hydro | 51 | 0 | 0 | 0 | 306 | 29 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 486 |
| Waste heat | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 45 | 125 | 0 | 0 | 0 | 0 | 270 |
| Wind | 1,595 | 1,159 | 242 | 138 | 2,178 | 2,666 | 970 | 454 | 0 | 130 | 0 | 0 | 0 | 9,532 |
| Wind, offshore | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Geothermal | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 |
| Solar | 0 | 0 | 0 | 0 | 964 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 964 |
| Other or unkown fuel | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 268 | 0 | 0 | 0 | 0 | 268 |
| **Total** | **5,179** | **6,945** | **1,020** | **2,518** | **12,145** | **6,045** | **1,250** | **539** | **3,596** | **130** | **10** | **10** | **0** | **39,386** |

Source: The Conference Board of Canada.

**Table 2**
Investments in Generation Capacity
(2010 $ millions)

| | B.C. | Alta. | Sask. | Man. | Ont. | Que. | N.S. | N.B. | N.L. | P.E.I. | Y.T. | N.W.T. | Nun. | Canada |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Refurbishment/ repowering | 2,955 | 26,427 | 7,639 | 1,410 | 18,926 | 10,814 | 2,776 | 283 | 2,621 | 345 | 14 | 1 | 18 | 74,229 |
| Retirement | 342 | 677 | 3 | 0 | 3,711 | 0 | 135 | 11 | 205 | 0 | 0 | 0 | 0 | 5,085 |
| New construction | 16,131 | 16,914 | 2,782 | 8,647 | 37,214 | 17,916 | 3,151 | 1,314 | 11,911 | 299 | 35 | 35 | 0 | 116,348 |
| **Total** | **19,428** | **44,019** | **10,423** | **10,057** | **59,851** | **28,730** | **6,062** | **1,608** | **14,736** | **644** | **49** | **36** | **18** | **195,662** |

Source: The Conference Board of Canada.

## DISTRIBUTION INVESTMENT

This report's approach to determining investments in distribution systems was also more generic than for investments in generation. Distribution systems typically separate their investment plans between sustaining and growth categories (with additional investments in administration and information technologies). Sustaining investments can be estimated based on the gross plant in service and depreciation assumptions. Growth investments can be estimated based on the assumed growth in electricity demand and the historical trend in investment per unit of energy delivered. This report assumes a total investment in distribution facilities of $62.3 billion between 2010 and 2030 as detailed in Table 4.

**Table 3**
Investments in Transmission Capacity
(2010 $ millions)

| Province | Total investments identified | Information Sources | Time Horizon |
|---|---|---|---|
| British Columbia | 4,330 | ◆ BC Transmission Corporation Capital Plan 2009–18<br>◆ Fortis 2005–2024 Transmission and Distribution System Development Plan<br>◆ British Columbia Utilities Commission decision reports | 2010–2018<br>2011–2024<br>2011 |
| Alberta | 16,654 | ◆ Alberta Electric System Operator (AESO) Long-Term Transmission System Plan<br>◆ Alberta Utilities Commission (AUC) decisions and pending applications | 2010–2020<br>2010–2015 |
| Saskatchewan | | ◆ Project costs not published | |
| Manitoba | 3,535 | ◆ Manitoba Hydro 2010–2011 and 2011–2012 Rate Application Tab 6 | 2010–2018 |
| Ontario | 5,481 | ◆ Hydro One Capital Plan<br>◆ Integrated Power System Plan, Section E<br>◆ Ontario's Long-Term Energy Plan | 2010–2012<br>2010–2020<br>2010–2030 |
| Quebec | 3,805 | ◆ Hydro-Québec TransÉnergie 2009–2013 Strategic Plan | 2009–2013 |
| Nova Scotia | 1,700 | ◆ Nova Scotia Power 10-Year System Outlook | 2010–2015 |
| New Brunswick | 88 | ◆ NBSO 10-Year Outlook: An Assessment of the Adequacy of Generation and Transmission Facilities in New Brunswick 2011–2021 | 2010–2018 |
| Newfoundland and Labrador | 244 | ◆ 2010 Capital Budget Application, prepared by Newfoundland and Labrador Hydro | 2010–2030 |
| Prince Edward Island | | ◆ Project costs not published | |
| **Total announced investment** | **35,838** | | |

Source: The Conference Board of Canada.

