2008 Edition I

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# Canada's Nuclear Energy:

## *Reliable, affordable and clean electricity*

Canadian Nuclear Association

# NUCLEAR FACTS

This 2008 handbook is an update of our popular nuclear facts. Our spring edition reflects the most up-to-date information available on nuclear energy in Canada and worldwide.

As energy supply, security, cost and environmental issues dominate government agendas and public consciousness, understanding how energy is produced, used and impacts our everyday lives becomes increasingly important for all of us. This reference guide is aimed at answering questions about energy and more specifically nuclear energy, to assist us all in making informed decisions about our energy future.

Canada — and in particular Ontario — continues on its long-term plan for electricity generation and will soon be making a number of critical decisions about nuclear power. In Alberta, harvesting the vast energy resource of the oil sands involves huge amounts of electricity for which many energy options are being considered including nuclear power. Hydro-Québec will make a decision this year on refurbishment of Gentilly-2 while New Brunswick is considering new nuclear construction in addition to its on-going refurbishment of the Point Lepreau nuclear power plant which began in late March.

The nuclear industry in Canada is proud of its accomplishments and continues to work nationally and with our international peers to improve upon our technology, performance and contribution to Canada's economic well-being. Please read our handbook to learn more about us.

Murray Elston
President and CEO, Canadian Nuclear Association
June 2008

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## Canada's Nuclear Industry

- Canada: 60 years in nuclear; Nobel Prize in Physics—1994: Dr. Bert Brockhouse.
- Nuclear energy in Canada is for peaceful purposes: used only in electricity generation, medicine, agriculture, research and manufacturing.
- Nuclear energy is a $6.6 bilion/year industry generating $1.5 billion in federal and provincial revenues through taxes: 21,000 direct jobs, 10,000 indirect jobs (contractors to the industry) plus 40,000 spin-off jobs, 150 firms and $1.2 billion in exports (Source: Canadian Energy Research Institute (CERI) 2008).
- In 2007: 22 CANDU Reactors—18 in service generating 14.6% of the country's electricity, cleanly and safely, in Ontario (51%), New Brunswick (30%) and Québec (3%).
- On March 31, 2008, Point Lepreau in New Brunswick began an 18-month refurbishment and will return to service in fall of 2009.
- In 2007 in Ontario: 20 reactors—16 in service providing 51% of the province's electricity (12,024 MW (Gross) of installed electrical capacity) (Source: CANDU Owners Group (COG)/Pressurized Heavy Water Reactor (PHWR) Performance Indicators).
- Canada has operated CANDU nuclear power reactors safely for 46 years.
- Canada has the world's largest known high-grade natural uranium deposits in Saskatchewan.
- Canada provides over half of the global supply of medical isotopes for nuclear medicine used in 60,000 procedures per day, 5,000 in Canada.
- Canada supplies 75% of the world's cobalt-60 used to sterilize 45% of the world's single-use medical supplies.
- The total amount of used nuclear fuel produced in 46 years from nuclear power plants in Canada would fill five hockey rinks up to the height of the boards.

# Canada is the World's Leader in Uranium

- Canada is the world's largest producer of natural uranium providing 22% of total world production from its Saskatchewan mines in 2007.
- Canadian uranium is used exclusively for the generation of electricity at nuclear power plants with end use strictly enforced by international non-proliferation agreements and export restrictions.
- The two major uranium mining companies in Canada are Cameco Corporation and AREVA Resources Canada Inc.
- Electricity generated from Canadian uranium worldwide avoids more than 650 million tonnes of $CO_2$ emissions annually (Sources: Canadian Nuclear Association (CNA) & World Nuclear Association (WNA) 2008).
- Uranium is a metal, common and abundant in nature, found in most rocks, soil, rivers, oceans, food and the human body. It is a unique element because of its potential to generate huge amounts of energy.
- Over the last four decades, uranium has been an important Canadian energy resource used in nuclear power reactors for the production of clean electricity.
- Saskatchewan's uranium reserves contain about four times more energy than all known Canadian conventional oil reserves (not including the Athabasca tar sands).

