The State of the Nuclear Industry in Canada and Abroad

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Presentation to the Standing Committee on Natural Resources of the House of Commons of Canada

October 2009

Introduction

This presentation is divided into four main parts. In the first part, I examine the factors that determine the economic competitiveness of nuclear power. In the second part, I examine what factors will determine whether the widely predicted Nuclear Renaissance will actually occur. In the third part, I examine the key markets worldwide for nuclear power and in the final part, in the light of this analysis, I will examine the prospects for sales of CANDU reactors worldwide.

Economic Competitiveness of Nuclear Power

While decisions on whether to order new nuclear plants will be taken on a range of considerations, not just economics, it is important to have as clear a picture of the economics of nuclear power as possible so that the nuclear option can be properly evaluated against other choices. As a rule of thumb, it is generally assumed that about 70% of the kWh cost of electricity from a nuclear plant is accounted for by the fixed costs of building and finance, so I will focus on the determinants of these fixed costs. There are three elements that make up the fixed cost: construction cost, cost of borrowing and annual plant output (reliability).

Construction Cost

Ten years ago, when the new designs that it is hoped will form the basis for the Nuclear Renaissance were first mooted, the nuclear industry confidently predicted that they could be built for US$1000/kW so that a typical 1200MW plant would cost US$1.2bn. This was far below most experience in the 1990s and this prediction has proved unrealistic. Cost estimates for proposed new US plants seem to be clustering around the US$5000/kW, while if press reports of the Ontario bidding contest for new nuclear capacity held in summer of 2009 are correct, the current price is US$7000/kW or more. These estimates are all in advance of any construction and, historically, such cost estimates have almost invariably been an underestimate of actual costs. The one plant of modern design that has significant construction experience, Olkiluoto in Finland, was reportedly about 75% over-budget in summer 2009. The plant is nearly 4 years from completion on current estimates so there is significant scope for further cost escalation. The instability of the US dollar means it is difficult to turn the latest Euro price (€5.2bn for a

1600MW plant) into a dollar price accurately, but the latest cost estimates are consistent with a cost of US$5000/kW.

Cost of borrowing

The cost of borrowing is difficult to generalise on as it depends strongly on the credit-worthiness of the customer and the role of competition in the electricity system the plant will feed into. In the past, financing nuclear power plants was cheap and easy because consumers took all the risk. Whatever costs were incurred were passed on to consumers so the risk of default was negligible. One of the prime motivations for electricity liberalization was to make utilities more financially responsible for their investment decisions by stopping this automatic cost pass-through.

Now, in most markets in Europe and North America, this assumption of cost pass-through does not apply either because electricity is bought and sold via competitive markets or because regulators are no longer willing to allow cost pass-through where utilities have not controlled costs well enough. This makes nuclear investment very risky and, for example, there is now a significant risk that the owner of the Olkiluoto plant will default on the loan. The privatised British nuclear company, British Energy, collapsed in 2002 because its costs were higher than the income it received from the wholesale electricity market. The cost of borrowing will, if finance is possible, be very high for such markets. In markets such as India and China, where cost pass-through is likely to apply and capital might be readily available, this is much less of an issue.

Reliability

In the past, the reliability of nuclear plants has been much poorer than predicted by the reactor vendors and utilities, and while the record of Canadian CANDU reactors was good up to the mid-80s, the problems that will be well-known to the Committee that led to long-term closures of some units has meant that the output of the CANDUs in Ontario has been far below expected levels. Worldwide, reliability levels have improved significantly from a world average capacity factor – annual output of a plant in kWh as a percentage of the maximum possible annual output – of about 60% in the 1980s to about 85% now. Reliability of new plants cannot be assumed, but it seems the risk of poor reliability is lower than it was.

Conclusions on economics

Many cost estimates for nuclear electricity are based on unrealistic assumptions on construction cost and on a cost of borrowing that does not reflect the economic riskiness of nuclear investments. In many cases, the assumed construction cost and the cost of capital are a half or less of more realistic values. More rational assumptions could easily triple the generation cost these estimates would produce.

Will the Renaissance occur?

The premise of the Renaissance was that there would be new designs of nuclear power plant (so-called Generation III+), evolved from existing designs, but for the first time, taking full account of lessons from Browns Ferry, Three Mile Island and Chernobyl, which would be cheaper and quicker to build, safer, would produce less waste etc. These would persuade countries in Western Europe and North America, such as USA, UK, Italy and Germany, that seemed to have permanently abandoned the option of new nuclear plants, to restart ordering. No orders have been placed yet in ‘Renaissance’ countries and the only firm orders for Gen III+ designs are from China (6 units), Finland (1 unit) and France (1 unit) and of these there is negligible experience yet in China, some (very bad) experience in Finland and after 1 year of construction, the French unit was more than 20% over-budget.