## ECONOMIC IMPACT METHODOLOGY

This report quantifies the economic impact of new investment in electricity infrastructure on the national economy over the next 20 years.

It is important to note that the capital investment data described in the previous section were converted from 2010 dollars to 2002 dollars to determine the economic impact of the investment. This was necessary because 2002 is the base year that Statistics Canada has adopted for the National Income Accounts.

Next, a simulation was produced using Statistics Canada's input-output model of the Canadian economy. This simulation provides the supply-chain (or indirect) impacts of investment in machinery and equipment and structures in the utilities industry. Finally, the Conference Board's national forecasting model was simulated to determine the

**Table 4**
Distribution Investments
(2010 $ millions)

| | Sustaining | Growth | Total |
|---|---|---|---|
| British Columbia | 2,536 | 1,540 | 4,076 |
| Alberta | 8,016 | 2,745 | 10,761 |
| Saskatchewan | 631 | 22 | 652 |
| Manitoba | 2,122 | 317 | 2,439 |
| Ontario | 16,636 | 3,966 | 20,602 |
| Quebec | 19,298 | 2,371 | 21,669 |
| Nova Scotia | 428 | 240 | 668 |
| New Brunswick | 618 | 284 | 902 |
| Newfoundland and Labrador | 357 | 61 | 418 |
| Prince Edward Island | 44 | 22 | 66 |
| Yukon | 12 | 5 | 18 |
| Northwest Territories | 24 | 16 | 40 |
| Nunavut | 5 | 1 | 6 |
| **Canada** | **50,727** | **11,590** | **62,316** |

Source: The Conference Board of Canada.

total economic impact of the projected new investment. The analysis evaluated the combined direct, indirect, and induced economic impacts:

- **Direct impacts** measure the value-added[5] from the construction of the new infrastructure; they are the impacts directly attributed to the employees, the wages earned, and the firms' revenues generated by the construction.
- **Indirect impacts** relate to determining the value that the investment generates economically for other industries through the supply chain. For example, increased construction activity will boost demand for intermediate inputs and generate increased activity in the transportation sector.
- **Induced impacts** are derived from the purchases of employees and reinvestment of profits from both the construction and supplier industries. These (usually smaller) impacts lead to more employment, wages, income, and tax revenues and have widespread impacts on the economy.

In effect, increased demand for a specific industry will not only have direct impacts on the economy but will also spread through the economy through a series of multiplier effects. Indirect effects are first felt because of an increase in demand for products and services from industries that are direct suppliers. Second-round induced effects produce a smaller but more widespread impact on all sectors of the economy, largely through a general increase in consumer spending.

To more accurately assess the direct and indirect value-added impact on related industries, the analysis relied on the use of Statistic Canada's national model of Canada's industrial structure. This input-output model of the Canadian economy has the advantage of finely detailing the industrial structure within Canada's economy as well as containing linkages for inputs that are imported.

**Increased demand for a specific industry will have direct impacts on the economy and will also spread through the economy through a series of multiplier effects.**

While the Conference Board's national forecasting model contains a more aggregate industrial sector, it has the benefit of assessing the impact of additional income, through changes in wages and profits, on a wide range of economic indicators. Moreover, the Conference Board's models allow for the analysis to be carried out over a time period, whereas Statistics Canada's input-output model produces a point-in-time measure of the impact. The direct and indirect effects obtained from the input-output model simulations were used as guides when simulating the Conference Board's model of the national economy to produce the overall economic impact of potential investment in electricity infrastructure over 2011 to 2030.

Once the model simulations were complete, the Conference Board used the results for the total increase in construction employment to determine the increase in employment in the electric power engineering construction industry and what this means in terms of increased demand by occupation. A number of simplifying assumptions were necessary to estimate the potential increase in employment by occupation resulting from the capital investment required.

5 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.

