



THE ENERGY
ROUNDTABLE

The Energy Roundtable

A sustainable nuclear future?

Toronto, Canada November 27, 2007

www.energyroundtable.org

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Introduction

Launched by industry in 2004, The Energy Roundtable is a forum where senior executives and government officials discuss the major drivers of investment required to develop the Canadian energy sector. A key concern of the Energy Roundtable is the future role of Canadian energy resources and the geopolitical and economic implications of foreign investors shifting increasingly to the Canadian market. This is addressed by organizing forums where senior executives discuss strategic industry issues in efforts to generate best outcomes solutions. Representatives from more than 100 companies participated in the most recent gathering on November 27, 2007 in Toronto. This occasion marked the first time that The Energy Roundtable hosted discussions specifically on the Canadian nuclear sector, in efforts to promote this vital industry and its supporting infrastructure. This paper provides an overview of the key outcomes from the discussions.

The nuclear picture

Nuclear energy in Canada is a \$5B/year industry that includes 150 firms and \$1.2 billion in exports and growing. Nuclear generates about 15% of Canada's electricity and over half of Ontario's. It directly employs about 21,000 people and another 10,000 indirectly in industry, government and other organizations involved in the nuclear field. 62% of the Ontario public support nuclear energy according to an Ipsos Reid poll commissioned by the Canadian Nuclear Association in July 2007. The report produced the following conclusions:

- Nuclear power is ranked fifth in preferred energy sources (after renewable energy sources and natural gas), but ahead of coal which accounts for the next largest component of Ontario's energy mix after nuclear.
- Support for nuclear energy is up 15% since May 2005, and has leveled in the past 18 months.
- 44% believe nuclear should play more of a role, versus 25% who say less and 29% who say it should stay the same.
- 62% of Ontarians are also worried that there will not be enough energy in the future. That is, conservation efforts alone will not be sufficient.

Renewable energy sources, largely due to their itinerant nature and susceptibility to NIMBYism, and natural gas due to a limited future supply, will not alone be enough to meet Canada's energy needs.

Amongst provinces, Ontario, New Brunswick and Alberta are the most supportive of nuclear power. In these areas there is either substantial nuclear capacity or plans for future new builds. Alberta views nuclear as a potential solution to reducing carbon emissions in the oil sands, which have risen dramatically in the past few years. The Canadian population is generally aware of the benefits and risks that nuclear energy is perceived to bring. In general, support for continuing with the use of nuclear power is evident, while predictably, there is a NIMBY contingent with the majority of respondents preferring refurbishments of existing facilities to new builds.

Given the prominence of the environment as a concern to the average Canadian, despite public concerns over the costs and safety of nuclear energy (notably, with regards to the disposal of waste) it is enjoying increasing popularity as a reliable source of electrical power that does not increase CO2 emissions, the primary green house gas responsible for global warming. Nuclear is also cited as an energy source with a low impact on air and water pollution. In essence, Canadians realize that a diverse future energy mix that includes nuclear, despite its perceived risks, outweighs the risks posed by climate change. While energy is generally not an issue Canadians think much about, climate change is. Energy and environmental risks are emerging as issues that are considered in tandem. As such, there is emerging support for increased taxation on carbon emitting activities and industries which would provide a substantial boost to the cost competitiveness of nuclear energy versus fossil fuel generated power.

The global expansion of the nuclear industry is projected to be rapid and sustained over the next 50 years, with plans for several new reactors globally. If Canada wants to be part of this massive growth industry, in addition to meeting its own energy and environmental needs, decisions on the future of the Canadian nuclear industry must be made as soon as possible.

Canada as a centre of nuclear excellence

As Canada—and in particular Ontario—embarks on making urgent and important decisions on the future electricity generation supply mix, it becomes even more important that the contributions of nuclear energy are well understood. Our society is grappling with the challenges of supplying its citizens with reliable, affordable electricity without harming the environment. Nuclear energy will be even more important in helping us reach our economic and environmental goals. It continues to be one of the best enablers by which Canada can reduce its greenhouse gas emissions and has for 45 years in Canada enjoyed an excellent safety record.

