Canadian Manufacturers & Exporters

Manufacturiers et Exportateurs du Canada

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

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Leadership makes the difference
Le leadership qui fait la différence

CME Studies Economic Benefits of Nuclear in Canada

The Canadian Nuclear Association engaged Canadian Manufacturers and Exporters to verify, update and extend knowledge of the economic benefits of nuclear. CNA values CME's independent economic modelling and research expertise.

The work was carried out from April to September 2012 with cooperation and support from CNA members. CME applied best methods with consistently conservative assumptions throughout the study.

Major themes:

Nuclear is a key and integral part of Canada's innovation, manufacturing and export capacity

Nuclear is a Canadian strategy for energy, jobs and innovation

Overview

- Nuclear is a critical source of base load electricity (55% in Ontario).
- Important to power consumers as it is one of the cheapest power sources available, and to all stakeholders for its minimal emissions.
- Refurbishing aging reactors provides an opportunity to affordably extend these benefits by 25–30 years.
- This report considers refurbishment of 10 reactors (as foreseen in Ontario's Long-Term Energy Plan) and operating 13 reactors.
- Report's assumptions are conservative.
- Refurbishment and continued operations of Canada's reactors offer substantial employment and economic benefits.
  - 27,000 jobs during the refurbishment period (2014-2024)
  - $6.9 billion annually in economic activity during that period
  - Long-term operational benefits thereafter: 16,640 jobs, $3.8 billion/year.
  - Refurbishment and continued operation of Quebec's Gentilly-2 will raise these results by approximately an additional 10%.

Summary of Annual Benefits to Canada

Combining 10 Refurbs and All Operations
During the Refurbishment Program Period

	Refurbishment	Operations	Total Impact
Employment	10,636	16,640	27,276
Labour Income	$1,248 m	$2,073 m	$3.3 b
Fuel Cost	Not Applicable	$518 m	$518 m
Equipment, materials and supplies	$1,890 m	$1,241 m	$3.1 b
TOTAL	**$3.1 b**	**$3.8 b**	**$6.9 b**

This analysis includes ongoing operation of the plant at Point Lepreau, NB, but not refurbishment or ongoing operation of Quebec's Gentilly 2 plant, nor construction of small modular reactors (SMRs). Construction of a pair of SMRs would add 800 jobs and $226 million for three years.

The Method: Estimating Current Direct Jobs

	Employees in Nuclear
Ontario Power Generation	5,198
Bruce Power	4,000
CANDU Energy	1,400
AECL Nuclear Laboratories	2,700
AMEC	800
Gentilly-2, QC	750
Point Lepreau, NB	700
Babcock & Wilcox	550
GE Canada	400
EMC Group	191
Org. of CANDU Industries (107 companies)	4,564
***Extrapolation from OCI DATA (see Methodology – OCI Data)**	3,615
TOTAL	**24,868**

Various Definitions of Highly Qualified Personnel (HQP)

Nuclear is a high-knowledge, high-wage industry.

While there is no single definition of HQP, the industry regulator designates certain workers as highly qualified, including Authorized Nuclear Operators, Certified Unit Operators, Control Room Shift Supervisors and Shift Managers. Average salary for these workers at OPG is $141,711.

AECL uses its own definition of HQP; it counts about 2,000 of its employees as HQP in nuclear with approximate average salary & benefits of $130,000.

This large number of highly qualified personnel working in Canada creates formative training and work experience opportunities for other workers with whom they come into contact. They also transfer knowledge and skills into other Canadian workplaces when they change employment.

This enriches the knowledge and skills of Canada's entire workforce.

HQP Salaries & Growth Outlook – Selected Firms

	Employees in Nuclear	# of HQP	Average Salary – HQP / Other	Est. Overall Employment in 5 yrs under LTEP*
OPG (Darlington & Pickering)	5,198	227	$141,711 / Not Available	Increase by 1,400 more
AECL	2,700	2,000	$130,000 / 85,000	Increase by 5-10%
CANDU Energy	1,400	800	N/A	N/A
AMEC	800	N/A	N/A	Increase by 50% to 1,200
GE Canada	400	160	$130,000/90,000	Increase by 10%
EMC	191	10	N/A	Increase to 500 (more than double)
Swagelok	14	6	HQP higher on average	Expect that it will increase
Brotech Precision	4	1	$70,000 / $35,000	Increase by 2-3 more
Nuclear Logistics	3	2	N/A	1 more HQP

***Ontario's Long-Term Energy Plan (LTEP)**

"The government of Ontario is committed to clean, reliable nuclear power remaining at approximately 50 per cent of the province's electricity supply. To do so, Ontario will rebuild what it can, and replace what it can't. Units at the Darlington and Bruce sites will need to be modernized and the province will need two new nuclear units at Darlington. Investing in refurbishment and extending the life of the Pickering B station until 2020 will provide good value for Ontarians."