As a first pass, results from the input-output model were used to determine the share of total employment in construction directly associated with electric power engineering construction. Next, we used data from the National Occupational Classification System (NOCS) database to project employment requirements by occupation. The NOCS data are currently only available from the 2006 Census. The projections must rely on the simplifying assumption that occupational shares have been constant since 2006 and will remain constant over the forecast horizon. In addition, the NOCS data were gathered with a sample that represents 20 per cent of the employment, and so the sum of occupational categories in the original data does not necessarily equal the total by broader occupational grouping. Therefore, it was necessary to constrain the more detailed two-digit-level NOCS data to sum to the more general one-digit NOCS employment data classified as electric power engineering construction as shown in Appendix A.

These occupational shares were then applied to our forecast for electric power engineering construction employment to derive the estimates of employment by occupation.

## FINDINGS

Cumulative investment in electricity infrastructure from 2011 to 2030 will total an estimated $347.5 billion, in current dollars. In real 2002 dollars, the cumulative value of the projected investment will be $259.5 billion, with $144.4 billion invested in structures and $115.1 billion in machinery and equipment.

Not surprisingly, the future investment spending requirements will have widespread impacts on the Canadian economy. From 2011 to 2030, the average contribution to real GDP—including direct, indirect, and induced impacts—will be $10.9 billion per year, and the contribution to employment will average 156,000 jobs per year. Table 5 summarizes the impact of the investment on key economic indicators.

Investment will peak over the first five years of the forecast horizon, when the increase in nominal investment spending is projected to average $22.7 billion per year. The impact of this investment will lift real GDP in the economy by an annual average of $16.1 billion contributing, on average, about 1.2 per cent per year to the Canadian economy. This activity will support an average of 247,000 jobs per year over 2011–2015. By 2026–2030, annual investment in nominal terms is expected to average $13.9 billion. During this period, the average annual impact on real GDP will be $7.6 billion, supporting roughly 97,000 jobs per year.

**From 2011 to 2030, the average contribution to real GDP will be $10.9 billion per year, and the contribution to employment will average 156,000 jobs per year.**

The sizable share of machinery and equipment investment expected to be imported from outside Canada will limit the overall impact on Canada's economy. Moreover, higher domestic prices resulting from the increase in overall economic activity will make Canadian exports less competitive, resulting in a mildly negative impact on exports. Overall, the impact analysis suggests that the impact on trade flows will reduce the current account balance by an average of $7.2 billion (current dollars) per year.

The increase in employment will push personal income in current dollars up by an annual average of $9.2 billion from 2011 to 2030, while corporate profits will be $2.7 billion higher per year on average. Increases in personal income and corporate profits will help to push GDP in current dollars up by an average of $21.3 billion per year from 2011 to 2030.

A sizable benefit will also accrue to the federal and provincial governments. The boost to personal incomes will result in an average annual increase of $1.5 billion in personal income tax collection, while increases in profits will yield an average increase of $840 million per year in corporate income taxes over 2011 to 2030 for the federal

**Table 5**
Impact of Electricity Investment on Key Economic Indicators
(level difference of shock minus control, except where otherwise indicated; average per year over each five–year period)

| | 2011–15 | 2016–20 | 2021–25 | 2026–30 |
|---|---|---|---|---|
| Increase in investment ($ millions) | 22,749 | 17,228 | 15,615 | 13,912 |
| Increase in investment (2002 $ millions) | 19,772 | 13,109 | 10,397 | 8,623 |
| Real GDP (2002 $ millions at market prices) | 16,081 | 11,015 | 8,995 | 7,632 |
| GDP ($ millions) | 22,981 | 21,013 | 20,731 | 20,568 |
| GDP deflator (percentage change) | 0.1 | 0.2 | 0.2 | 0.2 |
| Consumer price index (percentage change) | 0.1 | 0.1 | 0.1 | 0.1 |
| Average weekly wages industrial composite (percentage change) | 0.1 | 0.1 | 0.1 | 0.1 |
| Employment (000s) | 247 | 160 | 118 | 97 |
| Unemployment rate (per cent) | –1.1 | –0.8 | –0.6 | –0.5 |
| Personal income ($ millions) | 12,247 | 9,163 | 7,887 | 7,474 |
| Pre-tax corporate profits ($ millions) | 2,973 | 2,586 | 2,646 | 2,590 |
| 90-day Treasury bill rate (per cent) | 0.1 | 0.1 | 0.1 | 0.1 |
| Current account balance ($ millions) | –8,320 | –7,172 | –6,525 | –6,646 |
| Personal income tax ($ millions) | 1,829 | 1,399 | 1,239 | 1,368 |
| Corporate income tax ($ millions) | 907 | 812 | 818 | 824 |
| Indirect taxes ($ millions) | 1,300 | 1,259 | 1,060 | 1,080 |
| Federal govt. balance ($ millions) | 3,683 | 3,551 | 4,123 | 5,299 |
| Regional govt. balance ($ millions) | 2,378 | 2,051 | 1,669 | 1,609 |