Canada has the world's largest known high-grade natural uranium deposits in Saskatchewan, producing more than a quarter of total world production from its mines. Saskatchewan's McArthur River and Cigar Lake deposits are the world's richest, with average ore grades more than 100 times the global average for uranium mines. That energy is equivalent to that provided by 18 billion barrels of oil or 5 billion tonnes of coal. Canada also provides half of the global supply of medical isotopes for nuclear medicine, that are used in 18 million medical procedures a year, and supplies 75% of the world's cobalt-60 used to sterilize 45% of the world's single-use medical supplies. Even with this high level of nuclear activity, the total amount of nuclear waste produced in 45 years from nuclear power plants in Canada would fill 5 hockey rinks up to the height of the boards.

Given that Canada has a strong position in uranium mining and a strong position as a developer of nuclear technology, the country is well-placed to serve as a global centre of excellence for the expanding nuclear energy sector. Ontario, in particular, has the opportunity to establish itself as a centre of excellence capable not only of meeting domestic demand for nuclear energy, but in becoming a major contributor to the extensive activity that will take place in the United States and globally in the coming years. In addition to new builds, this will include skills and training, services, infrastructure and the potential for future application of nuclear energy in replacing coal generated power and also oil used in transport. If we are on the verge of a hydrogen economy, nuclear is one of the power sources that will be instrumental in developing a viable fuel cell industry.

The global supply chain

There were 435 nuclear power reactors in 30 countries at the beginning of 2007. As of January 2007, there were 28 nuclear reactors under construction, another 64 being planned and 158 being proposed, mostly in Asia and Eastern Europe (source: World Nuclear Association). According to SNC-Lavalin, a major Canadian engineering firm, if the Canadian nuclear industry can sell only 2 reactors to international customers, it can increase Canada's GDP by \$1.75 billion. Canada has 10 GW of new or refurbished nuclear generation scheduled by 2025, and new nuclear capacity of 1.4 – 3.4 GW scheduled to come on-stream by 2018. Yet there is a great deal of uncertainty as to the scope and magnitude of the work required in the industry, notably, on life extension opportunities on CANDU reactors in Canada.

In the supply chain for nuclear grade materials and components, a large lead time is required to overcome sporadic demand. There are also very high quality standards and assurance demands and worldwide there are limited sourcing options. There will also be competition from the US for these resources, as it is predicted that in that country 80 applications for extensions on 103 existing reactors and a further 32 more new build applications will be filed in the next 20 years. Over the same period of time China expects to add a massive 120-160 GW, and India and Russia are also planning significant extensions of their nuclear facilities. In total, the IAEA predicts 60 new builds

around the globe in the next 15 years, with up to 500 plants and 374 GW of nuclear power currently on the drawing board.

If Canada can maintain its current 10% share of the global nuclear market, this will translate into an additional 37 GW of new capacity, generating 415,000 person-years of employment and upwards of \$34 billion in additional GDP growth. Canada has the capacity to deliver the entire supply chain for nuclear energy, from uranium in the ground to energy on the grid, but must be careful not become just a consumer of nuclear power, but a producer of nuclear power. Ontario, with 90% of the Canadian nuclear industry, should be at the forefront.

Canada must define its place in the increasingly global nuclear industry. For example, standardization developments, such as on safety provisions for nuclear new builds, will have an added effect of providing Canadian subcontractors with access to international export opportunities. A vibrant Canadian nuclear sector incorporated into global supply chains will also provide access to manufacturers of nuclear grade components and materials, requirements for decommissioning and safe storage, as well as competition for resources from an expanding oil and gas industry. Qualified manpower and training will be central to meeting these challenges.

The Bruce A restart taught the nuclear industry a number of lessons. There is a heavy demand on project management, engineering and trades resources. Utilities in Canada are also facing the resource challenges to maintain existing facilities, as significant portions of the staff are eligible to retire in the near future. If all the current applications to CNSC to prepare a site in Canada go ahead, a total workforce of 12,000 workers could be required as early as 2016. In addition to impeding retirement, additional manpower challenges include losses to other industries, to other countries and of export opportunities. Meeting the labour demand will require a significant increase in funding for skills-based immigration, higher education and trades.

