

December 16, 2016



Ms. Andrea Pastori
Cabinet Liaison and Strategic Policy Coordinator
Ontario Ministry of Energy

RE: EBR Registry Number 012-8840 – Planning Ontario’s Energy Future

Dear Ms. Pastori,

On behalf of the Canadian Nuclear Association (CNA) I am pleased to submit our comments to the Ministry of Energy as part of Ontario’s Long-Term Energy Plan (LTEP) consultation. For your background, the CNA is a non-profit organization established in 1960 to represent the nuclear industry in Canada and promote the development and growth of nuclear technologies for peaceful purposes. Our approximately 100 members reflect the breadth and diversity of the most economically significant industry in Ontario’s electricity sector, including academic institutions, construction and engineering firms, fuel manufacturers, unions, component suppliers, waste management specialists and nuclear plant operators.

The CNA was encouraged by several recent policy statements and documents issued by the government and the Independent Electricity System Operator (IESO) which reinforce nuclear power’s foundational role in Ontario’s supply mix. This includes the Ontario Planning Outlook which reflects the **ten-unit** nuclear refurbishment schedule for Darlington and Bruce agreed upon in 2015, as well as the continued operation of **all six Pickering units beyond 2020**; and the **Speech from the Throne which confirms that electricity ratepayers will realize savings of up to \$600 million as a result of continuing operations at the Pickering nuclear generating station.**

Looking forward, **continued operations at Pickering will avoid up to 17 million tonnes of greenhouse gas (GHG) emissions in the near term**, and refurbishment at Darlington and Bruce will ensure **avoided carbon emission of 30 million tonnes** annually over the longer term. This represents the equivalent of **nearly one-fifth of all emissions in Ontario today**, or the carbon footprint of nearly all of the buildings in the province.

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The LTEP consultation document itself, *Planning Ontario's Energy Future*, includes nuclear in its *Clean Energy Supply* section as well as **notes the significant savings accruing to ratepayers both due to the continuing operations at Pickering**, as well as the optimization of the refurbishment schedule at Bruce which will save ratepayers \$1.7 billion compared to the 2013 LTEP.

Over the past several years, the Government of Ontario has been increasingly supportive of the efforts of Canada's nuclear industry to **promote its products, technology and services internationally**, including Ministers being directly engaged in trade missions and bilateral discussions with prospective export partners. The endorsement and backing of a nuclear technology's domestic governments is critical to inspiring confidence with prospective buyers of Canadian hardware and technical knowledge, and to effectively compete in the global marketplace with other nuclear countries whose national governments strongly assist their export efforts.

The emergence and commercialization of Small Modular Reactors (SMR) has the potential to open up new opportunities and more tailored applications for nuclear energy going forward, and Ontario took an important step in commissioning a feasibility study on the potential deployment of SMRs in the province.

Nuclear energy is also an essential aspect of Ontario's continued leadership on climate change, beginning with the phase-out of coal fired electricity generation which was accommodated in no small part due to the restart of the Bruce A units and Pickering units 1 and 4. **Both continuing operations at Pickering and refurbishing Darlington and Bruce will ensure Ontario has the stable, reliable, affordable and non-emitting foundation to pursue further modernization and decarbonization of the province's electricity system and economy in the decades ahead.**