Source: The Conference Board of Canada.

and provincial governments. Indirect taxes (which consist largely of sales taxes) will be boosted by the lift to income and consumer spending, increasing by an average of $1.2 billion per year over the forecast horizon. In current dollar terms, the federal government balance stands to improve by an average of $4.2 billion per year, while the provincial and territorial governments' balance is forecast to increase by an annual average of $1.9 billion from 2011 to 2030. Our analysis suggests that prices and interest rates will increase modestly in response to the increase in economic activity, acting to slightly dampen the positive economic impacts.

Table 6 shows the impact of increased investment on the components of real GDP by spending category. The direct impact of the shock—that is, the impact of electricity infrastructure investment using our economic modelling—is on private capital investment on structures and on machinery and equipment, which will increase by an annual average of $7.2 billion and $5.9 billion respectively over 2011 to 2030. However, the large import component associated with the initial hit to machinery and equipment investment represents a leakage that will offset the overall impact on Canada's economy. Additional imports are required to meet the extra demand for consumer goods resulting from increased employment and income. As a result of this extra demand, imports will increase by an average of $6 billion per year from 2011 to 2030, dampening the total impact on real GDP. The trade balance will be further eroded by a small decline in exports as higher domestic prices will reduce our ability to compete internationally, putting downward pressure on export volumes. But increased income will result in a small boost to residential construction, while higher inventories will add modestly to the increase in real GDP. Government spending will be unaffected, aside from the direct capital electricity infrastructure investment.

Economic impact results on GDP by industry are presented in Table 7. The largest impact will be on the construction industry, which will increase by an average of $3.8 billion per year. Manufacturing industries will also experience a sizable boost, with sectors such as the fabricated metals industry and the electrical equipment and component manufacturing industry benefiting from the investment. Private sector services industries will also experience an increase in demand for services that include architecture, engineering, and computer system design. The services sector will also benefit from the induced impacts when higher employment and wages lead to an increase in consumer demand. In total, output in business services is expected to increase by an average of $5.3 billion per year over 2011 to 2030.

**Table 6**

Impact of Electricity Investment on Components of GDP

(level difference of shock minus control, except where otherwise indicated; average per year over each five-year period; 2002 $ millions at market prices)

| | 2011–15 | 2016–20 | 2021–25 | 2026–30 |
|---|---|---|---|---|
| Consumer spending | 2,667 | 2,531 | 2,129 | 2,296 |
| Total government spending | 1 | 1 | 1 | 2 |
| Private capital investment | 22,712 | 14,386 | 11,020 | 8,408 |
| Structures | 11,063 | 7,566 | 5,890 | 4,440 |
| Machinery and equipment | 9,643 | 5,332 | 4,252 | 4,247 |
| Residential construction | 295 | 262 | 245 | 222 |
| Final domestic demand | 23,487 | 16,197 | 13,011 | 11,222 |
| Change in inventories | 397 | 263 | 209 | 173 |
| Exports | –177 | –187 | –191 | –196 |
| Imports | 8,523 | 6,066 | 4,798 | 4,475 |
| Net exports | –8,700 | –6,253 | –4,989 | –4,671 |
| GDP at market prices | 16,081 | 11,015 | 8,995 | 7,632 |

Source: The Conference Board of Canada.

**Many jobs will be created in construction and large gains will also accrue in commercial services industries, including wholesale and retail trade industries.**

The overall economic multiplier is calculated as the total change in real GDP divided by the initial constant dollar increase in investment in electricity infrastructure. Because of the large import leakages, the multiplier is less than one. Our estimates indicate that for every $100 million (inflation adjusted) invested in electricity generation, transmission, and distribution infrastructure, real GDP will be boosted by $85.6 million, and roughly 1,200 person-years of employment will be created.

