

Canadian Nuclear Association
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Canada's Nuclear Industry:

» An Overview

January 2012



» Global energy: Key driving forces

- **Energy markets are increasingly determined by countries outside the OECD which will account for 90% of energy demand growth through 2035.**
- **The age of fossil fuels is far from over, but their dominance declines. . . Cheap oil is ending.**
- **We cannot afford to delay further action to tackle climate change.**

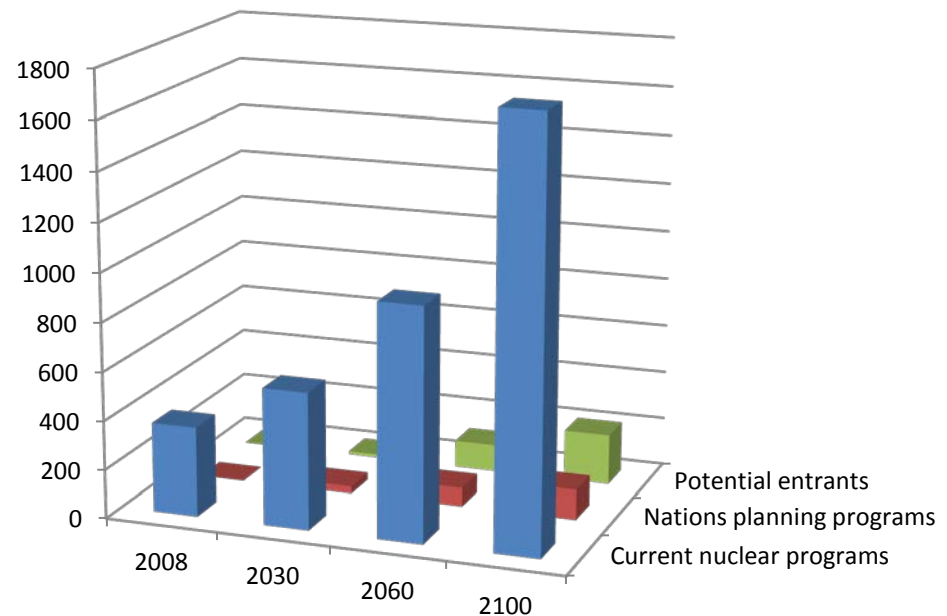
-- IEA World Energy Outlook 2011

» Nuclear has a major role to play

“Any substantial shift away from nuclear power would boost demand for fossil fuels, put additional upward pressure on energy prices, raise additional concerns about energy security and make it harder and more expensive to combat climate change.”

