Canadian Manufacturers & Exporters

Leadership makes the difference

The Economic Benefits of Refurbishing and Operating Ontario's Nuclear Reactors

July 2010

A new steam generator being installed at the Bruce A Generating Station.

EXECUTIVE SUMMARY

Nuclear power is a critical source of base load electricity supply. In 2009, Ontario's nuclear reactors provided over 55% of the province's electricity needs. This level of electricity generation is an integral part of the government's long-term plan. As the existing nuclear reactor units age, they need to be refurbished or rebuilt. Refurbishing a CANDU reactor offers the opportunity to extend the unit's operating life by 25-30 years. Nuclear power, on a dollar per megawatt basis, remains one of the cheapest power sources in Ontario's electricity portfolio.

In addition to generating almost 10,000 MW of cost-competitive base load electricity, the refurbishment and continued operation of Ontario's 12 nuclear reactors at Bruce and Darlington offers substantial employment and economic benefits to the province. The economic benefits to Ontario provided in the table below are expressed in terms of total employment, including both direct and indirect jobs, and economic activity as a result of the purchase of fuel, equipment, materials and supplies.

Summary of Annual Employment and Economic Benefits to Ontario

Power Plant Spending	Refurbishment	Operations	Total Impact
Ontario Employment	9,000	15,600	24,600
Labour income	$996 million	$1,966 million	$2.96 billion
Fuel cost	Not applicable	$189 million	$189 million
Ontario equipment, materials & supplies	$1.5 billion	$393 million	$1.89 billion
TOTAL	**$ 2.5 billion**	**$2.5 billion**	**$5.0 billion**

The employment and economic benefits to Ontario from refurbishing and operating the Bruce and Darlington reactors are substantial: almost 25,000 jobs and annual economic activity of over $5 billion. These benefits occur over the refurbishment period 2014 through 2024. Once the reactors are refurbished, the benefits will continue until approximately 2050 because of the continued operation of the reactors. These long-term operational benefits comprise 15,600 jobs and an annual economic benefit of $2.5 billion. All benefits are expressed in constant dollars (2010$).

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1. INTRODUCTION

BRUCE NUCLEAR GENERATING STATION

DARLINGON NUCLEAR GENERATING STATION

This report by Canadian Manufacturers & Exporters (CME) provides an economic impact analysis of the benefits of the refurbishment of Ontario's nuclear reactors. The report quantifies the increased employment and economic activity in Ontario resulting from the aggregate spending and employment attributable to refurbishing and continuing to operate approximately 8,300 MW of existing nuclear electricity generating capacity.

CME is Canada's leading trade and industry association and the voice of manufacturing and global business in Canada.

The association directly represents more than 10,000 leading companies nationwide. More than 85% of CME's members are small and medium-sized enterprises. As Canada's leading business network, CME, through various initiatives including the establishment of the Canadian Manufacturing Coalition, touches more than 100,000 companies from coast to coast, engaged in manufacturing, global business and service-related industries.

CME's membership network accounts for an estimated 82% of total manufacturing production and 90% of Canada's exports.

This report provides an economic impact analysis of the benefits of the refurbishment of Ontario's nuclear reactors. The report quantifies the increased economic activity in Ontario resulting from the aggregate spending and employment attributable to refurbishing approximately 8,300 MW of existing electricity generating capacity. An addditional 1,500 MW will be generated by the two Bruce A reactors currently under refurbishment.

Nuclear power is critical source of safe, emissions-free and cost competitive base load electricity supply. In 2009, Ontario's nuclear reactors provided over 55% of the province's electricity needs. This level of electricity generation is an integral part of the government's long-term plan. As the province's existing nuclear reactor units age, they need to be refurbished or replaced. Current government policy indicates that Ontario will need to refurbish all units at the Bruce and Darlington sites as a critical component of the Integrated Power System Plan (IPSP).

Refurbishing a reactor offers the opportunity to extend the unit's operating life by 25-30 years and can be done in a relatively short period of time when compared to

other options such as the construction of new reactors. The high capital construction and start-up costs of nuclear power are offset by the long and reliable operating lifetime of the plants. According to the Ontario Power Authority (OPA), nuclear power, on a dollar per megawatt basis, remains one of the cheapest power sources in Ontario's electricity portfolio. This is why the refurbishment of approximately 10,000 MW of nuclear capacity at Bruce and Darlington is critical to Ontario's electricity market [1]. [References are numbered in the report and provided on page 23].