Overall, employment will increase by an average of 156,000 jobs per year from 2011 to 2030 as a result of the investment in electricity infrastructure. The multiplier yields an estimate of total employment generated (measured in person-years of employment) for every $100 million of real infrastructure spending. In other words, for each $100 million invested, 1,200 jobs will be created for one year. Employment gains will peak in the first five years of the analysis: from 2011 to 2015, the lift to economic activity resulting from cumulative investment in electricity infrastructure over that period will be roughly 247,000 people employed in each year.

Table 8 breaks down the employment gains by industry. Construction accounts for the largest single share of employment gains. Construction employment peaks during the first five years of the analysis with an average of about 95,000 jobs created in the construction industry over 2011 to 2030. By the 2026 to 2030 period, the annual contribution to construction employment will drop to fewer than 40,000. While many jobs will be created in the construction industry, large gains will also accrue in commercial services industries, including wholesale and retail trade industries. In this scenario, the number of unemployed people will be reduced by an average of 150,000, pushing the unemployment rate down by an average of 0.7 percentage points per year.

**Table 7**
Impact of Electricity Investment on GDP by Industry
(level difference of shock minus control, except where otherwise indicated; average per year over each five-year period; 2002 $ millions at basic prices)

| | 2011–15 | 2016–20 | 2021–25 | 2026–30 |
|---|---|---|---|---|
| **Real GDP at basic prices** | 17,080 | 11,175 | 8,841 | 7,406 |
| **Total goods** | 8,730 | 5,641 | 4,410 | 3,687 |
| Primary | 557 | 375 | 295 | 242 |
| Utilities | 215 | 146 | 115 | 94 |
| Construction | 5,879 | 3,751 | 2,925 | 2,449 |
| Manufacturing | 2,079 | 1,369 | 1,075 | 902 |
| **Business services** | 8,029 | 5,312 | 4,256 | 3,573 |
| Wholesale and retail trade | 2,571 | 1,588 | 1,296 | 1,083 |
| Transportation and warehousing | 571 | 375 | 294 | 245 |
| Information and cultural services | 414 | 271 | 213 | 183 |
| Finance, insurance and real estate | 2,026 | 1,425 | 1,151 | 944 |
| Professional, scientific and technical | 1,385 | 930 | 736 | 627 |
| Other business services | 1,062 | 722 | 566 | 490 |
| **Public sector** | 320 | 222 | 175 | 146 |
| **Multiplier** | **0.86** | **0.85** | **0.85** | **0.86** |

Source: The Conference Board of Canada.

**Table 8**
Impact of Electricity Investment on the Labour Market
(level difference of shock minus control, except where otherwise indicated; average per year over each five-year period; 000s)

| | 2011–15 | 2016–20 | 2021–25 | 2026–30 |
|---|---|---|---|---|
| **Total employment** | 247.2 | 159.8 | 118.2 | 97.4 |
| Primary | 3.6 | 2.3 | 1.6 | 1.2 |
| Construction | 95 | 64.1 | 46.8 | 39 |
| Utilities | 1.1 | 0.7 | 0.5 | 0.4 |
| Manufacturing | 20.6 | 12.8 | 9.4 | 7.4 |
| Other commercial services | 62.4 | 40.7 | 30.6 | 25.6 |
| Wholesale and retail trade | 44.5 | 25.2 | 19.1 | 15.3 |
| Transportation and storage | 7.4 | 4.8 | 3.5 | 2.8 |
| Finance, insurance, and real estate | 8.1 | 5.8 | 4.4 | 3.6 |
| Public sector | 4.5 | 3.5 | 2.5 | 2.1 |
| **Unemployed** | –221 | –156 | –121 | –102 |
| **Unemployment rate** (%) | –1.1 | –0.8 | –0.6 | –0.5 |

Source: The Conference Board of Canada.

