Basic Assessment of Point Lepreau CANDU 6 nuclear reactor refurbishment

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This brief reviews the economics of nuclear power, including the Point Lepreau CANDU 6 nuclear reactor refurbishment project. The 680 MW Point Lepreau refurb is compared to the installation of 12 100 MW wind farms. The brief indicates that these wind farms could have been planned, constructed and operational by April 2008, so most of the replacement energy during refurb could have been supplied with new wind energy. This might have allowed older, inefficient and fossil-fuel based electricity sources to be retired sooner. Next steps are discussed with a few broad questions/statements.

Economics of nuclear power

The issues that affect the economics of nuclear power have been reviewed extensively, showing recent escalation in capital costs. The real costs of nuclear power can increase with an expansion of capacity (and in fact did increase in France) because of ever-increasing complexity in the design, construction, operation, management, and regulatory oversight of nuclear systems. It has been estimated that the total levelized busbar costs of 99 US reactors, including capital costs amortized at 6%/year, range from $0.03/kWh to $0.14/kWh (2004 USD), with the 50% percentile falling between $0.05/kWh and $0.06/kWh. Costs at the upper end of the $0.03-0.14/kWh range are driven in part by unanticipated factors, and the possibility of "cost surprises" should be incorporated formally into cost estimates for nuclear power.

The standardization of design, improvements in construction management, computer-assisted design, and other factors might tend to drive costs down, but the special conditions that attend each nuclear job site, and the possibility of cost "surprises," tend to drive costs up. It has been estimated that the real levelized cost of nuclear power using an "open" or "once-through" fuel cycle (in which spent fuel is treated as waste, rather than recycled back to the reactor) ranges from $0.04 to $0.08/kWh (2002 USD) (with an effective interest rate of 11.5%), depending on assumptions regarding the capacity factor, the plant lifetime, construction costs, and construction time. It has been estimated that since then, construction costs have escalated substantially, resulting in a doubling of capital costs and an increase in the estimated median levelized costs from $0.067/kWh to $0.084/kWh in 2007 USD. Some estimate higher costs of $0.09-0.12/kWh (2007 USD).

In summary, the economic costs of nuclear power are estimated to cover a very wide range, depending on a number of variables that are difficult to project: the costs of new, untested designs; construction times; interest rates; the impact of unforeseen events; regulatory requirements; the availability of specialty labour and materials; bottlenecks in the supply chains; the potential for standardization; and so on.

Point Lepreau CANDU 6 nuclear reactor refurb – "a different beast"

Point Lepreau is the first CANDU 6 nuclear reactor to be refurbished, so there is a lot of interest from Atomic Energy Canada Limited (AECL) to show that it can complete the project on time and on budget. The New Brunswick government has said if the project is late or over budget, it could shelve plans to build a second nuclear reactor with Team CANDU, a consortium of companies that includes AECL. Yet the reactor refurb has missed its September 2009 deadline to return to service and is over budget.

In October 2008 an accident at the Port of Saint John sank two, $10 million low pressure turbine rotors–about 115 tonnes each –to the bottom of Saint John Harbour . These had to be recovered from the harbour floor and sent to Scotland for a comprehensive engineering assessment and refurbishment by the manufacturer Siemens, arriving back into port in June 2009. In December 2008, following the accident when equipment plunged to the seafloor, New Brunswick Power President and Chief Executive Officer, David Hay, said although the pace of the retubing work was putting pressure on the September 2009 deadline, it was too early to say it could not be done on time. As of April 2010, NB Power said Point Lepreau was unlikely to return to service before February 2011. Now the return to service of the nuclear plant is scheduled for the fall in 2012.

Point Lepreau represents a complex refurbishment project and is shared between two companies, NB Power and AECL (provincial and federal crown corporations). It seems that AECL fell behind in its duty for cutting and removing the 380 reactor feeder tubes, despite special tools brought in by the federal agency to help the process. The polishing and inspection of the Point Lepreau Generating Station's 760 calandria tube sheet bores, located at each end of the calandria tube, was completed in February 2011. The next step in the work is the final cleaning and measurement of each tube sheet bore in March 2011. Other remaining milestones for the project include calandria tube installation (August 2011), fuel channel installation (December 2011), lower feeder installation (May 2012), and return to service (Fall 2012).

Point Lepreau's refurbishment costs were initially estimated at $1.4 billion, reflecting $1.022 billion plus a cost of replacement energy of $400 million. The planned maintenance outage was to be 18 months. If the nuclear power station

returns to service in September 2012, the project will be completed three years behind schedule and perhaps close to $1 billion over budget, without factoring in any cost over-runs from the refurbishment project itself.

Nuclear vs. wind power

If $2.4 billion had been the estimated cost of Point Lepreau's nuclear refurbishment project, assuming some delays or "cost surprises" are to be expected from the first CANDU 6 reactor refurbishment in the world, this project could have been compared more realistically to other options, such as perhaps a $2.4 billion wind development project in the region. A December 2009 study by a team at the University of Moncton estimated the cost of a 100 MW wind farm in Eastern Canada is $200 million. Thus, 12 100 MW wind farms could have been developed for the same cost. Instead, one 680 MW nuclear reactor was refurbished. To compare these two options, the nuclear and wind power might have capacity factors of ~90% and ~36% of installed capacity, respectively. Thus, ~5.36 and ~3.78 terawatt hours per year (TWh/yr) could be generated from the nuclear and wind, respectively. However, this cost does not address other life-cycle costs of nuclear, such as operating and decommissioning costs, the latter of which are certainly much higher for nuclear energy than wind. Nuclear fuel to operate the reactor may cost only $140,000 per year, but decommissioning costs are typically very expensive relative to wind.

Since the nuclear refurbishment project was well underway in 2005, and since planning-to-operation delays for wind development are only 2-5 years, 1,200 MW of installed wind capacity could have technically been planned, constructed, commissioned and operating in time for the planned maintenance shutdown of Point Lepreau's 680 MW CANDU 6 nuclear reactor back in April 2008. Furthermore, Point Lepreau had a capacity factor of ~76% before being shut down for maintenance. Thus, electricity generation from Point Lepreau was closer to ~4.53 TWh/yr, much less than the projected power from the refurbed Lepreau. It remains to be seen whether this first-of-a-kind refurbished nuclear project can be operated at its projected capacity factor for up to 30 more years.

Maritime Electric, Prince Edward Island's main electric utility, is a partner in Point Lepreau's refurbishment. The company expects 30% wind electricity supply plus 30 megawatts (MW) or 17% nuclear electricity supply in 2013, with the remainder coming from other off-Island sources. From the perspective of carbon emissions, for instance, wind is a better option than nuclear energy, but nuclear is a better option than natural gas, oil and coal-fired generation and after long and costly delays the Lepreau refurb seems to be near completion. Thus, if the Point Lepreau nuclear refurbishment is completed successfully it should still significantly reduce carbon emissions in the region's electricity system.

Next steps

Given this assessment, what should Canada be doing? Should the Government of New Brunswick shelve plans to build a second nuclear reactor with Team CANDU? Should more investment be channeled into nuclear or other alternative energies at federal/provincial levels? Beyond this, if renewable power is the fastest, best way to decarbonize the energy sector, beyond efficiency and conservation measures, then, to do it properly you'd almost have to replace our entire power generating grid. We've never tackled something like that before.