There are currently 10 nuclear reactor units that will require refurbishment if they are to continue to supply electricity in the long term. Ontario Power Generation has announced that they do not intend to refurbish the Pickering B nuclear reactor units [3]. The investment at Pickering over the next 10 years, estimated to be $300 million, is not considered in our analysis.

Table 1 identifies these reactors along with their electricity generating capacity and original in-service date. In general, a reactor needs to be refurbished after about 25 or 30 years of service. However, the safe operating lifetime of individual reactor units may differ from this or may be extended by specific life-extension and safety enhancements.

Table 1 Ontario Reactors Requiring Refurbishment

Reactor Unit	Capacity	Original In-service Date
Bruce A unit 1	750 MW	1977 (Currently being refurbished)
Bruce A unit 2	750 MW	1977 (Currently being refurbished)
Bruce A unit 3	750 MW	1978
Bruce A unit 4	750 MW	1979
Bruce B unit 5	817 MW	1985
Bruce B unit 6	817 MW	1984
Bruce B unit 7	817 MW	1986
Bruce B unit 8	817 MW	1987
Darlington unit 1	881 MW	1992
Darlington unit 2	881 MW	1990
Darlington unit 3	881 MW	1993
Darlington unit 4	881 MW	1993
TOTAL	**9,792 MW**	

As shown in Table 1, two reactors, Bruce A units 1 and 2 are currently being refurbished and are scheduled to resume operation in 2011. These two reactors have a combined electricity generating capacity of 1,500 MW making the total nuclear generating capacity at the Bruce and Darlington sites almost 10,000 MW.

This report provides an estimate of the employment and economic benefits to Ontario from completing the refurbishment of Ontario's nuclear reactors (i.e., refurbishing the 10 reactors identified in Table 1) and operating all 12 reactors once they are refurbished. The report first estimates the benefits of a staged refurbishment of ten reactors over the period 2014 through 2024 (Sections 2 and 3). Secondly, the report estimates the benefits of operating the Bruce and Darlington nuclear power plants through approximately 2050 (Sections 4 and 5). Finally, the total benefit to Ontario is estimated by adding both refurbishment and operating benefits (Section 6).

2. COSTS, EMPLOYMENT & SCHEDULE FOR REFURBISHMENT

Before the direct and indirect benefits to Ontario of refurbishing the currently operating nuclear reactors at Bruce and Darlington can be estimated, it is necessary to determine the capital cost, employment and schedule for refurbishing one nuclear reactor unit. The following sections provide this information, based on publically available information and best estimates based on available sources.

There are obviously some uncertainties associated with the following estimates which are generally conservative. Overall, however, CME believes the following estimates are reasonable and provide a defensible basis for estimating the benefits to Ontario for refurbishing the Bruce and Darlington power stations.

Economic and employment information provided in the following sections refers to the refurbishment of one nuclear reactor unit. It is assumed that this information can be extrapolated to provide the overall capital costs, employment and schedule for refurbishing all 10 of the Bruce and Darlington reactors.

2.1 Capital Cost Estimates

A review of the literature identified four cost estimates for refurbishing a Canadian CANDU reactor. These cost estimates are provided in Table 2 along with the electricity generating capacity of the reactors being refurbished.

Table 2 Cost Estimates for CANDU Refurbishment

Reactor	Capacity	Cost Estimate	Reference
Point Lepreau	680 MW	$1.21 billion	Ref [5]
Gentilly-2	675 MW	$1.9 billion	Ref [6]
Bruce A Units 1&2	2 @ 750 MW	~$4 billion	Ref [7]
Darlington Units 1-4	4 @ 881 MW	~$6-10 billion	Ref [8]

The above costs are subject to some uncertainty and include first-of-a-kind (FOAK) costs. For example, the Point Lepreau refurbishment is the first CANDU 6 reactor to be refurbished and Bruce A refurbishment is the first for a multi-unit station. Based on the information in Table 2, an average capital cost of $2 billion ($CAN 2010) is assumed for refurbishing the Bruce and Darlington reactors.