The labour requirements to accommodate the investment in electricity infrastructure will undoubtedly exert pressure on an already tight labour market. According to the Construction Sector Council's 2011 forecast, the construction industry will need to recruit 111,000 workers between 2011 and 2019 and also replace close to 208,000 workers who will leave the industry because of retirement or mortality. The council estimates there will not be enough supply to meet this demand, and solutions are being investigated as to how this shortfall could potentially be bridged.[6] Given these pressures, it is important to identify the specific occupational requirements resulting from any additional capital investment in electric power generation, transmission and distribution—providing a sense of labour market requirements for future increases in capital spending.

**The labour requirements to accommodate the investment in electricity infrastructure will undoubtedly exert pressure on an already tight labour market.**

Detailed simulation results using Statistics Canada's input-output model suggest that 80 per cent of the lift to construction employment will be directly attributable to electric power engineering construction. Thus, employment in electric power engineering construction is expected to increase by an average of 49,000 jobs per year from 2011 to 2030. Since most of the investment is front-end loaded, the lift to employment will be most important over 2011 to 2016, when, on average, 75,359 jobs will be created in the electric power engineering construction sector per year. (See Table 9.)

The increase to construction employment will encompass a wide range of occupations, as shown in Table 9. The largest impact will be on the trades, transport, and equipment operators and related occupations, where an average of 52,000 jobs per year will be created from 2011 to 2015.

6 Construction Sector Council, *Meeting Construction and Maintenance Workforce Challenges: Construction Owners Strategy 2011 to 2016*, 15.

Breaking this out for a few subcategories suggests there will be sizable annual employment impacts in the following: trades helpers, construction, and transportation labourers and related occupations (11,200); heavy equipment and crane operators, including drillers (10,800); and construction trades (9,100). (See Appendix A for more details.)

## CONCLUSION

This report builds on an earlier report produced by the Conference Board on Canada's electricity infrastructure.[7] In our earlier study, we carefully considered numerous sources to estimate the future capital investments in electricity infrastructure over the next 20 years. This report follows on our earlier research by assessing, over the 2011 to 2030 period, the potential contribution to economic activity of these investments. Economic models were used to quantify the overall impact on GDP, employment, government revenues, and other economic indicators.

The results highlight, at an aggregate level, the widespread effects that capital investment in electricity generation, transmission, and distribution will have across all sectors of the economy. Our analysis assumes that $347.5 billion in current dollars will be spent on new electricity infrastructure from 2011 to 2030. This translates into an average of $13 billion per year when converted to 2002 dollars (inflation-adjusted dollars). And, when accounting for direct, indirect, and induced impacts, this investment is projected to contribute roughly $10.9 billion per year to real GDP.

In other words, for every $100 million (inflation adjusted) invested in electricity generation, transmission, and distribution infrastructure, real GDP will be boosted by $85.6 million, and roughly 1,200 person-years of employment will be created. These economic multipliers are valuable for planning because they link each dollar of additional investment by the industry to a given dollar value of output, job creation, or tax revenues.

7 Baker and others, *Canada's Electricity Infrastructure.*

**Table 9**
Impact of Electricity Investment on Employment in Electric Power Engineering Construction
(average increase per year over each five-year period)

| | 2011–15 | 2016–20 | 2021–25 | 2026–30 |
|---|---|---|---|---|
| **Overall employment in electric power engineering construction** | **75,359** | **50,801** | **37,086** | **30,915** |
| Management occupations | 5,756 | 3,881 | 2,833 | 2,362 |
| Business, finance, and administrative occupations | 8,086 | 5,451 | 3,979 | 3,317 |
| Natural and applied sciences and related occupations | 5,260 | 3,546 | 2,589 | 2,158 |
| Health occupations | 95 | 64 | 47 | 39 |
| Occupations in social science, education, government services, and religion | 143 | 97 | 70 | 59 |
| Occupations in art, culture, recreation, and sport | 86 | 58 | 42 | 35 |
| Sales and service occupations | 1,031 | 695 | 507 | 423 |
| Trades, transport and equipment operators, and related occupations | 51,675 | 34,835 | 25,430 | 21,199 |
| Occupations unique to primary industry | 2,616 | 1,763 | 1,287 | 1,073 |
| Occupations unique to processing, manufacturing and utilities | 611 | 412 | 301 | 251 |

Sources: The Conference Board of Canada; Statistics Canada, 2006 Census, Catalogue Number 97-564-XCB2006006.