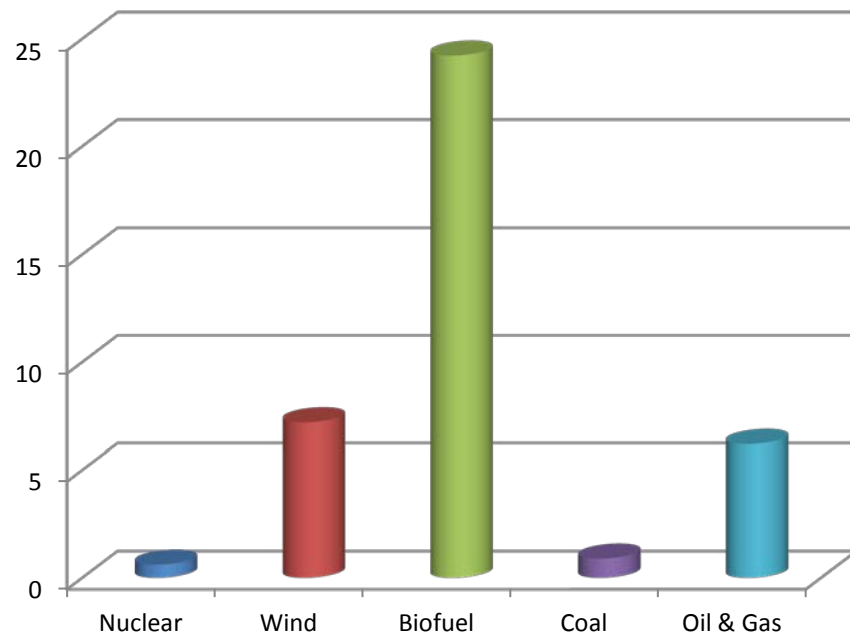
-- International Energy Agency

Worldwide reactors through 2100: LOW projection



Source: WNA Nuclear Century Outlook

» Highly cost-effective carbon mitigation



Investments in nuclear capacity through refurbishment represent the most effective application of federal funds for electricity generation and for greenhouse gas reduction.

Nuclear and wind reductions assume natural gas generation is avoided. Coal reductions assume emissions are abated by clean coal relative to traditional coal. Biofuel assumes avoided petroleum. Oil assumes total potential emissions abated through carbon capture & storage.

Net Canadian federal government cost per tonne of CO2 avoided

Source: SECOR Group research, 2011

» USA: Shovels are in the ground

- 12 combined construction and operating licence applications are under review.
- Work is most advanced at Vogtle 3 and 4 in Georgia.
- These are scheduled to begin commercial operation in 2016 and 2017.

Source: WNA



» Canada: Opportunities and assets

- Good **safety** record, good reactor **performance** record, small footprint, minimal greenhouse gas emissions.
- CANDU reactors already sold to six countries outside Canada.
- Many existing CANDUs have been, or are being, mid-life refurbished; refurbishment **economics are good**.
- Market trends (e.g. time-of-use pricing) favor baseload power.
- Opportunities to supply new units in Ontario, possibilities in Saskatchewan, long term in Alberta and North.

» CANDU: Opportunities ahead

- CANDU is a world recognized and **respected Canadian brand** with its roots in Ontario and a supply chain throughout the province.
- Many emerging markets have modest electric grid infrastructure where a mid-sized reactor like CANDU is more suitable than larger reactors.
- **Further opportunities lie** in existing CANDU countries – Romania, Argentina, China, India; also in Ukraine, Turkey, Jordan, Poland.
- CANDU is inherently suited for using alternative fuels.
 - recycled recovered uranium from light water reactors
 - potential for thorium, which is abundant in China & India

Tests on the use of these fuels are underway.

» Ontario prosperity, with affordable energy

- Nuclear technology was **developed in Ontario** and creates jobs in Ontario – in science, technology, engineering, operations, fuel, construction, medicine and other highly skilled, high-paid fields.
- Nuclear provides **more than half of Ontario's electric power**.
- Nuclear is one of the **most affordable** sources of electricity. This strength will grow if carbon pricing is implemented.
- Nuclear is **minimal-emissions** – generating as little CO₂ as wind or geothermal.

