Paper on

Impact of Point Lepreau Nuclear Generating Station Refurbishment on New Brunswick

By

Syed M. H. Zaidi
NB Power (Retiree)
New Brunswick
CANADA

For Presentation at

The Canadian Nuclear Society's 27th Annual Conference

To be Held in

Toronto, Ontario, Canada

June 11 - 14, 2006

Impact of Point Lepreau Nuclear Generating Station Refurbishment on New Brunswick

Syed M. H. Zaidi
NB Power (Retiree)
7 Clermont Lane, Rothesay, New Brunswick, CANADA E2E 5G6
smh@zaidi.net

Abstract

Point Lepreau Nuclear Generating Station (PLNGS), started commercial operation in 1983, has a gross output of 680 MWe, generates low-cost electricity and supplies 30% of the province's electricity.

Since commercial operation in 1983, the station has performed well. Technical and economic assessment recommended refurbishment between 2005 and 2011. Decision has been made to refurbish Point Lepreau, starting in April 2008, and will be completed by September 2009, with AECL as the general contractor. This paper describes the impact of PLNGS refurbishment on New Brunswick.

TABLE OF CONTENTS

1.0 Introduction

The Point Lepreau Nuclear Generating Station (PLNGS) is owned and operated by New Brunswick Power (NB Power – New Brunswick Provincial Corporation). It is a Pressurized Heavy Water Reactor (PHWR) 700 MWe class CANDU – 6 reactor designed by Atomic Energy of Canada Limited (AECL). It has a gross output of 680 MWe, and supplies approximately 30% of the province's electricity.

Point Lepreau construction began in May 1975 and was completed in 1981 at a cost of $1.44 billion. During peak of construction in 1979, approximately 3,500 people were employed on the project

Point Lepreau was the first CANDU – 6 to be licensed for operation (July 21, 1982), the first to achieve criticality (July 25, 1982), the first to achieve power (September 1982) and the first to begin commercial operation on February 1, 1983.

Point Lepreau has well trained and highly skilled work force of about 700 people, with an annual payroll of $50 – $70 million.

Point Lepreau opened its full-scale simulated control centre in 1992. It plays a key role in training station operators, as well as training operators for other CANDU – 6 plants.

Point Lepreau has been a very reliable generator of electricity during its 23 years of operation, ranked 12 times as a world leader for its lifetime capacity factor. Its in-service capacity factor is almost 83 percent, slightly above design performance expectations.

Point Lepreau has generated a cumulative total of over 100,000 GWh, since commercial operation in 1983, displacing the equivalent of about 150 million barrels of oil, averting the emissions of about 77.8 million tonnes of CO_2.

The uranium used at Point Lepreau is mined and refined in Canada.

Point Lepreau is important to the economic and environmental performance of NB Power, because it is one of the lowest cost generators on the system and displaces significant amounts of air-emissions.

Nuclear safety is the primary focus of station activities. CANDU is an established Canadian technology with an excellent nuclear safety record. Point Lepreau is a safe working environment and has exceeded one million person-hours without a lost-time accident on three occasions.

Point Lepreau is registered as (International Standards Organization) ISO 14001.

-

2.0 CANDU – 6 Nuclear Power Plants

The CANDU – 6 nuclear power plant is a 700 MWe class reactor, the most successful plant designed by AECL.

The CANDU – 6 design meets the requirements of Canada's nuclear regulator, Canadian Nuclear Safety Commission (CNSC). It was licensed in the early 1980s in Canada, Argentina and South Korea. In 1996, Cernavoda Unit 1 was licensed in Romania, and Wolsong Unit 2 was licensed in Korea. Wolsong Units 3 and 4 were licensed in Korea in 1997 and 1999 respectively. Qinshan Units 1 and 2 were licensed in China in 2002 and 2003 respectively.
At present 10 CANDU – 6 plants (1 – New Brunswick, 1 – Quebec, 4 South Korea, 1 – Argentina, 1 – Romania and 2 in China) are in operation and 11th is under commissioning in Romania.

3.0 Proposed Refurbishment of Point Lepreau

Since it went into service in 1983, the station has performed well. Its key reactor components (pressure tubes and feeder pipes) are nearing the point in time in which they will need to be replaced. Although pressure tubes and feeder pipes have been replaced on an individual basis, the number of pressure tubes requiring replacement may increase significantly after 2008.