(Source: Government of Ontario Website).

Capital and Labour Costs – One Reactor

Project Component	Overall Percentage	Capital Cost	Percentage Direct Labour	Net Percentage Salary & Wages	Net Salary & Wages
Engineering	15%	$375 m	75%	11.25%	$281 m
Project management	10%	$250 m	75%	7.50%	$188 m
Equipment and materials	35%	$875 m	Not applicable		
Construction labour	40%	$1,000 m	80%	32%	$800 m
TOTAL	**100%**	**$2,500 m**	**Not applicable**	**50.75%**	**$1,270 m**

The study estimated capital cost, employment and schedule for refurbishment of one average reactor unit using public information from various sources and jurisdictions. Based on this data, the economic analysis assumed an average capital cost of $2.5 billion per refurbishment. Financing costs were not included. There are many uncertainties and variations in capital cost estimates.

Costs, Employment and Schedule

- **We estimate that refurbishing each reactor will generate 6,500 person years of employment.**
- **Annual Cost per employee of $1,270 million/6,500 person years = $195,384 per year payroll cost. This includes salary, benefits and payroll taxes.**
- **Average annual salary per employee of $97,700, or approximately $50.00 per hour.**
- **Assumed average project schedule of 36 months for each reactor.**
  - Assumed combined refurbishment project duration runs from 2014-2024.

Projection over Ten Refurbishments

Parameter	One Reactor	10 Reactors
Capital cost*	$ 2,500 m	$ 25 b
Equipment , materials & supplies cost*	$1,230 m	$12.30 b
Direct labour cost*	$ 1,270 m	$ 12.70 b
Direct employment	6,500 person-years	65,000 person years
Schedule (Duration of physical works)	36 months	11 years (2014-2024)

* *All costs in 2012 Canadian dollars.*

This projection extends to the ten refurbishments anticipated in Ontario's Long-Term Energy Plan. It does not include the refurbishment of the reactor at Quebec's Gentilly 2 plant. Proceeding with Gentilly 2 refurbishment would further increase this projection.

Calculating the Economic Benefits

- Annual average expenditure of $2.27 billion.
- The majority of capital equipment and infrastructure to be used is in Canada, e.g. at Babcock & Wilcox, GE Canada, AECL, AMEC, etc.
- Estimated 80% of direct spending would take place in Canada.
  - Subtracting 20% for imported materials.
- Annual economic stimulus of $1.82 billion ($2.27 billion x .80).
- Allowed that up to 10% of workforce could come from outside Canada.
- This expenditure then leads to indirect and induced impacts.
- Assumed one job is created for each worker directly employed in refurbishment.
- Applied conservative multipliers of 2.4 for labour, 2.1 for industrial spending.

Annual Economic Impact of Refurbishment

	Direct Impact	Secondary Impact	Total Impact
Employment	5,318	5,318	10,636
Labour income	$520 m	$728 m	$1,248 m
Equipment, materials & supplies	$900 m	$990 m	$1,890 m
TOTAL	**$1,420 m**	**$1, 718 m**	**$3,138 m**

- 12 reactors in refurbishment or operation from 2012 to 2050.
- Used current employment levels for operation – 640/unit average.
- Used public data to estimate operating costs.
- Looked at direct cost of employment, materials, fuel, operations, maintenance and administration; estimated 80% of materials & supplies purchased in Canada.
- Took into account the effects of plant shutdown during refurb for 36 months.
- Estimated secondary benefits using same assumptions as for refurbishment.