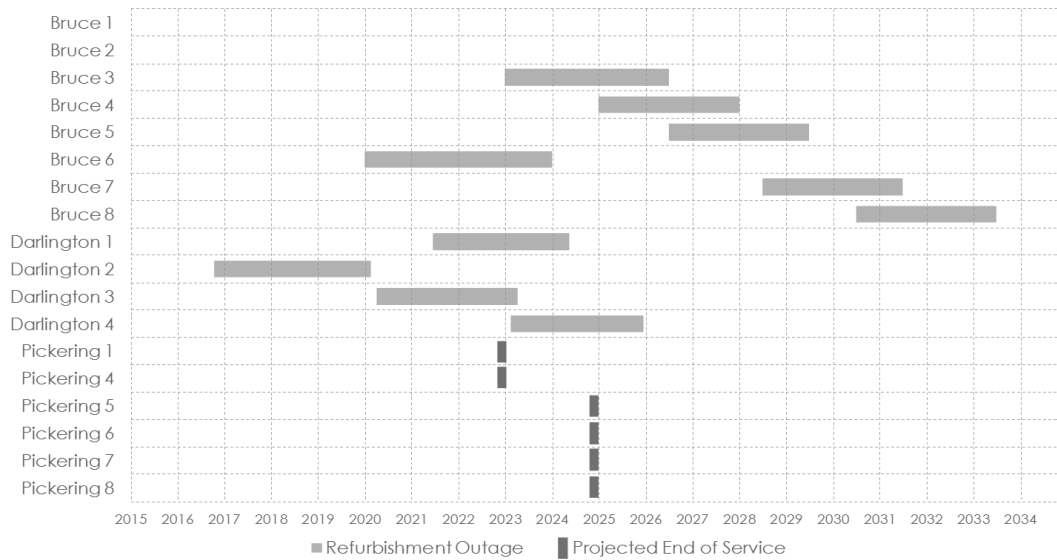
As Ontario looks across the 20-year horizon of the 2017 LTEP, balancing the needs of the economy, the environment, the electricity consumer, and adapting to emerging trends, technologies and uncertain demand growth will continue to present a challenge for the government, the IESO and utilities across the province.

Darlington & Bruce Refurbishment

The CNA believes that after safety, executing refurbishment in Ontario on-time and on-budget should be the primary focus of the nuclear industry over the next several years. **A decade's worth of engineering, analysis, training and planning have prepared Ontario's nuclear operators**, Ontario Power Generation (OPG) and Bruce Power, as well as their world-class workforces and suppliers, **to execute the successful, cost-effective**

In any scenario that may emerge, Ontario's nuclear baseload generating fleet can continue to provide irreplaceable value to the electricity system and to Ontarians; moderating electricity bills, ensuring cleaner air, anchoring a multi-billion dollar industry in Ontario, and directly sustaining thousands of highly-skilled jobs.

refurbishment of the Bruce and Darlington stations. The unprecedented communication and collaboration between the operators and across the sector, guided by the 2013 LTEP nuclear refurbishment principles, has helped the drive toward this goal. We also support adhering to the current nuclear refurbishment schedule reflected in the OPO:



Source: IESO Ontario Planning Outlook, September 2016

This is one of the largest coordinated clean energy investments taking place in the world now. Until the first few refurbishments are completed and those units are back on-line, **sustaining Pickering is particularly important to the province’s goals. As Ontario’s Environment Commissioner has pointed out, anything that were to shorten Pickering’s life would create serious gaps in Ontario’s clean power supply, and its GHG reductions, in the meanwhile.**

Now that refurbishment is underway at Darlington, the LTEP should likewise seek to highlight specific innovations and Ontario companies that are helping to ensure that undertaking, and subsequently Bruce Power’s undertaking, are well positioned for success. The CNA would be glad to work with the Ministry of Energy and our members to find appropriate examples in this regard. **Nuclear refurbishment represents a world-leading clean technology infrastructure investment in Ontario,** and in the future of the province’s electricity supply, with durable, highly skilled jobs and local economic returns that would not otherwise exist.

More than most industries, **nuclear power’s supply chain is concentrated in Ontario, delivering a strong economic multiplier from dollars invested, and is especially highly skill-intensive with long-lasting jobs.** A study conducted by the Conference Board of Canada in 2015 concluded that **the refurbishment of Darlington would contribute \$15 billion** to Ontario’s GDP over the course of the project, with

The nuclear refurbishment program is one of the largest coordinated clean energy investments taking place in the world now, something Ontario should be very proud of. Pickering’s operation to 2023-25 is its foundation.

employment increasing by **an average of 8,800 jobs and peaking with 11,800 jobs between 2014 and 2023**. Operating Darlington post-refurbishment will secure approximately 5,700 resident jobs in Durham Region until the 2050's and annual property tax revenue of approximately \$4 million. A similar study conducted by the Canadian Council for Public-Private Partnerships for the Bruce site in 2015 concluded that during normal operations, Bruce supports 18,000 direct and indirect jobs every year and delivers \$4 billion in annual economic benefit. During refurbishment the site will support an additional 5,000 direct and indirect jobs per year, and contribute an additional \$1.7-2.3 billion in economic benefit annually through direct and indirect spending in operational equipment, supplies, materials and labour income in the province.