- 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. The energy contained in these deposits is equivalent to 17 billion barrels of oil or 5 billion tonnes of coal.
- Saskatchewan-based Cameco alone accounts for 19% of the world's uranium production. The company has a uranium refining facility at Blind River, Ontario and conversion and fuel manufacturing facilities at Port Hope and Cobourg, Ontario.
- AREVA Resources Canada, based in Saskatoon, mines and mills uranium in Saskatchewan and is exploring for uranium in several provinces as well as in Nunavut.
- Rising uranium prices have fuelled a dramatic increase in exploration in Canada and around the world. The world's present measured resources of uranium that could be reasonably mined at current prices are enough to last for some 70 years. Over time, a doubling of uranium prices from present levels could be expected to create a tenfold increase in measured resources (Source: WNA).
- 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 comparable to other non-emitting generation systems such as hydro and wind.
- The uranium mining industry in Canada generates the employment of 5000 people (Source: CERI ) and is a leading employer of aboriginal people.
- Eight pellets of uranium, each smaller than an average adult thumb, contain enough energy to power an average home for about one year.

## Nuclear Reactors in Canada (22)

In 2007, 18 nuclear reactors provided 14.6% of Canada's electricity. Of these 18 reactors, Pickering A (ON) Unit 1 returned to service in 2005 and Pickering A (ON) Unit 4 was brought back to service in 2003. On March 31, 2008, New Brunswick Power began an 18-month refurbishment of the Point Lepreau nuclear power plant.

**2008 Operating Reactors**

| | | | |
|---|---|---|---|
| • Pickering A (ON) | 2 reactors | 542 MW each | (Gross) |
| • Pickering B (ON) | 4 reactors | 540 MW each | (Gross) |
| • Darlington (ON) | 4 reactors | 934 MW each | (Gross) |
| • Bruce A (ON) | 2 reactors | 805 MW each | (Gross) |
| • Bruce B (ON) | 1 reactor | 845 MW | (Gross) |
| • Bruce B (ON) | 3 reactors | 872 MW each | (Gross) |
| • Gentilly-2 (QC) | 1 reactor | 675 MW | (Gross) |

**2 CANDU Reactors Being Placed in Safe Storage in 2008**

| | | |
|---|---|---|
| • Pickering A (ON) Units 2 & 3 | 542 MW each | (Gross) |

**3 CANDU Reactors Being Refurbished 2008**

| | | |
|---|---|---|
| • Bruce A (ON) Units 1 & 2 | 805 MW each | (Gross) |
| • Point Lepreau (NB) 1 reactor | 680 MW each | (Gross) |