A breakdown of the estimated $2 billion cost of refurbishment is shown in Table 3 which provides the estimated percentage and amount estimated for engineering, project management, equipment and materials, and construction labour. The values in Table 3 have been developed by the authors based on information from various new build nuclear projects and input from those with many years of experience in nuclear power plant projects.

Table 3 Breakdown of Capital Cost of Refurbishment

Project Component	Proportion	Cost
Engineering	15%	$300 million
Project Management	10%	$200 million
Equipment and materials	35%	$700 million
Construction labour	40%	$800 million
TOTAL	**100%**	**$2,000 million**

2.2 Employment Estimates

Table 3 shows the largest cost items are the direct labour component of engineering, project management and construction. It is assumed that the cost for the engineering and management components are 75% salary and the labour wages make up 80% of the construction labour component. The balance of the costs in these components is made up of overhead, allowances and supplies.

The distribution of labour costs is further summarized in Table 4. The information in Table 4 is important in identifying the total employment benefit for refurbishment and reflects the salary and wages paid to engineers, management, trades and support workers working on the project.

Table 4 Labour Costs for each Rector Unit Refurbishment

Project Component	Overall Percentage	Percentage Direct Labour	Net Percentage Salary & Wages	Net Salary & Wages
Engineering	15%	75%	11.25%	$225 million
Project Management	10%	75%	7.5%	$150 million
Equipment & Materials	35%	Not applicable		
Construction labour	40%	80%	32%	$640 million
TOTAL	**100%**	**Not applicable**	**50.75%**	**$1,015 million**

The number of workers (engineers, management, trades and support workers) directly employed during refurbishment was developed by estimating the total labour, in person-years, required to completed the refurbishment. As outlined below, the literature provides some indication of the magnitude of the labour effort for refurbishment.

Ontario Power Generation (OPG) estimates that there will be 2,000-3,000 employees on-site over the decade while the four Darlington reactors are being refurbished [9, 17]. This corresponds to at least 5,000 person-years per unit. It is not clear, however, that this includes all of OPGs planning and engineering effort. Bruce Power has indicated that the refurbishment of Bruce A units 1&2 will involve more than 13,000 person-years or approximately 6,500 person-years per unit. It is noted that this latter project involves refurbishing two units at the same time while continuing to operate the other two units of the four-unit Bruce A power station. Based on the above estimates, a conservative value of 5,500 person-years of employment is assumed for the refurbishment of each of the Ontario CANDU reactors. Each of the units requiring refurbishment is part of a four-unit station where some units will continue to oper-

ate as others are being refurbished. This obviously involves greater complexity than refurbishing a single unit station.

The total employment cost of $1,015 million (see Table 4) can be divided by the total number of person-years of associated employment to obtain the annual cost per employee ($1,015 million / 5,500 person-years = $184,500 per year). This annual payroll cost of $184,500 includes both the annual salary paid to an employee and the associated payroll burden. We have assumed a payroll burden of 50% to include overtime, living allowances, retirement benefits, bonus incentives, payroll taxes, etc.). This results in an average annual salary per employee of approximately $92,300 or approximately $47 per hour. These are highly skilled technical jobs paying a high salary.

Verification of this estimate is available from the reported average salary of $80,000 in 2006 paid to nuclear power plant maintenance workers, technicians and technical support [10]. At 3% annual escalation, this corresponds to $87,400 in 2010 dollars, providing general agreement with the salary estimated in the preceding paragraph.

2.3 Estimated Schedule for Refurbishing One Reactor

All refurbishment projects to-date have taken longer than originally estimated. As noted, the current refurbishments at Bruce and Point Lepreau involve first-of-a-kind projects. As such, they may not provide a directly applicable estimate of future refurbishments. The refurbishment of the Point Lepreau reactor is now estimated to take approximately 48 months, including five months for commissioning [11]. Assuming they are successfully restarted in 2011, refurbishment of the Bruce A reactors will have taken 72 months for refurbishing the two reactors. For this study we have assumed an average project schedule or duration of 36 months. This is the estimated average time for the duration of the physical works. Additional time is required for project planning and engineering. Some of the earlier refurbishments may take longer than this; others may take less as experience is accumulated.