3.1 Hagler Bailly Review

Significant number of technical and operating issues experienced at Point Lepreau between 1995 and 1997, resulted in reduced capacity factor and additional OM&A costs, which led to concerns over the continued viable operation of the station.

NB Power commissioned Hagler Bailly, a leading worldwide provider of management consulting and other advisory services to corporations and governments on energy, network industries and the environment, to conduct a technical and economic assessment of Point Lepreau.

The March 1998, Hagler Bailly report concluded that Point Lepreau should not be shutdown in the near-term, and given natural gas prices at the time, life extension could be economically viable through refurbishment between 2005 and 2011 with the most probable date of outage commencement being 2008. The report recommended that continued investment in the plant should occur to preserve the option to refurbish.

3.2 Refurbishment Plan Initiation

In mid 1999, NB Power concluded to plan for Point Lepreau refurbishment with an outage date starting in April 2006, with a two-year contingency, recognizing the severe economic consequences of an earlier than planned forced shutdown.

In 2000, approval was granted for a study to define the detailed scope and cost estimate for refurbishment of Point Lepreau verses an alternative energy supply. The assessment was to be completed by the end of 2001 to allow decision and four years engineering prior to the planned April 2006 outage start for refurbishment.

In December 2001, NB Power completed the two-year comprehensive study looking into the scope and cost of refurbishing Point Lepreau, so that it could operate for another 25 to 30 years. As part of this study a rigorous review of plant systems was conducted to address issues relating to ageing and obsolescence.

This study indicated that the majority of plant components were capable of supporting extended operation without needing replacement or changes outside the scope of regular maintenance activities.

As a result of this work, the scope and cost of the project was determined. NB Power used this information, along with the long term operating costs of Point Lepreau and compared it to alternate forms of power generation. It was found that the most cost effective option was to refurbish Point Lepreau.

To allow sufficient time for conclusion of the approval process by the New Brunswick government and to recognize the value of an additional two years of station operation prior to refurbishment, the start date for the refurbishment outage was shifted from April 2006 to April 2008. A detailed technical evaluation of the impact of a delay on the ageing of fuel channel and feeder components was performed and concluded that this new schedule was appropriate.

3.3 Refurbishment Project Timeline

(Phase 1)

2000 – 2001 Define Scope and Cost

- Define Scope and Cost
- Condition Assessment Study
- Contract Framework with AECL

==========

(Phase 2)

2002 - 2004 Early Start Activities

- Regulatory Process
  - Public Utility Board
  - Canadian Nuclear Safety Commission
  - Department of Environment and Local government
- Dr. Robin Jeffrey Review
- Preliminary Engineering for Risk Reduction
- Province of New Brunswick Approval

2005 Project Approval

- Detailed Engineering and Procurement

2006 – 2007 Pre – Outage Construction

- Site Preparation
  - Construction of Waste Management Facilities and Temporary Facilities
  - Completion of Detailed Engineering
  - Material Procurement and Delivery

==========

(Phase 3)

2008 – 2009 Start of Planned Maintenance Outage

- Planned Maintenance Outage
  April 2008 to September 2009

2010 Completion of Planned Maintenance Outage

3.4 Dr. Robin Jeffrey Review

The province of New Brunswick commissioned nuclear expert Dr. Robin Jeffrey to compile a report on the potential refurbishment of Point Lepreau. In his report released in April 2004, Dr. Robin Jeffrey made three key recommendations on the project:

- NB Power should revise contracts with AECL to provide a more suitable risk balance in the project execution.

- NB Power should validate the costs of alternate fossil generation options.

- The New Brunswick government should consider alternative ownership or equity investment in the station.

Dr. Jeffrey also recommended that the New Brunswick government should consider additional factors, such as number of highly skilled employees, the environment and contribution to the economy, when making its decision. Dr. Jeffrey concluded that with effective management, the cost and schedule estimates for the Point Lepreau refurbishment were capable of being met.