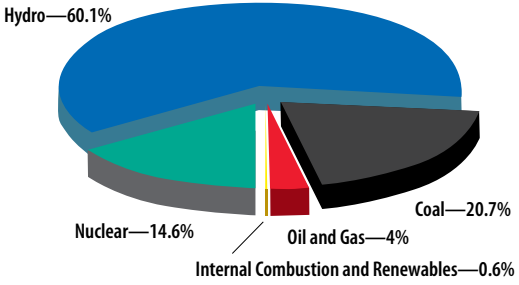
## CANDU Reactors in Canada 2008

Quebec
Gentilly-2 1 unit

Ontario
Darlington 4 units
Pickering 8 units
Bruce 8 units

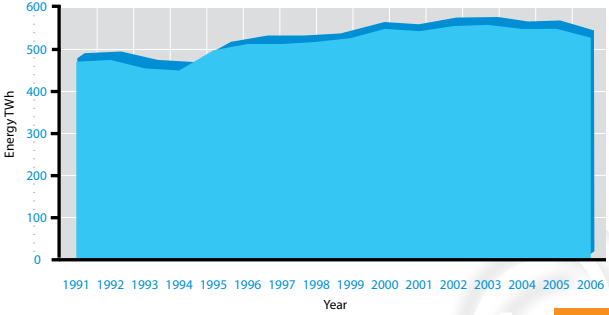
New Brunswick
Point Lepreau 1 unit

## Electricity Generation in Canada 2007



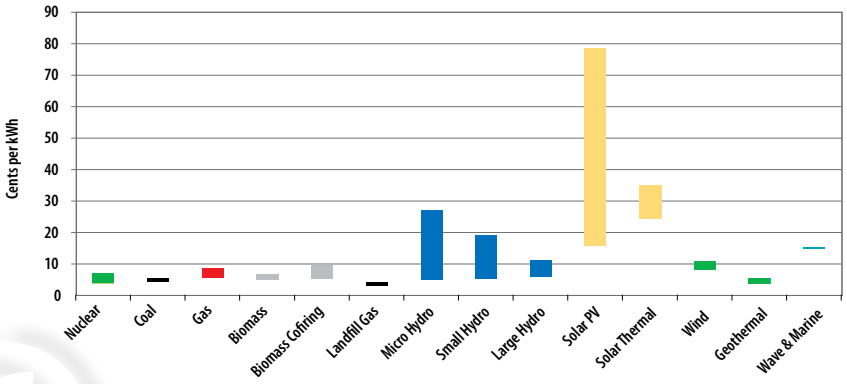

*Source: Natural Resources Canada (NRCan), 2008*

## Electricity Consumption in Canada 2006




*Source: Statistics Canada, Energy Statistics Handbook, February 2008*

## Costs of Different Energy Sources




*Source: Canadian Energy Research Institute (CERI), September 2006*

# CANDU Nuclear Reactor Performance 2007

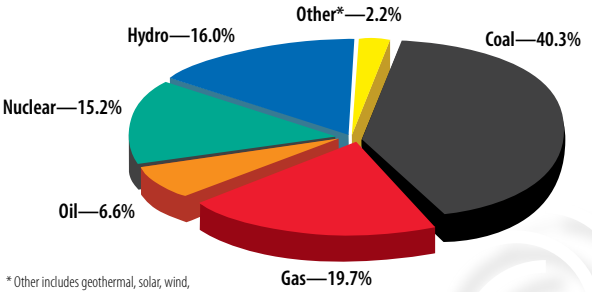
| Reactor | In Service | Capacity (MW) | Performance In 2007 (%) | Lifetime Performance (%) |
|---|---|---|---|---|
| Point Lepreau | 1983 | 680 | 74.9 | 82.1 |
| Gentilly-2 | 1983 | 675 | 78.4 | 79.5 |
| Wolsong 1 | 1983 | 622 | 89.8 | 85.7 |
| Wolsong 2 | 1997 | 730 | 90.9 | 94.0 |
| Wolsong 3 | 1998 | 729 | 94.3 | 95.4 |
| Wolsong 4 | 1999 | 730 | 93.2 | 97.2 |
| Embalse | 1984 | 648 | 76.2 | 84.9 |
| Cernavoda 1 | 1996 | 706 | 97.6 | 88.4 |
| Cernavoda 2 | 2007 | 705 | 93.2 | 93.2 |
| Qinshan 4 | 2002 | 700 | 88.3 | 87.5 |
| Qinshan 5 | 2003 | 700 | 99.9 | 89.2 |
| Pickering 1 | 1971 | 542 | 38.8 | 63.1 |
| Pickering 4 | 1973 | 542 | 43.7 | 66.1 |
| Pickering 5 | 1983 | 540 | 57.6 | 73.4 |
| Pickering 6 | 1984 | 540 | 71.5 | 77.1 |
| Pickering 7 | 1985 | 540 | 81.9 | 79.4 |
| Pickering 8 | 1986 | 540 | 85.9 | 76.5 |
| Bruce 3 | 1978 | 805 | 75.3 | 62.8 |
| Bruce 4 | 1979 | 805 | 80.1 | 61.5 |
| Bruce 5 | 1985 | 872 | 96.6 | 83.4 |
| Bruce 6 | 1984 | 872 | 71.6 | 79.9 |
| Bruce 7 | 1986 | 872 | 97.2 | 83.7 |
| Bruce 8 | 1987 | 845 | 93.2 | 81.6 |
| Darlington 1 | 1992 | 935 | 96.7 | 84.1 |
| Darlington 2 | 1990 | 935 | 83.0 | 75.7 |
| Darlington 3 | 1993 | 935 | 94.2 | 85.2 |
| Darlington 4 | 1993 | 935 | 81.0 | 85.1 |
| **Total/Average** | | **19 686** | **82.4** | **81.3** |

*COG CANDU/PHWR Performance Indicators, Bruce Power and Ontario Power Generation, 2008*

## Nuclear Generation Worldwide

- There were 439 operable nuclear power reactors in 31 countries in March 2008.
- As of January 2008, there were 35 nuclear reactors under construction, another 91 being planned and 228 being proposed, mostly in Asia and Eastern Europe (Source: World Nuclear Association).
- Nuclear power is the only large-scale generation option, other than hydro, that does not release greenhouse gas emissions that contribute to global warming.
- Nuclear power produces 15.2% of global electricity and is the world's fourth largest source of electricity (Source: (OECD/IEA), World Energy Outlook 2007).
- Around the world scientist in more than 50 countries use nearly 300 research reactors to investigate nuclear technologies and to produce radioisotopes for medical diagnosis and cancer therapy.