2.4 Overall Schedule for Refurbishment Program

Figure 1 provides the overall schedule for refurbishment assumed for our analysis. The refurbishment program is assumed to be completed over the period 2014 through 2024 with Bruce A units 3&4 being the first units to be refurbished. The schedule for replacing other specific units is not identified.

Figure 1 Assumed Schedule for Refurbishment Program

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Bruce Unit 3											
Bruce Unit 4											
Darlington Unit											
Darlington Unit											
Darlington Unit											
Darlington Unit											
Bruce B Unit											
Bruce B Unit											
Bruce B Unit											
Bruce B Unit											

2.5 Summary of Refurbishment Scope

We have estimated the cost, direct labour and schedule for refurbishing a single CANDU reactor unit at either the Bruce or Darlington four-unit power stations. The estimate is based on existing information and experience and reflects a conservative rather than optimistic approach. The information is summarized in Table 5. This information is used to develop the direct and indirect benefits to Ontario of refurbishing all 10 reactor units at the Bruce and Darlington power stations over the period 2014 through 2024. Accordingly, Table 5 includes the parameters associated with refurbishing one reactor unit and those that could result from the refurbishment of the 10 reactor units at Bruce and Darlington.

Table 5 Cost, Employment and Schedule for Refurbishment

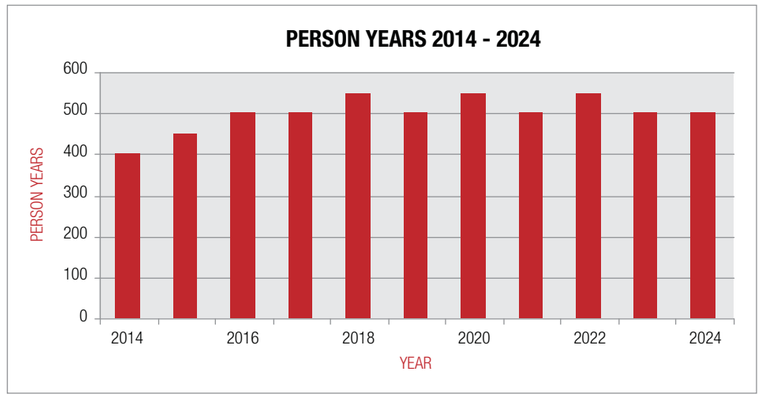
Parameter	Estimated Value used in this Study	
	One Reactor	10 Reactors
Capital cost*	$2 billion	$20 billion
Equipment, Materials & Supplies Cost*	$985 million	$9.85 billion
Direct labour cost*	$1,015 million	$10.15 billion
Direct employment	5,500 person-years	55,000 person-years
Schedule (Duration of physical works)	36 months	11 years (2014-2024)

* all costs in $CAN 2010

3. ECONOMIC BENEFITS OF REFURBISHMENT

As noted in Table 5, the refurbishment of Ontario's 10 nuclear reactor units is assumed to occur over the period 2014 through 2024. The direct employment over this period is shown on Figure 2. This corresponds to an average direct employment of 5,000 persons throughout the 11-year period of the refurbishment program.

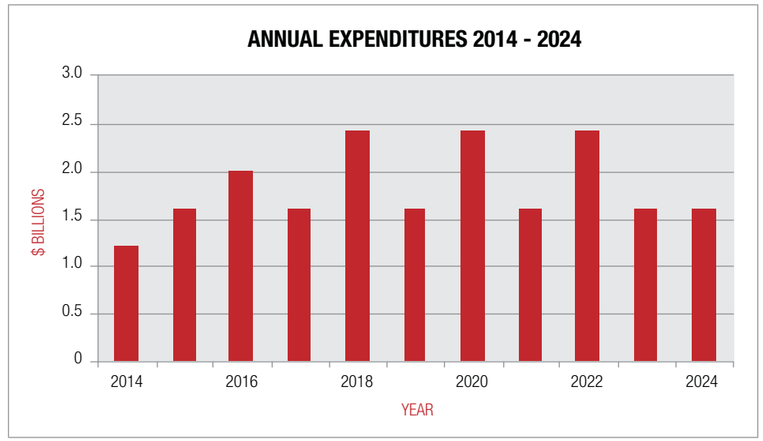
Figure 2 Annual Direct Employment of Refurbishment Program



The estimated direct annual expenditures through the 11-year refurbishment period are shown on Figure 3. These correspond to an annual average direct expenditure of $1.82 billion. The variation from one year to the next is because several reactors may be undergoing refurbishment in any year. For example, in 2017 there are two reactors being refurbished (one at Bruce and one at Darlington) and in 2018 there are four (two at Darlington and two at Bruce).

