The Conference Board of Canada

# Continued Operation of the Darlington Nuclear Generating Station:

## An Impact Analysis on Ontario's Economy

The Conference Board of Canada – October 2016

# Contents

## Preface

This research was undertaken by The Conference Board of Canada (Conference Board) with funding and support from Ontario Power Generation. In keeping with Conference Board guidelines for financed research, the design and method of research, as well as the content of this study, were determined solely by the Conference Board.

Prince Owusu, Senior Economist and Sabrina Bond, Economist, with the Board's Economic Forecasting and Analysis division were lead researchers on the project. Pedro Antunes, Deputy Chief Economist, was project manager.

## About the Conference Board

The Conference Board of Canada is the foremost independent, not-for-profit, applied research organization in Canada. We help build leadership capacity for a better Canada by creating and sharing insights on economic trends, public policy issues, and organizational performance. The Board's Economic Forecasting and Analysis division employs more than 35 professional economists who combine their knowledge across regions and sectors to produce their forecasts. The forecasting group constructs and maintains econometric models of the national and regional economies and a one-of-a-kind, comprehensive, quarterly database of the provincial economies in Canada. The Conference Board of Canada was established in 1954, and is affiliated with the U.S.-based Conference Board, Inc., which serves some 2,000 companies in 60 nations.

# Executive Summary

Ontario Power Generation's (OPG) Darlington Nuclear Generating Station (Darlington Station, or "the Station") supplies approximately 20 per cent of Ontario's electricity needs.[1] Having been in operation since the early 1990s, the station is approaching the mid-point of its operating life. At this stage, its CANDU reactors require a major refurbishment to replace critical components. As a result, OPG is currently overseeing a 17-year, $12.8 billion[2] refurbishment project that is designed to allow the station to continue operating safely for an additional 30 years until 2055.

The Conference Board of Canada was commissioned to estimate the economic impact of the continued operation of Darlington Station spanning from 2017 to 2055 on Ontario's economy. To achieve this, the Conference Board relied on detailed nuclear operating cost information provided by OPG. The information included planned expenditures by year, and type of spending. This provided the Conference Board with enough data to perform detailed economic simulations that were used to estimate the impact of ongoing nuclear operation at the Darlington Station on Ontario's economy.

An input-output economic modelling framework was used to estimate the station's direct, indirect, and induced effects on Ontario's economy. The direct effect includes the value of production of economic agents (i.e., workers and firms) directly involved in the station. But to complete their work, these agents need to purchase services and materials from suppliers. These suppliers will themselves require materials and supplies. This sets in motion a chain reaction in the economy, whereby industries supply inputs to other industries that are directly involved in the station. The economic impacts of this chain reaction represent the indirect (or supply chain) effects. Finally, induced effects follow, largely owing to the widespread impact of employees spending the wages and businesses reinvesting the profits earned from the station's direct and indirect activities.

Statistics Canada's detailed model of Ontario's industrial structure was used to capture the direct economic impact of continued operation of Darlington Station and the supply chain impacts of the station's expenditures. Results from these inputs were then used to guide simulations with the Conference Board's own proprietary model of Ontario's economy to estimate the full economic impact of the operation of Darlington through 2055. The objective of using two models was to take full advantage of each model's unique strengths. In particular, the Statistics Canada model has a more detailed breakdown of industries by region, which allows for a more accurate estimation of the indirect effects. Similarly, the Conference Board's model is more dynamic and provides results for a wider range of indicators, allowing for a detailed modelling of prices, interprovincial migration, the government sector, households, and businesses.

Our analysis shows that the economic footprint associated with the continued operation of Darlington Station is expected to represent a $75 billion increase to Ontario's nominal GDP from 2017 to 2055. The boost to economic activity would have far-reaching and, effectively, permanent stimulative effects on the Ontario economy. Darlington's continued operation is projected to increase the number of jobs in

[1] Hunt, *Nuclear Canada Yearbook 2015*.

[2] This is the escalated (i.e. nominal) spending estimate that includes $1.6 billion in interest payments.

Ontario by an average of 14,200 per year between 2017 and 2055, with five jobs created in the broader Ontario economy for each worker directly employed at Darlington Station. In other words, the operational expenditures associated with Darlington Station through 2055 will lift employment by roughly 555,000 person-years in Ontario over the life of the station, with Darlington's effectively permanent footprint serving as a critical source of job creation for Ontarians, both within and outside the utilities industry. The combined impact of the refurbishment and continued operation of Darlington Station is projected to increase employment by 704,000 person-years between 2010 and 2055.

Increased employment and GDP stemming from Darlington's continued operation will translate into increased income for households and businesses as a result of the Station's indelible economic footprint. The ongoing operation of Darlington Station is expected to raise personal income in Ontario by an average of $1.6 billion per year from 2017 to 2055, or by a total of $61.4 billion. The enrichment of Ontario households is expected to translate into more robust consumer spending—a lift of $53.4 billion over the life of the Station, or by an average of $1.4 billion per year— with no net change in the household savings rate. This amount is projected to be distributed across a wide spectrum of household consumption categories for goods and services, including shelter, food, clothing, and vehicles. Corporate profits before tax, similarly, would increase by $7.0 billion over the same 39-year period.

Residential construction, accordingly, is projected to rise by $2.2 billion from continued operation at Darlington Station. Moreover, Darlington's footprint will increase other non-residential business investment by an additional $3.3 billion as corporate profits are re-invested into the Ontario economy. Continued operation at Darlington Station, furthermore, is projected to lift imports by $14.0 billion and exports by $11.0 billion over its 39-year life span.

Higher labour income, increased corporate profits, and the purchase of supplies, raw materials, and services will all contribute to increase government tax revenues. The continued operation of Darlington Station is forecast to result in a $9.3 billion cumulative increase in Ontario provincial government revenues. Meanwhile, the federal government will collect $13.8 billion in revenue, while the local municipalities in Ontario will collect $356 million. In total, $23.4 billion will be added to government coffers over the span of Darlington's operations.

