

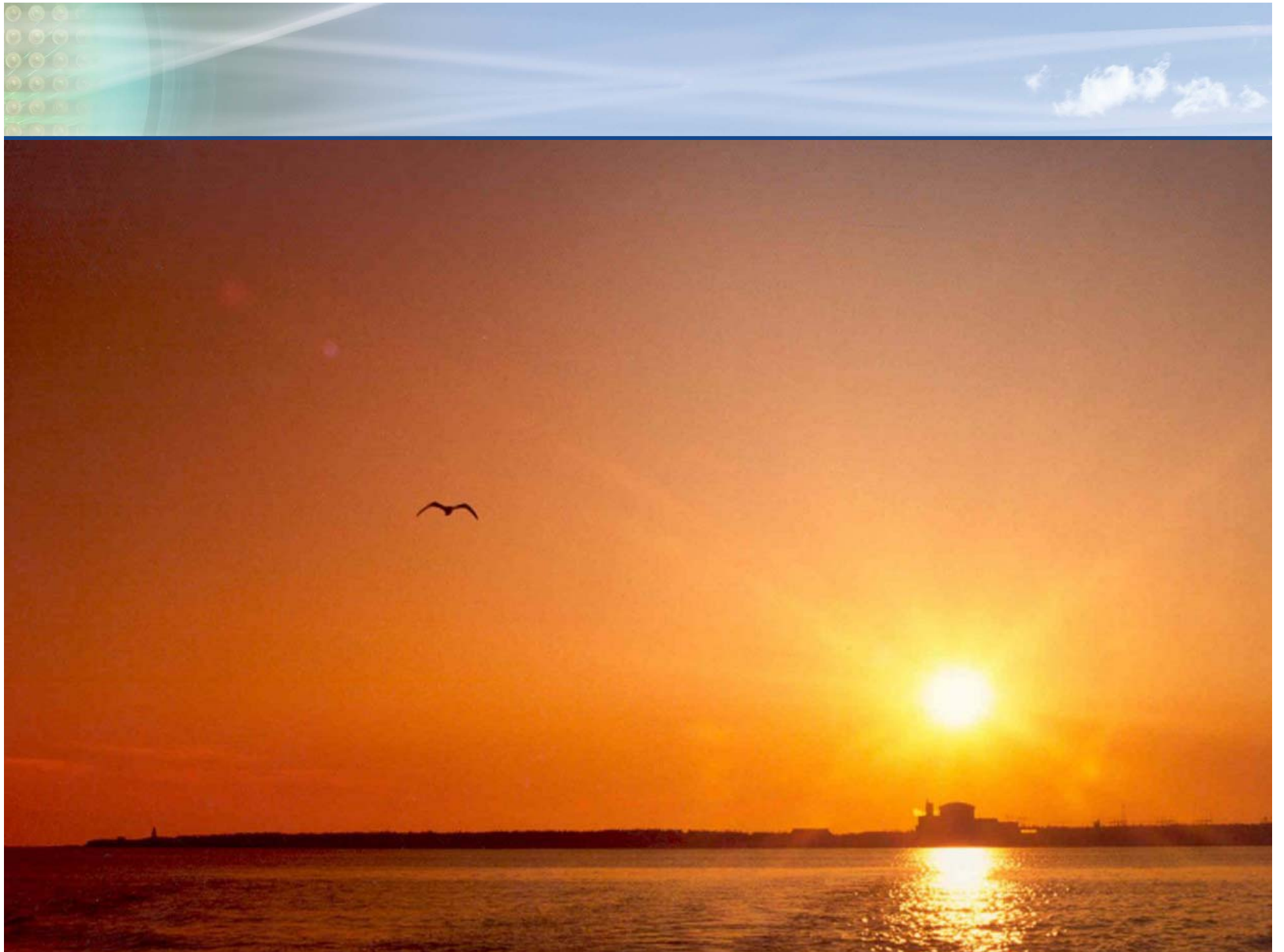
# Nuclear in Saskatchewan

Saskatoon EMTF  
March 4, 2009

**Dr. Ron Oberth**

**Director  
Marketing and Business Development**





# Today's Agenda



Introduction to AECL



Nuclear Power 101



Nuclear Developments Worldwide



Economic Impacts of Nuclear Power



Public Attitudes on Nuclear Power



Long Term Used Nuclear Fuel Management



# CANDU among top Canadian inventions



# Atomic Energy of Canada Limited

## Global Nuclear Technology Company

- Established in 1952 by Government of Canada
- More than 5000 employees mainly at Chalk River and Mississauga, Ontario

## Our Business

- CANDU Reactor Sales and Services
- Research & Development
- Nuclear Waste Management
- Medical Isotope Production

# Where it all began...

- **Canada was the first country outside USA to achieve a nuclear chain reaction - September 5, 1945 at Chalk River**
- **Two Canadian research reactors followed:**
  - **1947 NRX (National Research Experimental)**
  - **1957 NRU (National Research Universal)**
- **NRU is still used today for CANDU development, research, and isotope production**



Chalk River

# Nuclear Medicine

## Cancer therapy invented in Canada:

- 12 million cancer treatments a year using Cobalt-60
- Pioneered by Dr. Johns in Saskatchewan – with first cobalt cancer therapy treatment on November 8, 1951



## AECL produces more than 60% of the world's supply of radioisotopes

- More than 70,000 people a day around the world receive advanced medical diagnostics or cancer treatments

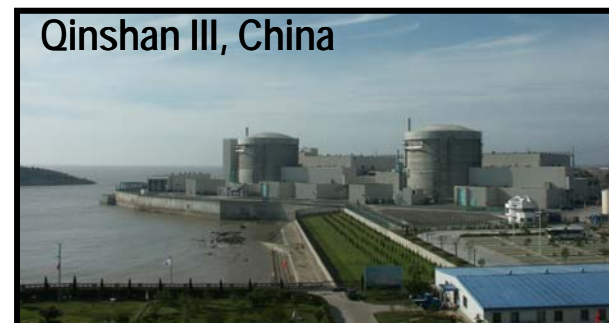
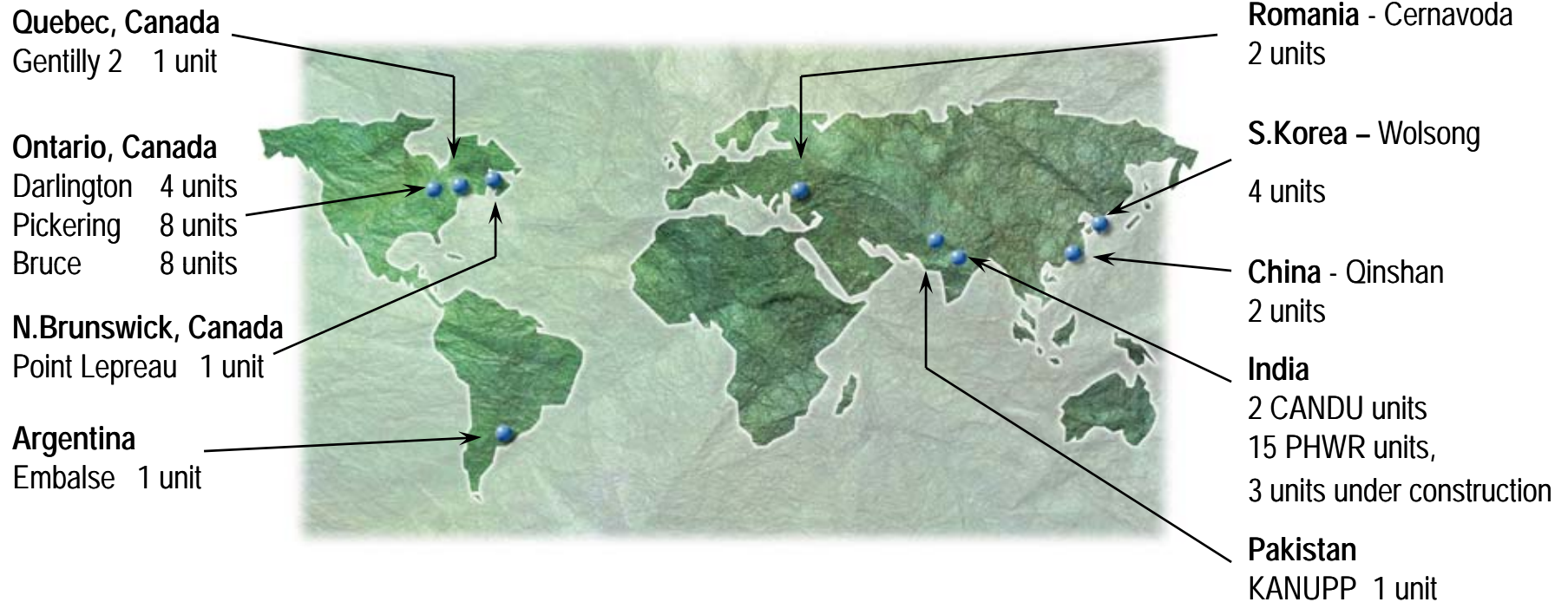
# Canadian Nuclear Industry

- **Canada has been a nuclear industry leader since 1940's**
  - Exported seven CANDU reactors in the past 10 years
  - World's largest exporter of isotopes & uranium
- **\$5 billion/year industry**
  - 30,000 workers, 150 companies
- **20 CANDU reactors in Canada**
  - Over 50% of generation in Ontario is nuclear
  - 17% of generation across Canada is nuclear





# CANDU – An International Success



# Nuclear Share of Electricity Production

**Figure II**  
**Nuclear Share of Total Electricity Generation**  
(percent in 2007)



Source: International Atomic Energy Agency, 2008.

