PICKERING CONTINUED OPERATIONS:
AN IMPACT ANALYSIS ON ONTARIO'S ECONOMY

ontario chamber of commerce

PREFACE

This research was undertaken by the Ontario Chamber of Commerce (OCC) in partnership with the Canadian Centre for Economic Analysis (CANCEA). The design and method of research, as well as the content of this study, were determined in collaboration with CANCEA. The study was sponsored by Ontario Power Generation (OPG).

The purpose of this study is to evaluate the economic contribution that the Pickering Nuclear Generating Station could make to Ontario to 2024.

This analysis is based on detailed operational and capital expenses provided by OPG. These included number of employees and employee salaries, primary contractors (with locations of businesses), goods and services required for the operation of the Pickering Nuclear Generating Station, and ongoing capital expenditures.

Paul Smetanin, President CANCEA and David Stiff, Director, CANCEA, were lead researchers on the project. Andrew Thiele, Policy Analyst, OCC, was project manager.

ABOUT THE ONTARIO CHAMBER OF COMMERCE

For more than a century, the Ontario Chamber of Commerce has been the independent, non-partisan voice of Ontario business. Our mission is to support economic growth in Ontario by defending business priorities at Queen's Park on behalf of our network's diverse 60,000 members.

From innovative SMEs to established multi-national corporations and industry associations, the OCC is committed to working with our members to improve business competitiveness across all sectors. We represent local chambers of commerce and boards of trade in over 135 communities across Ontario, steering public policy conversations provincially and within local communities.

Through our focused programs and services, we enable companies to grow at home and in export markets. The OCC provides exclusive support, networking opportunities and access to policy insight and analysis to our members. We also work alongside the Government of Ontario on the delivery of multiple programs, and leverage our network to connect the business community to public initiatives relevant to their needs.

ontario chamber of commerce

The OCC is Ontario's business advocate.

ISBN 978-1-928052-49-4

ABOUT THE CANADIAN CENTRE FOR ECONOMIC ANALYSIS

The Canadian Centre for Economic Analysis (CANCEA) is a socio-economic research and data firm. CANCEA provides objective, independent and evidence-based analysis and is dedicated to a comprehensive, collaborative, and quantitative understanding of the short- and long-term risks and returns behind market changes, policy decisions and economic behaviour.

CANCEA uses modern techniques in data science, including agent-based modelling, for econometric analysis, risk management assessments, demographic forecasts and epidemiology. CANCEA's work includes market analysis, policy evaluation and risk management, business model optimization, cost effectiveness and rate of return analysis, macroeconomic analysis, insurance risk evaluation, land use and infrastructure planning, logistics, and labour market analysis. CANCEA also provides comprehensive Canadian data services.

At the centre of CANCEA's analytical capabilities is an agent-based platform called Prosperity at Risk® that is an extensive, data-driven model of 56,000 locations across Canada. Given the systems focus behind all of CANCEA's work, CANCEA has a one model approach to its analysis which allows various disciplines and stakeholders to be incorporated into a single analysis.

CANCEA
CANADIAN CENTRE FOR ECONOMIC ANALYSIS

TABLE OF CONTENTS

GLOSSARY

Baseload Generation

Generation sources designed to operate continuously through the day and night across all seasons of the year. Nuclear and many hydro-electric generating stations are examples of baseload generation.

Demand Response

Provides price or financial incentives to residential and business users to shift or reduce their electricity usage away from peak periods of consumption.

Gigawatt (GW)

A unit of power equal to one million kilowatts (kW) or one billion watts (W)

Gross Operating Surplus (GOS)

Gross operating surplus is the surplus generated by operating activities after the labour factor input has been recompensed. It can be calculated from the value added at factor cost less the personnel costs. It is the balance available to the unit which allows it to recompense the providers of own funds and debt, to pay taxes and eventually to finance all or a part of its investment.

Independent Electricity System Operator (IESO)

The provincial agency that delivers key services across the electricity sector, including managing the power system in real time and planning for the province's future energy needs.

Shelter Consumption Affordability Ratio

The Shelter Consumption Affordability Ratio reports how realistically and sustainably Canadians can afford housing based on shelter consumption costs and discretionary income after paying for other necessities. Shelter consumption costs include: rent, maintenance/repair, insurance, utilities, and transportation. Discretionary income after other necessities is determined by subtracting the cost of financial necessities (taxes, food, clothing, health care costs) from total income. A higher ratio indicates lower levels of affordability.

Supply Mix

The variety of energy sources within a geographic region that contribute to the electricity supply. This could include fossil fuels (oil, natural gas and coal), nuclear energy, and renewable energy (biomass, wind, geothermal, water, and solar). Ontario possesses a diverse supply mix, which is considered a strength of our energy system.

Megawatt-Hour (MWh)

A measure of the energy produced by a generating station over time: a 1 MW generator, operating 24 hours, generates 24 MWh of energy.

Terawatt-Hours (TWh)

One thousand billion kilowatts of electricity used for one hour.

Watt (W)

A unit of measure that indicates how much electricity is generated or used at any one time.

EXECUTIVE SUMMARY

Since the turn of the century, Ontario's electricity system has undergone a fundamental shift. Between 2005 and 2015, over six gigawatts (GW) of installed coal-fired capacity was shut down.[1] This radical transformation of Ontario's electricity system would not have been possible without the presence of Ontario's nuclear generating stations. To eliminate its dependence on burning coal for generating electricity, the province's reliance on nuclear power increased significantly. From 2003 to 2014, the share of power generated from nuclear steam turbines increased from 42 percent to 62 percent in 2014.[2] Despite accounting for only one third of Ontario's installed capacity, nuclear power produces approximately two thirds of Ontario's electricity.

Low-cost, clean and reliable nuclear power has become the backbone of Ontario's electricity system. Currently, there are three nuclear generating stations within the province's borders. In 2016, these three stations generated 91.7 TWh of electricity, constituting 61 percent of the total electricity produced in the province.[3] This energy is nearly free from greenhouse gas (GHG) emissions, which helps Ontario meet its climate change goals.

The nuclear industry is comprised of 180 companies and employs approximately 60,000 Ontarians.[4]

The nuclear industry more broadly contributes to the Ontario economy by creating jobs, supporting a province-wide manufacturing supply chain, and providing baseload generation electricity. It is a more than $5 billion industry that also contributes to the health care, research and innovation sectors.

In January 2016, the Province announced that it had endorsed OPG's plan to pursue the continued operations of Pickering until 2024. Any plan to extend Pickering's life would require approval from the Canadian Nuclear Safety Commission (CNSC). Continuing the operation of the Pickering Nuclear Generating Station (Pickering Station) ensures that a reliable source of clean energy is available to make up for the planned outages during the Darlington Nuclear Generating Station refurbishment and during the initial stages of the Bruce Nuclear refurbishment. This report details the economic contribution of continued operations of Pickering Station, supported by an impact analysis conducted by CANCEA. This analysis is based on detailed operational and capital expenses provided by OPG.

Pickering Station currently supplies enough power for 1.5 million homes each day. The continued operation of Pickering Station to 2024 is expected to contribute over $12.3 billion to Ontario's GDP and is expected to contribute on average per year:

- 1.54 billion to Ontario's GDP;
- 7,590 full-time equivalent (FTE) jobs (the 7,590 jobs arise from direct employment at Pickering, indirect employment at suppliers, and induced spending from wages earned by individuals across all industries)[1]; and
- $290 million in government taxation revenues ($155 million in federal and $135 million in provincial).

The Pickering Station provides an estimated 14 percent of Ontario's energy supply. If the station were to cease operation, this energy generation would need to be replaced with other sources of electricity that could be more expensive. Increasing electricity costs could result in changes in housing affordability. In these alternative generating scenarios Ontario could see increased energy costs which would see households experience on average a 0.2 percent to 0.8 percent decrease in their housing affordability as measured by CANCEA's Shelter Consumption Affordability Ratio (SCAR) index.[2]

Based on the results of this study, Pickering's continued operation to 2024 would be a benefit to Ontario's economy, its climate change goals, and the stability of its energy system.