The economic impact analysis allows for the calculation of *multipliers*, which are rules of thumb that associate the ongoing operation of the Darlington Station with employment and overall economic activity. The Station's operation has an elevated Total Multiplier of 1.4. This means that, on average, for every $1 of operation spending, Ontario's GDP will increase by $1.40. Furthermore, the Type II Multiplier of 2.3 indicates that the total impact of the operation of Darlington Station through 2055 is more than twice as large as the contribution of utilities GDP associated directly with Darlington operation. This multiplier reflects the extensive supply chain and economic footprint generated by Darlington Station outside the utilities industry. These multipliers are considered elevated, which can be attributed to the low import content of the operation of Darlington Station.

# 1. Darlington Station Operation

## 1.1 Introduction

Since its first reactor entered service in 1990, the Darlington Nuclear Generating Station has produced over 560 million MWh of electricity from its four CANDU reactors, about the equivalent of Canada's total annual energy consumption. Today, Darlington has a generating capacity of approximately 3,600 MW,[3] and produces about 20 per cent of Ontario's electricity needs.[4] Having been in service for well over two decades, the Darlington Station is undergoing a $12.8 billion[5] refurbishment investment that is designed to allow for an additional 30 years of continued operation.[6] The Conference Board of Canada was commissioned to estimate the economic impact of the continued operation during and following refurbishment of the Darlington Station through 2055 on Ontario's economy.

In the first part of this briefing, an overview of the continued operation of Darlington is provided. In the second chapter, a description of our methodology and assumptions is provided, followed by the findings of our economic impact analysis.

## 1.2 Nuclear Power in Ontario

There are currently three nuclear generating stations in Ontario: Darlington, Bruce, and Pickering stations. In 2015, nuclear plants generated 92.3 million MWh of electricity in Ontario, which constituted 60 per cent of the total 153.7 million MWh produced in the province. (See Table 1.)

**Table 1**
Electric Power Generation in Ontario, 2015, by type of fuel

| Fuel Type | Share of Production (Per cent) |
|---|---|
| Nuclear | 60.1 |
| Hydro | 23.6 |
| Gas/oil | 10.0 |
| Wind | 5.9 |
| Biofuel | 0.3 |
| Solar | 0.2 |
| Coal | n.a. |

Source: Independent Electricity System Operator.

For more than a decade, the Ontario government was committed to eliminating its reliance on coal for generating electricity.[7] The province achieved this goal in 2014, when its last coal-fired plant was

[3] Ontario Power Generation, *Performance Report.*

[4] Hunt, *Nuclear Canada Yearbook 2015*.

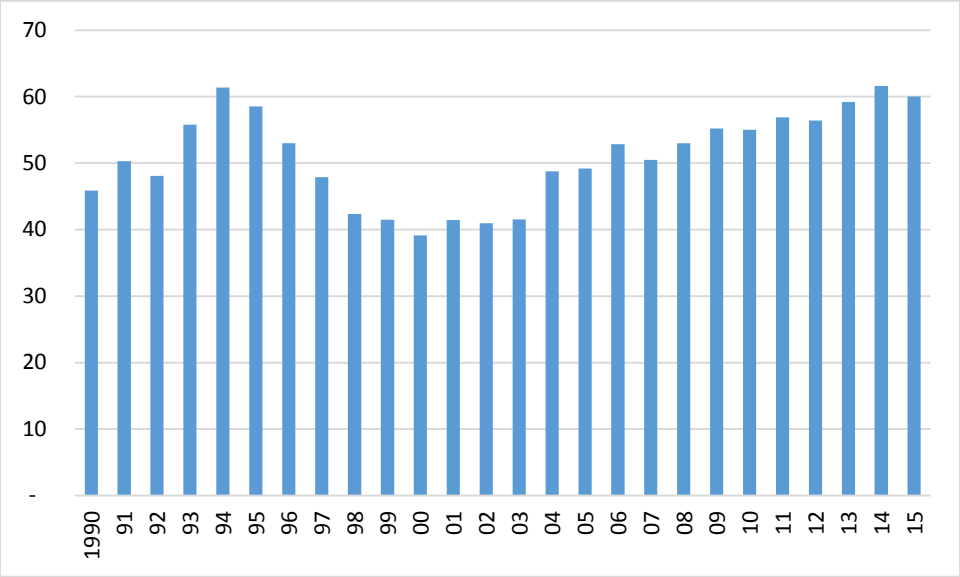
[5] This figure represents the escalated (i.e., nominal) estimate of the costs, including interest payments of about $1.6 billion. Throughout the briefing, escalated costs are used to describe the project and its impacts.

[6] Ontario Power Generation, *Submission to the Ontario Energy Board.*

[7] Gross, "How Ontario Is Winning the War on Coal."

closed.[8] During this period, the province's reliance on nuclear power increased significantly. The share of power generated in Ontario from nuclear steam turbines increased from 42 per cent in 2003 to 60 per cent in 2015. (See Chart 1.)

**Chart 1**
Share of Nuclear Power Generation in Ontario, by Year
(per cent)




Sources: Statistics Canada, CANSIM tables 127-0001 and 127-0002; Independent Electricity System Operator; The Conference Board of Canada.

