

A Nuclear Renaissance in Canada

Presented by:

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 **AECL EACL**

Atomic Energy of Canada Limited



Global Nuclear Technology Company

- Established in 1952 by the Government of Canada
- Employs almost 4,800 people
- More than \$500 Million annual revenues



Our Business

- CANDU Reactor Sales
- Reactor Maintenance Services
- Reactor Refurbishment
- Nuclear Safety/Performance Products
- Research & Development
- Environmental Management



AECL's Dual Role



Commercial Operations = 80% Profit –Driven, Self Sustaining	Government of Canada Public Policy = 20% Funded by Appropriations
Reactor Sales	Safe Production of Electricity
Nuclear Products/Services	Nuclear Platform Research & Development
Waste Management	Medical Isotope Production
Commercial Research & Development	International Science Projects

CANDU – a Canadian Invention



CANDU -- “One of Canada’s top ten engineering achievements of the past century”

Canadian Engineering centennial, 1987 

CANDU – An International Success

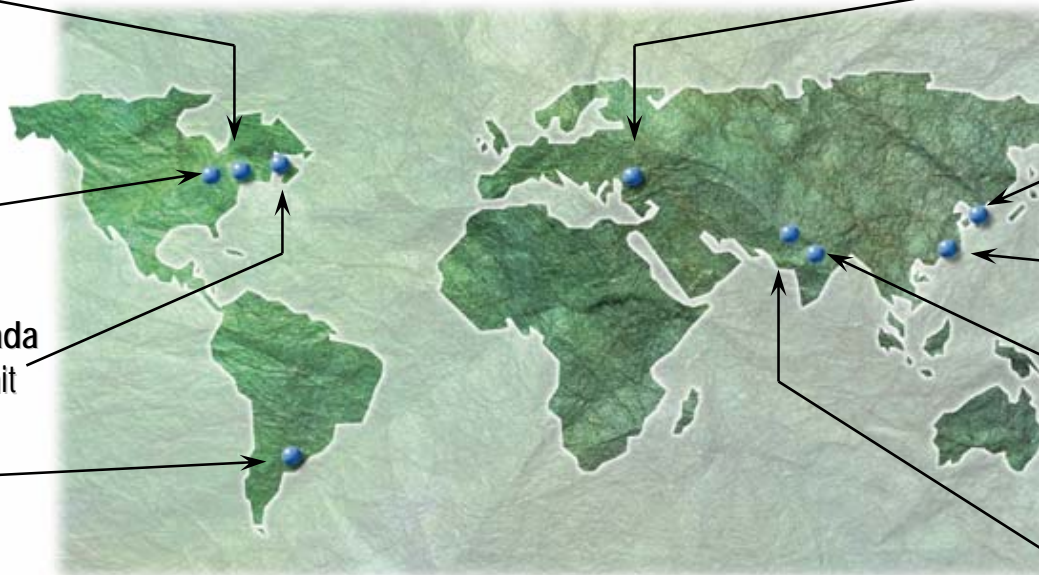
Approx 10% world market share

Quebec, Canada
Gentilly 2 1 unit