---

1 **Note:** This analysis differs from an earlier analysis* by the City of Pickering by

1. Using updated OPG data including more recent employment and operational costs;
2. Examining the continued operation of Pickering Station until 2024 instead of 2020; and
3. Including the compounding of economic impacts over the period rather than only the difference between pointwise estimates of 2015 and 2025;
4. For more information on the SCAR index: Canadian Centre for Economic Analysis (CANCEA). *Understanding the Forces Driving the Affordability Issue.* 2017. http://rccao.com/news/files/Affordability-Phase2-report.pdf

***City of Pickering.** *Economic and Financial Impact of the Retirement of Pickering Nuclear Generating Station.* 2015.

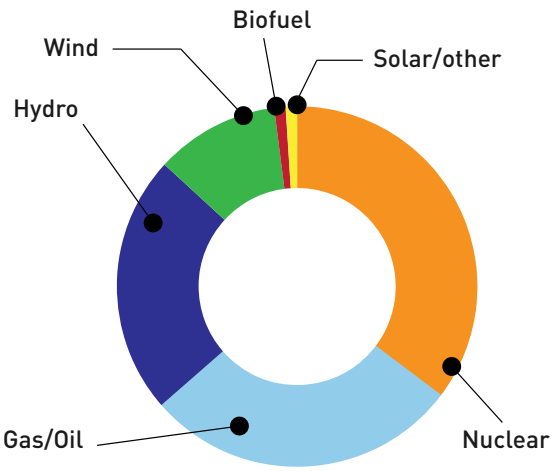
2 For more information on the SCAR index: Canadian Centre for Economic Analysis (CANCEA). *Understanding the Forces Driving the Affordability Issue*. 2017. http://rccao.com/news/files/Affordability-Phase2-report.pdf

NUCLEAR POWER AND ONTARIO

Ontario's Electricity System

Ontario has made considerable strides over the past decade to establish a diverse and clean energy supply mix. During this time, the province's electricity supply mix, historically categorized as a fossil-fuel reliant system, shifted. Between 2005 and 2015, over six gigawatts (GW) of installed coal-fired capacity was shut down and replaced with more than 14 GW of nuclear, renewable, natural gas-fired and demand response resources.[5]

Figure 1: Ontario Installed Capacity as of 2016



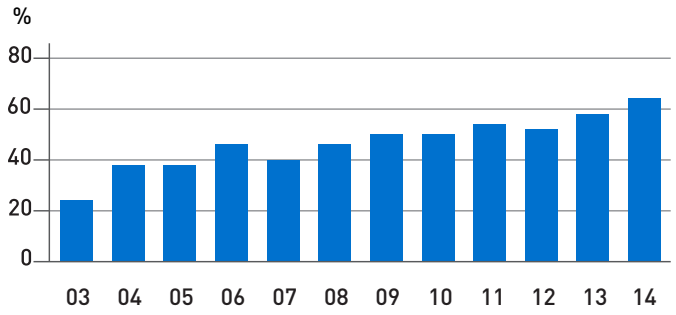
Nuclear	13,009 MW or 35%
Gas/Oil	10,277 MW or 28%
Hydro	8,480 MW or 23%
Wind	4,213 MW or 11%
Biofuel	495 MW or 1%
Solar/other	380 or 1%

Source: IESO http://www.ieso.ca/learn/ontario-supply-mix/ontario-energy-capacity

Due to the retirement of coal-fired generation, GHG emissions from Ontario's electricity sector have fallen by 80 percent since 2005 and clean energy now comprises 70 percent of Ontario's installed capacity (Figure 1). Carbon emissions from the electricity sector now make up approximately four percent of the province's total emissions compared to a decade ago.[6]

To eliminate its dependence on burning coal for generating electricity, the province's reliance on nuclear power increased significantly. From 2003 to 2014, the share of power generated from nuclear generating stations increased from 42 percent to 62 percent in 2014 (Figure 2).[7] This transformation allowed the Government of Ontario to shut down the last coal plant in 2014, which has contributed to savings of an estimated $4.4 billion per year in health and environmental cost reduction for the province.[8]

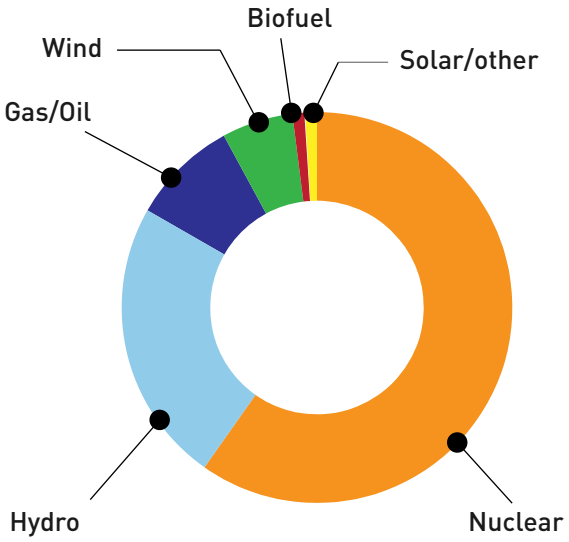
Figure 2: Share of Nuclear Power Generation in Ontario, by Year (Percent)



Source: Statistics Canada CANSIM Tables 127-0001 and 127-0002 Independent Electricity System Operator; The Conderence Board of Canada

Nuclear Generation in Ontario

Currently, there are three nuclear generating stations in Ontario: Darlington Nuclear Generating Station, Pickering Nuclear Generating Station, and the Bruce Power facility in Tiverton. In 2016, these three stations generated 91.7 TWh of electricity in Ontario which constituted 61 percent of the total 150.35 TWh produced in the province.[9] Despite accounting for only one-third of Ontario's installed capacity, nuclear power produces approximately two-thirds of Ontario's electricity.[10] This increase in energy production from existing Nuclear resources demonstrates the increased reliance on this energy supply vs the other renewable capacity that has been added.



Nuclear	91.7 TWh or 61%
Hydro	35.7 TWh or 24%
Gas/Oil	12.7 TWh or 9%
Wind	9.3 TWh or 6%
Biofuel	0.49 TWh or <1%
Solar/other	0.46 TWr or <1%

Figure 3: 2016 Electricity Production by Generating Source

Source: Ontario Planning Outlook

The Importance of Nuclear Power to Ontario

The nuclear industry contributes to the Ontario economy by providing less costly electricity, supporting the province's climate change goals, creating jobs across its high-tech supply chain, contributing to research and innovation, and providing a critical isotope to the health care system.

In Ontario, nuclear generation is currently paid 6.9 cents per kilowatt/hour (kWh) compared to the average residential price of 11 cents per kWh (figure 4).[11] Nuclear generation is one of the least expensive generating sources when compared to other forms of electricity generation, therefore providing consumers a low-cost source of power.

Table 1: Energy Supply and Price by Source

ENERGY BY SOURCE	% OF TOTAL SUPPLY	TOTAL UNIT COST (CENTS PER KWH)
Nuclear	60%	6.9
Hydro	24%	5.8
Gas	6%	20.5
Wind	8%	17.3
Solar	2%	48.0

Source: Ontario Energy Board May 2017

Nuclear power helped facilitate Ontario's transition to a low-carbon energy mix and, with a global shift away from GHG-emitting fuels, nuclear energy is an integral part of the larger low-carbon future. When considering the entire power generation life cycle, including construction, mining, operation and decommissioning, nuclear is found to be one of the cleanest technologies available.[12] Between 2017 and 2064, carbon-free nuclear power from Bruce Power and OPG will avoid between $18 billion and $95 billion in carbon costs that Ontario ratepayers would have otherwise had to manage if this output were to be produced by fossil fuels.[13]

Nuclear power in Ontario also has an integral role in supporting Canada's status as a leader in research and innovation. The nuclear industry in Ontario is greater than $5 billion and supports 60,000 Ontario jobs.[14] This includes the over 180 companies within the nuclear supply chain, many of which are sources of high-tech jobs.