Regulatory and procurement strategies

Some roundtable participants felt that the permitting and licensing procedures for new builds in Canada are lengthy overly complicated and should be streamlined. OPG estimates that the earliest that the first unit will be in service for its planned Darlington B project (4800 MW of capacity) as being no earlier than 2018, even though the technology selection process, environmental assessment and site preparation have already commenced. The US provides a useful comparison, having recently overhauled its regulatory framework for nuclear energy and becoming a more active advocate for the nuclear industry.

The US passed the Energy Policy Act of 2005 that provides tax incentives and loan guarantees for energy production, including nuclear power. It provides for a single step Design Certification licensing process for a Nuclear Plant Design. In Canada, the CNSC uses a multi - step individual site based process, which increases delays and risks. The CNSC steps are as follows:

1. License to prepare the site.
2. License to construct.
3. License to operate.
4. License to decommission.
5. License to abandon.

Additionally, the application for Site License triggers an environmental assessment, which needs to be successfully completed before the next step Construction is approved. In the US, the Department of Energy provides financial support - up to 50% for the development costs of unlicensed reactors. No such support is provided in Canada. A production tax credit is offered in the US of up to \$125 million per year for the first 8 years of operation for the first 6000 MW of capacity. Again, no such tax credit is offered in Canada. The US also offers standby support, which is an

incentive for new plant development that offsets the financial impact of construction delays beyond industries control. This mitigates risk to investors and spurs new investment. Finally, Americans have a loan guarantee programme for up to 80% of the projects that use innovative technology, including nuclear energy.

Given the risk inherent in the nuclear permitting process, the more clarity and encouragement that the government can provide at both the Provincial and Federal level, the better the chance that Canada will capitalize on its nuclear advantages. The Canadian government could be a more active advocate for nuclear power, as is occurring in the US. Nuclear power's contribution to energy security and carbon emissions reductions are strong arguments in this regard. Established nuclear facilities provide a strong economic multiplier, generating long-term, high paying jobs and significant industrial infrastructure.

There has only been one procurement method used to date throughout the world on new nuclear, and that is cost-of-service regulation. If it is not done under cost-of-service regulation, new nuclear is likely to be a heavily negotiated Public/Private Partnership. There could theoretically be a contract model or a competitive procurement, but these have never been tried and therefore, there is not any evidence of "success" available for these approaches. Either way, there is no reason to believe that the necessary capital and procurement strategies can not be developed to bring new builds to fruition. Furthermore, an established carbon price for fossil fuelled power plants will more accurately reflect the cost competitiveness of nuclear power.

Environment

Support for nuclear energy has rebounded in recent years, due largely to recognition of the role that it can play in mitigating climate change. British Prime Minister Gordon Brown believes greenhouse gas emissions will need to be cut in half by 2050, ensuring that \$22 trillion of new energy investment over the next 20 years contributes 'more to its [climate change] solutions than its causes'.

Nuclear energy does not pollute the air, produces virtually none of the pollutants that contribute to smog and acid rain and produces virtually no greenhouse gases. By using nuclear energy to produce electricity in Canada the emission of about 90 million tonnes of greenhouse gases per year is avoided, or about 12% of Canada's total greenhouse gas emissions. To date, Canadian power reactors have avoided the emission of more than 1 billion tonnes of GHGs. Nuclear generated electricity further avoids the emission of an additional 10% of smog and acid rain-producing gases. Canada's energy demand is projected to increase by 34% by 2025, creating an increased requirement for reliable, clean electricity. A number of independent studies have shown that life-cycle emissions for nuclear power plants—including construction, operations, fuel production, decommissioning and waste disposal—are not greater than other non-emitting generation systems such as hydro and wind. Rising uranium prices have fuelled a dramatic increase in exploration for uranium in Canada and around the world to meet anticipated future demand. About half of the workers at Canadian uranium mines are aboriginal, providing further social benefit.

Exploration firms have complained that some of their oil sands initiatives are stalled because Ottawa has failed to put a price on future carbon emissions. The same sentiments are being voiced by power producers; perhaps most vocally, by the nuclear power industry. A carbon price, generated through a carbon tax or established via an emissions trading regime are options that enjoy increasing levels of public support in Canada and would provide added incentive for the development of new nuclear facilities.