Benefits of Ongoing Plant Operation

	Case A (6 Units)	Case B (4 Units)	Est. Average for a 4-Unit Station
Number of Employees	approx. 4,000	approx. 2,400	2,560
Fuel Cost	$162 m	$256 m	$105 m
Operations, maintenance and administration	$1,073 m	$1,964 m	$760 m
Rent/Taxes	$172 m	$26 m	N/A
Depreciation and Amortization	$212 m	$463 m	N/A

Annual Operating Spending and Employment (Estimated Value)

Parameter	One 4-Unit Station	13 reactor units (Ontario plus NB)
Direct employment	2,560	8,320
Direct labour earnings	$266 m	$864 m
Fuel Cost	$76 m	$247 m
All other operating costs	$182 m	$591 m

This analysis includes operation of 12 reactors in Ontario — 10 refurbished and two new, as anticipated in the province's Long-Term Energy Plan — plus the reactor at Point Lepreau, NB, which was recently refurbished and restarted in 2012.

Annual Economic Impact of Operations

	Direct Impact	Secondary Impact	Total Impact
Employment	8,320	8,320	16,640
Labour income	$864 m	$1,209 m	$2,073 m
Fuel cost	$247 m	$271 m	$518 m
Equipment, materials and supplies	$591 m	$650 m	$1,241 m
TOTAL	**$1,702 m**	**$2,130 m**	**$3,832 m**

Summary of Annual Benefits to Canada

Combining 10 Refurbs and All Operations During the Refurbishment Program Period

	Refurbishment	Operations	Total Impact
Employment	10,636	16,640	27,276
Labour income	$1,248 m	$2,073 m	$3.3 b
Fuel cost	Not Applicable	$518 m	$518 m
Equipment, materials and supplies	$1,890 m	$1,241 m	$3.1 b
TOTAL	**$3.1 b**	**$3.8 b**	**$6.9 b**

This analysis includes ongoing operation of the plant at Point Lepreau, NB. It does not include refurbishment or ongoing operation of Quebec's Gentilly 2 plant, which would further raise the impact in all columns.

The Economic Benefits of Building a New Nuclear Power Plant in Canada

Cost, Employment and Schedule for a Full-Sized, Two-Reactor Nuclear Plant

This is a much different exercise than the study of refurbishments and operations, mainly due to the lack of recent data in Canada. The following data were selected by the analytical team for the purposes of economic impact analysis, with a view to obtaining conservative impact estimates.

Parameter	2 New Full-Sized Reactors
Equipment, materials & supplies cost	$8.62 billion
Direct labour cost	$ 8.88 billion
Direct employment	60,000 person-years
Schedule (Duration of physical works)	5 years

Breakdown of Costs

Project Component	Proportion	Percentage Direct Labour	Net Percentage Salary & Wages	Net Salary & Wages
Engineering	15%	75%	11.25%	$1.97 b
Project management	10%	75%	7.50%	$1.31 b
Equipment and materials	35%	Not applicable		
Construction labour	40%	80%	32%	$5.6 b
TOTAL	**100%**	**Not applicable**	**50.75%**	**$8.88 b**

Annual Economic Impact of Building a New Full-Sized, 2-Reactor Nuclear Power Plant

	Direct Impact	Secondary Impact	Total Impact
Employment	10,800	10,800	21,600
Labour Income	$799m	$1.12b	$1.92b
Equipment, materials & supplies	$1.38b	$1.52b	$2.90b
TOTAL (Annual for five years)	**$2.18b**	**$2.64b**	**$4.82b**

Examples of Material Inputs

Building a plant of this type requires:

- 400,000 cubic meters of concrete
- 20,000 tonnes of steel
- 700 kilometres of wiring
- 70 kilometres of piping

Source: Bruce Power, Saskatchewan 2020

Cost,Employment and Schedule for a New Small Modular 2-Reactor Plant

Parameter	2 x 180MW Modular Reactors
Engineering and procurement	$1.6 billion
On-site labour cost	$ 400 million
Direct employment	2,400 person-years
Schedule (Duration of physical works)	3 years

Local content assumption: 20% for engineering and procurement (net $320 million), 90% for on-site labour (net $360 million). $320M + $360M = $680M expenditure in Canada over three years, or **$226 million and 800 jobs annually** for three years.