There are also considerable supply chain jobs generated across the province thanks to nuclear investment. These include employment via large firms such as SNC-Lavalin and Aecon Group Inc., and smaller firms such as ATS Automation Tooling Systems Inc. and BWXT Canada Ltd. The latter frequently provides support and expertise in engineering, project manufacturing, design, and component manufacturing fundamental to the nuclear industry.

Additionally, nuclear power in Ontario contributes to the health care system. Cobalt-60, produced at Pickering Station and Bruce Power, is a medical isotope used to sterilize medical equipment such as gowns, gloves, masks, implantable devices and syringes in hospitals around the world. These two facilities currently work with Ottawa-based Nordion to supply 70 percent of the world's Cobalt-60.[15]

Pickering Nuclear Generating Station

Since the early 1970s, Pickering Station has produced baseload nuclear power for Ontario. The station consists of six operating 540 MW reactors which helps to meet 14 percent of Ontario's electricity needs, or serve approximately 1.5 million people.[16]

Pickering Station received a positive assessment from the Canadian Nuclear Safety Commission, including the highest possible integrated plant rating of 'Fully Satisfactory',[17] while the Pickering Waste Management Facility has gone 23 years without a lost time accident.[18]

The Station was also recently recognized by its industry peers for safety and performance by the World Association of Nuclear Operators (WANO) with an international review team identifying areas for industry recognition.[19]

Pickering Continued Operations

The Province announced in January 2016 that it had approved OPG'S plan to seek regulatory approvals from the Ontario Energy Board (OEB) and the CNSC in respect of the continued operations of Pickering Station until 2024.[20] The OEB will ensure that the costs of OPG's plan for continued Pickering operation are prudent, while the CNSC will ensure that Pickering operates safely during this period. OPG will still need to get final approval from the government to proceed with the continued operation of Pickering after these regulatory reviews are completed. OPG will also update the government on the safety and operational performance of Pickering as part of its regular reporting and business planning.

After extensive review, OPG technical work and ongoing inspections showed strong potential that the station could be safely operated to 2024. As a result, in May 2016, OPG informed the CNSC of their intent to request a 10-year license for the station's Power Reactor Operating License. This license term is requested to cover the period between September 1, 2018, and August 31, 2028. The OEB has approved the enabling costs of OPG's plan for continued Pickering operations. The plan is to operate all six units at Pickering until 2022, at which point two units would then shut down and four units would operate to 2024.[3]

3 Note: On December 28, 2017 the Ontario Energy Board issued its decision and order regarding Ontario Power Generations application for payment amounts for the period from January 1, 2017 to December 31, 2017. Case number EB-2016-0152

After operation of the Pickering Station ends, it will go into a long-term decommissioning process, which includes the layup and safe storage of the reactors. This period is not included in this analysis.

While further study has given OPG confidence that the Pickering Nuclear Station can safely operate to 2024, the purpose of the following analysis is to provide an overview of the quantitative evidence supporting Pickering's continued operations as well as introduce new economic impact data detailing the expected whole-of-Ontario impact of continued operations.

This report begins by exploring previous studies from the IESO on the Pickering Nuclear Generating Station continued operations, moves onto dispelling myths surrounding the Pickering station, and closes with the economic impact analysis data prepared by CANCEA.

Assessment of Pickering Life Extensions – IESO Power System Planning

In March 2015 upon Ministry of Energy request, the IESO provided an independent assessment of the integrated power system impacts of various Pickering life extension scenarios between 2018 and 2024. In October 2015, the IESO updated its evaluation of the merits of Pickering extension with a focus on extension of Pickering A units to 2022 and B units to 2024.

The conclusions of the IESO's updated assessment of Pickering life extension to 2024 were consistent with the IESO's March 2015 evaluation. Most notably, the IESO conducted an independent analysis for the Ministry of Energy that calculates the Ontario electricity system benefits of extended operations at between $300 million and $500 million.[21]

Other benefits identified include:

- Defers the timing for the need and the supply/transmission investments that would otherwise be required;
- Defers the increase in the total electricity costs that eventually takes place, generally leading to lower electricity costs for consumers in the period prior to 2024 and higher costs for a few years thereafter;
- Defers procurement decisions with respect to new resources, providing more time in exercising options while reducing risk of over investment during a period of supply/demand uncertainty;
- Provides insurance supply in some years in case of nuclear refurbishment delays;
- Defers Pickering decommissioning and severance costs;
- Offsets production from natural gas-fired resources; and
- Increases export revenues and reduces carbon emissions.

The IESO, therefore, concluded that, while not without potential pitfalls, extended Pickering operation holds potential benefit and merits further exploration. The findings of this study determined "Extension of Pickering A units to 2022 and B units to 2024 shows the greatest net benefit among Pickering scenarios assessed, minimizes increases to OPG nuclear rates to 2024, defers the increase in the total cost of electricity service that eventually takes place under each of the scenarios considered and minimizes the magnitude of the total cost increase.[22]

The study also concluded that the challenges of early shutdown would present practical challenges related to labour and community impacts therefore further supporting the continued operations of Pickering to 2024.

Four Myths about Pickering Continued Operations

1 MYTH

We can just import the necessary power from Quebec at a cheaper cost to Ontario ratepayers

Critics have argued that the results of the IESO interties study, *Ontario-Quebec Interconnection Capability: A Technical Review*, suggest Ontario could import much more hydro power from Quebec (16.5 to 18.5 billion KWh per year) using our existing transmission lines, enough to fully replace power from Pickering Station.[23]

FACT

This study, released in May 2017, provided an update on cost and lead time estimates for increasing firm purchases from Quebec. The report looked at the cost and timing on the Ontario side to enable the existing 1250 MW high voltage direct current intertie at Outaouais and the 800MW intertie at Beauharnois to supply Ontario with firm imports from Quebec.

The interties study showed that developing a new intertie to provide 2000 MW of capacity and the capability to deliver this energy to the GTA load centre would cost $1-1.4 billion, with a lead time of 10 years to carry out planning, design, local and indigenous consultations, and environmental studies.[24] The conclusion reaffirmed the previous position of the IESO that continued operation of 3100MW at Pickering to 2024 remains the most attractive option for Ontario because of the costs, reliability, avoided GHG emissions and capacity benefits, especially during the planned nuclear refurbishments of Darlington Generating Station and the Bruce Power facility in Tiverton.

2 MYTH

Pickering Continued Operations is Unsafe for Ontarians

Critics have argued that the design of Pickering Station and its particular reliance on radiation containment systems is unsafe and would not be considered appropriate in a new station built today.[25]

FACT

The safety and security of the Pickering Station is overseen by multiple external oversight bodies. In 2016, the CNSC issued Pickering the highest possible rating, "Fully Satisfactory" in its Regulatory Oversight Report,[26] and the World Association of Nuclear Operators (WANO) reconfirmed for a second time Pickering's exemplary safety performance.[27]

3 MYTH

Decommissioning Pickering Now Saves Money

Critics have argued that decommissioning Pickering Station after shutdown in 2018 would save ratepayers close to $1 billion and provide 32,000 person years of direct and indirect employment.[28]

FACT

While there are some savings by not requiring a 30 year layup period, based on the 2017 Ontario Nuclear Funds Agreement (ONFA) submission to the OEB, the fastest timeline that could be achieved for a prompt decommissioning would be 11 years after plant shutdown, due to constraints of getting the fuel cooled down enough to be removed from the wet fuel storage bays.[29]

Based on this constraint, a review was completed that indicated that a 11 year prompt decommissioning of the Pickering plant would increase the Present Value of the decommissioning by approximately $490 million if this was chosen over the base case of 30 years.[30] Therefore decommissioning costs occurring under a prompt strategy would add approximately $500M in present value costs to the decommissioning of the Pickering station. This would be an incremental cost, not a savings.

