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CANDU at Darlington: Securing Jobs and Energy for the new Economy

by DON LAWSON

Council for Clean & Reliable Electricity
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THE AUTHOR

Don Lawson spent the first half of his career in design, testing, commissioning and project management in the private sector of the UK nuclear industry. After a short period in New York working on power and desalination projects in Saudi Arabia he joined Atomic Energy Canada Limited (AECL) in 1978. He retired as President of AECL CANDU in 1995. In 1992 he was awarded an Engineering Medal (Management Category) by the Association of Professional Engineers of Ontario and in 1996 an Outstanding Contribution Award by the Canadian Nuclear Society.

The Council for Clean & Reliable Electricity

The Council is a federally incorporated non-profit organization that was formed to provide a platform for open public dialogue and a solutions-oriented approach to the challenges of the energy sector. It is a forum where representatives from universities, public and private sector business leaders, and strategic planning professionals collaborate to broaden the public debate on energy issues. The Council has organized conferences on distributed generation, biomass, coal, nuclear and public sector governance in the electricity sector.

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CANDU at Darlington: Securing Jobs and Energy for the new Economy

DON LAWSON

The Ontario government has decided that half of the province's electricity supply will come from nuclear generators[1]. Much of this generating capacity is already in place but is aging and will require either refurbishment or replacement. The six reactors at Pickering will reach the end of their operating lives shortly after 2020, capacity that will need to be replaced. The Darlington site[2] of Ontario Power Generation (OPG) has been selected for building the next nuclear units. So far the province has yet to decide on the type of reactor to be purchased. This note reviews the issues and recommends that two Enhanced CANDU[3] 6s are the best choice and that negotiations for purchase should start immediately.

COST COMPARISONS

"Enhanced CANDU6 reactors are the best choice"

A major factor for any government considering future power supplies is cost. A detailed financial analysis might help identify which type of power plant and fuel is most economical, but such an analysis has limitations. For example, comparing nuclear power with electricity produced by fossil fuels is an exercise in comparing the high initial capital cost of nuclear with fossil fuels' long-term supply costs. A 2004 Canadian Research Institute study comparing lifetime costs for a gas-fired and nuclear plant, both operating as base load[4] in Ontario, showed the fuel cost of the gas-fired plant comprised 77 per cent of the total electricity cost while it was just four per cent for a CANDU reactor (Ayres, MacRae and Stogran, 2004).

Electricity cost estimates over a power plant's lifetime must assess construction cost and schedule performance, how much electricity will be produced over the life of the investment, the cost of fuel and the effective cost of money over the same period. International studies (International Energy Agency, 2010) have shown that the range of probable electricity costs is similar for fossil fuels and nuclear – with higher costs for wind and solar power.

History shows that we do not have a good record of predicting fuel prices or the cost of money even one year ahead, never mind the decades-long lifetime of a generating station. Hence, estimates of future electricity costs are based on a collection of uncertain assumptions. Financial analyses are useful pointers, but the final decision is inevitably a judgment.

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[1]"Nuclear generators have accounted for some half of electricity production in Ontario for many years, approximately 55 per cent in 2011.

[2]Darlington has four CANDU reactors, each 878 MW, built by Ontario Hydro between 1981 and 1993 and now operated by Ontario Power Generation. These are the most recent nuclear units built in Ontario.

[3]CANDU is a registered trademark of Atomic Energy Canada Ltd. (AECL) and stands for CANadian Deuterium Uranium. It is a pressurized heavy water (deuterium oxide) cooled and moderated reactor first designed in the 1950s by a joint team of AECL, Canadian utilities and Canadian industry.

[4]A "base load" generator is one that is chosen to operate continuously at close to its maximum capacity.

NUCLEAR POWER POST-FUKUSHIMA

After last year's Japanese tsunami and nuclear power plant disaster, the Canadian Nuclear Safety Commission established the Fukushima Task Force to study safety implications for Canada. Its report concluded that Canadian nuclear plants are safe and the CANDU design "ensures that there will be no impact on the public from external events that we regard as credible."