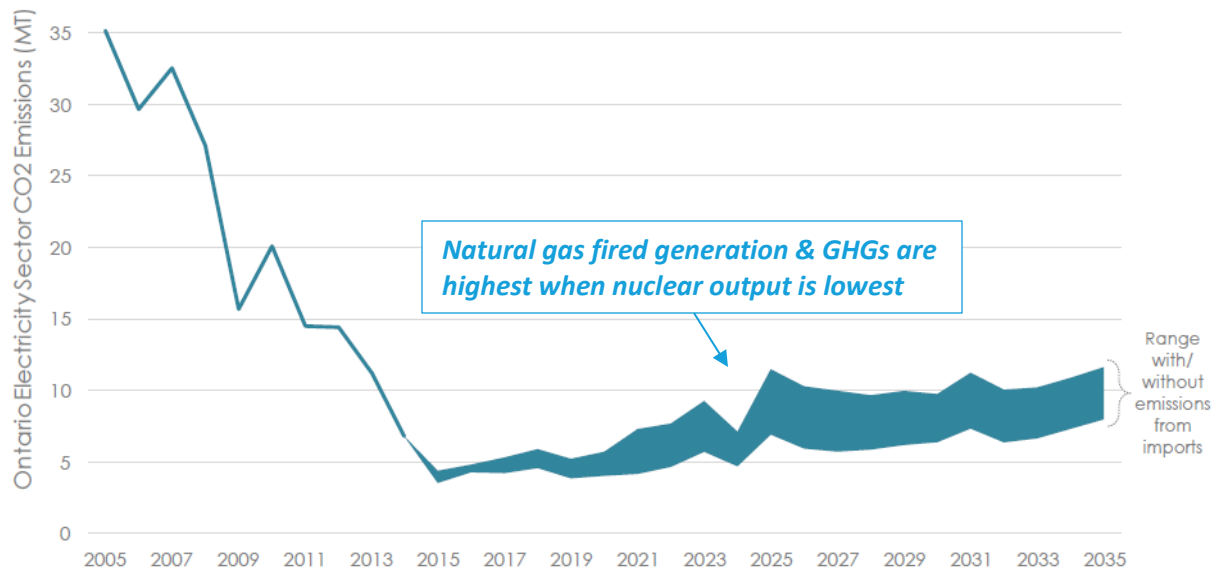
The LTEP is an opportunity to profile the positive impact of these investments economically, environmentally and regionally. **Refurbishment is not as some have suggested a driver of rates, but on the contrary a significant moderator of them**, because while it is capital- and knowledge-intensive, it is very efficient in natural resource consumption, so **the resulting unit power costs are low and stable**.

Ongoing Pickering Operations

The 2016 Mandate letter from the Premier to the Minister of Energy instructed the Minister, through the development of this LTEP, to **maintain focus on the affordability of electricity and GHG reductions. Operating Pickering beyond 2020 accomplishes both**, saving Ontario ratepayers \$600 million from 2020-2024, and directly translating into savings on consumers' electricity bills. Both **OPG and the IESO, having respectively completed a technical and economic assessment, and a system impact assessment of continued operations at Pickering to 2024 have concluded that the proposal provides the greatest benefit to ratepayers and the electricity system.**

Additionally, the 2013 LTEP assumed that a 2020 shutdown of Pickering would result in electricity sector GHG emissions increasing by approximately 60 per cent. Given the refurbishment schedule indicates the most significant overlapping unit outages occur between 2020 and 2025, **generation from Pickering over that period will offset a prolonged decrease in baseload generation from Darlington and Bruce. This will displace natural gas that would otherwise have been burned and would have substantially increased Ontario's GHG emissions.**

Nuclear is a cost-effective hedge against fossil fuel and carbon prices.



Source: IESO SAC, Ontario Supply/Demand Balance to 2035, March 2016

In fact, according to the IESO assessment of life extension options, up to 17 million tonnes of GHG may be avoided in operating Pickering in the period from 2021-2024. This represents the equivalent GHG emissions savings of taking 3.4 million cars annually off Ontario’s roads, and would represent the single largest contributor to meeting Ontario’s 2020 emissions reduction target if it were part of the Climate Change Action Plan (CCAP), as well as being a major contributor to the Government of Canada’s climate change plan and national emissions targets.