# What the future holds

## **Nuclear Renaissance is here:**

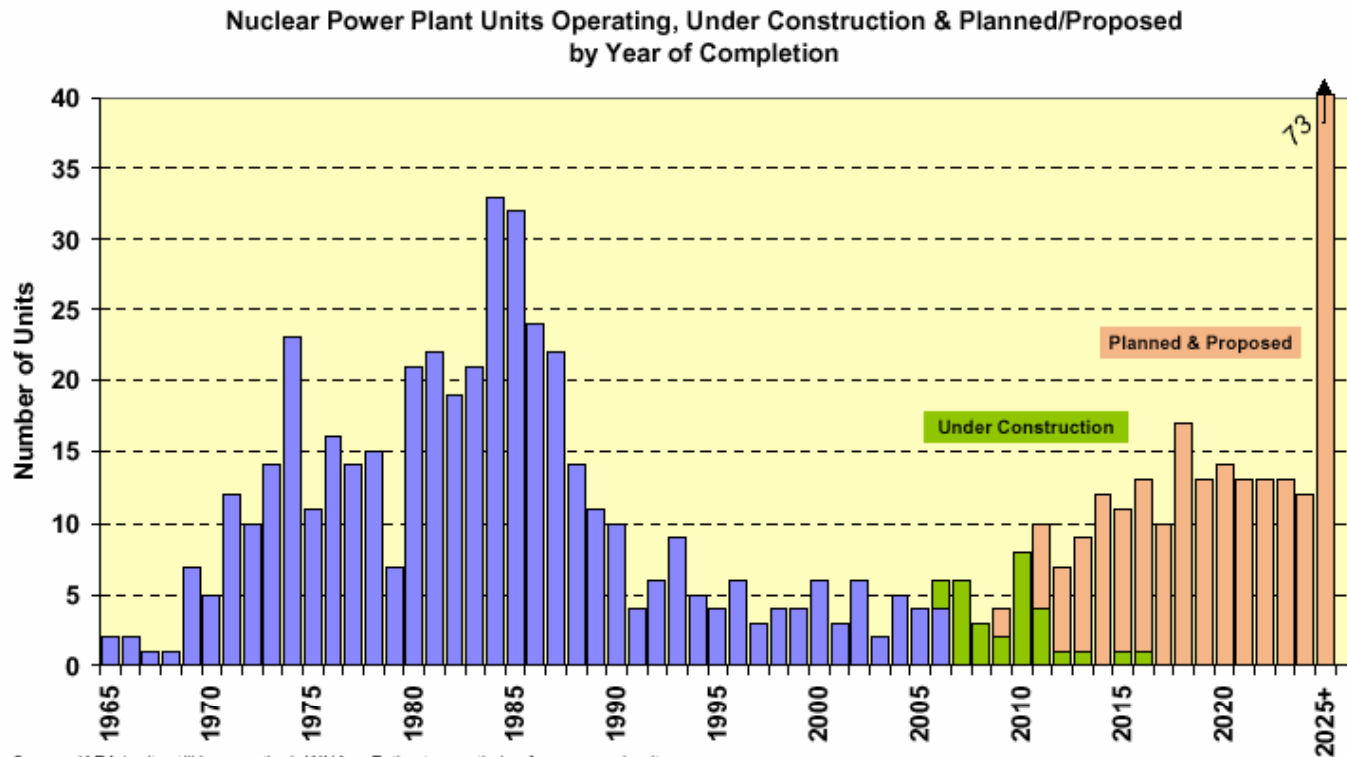
- **440 nuclear power plant units operating worldwide**
- **30 nuclear power plant units under construction**
- **200 plants planned or proposed**



**World Nuclear Association predicts that by 2030 there will be between 700 and 1500 nuclear plants worldwide**

# Worldwide Growth in Nuclear

- New growth – North & South America, Europe
- Continued growth – Asia & Russia
- New interest in many developing countries