3.5 Refurbishment Business Case

NB Power filed the necessary evidence on the Point Lepreau proposed refurbishment with the Public Utility Board (PUB) in February 2002, as planned expenditure in excess of $75 million required a review by the Board of Commissioners of PUB. The PUB reviewed the financial aspects of the project, including comparison to alternatives and followed the due process for decision.

On September 24, 2002, the PUB recommended to NB Power's Board of Directors that it not proceed with the refurbishment of Point Lepreau, based on its conclusion that there was no significant economic advantage.

The PUB's mandate was to consider only the economic evidence presented and did not assess other factors such as CO_2 reduction targets, further legislated SO_2 release reductions, socio-economic impacts, ensuring long term availability of generation fuel at a reasonable cost and diversity of generation fuels. The uranium fuel used at Point Lepreau is mined and refined in Canada and it is also much less volatile compared to other generation fuel availability and costs such as Orimulsion, oil or natural gas.

NB Power had to make decision for going forward:

- With Refurbishment of Point Lepreau

  Or

- Without Refurbishment of Point Lepreau

3.6 Going Forward – Events and Timeline

With Refurbishment of Point Lepreau	
Decision on refurbishment	July 2005
Completion of the detailed engineering procurement	July 2005 – March 2008
Operating License renewal with the Canadian Nuclear Safety Commission	Sept. – Nov. 2005
Temporary facilities and waste storage construction	April 2006
Start planned maintenance outage	April 2008
Complete planned maintenance outage	September 2009

Without Refurbishment of Point Lepreau	
Continue operating the facility	Mid 2008
Early decommissioning (reducing fuel, heavy water, taking systems out of service and reducing station staff by 50%)	Mid 2008 – 2011
Maintaining systems that cool the fuel, provide security and continue reducing station staff to less than 50 employees	2011 – 2015
Monitoring and security for dry storage site	2016 – 2040
Dismantle station, return area to an industrial purpose site	2040 – 2050
Continue monitoring dry storage site or transfer waste to a central depository	2040 – 2050

NB Power completed an exhaustive examination of all options and addressing concerns identified by the Board of Commissioners of PUB and nuclear expert Dr. Robin Jeffrey, and concluded that refurbishment with AECL represents the best balance of cost and risk for the ratepayers of New Brunswick.

NB Power Board of Directors finally recommended in late July that the cost and risk of the external investment option and the fossil fuel option were too high and that the AECL option represented the best balance of cost and risk. In addition to the items that were directly factored into the business case, it should be noted that the continued operation of the station has significant environmental as well as socio-economic benefits for the residents of New Brunswick. The province of New Brunswick accepted this recommendation.

4.0 Decision to Refurbish Point Lepreau

The Premier of New Brunswick announced on July 29, 2005, that the Province of New Brunswick would proceed with the refurbishment of Point Lepreau with AECL as the general contractor.

Refurbishment of Point Lepreau, by investing in **Nuclear Power – Energy Source of Future** is a positive decision for future prosperity of New Brunswick.

Proceeding in partnership with AECL will allows NB Power to meet all the project objectives, including balancing the risk and the cost, ensuring security and diversity of supply, maximizing environmental benefits, and maintaining 700 highly skilled jobs.

The plant is in good condition going into refurbishment. NB Power has invested in maintenance and improvements on an ongoing basis and the plant will operate reliably for an additional 25 years once refurbishment work is done.

Completion of the detailed engineering and procurement began in the summer of 2005 with completion expected by March 2008. The construction of temporary facilities and waste storage will begin in April 2006. The planned maintenance outage will start in April 2008 and will be completed by September 2009.

Point Lepreau will continue to play a key role in providing New Brunswick with a base load of safe, dependable electricity for many years to come.

The estimated cost of the project, including the purchase of replacement electricity, is $1.4 billion.