Meanwhile, as part of its review for the Darlington site, the Canadian Environmental Assessment Agency Joint Panel also commented on events at Fukushima. The panel's report concluded that more units are "not likely to cause significant adverse environmental effects."

Detailed technical assessments of the events at Fukushima will continue for some time by Japanese and international organizations. Canadian engineers are involved in many of these reviews, and their experience will be incorporated in the detailed operation of all Canadian reactors.

However, we need to keep in mind that the geological conditions at Fukushima on the edge of a very active tectonic plate are very different from those at Darlington.

"low-interest rates advantageous for high capital-cost projects now"

COST CONCERNS

The first Darlington project is an example of how construction costs can run amok. However, the bulk of the cost increase can be attributed to political decisions that several times stopped and then re-started the construction of a high capital-cost project in a period of double-digit inflation. Furthermore, construction costs were not capitalized until the start of electricity production. As a result, interest accumulated during construction and the delays cost $6.2 billion or 43 per cent of the total $14.33-billion construction cost (Horton, 2009). Today's low-interest rates offer a good opportunity to build high capital-cost projects such as nuclear plants.

Despite the high cost of nuclear power plant construction, Ontario has benefitted from relatively low electricity prices since the plants became operational in the 1970s. Similarly, it should be noted that France has not been at an economic disadvantage by relying on nuclear power for some 75 per cent of its electricity. Indeed, electricity is also France's fourth largest export, and it exports nuclear power to Germany, Italy, the U.K., Belgium, Spain and Switzerland.

After the province signaled its intention of building new reactors at Darlington, it received unexpected high bids that have led to delaying a decision (Ontario Ministry of Energy, 2009). While the details of the bids have not been made public, it appears that the high prices resulted from bundling the related infrastructure, as well as the lifetime fuel and decommissioning costs with the power plant construction cost. The Canadian Nuclear Society Bulletin at the time editorialized that, "Many people around the world are wondering how Ontario made such a big mess of the bidding process (Fluke, 2009)."

TECHNOLOGY OPTIONS FOR NEW REACTORS

In meeting its future energy requirements, Ontario can choose from several different nuclear technologies, one of which, the CANDU, was developed in Canada and is Canadian owned. All the nuclear generating stations in Canada use CANDU reactors, as do units in Argentina, South Korea, Romania, India and China.

Along with various CANDU designs, the other choices for new reactors at Darlington are the EPR and the AP1000, both of which are variations of pressurized water reactors (PWR) that use enriched uranium. None of the designs are in commercial operation but have evolved from extensive operating experience.

The EPR (1,600 MW[5]) is a PWR offered by Areva, the French government nuclear power multinational. The AP1000 (1,150 MW) is a product of Westinghouse, which is now owned mainly by Toshiba. Both of these designs are under construction.

There are three designs for CANDU reactors. The ACR-1000 (1,200 MW) is an advanced and innovative concept that deviates from previous CANDU designs by using slightly enriched fuel. It requires further development, and it appears unlikely that there will be funds available to complete this work in time to produce power when the units at Pickering are closed. The CANDU 9 (925 MW to 1,300 MW) is based on a single unit of the operating Darlington station. The Enhanced CANDU 6 (740 MW) has its pedigree starting with the Pickering A generating station in the 1970s, a design adopted by other units in Canada and elsewhere. It incorporates experience from refurbishing CANDU units, some features from the ACR-1000 and is designed to have a longer life and easier maintenance than earlier CANDU models

LONG-TERM CANDU BENEFITS

"over 150 Canadian companies supply equipment for CANDU"

Beyond meeting Ontario's electricity supply requirements, the Enhanced CANDU 6 nuclear technology would also support Canada's industrial and economic strategies. PWRs are imported designs from manufacturers whose priority is to fill their own factories. In contrast, CANDU was designed to utilize local manufacturing capability, and more than 150 companies, mainly in Ontario and Quebec, supply equipment for CANDU power plants. As well, CANDU natural uranium fuel is manufactured in Ontario, whereas Canada does not have the capability to supply enriched fuel for PWRs so it, too, would have to be imported.