Additionally, continuing operations of Pickering Station to 2024 contributes over $12.3 billion to Ontario's GDP in total and preserves 7590 FTE jobs per year as revealed by this economic impact analysis. Irrefutably, this impact to the Ontario economy and these jobs would be lost if Pickering Station is to shut down early.

4 MYTH

We Simply Don't Need the Power

Since Ontario has a large surplus of electricity and exports some of this power to other jurisdictions, we no longer need the extended capacity of Pickering Station.

FACT

Ontario does have an abundant supply of electricity. However, the refurbishment of the Darlington facility and the life extension project of the Bruce Power facility will place a constraint on the electricity supply reserves upheld by the IESO. The electricity system planning jurisdiction uses a reserve margin to account for variations in demand forecasts, generation unit outages, and other electricity system outages. In Ontario, the IESO uses a 20 percent reserve margin. Clean electricity generated by Pickering Station can meet this target during the outage period caused by Darlington and Bruce refurbishments.

ECONOMIC IMPACT ANALYSIS

Objective

CANCEA was commissioned to evaluate the economic contribution that the Pickering Generating Station could make to Ontario, to the point when decommissioning would begin.

Project Data

This analysis is based on detailed operational and capital expenses provided by OPG. These included number of employees and employee salaries, primary contractors (with locations of businesses), goods and services required for the operation of Pickering Station, and ongoing capital expenditures.

Methodology

The economic impact analysis of the continued operation of Pickering Station was conducted using CANCEA's Prosperity at Risk® (PaR) platform.[4] Using over 170 tables from Statistics Canada, including Statistics Canada input-output data (I/O), and over 56,000 Canadian Census dissemination areas. The PaR platform takes into account the demand and supply of commodities across industry sectors and unifies it with demographics, labour force dynamics, government finances, private capital investment, and the interdependencies of production to allow for the economic impacts of the continued operation of the station to be quantified and forecasted.

The economic impact of the continued operation of Pickering Station on the economy can be divided into three main traditional effects (direct, indirect, and induced):

- **Direct Effects:** The direct effects are the impacts directly involved in the operation of the station. This includes income and value of production of economic agents (i.e., workers and firms) directly involved in the operation of the station. These effects are considered to be the value-added to the Ontario economy due to the operation of the station. For example, this could include the operation and maintenance employment associated with the station.

- **Indirect Effects:** The indirect effects of operation are the economic impacts that arise through business to business interactions throughout the supply chain. In order for the agents in the direct effects to complete their work, they require supplies and materials that they must purchase from suppliers. This leads to a chain of expenditures in different sectors of the economy. The sector that receives the stimulus will purchase intermediate inputs and the producers of those inputs will need to buy the raw inputs from other industries further upstream in the supply chain. These impacts are captured under indirect effects.

- **Induced Effects:** Induced effects are the economic activity created through increased spending of those workers receiving incomes from the ongoing operation of the Pickering Station. However, induced effects can also occur due to reinvestment of business profits to expand capacity or replace depreciated capital stock. These purchases or activities can lead to further employment, wages, income, and tax revenue that reverberate throughout different industries.

4 For an in-depth breakdown of CANCEA's Prosperity at Risk® platform, please refer to "The Economic Impact of Canadian P3 Projects" and the recent report on Bill 148: *Fair Workplaces, Better Jobs Act*, 2017 (The Canadian Centre for Economic Analysis 2016, 2017).

As the PaR platform is an agent-based, event-driven microsimulation platform, it is capable of capturing the direct, indirect, and induced contributions of the continued operation of the Pickering Station to the Ontario economy as well as identifying the contribution at different regional levels. By incorporating household behavior, industry and firm behavior, and federal and provincial tax rates, PaR can provide the economic impact of the continued operation of the Pickering Station across different economic indicators such as GDP (real and nominal), employment, wages, government revenue, and household income.

Furthermore, Prosperity at Risk also captures the "system impacts", which take the broader impact of operations into consideration:

- **System Effects:** System effects are the broadest category of effects. They focus on how the asset (i.e., Pickering Station) is used and how this use changes behavior and/or the states of residents and the community. For example, in terms of Pickering Station, it could have implications on the affordability of housing in the region due to the replacement cost of electricity if the station were not in operation.

In addition to internal model validation, the output from the Prosperity at Risk platform is regularly tested against the results of other models. Cross model validation ensures PaR is producing baselines that are in accordance with other models. Key models include:

- Public sector forecasts including the Ontario Ministry of Finance (e.g., population and GDP); and
- Private sector forecasts, including major Canadian banks.

For more information on the PaR platform and its applications, please refer to the Canadian Centre for Economic Analysis.[31]

Key Assumptions

In order to perform the analysis several assumptions are required about the evolution of Ontario's economy. The first is that there will be no significant changes to the structure of Ontario's economy over the duration of the analysis and that input/output industry data used remains valid. This includes industry supply chains, import/export markets, and consumer consumption behaviour. This includes the rate at which people spend money that they earn. Secondly, it does assume economic activity diffuses across the province at a rate proportional to geographic proximity without bias for any particular company within a sector, or along any particular transportation corridors.

Results

Results Snapshot

NUCLEAR INDUSTRY

Nuclear energy provides just under 60 percent of Ontario's electricity needs. The nuclear industry is comprised of 180 companies and employs approximately 60,000 Ontarians every year.[32]

ECONOMIC IMPACT

Continued operation of the Pickering is expected to contribute on average per year:

- $1.54 billion to Ontario's GDP;
- 7,590 full-time equivalent (FTE) jobs per year;
- $290 million in government taxation revenues ($155 million in federal and $135 million in provincial).

PICKERING STATION

Pickering Station supplies enough power for 1.5 million homes each day and represents 14 percent of Ontario's electricity.

ELECTRICITY PRICES AND SHELTER AFFORDABILITY

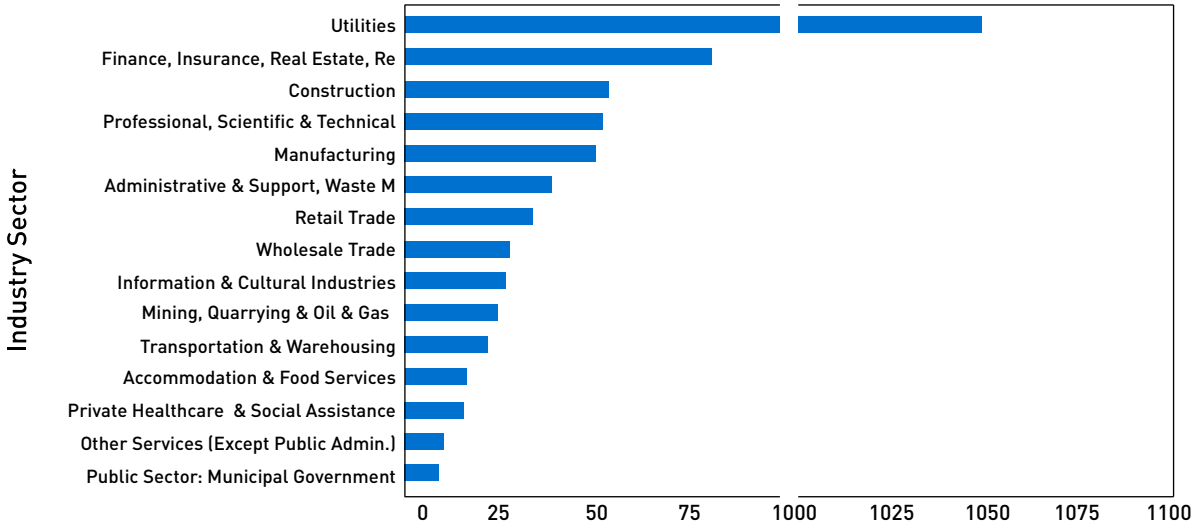
The Pickering Station provides an estimated 14 percent of Ontario's energy supply. If the station were to cease operation, this energy generation would need to be replaced with other sources of electricity that could be more expensive. Increasing electricity costs could result in changes in housing affordability. In these alternative generating scenarios Ontario could see increased energy costs which would see households experience on average a 0.2 percent to 0.8 percent decrease in their housing affordability as measured by CANCEA's SCAR index

GDP and Industry Impacts

The continued operation of the Pickering Station to 2024 is expected to contribute over $12.3 billion to Ontario's GDP (an average of $1.54 billion per year). Pickering Station's largest contribution to GDP is in Durham region, as just under 70 percent of the average annual GDP contribution occurs in the Durham region. A third of the contributions come from regions outside Durham, led by Toronto (11 percent), and York (5 percent).