Over the 2011 to 2015 period, when capital investment activity is expected to peak, real GDP will be lifted by over $16 billion per year, contributing, on average, about 1.2 per cent per year to the Canadian economy. This is a sizable impact that occurs in addition to the contribution that electric power generation itself brings to the economy. Moreover, this activity supports an average of 247,000 jobs per year over 2011 to 2015. Capital investment spending will ease over the forecast horizon. Still, over the 2026–2030 period, construction activity related to electricity infrastructure will still support employment for 97,000 workers annually.

**Capital investment activity supports an average of 247,000 jobs per year over 2011 to 2015.**

The labour requirements to accommodate the investment in electricity infrastructure will undoubtedly exert pressure on an already tight labour market. According to the Construction Sector Council, demand for construction workers is expected to exceed supply over the next decade. This suggests that the electric power generation industry in Canada may encounter supply constraints when adding to new generation capacity or when refurbishing existing facilities. Therefore, it is important to identify the occupational requirements resulting from any additional capital investment in electric power infrastructure. Our analysis shows that this investment will increase the demand in particular for tradespeople and for transport and equipment operators.

Employment in electric power engineering construction is expected to increase by an average of 49,000 jobs per year from 2011 to 2030. Since most of the investment is front-end loaded, the lift to employment will be most important over 2011 to 2016, when, on average, 75,359 jobs per year will be created in the electric power engineering construction sector. More specifically, the largest impact will be on the trades, transport, and equipment operators and related occupations, where an average of 52,000 jobs per year will be created from 2011 to 2015. Within this category, the most sizable annual employment impacts will be in the following subcategories: trades helpers, construction, and transportation labourers and related occupations (11,200 jobs); heavy equipment and crane operators, including drillers (10,800 jobs); and construction trades (9,100 jobs).

## APPENDIX A

# Impact of Electricity Investment on Employment in Electric Power Engineering Construction

**Table 1**
Impact of Electricity Investment on Employment in Electric Power Engineering Construction
(average increase per year over each five-year period)

| Employment in Electric Power Engineering Construction | 2011–15 | 2016–20 | 2021–25 | 2026–30 |
|---|---|---|---|---|
| **TOTAL** | **75,359** | **50,801** | **37,086** | **30,915** |
| **A. Management occupations** | **5,756** | **3,881** | **2,833** | **2,362** |
| A0. Senior management occupations | 897 | 605 | 442 | 368 |
| A1. Specialist managers | 1,088 | 734 | 536 | 446 |
| A2. Managers in retail trade, food, and accommodation services | 67 | 45 | 33 | 27 |
| A3. Other managers, not elsewhere classified (n.e.c.) | 3,704 | 2,497 | 1,823 | 1,520 |
| **B. Business, finance, and administrative occupations** | **8,086** | **5,451** | **3,979** | **3,317** |
| B0. Professional occupations in business and finance | 554 | 374 | 273 | 227 |
| B1. Finance and insurance administrative occupations | 736 | 496 | 362 | 302 |
| B2. Secretaries | 1,309 | 883 | 644 | 537 |
| B3. Administrative and regulatory occupations | 1,596 | 1,076 | 785 | 655 |
| B4. Clerical supervisors | 191 | 129 | 94 | 78 |
| B5. Clerical occupations | 3,699 | 2,493 | 1,820 | 1,517 |
| **C. Natural and applied sciences and related occupations** | **5,260** | **3,546** | **2,589** | **2,158** |
| C0. Professional occupations in natural and applied sciences | 2,005 | 1,351 | 987 | 822 |
| C1. Technical occupations related to natural and applied sciences | 3,255 | 2,194 | 1,602 | 1,335 |
| **D. Health occupations** | **95** | **64** | **47** | **39** |
| D0. Professional occupations in health | – | – | – | – |
| D1. Nurse supervisors and registered nurses | – | – | – | – |
| D2. Technical and related occupations in health | 76 | 51 | 38 | 31 |
| D3. Assisting occupations in support of health services | 19 | 13 | 9 | 8 |

