

Nuclear Renaissance and CANDU

AECL CANDU Supply Chain Forum
Saskatoon

November 30, 2010

Dr. Ron Oberth

Director Marketing and Business
Development



Nuclear Share of Electricity Production

- **France - 77%**
- **Belgium - 54%**
- **Slovakia - 54%**
- **Ukraine - 48%**
- **Sweden - 46%**
- **Switzerland - 40%**
- **South Korea - 35%**
- **Japan - 28%**
- **Germany - 27%**
- **USA - 19%**
- **India - 3%**
- **China - 1%**



Worldwide Nuclear Renaissance

- 450 operating nuclear units
- 57 units under construction
- > 200 units planned or proposed

- Key drivers:
 - Environment – No GHG emissions
 - Fuel supply certainty



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

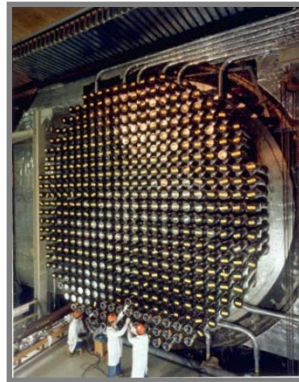
CANDU Power Reactor



Qinshan Phase III, China



CANFLEX Fuel Bundle



CANDU Reactor Face

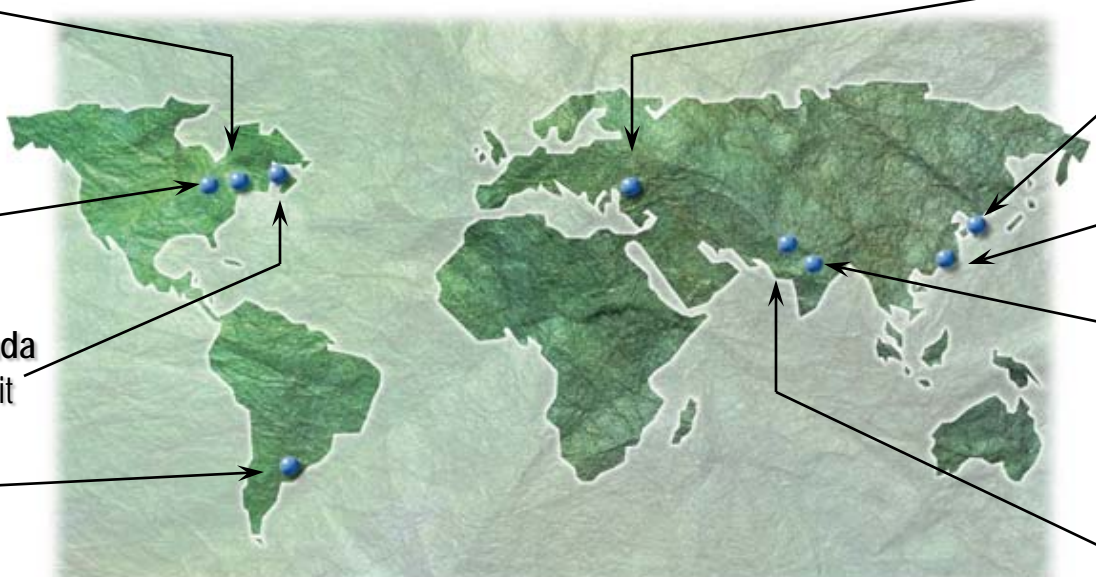
CANDU – A Global Success

Quebec, Canada
Gentilly 2 1 unit

Ontario, Canada
Darlington 4 units
Pickering 6 units
Bruce 8 units

N. Brunswick, Canada
Point Lepreau 1 unit

Argentina
Embalse 1 unit



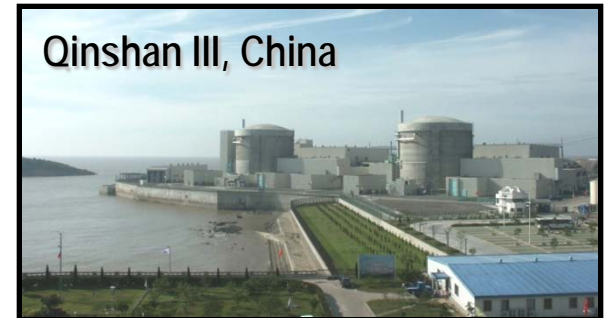
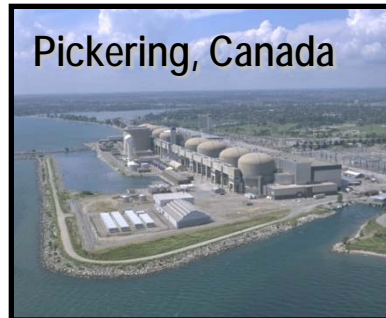
Romania
Cernavoda 2 units
+ 2 units planned