These options were further examined by the **economic consultancy Strapolec** in a 2015 study of Pickering life extension, and also in two recent reports for input to the LTEP review process (www.strapolec.ca). The Pickering study finds that extending the plant’s life beyond 2020 lowers GHG emissions, lowers electricity system cost, and creates positive net jobs and GDP.

Looking at the whole power system, Strapolec’s first LTEP report shows that significantly more electricity is likely to be required than contemplated in the IESO’s Ontario Planning Outlook (OPO) and that with the electricity prices documented in the OPO, achieving Ontario’s emissions reduction targets will cost Ontarians \$27B/year. The second report **builds on research into alternative energy solutions and develops an alternative supply mix that** includes substantial new nuclear – 14 GW.

By Strapolec’s analysis, this innovative supply mix **would deliver electricity at half the incremental cost of the OPO options, reduce the economic cost of emission reduction to below \$4B/year, and make Ontario an economic winner** in combatting climate change by enabling significant new globally competitive industrial capabilities. Nuclear’s economic contribution to Ontario is

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enormous and highly skill-intensive. Economically, **Pickering alone employs about 4,500 people and is the largest employer in Durham Region providing up to \$1.3 billion annually in community benefit.** Locally, Pickering likewise has a very active Corporate Citizenship Program which provides charitable and not-for-profit support to over 140 grass roots initiatives on average annually in Pickering, Ajax and Whitby. The plant's community partnerships focus on the areas of environment, education, health and safety, arts and culture, youth amateur sport, humanitarian and local causes, and support for First Nations and Métis initiatives. Continued operations at Pickering will allow this **important community presence** to continue into the future.

The CNA encourages moving forward to secure regulatory approval for ongoing Pickering operation through 2024. Reinforcing that commitment in the LTEP provides an opportunity to highlight just how positive for the environment, the local and provincial economy, electricity consumers and Ontario taxpayers this supply choice is.

Nuclear Innovation & Science

Nuclear innovation and science is essential to the health, safety, and prosperity of every Canadian. That is why Canada and the nuclear industry have a long history of investing in innovation and science. Research initiatives at national laboratories, universities, and research reactors across the country support affordable electricity, product improvements, medical services, training, and other activities. **Nuclear technology plays an important role in almost every technical field across Canada. Nuclear science and technology facilities are thus an integral part of Canada's science, technology and engineering capacity, and a vital support to economic competitiveness.** As home to the vast majority of Canada's nuclear industry, Ontario is well positioned to both show leadership and take advantage of advancements in nuclear innovation and science.

Just recently, Bruce Power successfully harvested 24 Cobalt-60 rods during the planned maintenance outage of one of their units, which will provide benefit to hospital patients around the world. The Cobalt-60 will be shipped to Nordion, an Ottawa-based company which produces **radioactive sources that are used to sterilize 40% of the world's single-use medical devices** such as gowns, gloves, masks and syringes, and certain food products. Over the past several decades, Nordion's supply of Cobalt-60 has come primarily from the National Research Universal (NRU) reactor at Chalk River Laboratories, which is currently scheduled to reach its end-of-life in 2018, creating the risk of a global shortage of this particular isotope; a gap which Bruce Power is now helping to fill. These innovative, non-power applications of Ontario's nuclear fleet should continue and be further explored to maximize the utility of the assets over their useful life.

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Small modular reactors (SMRs) are another emerging technology that Ontario should bear in mind, both from a power system planning perspective and from a national regulatory and licensing perspective. **The potential benefit of SMRs and the range of applications are broad.** Given that SMRs are designed to be built economically in factory-like conditions, rather than fully constructed on site, the reduced lead time and smaller footprint provide a level of flexibility that is more of a challenge with larger, traditional reactors.