## 1.3 Continued Operation

OPG has provided the Conference Board with some details about Darlington's ongoing operation. Darlington's costs for operations, investments, and fuel are approximately $1.4 billion per year in current dollars ($1.2 billion in 2015 real dollars). Operating costs include labour compensation and purchases of goods and services.[9] The Darlington Station typically employs about 2,300 to 2,600 workers, including regular staff at the station and those performing various support functions. The majority of the regular station staff (63 per cent) live in the Regional Municipality of Durham, while the remaining reside largely in Northumberland County, the City of Peterborough, and Peterborough County. Supplemental workers are brought in to support scheduled maintenance outages (these can be large such as the 2015 Vacuum Building Outage, which required 1,800 supplemental staff). Post-refurbishment, it is expected that Darlington's direct station staff, nuclear support staff, and allocated corporate support staff will be equivalent to about 2,600 to 2,800 on a full-time equivalent basis to support continued operation.

[8] Ontario Newsroom, *Creating Cleaner Air in Ontario*.

[9] This includes the compensation of staff resident at the Darlington Station, as well as all the share of compensation of OPG's nuclear support staff and corporate support staff which may be allocated to Darlington on a proportionate basis.

Additionally, OPG contributes annually to government revenues in numerous ways, including $4 million in property taxes to the Municipality of Clarington and an equivalent amount to the Province of Ontario. Through its Corporate Citizenship Program, OPG provides community investment support to over 300 initiatives annually in Durham Region in the program focus areas of environment, education, and community (approximately $600,000 a year, or 25 per cent of the program community investment). Since 1999, OPG has provided $10.4 million in Corporate Citizenship Program support in Durham Region. It has also provided $20 million in collaborative educational partnerships with the University of Ontario Institute of Technology (UOIT) and Durham College (Phase III ($5 million) was announced in May 2016). Approximately $1 million in support has been provided to UOIT via the Universities Network of Excellence in Nuclear Engineering. The value of these corporate social responsibility initiatives provides economic benefit to the greater community in addition to the economic impact assessed for the continued operation of Darlington Station detailed in the sections to follow.

# 2. Economic Impact Analysis

## 2.1 Key Assumptions

Starting in October 2016, OPG will begin the refurbishment Darlington Station in Clarington, Ontario. The refurbishment project —consisting of the 2010-2015 Definition phase and 2016-2026 Execution phase— is expected to comprise a total investment of $12.8 billion spanning 2010 to 2026, including cost escalation associated with expected increases in the price of goods and services.[10] The total investment figure also incorporates the $1.5 billion cost associated with interest payments to be made by OPG to the Ontario Electricity Financial Corporation (OEFC) on loans borrowed to complete the refurbishment phase.

As a continuation of the Conference Board's November 2015 analysis of the economic impact of refurbishment of Darlington Station titled *Refurbishment of the Darlington Nuclear Generating Station*, the objective of this report is to estimate the economic impact associated with the continued operation of the Darlington station between 2017 and 2055 on the Ontario economy. It is important to note that, unless otherwise stated, the economic impact analysis presented in this briefing is concentrated on the evaluation of the continued operation of the Darlington Station.

OPG has provided The Conference Board with detailed information, based primarily on OPG's Darlington Refurbishment Business Case Summary, with respect to the expenditures associated with ongoing nuclear operation of the Darlington Generating Station over the 2017 to 2055 period. Four broad nuclear operating cost categories were considered in this analysis to inform specific modeling assumptions:

1. **Station expenditures.** For the purposes of this assessment, station expenditures include: base operating, maintenance, and administration (OM&A) costs,[11] outage OM&A,[12] project capital and OM&A, and minor fixed assets (MFA). Labour costs are assumed to comprise 70 per cent of station expenditures, with the remaining 30 per cent allocated to materials costs.

2. **Station support expenditures.** Support expenditures consist of base OM&A funding for support groups allocated to the Darlington Nuclear Generating Station, including Nuclear Support and

[10] Bounajm, Fares, and Pedro Antunes. Refurbishment of the Darlington Nuclear Generating Station: An Impact Analysis on Ontario's Economy. Ottawa: The Conference Board of Canada, 2015. Represents escalated (nominal) figures.

[11] Base operating costs are calculated as station direct costs plus low and intermediate level waste (L&ILW) costs, minus the cost of goods sold for other revenues. Per OPG's February 2013 report, *OPG's Deep Geologic Repository Project: For Low and Intermediate Level Waste,* L&ILW costs are associated with the secure storage of "industrial items that have become contaminated with low levels of radioactivity during routine clean-up and maintenance." (OPG February 2013, pp.2.)

[12] Outage OM&A consists of direct station costs and support provided, or work conducted by Nuclear Support Groups. Nuclear Support Groups include: Nuclear Engineering, Decommissioning and Nuclear Waste Management, Fleet Operations and Maintenance, Inspection and Maintenance Services, Security and Emergency Services, and Projects and Modifications.

Corporate Support.[13] Labour and material costs are assumed to account for 85 per cent and 15 per cent of station support expenditures, respectively.

3. **Fuel and fuel related costs**. Fuel is assumed to encompass two thirds of total fuel and related costs, with uranium accounting for one third of fuel costs. Uranium concentrate is assumed to be sourced primarily out of province, with the supply chain concentrated in Saskatchewan, Australia, and Namibia. All refining, conversion, and fuel manufacturing activities occur in Ontario in this analysis. Used fuel dry storage (UFD) and used fuel storage (USD) costs are calculated as average annual monies set aside in provision funds, and are included in fuel and fuel related costs.

4. **Property taxes.** OPG pays an estimated annual $4 million in property taxes to the Municipality of Clarington, and an equivalent amount to the Province of Ontario.

Please note that, for sections pertaining to the joint impact of the refurbishment and continuing operation of Darlington Station, interest payments made by OPG to the OEFC were not included in our model simulations. Therefore, the total amount of the investment shock attributed to refurbishment was $11.3 billion in nominal terms.