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

N.Brunswick, Canada
Point Lepreau 1 unit

Argentina
Embalse 1 unit



Romania - Cernavoda
2 units
2 units in planning stage

S.Korea – Wolsong
4 units

China - Qinshan
2 units

India
2 CANDU units
15 PHWR units,
3 units under construction

Pakistan
KANUPP 1 unit



Wolsong, S. Korea



Pickering, Canada



Qinshan III, China

What the Future Holds

Nuclear Renaissance is here

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

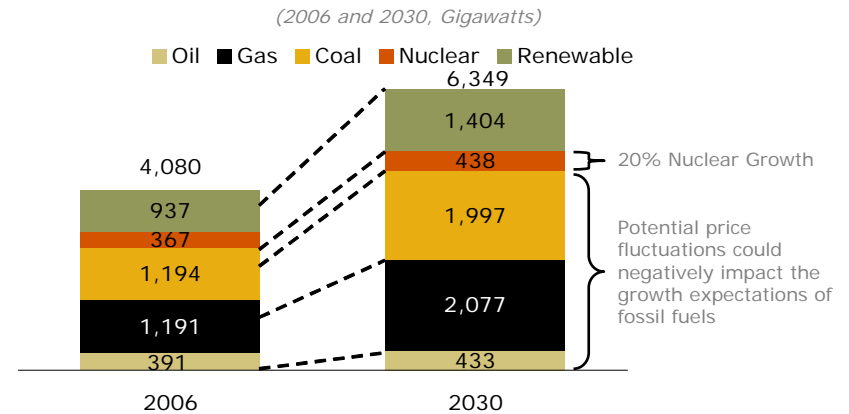


AECL/CANDU poised to play a major role in the nuclear renaissance

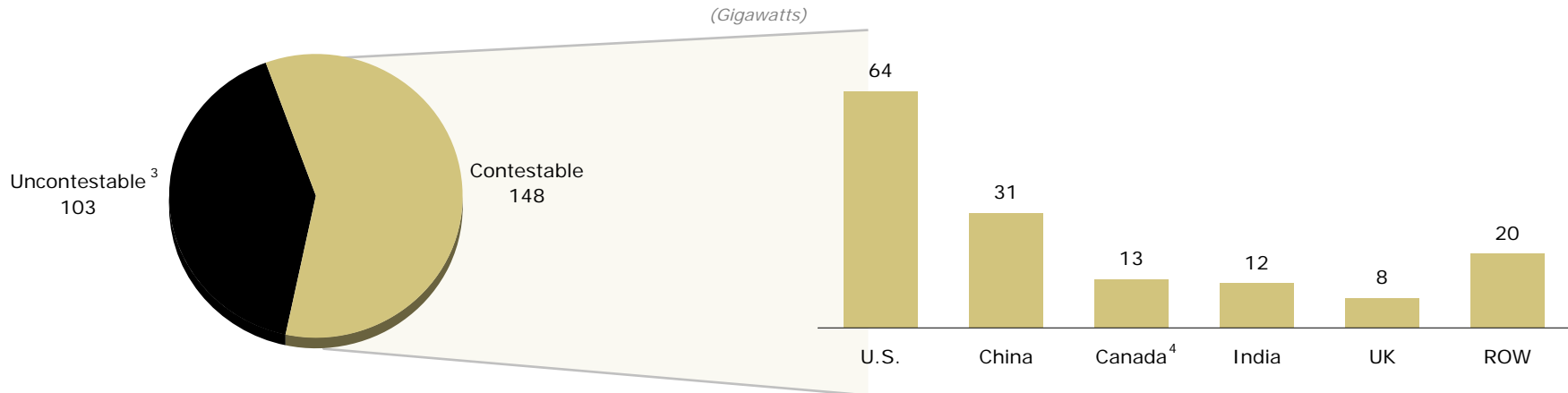
A Global Nuclear Renaissance

- Electricity consumption is expected to double by 2030, with capacity rising to over 6,350 GW installed
- 250 GW of new nuclear units
 - 148 GW of units are in countries with open markets
 - \$400 billion in sales

International Electricity Capacity by Fuel Source¹



Nuclear Reactor New Build Market Potential²



¹ Source: EIA, WNA.

² Source: EIA, IAEA, General Directorate for Energy and Raw Materials.

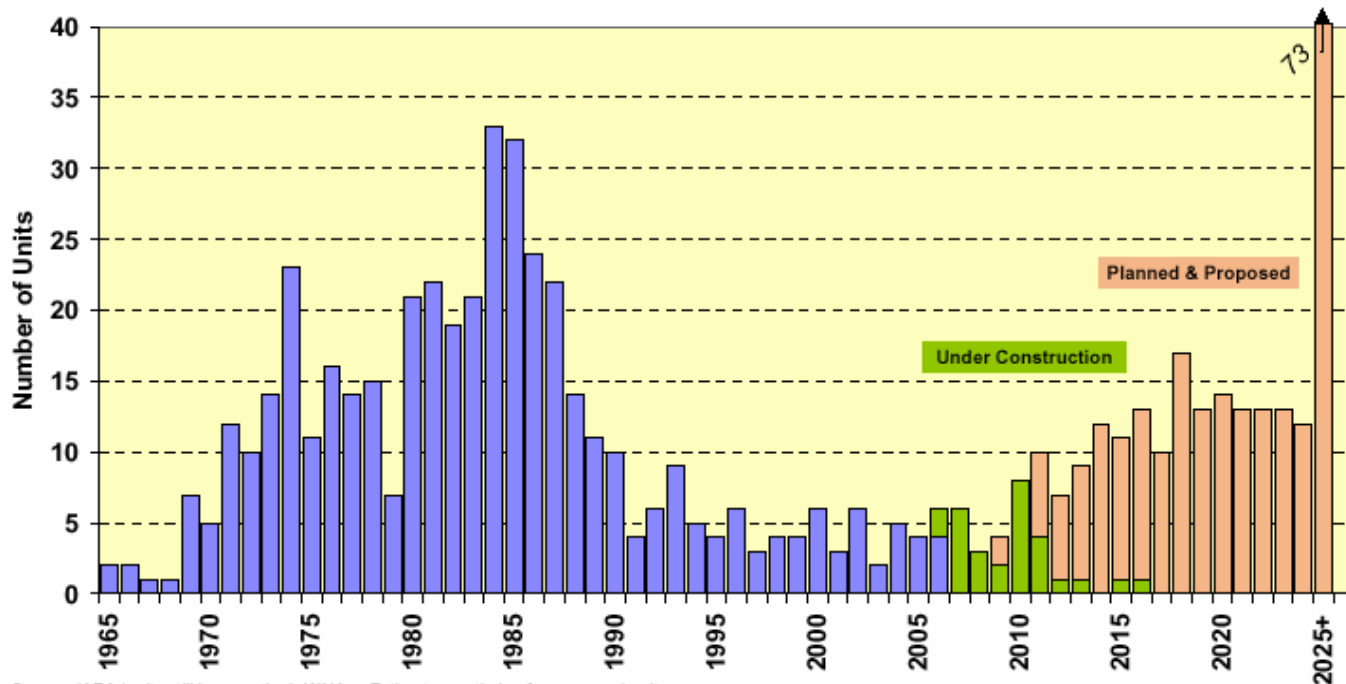
³ Represents Russia, Japan, France, Korea and other parts of Europe.