Industry consolidation

Since the 1980's, the global nuclear industry has consolidated into a handful of reactor providers. The Canadian nuclear industry is the only significant nuclear player to not have participated in this

consolidation, resulting in a potential scale disadvantage for AECL, the only major producer to have remained entirely independent. However, through the formation of Team CANDU, AECL has established an industrial partnership that involves some of the largest companies with nuclear experience in the world. A further important point is that most build entities are independent of the research and legacy liabilities, with AECL being a notable exception. For annual government nuclear research lab funding, Canada is amongst the lowest.

In terms of new builds, AECL has promising new technology. Critical to the future of any new technology, will be the commitment to a FOAK project, a decision which now rests with Canadian utilities and is dependent on the support of the Government of Canada.

A number of key questions remain for the Canadian nuclear industry. As the global nuclear industry continues to restructure, will Canada participate, and if so, in what part of the supply chain? How can Canada best exploit its advantages, such as a well-established nuclear infrastructure and knowledge base and a unique reactor technology with extensive experience of on-time and on-budget delivery? How will Canada benefit from the global nuclear resurgence? If Canada remains a player, how will Canada fund legacy liabilities and ongoing research? With or without a partner, how will AECL restructure to achieve commercial imperatives? Will governments align federal restructuring decisions and provincial power technology decisions, and will these decisions be made fast enough, or will Canada miss the boat? The answers to these questions are vital if Canada is to continue to assume a role as a lead nation in the global nuclear industry.

Conclusion

The key decisions required to commence new builds are lagging – some say it is already two years too late. In turn, the life of coal plants will likely need to be extended, and additional natural gas plants will likely need to be built to compensate for the increased time before new nuclear power facilities come on-line. Given the resources that will be needed for the planned new builds in the US and globally, Canada should commence with new builds so as to ensure that the necessary engineering and labour capacities are secured.

Firms wanting to participate in the expansion of the Canadian nuclear sector are clearly interested in domestic opportunities, but are also looking to incorporate into supply chains for the larger volume of projects planned for south of the border and abroad. Simplifying regulatory structure, finalizing decisions on refurbishments and new builds and articulating a future for AECL in a period of global industry consolidation will provide the basis for the future growth of the Canadian nuclear industry. These decisions will also help define the role that Canada will play within the emerging global supply chains. This is an opportunity to important to be missed.

Annex I: Programme - 2007 Nuclear Roundtable: A sustainable energy future?

Tuesday, November 27, 2007

Blake, Cassels & Graydon LLP, 199 Bay Street, 23rd Floor, Commerce Court West, Toronto, ON M5L 1A9

8:30 Registration and continental breakfast

9:00 Opening remarks – **Duncan Hawthorne**, President & CEO, Bruce Power

9:20 Panel Discussion I: Industry challenges

- **Jim Rippon**, President, AMEC NCL: *Construction and engineering capacity*
- **Armand Laferrere**, President, AREVA Canada: *Public acceptance of nuclear energy*
- **Patrick Lamarre**, President, SNC–Lavalin Nuclear Inc: *Enviro-economic benefits of nuclear power*

10:45 Break

11:00 Panel discussions II: Economic and market conditions

- **Paul Bradley**, Managing Director, PJB Energy Solutions: *Procurement and public private partnerships for nuclear power*
- **Patrick McNeil**, Senior Vice President, Generation, Ontario Power Generation: *New builds in Ontario*
- **Kenneth Smith**, Chair, Secor Consulting: *Competitive structure for nuclear renaissance*

12:15 Lunch with keynote address by:

- **Dr. Dave Torgerson**, President, Research and Technology Division & Chief Technology Officer, Atomic Energy of Canada Ltd.: *New markets for nuclear*

Conference Chair: **Robert Power**, Chair, National Energy Practice, Blake, Cassels & Graydon LLP