APPENDICES

Appendix 1:

2008 Organization of CANDU Industries (OCI) Employment Data

	Employees In Nuclear	% of TOTAL	Average # of Employees
TOP 20 COMPANIES Employees in Nuclear (18.7% of sample)	4,431	83%	225
COMPANIES WITH LESS THAN 30 Employees in Nuclear (76.6% of sample)	714	13%	10
The rest (4.7% of sample)	198	4%	40
2008 OCI TOTAL	**5,343**	**100%**	**Not Applicable**

2008 OCI Data — Top 20 Companies — Employees in Nuclear (18.7 % of sample)

	Employees in Nuclear
E.S. Fox	500
Hitachi Canada	500
CAMECO Corporation (Ontario)	408
Babcock & Wilcox Canada Ltd.	400
GE Canada	400
SNC Lavalin Nuclear Inc.	380
Zircatec Precision	320
AMEC	250
MDS Nordion	150
Merlin General Corporation	150
Nuclear Safety Solutions Limited	150
Numet Engineering	150
Aecon Industrial	125
Wardop Engineering	100
Comstock Canada	100
Kinetrics Inc.	100
Nu-Tech Precision Metals	85
Hatch-Sargent Lundy	62.5
Niagara Energy Products	50
RCM Technologies Canada Corp.	50
TOTAL	4430.5

METHODOLOGY (1) – Refurb & Operation

Capital Cost Estimates

The study estimated capital cost, employment and schedule for refurbishment of one average reactor unit using public information from various sources and jurisdictions. Based on this data, the economic analysis assumed an average capital cost of $2.5 billion per refurbishment. Financing costs were not included. There are many uncertainties and variations in capital cost estimates.

Breakdown of the $2.5 billion cost of refurbishment: the estimated percentage for engineering, project management, construction labour, equipment and materials.

Project Component	Proportion	Cost
Engineering	15%	$375 million
Project Management	10%	$250 million
Equipment and Materials	35%	$875 million
Construction Labour	40%	$1,000million
TOTAL	**100%**	**$2,500 m**

METHODOLOGY (2) – Refurb & Operation

Employment Estimates

The direct labour components: Engineering, Project Management, and Construction.

It is assumed that out of the cost for Engineering and Project Management, 75% of that is payroll cost.

It is assumed that out of the cost for Construction Labour, 80% of that is payroll cost.

The rest of the costs in these areas are made up of overhead, allowances and supplies.

Project Component	Overall %	% Direct Labour	Net % Salary & Wages	Net Salary/Wage
Engineering	15%	75%	11.25%	$281 million
Project Management	10%	75%	7.5%	$188 million
Equip. & Materials	35%	Not Applicable		
Construction Labour	40%	80%	32%	$800 million
TOTAL	**100%**		**50.75%**	**$1,270 million**

The number of workers (engineers, management, trades and support workers) directly employed during refurbishment developed by estimating the total labour in person years, required to complete the refurbishment.

OPG estimates 2,000 – 2,500 employees on site over the decade. This corresponds to at least 6,250 person years per unit.

Bruce Power indicates that refurbishment of Bruce A units 1& 2 will involve more than 13,000 person years or approximately 6,500 person years per unit.

Therefore, (based on the above), an estimate of 6,500 person years of employment is assumed for the refurbishment of each Ontario CANDU reactor.

METHODOLOGY (3) – Refurb & Operation

Total Employment Cost divided by # of person years ($1,270m/6,500 = $195,384 per year).
Payroll cost includes both the annual salary paid to employee and the associated payroll burden. (**It is assumed** a payroll burden of 50% to include overtime, living allowances, retirement benefits, bonus incentives, payroll taxes, etc.)
This gives us an annual salary per employee of approximately $97,700 or $50.00 per hour.
Average salary of $80,000 in 2006 paid to nuclear power plant maintenance workers, technicians and technical support, or $92,742 in 2011 dollars.

Estimated Schedule for Refurbishing One Reactor
There is some uncertainty due to the dynamic nature of the industry which makes it susceptible for scheduling changes. Have **assumed** an average project schedule of 36 months for the physical work. Additional time required for project planning and engineering. Bruce A reactors will have taken 72 months.(First-of-a-Kind project)

Summary of Refurbishment Scope
Have estimated the cost, direct labour and schedule for refurbishing a single CANDU reactor unit.