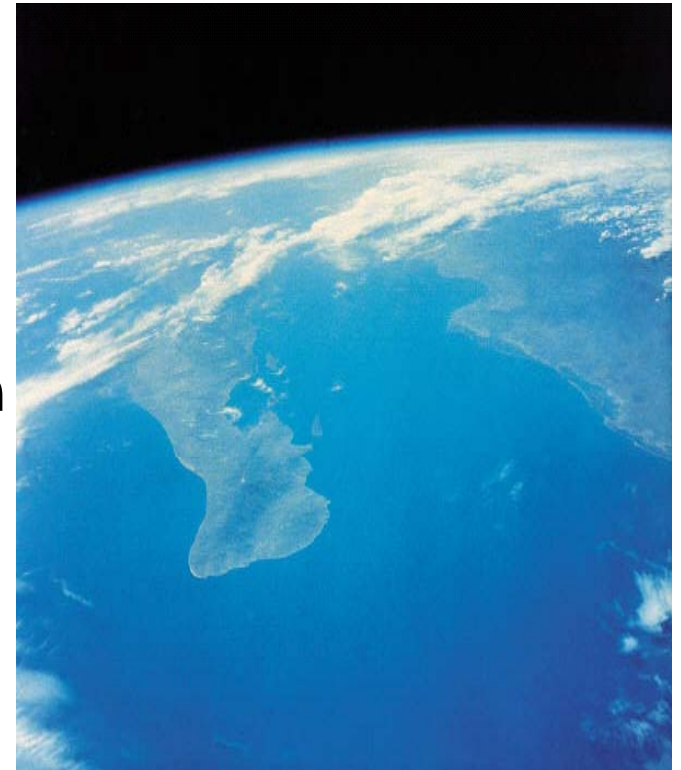




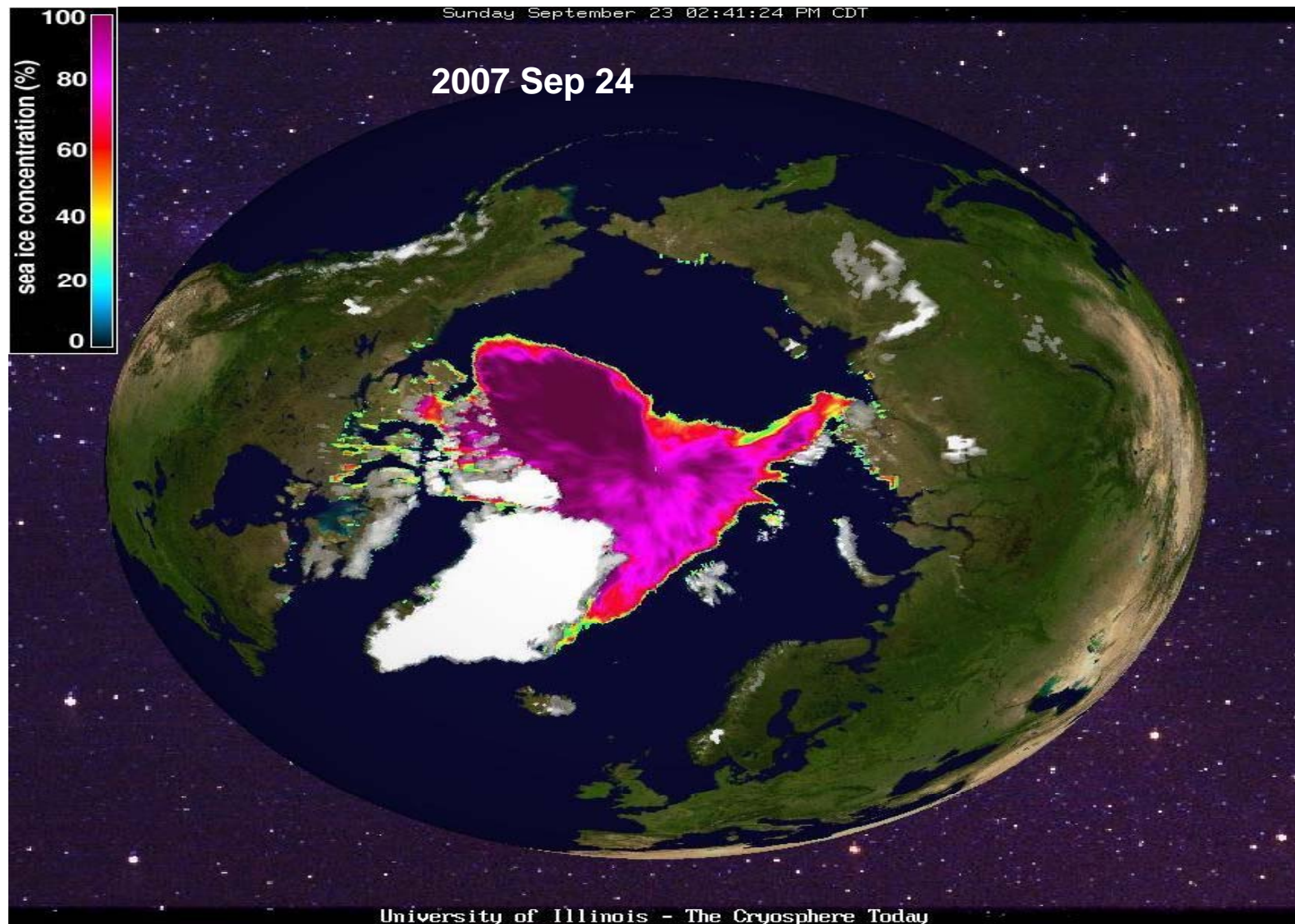
# Key Driver of Nuclear Renaissance

## The Environment

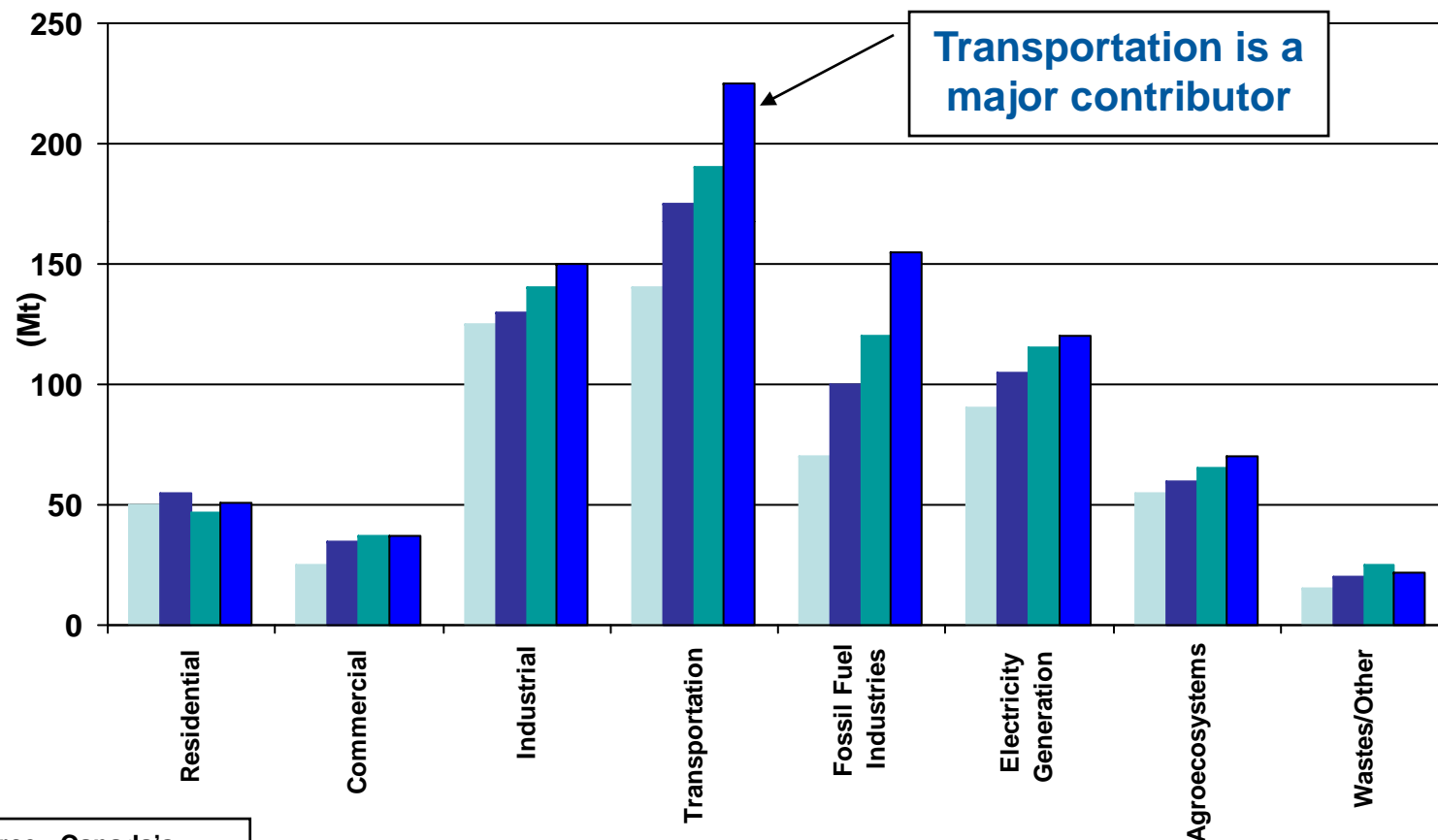
- Nuclear plants do not produce green house gases (GHG) or other harmful emissions
- CANDU units in Canada save 90 million tonnes of GHG emissions annually
- Equal to 18 million cars and trucks
  - 12% of Canada's total GHG production



# The Planet Isn't Waiting



# Canada's GHG Emission Breakdown by Sector

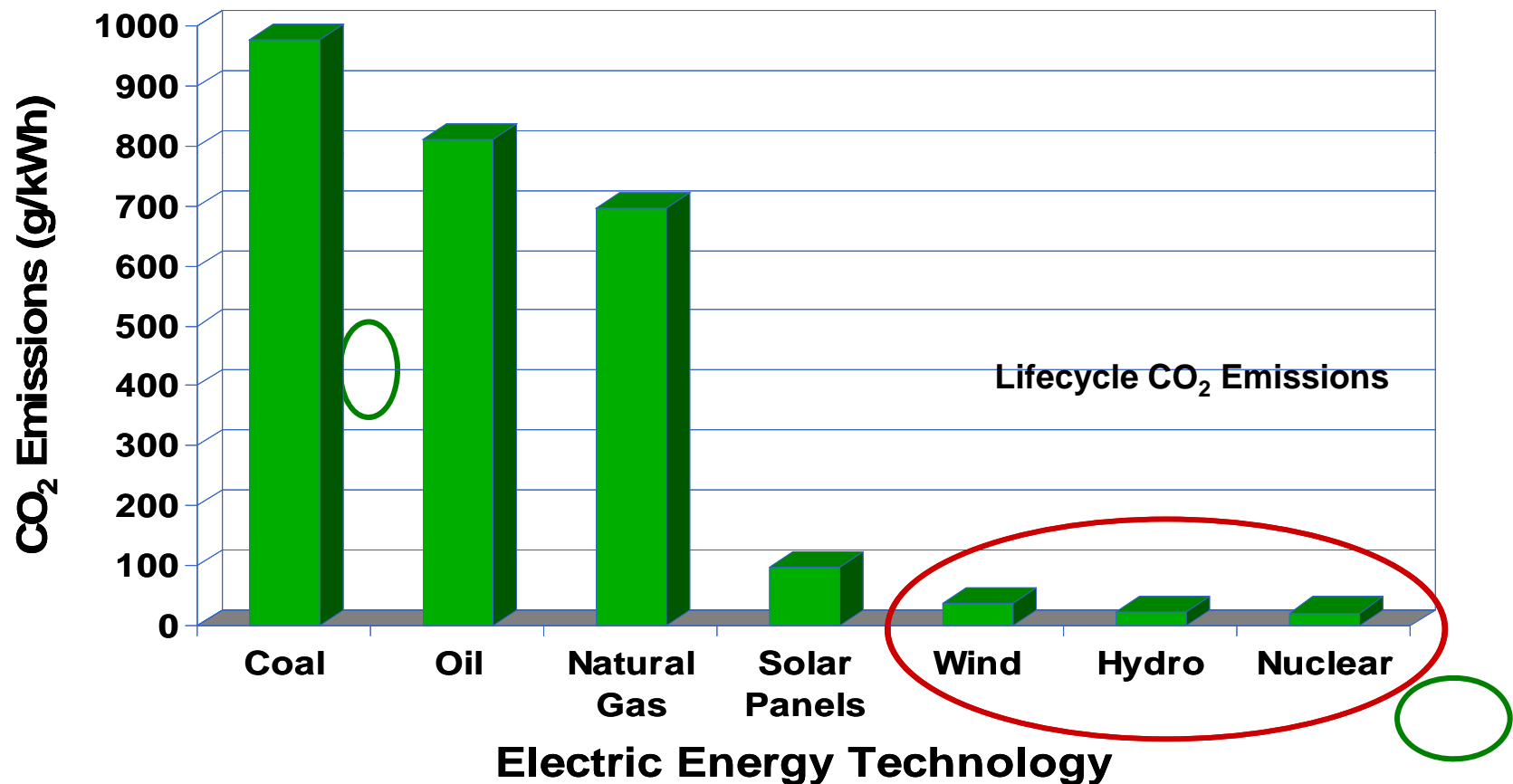


Source: Canada's Emissions Outlook: An Update 1999

1990 2000 2010 2020

# Nuclear Environmental Benefits

- Nuclear environmental impact very low / equivalent to renewables – especially wind & large hydro