## 2.2 Concepts and Definitions

The economic impact of any investment in the economy can be divided into three effects: the direct, indirect, and induced effects. Direct effects capture the economic value generated by economic agents, specifically workers and firms, involved in production and income generating activities. Agents need to purchase services and materials from suppliers to complete their work. These suppliers will themselves require materials and supplies. This sets in motion a chain reaction in the economy, whereby industries supply inputs to other industries that are directly involved in the Station. The economic impacts of this chain reaction are referred to in this briefing as the "indirect effects." Finally, induced effects follow, arising from the reactions of economic agents when production (and therefore income) increases. The majority of induced effects are due to the spending of income associated with the employment created by the initial impact of a project. However, reinvestment of corporate profits in expansions of plant capacity or replacement of depreciated capital stock can also elicit induced effects.

The analysis undertaken used a two-step process (discussed in the next section) to evaluate the combined direct, indirect, and induced economic impacts over the 2017 to 2055 time horizon, where:

- Direct impacts were first assessed as the change in value added[14] to the Ontario economy of the contribution to utilities output attributed directly to the operation of the Darlington Station.

[13] Corporate support groups include: Business and administrative services, Finance, People, Culture and Communications, Commercial Operations and Environment, Executive Office, and other corporate costs (such as insurance).

[14] Value added, or net output, is calculated as the difference between total revenue (or gross output) and the sum of expenses on parts, materials, and services used in the production process. The sum total of value added across all industries in a region yields regional GDP.

- Indirect impact measures the value added that the direct impact firms generate economically through their demand for intermediate inputs or other support services. A large number of industries contribute indirectly to Darlington's ongoing operation. The most significant include fuels; inorganic chemicals; computer systems design; engineering; management, scientific, and technical services; and repair and maintenance.

- Induced impacts are incurred when employees of industries affected by direct and indirect impacts 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.

As a result, increased demand for the goods and services of a specific industry will not only have direct impacts on the economy but these will spread through the economy through a series of multiplier effects. Indirect effects are first felt on demand for industries that are direct suppliers. Second-round induced effects produce a widespread (although usually smaller) impact on all sectors of the economy, largely through a general increase in consumer spending.

It is important to note that total expenditures (or revenues) associated with operating the Darlington plant does not result in a one-to-one increase in GDP. This is because the purchase of goods and services associated with the continued operation of the Darlington Station will have leakages associated with purchased inputs and services. For example, demand for fuel, transportation services or manufactured products will require intermediate inputs purchased from suppliers that may be outside regional and national boundaries. The dependence of the supply chain on imported components will determine the level of leakages and the extent to which the overall economic multiplier is reduced. Depending on the import content of the inputs of each industry, the economic multipliers can vary significantly. Because Ontario is an important supplier of professional, scientific, and technical services, as well as engineering and architectural services, the province has a large multiplier associated with the operation of nuclear reactors relative to other regions in Canada. Moreover, Ontario's manufacturing base allows it to gain a relatively larger share of the benefits associated with induced increases in consumer spending and business investment.

## 2.3 Methodology

The economic impact analysis was conducted using a two-step process. Statistics Canada's provincial input-output (I-O) model simulations, based on a custom production function specific to the nuclear power generation industry in Ontario, were first used to identify detailed supply chain impacts associated with the ongoing operation of Darlington. Results from these simulations were then used as inputs to the Conference Board's provincial forecasting model to estimate the full range of economic impacts stemming from the station's operation.

The Conference Board's provincial forecasting model captures the sum of direct, indirect, and induced impacts on Ontario's economy, based on its estimated historical relationships. The model incorporates a detailed modelling of prices, households, and businesses, and provides economic impact results for a wide range of economic indicators. The simulations were produced over the 2017 to 2055 horizon to reflect the value of ongoing operation at Darlington over the useful life of the Station. The Conference

Board's latest long-term economic forecast of Ontario's economy was used as the backdrop of the impact analysis.

Given the complex nature of the nuclear power generating industry operations typified by Darlington Station, the research relied on the use of Statistics Canada's detailed model of Ontario's industrial structure to assess the direct and indirect effects associated with the expenditures and activities related to the continued operation of Darlington Station. The Statistics Canada interprovincial I-O model finely details the industrial structure within an industry and the linkages of input commodities to other industries.[15] As many of these links are unpublished (due to confidentiality), Statistics Canada has the advantage of being able to assess much more accurately both the direct and indirect effects of the specific investment profiles provided on a national and regional basis.

However, while the input-output analysis is important in measuring detailed supply chain effects, the economic impact results of Statistics Canada's model are static and limited to industrial and employment impacts. In order to generate impacts over time and quantify induced impacts, additional simulations were performed using the Conference Board's provincial economic model. This model contains a less detailed industrial sector but has the benefit of assessing the impact of additional income (through changes in employment, labour income, and profits) on the regional economies. Moreover, it incorporates a dynamic modelling of prices, government sector, households, and businesses, providing economic impact results over time and for a wider range of economic indicators.

## 2.4 Results: Continued Operation Impact

### *GDP and Multipliers*

Table 2 presents the economic impact results of the expenditures related to the continued operation of the Darlington Station through 2055. The table displays the cumulative sum of operation spending and economic benefits as well as the annual average impact over the 39-year time frame of the Station's operation. More detailed results by year are provided in data tables in Appendix B.

Our analysis shows that the operation of the Darlington Station will boost Ontario's nominal GDP by a total of $75.0 billion from 2017 to 2055. Adjusting for inflation, the Station will increase real GDP by $53.9 billion in 2015 dollars.[16]

Comparing the total nominal GDP impact with that of total operation spending of $55.3 billion yields a Total Multiplier of 1.4. This means that every dollar of nuclear operation expenditures earmarked for the continued operation of Darlington Station is expected to increase Ontario's GDP by $1.40 as a result of the direct, indirect, and induced effects of the ongoing nuclear expenditures. The GDP multiplier (or Type II multiplier) is 2.3, such that for each dollar of GDP generated directly by Darlington operation, the total impact on Ontario's GDP is 2.3. (See Text Box for a description of multipliers.)