Figures 2 and 3 provide a graphical summary of the likely direct benefits of the refurbishment of Ontario's nuclear reactors. This information is used in the following section to determine the likely indirect or secondary benefits of the refurbishment program.

Figure 3 Annual Direct Expenditures of Refurbishment Program



3.1 Adjusting Direct Benefits for Leakage

There is a well-established supply chain for equipment, materials and services for refurbishment. However, not all of the refurbishment expenditures on labour or materials necessarily remain in Ontario and contribute to the Ontario economy. Our study includes an allowance for loss of economic benefits because of purchases of materials and services from outside of Ontario.

The preceding section identifies the average annual spending associated with the refurbishment program at $1.82 billion. The majority of this equipment, materials and supplies will be purchased in Ontario. Typical major equipment suppliers include Foster Wheeler, Babcock and Wilcox, GE Canada, Comstock, AECL and Siemens Canada. However, some power plant components will be manufactured overseas, typically turbines and pressure tubes which are of European origin. Spending on non-Ontario manufacturing must be excluded from the impact analysis. We have assumed that 80% of the refurbishment program direct spending would occur in Ontario. Accordingly, the annual economic stimulus from refurbishment would be $1.456 billion ($1.82 billion x 0.8).

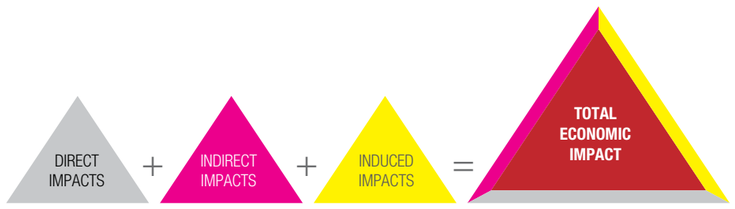
We have estimated that the refurbishment would require an average of 5,000 full time equivalents per year throughout the 11-year program. We have estimated the average annual salary of workers at $92,300. A long-term refurbishment program is

conducive to training and maintaining a workforce capable of carrying out the technically challenging activities associated with refurbishment. Accordingly, the majority of workers, including engineers, managers and trades may be expected to come from Ontario. However, based on information from Bruce Power, we have assumed that up to 10% of the workforce might come from outside of Ontario. This includes, for example, engineers and project managers from the US and trades workers from other provinces. Our economic analysis assumes 90% of the direct labour income remains in Ontario.

3.2 Secondary Benefits of Refurbishment

Our economic impact analysis quantifies the aggregate economic activity in Ontario as a result of the 11-year refurbishment program. Our methodology for estimating the impact of refurbishment follow an approach used in several other studies of the benefits of nuclear facilities in Ontario [10]. The activity is shown both in project employment and spending and is driven by the direct and secondary (indirect and induced) impacts of the program.

Direct economic impacts are the total expenditures on goods and services, including wages and salaries, for the refurbishment program. For the purpose of our analysis, the direct impacts of the refurbishment program are considered to be the total value of all equipment, materials and supplies purchased in Ontario plus all wages paid to Ontario workers.



Ontario Ministry of Agriculture, Food and Rural Affairs [12]

Secondary impacts arise because the economic activity associated with the refurbishment program generates positive feedback loops between project employees, equipment manufacturers and suppliers and Ontario businesses and households. As shown above, there are two types of secondary impacts: indirect and induced.

- Indirect Economic Impacts comprise the purchase of goods and services needed to produce the goods and services that are directly purchased for the refurbishment program. Indirect impacts therefore measure the magnitude of interactions with other businesses which supply the necessary materials and services, which lead to indirect demand for goods and services from other industries.

- Induced Economic Impacts comprise the impact of personal expenditures by people who have been paid wages and salaries because of their employment in the refurbishment program.