Annex II: Delegates list – 2007 Nuclear Roundtable

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| Shiro | Akahori | General Manager, Power and Industry Division | Hitachi Canada Ltd. |
| Neil | Alexander | Director of Business Development and Marketing | Babcock and Wilcox |
| Jane | Allen | Partner, National Leader, Power & Utilities | Deloitte Inc. |
| Steven | Andrews | Consultant | Borden Ladner Gervais LLP |
| Nicholas | Armour | Director UK Trade & Investment Canada | British Consulate General Toronto |
| Gabe | Balog | Vice President, Technical Support Services | AMEC NCL |
| Harold | Bartlett | Business Representative | L.I.U.N.A. Ontario Provincial District Council |
| John | Beck | Chairman & Chief Executive Officer | Aecon Group Inc. |
| Chris | Benedetti | Vice President | Sussex Strategy Group |
| Steven | Beswick | Senior Vice President | Marsh Canada Limited |
| David | Biette | Director, Canada Institute | Woodrow Wilson International Center |
| Dave | Birgenheier | New Business Development Engineer | Hayward Tyler Inc. |
| Geoff | Birkbeck | Chief Executive Officer | Comstock Canada Ltd. |
| Paul J. | Bradley | Managing Director | PJB Energy Solutions Inc. |
| Scott | Brownrigg | Senior Associate | Sussex Strategy Group |
| Michael | Bruni | Executive Manager Energy Team | Alberta Energy & Utilities Board |
| David | Butters | President | Association of Power Producers of Ontario |
| Jason | Chee-Aloy | Manager, Generation Development | Ontario Power Authority |
| Jordan | Chou | President & CEO | Canadian Power Utility Services Ltd. |
| Jim | Christie | Chairman | Blake, Cassels & Graydon LLP |
| David | Claggett | Vice President | Kiewit Energy Canada Corp. |
| Bruce | Clarida | Manager, Special Projects | Peter Kiewit Sons Co. |
| Jerry | Cuttler | President | Cuttler & Associates Inc. |
| Ron | Deyholos | Partner | Blake, Cassels & Graydon LLP |
| Frank | Didomizio | Fuel Handling Sales Manager | GE-Hitachi Nuclear Energy Canada Inc. |
| Steve | Dorey | Vice President, External Relations | Hydro One Inc. |
| Ernie | Downes | VP Business Development | E.S. Fox Ltd |
| Joe | Dymek | Vice President Marketing, Energy Division N.A. | Nexans |
| Aaron | Engen | Managing Director, Investment & Corporate Banking | BMO Capital Markets |
| Rick | Firlotte | President | Golder Associates Corporation |
| E. Spencer | Fox | President | E.S. Fox Ltd |
| Michael | Gabbani | VP Fuel Sales GE Hitachi Nuclear Energy Canada | GE Hitachi Nuclear Energy Canada |
| Rick | Goodman | President & CEO | Merlin General Corporation |
| Finn | Greflund | Vice President, Business Development | TransCanada Energy Ltd. |
| Andrew | Grieve | Director, Business Development | Kinectrics |
| Jason | Haas | Development Manager | Ganotec |
| John | Hawkes | Strategic Planning and Growth | HHAngus and Associates |
| Duncan | Hawthorne | President & CEO | Bruce Power |
| Robert | Haylor | Director - Sales Network Ontario | Alstom Canada |
| Helen | Hemmingsen | Trade Officer | British Consulate General |