[15] Statistics Canada's regional I-O model breaks down close to 300 industries and over 700 commodities. The 2010 I-O model, just completed in November 2014, was used for the analysis. For more information, see Statistics Canada, *Input-Output Model Simulations*.

[16] Due to inflation, dollar amounts in the future years of the project (2017-2055) will be worth less than they are today. The "real GDP" figure cited here converts the impact on GDP into present-day dollars, which makes it easier to appreciate or interpret the value of the benefits.

**Table 2**
Economic Impact of Darlington Continued Operation

| | Total (sum) | Average (2017-2055) |
|---|---|---|
| Total nuclear operational expenditures (current $ millions) | 55,259 | 1,417 |
| GDP at market prices ($ millions) | 75,046 | 1,924 |
| Personal income ($ millions) | 61,397 | 1,574 |
| Labour force (000s) | 402.0 | 10.3 |
| Employment years (000s) | 555,013 | 14,231 |
| Housing starts | 1,688 | 43 |
| **Multiplier** | **1.4** | |

Source: The Conference Board of Canada.

The total multiplier can be considered elevated. This is attributable to the relatively low import content of Darlington Station's ongoing operation. Moreover, the multiplier is high because of Ontario's large manufacturing base, which allows the province to capture a relatively elevated share of the production (and income) from both indirect and induced effects.

When considering the combined impacts of the refurbishment and operation phases of the Darlington Station, Ontario's nominal GDP is estimated to increase by a total of $89.9 billion[17] in the period spanning 2010 to 2055. When compared against aggregate refurbishment investment and nuclear operational expenditures of $66.5 billion across the two phases of the Station, this generates a Total Multiplier of 1.4.

**The Four Different Types of Recognized Multipliers**

Economic impact studies often refer to multiplier effects when describing their results. However, the type of multiplier described is rarely explicitly mentioned. This creates confusion in some cases, because there are four different types of recognized multipliers that can be derived from an economic impact analysis: 1) Simple Multiplier, 2) Total Multiplier, 3) Type I Multiplier, and 4) Type II Multiplier. Furthermore, each of these four can either refer to GDP or to jobs, yielding a combination of eight different multipliers.

The continued operation of Darlington Station through 2055 was estimated to have a Total GDP Multiplier of 1.4. The difference between a Total Multiplier and a Type II multiplier is the denominator. The Total Multiplier uses the amount of spending (in this case, total expenditures on operation) as the denominator, whereas Type II Multipliers use the direct impact as the denominator. When assessing the impact of additional spending, the direct impact is smaller than total spending, depending on the amount of goods and services purchased through the supply chain and imports. In cases when the direct

[17] For the refurbishment phase of Darlington Station, this figure consists of the $12.8 billion total investment amount less interest payments of $1.6 billion. Interest payments were excluded from the multiplier calculations because they were not included in our economic impact analysis, except as government revenues.

impact is much smaller than the amount of spending, there will be large variances between the Total Multiplier and Type II Multiplier—however, the real economic impact is unchanged.

The following equations show how each is calculated:

Total Multiplier = (direct + indirect + induced impacts)/investment amount

Type II Multiplier = (direct + indirect + induced impacts)/direct impact

The Simple and Type I multipliers are similar to the Total and Type II multipliers, respectively, and differ only in that they do not include the induced impacts in the numerator.

Source: Statistics Canada.

### *Employment*

Darlington's continued operation over 2017 to 2055 are estimated to increase employment levels in Ontario by a total of 555,000 person-years over the 39-year period. This means that the ongoing operation of Darlington will lift the total number of jobs in Ontario by about 14,200 jobs per year from 2017 to 2055, creating approximately 5 jobs within the broader economy for every one job at Darlington Station. An analysis of the impact of continued operation over time shows that the employment benefit will be incurred in a fairly stable way over the life span of Darlington Station. It is important to note that these figures represent the number of additional jobs present in a given year—and not the number of jobs created during a specific year.[18] Factoring in the combined impact on employment of the refurbishment and continued operation of Darlington Station, employment levels in Ontario are projected to increase by a 704,100 person-years between 2010 and 2055.

The operational expenditures associated with continued operation of Darlington Station will also increase the size of Ontario's labour force, thereby increasing the province's productive capacity. The labour force, the population of Ontarians eligible and willing to work, increases by 402,000 by 2055, with an average increase to the labour force of 10,300 per year over the life of Darlington Station. This occurs due to two effects: Ontarians entering (or re-entering) the workforce and interprovincial migration to the province. When demand for labour increases, as is the result in this analysis, job prospects improve, drawing more people into the workforce. The increase in the labour force participation rate can occur among all age groups, but is typical of younger cohorts who often opt to work when employment prospects improve, sometimes while remaining in school.

### *Household Income and Corporate Profits*

Increased employment and GDP translate into increased income. In fact, the operation of the Darlington Station through 2055 is expected to raise average provincial wages and salaries by $48.8 billion and personal income by a total of $61.4 billion, or $1.6 billion per year from 2017 to 2055. Similarly, the continued operation of Darlington is expected to raise pre-tax corporate profits by $7.0 billion in this time period.

[18] The implication of this statement is that it would not be advisable to add the number of additional jobs from two or more years together to create a total. Doing so would give the number of person-years of employment, but not the number of jobs created.

### *Household Spending and Investment*

The increase in wages and salaries elicited by the continued operation of Darlington Station will increase household spending by $53.4 billion between 2017 and 2055, or by an average of $1.4 billion per year, with no net change in the household savings rate. This amount is projected to be distributed across a wide spectrum of household consumption categories for goods and services, including shelter, food, clothing, and vehicles.