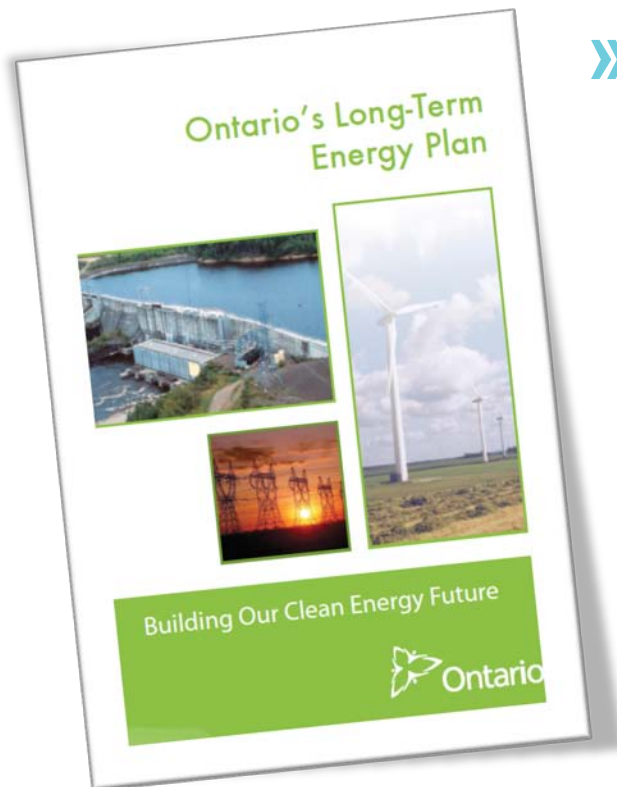
» Truly affordable energy

- “GTAA hydro is 5.9, 8.9 or 10.7 cents / kWh (dep time of day), excl. delivery.
- “OPA contracts for wind are 13.5 cents / kWh, 10.5 cents / kWh and up for biogas, and starting at 45 cents / kWh and up for solar. Most renewable projects are in locations which require transmission infrastructure. Cost for wind and solar does not include transmission, distribution, or spinning reserve to compensate for the fact they are intermittent sources of power.”
- “Two Enhanced Candu 6 reactors for Darlington would ... cost 6 to 9 cents/kWh on a 5 % discount rate . . . lifetime energy cost including mid-life refurbishment and ‘end of life’ decommissioning, with no need for additional ‘spinning’ reserve.”
- “New nuclear is a cost competitive generation option and the incremental design of the EC6 has inherently low technology risk.”

*-- Patrick Lamarre, Executive Vice President,
SNC-Lavalin Inc., Oct. 2011*

» Ontario's Long Term Energy Plan

- Comprehensive 20-year plan for electric power.
- “To preserve the long-term reliability of the system, particularly for baseload generation, **additional investment in nuclear generation** will be required.”
- “Over the first 10-15 years, 10,000 MW of **existing nuclear capacity will be refurbished and modernized** at Darlington and Bruce.”
- “The government is committed to continuing to use nuclear for about 50 percent of Ontario’s energy supply -- a capacity of 12,000 MW. About **2,000 MW** will be made up of **new nuclear at Darlington.**”



» Highly paid, high knowledge jobs

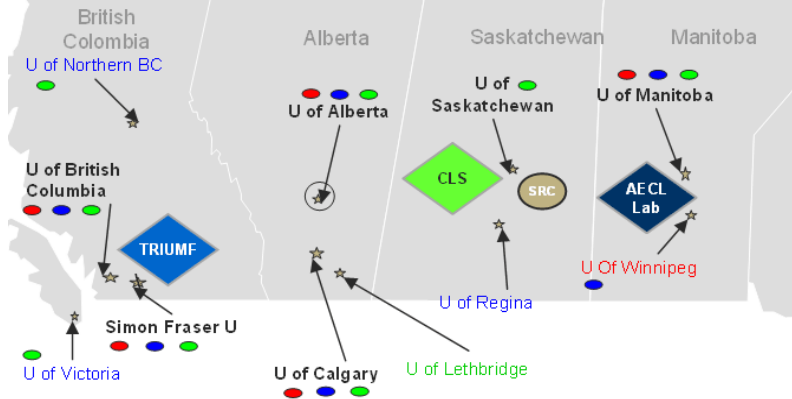
- Ongoing operations and refurbishments are expected to yield about \$60 billion in benefits and support **almost 700,000 person-years of employment through 2044**. This is *without new plants being built*.
- Refurbishing 10 nuclear plants in Ontario is projected to create at least 55,000 jobs over 10 years (Canadian Manufacturers and Exporters study) while a CANDU **new-build in Ontario would create more than 60,000 further person-years of employment** (Conference Board of Canada estimate quoted by SNC-Lavalin).
- Direct jobs in nuclear operations are **highly skilled and highly paid**, with salaries over \$100,000 annually. Uranium mining is a **leading employer of Aboriginal people in Canada**.
- **The net federal government's nuclear S&T investments represent a cost per nuclear job of about \$300**. Jobs created by wind energy cost the federal government many times more.