Scalability is another benefit of SMRs. With capacities ranging from approximately 10 MW to 300 MW, units can be stacked in smaller increments based on needs, be they serving urban growth, powering **smaller, indigenous and/or remote communities**, or providing heat for mining or oil extraction operations. Marine propulsion reactors that have been used in hundreds of submarines and other craft by various countries since the early 1950s provide a large base of operating and safety experience for SMRs. Currently there are more than 45 SMR designs under development, including four already under construction in Argentina, Russia, and China. As **SMRs could provide a smaller-scale and more easily financed option for Ontario, and could be deployed in currently under-served communities or in the Ring of Fire region**, the LTEP should commit Ontario to actively monitor SMR technologies globally. The Ministry of Energy should periodically reassess the feasibility of their deployment in Ontario as part of the ongoing power system planning processes and subsequent LTEP updates.

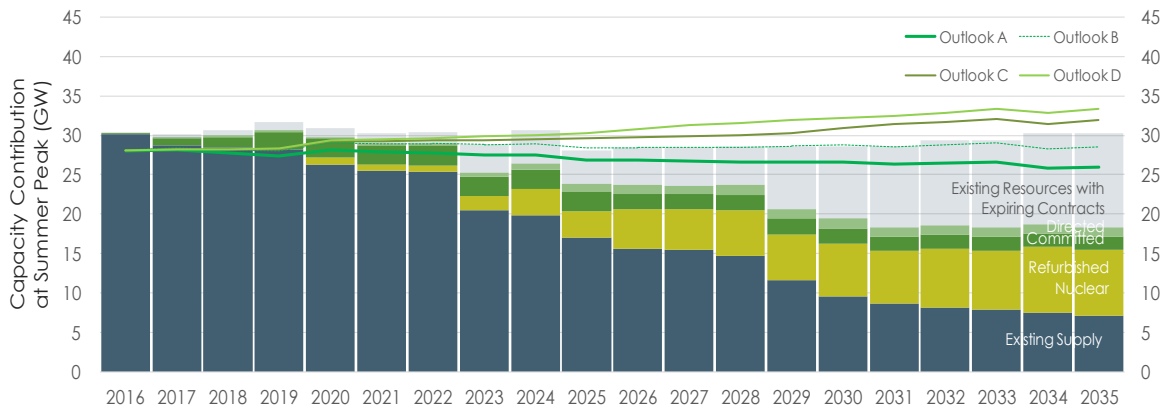
Future Electricity Supply

Nuclear provides an effective hedge against higher consumer costs by securing substantial amounts of capacity and energy **insulated from carbon pricing and commodity price volatility** relative to an equivalent natural gas alternative. Assuming measures outlined in the CCAP are implemented, **greater electrification of transportation and buildings will result in increased demand for electricity, particularly around the winter peak which (even if transmission constraints could be resolved) cannot be served by imports from Québec or non-hydro renewables.**

The Ontario Planning Outlook (OPO) indicates that **over the next 20 years** approximately half of Ontario's currently installed capacity will reach contract term or end of service life. This substantial **looming turnover in power supply**, coupled with increasing projected demand in Outlooks C and D, presents important opportunities to consider and risks to manage for Ontario and the IESO.

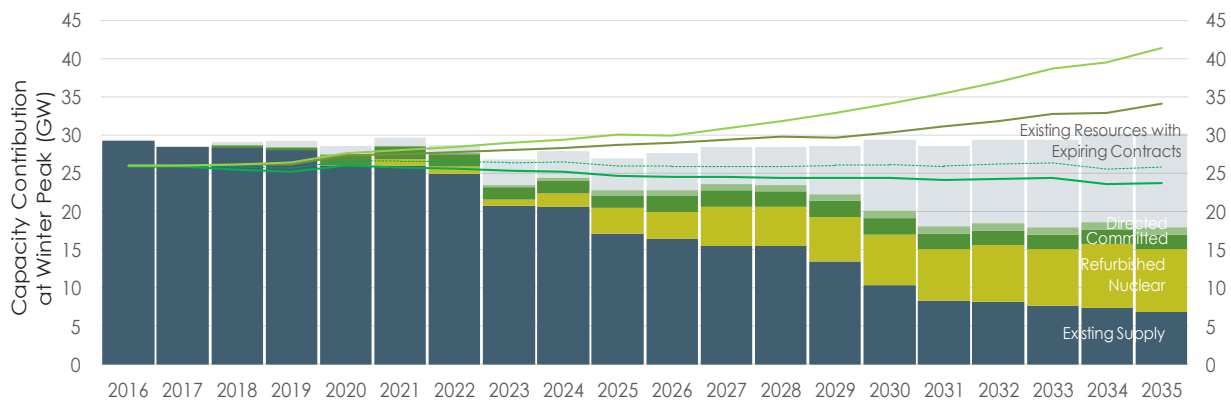
Small modular reactors (SMRs) could provide a smaller-scale and more easily financed option for Ontario, and could be deployed in currently under-served communities or in the Ring of Fire.