Residential construction, accordingly, is projected to rise by $2.2 billion from continued operation at Darlington Station. Moreover, the continued operation of Darlington Station through 2055 will increase other non-residential business investment by an additional $3.3 billion as corporate profits are re-invested into the Ontario economy. This includes structures and purchases of new machinery and equipment.

### *Trade*

Continued operation at Darlington Station are projected to lift imports by $14.0 billion and exports by $11.0 billion over its 39-year life span. Although the large increase in imports (composed of international and interprovincial imports) occurs in part because some project supplies will be imported (notably uranium concentrate from Saskatchewan), the primarily cause of the surge in imports is attributable to the high import content of household purchases and machinery and equipment resulting from the second round "induced effects" described above. The rise in exports occurs due to supply chain transactions that take place internationally or on an interprovincial basis, as a result of stronger household income growth resulting from Darlington Station's continued operation.[19]

### *Government Revenues*

Higher labour income, increased corporate profits, and the purchase of raw materials, supplies, and household goods and services contribute to increased government tax revenues. The continued operation of Darlington is projected to result in $238 million per year in additional revenues to the Ontario government between 2017 and 2055, for a total of $9.3 billion over the life of the Station. Meanwhile, the federal government would collect $354 million per year through the operation of Darlington Station through 2055, for a total of $13.8 billion in revenue over the 39-year period. A larger portion of personal and corporate income taxes accrue to the federal government since its tax rates are higher. Local municipalities in Ontario would collect $9 million per year as a result of continued operation of the Darlington Station, consisting mainly of property taxes, developer lot levies, and deed transfer taxes, for a total of $356 million incremental revenues by 2055. In total, the three levels of government collect $23.4 billion over the 2017 to 2055 lifespan of Darlington Station, or an annual average of $601 million. Due to the long-lived nature of the Station's operation, these increases in government revenue can effectively be considered permanent. (See Table 3.) Please note that the above figures do not include payments or dividends that OPG may make to the Province of Ontario.

Given the long duration of the continued operation of Darlington Station, it was impractical to include data by year in this briefing. More detailed economic impacts of continued operation of Darlington on

[19] For example, the Station's operation may require machinery and equipment purchases from Quebec. If, in order to produce this machinery, the Quebec-based manufacturer purchases steel from Ontario, then Ontario's exports to Quebec increase.

consumer spending, investment, trade, employment by industry, and real GDP by industry can all be found in supplementary data tables in Appendix B.

**Table 3**
Darlington Continued Operation Impact on Government Revenues, 2017-2055

| Type of government revenue | Amount ($ millions) |
|---|---|
| **Total federal** | **13,787** |
| Taxes on income | 13,586 |
| Taxes on personal Income | 12,448 |
| Taxes on corporate Income | 1,138 |
| Taxes on products | 198 |
| Taxes on production | 3 |
| **Total provincial** | **9,299** |
| Taxes on income | 8,783 |
| Taxes on personal income | 8,057 |
| Taxes on corporate income | 726 |
| Taxes on products | 416 |
| Taxes on production | 99 |
| **Total municipal** | **356** |
| **Total taxes collected** | **23,442** |

Sources: The Conference Board of Canada, Statistics Canada, *Input-Output Model*.

# 3. Conclusion

Our economic impact analysis suggests that continued operation of the Darlington Nuclear Generating Station will create a significant and long-lived increase to the Ontario economy. The Station's continued operation is estimated to increase Ontario's nominal GDP by a total $75.0 billion between 2017 and 2055. Due to the low import content and heavy reliance on Ontario-based contractors associated with Darlington's operation, the Station's operation has an elevated Total Multiplier of 1.4. This means that, on average, for every $1 of operation spending, Ontario's GDP will increase by $1.40. Furthermore, the Type II Multiplier of 2.3 indicates that the total impact of the operation of Darlington Station through 2055 is more than twice as large as the contribution of utilities GDP associated directly with Darlington operation. This elevated multiplier reflects the extensive economic footprint generated by Darlington Station outside the utilities industry.

Over the 2017 to 2055 period, the ongoing operation of Darlington Station is projected to lift employment by an average of 14,200 jobs per year. Personal income increases by a cumulative $61.4 billion as a result of Darlington's continued operation, while pre-tax corporate profits rise by $7.0 billion. The increase in economic activity and the resulting increase in labour income and corporate profits boost federal, provincial, and municipal governments' tax revenues by a total of $23.4 billion over the life of Darlington Station. Of those, $13.8 billion accrue to the federal government, $9.3 billion to the Ontario provincial government (including interest payments made by OPG to the province), and $356 million to local municipalities. Due to the longevity of Darlington Station, these enhancements resulting from Darlington's footprint effectively represent permanent increases in economic value to Ontario's economy and the three levels of government.

When considering the broader economic impact of the combined refurbishment and continued operation of Darlington, the footprint of the Station spanning 2010 to 2055 is projected to represent a total GDP impact of $89.9 billion. The Station's position as an effectively permanent feature of the Ontario economy will generate a Total Multiplier of 1.4. This translates into $1.40 of economic value generated per dollar of combined investment and expenditure in the refurbishment and continued operation, respectively, of Darlington Station.

# Appendix A

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# Appendix B

## Supplemental Data Tables

### Table 1: Darlington Station Continued Operation - Expenditures

| Indicator | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | AVERAGE OVER 2026-55 | TOTAL 2017-55 | ANNUAL AVERAGE 2017-2055 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Operational Expenditures (current $ millions) | 1,169 | 1,151 | 1,146 | 1,150 | 971 | 1,091 | 979 | 1,090 | 1,539 | 1,499 | 55,259 | 1,417 |
| Total Operational Expenditures (2015 $ millions) | 1,127 | 1,091 | 1,067 | 1,054 | 875 | 967 | 854 | 935 | 1,299 | 1,244 | 46,585 | 1,194 |

Sources: Ontario Power Generation; The Conference Board of Canada.