⁴ Source: AECL estimate.

Worldwide Growth in Nuclear

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

Nuclear Power Plant Units Operating, Under Construction & Planned/Proposed by Year of Completion



Source: IAEA (units still in operation). WNA. Estimates on timing for proposed units.

Key Drivers of Nuclear Renaissance

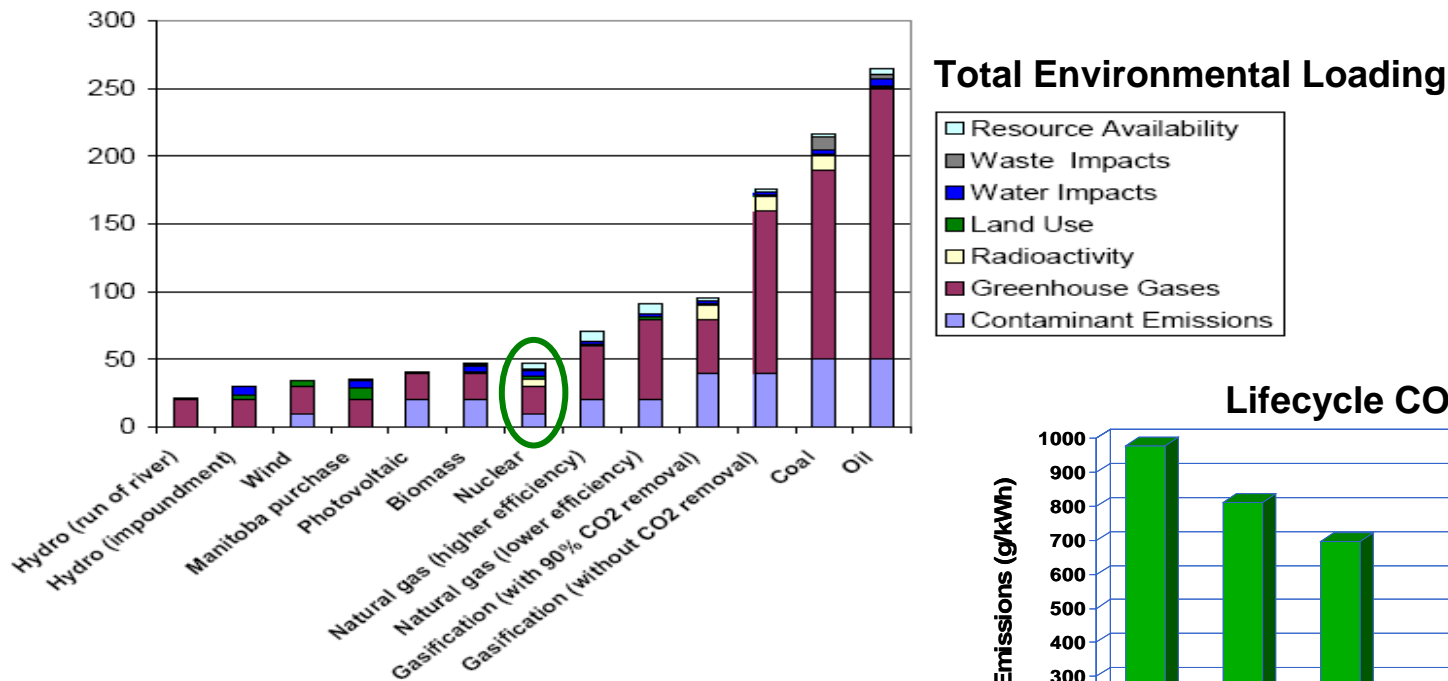
The Environment

- **Nuclear = Clean Air**
- **Nuclear plants do not produce GHG or other air-borne emissions**
- **CANDU units Canada save 90 million tonnes of GHG's annually**
- **CANDU units in Ontario contribute to improved air quality**