» Nuclear: Part of the innovation system

- Our nuclear science and technology infrastructure **nurtures careers** of highly qualified scientists, engineers and others who contribute in other fields.
 - e.g. chemistry, metallurgy, medicine
- **Materials testing** with neutron beams is critical for both nuclear and non-nuclear industries.
 - e.g. aerospace, auto manufacturing, medical devices
- There are **long-term payoffs in innovation**, highly qualified personnel, reactor safety, and Canada's international voice in nuclear issues.

» Nuclear S&T: A nationwide public asset

Map only shows universities and public research centres, and does not include corporate capabilities.

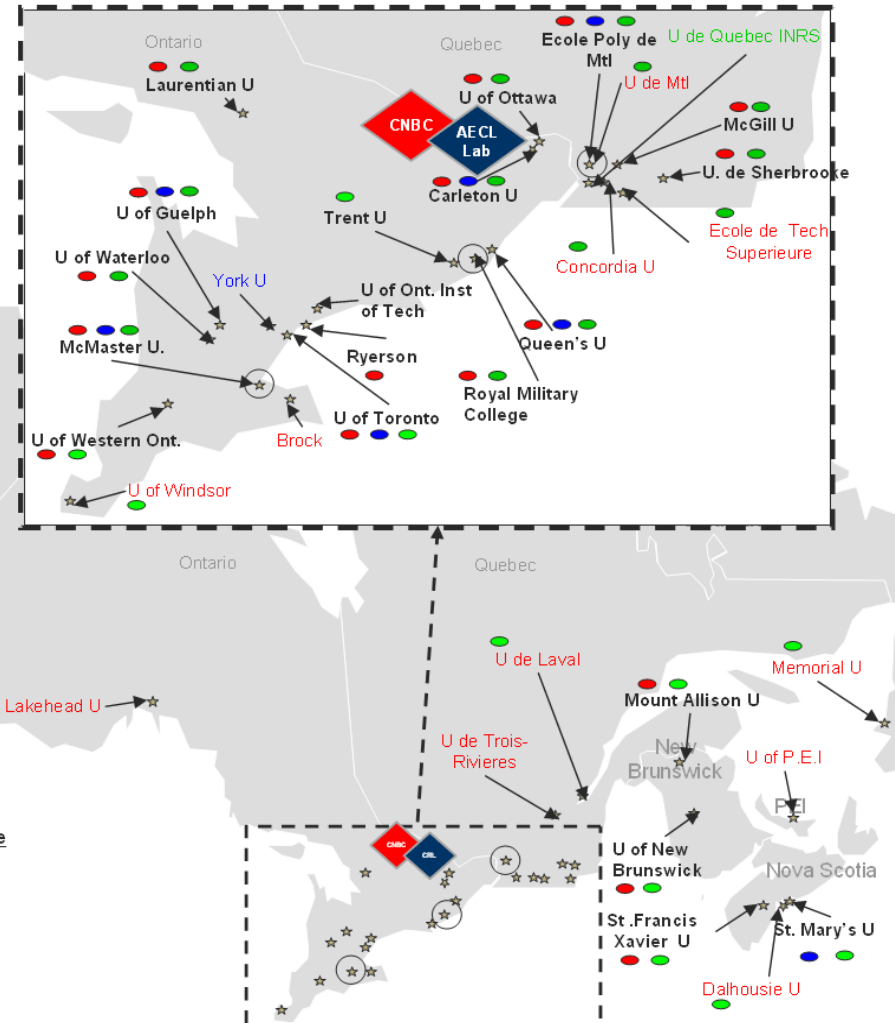


Legend

- ★ University
- ◇ Public Research Centre
- Other Institution Research Reactor

School Affiliations to Major Research Centre

- AECL Labs (27 schools) (identified by black text)
- CNBC/CINS (33 schools) (red dot or text)
- TRIUMF (17 schools) (blue dot or text)
- CDN LIGHT SOURCE (35 schools) (green dot or text)