### Table 2: Continued Operation Expenditure Impact—Key Economic Indicators.

Level difference shock minus control except where otherwise indicated

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | AVERAGE OVER 2026-55 | TOTAL 2017-55 | ANNUAL AVERAGE 2017-2055 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **GDP at Market Prices (millions $ 2015)** | **1,275** | **1,245** | **1,236** | **1,224** | **1,014** | **1,119** | **986** | **1,085** | **1,507** | **1,441** | **53,925** | **1,383** |
| **GDP at Market Prices (millions $)** | **1,500** | **1,336** | **1,282** | **1,329** | **1,071** | **1,412** | **1,215** | **1,516** | **2,323** | **2,069** | **75,046** | **1,924** |
| Personal Income (millions $) | 934 | 977 | 1,033 | 1,118 | 964 | 1,177 | 1,061 | 1,243 | 1,799 | 1,703 | 61,397 | 1,574 |
| Personal Disposable Income (millions $) | 629 | 649 | 683 | 738 | 631 | 771 | 690 | 808 | 1,172 | 1,101 | 39,788 | 1,020 |
| Labour Force (000) | 7.2 | 8.1 | 8.5 | 8.8 | 7.8 | 8.4 | 7.8 | 8.3 | 10.8 | 10.9 | | 10.3 |
| Employment (000) | 10.5 | 11.7 | 12.3 | 12.6 | 11.1 | 11.8 | 10.8 | 11.4 | 15.0 | 14.9 | 555* | 14.2 |
| Net Operating Surplus: Corporation (millions $) | 297 | 191 | 130 | 107 | 49 | 117 | 72 | 136 | 273 | 187 | 6,988 | 179 |

*Represents total person-years of employment

Source: The Conference Board of Canada.

## Table 3: Continued Operation Expenditure Impact—Ontario Components of GDP, Expenditure-Based

Level difference shock minus control except where otherwise indicated

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | AVERAGE OVER 2026-55 | TOTAL 2017-55 | ANNUAL AVERAGE 2017-2055 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Millions of current $ (market prices)** | | | | | | | | | | | | |
| Final Consumption Expenditures | 1,399 | 1,248 | 1,162 | 1,171 | 943 | 1,220 | 1,051 | 1,274 | 1,934 | 1,740 | 63,616 | 1,631 |
| Household Consumption Expenditures | 1,254 | 1,088 | 1,007 | 1,001 | 803 | 1,027 | 885 | 1,067 | 1,614 | 1,454 | 53,369 | 1,368 |
| Government Consumption Expenditures | 130 | 141 | 128 | 136 | 108 | 157 | 134 | 174 | 280 | 246 | 8,770 | 225 |
| Non-profit Institutions Consumption Expenditures | 16 | 19 | 26 | 34 | 33 | 35 | 32 | 33 | 41 | 40 | 1,475 | 38 |
| Gross Fixed Capital Formation | 91 | 162 | 240 | 281 | 266 | 280 | 265 | 308 | 398 | 405 | 14,454 | 371 |
| Residential Investment | 15 | 22 | 38 | 44 | 33 | 42 | 33 | 47 | 72 | 61 | 2,175 | 56 |
| Non-Residential Investment in Structures | 29 | 52 | 70 | 73 | 63 | 64 | 58 | 65 | 88 | 90 | 3,262 | 84 |
| Business and Government Investment in Machinery & Equipment | 25 | 59 | 99 | 127 | 140 | 159 | 169 | 187 | 219 | 240 | 8,379 | 215 |
| Investment in Intelectual Properties | 1 | 2 | 4 | 5 | 4 | 4 | 4 | 5 | 7 | 6 | 227 | 6 |
| Government Investment in Structures | 21 | 27 | 29 | 32 | 27 | 10 | 1 | 4 | 12 | 8 | 411 | 11 |
| Non-profit Institutions Fixed Capital Formation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - |
| Exports | 186 | 149 | 137 | 149 | 110 | 194 | 157 | 226 | 379 | 309 | 10,958 | 281 |
| Imports | 176 | 223 | 257 | 273 | 249 | 281 | 257 | 292 | 388 | 386 | 13,982 | 359 |
| Net Exports | 10 | -74 | -120 | -123 | -138 | -87 | -100 | -66 | -9 | -77 | -3,024 | (78) |
| **Gross Domestic Product at Market Prices** | **1,500** | **1,336** | **1,282** | **1,329** | **1,071** | **1,412** | **1,215** | **1,516** | **2,323** | **2,069** | **75,046** | **1,924** |

Source: The Conference Board of Canada.