3.3 Multipliers Used to Estimate Secondary Impacts

For the purposes of this report, CME has used separate multipliers to estimate the secondary employment and spending. A multiplier is the number used to determine the impact of an event/project/industry on the economy. The multiplier gives the ratio of total change in employment or spending to the initial or direct employment or spending. For example, if a project were to create 1,000 new jobs it would require materials and services from its supplying industries. If this increase in demand created 1,300 new jobs in the supplying industries, the employment multiplier would be 2.3 [i.e., 1,000 (direct) plus 1,300 (spinoff or secondary)].

CME assumes that one additional full time job would be created in Ontario for each worker employed in the refurbishment program [13, 14]. This is less than the 1.4 additional jobs created for each manufacturing job typically assumed by the CME [15]. Our conservative approach reflects the fact that refurbishment has aspects of construction in addition to manufacturing.

The level of economic activity associated with refurbishment is estimated from the direct and secondary effects of labour spending and the direct and secondary spending on equipment, materials and supplies. The labour multiplier represents the additional income earned by other Ontario workers for every dollar earned by an employee working on refurbishment. We use a labour multiplier of 2.4 [10]. We use a multiplier of 2.1 for industrial and business expenditures in Ontario [13]. These multipliers are also less than those typically used by CME for the manufacturing industry which assumes that each dollar in direct spending results in a further $3.25 in secondary economic activity, i.e. a multiplier of 4.25 [15].

3.4 Total Benefits of Refurbishment

Table 6 provides a summary of the total annual impact to Ontario of the refurbishment program. Total impacts include both the direct employment and spending associated with the project and the resulting secondary employment and spending. As noted above, the values in Table 6 have been adjusted to remove the economic effects of employment and spending that would be lost to out-of province workers or expenditures.

Table 6 Annual Economic Impact of Refurbishment in Ontario

	Direct Impact	Secondary Impact	Total Impact
Ontario Employment[1]	4,500	4,500	9,000
Labour Income[2]	$415 million	$581 million	$996 million
Ontario Equipment, materials & supplies[3]	$716 million	$788 million	$1.5 billion
TOTAL	**$1.13 billion**	**$1. 37 billion**	**$2.5 billion**

Notes:

1 Of the annualized direct employment of 5,000, it is estimated that 10% would be from outside Ontario.

2 Direct labour earnings are $92,300 per year for each worker. Based on a multiplier of 2.4, it is expected 140% of direct labour would be spent and re-spent in Ontario.

3. Secondary impacts occur when other Ontario industries and businesses increase their supply of goods and services to meet the needs of the refurbishment. Based on a multiplier of 2.1, it is assumed that 110% of direct spending on equipment, materials and supplies is spent and re-spent in Ontario. It is assumed that 80% of all purchases are made in Ontario.

The annual economic benefits to Ontario summarized in Table 6 are considerable, including at least 9,000 high paying jobs per annum and a total economic benefit of $2.5 billion. These estimates are conservative and have been developed using modest multipliers for secondary effects and recognising that some expenditures and employment may be created outside of Ontario. These benefits would occur annually over the 11-year refurbishment program and do not include the even greater benefits that result for the operation of the reactors for the 25-30 year lifetime over which they continue to meet the province's electricity needs.

4. COSTS, EMPLOYMENT AND SCHEDULE FOR OPERATIONS

The benefits of operating Ontario's nuclear reactors over the period 2012 through 2050 is focused on the 12 reactors shown in Table 1. These reactors are located at the Bruce and Darlington sites. As noted, the operation of the Pickering reactors over the remainder of this decade is excluded from the analysis.

The costs, employement and schedule for operations are based on existing experience at the Bruce and Darlington sites. It is assumed that the staffing level remains constant throughout the period and is independent of the number of reactors units in actual operation at a particulair time.

4.1 Employment Estimates

Current employment levels at Darlingron (2,712 for four reactor units [9]) and Bruce (3,747 for six reactor units [16]) are used to estimate the permanent employment levels to operate one reactor. This corresponds to approximately 650 full-time employees per reactor unit. This number is used in this analysis.

A similar number of full-time employees are reported for the smaller single reactor unit at Gentilly-2 [6].