Source: IAEA Spadaro et al. 2000



# Nuclear Safety

- In 40 years of nuclear power production in Canada no member of the public has been harmed by radiation from a nuclear power plant or waste storage facility
- Nuclear power is a highly regulated industry – to protect the health and safety of workers/public and to protect the environment
- CANDU facilities are designed to withstand disaster events (e.g. earthquakes, plane crashes)
- Additional enhanced public security / anti-terrorism features are incorporated in the new Advanced CANDU Reactor (ACR) design





# CANDU<sup>®</sup>

## Understanding the Technology



# CANDU Products

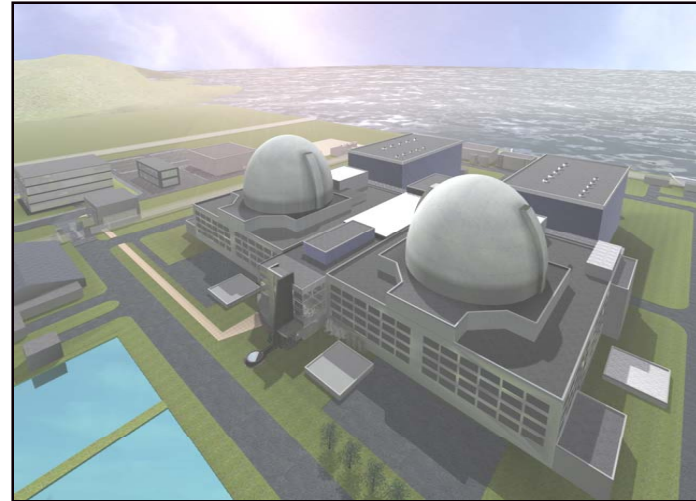
## CANDU 6/EC6

- 700 MW net output
- Natural uranium fuel
- Long track record
- Lowest risk
- Licensed in five countries



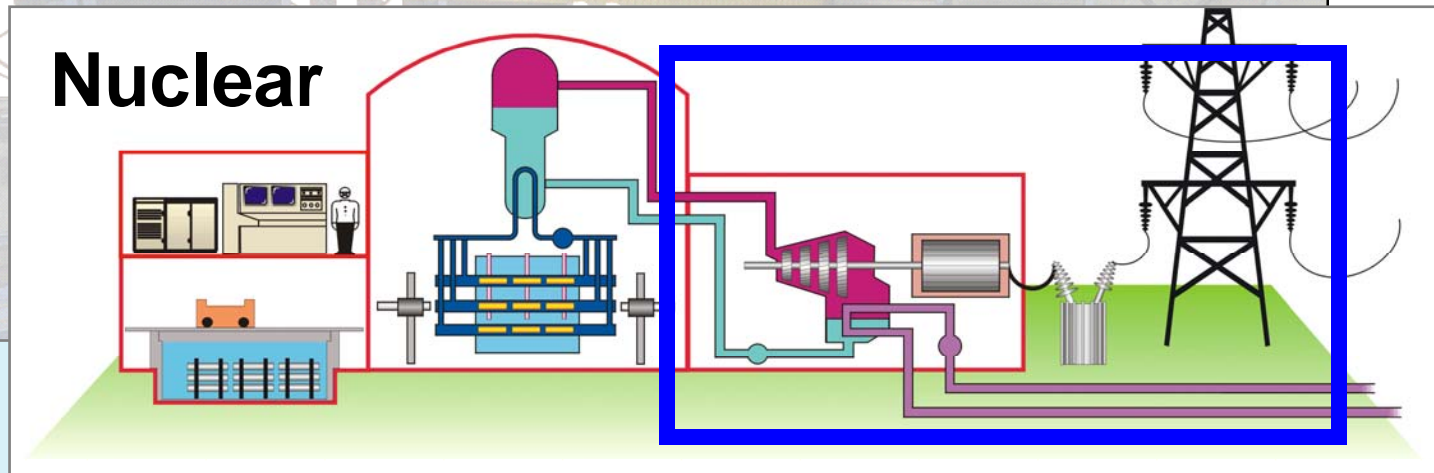
## ACR-1000

- 1085 MW net output
- Enriched U fuel (2.4%)
- New advanced design
- Lower capital cost
- Improved operations & economics