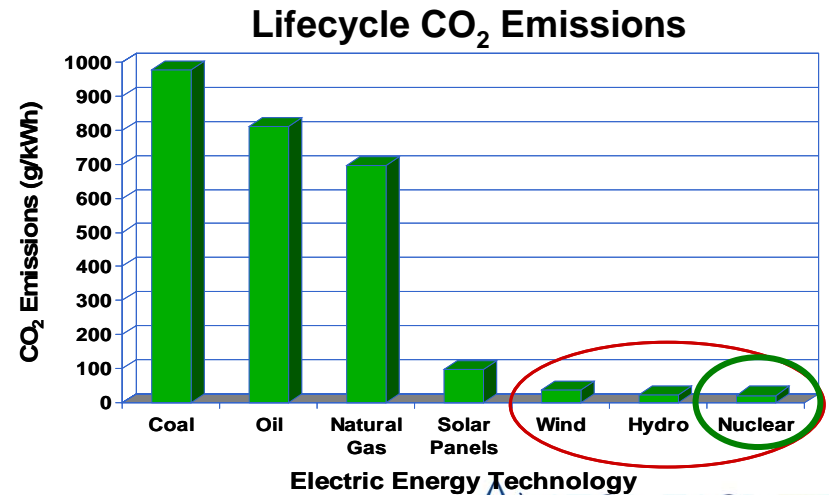


Nuclear Environmental Benefits

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



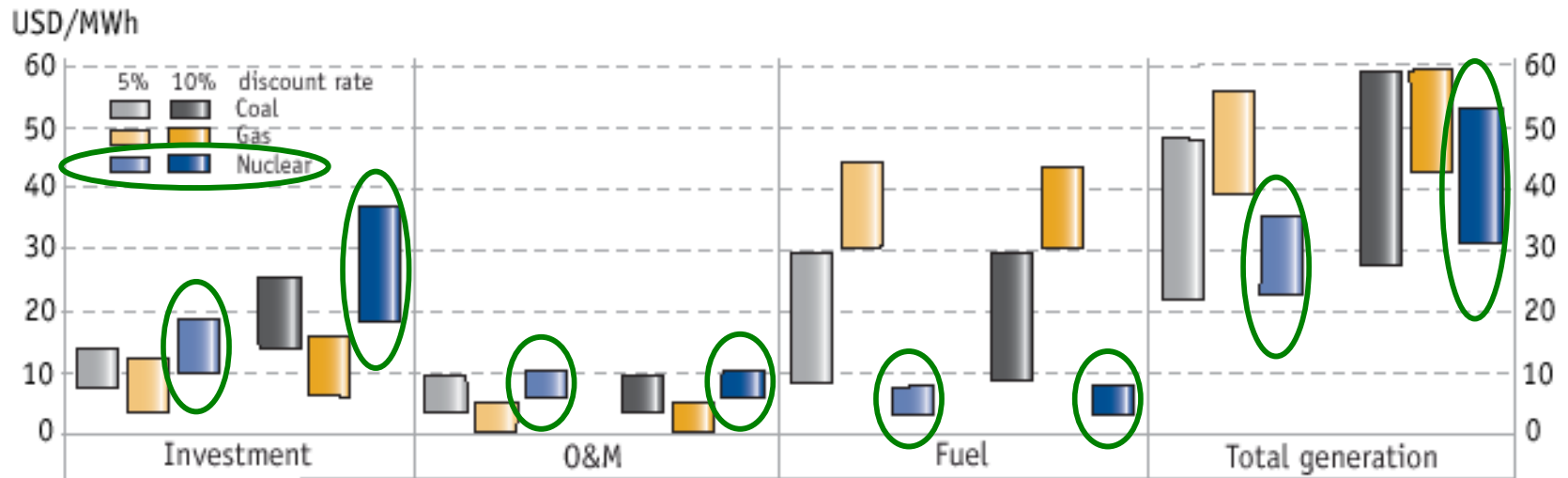
Source: OPA – Ontario Power Authority Supply Mix Report Part 2.7