## Global Electricity Generation




* Other includes geothermal, solar, wind, combustible renewables and waste

*Source: OECD/IEA Key World Energy Statistics 2007*

## CANDU Technology

- Advanced CANDU reactor under development: **ACR-1000®**
- World record for longest non-stop operation: **Pickering 7** (894 days—1994)
- Top lifetime performance by a CANDU: **Wolsong 4** (97.2%—December 2007)
- Top annual performance by a CANDU: **Qinshan 5** (99.9%—2007)
- Percentage of electricity generated by CANDUs (2007):

| | |
|---|---|
| In Canada | 14.6 % |
| In Ontario | 51 % |
| In New Brunswick | 30 % |
| In Quebec | 3 % |

- Number of tonnes of emissions of carbon dioxide ($CO_2$) avoided by nuclear energy in Canada: **2.3 billion** (Source: CNA/CANDU Owners Group (COG)).
- Number of tonnes of emissions of sulphur dioxide avoided by nuclear energy in Canada: **42 million**
- Annual production of goods and services: **$6 billion**
- Total annual value of electricity from nuclear: **$5 billion**
- Total direct and indirect employment from nuclear power production in Canada **67,000 jobs** (full-time equivalent not including uranium mining) (Source: The Canadian Nuclear Industry: Contributions to the Canadian Economy, Canadian Research Institute (CERI) 2008).

# CANDU Reactors Worldwide 2008

Quebec, Canada
Gentilly-2 1 unit

Ontario, Canada
Darlington 4 units
Pickering 8 units
Bruce 8 units

New Brunswick, Canada
Point Lepreau 1 unit

Argentina
Embalse 1 unit

Romania
Cernavoda 2 units

Pakistan
KANUPP 1 unit

India
RAPS 2 units

China
Qinshan 2 units

Republic of Korea
Wolsong 4 units

## Nuclear Facts—Ontario

- In 2007, electricity in Ontario was generated from nuclear (51%), hydro (21%), coal (18%), oil and natural gas (8%) and other alternative sources (2%).
- By 2020, Ontario will need to replace about 80% of its electrical generation (25,000 MW) because of growth in demand and aging plants, about half of which are nuclear.
- Load growth1997-2007—Ontario's electricity demand has increased from 146 TWh to 154 TWh over the last decade – less than 1.0% per year and by average 0.5 % per year (Source: Independent Electricity System Operator [IESO]).
- In 2007, Ontarians electricity consumption was 152 TWh an increase of one TWh from 2006.
- By 2015, by refurbishing existing nuclear capacity, Ontario will ensure 14,890 MW of electrical generation.
- By 2015, by not replacing existing nuclear capacity through refurbishment or new nuclear construction, Ontario would be left with only 5,900 MW of nuclear capacity.
- Bruce Power is refurbishing Bruce A (ON) Units 1 & 2 (805 MW each) with a return to service date 2009-2010 and will refurbish Bruce A Units 3 & 4 at the completion of 1 & 2.
- The top two performing nuclear reactors in Ontario in 2007 were: Bruce 7 (872MW) with 97.2 % performance and Darlington 1 (935 MW) with 96.7% performance.
- In 2006, Ontario Power Generation and Bruce Power began the environmental assessment process for new nuclear construction.
- March 7, 2008, the Government of Ontario began the process to review available nuclear technologies to bring on replacement nuclear generation.
- The cost of building new nuclear capacity is competitive with coal and natural gas generation (Source: Canadian Energy Research Institute, 2006).

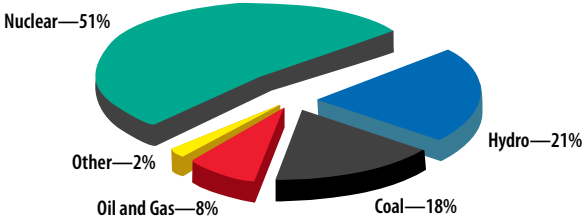
## Nuclear Reactors in Ontario (20 in 2007)

Pressurized Heavy Water CANDU reactors provide 51% of Ontario's electricity.