South Korea
Wolsong 4 units

China
Qinshan 2 units

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

Pakistan
KANUPP 1 unit

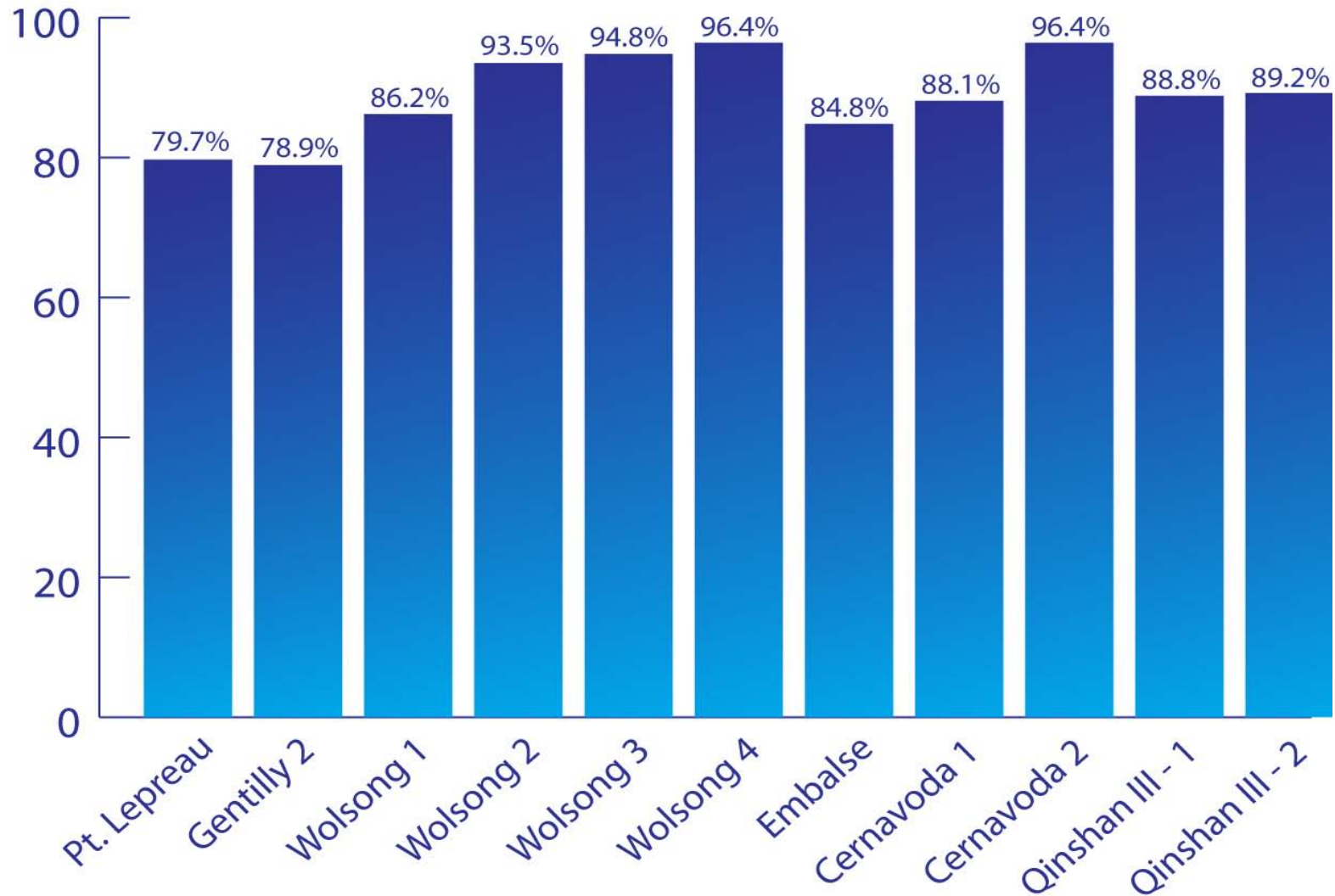


AECL Track Record on New Projects

In-Service Date	Plant	Status
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	On budget, 6 weeks ahead of schedule
2003	Qinshan Phase III, Unit 2, China	Under budget, 4 months ahead of schedule
2007	Cernavoda Unit 2	Completion Project



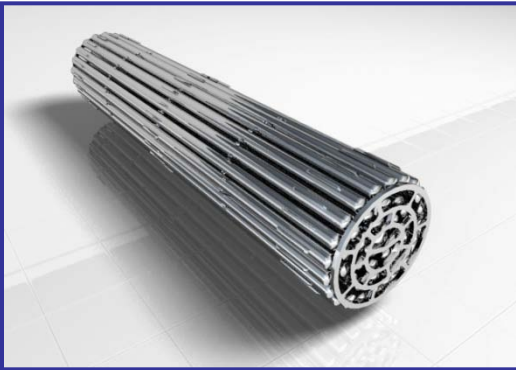
CANDU 6: Performance Excellence



Unique Aspects of CANDU



- **CANDU is the most neutron-efficient reactor**
 - Heavy water moderator
 - On-power refuelling
 - Natural uranium fuel
 - 20% more efficient uranium use than PWR
 - Recycled uranium and thorium fuel



Nuclear Market Selection

- **Canadian Markets**

- World's 6th largest electricity market

- **International Markets**

- Existing PHWR countries
 - Trade relationships – Nuclear Cooperation Agreement
 - Markets that value CANDU's unique fuelling capability
 - Natural uranium – fuel supply independence
 - Recycled uranium from LWR's
 - Thorium fuel

Ontario



Background

Ontario generates 50% of its electrical energy from nuclear and long term plan is to stay at this level

Ontario New Build Procurement launched in 2008 and suspended in June 2009 due to short term decline in power demand

Market Drivers

All coal units in Ontario will be shutdown by 2014

Need for new clean baseload generation to support an expanding the economy and create jobs in the CANDU nuclear industry

Status

“Ontario ‘s Long Term Energy Plan” released on Nov 22 calls for refurbishment/life extension of 10,000 MW of nuclear units plus construction of 2000 MW of new nuclear at Darlington

Ontario Plan confirms that the province intends to conclude a deal with new owner of AECL to build CANDU units at Darlington

Alberta



Background

Demand for up to 11,000 MW of new generation by 2027. Electricity for oil sands operations alone reach 3000 MW by 2030

Alberta Government announced its policy on nuclear power in December 2009 – “OK on case by case basis”

Market Drivers

“Greening” of the oil sands – low GHG energy source for bitumen extraction and upgrading.