The economic influence of Pickering Station extends to sectors across the province. The figure below illustrates the top 15 sectors impacted by the station, with utilities expectedly representing the largest share. While the bulk of the economic activity is directly associated with the operation of the station, a full 1/3 of the economic activity is in other sectors and regions of the province.

Figure 4: Average annual GDP contribution by Sector ($millions) of Pickering Continued Operations



Source: The Canadian Centre for Economic Analysis. *Pickering Nuclear Generating Station: Contribution of Continued Operation to the Ontario Economy.* October, 2017.

Figures 5 and 6 illustrate the average annual GDP per capita contribution to the Ontario economy in the manufacturing and the accommodation and food services industries. The economic contributions are felt differently across the province. For example, the operation of the station requires manufactured goods and services, some of which increase employment in south-western Ontario (left), while household income supported by the station allows increased spending in the accommodations and food services industries (right).

Figure 5: Average Annual GDP per Capita Contribution in Manufacturing ($) of Pickering Continued Operations (Left) and **Figure 6:** Average Annual GDP per Capita Contribution in Accommodation and Food Services industries ($) of Pickering Continued Operations (Right)

Fig. 5

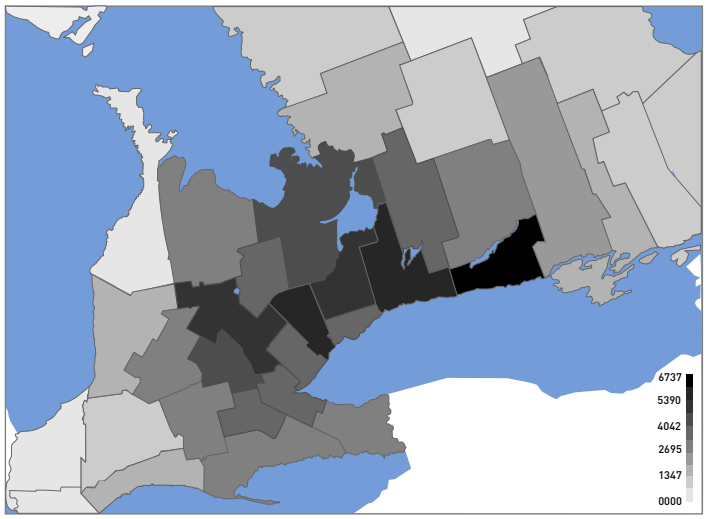
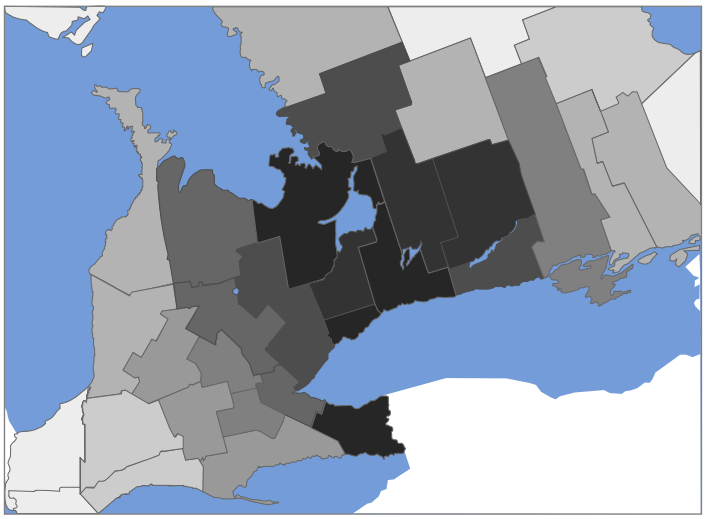


Fig. 6



Source: The Canadian Centre for Economic Analysis. *Pickering Nuclear Generating Station: Contribution of Continued Operation to the Ontario Economy.* October, 2017.

Not only are the benefits of Pickering Station continued operations spread across Ontario, they are also largely captured within the province through increased consumer spending and activity in numerous sectors such as manufacturing, accommodation, and food services.

Jobs and Income

Continued operation of the Pickering Station to 2024 could generate an average of 7,590 full-time equivalent (FTE) jobs per year, representing an average annual $747 million in wages. The 7,590 jobs arise from direct employment at Pickering, indirect employment at suppliers, and induced spending from wages earned by individuals across all industries. Many of the jobs are high skilled jobs in the science, technology, engineering and math (STEM) fields as well as in the skilled trades. Many of the jobs are high skilled jobs in the science, technology, engineering and math (STEM) fields as well as in the skilled trades.

Even when excluding the utilities sector, which makes up the largest proportion of annual employment, the contribution of employment in the professional, scientific and services sector, and the manufacturing sector, dominated by STEM graduates, contributes nearly 900 jobs annually.

Employment from the station is largely captured by the utilities sector contributing approximately 2,300 jobs annually to Ontario (Appendix). However, the induced effects of these jobs percolate

throughout the Ontario economy contributing significantly to jobs in other sectors, such as the accommodation and food services sector, and retail trade.

Table 2 provides the annual number of jobs supported by Pickering Station. Like GDP, the largest contribution relates directly to utilities, followed by retail trade and administrative and support, waste management and remediation services.

Table 2: Annual Contribution of Jobs by Sector of Pickering Continued Operations

	2017	2018	2019	2020	2021	2022	2023	2024
Accommodation and Food Services	527.13	505.00	475.03	479.91	449.59	493.98	453.07	454.31
Administrative and Support, Waste Management and Remediation Services	706.74	671.32	651.98	662.45	631.48	694.49	636.26	637.41
Arts, Entertainment and Recreation	89.52	86.00	80.08	80.71	75.21	82.59	75.75	76.01
Construction	819.29	730.40	533.33	469.06	372.78	362.18	322.70	323.08
Crop and Animal Production	30.32	29.02	26.76	26.84	24.90	27.23	24.96	25.06
Finance, Insurance, Real Estate, Rental and Leasing and Holding Companies	536.29	507.24	456.86	452.11	414.99	448.47	410.89	412.34
Fishing, Hunting and Trapping	0.66	0.63	0.59	0.60	0.56	0.62	0.57	0.57
Forestry and Logging	3.01	2.79	2.41	2.33	2.10	2.21	2.02	2.03
Information and Cultural Industries	149.60	143.01	135.87	137.87	129.55	142.41	130.54	130.89
Manufacturing	442.62	419.77	384.58	382.50	354.66	384.95	352.09	353.76
Mining, Quarrying, and Oil and Gas Extraction	93.36	91.39	91.54	79.40	86.45	89.26	68.83	79.87
Non-Profit Sector	90.94	87.29	81.59	82.31	76.85	84.41	77.41	77.66
Other Services (except Public Administration)	230.83	221.31	207.40	208.86	195.57	214.58	196.41	197.32
Private Educational Services	62.61	60.25	56.33	56.92	53.11	58.44	53.63	53.79
Private Health Care and Social Assistance	154.31	148.68	142.00	144.42	136.24	150.51	138.02	138.44
Professional, Scientific and Technical Services	548.84	518.41	489.36	490.70	462.34	503.79	460.66	462.32
Public Sector: Aboriginal Government	16.50	15.90	14.87	15.03	14.02	15.44	14.16	14.21
Public Sector: Educational Services	82.30	78.99	73.75	74.39	69.41	76.23	69.92	70.14
Public Sector: Federal Government	31.03	29.49	27.77	27.93	26.24	28.70	26.28	26.36
Public Sector: Health Care and Social Assistance	32.22	30.88	29.34	29.71	27.99	30.80	28.22	28.31
Public Sector: Municipal Government	89.57	85.42	81.00	81.66	77.00	84.41	77.21	77.54
Public Sector: Provincial Government	10.96	10.42	9.72	9.74	9.11	9.94	9.09	9.13
Retail Trade	859.33	825.56	767.93	773.96	720.64	791.34	725.94	728.29
Support Activities for Agricultural and Forestry	4.90	4.68	4.36	4.37	4.08	4.47	4.09	4.10
Transportation and Warehousing	254.45	242.97	228.21	229.51	215.33	235.80	215.73	216.70
Utilities	2371.46	2355.15	2273.43	2362.79	2221.03	2502.18	2310.04	2310.24
Wholesale Trade	248.30	236.08	216.75	216.00	200.40	217.95	199.39	200.34