| Unit | Status | Design Capacity (MW) | Actual Capacity (MW) | | In-Service Date |
|---|---|---|---|---|---|
| | | | Net | Gross | |
| Bruce A–1 | Restart 2010 | 905 | 750 | 805 | 09/01/1977 |
| Bruce A–2 | Restart 2009 | 905 | 750 | 805 | 09/01/1977 |
| Bruce A–3 | Operational | 905 | 750 | 805 | 02/01/1978 |
| Bruce A–4 | Operational | 905 | 750 | 805 | 01/18/1979 |
| Bruce B–5 | Operational | 915 | 795 | 845 | 03/01/1985 |
| Bruce B–6 | Operational | 915 | 822 | 872 | 09/14/1984 |
| Bruce B–7 | Operational | 915 | 822 | 872 | 04/10/1986 |
| Bruce B–8 | Operational | 915 | 795 | 845 | 05/22/1987 |
| Darlington 1 | Operational | 935 | 878 | 934 | 11/14/1992 |
| Darlington 2 | Operational | 935 | 878 | 934 | 10/09/1990 |
| Darlington 3 | Operational | 935 | 878 | 934 | 02/14/1993 |
| Darlington 4 | Operational | 935 | 878 | 934 | 06/14/1993 |
| Pickering A–1 | Operational | 542 | 515 | 542 | 07/29/1971 |
| Pickering A–2 | Safe Storage | 542 | 515 | 542 | 12/30/1971 |
| Pickering A–3 | Safe Storage | 542 | 515 | 542 | 06/01/1972 |
| Pickering A–4 | Operational | 542 | 515 | 542 | 06/17/1973 |
| Pickering B–5 | Operational | 540 | 516 | 540 | 05/10/1983 |
| Pickering B–6 | Operational | 540 | 516 | 540 | 02/01/1984 |
| Pickering B–7 | Operational | 540 | 516 | 540 | 01/01/1985 |
| Pickering B–8 | Operational | 540 | 516 | 540 | 02/28/1986 |
| **Total installed capacity** | | | **13,870** | **14,718** | |

*Source: CANDU Owners Group (COG), Bruce Power and Ontario Power Generation*

## Electricity Sources in Ontario 2007




*Source: Independent Electricity System Operator (IESO), 2007*

**Nuclear power was Ontario's principal source of electricity in 2007.**

Ontarians consumed about 152,000 GWh (152 TWh) of electricity in 2007, slightly higher than consumption in 2006 (151 TWh). Ontario exported a net total of 5.1 TWh in 2007.

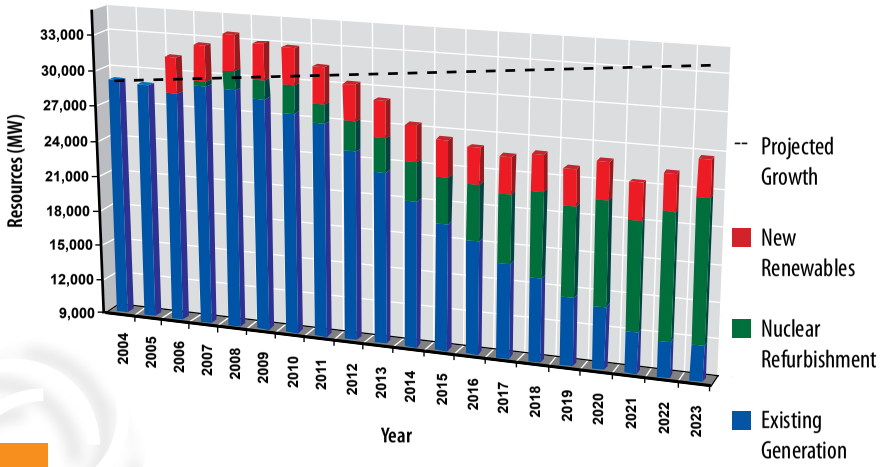
Nuclear facilities continue to provide the majority of supply for Ontario at 80.9 TWh, or 51 % of the total. The portion of Ontario's electricity production from hydroelectric generators remained steady at 21%, or 33.4 TWh.

**Sources of electricity in 2007:**

| | | |
|---|---|---|
| Nuclear | 51% | 81 TWh |
| Hydro | 21% | 33 TWh |
| Coal | 18% | 28 TWh |
| Oil and Gas | 8% | 12 TWh |
| Other | 2% | 3 TWh |
| **Total** | **100 %** | **157 TWh** |