## Table 4: Continued Operation Expenditure Impact—Ontario Components of GDP (Market Prices), Income-Based

Level difference shock minus control except where otherwise indicated

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | AVERAGE OVER 2026-55 | TOTAL 2017-55 | ANNUAL AVERAGE 2017-2055 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Millions of current $ (market prices)** | | | | | | | | | | | | |
| Compensation of Employees | 791 | 823 | 870 | 946 | 816 | 1,000 | 901 | 1,058 | 1,530 | 1,445 | 52,087 | 1,336 |
| Wages and Salaries | 742 | 771 | 816 | 887 | 765 | 938 | 845 | 992 | 1,435 | 1,355 | 48,837 | 1,252 |
| Employers' Social Contributions | 49 | 52 | 55 | 59 | 51 | 62 | 56 | 66 | 95 | 90 | 3,250 | 83 |
| Gross Operating Surplus | 558 | 355 | 242 | 199 | 91 | 213 | 131 | 244 | 489 | 331 | 12,439 | 319 |
| Net Operating Surplus: Corporation | 297 | 191 | 130 | 107 | 49 | 117 | 72 | 136 | 273 | 187 | 6,988 | 179 |
| Consumption of Fixed Capital: Corporation and Government | 261 | 164 | 112 | 92 | 42 | 96 | 59 | 109 | 216 | 143 | 5,452 | 140 |
| Gross Mixed Income | 131 | 138 | 148 | 163 | 145 | 178 | 164 | 192 | 273 | 264 | 9,446 | 242 |
| Net Mixed Income | 130 | 136 | 143 | 154 | 133 | 163 | 147 | 173 | 250 | 236 | 8,516 | 218 |
| Consumption of Fixed Capital: Unincorporated Businesses | 1 | 2 | 5 | 9 | 12 | 15 | 17 | 19 | 23 | 28 | 931 | 24 |
| Taxes less Subsidies on Production | 9 | 9 | 9 | 9 | 8 | 9 | 8 | 9 | 13 | 13 | 459 | 12 |
| Taxes less Subsidies on Product and Imports | 12 | 12 | 12 | 13 | 11 | 12 | 11 | 12 | 17 | 17 | 614 | 16 |
| **Gross Domestic Product at Market Prices** | **1,500** | **1,336** | **1,282** | **1,329** | **1,071** | **1,412** | **1,215** | **1,516** | **2,323** | **2,069** | **75,046** | **1,924** |

Source: The Conference Board of Canada.

## Table 5: Continued Operation Expenditure Impact—Ontario. Real (2015 $ millions) GDP, Basic Prices, by Industry

Level difference shock minus control except where otherwise indicated

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | AVERAGE OVER 2026-55 | TOTAL 2017-55 | ANNUAL AVERAGE 2017-2055 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Real GDP at Basic Prices (millions of $2015)** | **1,113** | **1,089** | **1,083** | **1,073** | **889** | **981** | **864** | **951** | **1,321** | **1,264** | **47,271** | **1,212** |
| Agriculture | 6 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 7 | 7 | 248 | 6 |
| Forestry | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 35 | 1 |
| Support Activities for Agriculture & Forestry | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 19 | 0 |
| Fishing and Trapping | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 4 | 4 | 132 | 3 |
| Manufacturing | 26 | 31 | 37 | 39 | 31 | 34 | 29 | 34 | 48 | 45 | 1,672 | 43 |
| Construction | 32 | 39 | 50 | 53 | 42 | 46 | 39 | 46 | 64 | 59 | 2,189 | 56 |
| Utilities | 699 | 676 | 662 | 653 | 542 | 599 | 529 | 580 | 805 | 771 | 28,880 | 741 |
| Transportation & Warehousing | 11 | 11 | 11 | 11 | 9 | 10 | 9 | 10 | 14 | 13 | 485 | 12 |
| Information & Culture | 16 | 16 | 16 | 15 | 13 | 14 | 13 | 14 | 19 | 18 | 686 | 18 |
| Wholesale and Retail Trade | 52 | 50 | 49 | 49 | 41 | 45 | 40 | 43 | 60 | 58 | 2,159 | 55 |
| Finance, Insurance and Real Estate | 161 | 153 | 147 | 144 | 120 | 133 | 118 | 128 | 177 | 170 | 6,387 | 164 |
| Community, Business and Personal Services | 73 | 71 | 71 | 70 | 58 | 64 | 57 | 62 | 86 | 83 | 3,090 | 79 |
| Public Sector (Including Education, Health, Public Administration) | 34 | 32 | 30 | 29 | 24 | 27 | 24 | 26 | 36 | 34 | 1,286 | 33 |

Source: The Conference Board of Canada.

## Table 6: Continued Operation Expenditure Impact—Ontario. Employment, annual averages and total person-years, by Industry

Level difference shock minus control except where otherwise indicated

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | AVERAGE OVER 2026-55 | TOTAL 2017-55 | ANNUAL AVERAGE 2017-2055 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total Employment** | **10,485** | **11,670** | **12,255** | **12,572** | **11,054** | **11,784** | **10,773** | **11,443** | **15,007** | **14,932** | **555,013** | **14,231** |
| Agriculture | 74 | 93 | 97 | 95 | 80 | 81 | 73 | 75 | 98 | 98 | 3,697 | 95 |
| Other Primary Sector | 5 | 9 | 12 | 14 | 13 | 12 | 11 | 11 | 14 | 15 | 537 | 14 |
| Utilities | 7,208 | 7,444 | 7,636 | 7,776 | 6,782 | 7,418 | 6,749 | 7,270 | 9,647 | 9,431 | 350,860 | 8,996 |
| Manufacturing | 141 | 229 | 293 | 323 | 289 | 286 | 259 | 272 | 349 | 360 | 13,235 | 339 |
| Construction | 194 | 433 | 606 | 721 | 681 | 635 | 591 | 585 | 733 | 814 | 29,598 | 759 |
| Wholesale & Retail Trade | 851 | 1,001 | 1,026 | 1,018 | 873 | 906 | 819 | 857 | 1,129 | 1,132 | 42,441 | 1,088 |
| Transportation & Warehousing | 92 | 144 | 153 | 152 | 133 | 130 | 121 | 122 | 157 | 166 | 6,172 | 158 |
| Finance, Insurance, Real Estate | 325 | 480 | 526 | 539 | 486 | 487 | 452 | 457 | 568 | 591 | 22,050 | 565 |
| Other Commercial Services | 1,191 | 1,336 | 1,437 | 1,485 | 1,332 | 1,434 | 1,330 | 1,423 | 1,826 | 1,826 | 67,583 | 1,733 |
| Public Sector (Including Education, Health, Public Administration) | 403 | 500 | 469 | 449 | 385 | 396 | 369 | 371 | 486 | 501 | 18,861 | 484 |

Source: The Conference Board of Canada.

Source: The Conference Board of Canada.Continued Operation of the Darlington Nuclear Generating Station: An Impact Analysis on Ontario's Economy.
Prince Owusu, Sabrina Bond, and Pedro Antunes.

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