Parameter	One Reactor	10 reactors
Capital cost	$2.5 billion	$25 billion
Equip., materials & supplies cost	$1,230million	$12.30 billion
Direct labour cost	$1, 270 million	$12.70 billion
Direct employment	6,500 person years	65,000 person years
Schedule (Duration of physical works)	36 months	11 years (2014-2024)

METHODOLOGY (4) – Refurb & Operation

Adjusting Direct Benefits for Leakage

Even though there is an established supply chain for equipment, materials and services for refurbishment, not all expenditures remain in the Ontario economy. There is a loss of economic benefits due to buying materials and services outside Ontario (some may come from overseas).

The average annual spending associated with the refurbishment program is $2.5b/11 years = $2.27b per year. It is **assumed** that 80% of the refurbishment program direct spending would occur in Canada, providing an economic stimulus from refurbishment of $2.27b x 0.8 = $1.82b.

It is estimated that refurbishment would require an average of 65,000 person years/11years = 5,909 full time equivalents per year, with an average annual salary of $97,700.

The majority of workers, (including engineers, managers and trades), are expected to come from Canada. However, based on info from Bruce Power it is conservatively **assumed** that 10% of the workforce might come from outside Canada. Therefore, 90% of the direct labour income remains in Canada.

Secondary Benefits of Refurbishment

Methodology for estimating the impact of refurbishment follows an approach used in several other studies of the benefits of nuclear facilities in Ontario (Kitchener).
Direct economic impact plus secondary impacts (Indirect and Induced).

METHODOLOGY (5) – Refurb & Operation

Multipliers Used to Estimate Secondary impacts

CME has used separate multipliers to estimate the secondary employment and spending.
It is assumed that one additional full-time job would be created in Canada for each worker employed in the refurbishment program. The multiplier used to estimate secondary employment is two.
The secondary labour earnings multiplier is 2.4 (spending and respending by employees creates an additional 140%) which represents the additional income earned by other Canadian workers for every dollar earned by an employee working on refurbishment.
A multiplier of 2.1 is used for spending on equipment, materials and supplies (Industrial and business expenditures in Canada).

Total Benefits of Refurbishment

Summary of the total annual impact to Canada of the refurbishment program.
Employment is 5,909 x .9 = 5318.
Labour income is 5,318 x $97,700 = $520 million.
Equipment, materials & supplies is $12.30 billion/11years = $1.12b per year x 0.8 =$900m

	Direct Imp.	**Second. Imp.**	**Total Impact**	
Employment	5,318		5,31	10,636
Labour income	$520m	$728m	$1,248m	
Equip. material & supplies	$900m	$990m	$1,890m	
TOTAL	**$1.420m**	**$1,718m**	**$3,138b**	

Annual economic benefits to Canada include 10,600 jobs and a total economic benefit of $3.1billion.
Benefits would occur annually over the 11-year refurbishment program.

METHODOLOGY (6) – Refurb & Operation

It is **assumed** that Bruce and Darlington will keep staff levels constant throughout the period. The following numbers are based on existing experience at Bruce and Darlington and their 2011 Year in Review reports.

Employment Estimates

The current OPG full-time employment at Darlington is approximately 2,400 for four reactor units. Bruce Power (for 6 reactor units), has approximately 4,000 employees and contractors: That is approximately 640 full-time employees per reactor unit.

Operating Cost Estimates

Using the annual reports for Bruce 2011 and OPG 2011 to show costs of fuel, operations, maintenance and administration costs.

	Bruce	**OPG**	**Estimate for 4 Units**
Number of employees	approx. 4000	approx. 2400	2560
Fuel cost	$162 m	$256 m	$105m
Operations, maintenance, admin.	$1,073m	$1,964m	$760m
Rent/Taxes	$172m	$26m	N/A
Depreciation/Amortization	$212m	$463m	N/A

The operations, maintenance and administration costs include the direct cost of employment and the cost of materials and supplies purchased to support operations. **It is assumed** that approximately 70% of these costs ($760m x 0.7=$532m) are direct labour costs.

METHODOLOGY (7) – Refurb & Operation

The direct labour costs can be divided by the estimated number of employees to give a payroll cost of $532m/2,560 =$207,800 per full-time employee.

Assuming an overhead cost of 50% this gives us annual employment income per full-time employee of $104,000.

$760m – 532m = $228m. $228m is the cost of equipment, materials and supplies purchased annually to operate the power stations. **It is assumed** that 80% of these costs ($228m x 0.8=$182m) are spent in Ontario.