*Note: Values are rounded. Source: IESO, January 10, 2007*

## Renewable Potential Added to Nuclear Refurbishment



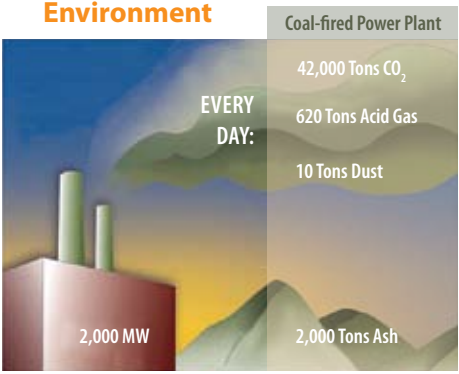
## Nuclear Facts—Quebec

- Hydro-Québec has efficiently managed its nuclear program for more than 30 years.
- In 1971, the 250 MW Gentilly-1, a prototype reactor, came into operation near Trois-Rivières on the south shore of the St. Lawrence River. Built and owned by AECL and operated by Hydro-Québec staff, the reactor had design and operational problems and was not economical. It was taken out of service in 1979.
- Quebec has only one nuclear power station in operation: Gentilly-2, owned by Hydro-Québec. Equipped with a 675 MW CANDU 6 reactor, the plant was constructed on the same site as Gentilly-1 and came into commercial operation in 1983.
- In 2007, Gentilly-2 achieved a gross capacity factor (performance rate) of 78.4%; it has a lifetime gross capacity factor of 79.5%.
- In 1995, one of Canada's first dry storage facilities for used nuclear fuel commenced operation at the Gentilly site.
- Gentilly-2 generates around 3% of the energy in the Hydro-Québec grid and plays an important part given its excellent performance and profitability. As a result of its location close to the main load centres, it also contributes to the stability of the network.
- Hydro-Québec will make a decision in 2008 on refurbishment of Gentilly-2. The work would be carried out in 2011–12 to allow continued operation until 2035.

## Nuclear Facts—New Brunswick

- New Brunswick Power Nuclear Corporation is a subsidiary of New Brunswick Power Corporation (NB Power), the largest electricity utility in Atlantic Canada. It operates Atlantic Canada's only nuclear facility, Point Lepreau Generation Station.
- Point Lepreau started generating nuclear power commercially in February 1983 and built the first CANDU 6 in Canada and in the world to be licensed for operation with a gross capacity of 680 MW.
- The Point Lepreau CANDU 6 supplies up to 30% of New Brunswick's electrical generation.
- In 2007, Point Lepreau operated with a capacity factor of 74.9%. Since 1983, the station's in-service lifetime capacity factor has been 82.1%.
- Point Lepreau became NB Power's first ISO 14001 registered generating station, demonstrating that advanced systems are in place to manage environmental issues.
- In 2006, the Canadian Nuclear Safety Commission approved proposed modifications to the Solid Radioactive Waste Management Facility at Point Lepreau.
- Low and stable uranium fuel costs contribute to a reliable supply of economical electricity.
- NB Power began an 18-month refurbishment of its reactor on March 31, 2008 to extend the station's life to 2032. Atomic Energy of Canada Limited (AECL) is the prime contractor.

## Environment




- **Nuclear energy does not pollute the air.**
- Nuclear energy produces virtually none of the pollutants that contribute to smog and acid rain.
- Nuclear energy produces virtually no greenhouse gases—gases that trap solar energy and contribute to global warming.
- Greenhouse gases, as listed in the Kyoto Protocol, are: carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride ($SF_6$).
- By using nuclear energy to produce electricity in Canada, we avoid the emission of about 90 million tonnes of greenhouse gases per year, equivalent to the greenhouse gases produced by 18 million cars or trucks—about 12% of Canada's total greenhouse gas emissions.
- Using nuclear power to produce electricity in Canada, we avoid the emission of an additional 10% of smog and acid rain-producing gases.

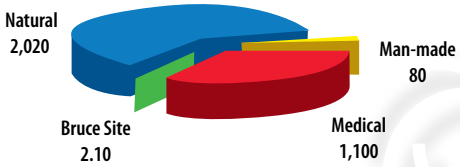
## Environment: The Kyoto Protocol

- By ratifying the Kyoto Protocol, Canada committed to lowering its emissions of six man-made greenhouse gases to 6% below emission levels in 1990: carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride ($SF_6$). Canada will not meet its Kyoto objectives.
- Greenhouse gases trap solar energy, reflecting some of it back to the earth.
- There is a concern that man-made greenhouse gases have raised temperatures and are changing the global climate. Fossil fuel combustion is the largest source of greenhouse gas emissions.
- To meet the reduction objectives set by the Government of Canada for 2025, Canada will need to rely on nuclear energy, which does not emit man-made greenhouse gases.
- Canada's energy demand is projected to increase by 34% by 2025, creating an increased requirement for reliable, clean electricity.
- Nuclear electricity generation in Canada saves us from emitting about 90 million tonnes of greenhouse gases a year—about 12% of Canada's total emissions.
- If all nuclear power plants in the world were replaced by modern fossil-fuelled power plants, $CO_2$ emissions from the world energy sector would rise by about 8%.