4.1 Point Lepreau Refurbishment Project Estimate

No	Item	$ million
1	Costs expended on determining the project scope	37
2	AECL Contracts • Retube contract; firm price ---------- ($338 million) • Refurbishment contract; firm price -------- ($141 million) • Refurbishment contract: non-firm price --- ($38 million)	517
3	NB Power project team and station cost	77
4	**Generation Revenue during Commissioning**	**(6)**
5	Contingency	36
6	Estimated escalation on items 1 – 5	101
7	Interest during construction	173
8	Purchase of electricity equivalent of Point Lepreau output during the 18-months when the plant is shutdown for refurbishment during 2008/9	280
9	Avoidable cost items and capital work to be done, post refurbishment, that should be brought forward to the refurbishment period	80
10	Further contingency	60
	(Numbers in bracket for item 4 are credit to the project) Total	**$1.4 billion**

5.0 AECL – General Contractor for Refurbishment

AECL is responsible for two aspects of the overall project:

- Retubing in which 380 fuel channels and associated feeder tubes will be removed and replaced, and construction of a facility on site to store the removed active material.
- Refurbishment, where ageing components and outdated technology will be removed and upgraded.

AECL's 25 years of actively supporting the operation of the station and its strong working relationships with Point Lepreau staff, NB Power staff and local suppliers enables the project team to continue working smoothly and seamlessly. AECL fully intends to maintain its long-standing commitment to hiring and working closely with qualified local trades and suppliers. Reflecting this growth, and depending on the timing of project implementation, AECL is planning to add as many as 500 professional and technical employees over the next two years.

The plant owner, NB Power, will be responsible for other aspects of the project including: normal shut down of plant for outage, removal of fuel, heavy water, normal maintenance during outage, providing new fuel, reloading heavy water and providing station staff to restart the plant.

Technology developed by AECL will allow CANDU reactors to be refurbished efficiently, extending economic service life for another 25 to 30 years. A solid background in Research and Development capabilities backs AECL expertise. This gives AECL an unparalleled advantage in providing a full line of engineering and technical products and service that support operating CANDU plants and improve customer productivity and competitiveness.

At present there are ten CANDU – 6 reactors in operation and one under commissioning. It is anticipated that all CANDU – 6 reactors will undergo life extension and refurbishment programs. These refurbishment projects are expected to result in significant commercial business over the next several years.

Point Lepreau is the first CANDU – 6 in service and first to be refurbished by AECL. Refurbishment feasibility work for Hydro-Quebec for Gentiliy – 2 station has been completed by AECL and negotiations have also started to refurbish CANDU – 6 reactors in South Korea and Argentina.

Point Lepreau being the first CANDU – 6 to be refurbished will provide significant benefits to the nuclear industry to participate in further CANDU – 6 refurbishments.

Refurbishment and life extension represent an exciting growth area for AECL, and demonstrate again the strength and flexibility of CANDU design. AECL has a proven track record in successfully managing major power projects in Romania, South Korea and China, over the past decade.

6.0 Management – Workers Union Relationship

Point Lepreau enjoys a positive working relationship with the workers union - International Brotherhood of Electrical Workers (IBEW) Local 37 and in Oct. 2004 extended its existing Jan. 1, 2001 – Dec. 31, 2007 union contract to Dec. 31, 2010.

This extension will provide stability in Management – Workers Union relationship, as Point Lepreau prepares for and executes station refurbishment.

7.0 Socio-economic Impact

The economics for Point Lepreau refurbishment are compelling, since the net result is a power plant at half the price of a new nuclear power plant. So too are the environmental benefits of not burning fossil fuels. Its continued operation is also of particular importance due to the volatility in thermal fuel pricing and diversification of supply.

The Point Lepreau refurbishment objective is straightforward by providing the New Brunswick electricity safely, reliable, at a reasonable price with respect for the environment, while providing a return to the shareholders – the Government of New Brunswick. Successfully completing the project will extend the station's life to 2034.

Since commercial operation in 1983, Point Lepreau has generated a cumulative total of over 100,000 GWh. Point Lepreau supplies up to 30% of the NB electricity supply. During recent cold winters, NB Power had many Peek Electricity demands (3 times in January 2004).

Nuclear generation cost is lower and it is also much less volatile compared to other generation fuel costs such as oil or natural gas. A fuel bundle, which costs between $2,000 and $3,000, can produce enough electricity for the average home for 100 years. 400 tonnes of oil or 1,500 barrels of oil would be needed to produce the same amount of energy. The uranium used at Point Lepreau is mined and refined in Canada.

Purchasing of electricity equivalent to Point Lepreau's output during the 18-months when the plant is shut down for refurbishment during 2008/9 is estimated at $280 millions. The electricity replacement cost would be about $4.7 Billions (assuming refurbished Point Lepreau's life to be 25 years), if we had missed the opportunity to refurbish.