Although the annual number of jobs supported by Pickering Station continued operations are largely concentrated in the Durham region, depending on the distribution of dual incomes at the same household, between 4,500 and 7,590 total homes across Ontario could be affected if Pickering's operation license is not renewed.

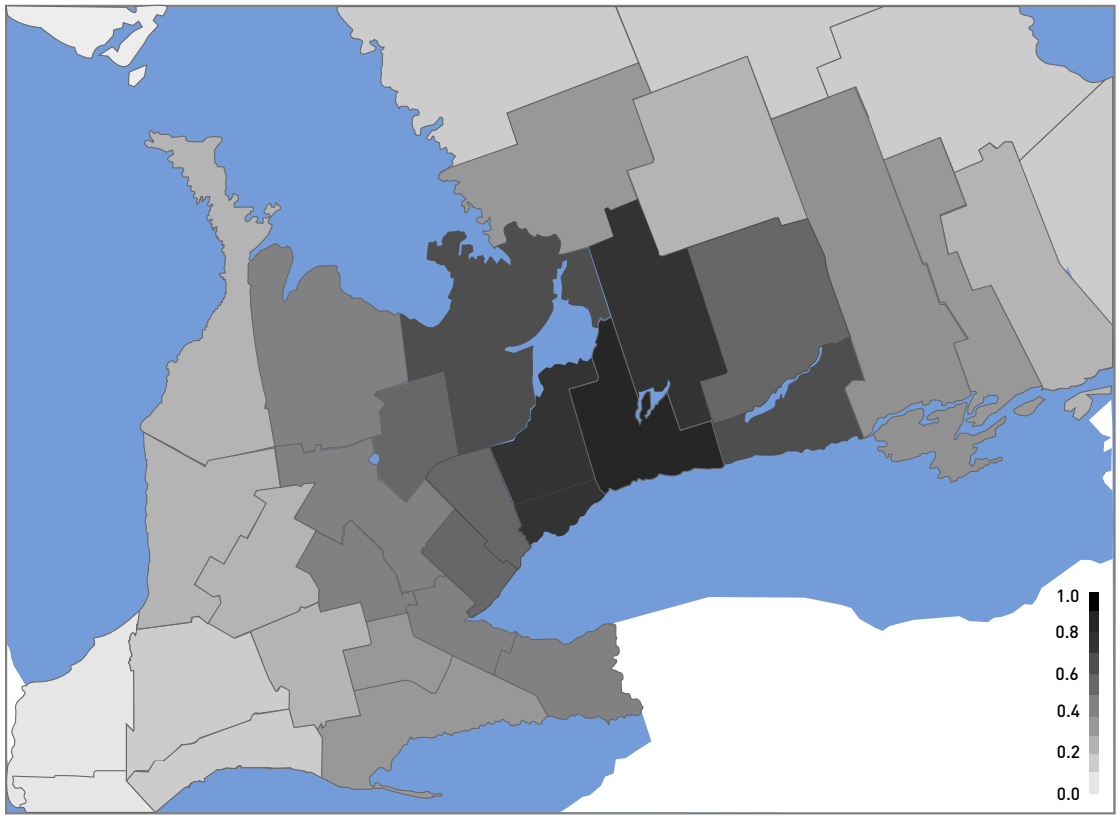
In terms of average annual jobs supported by the Pickering Station, the largest number are in Durham (2,700), followed by Toronto (1,700) and Peel (750). Table 3 highlights the annual jobs contributed by Pickering Station continued operations by region and highlights how jobs for all Ontarians province-wide rely on Pickering Station.

Table 3: Annual Jobs Contribution by Region of Pickering Continued Operations

	2017	2018	2019	2020	2021	2022	2023	2024
Algoma	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Brant	41.92	39.83	36.49	36.01	33.45	36.26	33.18	33.35
Bruce	10.50	9.95	9.08	8.91	8.31	8.95	8.13	8.22
Chatham-Kent	1.90	1.83	1.68	1.60	1.53	1.64	1.50	1.51
Cochrane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dufferin	30.12	28.48	25.88	25.57	23.64	25.55	23.34	23.47
Durham	2862.23	2779.61	2620.87	2742.58	2528.21	2830.99	2603.77	2605.86
Elgin	6.73	6.44	5.89	5.72	5.36	5.79	5.30	5.33
Essex	1.59	1.54	1.40	1.33	1.28	1.36	1.25	1.26
Frontenac	24.38	23.07	21.10	21.03	19.62	21.20	19.39	19.47
Greater Sudbury/Grand Sudbury	2.99	2.87	2.73	2.54	2.54	2.68	2.25	2.43
Grey	33.39	31.55	28.56	28.04	25.97	27.95	25.42	25.66
Haldimand-Norfolk	28.31	26.87	24.48	23.90	22.24	23.98	21.79	22.02
Haliburton	3.55	3.33	2.98	2.95	2.70	2.90	2.66	2.67
Halton	339.01	343.24	332.40	304.39	271.36	312.75	290.36	291.92
Hamilton	220.22	208.80	190.84	188.71	174.85	189.47	173.29	174.16
Hastings	48.80	46.09	41.98	41.84	38.80	41.94	38.39	38.53
Huron	10.66	10.13	9.24	8.93	8.40	9.01	8.12	8.26
Kawartha Lakes	52.81	49.78	44.91	44.34	40.92	44.04	40.12	40.42
Kenora	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lambton	3.79	3.64	3.33	3.19	3.04	3.25	2.96	2.99
Lanark	4.15	3.91	3.53	3.49	3.25	3.49	3.19	3.20
Leeds and Grenville	6.21	5.86	5.31	5.26	4.90	5.26	4.81	4.83
Lennox and Addington	10.42	9.80	8.80	8.72	8.03	8.63	7.91	7.93
Manitoulin	0.09	0.09	0.08	0.08	0.07	0.08	0.07	0.07
Middlesex	44.07	42.13	38.62	37.63	35.32	38.13	34.93	35.12
Muskoka	21.40	20.11	18.01	17.74	16.29	17.49	15.96	16.06
Niagara	189.77	179.91	164.55	163.04	150.98	163.74	149.66	150.47
Nippissing	6.08	5.77	5.34	5.19	4.95	5.30	4.71	4.84
Northumberland	53.13	50.11	45.48	45.00	41.69	44.93	40.92	41.24
Ottawa	32.79	31.05	28.47	28.32	26.64	28.70	26.24	26.36
Oxford	22.28	21.21	19.39	19.03	17.71	19.16	17.54	17.63
Parry Sound	4.69	4.41	3.93	3.86	3.55	3.80	3.46	3.49
Peel	862.28	817.13	750.26	745.33	692.00	750.90	686.38	689.91
Perth	17.25	16.39	14.91	14.59	13.57	14.64	13.38	13.46
Peterborough	80.48	80.32	71.04	61.20	75.86	71.09	65.51	66.00
Prescott and Russell	0.88	0.83	0.74	0.73	0.68	0.73	0.67	0.67
Prince Edward	7.18	6.77	6.13	6.09	5.62	6.07	5.55	5.57
Rainy River	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Renfrew	9.30	8.78	7.99	7.94	7.40	7.98	7.29	7.33
Simcoe	307.99	290.64	263.56	260.69	240.82	259.90	237.09	238.63
Stormont, Dundas and Glengarry	1.44	1.36	1.23	1.22	1.14	1.22	1.12	1.12
Sudbury	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Thunder Bay	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Timiskaming	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03
Toronto	1943.90	1842.45	1698.48	1692.00	1573.96	1710.04	1562.23	1570.68
Waterloo	202.30	197.30	176.94	162.71	174.97	175.43	161.55	162.28
Wellington	88.53	83.97	76.74	75.74	70.32	76.11	69.51	69.95
York	847.48	800.60	729.39	724.46	669.59	724.78	662.79	665.78

Figure 7 highlights the employment impact of the continued operation of the Pickering Station by region. As seen below, the continued operations at Pickering Station spread across Southern and Central Ontario contributing to the whole of the Ontario economy.