4.2 Operating Cost Estimates

We have determined the operating cost estimates using the annual reports issued by Bruce Power [6] and OPG [2]. These costs are summarized and apportioned in Table 7 to show the cost of fuel, operations, maintenance and administration cost, and rent, taxes, amortization and depreciation. These latter costs (rent, taxes, amortization and depreciation) are not relevant to this study. The current number of full time employees reported by Bruce and OPG are also shown. It should be noted that the OPG information includes the Pickering A and Pickering B stations in addition to Darlington. The Pickering stations, which are scheduled to close at the end of this decade, have a capacity of 3,100 MW or approximately 46% of OPG's total nuclear electricity generating capacity.

Table 7 Estimated Operating Costs

	Bruce Power (6 units) Ref [16]	OPG (2009) (10 units) Ref [2]	Estimate for a 4 Unit Station
Number of employees	3,747	Appox. 2,500	2,600
Fuel cost	$104 million	$210 million	$80 million
Operations, maintenance and administration	$1,054 million	$2,057 million	$780 million
Rent/Taxes	$170 million	$41 million	Not applicable to this analysis
Depreciation and Amortization	$150 million	$481 million	Not applicable to this analysis
Total	**$1,478 million**	**$2,789 million**	**$860 million**

The operations, maintenance and administration costs in Table 7 include the direct cost of employment and the cost of materials and supplies purchased to support operations. It is assumed approximately 70% of these costs ($780 million x 0.7) are attributable to direct labour costs. This can be divided by the estimated number of employees (2,600) to give a payroll cost of $210,000 per full time employee. Assuming an overhead cost of 50% this corresponds to an annual employment income of $105,000 per full time equivalent.

The balance of the operating, maintenance and administration costs (i.e., $234 million) are the cost of equipment, materials and supplies purchased annually to operate the power stations. It is assumed that approximately 80% of these costs (i.e., $187 million) are spent in Ontario.

Table 7 provides an estimated fuel cost of $80 million per year for a four-unit station. This includes both cost of the uranium and the manufacture of the fuel. It is assumed that the current practice of preparation and manufacture of the fuel in Ontario continues throughout the period. The raw fuel, uranium, is assumed to be mined and purchased from outside of Ontario. Accordingly, it is assumed that 50% of the fuel cost will be spent in Ontario. This corresponds to $40 million per year in Ontario purchasing for a four-unit power station.

Not all 12 reactors will operate continuously through the period 2014-2024 as individual reactors are shutdown for refurbishment. Obviously during the three-year shutdown for refurbishing no fuel will be used. The fuel purchases have been reduced by a factor of 8/11(~0.7) to compensate for the actual years of operation over the 11-year period 2014-2024.

4.3 Summary of Operations Scope

We have estimated the cost, direct labour and schedule for operating four reactors at a four-unit power station (i.e., either the Bruce A, Bruce B or Darlington power stations). The information is summarized in Table 8. This information is used to develop the direct and indirect benefits to Ontario of operating these power stations over the period from 2014 through approximately 2050.

Table 8 Annual Ontario Operating Spending and Employment

Parameter	Estimated Value used in this Study	
	One 4 Unit Station	12 reactor units
Direct employment[1]	2,600	7,800
Direct labour earnings[2]	$273 million	$819 million
Fuel cost[3]	$30 million	$90 million
All other operating costs[4]	$187 million	$561 million
Schedule	Throughout period	Throughout period

Notes:

1 It is assumed that 100% of employees reside in Ontario

2 Direct labour earnings are $105,000 per year for each worker. Payroll burden (100%) has been removed from this total to reflect the direct income earned by employees

3 50% of the total fuel cost is assumed for refining and manufacturing in Ontario

4 80% of these non-staff operating and maintenance costs are assumed to be for Ontario-supplied equipment, materials and supplies

5. ECONOMIC BENEFITS OF OPERATIONS

The information in the preceeding section is used in this section to estimate the annual direct and indirect benefits (employment and economic activity) that may be anticipated from the continued operation of the 12 nuclear reactor units at Bruce and Darlington over the period 2014-2050.