New Brunswick has one of the most electricity intensive industrial production structures among the provinces in Canada. The electricity intensity of industrial production of New Brunswick, measured in terms of KWh per $ of GDP, is among the highest in Canada and in the world, second only to Norway. Thus, a secure and competitive supply of electricity is of special importance to the economic well being of New Brunswick.

Point Lepreau will continue to operate safely and reliably, while preparing for the successful refurbishment project, an 18-month outage beginning in April 2008.

7.1 NB Power Generation Costs

NB Power uses six fuels to generate electricity - oil, coal, uranium, orimulsion, water, diesel and seeking up to 400 MW of Wind Energy. Generation costs have a significant impact on financial performance.

- **Hydro Generation**
  Hydro accounts for approximately 15 per cent of total production as NB Power's lowest cost fuel to generate electricity.
  Other most expensive fuels are used to account for the shortfall thereby increasing generation costs, when water flows are below anticipated levels.

- **Oil Prices**
  Heavy fuel oil represents approximately 50 per cent of fuel costs and it is also used as the replacement fuel when low-cost nuclear and hydro generation is unavailable.

- **Natural Gas Prices**
  Natural gas represents 13 per cent of the total fuel cost.

- **Coal Prices**
  Coal represents 15 per cent of total fuel costs

- **Nuclear Generation**
  Supplying 30 per cent of New Brunswick's energy requirements, consistent performance from the Point Lepreau Generating Station is essential to positive financial performance of NB Power.

The NB Power provides reliable, safe and reasonable-priced electricity generated at 15 facilities, delivered via power lines, substations and terminals to more than 360,000 direct and indirect customers within New Brunswick and surrounding markets.

7.2 NB Power Generating Capacity

Thermal	
Belledune	458 MW
Coleson Cove	978 MW
Courtenay Bay	110 Mw
Dalhousie	300 MW
Grand Lake	57 MW
Total Thermal	**1,903 MW**
Combustion Turbine	
Grand Manan	27 MW
Millbank	399 MW
Ste. – Rose	100 MW
Total Combustion Turbine	**526 MW**
Hydro	
Beechwood	113 MW
Grand Falls	66 MW
Mactacquac	672 MW
Milltown	4 MW
Sisson	9 MW
Tobique	20 MW
Total Hydro	**884 MW**
Nuclear	
Point Lepreau	**635 MW**
Grand Total	**3,948 MW**

7.3 Greenhouse Gas Emissions

NB Power is committed to the achievement of excellence and innovation in protecting the environment of the province while meeting its mandate to provide economic and reliable energy to the people of New Brunswick.

- Since commercial operation in 1983, Point Lepreau has generated a cumulative total of over 100,000 GWh, displacing the equivalent of about 150 million barrels of oil, averting the emissions of about 77.8 million tonnes of CO_2.

- As a comparison, total CO_2 emissions in New Brunswick in 2001 were 22.7 million tones. Without Point Lepreau generation, annual CO_2 emissions in New Brunswick would have been about 15% higher.

- In terms of SO_2, NB Power must stay below 123,000 tonnes annually, and the province has to stay below 175,000 tonnes annually.

- The operation of Point Lepreau contributes significantly towards the goal of limiting CO_2 / greenhouse gas emissions in New Brunswick.

In 2004, with a capacity factor of 77.5% Point Lepreau averted following emissions, which could have resulted from fossil – fuelled generations:		
Carbon Dioxide	CO_2	3,320,000 tonnes
Sulphur Dioxide	SO_2	58,700 tonnes
Nitrogen Oxide	NO_x	13,300 tonnes

7.4 Economic Benefits to the Local Economy

Continued operation of Point Lepreau will provide approximately 700 direct jobs with an annual payroll of $50 - $70 million at the station and 1,100 indirect jobs a further $35 million annually for service and contract work throughout New Brunswick. In addition, the Point Lepreau refurbishment project will involve leading edge technology that will generate new research and development opportunities in the province.

Opening of an AECL office in Saint John to work on the Point Lepreau Refurbishment Project will make Saint John companies and employees the preferred suppliers on CANDU refurbishment that will take place around the world and making Saint John a new Centre of Excellence in nuclear power and CANDU refurbishment and technology.