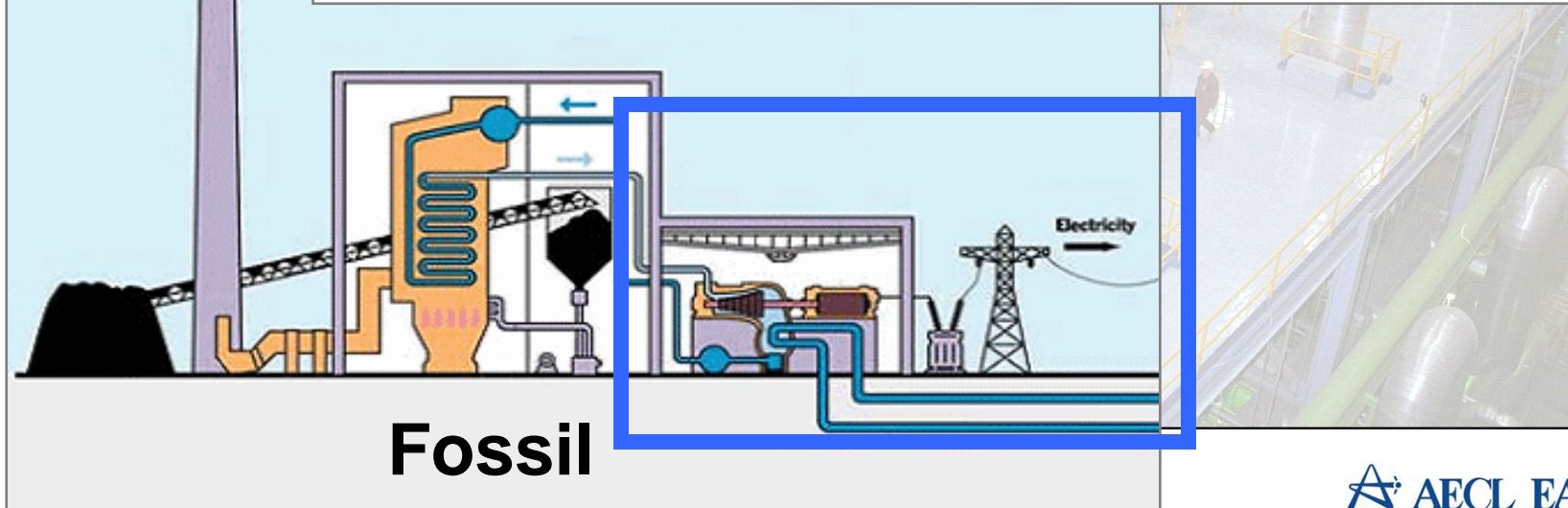


# Making Electricity

## Nuclear



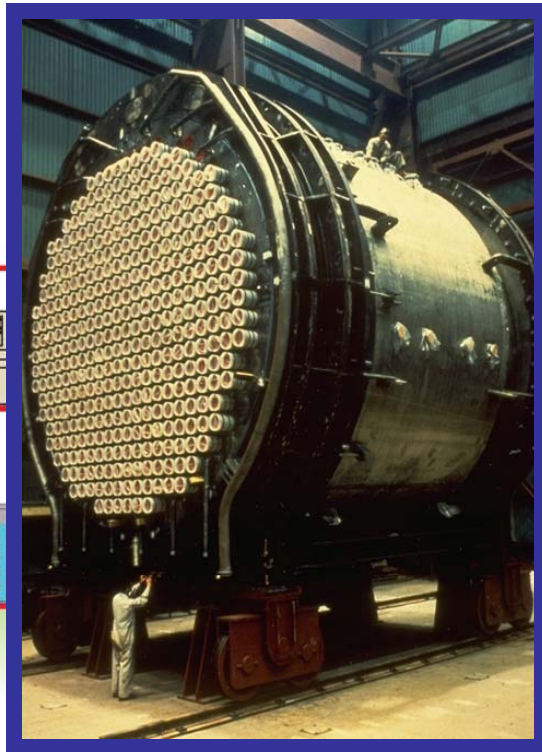
## Fossil



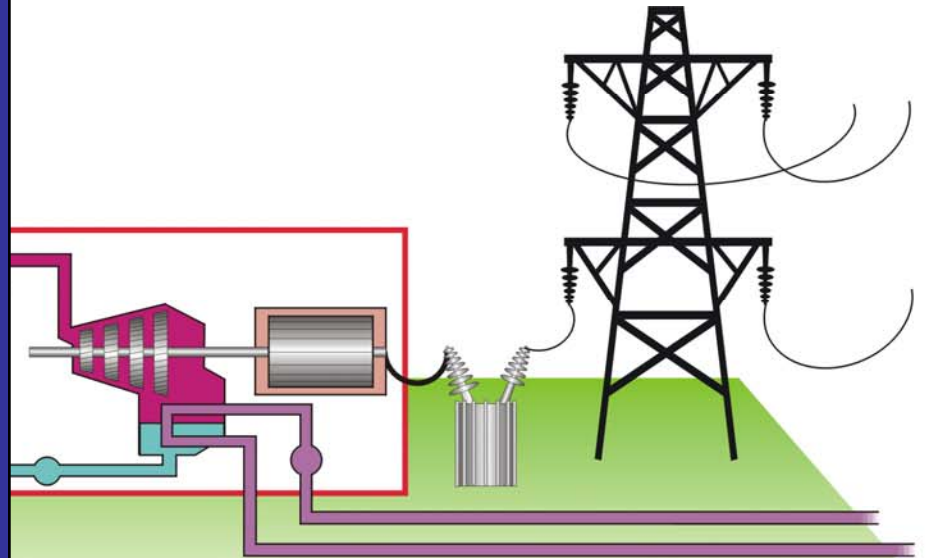


# Inside a CANDU Nuclear Power Station:

## The Reactor Core



**Calandria**



# CANDU Fuel:

A little bit goes a long way



**1 CANDU  
fuel bundle  
(50 cm long,  
23 kg)**

=

**Electricity for 100  
homes for 1 year**



# Energy Content Comparison



**1 CANDU  
fuel bundle  
(50 cm long,  
23 kg)**



**= 400 tonnes  
coal**

↓  
**1000 tonnes CO<sub>2</sub>  
1 tonne particulates  
8 tonnes acid gas**



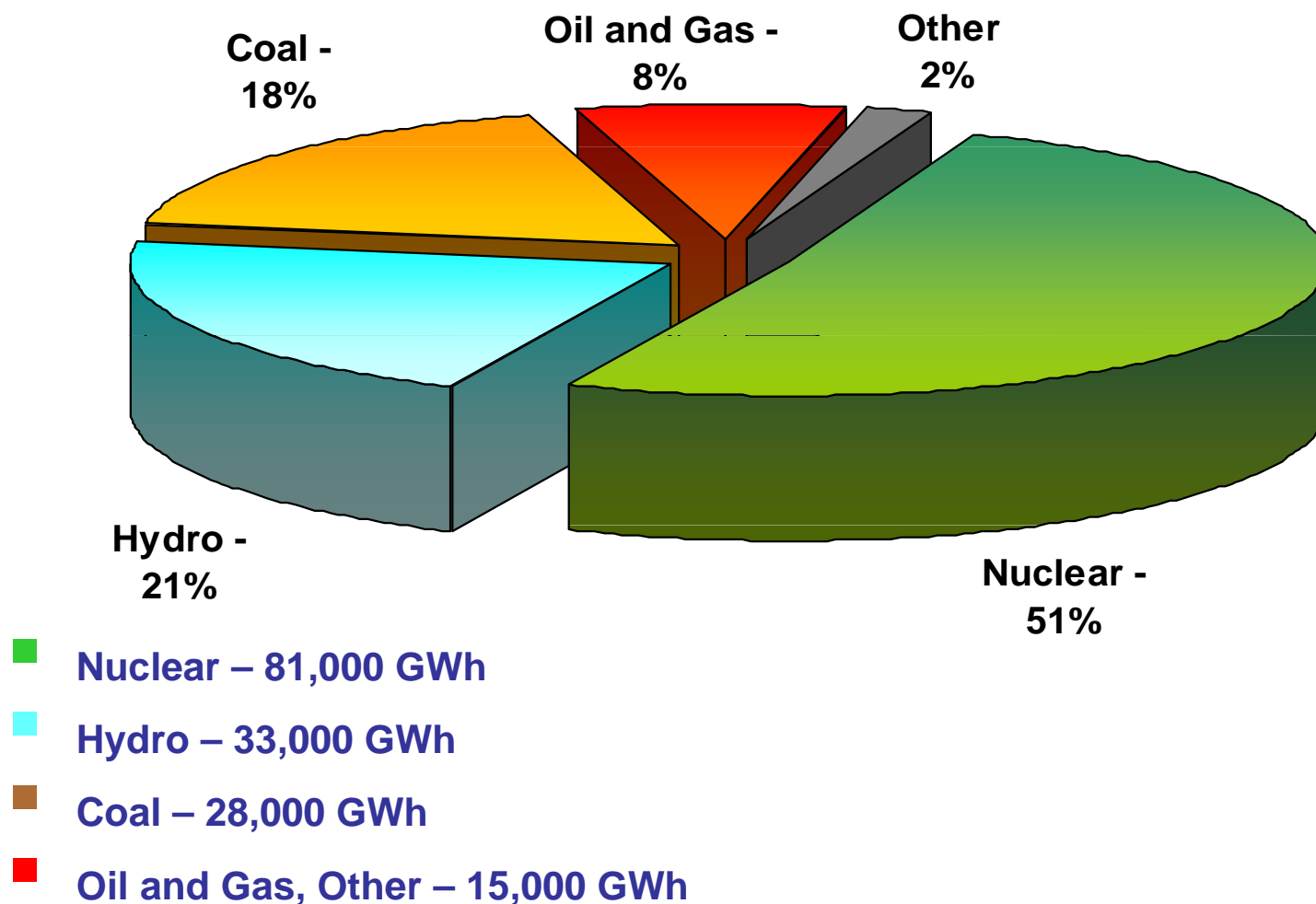
**= 60,000 gal  
oil**



**= 10 million ft<sup>3</sup>  
natural gas**

↓  
**600 tonnes CO<sub>2</sub>  
1 tonne acid gas**

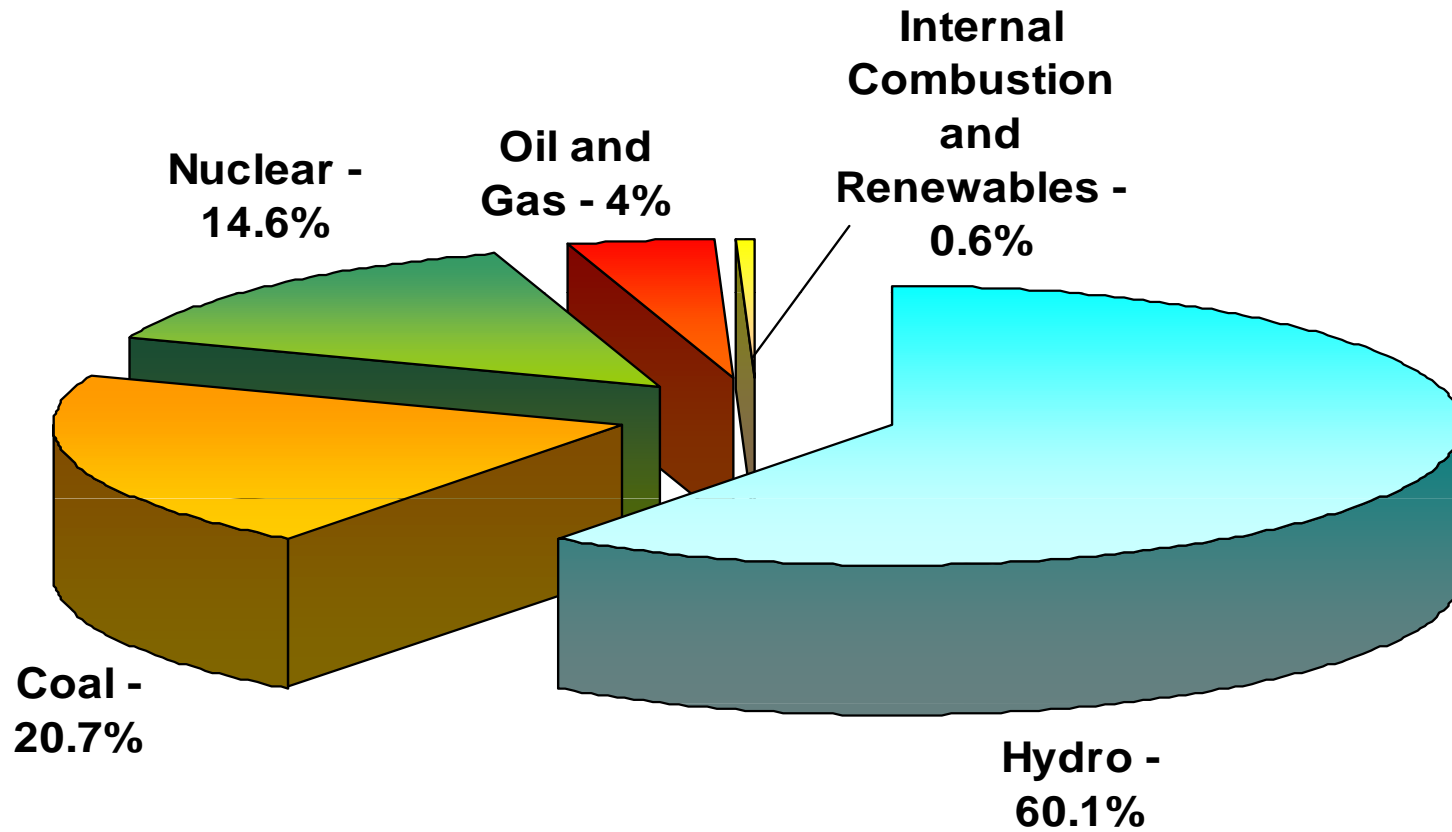
# Electricity Sources in Ontario (2007)