*(continued . . .)*

**Table 1**
Impact of Electricity Investment on Employment in Electric Power Engineering Construction (cont'd)
(average increase per year over each five-year period)

| Employment in Electric Power Engineering Construction | 2011–15 | 2016–20 | 2021–25 | 2026–30 |
|---|---|---|---|---|
| **E. Occupations in social science, education, government service, and religion** | **143** | **97** | **70** | **59** |
| E0. Judges, lawyers, psychologists, social workers, ministers of religion, and policy and program officers | 124 | 84 | 61 | 51 |
| E1. Teachers and professors | 19 | 13 | 9 | 8 |
| E2. Paralegals, social services workers and occupations in education and religion, n.e.c. | – | – | – | – |
| **F. Occupations in art, culture, recreation, and sport** | **86** | **58** | **42** | **35** |
| F0. Professional occupations in art and culture | 52 | 35 | 25 | 21 |
| F1. Technical occupations in art, culture, recreation, and sport | 34 | 23 | 17 | 14 |
| **G. Sales and service occupations** | **1,031** | **695** | **507** | **423** |
| G0. Sales and service supervisors | – | – | – | – |
| G1. Wholesale, technical, insurance, real estate sales specialists, and retail, wholesale and grain buyers | 124 | 84 | 61 | 51 |
| G2. Retail salespersons and sales clerks | 229 | 154 | 113 | 94 |
| G3. Cashiers | – | – | – | – |
| G4. Chefs and cooks | 76 | 51 | 38 | 31 |
| G5. Occupations in food and beverage service | – | – | – | – |
| G6. Occupations in protective services | 162 | 109 | 80 | 67 |
| G7. Occupations in travel and accommodation, including attendants in recreation and sport | – | – | – | – |
| G8. Child care and home support workers | – | – | – | – |
| G9. Sales and service occupations, n.e.c. | 439 | 296 | 216 | 180 |
| **H. Trades, transport and equipment operators, and related occupations** | **51,675** | **34,835** | **25,430** | **21,199** |
| H0. Contractors and supervisors in trades and transportation | 6,427 | 4,333 | 3,163 | 2,637 |
| H1. Construction trades | 9,149 | 6,167 | 4,502 | 3,753 |
| H2. Stationary engineers, power station operators, and electrical trades and telecommunications occupations | 6,274 | 4,230 | 3,088 | 2,574 |
| H3. Machinists, metal forming, shaping, and erecting occupations | 3,457 | 2,330 | 1,701 | 1,418 |
| H4. Mechanics | 1,509 | 1,017 | 743 | 619 |
| H5. Other trades, n.e.c. | 888 | 599 | 437 | 364 |
| H6. Heavy equipment and crane operators, including drillers | 10,820 | 7,294 | 5,325 | 4,439 |
| H7. Transportation equipment operators and related workers, excluding labourers | 1,948 | 1,313 | 959 | 799 |
| H8. Trades helpers, construction, and transportation labourers and related occupations | 11,202 | 7,552 | 5,513 | 4,596 |

*(continued . . .)*

**Table 1**
Impact of Electricity Investment on Employment in Electric Power Engineering Construction (cont'd)
(average increase per year over each five-year period)

| Employment in Electric Power Engineering Construction | 2011–15 | 2016–20 | 2021–25 | 2026–30 |
|---|---|---|---|---|
| **I. Occupations unique to primary industry** | **2,616** | **1,763** | **1,287** | **1,073** |
| I0. Occupations unique to agriculture, excluding labourers | 163 | 110 | 80 | 67 |
| I1. Occupations unique to forestry operations, mining, oil and gas extraction, and fishing, excluding labourers | 929 | 627 | 457 | 381 |
| I2. Primary production labourers | 1,523 | 1,027 | 750 | 625 |
| **J. Occupations unique to processing, manufacturing, and utilities** | **611** | **412** | **301** | **251** |
| J0. Supervisors in manufacturing | 87 | 59 | 43 | 36 |
| J1. Machine operators in manufacturing | 339 | 229 | 167 | 139 |
| J2. Assemblers in manufacturing | 68 | 46 | 33 | 28 |
| J3. Labourers in processing, manufacturing, and utilities | 116 | 78 | 57 | 48 |

Sources: The Conference Board of Canada; Statistics Canada, 2006 Census, Catalogue Number 97-564-XCB2006006.

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