Source: IAEA Spadaro et al. 2000

Competitive Base Load Power

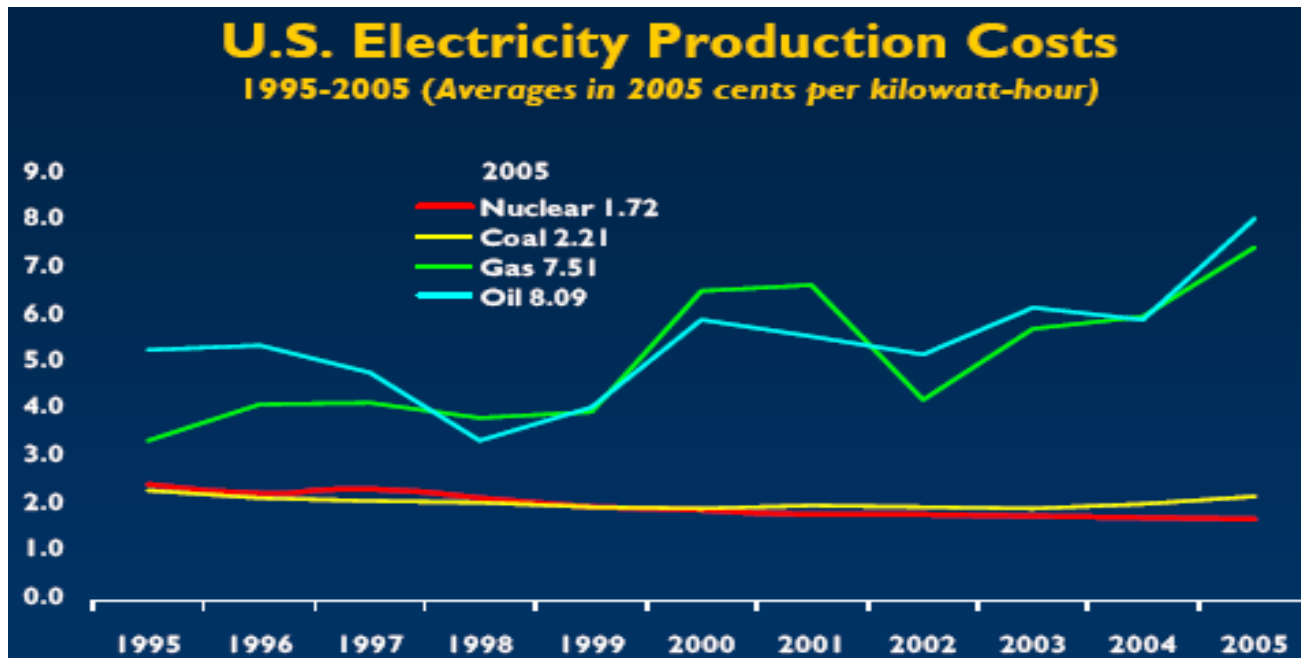
- **Nuclear**: high capital cost / low and predictable production cost



- **Production costs for base load electricity generation**
 - Nuclear: 75% O&M (25% fuel-U price is 5-10% of O&M cost)
 - Coal: 25% O&M (75% fuel)
 - Gas-fired: 10% O&M (90% fuel - gas price dominates)