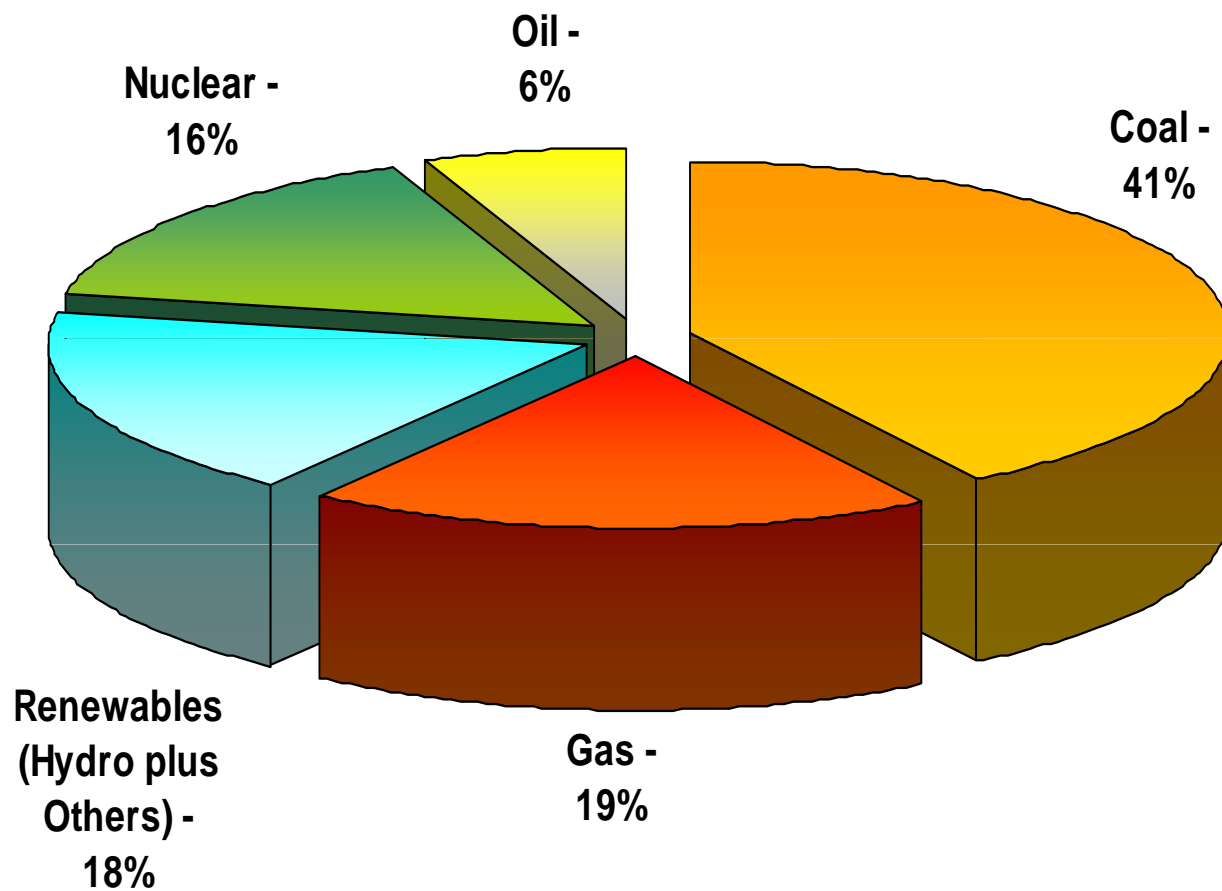
Source: Independent Electricity System Operator (IESO), 2007



# Electricity Sources in Canada (2007)



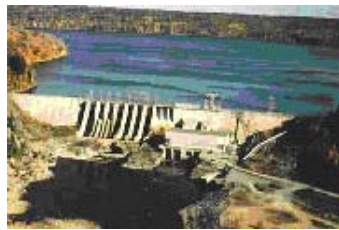
# Global Electricity Generation



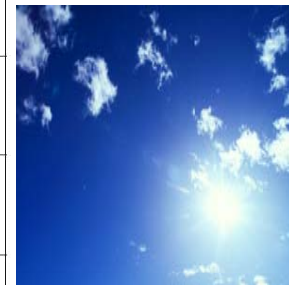
Nuclear power produces 16% of global electricity and is the world's third largest source of electricity

Source: OECD/IEA World Energy Outlook (2006)  
Data for the year 2004. Page 492.

# Filling the Gap: What are the tradeoffs?



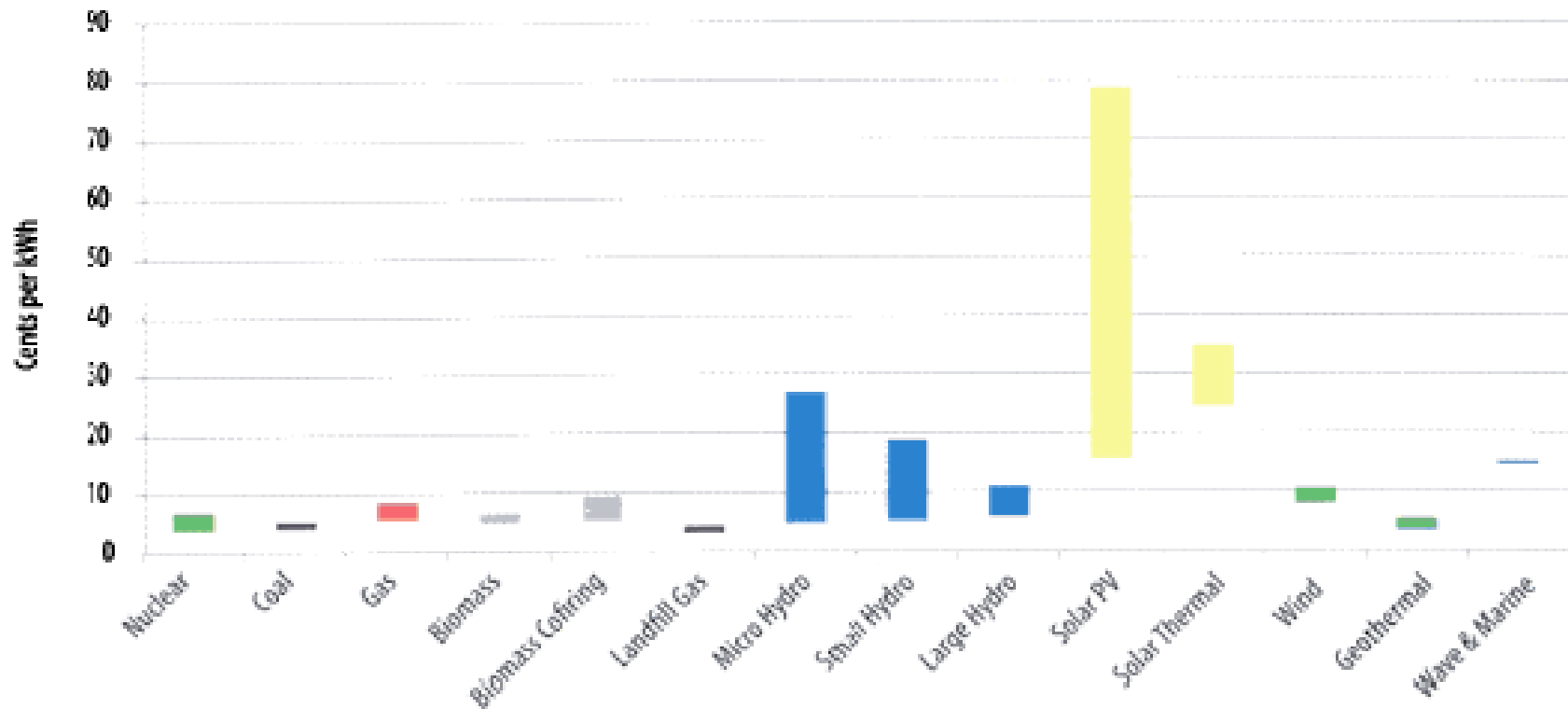
	Renewable	No CO2 and GHG Emissions	Small Footprint (Env. Impact of use of land)	Low Operating Cost	Low Capital Cost	Suitable for Reliable Baseload Supply
Gas			✓		✓	✓
Hydro	✓	✓	✓			
Coal			✓		✓	
Wind	✓	✓		✓		
Solar	✓	✓	✓			
Nuclear		✓	✓	✓		✓



**All of these energy sources are part of the solution to the energy crisis**

# Cost Comparison

## Costs of Different Energy Sources



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



# Saskatchewan Electricity Supply

- **SaskPower has a generating capacity of 3,200 MW:**
  - three coal-fired plants
  - four natural gas-fired plants
  - seven hydroelectric plants
  - two wind facilities
- **SaskPower must replace up to 2800 MW of retiring fossil-fired generation between 2020 and 2030**
- **Provincial GHG-reduction programs and strong growth of the Saskatchewan economy (including development of oils sands in NW Saskatchewan) could increase this new supply need**
- **SaskPower was requested by the new government to prepare a Long Range Plan for energy supply for the period of 2015 to 2050 and to consider provincial economic impacts**