The $105m fuel cost-per-year for a four-unit station includes the cost of the uranium and the manufacturing of the fuel. **It is assumed** that the current practice of preparing and manufacturing the fuel in Canada continues.

Not all reactors will operate continuously in the 2014-2024 period as reactors will be shut down for refurbishment and no fuel will be used at that time. Therefore, fuel purchases are reduced by a factor of 8/11, or approximately 0.7 to compensate for actual years of operation.

Summary of Operations

Have estimated values for cost, direct labour and schedule for operating a four unit-power station.

	One 4-Unit	**12 reactors**
Direct Employment	2,560	7,680
Direct Labour earnings	$266m	$798m
Fuel Cost	$76m	$229m
All other Operating Costs	$182m	$546m

METHODOLOGY (8) – Refurb & Operation

ECONOMIC BENEFITS OF OPERATIONS
The direct benefits or operating 13 nuclear reactor units after having adjusted for leakage (spending on equipment, materials and supplies outside of Canada) is the total value of all equipment, materials and supplies purchased in Canada + all wages paid to Canadian workers.

Secondary Benefits
The multiplier used to estimate secondary employment is two (one additional job for every job at the power station). The secondary labour earnings multiplier is 2.4 (spending and respending by employees creates an additional 140%). A multiplier of 2.1 is use for spending on equipment, materials and supplies.

Total Benefits of Operations
Includes the direct employment and spending associated with operations and the resulting secondary employment and spending. Values have been adjusted to remove the economic effects of spending that would be lost to out of province expenditures.

Benefits to Canada are 27,276 high-paying jobs during the refurbishment period and total annual economic benefit of approximately $6.9 billion.

METHODOLOGY (9) – Refurb & Operation

SUMMARY OF BENEFITS FOR REFURBISHMENT AND OPERATIONS

Total annual benefits of refurbishing and operating existing nuclear power reactors at Bruce and Darlington plus Point Lepreau. Total employment includes both direct and indirect jobs.

	Refurbishment	**Long-term**	**OpsTotal Impact**
Employment	10,636	16,640	27,276
Labour income	$1,248m	$2,073m	$3.32 billion
Fuel cost	Not Applicable	$518m	$518 million
Ont. equip. material & suppl.	$1,890m	$1,241m	$3.13 billion
TOTAL	**$3.138 b**	**$3.832b**	**$6.9 billion**

The benefits to Ontario alone are approximately 26,000 jobs and annual economic activity of $6.4 billion over the refurbishment period of 2014-2024. After that, the long-term operation benefits continue until approximately 2050.

METHODOLOGY (1) – New Build

Need to determine capital cost, employment, and schedule for the building of two new nuclear reactors.

There are many uncertainties about capital cost of new builds. In order to be independent and conservative, the analysts worked from a capital cost figure from outside of Canada (two projected Westinghouse AP-1000 units in Alabama) that was conservatively consistent with public estimates relating to new build in Ontario.

Breakdown of the $17.5 billion cost of a new build of two reactors: the estimated percentage for engineering, project management, construction labour, equipment and materials.

Project Component	**Proportion**	**Cost**
Engineering	15%	$2.63 billion
Project Management	10%	$1.75 billion
Equipment and Materials	35%	$6.13 billion
Construction Labour	40%	$7 billion
TOTAL	**100%**	**$17.5 billion**

METHODOLOGY (2) – New Build

Employment Estimates
The direct labour components: Engineering, Project Management, and Construction.
It is assumed that out of the cost for Engineering and Project Management, 75% of that is payroll cost.
It is assumed that out of the cost for Construction Labour, 80% of that is payroll cost.
The rest of the costs in these areas are made up of overhead, allowances and supplies.

Project Component	Overall %	% Direct Labour	Net % Salary & Wages	Net Salary/Wage
Engineering	15%	75%	11.25%	$1.97 billion
Project Management	10%	75%	7.5%	$1.31 billion
Equip. & Materials	35%	Not Applicable		
Construction Labour	40%	80%	32%	$5.6 billion
TOTAL	**100%**		**50.75%**	**$8.88 billion**

The number of workers (engineers, management, trades and support workers) directly employed during a new build is developed by estimating the total labour in person years, required to complete the refurbishment.