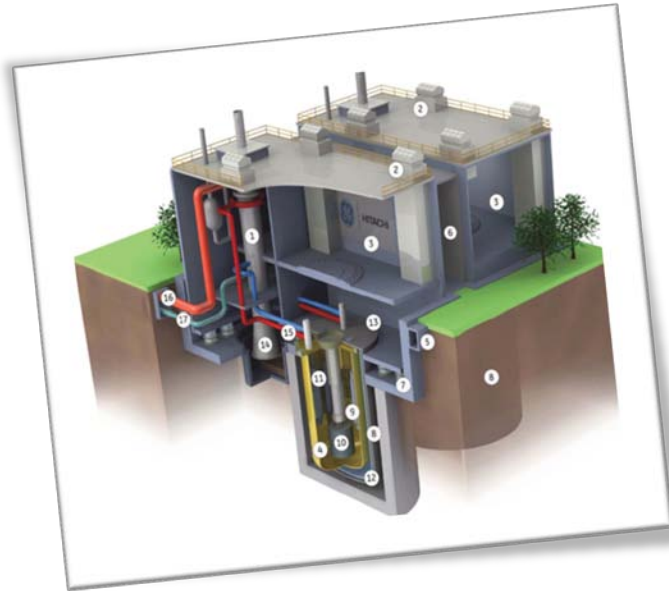


» A dynamic industry

» The cast of corporate players has grown; so has CNA membership

- In the 1990s Eldorado Nuclear was folded into a new firm, **Cameco**, that now has multinational operations. Uranium mining has become a large and dynamic part of Canada's mining scene.
- The businesses now known as **Nordion** and Best Theratronics were privatized out of AECL in 1991 and 1998 respectively, and now form the heart of Canada's nuclear health and medical industry.
- After building three major nuclear generating stations from the 1960s to the 1990's, Ontario Hydro became **Ontario Power Generation** and a new entity, **Bruce Power Limited Partnership**, became the licensed operator of the eight-reactor Bruce nuclear power plant in 2001.
- In 2011 AECL's commercial reactor division was acquired by **Candu Energy Inc**, a wholly owned subsidiary of SNC-Lavalin.
- A federal decision on the future of the AECL Nuclear Laboratories is expected.

» New technologies & applications



Small Modular Reactors

- Modularity & simplicity
- Scalable – add/shut units as demand changes
- Lower staffing/security needs
- Can supply smaller communities with less grid infrastructure, e.g. Replacing diesel generators in Ontario’s North.
- Possible applications of direct heat for communities, industrial processes, e.g. Potential to transform and “decarbonize” oilsands extraction in Alberta.

» Safety: Post-Fukushima Canadian response

- Safety remains our industry's top priority.
- Following events in March 2011, Canadian nuclear operators launched a thorough assessment of our systems and operations to confirm their safety. This included:
 - Back-up power systems
 - Ability of plants to withstand any potential natural disasters in Canada
- In October 2011 CNSC, the lead regulator, released the [Fukushima Task Force Report](#) concluding:
 - All Canadian nuclear power plants are safe
 - Plants are designed to withstand conditions similar to those that triggered the Fukushima event
 - Canada's nuclear regulatory framework is strong
- **Our industry is continuously identifying opportunities to improve all aspects of our operations, and taking steps to implement those improvements.**