5.1 Direct Benefits

For the purpose of our analysis, the direct impacts of operating the 12 nuclear reactor units at Bruce and Darlington are considered to be the total value of all equipment, materials and supplies purchased in Ontario plus all wages paid to Ontario workers. These direct benefits are adjusted to take account of leakage because of spending on equipment, materials and supplies outside of Ontario. This is similar to the method used to determine the direct benefits for refurbishment (see Section 3.1).

5.2 Secondary Benefits

Secondary benefits from operating the power stations are estimated in a similar manner to those estimated for refurbishment (see Section 3.2). A similar multiplier is used to estimate the secondary employment (one additional job is assumed for each job at the power stations). The secondary labour earnings multiplier meaning that spending and re-spending by employees creates an additional 140% of the power stations' payroll. Finally, we use a multiplier of 2.1 for spending on equipment, materials and supplies.

5.3 Total Benefits of Operations

Table 9 provides a summary of the total annual impact to Ontario from operating the12 nuclear reactor units at Bruce and Darlington. Total impacts include both the direct employment and spending associated with the project and the resulting secondary employment and spending. As noted above, the values in Table 9 have been adjusted to remove the economic effects of spending that would be lost to out-of province expenditures.

Table 9 Annual Economic Impact of Operations

	Direct Impact	Secondary Impact	Total Impact
Ontario Employment[1]	7,800	7,800	15,600
Labour income[2]	$819 million	$1,147 million	$1,966 million
Fuel cost[3]	$90 million	$99 million	$189 million
Ontario equipment, materials and supplies[4]	$187 million	$206 million	$393 million
TOTAL	$1,096 million	$1,452 million	$2,548 million

Notes:

1 Of the annualized direct employment of 7,800, it is estimated that 100% would be from Ontario.

2 Direct labour earnings are $105,000 per year for each worker. Based on a multiplier of 2.4, it is expected 140% of direct labour would be spent and re-spent in Ontario.

3. Secondary impacts occur when other Ontario industries and businesses supply fuel to meet the needs of operating the power stations. Based on a multiplier of 2.1, it is assumed that 110% of direct spending on fuel is spent and re-spent in Ontario. It is assumed that 50% of the full cost is incurred in Ontario because of refining and manufacture.

4. Secondary impacts occur when other Ontario industries and businesses supply goods and services to meet the needs of operating the power stations. Based on a multiplier of 2.1, it is assumed that 110% of direct spending on equipment, materials and supplies is spent and re-spent in Ontario. It is assumed that 80% of all purchases are made in Ontario.

The annual economic benefits to Ontario summarized in Table 9 are considerable, including at least 15,600 high paying jobs per annum and a total annual economic benefit of more than $2.5 billion. These estimates are conservative and have been developed using modest multipliers for secondary effects and recognising that some expenditures and employment may be created outside of Ontario. These benefits would occur annually throughout the operation of the reactors for the 25-30 year lifetime over which the refurbished reactors continue to meet the province's electricity needs.

6. SUMMARY OF BENEFITS FOR REFURBISHMENT AND OPERATIONS

This section provides a summary of the total annual benefits to Ontario of refurbishing and operating the existing nuclear power reactors at Bruce and Darlington. The 12 refurbished reactors have a total electricity generating capacity of almost 10,000 MW. This corresponds to approximately half of Ontario's summer-time peak demand.

The benefits to Ontario are expressed in terms of total employment, including both direct and indirect jobs. The benefits are adjusted to account for loss as a result of some out-of-province employment and purchasing.

Table 10 Summary of Annual Benefits to Ontario

	Refurbishment	Operations	Total Impact
Ontario Employment	9,000	15,600	24,600
Labour income	$996 million	$1,966 million	$2.96 billion
Fuel cost	Not applicable	$189 million	$189 million
Ontario equipment, materials and supplies	$1.5 billion	$393 million	$1.89 billion
TOTAL	**$ 2.5 billion**	**$2.5 billion**	**$5.0 billion**

The benefits identified in Table 10 are substantial: almost 25,000 jobs and an annual economic activity of over $5 billion. These benefits occur over the refurbishment period 2014 through 2024. Once the reactors are refurbished, the benefits will continue until approximately 2050 because of the continued operation of the reactors. These long-term operational benefits comprise 15,600 jobs and an annual economic benefit of $2.5 billion. All benefits are expressed in constant dollars (2010$).

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