A CANDU **new-build in Ontario would create more than 60,000 further person-years of employment** (Conference Board of Canada estimate quoted by SNC-Lavalin).

METHODOLOGY (3) – New Build

Total Employment Cost divided by # of person years ($8.88b/60,000 = $148,000 per year payroll cost).
Payroll cost includes both the annual salary paid to employee and the associated payroll burden. (**It is assumed** a payroll burden of 50% to include overtime, living allowances, retirement benefits, bonus incentives, payroll taxes, etc.)
This gives us an annual salary per employee of approximately $74,000 or approximately $38.00 per hour.

Estimated Schedule for New Build
Have assumed five years (60 months) from first concrete to operation (i.e. for the physical work).

Summary of New Build Scope
Have estimated the cost, direct labour and schedule for 2two new nuclear reactors.

Parameter	Two New Reactors
Capital Cost	$17.5 billion
Equip., Materials & Supplies Cost	$8.62 billion
Direct Labour cost	$8.88 billion
Direct Employment	60,000 person years
Schedule (Duration of physical works)	five years

METHODOLOGY (4) – New Build

Adjusting Direct Benefits for Leakage

Even though there is an established supply chain for equipment, materials and services for a new build, not all expenditures remain in the Canadian economy. There is a leakage of economic benefits abroad due to buying materials and services outside Canada.

The average annual spending associated with the new build program is $17.5b/5 years = $3.5b per year. It is **assumed** that 80% of the new build program direct spending would occur in Canada, providing an economic stimulus from a new build of $3.5b x 0.8 = $2.8b.

It is estimated that a new build would require an average of 60,000 person years/five years = 12,000 full time equivalents per year, with an average annual salary of $74,000.

The majority of workers (including engineers, managers and trades), are expected to come from Canada. However, it is conservatively **assumed** that 10% of the workforce might come from outside. Therefore, 90% of the direct labour income remains in Canada.

Secondary Benefits of a New Build

Methodology for estimating the impact of refurbishment follows an approach used in several other studies of the benefits of nuclear facilities in Ontario. (Kitchener).
Direct economic impact plus secondary impacts (Indirect and Induced).

METHODOLOGY (5) – New Build

Multipliers Used to Estimate Secondary impacts

CME has used separate multipliers to estimate the secondary employment and spending.
It is **assumed** that one additional full-time job would be created in Ontario for each worker employed in the new build program.
The labour multiplier of 2.4 represents the additional income earned by other Ontario workers for every dollar earned by an employee working on a new build. For industrial and business expenditures in Ontario use a multiplier of 2.1.

Total Benefits of New Build

Summary of the total annual impact of the new build program.
Domestic employment is 12,000 x .9 = 10,800.
Labour income is 10,800 x $74,000 = $799 million.
Equipment, materials & supplies is $8.62 billion/5 years = $1.72b per year x 0.8 =$1.38b.

	Direct Imp.	**Second. Imp.**	**Total Impact**
Employment	10,800	10,800	21,600
Labour income	$799m	$1.12b	$1.92b
Equip. material & supplies	$1.38b	$1.52b	$2.90b
TOTAL	**$2.18b**	**$2.64b**	**$4.82b**

Annual economic benefits to Ontario and Canada include 21,600 jobs and economic benefit of $4.8 billion annually over the five-year new build program.

METHODOLOGY – OCI Data

The OCI data from 2008 consisted of employment figures for 107 companies. During this study, CME contacted approximately 177 companies that were either CNA or OCI members. The extrapolation estimate was done to bring the 2008 employment number for 107 companies up to the 177 companies in the current study.

From the 2008 OCI data:

18.7% of the companies had more than 50 employees. The average number of employees in nuclear for these companies was **225**.
4.7% of the companies had more than 30 but less than 50 employees. The average number of employees in nuclear for these companies was **40**.
76.6% of the companies had less than 30 employees. The average number of employees in nuclear for these companies was **10**.

These **averages and percentages** were used to expand from 107 companies to 177 by applying these characteristics to an additional 70 companies.

18.7% x 70 = 13.09 x 225 (average employees) = 2,946
4.7% x 70 = 3.29 x 40 (average employees) = 132
76.6% x 70 = 53.62 x 10 (average employees) = 537

We then sum: 2,946 + 132 +537 = 3,615