» Safety: Post-Fukushima global response

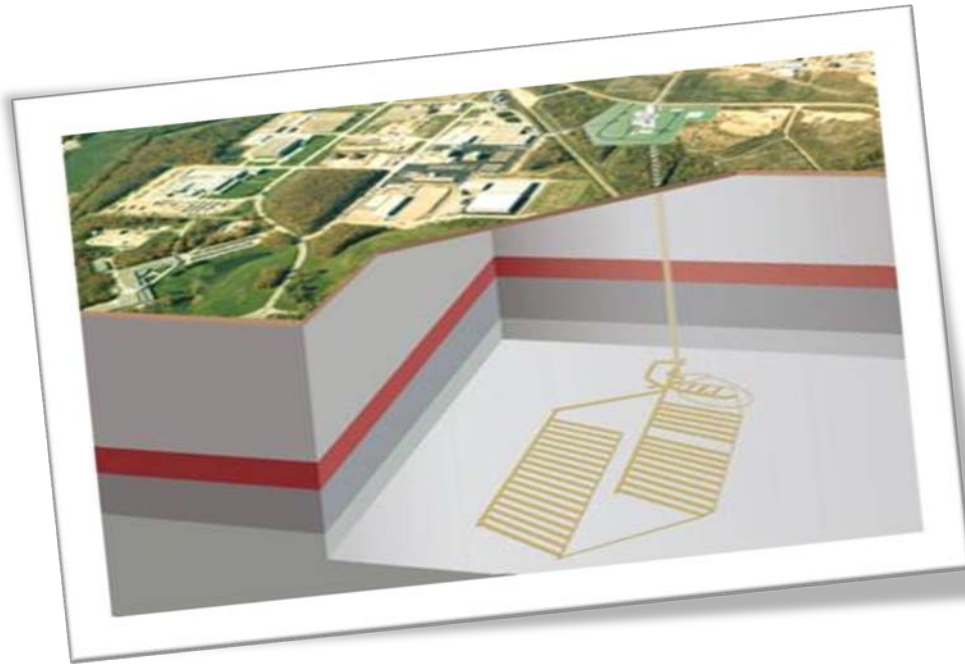
- The international community conducted comprehensive assessments of Fukushima.
- At the request of the World Association of Nuclear Operators (WANO), Ontario Power Generation CEO Tom Mitchell chaired a special post-Fukushima Commission, made of 14 commissioners from eight countries. Findings were presented in October.
- Commission findings included the recommendation that WANO should expand the scope of its programs to include lessons from Fukushima and take a more active role in promoting and implementing a worldwide, integrated response strategy.
- Commission's recommendations were unanimously approved by WANO.



» Full cycle management

- Nuclear plant operators set aside funds to **cover the decommissioning of their plants** and the disposal of radioactive materials. The price paid for nuclear power in Canada includes provision for these costs.
- There are **no hidden or buried financial costs** in Canadian nuclear power.
- Canada has a plan for the long-term management of its used nuclear fuel.
 - See www.nwmo.ca
- Part of NWMO's plan will be a Deep Geological Repository (DGR) project, with a national centre of expertise, in an informed and willing host community.

» Full cycle management



Communities in Saskatchewan and Ontario have expressed interest in hosting the deep geological repository.

» Key issues: What is needed?

- Clear Government Policy
 - At federal level, a new model for the Nuclear Laboratories
 - In Ontario, moving forward with the Long Term Energy Plan
- Coordinated & Efficient Laws and Regulations
 - Update legislation in a timely way (Nuclear Liability Act)
 - Working together to achieve or surpass regulatory goals
- State-of-the-art project management – on time, on budget
 - Every project is an opportunity to learn and improve
 - Good science alone is not enough; engineers/managers bring it to life

» Federal Laws and Regulations:

- The Canadian Nuclear Safety Commission regulates all nuclear facilities and activities in Canada.
- **Key federal legislation** that regulates all aspects of the nuclear industry includes:
 - *Nuclear Safety and Control Act* – gap analysis under way;
 - New limits to be established for releases to water;
 - *Canadian Environmental Protection Act* – pollution prevention planning under way;
 - New limits to be established for releases to water;
 - *Canadian Environmental Assessment Act* – 7-year review under way;
 - *Nuclear Liability Act* - 4 attempted updates; and
 - *Transportation of Dangerous Goods Act* – shipments under scrutiny.
- These and other associated Acts and regulations require coordination.

» Provincial Laws and Regulations

- Nuclear is constitutionally under federal jurisdiction, but provincial legislation applies in Ontario and elsewhere.
- **Key provincial legislation** that regulates the nuclear industry in Ontario includes:
 - *Environmental Protection Act* – the Ministry of the Environment establishes release limits for water (e.g., through Certificates of Approval); and
 - *Clean Water Act* – Source Protection Committees are in place and source water protection planning is under way;
 - New limits to be established for releases to water.
- These and other associated Acts and regulations require coordination.

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