Decrease in Nuclear Production Cost

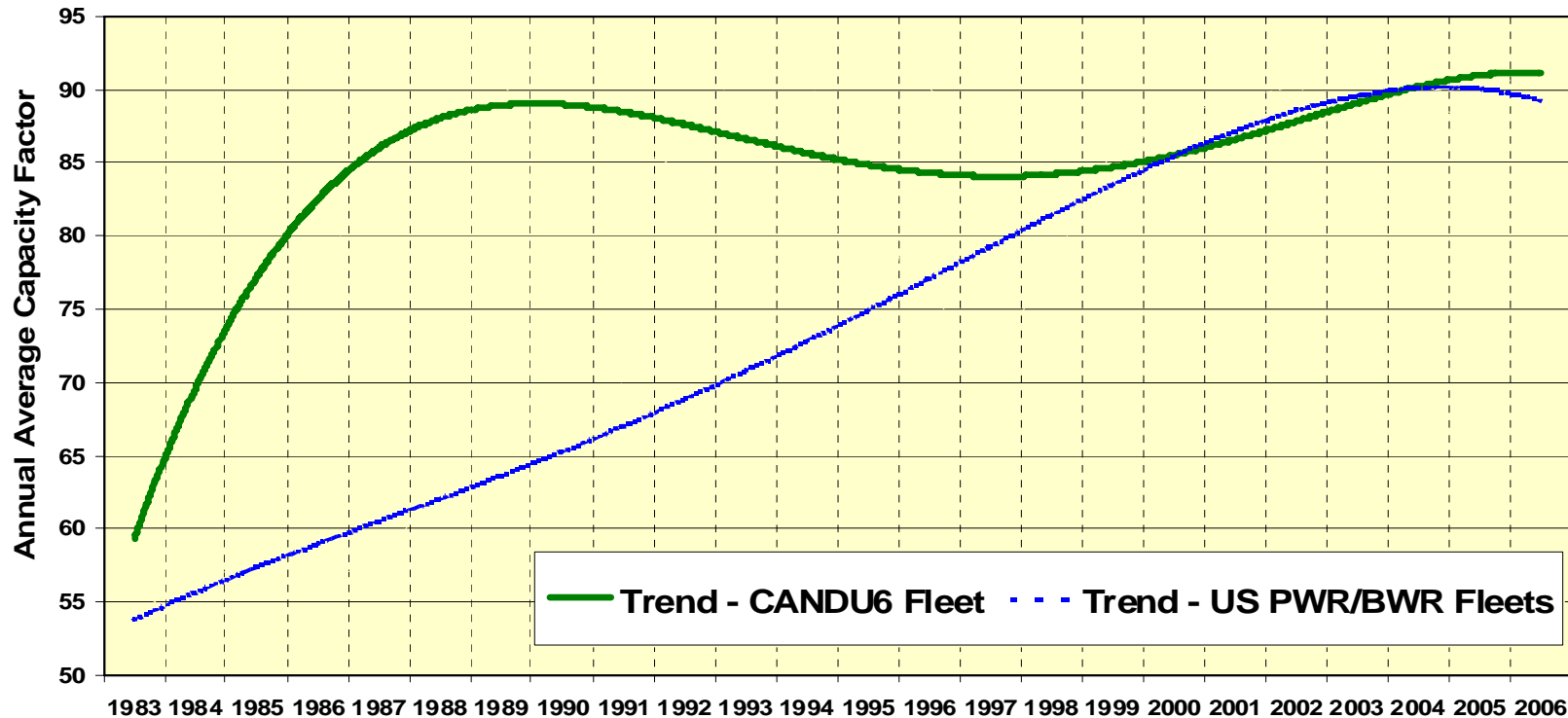
- **Nuclear - lowest production cost in US**
 - **Darlington (~1.3 US cents/kWh) - below US average**
- **Nuclear production costs include charges for long term waste management**



Improvement in Nuclear Performance

- **Worldwide/US improvement (from 60% capacity factor range to ~90%)**

**Total CANDU6 Fleet vs US Plant Fleet Average Annual Performance
from introduction of first CANDU6s to most recent**



Sources: Canadian Nuclear Association (CNA); Nuclear Energy Institute (NEI); Nucleonics Week

Improvements in Nuclear Safety

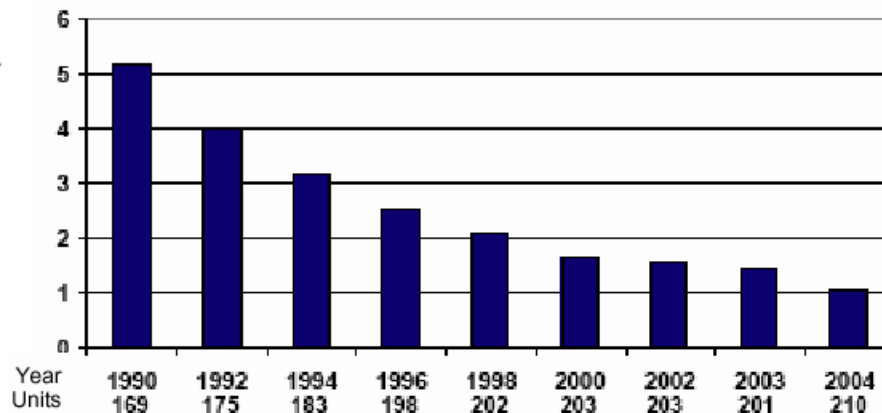
- **Nuclear – safest, most regulated form of generation**
 - Health, safety, environment, security regulated by national government bodies (CNSC in Canada)
- **Strong safety record with forecast improvements in Generation III designs**

Comparison of Accident Statistics in Primary Energy Production¹⁰
 (Electricity generation accounts for about 40% of total primary energy).

Fuel Type	Immediate Fatalities 1970-92	Who?
Coal	6,400	workers
Natural gas	1,200	workers & public
Hydro	4,000	public
Nuclear	31*	workers

* 1986 accident at Chernobyl in Ukraine cost the lives of 31 staff and firefighters.