# Nuclear Update –East

## Ontario

- **Ontario Government is conducting a competitive tender process to select the supplier for next nuclear plant in Ontario**
- **The Ontario Government announced that the next plant would be located at the Darlington site and would be operated by OPG**
- **Decision on the winning bid from among Canadian, French and US suppliers is expected in June 2009 – three bids received on Feb 27-09**

## New Brunswick

- **AECL and partners completed a Feasibility Study in 2008 on constructing an ACR-1000 at the Point Lepreau Site in New Brunswick to supply power to the maritime provinces and to New England States.**
- **NB Government announcement on this Project is expected in Spring 2009 pending confirmation of an investor group**

# Nuclear Update – West

## Alberta

- **Alberta Government appointed a three person expert panel to advise on feasibility of introducing nuclear power to the province – report will be released in March 2009 to form the basis for public debate.**
- **Bruce Power Alberta is seeking approval for a nuclear plant at a site near Peace River to supply the power grid as well as oil sands projects.**

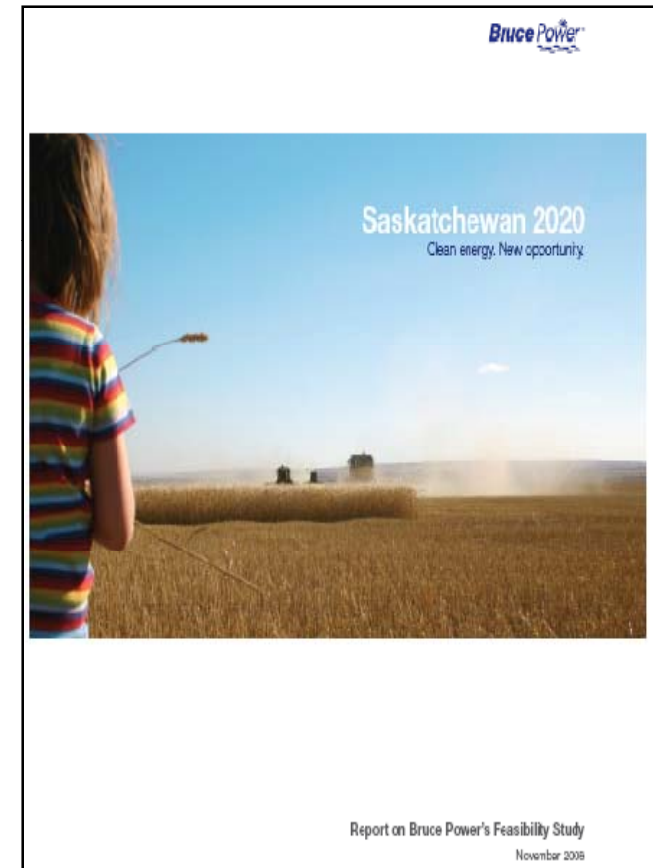
## Saskatchewan

- **Saskatchewan Government recently announced the formation of a “Uranium Development Panel” to identify opportunities to expand the nuclear industry in Saskatchewan beyond Uranium mining – this could include a nuclear plant to supply the provinces expanding economy**
- **Bruce Power released their nuclear feasibility study “Saskatchewan 2020” in November 2008 which concluded that:**
  - **nuclear could contribute at least 1000 MWe of generation by 2020.**
  - **North and South Saskatchewan Rivers were identified as viable water sources (Prince Alberta economic sub-region)**

# Economic Impacts of Nuclear

Saskatchewan 2020 Feasibility Study  
(Bruce Power, November 2008):

- **Base case: two-units of 1000 MWe each**
- **EA and Construction Phase (nine years)**
  - 20,000 direct, indirect and induced jobs
  - Contribute \$4B to provincial economy
- **Operations Phase (60 years)**
  - 1000 full time positions
  - 900 indirect jobs
  - \$240 M annual contribution to provincial economy





# Public Attitudes to Nuclear

- Canadian Nuclear Association Poll (Feb/08)

## Saskatchewan

- Support – 55%
- Oppose – 41%

## Ontario

- Support – 65%
- Oppose – 34%

- POLLARA Poll for Bruce Power (800 residents in July/08)

## Saskatchewan

- Support – 52%
- Oppose – 39%

# Long Term Used Nuclear Fuel Management



# Pool Storage of Used Fuel

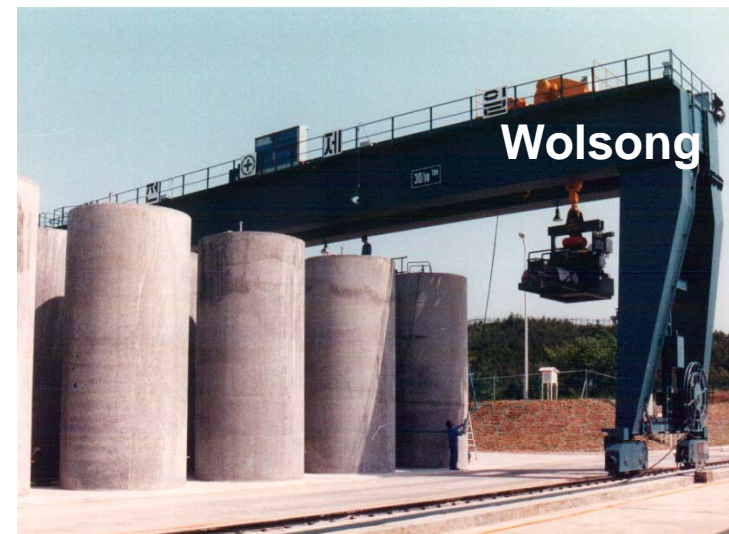
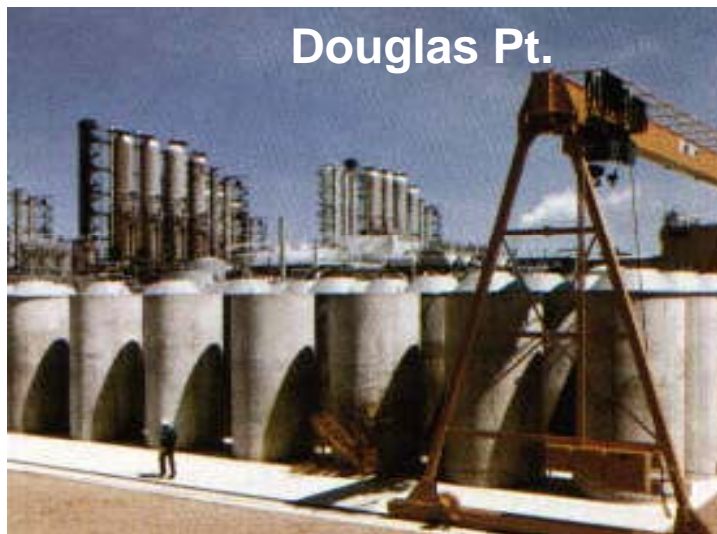
**Six to ten years in pools to allow decrease in decay heat generation (from  $>30,000$  W / bundle to  $\sim 5$  W / bundle at 10 years)**

**Total used fuel from all Canadian reactors produced so far would fit in a football field to the height of one player**





# Dry Storage Facilities





# Geologic Disposal – Int'l Progress

Sweden – Two sites in granite rock under evaluation.



Finland – One site selected in granite rock under evaluation

USA – One site selected in tuff rock. License application 2008



# Management of Used Fuel in Canada

- **Nuclear Waste Management Organization (NWMO) studied three approaches for the long-term management of used fuel and issued a recommendation to the government on Nov. 15, 2005:**