Successful completion of Point Lepreau refurbishment and continued operation will make way for a second CANDU reactor at Point Lepreau.

New Brunswick has an established community of suppliers and skilled workers, who will contribute to the successful completion of the refurbishment project. AECL is committed to working with these local suppliers and skilled workers. It is estimated that of the 500 trades required to complete the work – including boilermakers, pipe fitters, ironworkers, labourers, and carpenters – 90% will be hired locally. Of the 100 – 150 administrative and project management positions – including engineers, planners, trainers, and supervisors – at least 50% will be local.

7.5 Point Lepreau Employees contribution to the Local Economy

Point Lepreau has well trained and highly skilled work force of about 700 with an annual payroll of $50 – $70 million. It is no surprise that this work force is the greatest strength of NB Power and Point Lepreau refurbishment will also ensure their future prosperity.

In the Greater Saint John area (communities of Saint John, Grand Bay – Westfield, Quispamsis, Rothesay) alone there are close to 500 employees of Point Lepreau. Together they contribute over $19 million annually to the area's economy!

In New Brunswick, an average household spends $36,644 a year on food, shelter and entertainment, that translates into millions of dollars spent in the communities where people live.

Number of Point Lepreau employees living in various counties of New Brunswick and their contribution to the local economy.

County	**Employees**	**Contribution to the local economy**
Kings County	260	$ 9.5 million
Saint John County	258	$ 9.5 million
Charlotte County	114	$ 4.2 million
York County	29	$ 1.1 million
Other Counties	17	$ 0.6 million

Point Lepreau is very important for New Brunswick, considering the factors, such as number of highly skilled employees, the environment and contribution to the economy for a province with population of 752,000.

Refurbishment of Point Lepreau will ensure future prosperity of the local economy and will also provide continued economic growth in the province of New Brunswick.

Point Lepreau refurbishment project will involve leading edge technology that will generate new research and development opportunities in the province.

8.0 Conclusion

- Point Lepreau generates low cost power, supplies 30% of the province's electricity and is important to the economic and environmental performance of NB Power
- Technical and economic assessment recommended Point Lepreau refurbishment between 2005 and 2011, the most probable date of outage commencement being 2008
- Point Lepreau refurbishment starting in April 2008 will be completed by September 2009, at the estimated cost of $1.4 billion, with AECL as the general contractor
- A solid background in Research & Development and successfully managing of major power projects in Romania, South Korea and China backs AECL expertise
- Purchasing of electricity equivalent to Point Lepreau's output during the 18-months shutdown for refurbishment during 2008/9 is estimated at $280 millions
- The uranium fuel used at Point Lepreau is mined and refined in Canada and it is also much less volatile compared to other generation fuel costs such as oil or natural gas
- Refurbishment of Point Lepreau, by investing in **Nuclear Power – Energy Source of Future** is a positive decision for future prosperity of New Brunswick
- New Brunswick has one of the most electricity intensive industrial production structures among the provinces in Canada
- Successful completion of Point Lepreau refurbishment and continued operation will make way for a second CANDU reactor at Point Lepreau
- Point Lepreau's 700 employees have a Payroll of $50 - $70 million annually and 1,100 indirect jobs a further $35 million annually
- About 500 trades required to complete the work – including boilermakers, pipe fitters, ironworkers, labourers, and carpenters – 90% will be hired locally
- Of the 100 – 150 administrative and project management positions – including engineers, planners, trainers, and supervisors – at least 50% will be local
- Point Lepreau being the first CANDU – 6 to be refurbished will provide significant benefits to the nuclear industry to participate in further CANDU – 6 refurbishments

9.0 References

[1] NB Power 2004/05 Annual Report
[2] Point Lepreau Refurbishment Review by Dr. Robin Jeffrey
[3] Point Lepreau Public Affairs Brochures
[4] Consultation on the Future of Point Lepreau
[5] New Brunswick Department of Energy
[6] Powering The Future – Point Lepreau Refurbishment Website
[7] AECL 2005 Annual Report
[8] Statistics Canada
[9] Point Lepreau Refurbishment – Update 5 (26th CNS Annual Conference, June 2005)