Available Supply at the Time of Peak Demand Relative to Total Resource Requirements (Summer)



Source: IESO Ontario Planning Outlook, September 2016

Available Supply at the Time of Peak Demand Relative to Total Resource Requirements (Winter)



Source: IESO Ontario Planning Outlook, September 2016

Beginning in 2023, Ontario will need to have substantial new or re-contracted resources in place to maintain system reliability and these needs grow considerably over the following decade even with negligible assumed demand growth as additional resources retire. Given the fact that the price of carbon is likely to increase over time, and achieving the CCAP emissions target for 2030 requires that emissions from the electricity sector do not increase, it would be inadvisable to risk creating a situation in which the system must pursue future long-term natural gas procurements to fill this need. While securing the required energy and capacity to serve the province in these 2025-2035 years without increasing emissions will likely require a diversity of resources, the option for additional nuclear must be maintained as part of that solution.

The largest driver of the need materializing in the mid-2020s is the retirement of Pickering’s 3,100 MW and approximately 20 TWh of annual energy contribution to Ontario, more than all of the province’s natural gas generation in 2015 and ten times more than the recently announced import agreement with Hydro Quebec. **Given the lead time involved in securing large blocks of supply, particularly nuclear, it is advisable that the IESO begin a process to assess not just the future**

supply and demand gap, but the characteristics and quantities of resources based on the product they can provide the province that they will need to reliably operate the system. Based on this assessment the IESO will be able identify an optimum resource mix, refine cost estimates and regional implications for potential sites, transmission availability and ability to serve load growth.

The CNA believes, and other analysts agree, that the end of life of Pickering units in 2022 and 2024, coupled with other natural gas retirements and CCAP-driven electrification throughout the 2020s will result in **a substantial supply-demand gap that should not be addressed through increased reliance on natural gas. Ontario's long history of acceptance and safe operation of nuclear energy, the availability of licensed nuclear sites with existing high voltage transmission, a skilled and experienced workforce, and the presence of a large, sophisticated domestic supply chain should lead to the logical consideration of additional nuclear.**

Exporting Ontario's Technology & Expertise

The 2013 LTEP contained strongly supportive language around the export of Ontario's nuclear technology, components and expertise. The CNA believes that this **support from Ontario for international growth of our domestic nuclear industry should be renewed** in the 2017 LTEP.

Ontario's nuclear industry has already been quite successful in exporting CANDU technology and expertise around the world to countries such as China, South Korea, Romania, India and Argentina. Certainly, **government's strong, ongoing support** of the province's nuclear operations and supply chain through confident investment in our domestic technology and knowledge-base, such as refurbishment, **is essential to establishing confidence in Canada's nuclear products and services internationally -- a global market that could reach more than 500 reactors by 2030** as high-growth countries seek clean power on a large scale.

There are several international nuclear opportunities which have a significant positive impact on the Canadian nuclear industry. **Over 180 private sector suppliers, 95% of which are Ontario-based, participate regularly in international trade missions** to explore opportunities with international nuclear vendors. These projects can be divided in three main areas: new build, life extension and operating and maintenance (O&M) services.

A substantial supply-demand gap should not be addressed through increased reliance on natural gas. Ontario's long history of acceptance and safe operation of nuclear energy, the availability of licensed nuclear sites with existing high voltage transmission, a skilled and experienced nuclear workforce, and the presence of a large, sophisticated domestic supply chain should lead to the logical consideration of additional nuclear.