Industrial Accidents at Nuclear Power Plants
 per 1 000 000 person-hours worked



Source: WANO 2004 Performance Indicators

Long Term Nuclear Waste Solution

- **Nuclear Waste Management Organization (NWMO) recommended:
“Adaptive Phased Management” approach for used fuel:**
 - **At reactor site storage (up to 60 years) – time to site, construct and commission the deep geologic repository**
 - All used fuel from Canadian reactors fit on soccer field to height of two meters
 - **Containment and isolation in a deep geological repository -either in crystalline rock of the Canadian Shield or Ordovician sedimentary rock**
 - **Optional provision for interim, co-located shallow underground centralized storage**
 - **Continuous post-closure monitoring with potential for retrieval over an extended period**
- **Accepted by the Gov’t of Canada - July/2007**



Financial Market Support for Nuclear

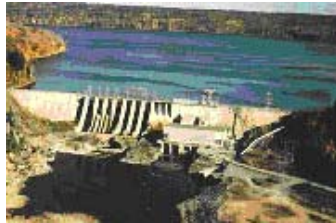
Public

- **GlobeScan worldwide survey → 62% believe nuclear power should continue to be used**
- **Ipsos-Reid Poll (Feb/07) → 75% of Ontarians support same or increased role for nuclear**

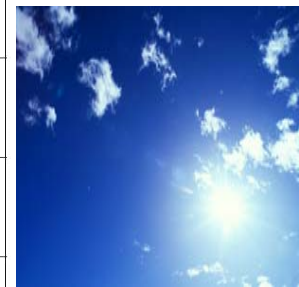
Financial Markets

- **Over 30 acquisitions of operating nuclear facilities, at increasing valuations since 1999 in the US**
- **Investment bankers see value in nuclear assets**
 - *rising costs of coal/gas generation ... costs of nuclear power are relatively stable ... higher [electricity] prices lead to higher margins for the nuclear plants*
 - *nuclear plants represent a low cost hedge against future carbon taxes*

Filling the Gap : 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		✓	✓	✓		✓



CANDU Products

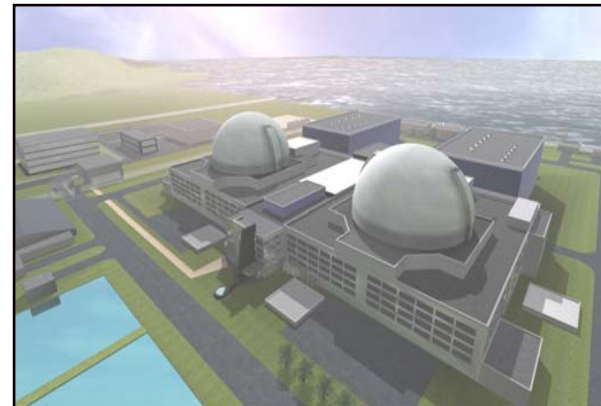
CANDU 6/EC6

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



ACR-1000

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



Nuclear Update –Ontario

- **Two nuclear utilities (Bruce Power & OPG) filed Nuclear Site Preparation License Applications in 2006 for the Bruce and Darlington Sites**
- **Ontario Govt retained McKinsey in May 2007 to evaluate alternative nuclear technologies.**
- **Ontario Govt expected to make its technology decision in first half of 2008**
- **ACR-1000 is one of the front runners**

Nuclear Update -Alberta

- **Energy Alberta Corp (EAC) filed a Site Preparation License Application in August 2007 for a twin ACR-1000 at Peace River to supply electricity to a major oil sands project and to the Alberta grid**
 - **Strong local support at both Peace River and Whitecourt for a nuclear project**
- **Bruce Power announced in December/07 intent to acquire assets of EAC in order to further development of the nuclear option in Alberta**
- **Alberta Premier Ed Stelmach is calling for public meetings to review the nuclear option in early 2008**

Nuclear Update –New Brunswick

- **Team CANDU NB is completing a Feasibility Study on constructing a single/twin ACR-1000 at the Point Lepreau Site in New Brunswick**
- **Power would be sold to maritime provinces and exported to New England States**
- **CANDU Project in New Brunswick supports the provinces desire to become an “energy hub”**

CANDU Offshore Markets

- **Retain/expand offshore CANDU clients that have an with CANDU/HW infrastructure**
 - Argentina / Romania
- **Capture sales in large markets where nuclear expansion limited by competitor supply bottlenecks**
 - UK / China
- **Capture sales in unique markets that have a preference for CANDU fuel cycle flexibility**

Team CANDU Overview

- **Five leading global nuclear suppliers based in Ontario (more than 12,000 employed in Ontario)**
 - Atomic Energy of Canada Limited
 - Babcock & Wilcox Canada
 - GE - Hitachi Nuclear Energy Canada
 - Hitachi Canada
 - SNC-Lavalin Nuclear
- **Offering a guaranteed delivery solution for new CANDU units in Ontario and beyond**