**Extensive public consultation in four nuclear provinces**

**Long Term Plan approved by Federal Government - July 2007**

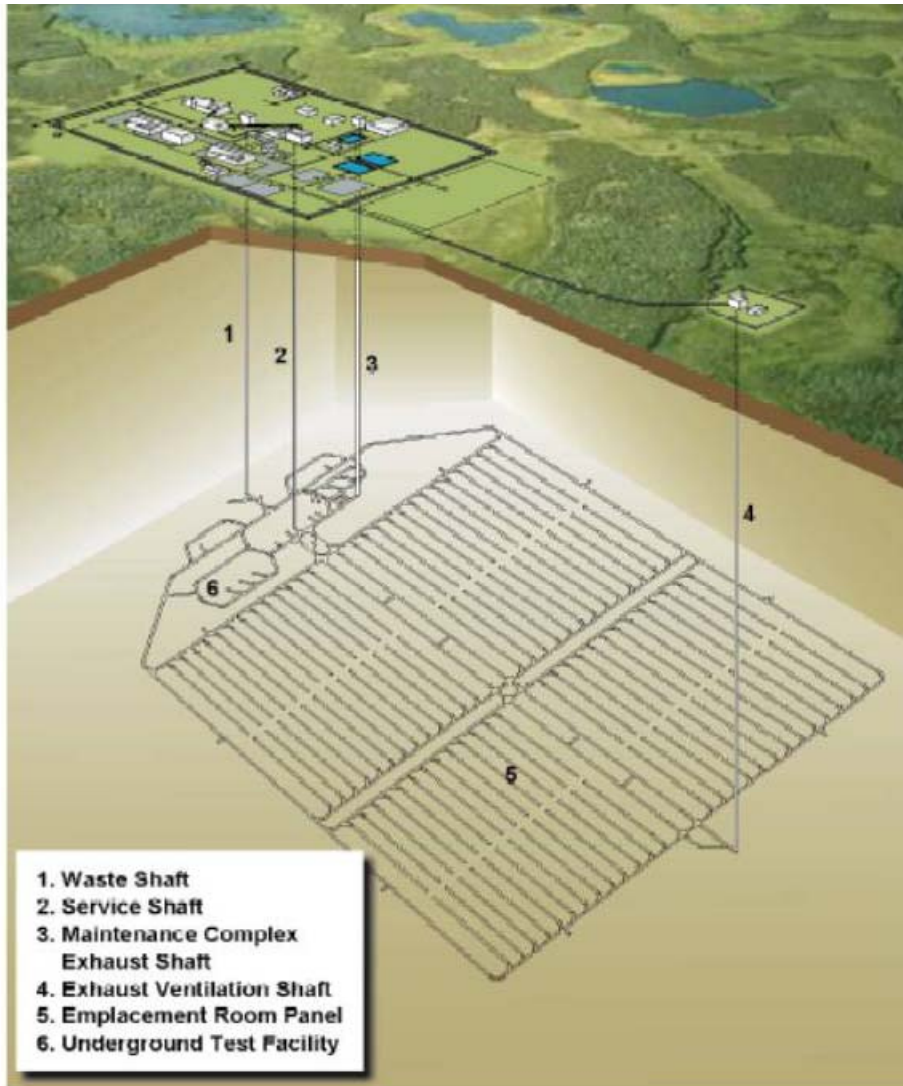
**Preliminary Site Selection activities underway**

**On-site storage: 30 years**

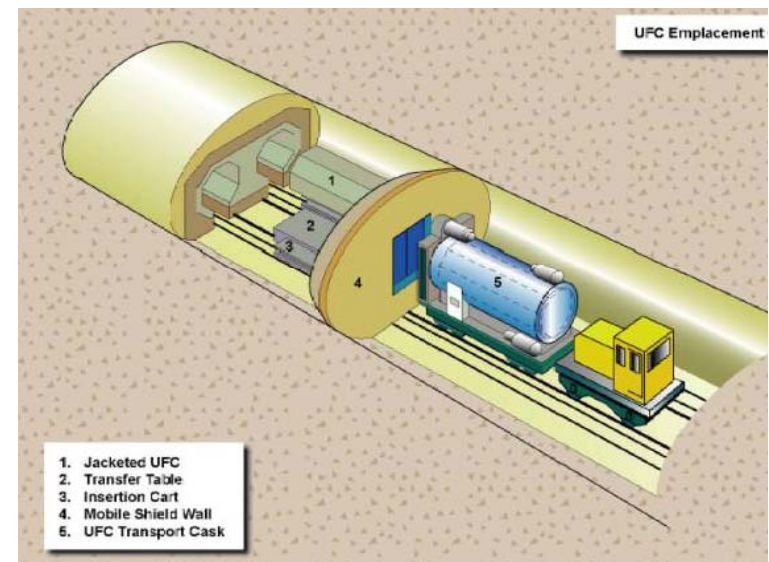
**Centralized storage and demonstration of geologic disposal: 30 years**

**Emplacement in deep geologic repository : beyond 60 years**

# Deep Geologic Repository for Used Fuel

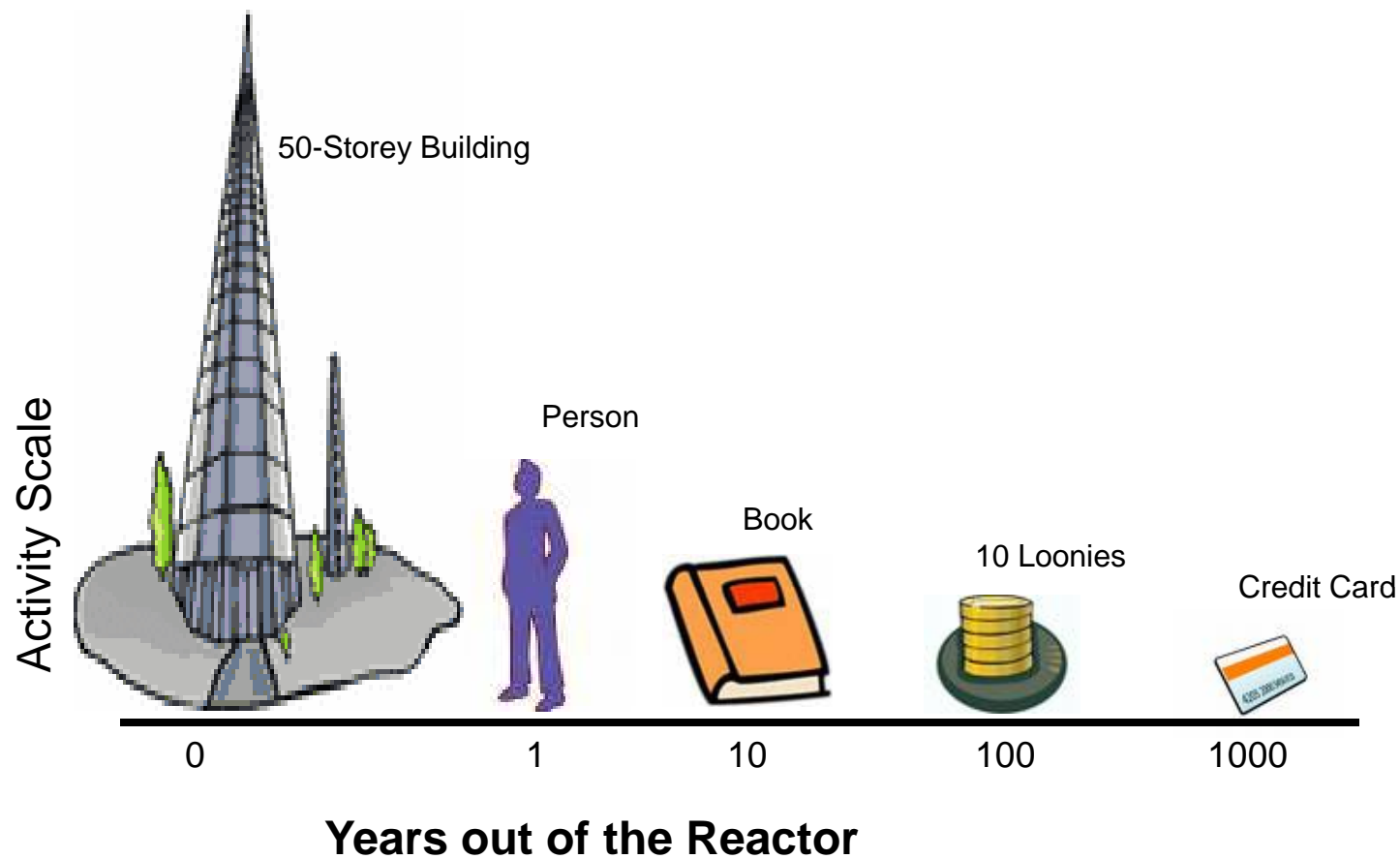


**Canadian Shield**





# Decrease in Radioactivity in a Used Nuclear Fuel





# Path Forward for Saskatchewan

- **Nuclear power offers huge opportunities for Saskatchewan:**
  - **CANDU reactors for electricity and oil-sands**
  - **adding value to the fuel cycle chain (mining, refining, enrichment, fuel manufacturing,)**
  - **used fuel management (fuel recycle)**
- **Opportunity for developing nuclear science and engineering program at U of S:**
  - **Complement and leverage work at Chalk River and at other universities**
- **AECL can be a partner for expanding the Saskatchewan nuclear industry and can work with Saskatchewan universities to set up a nuclear R&D Center of Excellence.**

# Resources

Where can you find more information?

- **AECL:** <http://www.aecl.ca>
- **CANDU Canada:** <http://www.canducanada.ca/>
- **CANDU Owners Group:** <http://www.candu.org/>
- **Voice Your Choice:** <http://www.canducanada.ca/eng/voice.html>
- **Organization of CANDU Industries:** <http://www.oci-aic.org>
- **Nuclear Waste Management Organization:** <http://www.nwmo.ca>
- **Canadian Nuclear Association:** <http://www.cna.ca>
- **Canadian Nuclear Society:** <http://www.cns-snc.ca>
- **Canadian Nuclear FAQ:** <http://www.nuclearfaq.ca>
- **CANTEACH:** <http://canteach.candu.org/>
- **Women in Nuclear:** <http://www.win-global.org>
- **Or, contact us directly:**

**Sonja Galton**  
**905-823-9060 Ext. 36191**  
**[galtonso@aecl.ca](mailto:galtonso@aecl.ca)**

# Questions



**Do you have any questions?**

# AECL & CANDU

## Made-in-Canada Success Stories