International new build opportunities provide the largest revenue potential for the Canadian nuclear industry. **The supply chain for CANDU reactors built abroad is densely concentrated in Ontario, and reaches back into the province's universities, colleges, workforces and communities.** A study carried out by the Conference Board of Canada in 2013, showed that an offshore twin CANDU project would result in approximately 37,000 person years of employment and increase real GDP by a cumulative \$3.8 billion.

SNC-Lavalin has recently signed a pre-project agreement with Nucleoelectrica Argentina Sociedad Anonima (NA-SA) to build **a CANDU reactor in Argentina.** The pre-project work is underway with a full project contract expected to be signed in early 2017. Additionally, SNC-Lavalin is working with China National Nuclear Corporation (CNNC) to build **two Advanced Fuel CANDU Reactors (AFCRs) in China.** A joint venture in principle was signed in September of 2016 to complete the development of the technology and establish a new entity that will build the reactors in China and internationally.

Another new build project is being pursued for the construction of **two CANDU units in Romania.** These units will be operated by the Romanian state utility, Societatea Nationala Nuclearelectrica S.A. (SNN), with the participation of international investors. Canadian export credit opportunities from Export Development Canada (EDC) are being explored to ensure that Canadian scope is maximized.

Finally, the CANMOX EC6 project proposed for implementation in the United Kingdom consists of **4 CANDU units which will be able to process the disposition of 140 tonnes of British plutonium stockpiles.** A contract for the continuation of commercial work to support this initiative was signed in late 2016.

These nuclear export opportunities are Ontario's opportunities. They deliver concentrated, sustained revenues for our province's people, companies, research organizations and governments, strengthening Ontario's whole scientific and engineering capability and economic competitiveness.

Life extension projects of existing CANDU plants also represent great revenue opportunities for the Canadian nuclear industry. In addition to the huge program of Ontario refurbishments, the industry is providing major components, parts and services for the life extension of the Embalse power station in Argentina. There are additional long term opportunities for life extension of two CANDU units in China, three units in South Korea, and two units in Romania.

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Finally, there are a number of opportunities for the Canadian nuclear industry to provide **operations and maintenance services** to the existing international CANDU fleet. This includes the provision of spare parts and a wide breadth of engineering services to units around the world.

To give just one example of our province's capabilities, Ontario-based company and long term supplier to the international nuclear market, **BWXT Canada Ltd.** (BWXT Canada), engineers, **manufacturers, inspects and repairs critical components for nuclear utilities globally**, including both pressurized water reactor (PWR) and CANDU plants. BWXT Canada is an original equipment manufacturer (OEM) for critical components, like **nuclear steam generators, pressure vessels and other heavy components** for CANDU and PWR nuclear plants in North America, Argentina, Romania, China, and South Korea. As well, BWXT Canada routinely performs **engineering and field service work** at international customer sites to extend the life of their equipment. This includes the development and deployment of remote inspection robots and waterlancing equipment for routine outage maintenance of international nuclear units.

Part of the growing opportunity internationally for Canada's nuclear industry is expanding its business offerings to non-traditional CANDU space, by leveraging its capabilities and **providing services and products to Light Water Reactors (LWRs)** in the U.S. and Europe. This also includes **decommissioning and waste management services** to the global fleet of commercial and research reactors that are approaching their end of life.

Driven by the world's rapidly expanding need for clean energy, the international market for nuclear technology is growing across the world. The Canadian nuclear industry is well positioned to capture a significant portion of this market share, as it is strengthened by investments being made in Ontario today. This vote of confidence in the industry, as well as the appropriate policy and political support in various areas, will help the industry export Ontario's expertise abroad; bringing high quality employment to the province, and helping Ontario meet its objectives in the areas of economic development, innovation and climate change.

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The CNA looks forward to working with the Government of Ontario to ensure the province continues to enjoy a stable and reliable supply of affordable, low-emission electricity. We would be pleased to meet with the Ministry of Energy to discuss nuclear energy's critical place in Ontario's supply mix going forward.

Sincerely,



John Barrett, Ph.D.
President and CEO
Canadian Nuclear Association

CC: Hon. Glenn Thibeault, Minister of Energy
Serge Imbrogno, Deputy Minister of Energy
Steen Hume, Assistant Deputy Minister, Energy Supply Policy
Andrew Teliszewsky, Chief of Staff, Office of the Minister of Energy
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