GE-HGNC



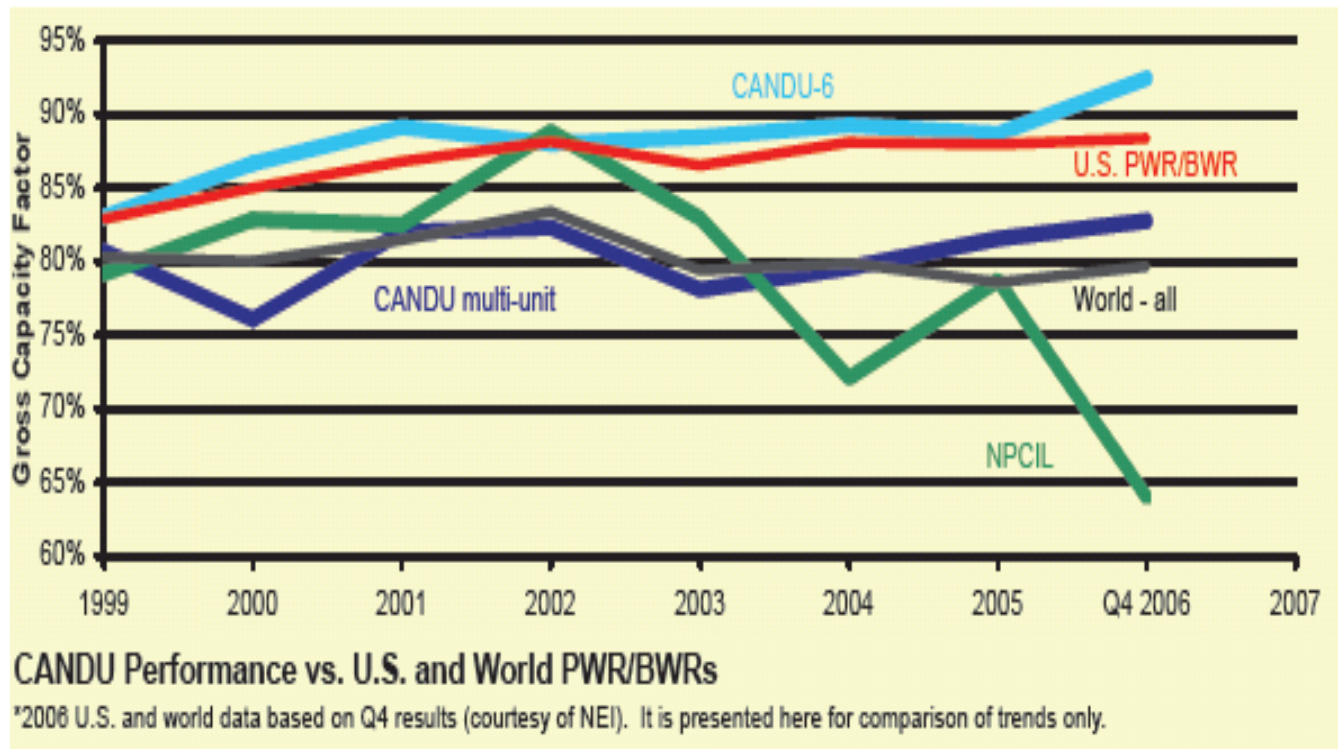
CANDU Track Record/Performance

- **AECL/Team CANDU** have managed all international CANDU builds over the past 11 years
 - All delivered on-time, on-budget – a record unmatched by any other nuclear vendor

In-Service	Plant	Status
1996	Cernavoda Unit 1, Romania	On budget, on schedule*
1997	Wolsong Unit 2, S. Korea	On budget, on schedule
1998	Wolsong Unit 3, S. Korea	On budget, on schedule
1999	Wolsong Unit 4, S. Korea	On budget, on schedule
2002	Qinshan Phase III, Unit 1, China	Below budget, 6 weeks ahead of schedule
2003	Qinshan Phase III, Unit 2, China	Below budget, 4 months ahead of schedule
2007	Cernavoda, Unit 2, Romania	Full Power 2/07

CANDU 6 Performance

Comparative Performance of CANDU 6, Multi-unit CANDU's and Other Reactor Types



Summary

- **Worldwide Nuclear Renaissance is driven by environmental considerations, strong nuclear performance and pending fossil fuel shortages**
- **Nuclear also poised for robust expansion in eastern, central and western Canada**
- **AECL and Team CANDU are well-positioned to participate in the Nuclear Renaissance both at home and abroad**
- **The success of Canada's CANDU industry contributes to Canada's role as an "Energy Super Power"**
- **Each CANDU export sale creates over 400,000 person years of employment in Canadian firms and many high technology career opportunities for university and college graduates**

AECL & CANDU

Made-in-Canada Success Stories