The future security of Ontario's electricity supply is dependent on successfully refurbishing the existing units at Bruce and Darlington. This work will require many experienced staff. On the other hand, designing and building new nuclear plants requires additional skills that are not used in refurbishing. If these additional skills are not used for extended periods, they will not be available when needed. Hence, there is a strong probability that if new CANDU units are not ordered in the near future, the ability of Canada to have an indigenous nuclear design and supply industry will disappear.

The U.K. experience shows how in a similar situation it lost the ability to design and supply reactors and is now dependent on imported designs and equipment. Ordering Enhanced CANDU 6s for Darlington would allow the Canadian nuclear industry to rebuild and have the ability in future to participate in continuing design evolution as well as providing business opportunities in Canada and overseas.

Committing now to build new units at Darlington will allow the operating staff from nearby Pickering to be redeployed once its units are retired. Such operating staff are a valuable asset, with years of training and experience.

[5]Reactor size is specified in megawatts (MW), which is the amount of electricity delivered from the one or more turbine generators attached to a reactor.

Patrick Lamarre, executive vice-president of SNC-Lavalin Group, noted other benefits from commissioning CANDUs for Darlington in a recent speech to the Toronto Board of Trade. Among them, Lamarre said that the Enhanced CANDU 6 can provide competitive generation that will also be much cheaper than renewable energy such as wind and solar.

POTENTIAL RISKS

The CANDU design has a long pedigree, so the risks of not getting good operating performance over a long life are small. Risks are further reduced because Darlington is already operated by OPG, a utility with extensive existing infrastructure and experience with similar designs.

The recent bids for new facilities at Darlington all proposed large reactors of more than 1,000 MW in multi-unit configurations. Because of its smaller size, the Enhanced CANDU 6 would have a lower economy of scale and not result in the lowest cost per unit of electricity. However, it would require less capital investment.

As well, ordering two Enhanced CANDU 6s would not provide the capacity to ensure that Ontario meets its electricity needs under its long-term plan. These units would add 1,480 MW at a time when 3,100 MW will be decommissioned at Pickering. Further choices in a few years' time will decide how this gap can be filled, using either more nuclear units or other fuel sources.

"rebuild capability to pursue business opportunities in Canada and overseas"

A remaining risk is that 10 years have passed since the last CANDU was built in China and even longer since 1993, when the last unit was built in Ontario. The teams involved in these past projects have largely dispersed. The design experience of Ontario Hydro has been disbanded, although the operating experience is still with OPG.

AECL, the federal Crown corporation that developed the CANDU technology, has had problems with cost and delivery on recent work despite having built the CANDU units in China on schedule and under budget. Meanwhile, the federal government last year sold AECL's CANDU design and project work to SNC-Lavalin while retaining ownership of the CANDU technology. SNC-Lavalin has incorporated its purchase as Candu Energy Inc.

SNC-Lavalin already had a nuclear unit with roots in Canatom, a private sector engineering company founded in 1967. Canatom has been the largest sub-contractor to AECL on all CANDU projects outside of Ontario. In Ontario, the traditional Canatom scope of work was carried out in-house by the design and project teams of Ontario Hydro that have now been disbanded.

The future of the CANDU technology will depend on SNC-Lavalin obtaining orders to build new CANDU reactors, as well as its ability to complete these projects within schedule and budget.

CONCLUSION

On balance, the above factors support the entering into immediate negotiations for two Enhanced CANDU 6 reactors for the Darlington site. This is an interim solution that would allow the new team under SNC-Lavalin management to demonstrate its capability not only in Ontario but also to the world nuclear market. In addition, it would provide time to further assess future needs and then develop an appropriate solution.

Implementing this recommendation requires careful sole-source negotiations to ensure that the price is reasonable. The reality is that neither OPG, nor SNC-Lavalin has current experience in negotiating a nuclear power plant contract. Discussions will have to be conducted skilfully to ensure realistic requirements and prices.

Deciding to build the Enhanced CANDU 6 at Darlington is a sound way to maintain a secure electricity supply for Ontario and provide the flexibility of having all options available when new commitments need to be made. It ensures also that an indigenous nuclear industry will remain available to supply Canada's energy requirements.

"a sound way to maintain a secure electricity supply for Ontario "

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