## Radiation

- Radiation is natural and everywhere. Radioactivity has been in all rocks, soils, waters and air since the earth was formed, and is responsible for the formation of mountains.
- X-rays are invisible and were discovered accidentally in 1895 by Wilhelm Roentgen in Germany when he noticed a crystal would glow whenever he turned on an electric current in a vacuum tube.
- In France, Henri Becquerel discovered nuclear radiation accidentally in 1896 when he noticed a photographic plate would darken after he put a piece of uranium rock on it.
- The radiation dose to the public as a result of radioactivity from all nuclear power plants in Canada is much less than regulatory limits and the radiation dose from naturally occurring sources.
- All Canadians are exposed to naturally-occurring radiation, mostly from the sun and from radon which is found in soil as well as manmade sources such as X-rays and air flight. As an example, a person flying one-way from Toronto to Vancouver will receive about 15 to 20 times the amount of radiation exposure as living at the perimeter of a nuclear plant for a whole year.

**Breakdown of Radiation Dose to Public in µSV (microsieverts)**



## Nuclear Regulation in Canada

- The Canadian Nuclear Safety Commission (CNSC) is the federal regulator mandated to protect the health and safety of persons and the environment, and to ensure national security from risks associated with the use of nuclear energy and nuclear material.
- The regulator issues regulations dealing with nuclear reactors, uranium mines, the use of radioactive material, radioactive waste and other related activities.
- Nuclear power plants (and other major nuclear facilities) require specific approvals for all stages from site selection to decommissioning. An extensive "Safety Report" is required before construction can begin. CNSC staff conduct inspections during construction and throughout the operating life. Members of CNSC staff located at each nuclear power site monitor operations on a day-to-day basis.
- The Canadian Nuclear Association, through its Regulatory Affairs Program, works with licensees to ensure that regulations are clear, cogent, and implemented in all respects.
- The industry works with the CNSC to develop and improve standards and operating procedures to ensure that the Canadian public have safe nuclear power plants.
- International peer reviews and shared practices are frequently conducted through the International Atomic Energy Agency and the World Association of Nuclear Operators.

## Long-term Care of Canada's Used Nuclear Fuel

- The small amount of used fuel (waste) produced by Canadian nuclear power plants to generate huge amounts of electricity is controlled and stored in carefully managed facilities.
- Used fuel is initially stored in water-filled bays at the site of the nuclear power plants for 5–10 years and then placed in large concrete canisters safely stored on site.
- Designs have been developed for a large underground storage facility, but no decision has yet been made to construct one at this time.
- The total amount of used fuel from Canada's nuclear power plants could be stored in five hockey rinks up to the height of the boards.
- In 2006, Ontario Power Generation began the environmental assessment for a deep geological repository to store low and intermediate level waste at the Bruce nuclear site.
- In Canada's 46 years of using nuclear energy, no member of the public has been harmed as a result of a radiation leak from a nuclear power plant or waste storage facility.
- The Nuclear Waste Management Organization (NWMO), established in 2002 to develop with Canadians a management approach for the long-term care of Canada's used nuclear fuel recommended to the federal

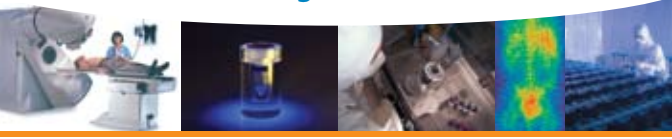
government in November 2005 an **Adaptive Phased Management** approach which includes: storage at reactor sites and long-term geological storage.

Adaptive Phased Management features:

- Centralized containment and isolation of used nuclear fuel in a deep geological repository in a suitable rock formation (Canadian Shield and Ordovician sedimentary rock)
- Optional shallow underground storage facility while developing deep geological repository
- Continuous monitoring with the potential for retrieval for an extended period of time
- Seek an informed and willing community
- Focus site selection in provinces directly involved in the nuclear fuel cycle
- The NWMO recommendation would have the used CANDU fuel remain safely stored at Canadian nuclear reactor sites until the design, siting, environmental assessments, site licensing, specific site R&D, transportation systems, confirmation of suitability of site, final design, safety analysis, public consultations and decision to construct are completed.

In 2007, the Government of Canada accepted the **Adaptive Phased Management** approach.