Figure 7: Average Annual Jobs per 1,000 People by Region of Pickering Continued Operations



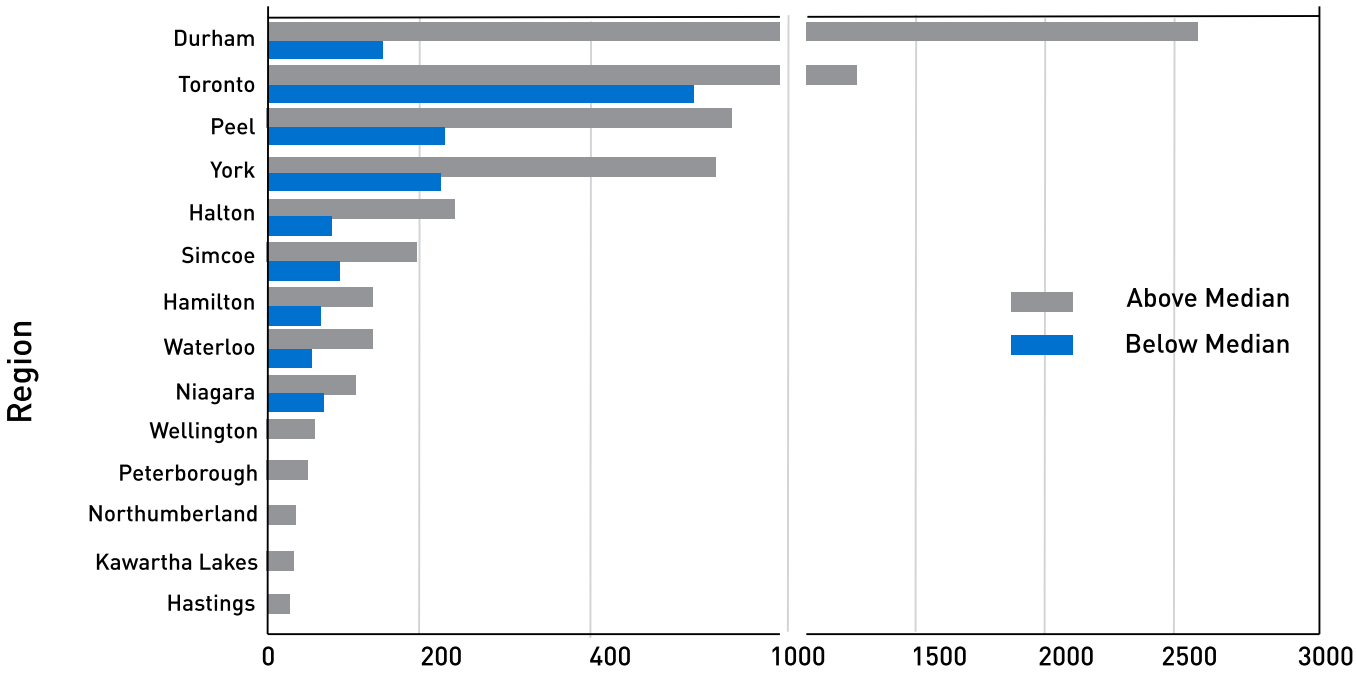
Source: The Canadian Centre for Economic Analysis. *Pickering Nuclear Generating Station: Contribution of Continued Operation to the Ontario Economy.* October, 2017.

In addition to the jobs directly at the Pickering Station, over 30 percent of non-utility jobs are held by individuals with below median income,[5] largely a result of induced consumer spending in retail and the food services sector.

As evident in Figure 8, most of below median income jobs are in Toronto, followed by York and Peel which demonstrates the impact on the food services sector, while the extended impact in Niagara and Kawartha Lakes highlight the diverse impact of continued operations.

5 Based on an individual median income of $35,000.

Figure 8: Average Annual Contribution to Jobs by Income Level of Pickering Continued Operations



Source: The Canadian Centre for Economic Analysis. *Pickering Nuclear Generating Station: Contribution of Continued Operation to the Ontario Economy.* October, 2017.

Tax Revenue – Federal and Provincial

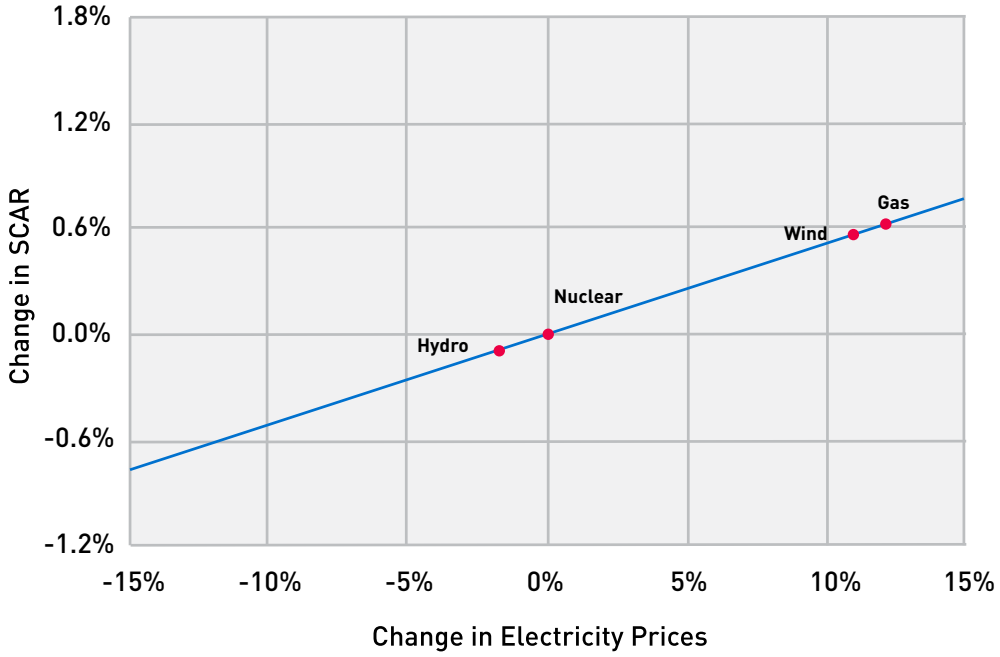
Across all industry sectors, the continued operation of the Pickering Station is estimated to contribute an average annual $788 million in gross operating surplus (GOS) through to 2024. Furthermore, the increased GOS and wages are estimated to generate an average of $155 million per year in federal government tax revenue and $135 million per year in provincial government tax revenue. This includes personal income tax, corporate tax and consumption tax. Of this, 76% is personal income tax, 13% is from consumption taxes (HST), and the remainder are corporate taxes.

Electricity Prices and Shelter Affordability

The Pickering Station provides an estimated 14 percent of Ontario's energy supply. If the station were to cease operation, this energy generation would need to be replaced with other sources of electricity that could be more expensive.