When the US programme to re-launch nuclear orders was instigated in 2001, it was forecast that at least one unit would be in operation by 2010. It now looks likely that construction on new orders in the USA

will not be before about 2013 because the new designs have yet to receive regulatory approval so, at best, the Renaissance will be very late. These US orders will only be placed if the Obama administration is willing to cover 80% or more of the construction cost with Federal loan guarantees. If the programme of subsidizing 3 units of each of the 5 new designs being considered by the US safety regulator is granted, this could require guarantees worth about US$120bn. The Congressional Budget Office estimates that the default rate could be about 25% which would leave a bill to US taxpayers of about US$30bn. In the UK, the government is adamant it will not provide subsidies for new nuclear orders but the utilities, who had previously suggested orders without subsidy would be possible, are now becoming nervous and are lobbying, for example, for a guaranteed Carbon price and a consumer levy to pay additional costs. If the UK and US governments do not provide subsidies, orders are unlikely and if these two important markets do not materialize, orders elsewhere in the West are much less likely. If orders are placed in the UK and the USA, it might prove no more than that governments can get nuclear plants built if they are willing to provide large enough subsidies. This will not be the demonstration of the virtues of Gen III+ designs the nuclear industry needs.

Key markets for nuclear power

There are 4 key markets nuclear vendors must open up for the Renaissance to happen: USA, UK, China and India. The USA and UK markets are of symbolic importance and the Indian and Chinese markets could provide a large enough volume of orders, if won by non-indigenous suppliers, to allow the nuclear industry to rebuild some of the capabilities it lost in the long period since ordering rates were high.

The USA and UK were the pioneers of civil nuclear power and still have strong influence over other markets as a result. The very bad economic experience with nuclear power in both countries seemed to mean that new orders would not be possible. So to convince these two countries to give nuclear power one more chance would be a considerable coup for the nuclear industry. The symbolic importance of the Indian and Chinese markets is much lower. China is building 21 of the 55 nuclear plants worldwide under construction or firmly ordered. Whether it can sustain this rate of ordering and whether these plants will be built to time and cost remains to be seen. Plants have been built mostly to time in China in the past but there is no independent data on costs. Of the 21 units ordered by China, 15 are being supplied by Chinese companies based on a 1970s French design. China has ordered CANDUs in the past but China's policy seems to be to investigate all nuclear technologies and then supply the options it chooses from indigenous companies. So the international companies that are successful in China are likely to get no more than a few orders before Chinese suppliers take over and China would order few, if any, units from Canada if it did opt for CANDU technology.

India's experience is very different and its history with Canada will be well-known to the Committee. Its civil nuclear programme has been plagued by delays, unreliability of plants and cost over-runs. How far this was due to problems with Indian capabilities and how far it was due to the use of a very old Canadian design is hard to tell. The projections from the Indian government of a huge number of orders for India are implausible and the Indian nuclear industry will fight hard to ensure that a large proportion of any orders that are placed are for Indian designs. Orders for CANDUs seem highly unlikely.

Prospects for CANDU sales

Part of the UK's and the USA's policy to re-launch nuclear ordering was to give generic safety approval to several Gen III+ designs, so that utilities could choose from a range of designs. CANDU, in the form of the ACR-1000 was submitted to both processes but was withdrawn from them at an early stage. This means sales of CANDUs in the USA and Europe in the next decade are implausible apart from the possibility that a unit from the 30 year old order from Romania could be firmed up (using an old design, CANDU-6. Outside Europe and North America, CANDUs have been sold to China, Korea, Argentina,

India and Pakistan (for a design that even pre-dates the Indian orders). As argued above, further orders for China and India seem unlikely; Korea has developed a US PWR design for its home market to be supplied by a Korean vendor and will not import units. The Pakistan market is small and problematic from a proliferation point of view and Pakistan will probably continue to buy the few plants it orders from China while Argentina has been unable to complete construction on a plant (a German heavy water design) it ordered 30 years ago so orders there will be few.

Exports of CANDU reactors beyond one or two for the old designs, are only likely to be possible if the new design, ACR-1000, can be demonstrated to be competitive and reliable in Canada. This summer's bid by AECL for a CANDU was reported to be about US$10,000 per kW, a prohibitively high price. One of the factors behind this very high price was reported to be that AECL (unlike Areva NP, the other bidder) had factored into the price, as it was requested to do, that it would assume some of the construction risk. It was not specified what risks were covered and in what way, but this clearly reinforces the message that nuclear power orders are economically highly risky and the cost to whoever bears the risk will be high and will be paid ultimately by the public. If vendors, rather than taxpayers and/or electricity consumers are required to bear this risk, it will significantly increase the quoted cost. Whether Canadian taxpayers and electricity consumers are again going to bear this risk, if vendors are unwilling, is for the Canadian people to decide but a decision to opt for new nuclear orders does have opportunity costs. Nuclear programmes tend to absorb a very high proportion of the available R&D funds and, equally important, they absorb political resources and attention. In short, if a nuclear programme is chosen, renewable and energy efficiency options, which would appear far less risky and probably more cost-effective, are likely to be neglected.

The suggestion that countries must pursue all options if they are to make their contribution to combating climate change is often made but it is not realistic. Countries do not have the resources to pursue all options: difficult political choices have to be made aimed at ensuring that we pursue the best options available now and that we create new options for the future. If nuclear power is chosen on the basis of over-optimistic cost assumptions, the direct costs will be high, but the opportunity cost of not pursuing the best options will be much higher.