## Advancing Global Health



- Global nuclear medicine largely started in Canada in 1951, when the first two cancer-treatment machines using cobalt-60 (radioisotopes) were built. One was built by Dr. Harold Johns of Saskatoon and one by Eldorado Mining and Refining Ltd., later to become part of Atomic Energy of Canada Limited (AECL) and then later again to become part of MDS Nordion.
- A global leader, MDS Nordion provides innovative technologies for medical imaging, targeted cancer treatments, and sterilization of medical devices. Their innovation touches the lives of millions of people in more than 70 countries around the world.
- MDS Nordion supplies over half of the world's medical isotopes used in capturing molecular images. These images enable physicians to diagnose and treat a multitude of diseases including cardiac and neurological conditions, in addition to several types of cancers.
- MDS Nordion provides innovative targeted cancer treatments for a variety of conditions including liver and brain cancer, and non-Hodgkins lymphoma. Many of these treatments target cancer from within the body to deliver a higher concentration of treatment to the tumour.

- Canadian-produced medical isotopes for nuclear medicine are used in over 60,000 procedures a day world-wide, 5,000 in Canada.
- Canada's nuclear infrastructure is essential to the global medical isotope supply. MDS Nordion processes materials from Atomic Energy of Canada Limited (AECL) at the Chalk River Laboratories to produce 50% of the world's medical isotopes.
- Canada supplies 75% of the world's cobalt-60 used to sterilize more than 45% of the world's single-use medical supplies and devices, such as bandages, catheters and syringes. This technology is also used to sterilize a vast array of consumer products, including food, contact lens solution and cosmetics.
- Canada's cobalt-60 is produced in nuclear reactors at Bruce Power and Pickering in Ontario and Gentilly-2 in Quebec.
- Canada is a leader in the development of gamma technology used to eliminate food-borne pathogens, such as harmful E.Coli and Salmonella, to make food safer and as a quarantine treatment for fruits and vegetables to reduce post-harvest losses caused by spoilage, pest infestation and contamination.
- Through a partnership with the TRIUMF Laboratory and MDS Nordion, medical isotopes are also produced by three cyclotrons on the University of British Columbia campus. Radioisotopes are also produced at McMaster University in Ontario.

## Resources

**American Nuclear Society**
www.ans.org

**AREVA Canada**
www.arevacanada.ca

**AREVA Resources Inc.**
www.arevaresources.ca

**Atomic Energy of Canada Limited**
www.aecl.ca

**Australian Uranium Association**
www.aua.org.au

**Bruce Power**
www.brucepower.com

**Cameco Corporation**
www.cameco.com

**Canadian Nuclear Association**
www.cna.ca

**Canadian Nuclear Safety Commission**
www.nuclearsafety.gc.ca

**Canadian Nuclear Society**
www.cns-snc.ca

**Canadian Nuclear Workers Council**
www.cnwc-cctn.ca

**CANDU Owners Group**
www.candu.org

**Centre for Energy**
www.centreforenergy.com

**European Nuclear Society**
www.euronuclear.org

**Foratom—European Atomic Forum**
www.foratom.org

**Hydro-Québec**
www.hydroquebec.com

**Independent Electricity Systems Operator (IESO)—Ontario**
www.ieso.ca

**International Atomic Energy Agency (IAEA)**
www.iaea.org

**International Commission on Radiological Protection**
www.icrp.org

**International Energy Agency**
www.iea.org

**McMaster University**
www.mcmaster.ca

**MDS Nordion**
www.mds.nordion.com

**Natural Resources Canada—Nuclear Energy Division**
www.nuclear.nrcan.gc.ca

**New Brunswick Power**
www.nbpower.com

**Nuclear Energy Institute (U.S.)**
www.nei.org

**Nuclear Waste Management Organization**
www.nwmo.ca

**Ontario Power Generation**
www.opg.com

**Organisation for Economic Co-operation and Development Nuclear Energy Agency**
www.nea.fr

**Power Workers' Union**
www.pwu.ca

**Society of Nuclear Medicine**
www.snm.org

**United Nations Scientific Committee on the Effects of Atomic Radiation**
www.unscear.org

**University of Ontario Institute of Technology**
www.uoit.ca

***Unlocking the Atom: The Canadian Book on Nuclear Technology***
Hans Tammemagi, David Jackson, McMaster University Press, 2002
www.unlockingtheatom.ca

**World Nuclear Association**
www.world-nuclear.org

**World Nuclear University**
www.world-nuclear-university.org

## NUCLEAR ENERGY IS EFFICIENT

CANDU nuclear power plants produce 14.6 % of Canada's electricity including 51% of Ontario's power using small pellets like these. Eight of these tiny uranium fuel pellets contain enough energy to power an average 2000-square-foot home for almost a year. And all that electricity is clean with none of the emissions that contribute to smog, acid rain or global warming.

Canadian Nuclear Association

**THE VOICE OF CANADA'S NUCLEAR INDUSTRY**

The Canadian Nuclear Association (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.

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