Increasing electricity costs could result in changes in housing affordability. In these alternative energy generating scenarios Ontario could see increased energy costs which would see households experience on average a 0.2 percent to 0.8 percent decrease in their housing affordability as measured by CANCEA's Shelter Consumption Affordability Ratio (SCAR) index. Figure 9 illustrates the range of possible outcomes on affordability given changes in electricity price. The figure highlights the change in affordability if the 14 percent of the total electricity supply that the Pickering Station supplies were to be absorbed by the other forms of electricity (i.e., Ontario hydro, wind, and gas). For example, in the gas scenario, gas would now be responsible for 20 percent of the electricity supply as opposed to its original 6 percent, as outlined in Table 1.

Figure 9: Replacement Electricity and Change in SCAR



Source: The Canadian Centre for Economic Analysis. *Pickering Nuclear Generating Station: Contribution of Continued Operation to the Ontario Economy.* October, 2017.

CONCLUSION

The nuclear industry contributes to the Ontario economy by creating jobs, supporting a large-scale supply chain, and stabilizes the production of power contributing to our energy security. This report finds that continued operation of the Pickering Nuclear Generating Station would have a positive economic impact not merely on Durham Region, but on the province as a whole; and not merely to the utilities sector, but to nearly all sectors operating across Ontario.

Based on the results of this study, continued operations to 2024 would be a benefit to Ontario's economy, its climate change goals, and the stability of its energy system.

APPENDIX

Average Annual Contribution of Jobs by Sector

Sector	Average Number of Jobs
Utitlities	2,338
Retail Trade	774
Administrative Support, Waste Management, and Remediation Services	662
Professional, Scientific and Technical Services	492
Construction	490
Accommodation and Food Services	480
Finance, Isurance, Real Estate, Rental and Leasing Holding Companies	455
Manufacturing	384
Transportation and Warehousing	230
Wholesale Trade	217
Other Services (Except Public Administration)	209
Private Healthcare and Social Assistance	144
Information and Cultural Industries	137
Mining, Quarrying and Oil and Gas Extraction	85
Non-Profit Sector	82
Public Sector: Municipal Government	82
Arts, Entertainment and Recreation	81
Public Sector: Educational Services	74
Private Educational Services	57
Public Sector: Healthcare and Social Assistance	30
Public Sector: Federal Government	28
Crop and Animal Production	27
Public Sector Aboriginal Government	15
Public Sector: Provincial Government	10
Support Activities for Agriculture and Forestry	4
Forestry and Logging	2

WORKS CITED

1 Independent Electricity System Operator (IESO). *Ontario Planning Outlook: A Technical Report on the Electricity System.* 2016. http://www.ieso.ca/Documents/OPO/OntarioPlanning-Outlook-September2016.pdf.

2 Conference Board of Canada. *Refurbishment of the Darlington Nuclear Generating Station: An Impact Analysis on Ontario's economy.* 2015. http://www.opg.com/darlington-refurbishment/Documents/CBCDRP-EconomicAnalysisReportFINAL.pdf.

3 Independent Electricity System Operator (IESO). *Ontario's Independent Electricity Operator Releases 2016 Electricity Data.* 2017. http://www.ieso.ca/en/corporate-ieso/media/news-releases/2017/01/ontarios-independent-electricity-system-operator-releases-2016-electricity-data.

4 Government of Ontario. Ministry of Energy. *Delivering Fairness and Choice: Ontario's Long-Term Energy Plan 2017.* https://files.ontario.ca/books/ltep2017_0.pdf

5 Independent Electricity System Operator (IESO). *Ontario Planning Outlook: A Technical Report on the Electricity System.* 2016. http://www.ieso.ca/Documents/OPO/OntarioPlanning-Outlook-September2016.pdf.

6 IBID.

7 Conference Board of Canada. *Refurbishment of the Darlington Nuclear Generating Station: An Impact Analysis on Ontario's economy.* 2015. http://www.opg.com/darlington-refurbishment/Documents/CBCDRP-EconomicAnalysisReportFINAL.pdf.

8 Independent Electricity System Operator (IESO). *Ontario Planning Outlook: A Technical Report on the Electricity System.* 2016. http://www.ieso.ca/Documents/OPO/OntarioPlanning-Outlook-September2016.pdf

9 Independent Electricity System Operator (IESO). 2017. *Supply Overview.* 2017. (http://www.ieso.ca/power-data/supply-overview/transmission-connected-generation.

10 Ontario Energy Board. *Ontario's System-Wide Electricity Supply Mix: 2017 Data.* May 2017. https://www.oeb.ca/sites/default/files/2017_Supply_Mix_Data.pdf.

11 IBID.

12 Canadian Nuclear Association. *Why Nuclear Energy?* https://cna.ca/why-nuclear-energy/clean/.

13 Ontario's Nuclear Advantage. https://ontariosnuclearadvantage.com/.

14 The Canadian Centre for Economic Analysis. *Pickering Nuclear Generating Station: Contribution of Continued Operation to the Ontario Economy.* October 2017.

15 Bruce Power. *Bruce Power, Ontario Power Generation, Collaborate to Ensure Steady Supply of Cobalt-60.* 2016. http://www.brucepower.com/bruce-power-ontario-power-generation-collaborate-to-ensure-steady-supply-of-cobalt-60.

16 Independent Electricity System Operator (IESO). *Ontario Planning Outlook: A Technical Report on the Electricity System.* 2016. http://www.ieso.ca/Documents/OPO/OntarioPlanning-Outlook-September2016.pdf

17 Government of Canada. *Regulatory Oversight Report for Canadian Nuclear Power Plants.* 2016. http://nuclearsafety.gc.ca/eng/reactors/power-plants/regulatory-oversight-report-npp/index.cfm

18 http://www.opg.com/generating-power/nuclear/nuclear-waste-management/Documents/WWMFbrochure.pdf

19 World Association of Nuclear Operators (WANO). 2016. http://www.wano.info/en-gb/programmes/peerreviews

20 Government of Ontario. Ministry of Energy. Delivering Fairness and Choice: Ontario's Long-Term Energy Plan 2017. https://files.ontario.ca/books/ltep2017_0.pdf

21 Independent Electricity System Operator (IESO). Assessment of Pickering Life Extension November 2015 Update. 2015. http://www.opg.com/about/regulatory-affairs/Documents/2017-2021/F2-02 03_Pickering_Extended_Operations_20161110.pdf

22 IBID.

23 Independent Electricity System Operator (IESO). *Ontario-Quebec Interconnection Capability: A Technical Review.* 2016. http://www.ieso.ca/sector-participants/ieso-news/2017/05/ontario-quebec-interconnection-capability---a-technical-review.

24 IBID.

25 Ontario Clean Air Alliance. *Pickering Nuclear Unsafe at Any Speed.* 2016. http://www.cleanairalliance.org/pickering-safety/

26 Government of Canada. *Regulatory Oversight Report for Canadian Nuclear Power Plants.* 2016. http://nuclearsafety.gc.ca/eng/reactors/power-plants/regulatory-oversight-report-npp/index.cfm.

27 World Nuclear Association. *Advanced Nuclear Power Reactors.* 2017. http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-power-reactors/advanced-nuclear-power-reactors.aspx.

28 Spears, John. *Nuclear Power too costly, Ontario Clean Air Alliance Argues.* Business Reporter. 2016. https://gpo.ca/nuclear-power-too-costly-ontario-clean-air-alliance-argues.

29 Ontario Power Generation. 2017. *Nuclear Waste Management and Decommissioning – Supplementary Information.* https://www.opg.com/about/regulatory-affairs/Documents/2017-2021/C2-01-02_Nuclear_Waste_Management_and_Decommissioning-Supplementary_Information_updated_20170322.pdf.

30 IBID.

31 Canadian Centre for Economic Analysis. *Prosperity at Risk*. 2017. https://www.cancea.ca/

32 Government of Ontario. Ministry of Energy. *Delivering Fairness and Choice: Ontario's Long-Term Energy Plan 2017.* https://files.ontario.ca/books/ltep2017_0.pdf