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| Wayne | Henuset | President | Energy Alberta Corp. |
| Christopher | Hughes | President | Laker Energy Products Ltd. |
| Koji | Ishimatsu | President | MIT Power Canada Investment |
| Brett | James | Principal | Sussex Strategy Group Inc. |
| Michael | Jolliffe | Senior Vice President, Government Relations | AMEC |
| Neal | Kelly | Director - Public Affairs Special Assignments | Ontario Power Generation |
| Jonathan | Khan | Partner | Blake, Cassels & Graydon LLP |
| Hans | Konow | President and Chief Executive Officer | Canadian Electricity Association |
| John | Krasznai | Senior Director, Business Development | Kinectrics |
| Bill | Kurtin | CEO | Plan Energy |
| Armand | Laferrere | President | AREVA Canada Inc. |
| Patrick | Lamarre | President & CEO | SNC-Lavalin Nuclear Inc. |
| Jason | Langrish | President | The Energy Roundtable |
| John | Leslie | Project Management Specialist | SNC Lavalin Inc. |
| Patrick | Little | Business Manager | L.I.U.N.A. Ontario Provincial District Council |
| Don | MacKinnon | President | Power Workers' Union |
| David | MacPherson | Director, Americas | Norman Broadbent |
| Larry | Maloney | Country Executive | ABN AMRO Bank N.V., Canada Branch |
| Pat | Marchione | Vice President, Operations | Wardrop Engineering Inc. |
| Melissa | Mayhew | EA Project Manager | Golder Associates Ltd. |
| John | McDougall | President and CEO | Alberta Research Council |
| Tom | McKee | Partner | Blake, Cassels & Graydon LLP |
| John | McManus | Senior Vice President | Borealis Infrastructure Management Inc. |
| Patrick | McNeil | Senior Vice President | Ontario Power Generation |
| Frederick J. | Miffilin | Partner | Blair Franklin Capital Partners Inc. |
| Duncan | Moffett | Senior Principal | Golder Associates Ltd |
| Ron | Moleschi | VP Corporate Development and Technologies | SNC Lavalin Nuclear Inc. |
| Eric | Morand | Deputy Economic & Trade Commissioner | Embassy of France-Economic Commission |
| Katherine | Moshonas Cole | Managing Director | Candesco Corporation |
| John | Muir | Country Executive - Canada | GE Energy |
| Joseph | Mulhall | President | Canadian Union of Skilled Workers |
| Paul | Murphy | President and CEO | Independent Electricity System Operator |
| Fouad | Mustafa | Vice President, Business Development | Giffels Associates Limited |
| Al | Norsworthy | Director Business Development | SNC Lavalin Nuclear Inc. |
| Richard | Owens | Partner | Blake, Cassels & Graydon LLP |
| Leigh-Anne | Palter | Vice President, Commercial & Regulatory Affairs | EPCOR Utilities Inc. |
| John | Parsons | Account Executive - Energy & Utilities | SAS Institute (Canada) Inc. |
| Harshad | Patel, P.Eng | Section Manager | BC Instruments |
| Xavier | Pietri | President & CEO Dalkia Canada | Dalkia Canada Veolia Energie |
| Robert | Power | Co-Chair, National Energy Group | Blake, Cassels & Graydon LLP |
| Robert | Quinn | President & COO | Comstock Canada Ltd. |
| Guy | Raffaele | Contracts | Ontario Power Authority |

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|-------------|--------------|--|------------------------------------|
| Isabelle | Rayle-Doiron | Director, Legal Affairs Generation | Hydro-Québec |
| Jim | Rippon | President | AMEC NCL |
| Rocco | Sebastiano | Chair, Energy (Power) Group | Osler, Hoskin & Harcourt LLP |
| Oskar | Sigvaldason | Director, Advisory Board | Hatch Energy |
| Terence | Smith | President | O2Z Corporation |
| Kenneth | Smith | Chairman | Secor Consulting |
| Bill | Smith | Vice President | Siemens Canada Limited |
| Cliff | Sosnow | Partner | Blake, Cassels & Graydon LLP |
| Craig | Spurn | Co-Chair, National Energy Group | Blake, Cassels & Graydon LLP |
| Bob | Taylor | Manager | Kiewit Energy Canada Corp. |
| Ralph | Tedesco | President & C.E.O | Nova Scotia Power Inc. |
| John Walter | Thompson | Vice President, Commercial Operations Division | Nuclear Safety Solutions Ltd. |
| Mark | Tonner | Managing Director | GE Energy Financial Services |
| Dave | Torgerson | Chief Technology Officer | Atomic Energy of Canada Ltd. |
| Rick | Vascotto | Vice-President Sales & Marketing | Nexans |
| Apostolos | Vogiatzis | Vice-President | O2Z Corporation |
| Bob | Walker | Executive Member | Canadian Nuclear Workers Council |
| Kevin | Wallace | VP and General Manager | SNC Lavalin Inc. |
| Phil | Welan | Senior Vice President | Plan Energy |
| Howard | Wetston | Chair | Ontario Energy Board |
| George | White | Office of the President -Senior Advisor | Sherritt International Corporation |
| Eric | Williams | President | Canadian Nuclear Society |
| Gerald | Wright | General Manager | National Electricity Round Table |