Canadian regulations that will limit GHG emissions from existing and new coal burning generators

Status

**AECL in discussions with Alberta utilities who want evaluate a nuclear option in light of pending federal restrictions on coal units
- but natural gas is low cost near term option**

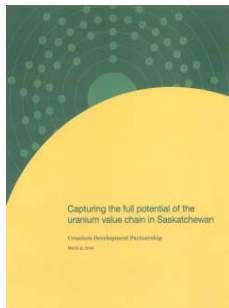


Background

2000 MW of new baseload generation required after 2023 to replace aging fossil units and meet expected load growth

Uranium Development Partnership (UDP) Panel stated that a nuclear power project in the province would have significant economic benefits - but public consultations in 2009 revealed mixed opinions.

Saskatchewan Government directed SaskPower to include nuclear power as a supply option for the long term (beyond 2023).



Market Drivers

Economic benefit through creation of an expanded nuclear industry in Saskatchewan including power generation, NPP equipment manufacturing, as well as training and R&D at the UoFS

Status

AECL is collaborating with SaskPower on their evaluation of nuclear supply options

Romania



Background

Government decree has declared Cernavoda units 3&4 as CANDU 6

Project Company (Energo Nuclear) has been formed with SNN and four European utilities / one large power user

Market Drivers

Projected growth of Romanian economy and opportunity for power export

Status

Energy Section of the European Union has reviewed the CANDU 6 design for Cernavoda 3&4- outcome was positive

Energo Nuclear has targeted a Contract Effective Date (CED) for Cernavoda 3 & 4 at early 2012.

Argentina



Background

Argentine Government announced in 2008 that the next NPP would be a CANDU at the Atucha site.

Market Drivers

Current CANDU infrastructure supports the expansion of heavy water reactor program.

Status

Discussions are advancing on Embalse retube and new build

China



Background

Two CANDU units at Qinshan were delivered on time and on budget and are performing well

Market Drivers

Rapid growth in China and concerns over uranium supply leads to interest in alternative fuel cycles such as thorium

Status

Testing of 24 Recycled Uranium fuel bundles in two channels at Qinshan Unit 1 started in May 2010

AECL working with Chinese partners on a full core of Recycled Uranium fuel at Qinshan and on a CANDU thorium fuel development and demonstration project



Background

17 reactors (4 GW) in operation (15 based on CANDU design) and five reactors under construction.

Plans call for expansion of nuclear capacity to 60,000 MWe by 2030.

Market Drivers

Indian interest in acquiring advanced reactor technology from abroad to augment program based on domestic PHWR designs

Nuclear Cooperation Agreement signed in June 2010

Status

AECL in discussions with Nuclear Power Corp of India Ltd (NPCIL) on product development and nuclear services

AECL plans to open a Regional Office in Mumbai in 2011

Jordan



Background

Jordan imports 95% of its energy need nuclear power plant in-service by 2020 for electricity and desalination

In January 2010 Jordan Atomic Energy Commission invited four vendors to submit information on reactor product and options

Market Drivers

CANDU well suited for Jordan because its medium size and use of natural uranium fuel that could utilize local uranium resources

Status

CANDU selected as one of the three technologies to proceed to Phase 2 of the project development.

Ukraine



Background

13 Russian nuclear units in operation with plans to add 15,000 MW of new nuclear generation by 2030 (retirements and load growth)

Ukraine would like to develop a second nuclear reactor option to reduce its dependency on Russia

Market Drivers

CANDU offers fuel supply independence from Russian enrichment services and potential to burn uranium recovered from VVER used fuel

AECL and Energoatom completed a Technical and Economic Evaluation of CANDU in Ukraine in May 2010

Status

CANDU should be announced as part of the Ukraine Energy Plan by early 2011

Southeast Asia

Background

Indonesia, Thailand and Malaysia have all announced plans to have nuclear units In-Service by 2021-2023

These countries have growing economies with a need to increase electrification in all regions

Market Drivers

CANDU has proven to be a good technology for countries entering into nuclear generation with potential ie. Argentina, Korea and Romania

Ontario – Darlington Refurb



The 3400 four unit Darlington plant supplies almost 20% of Ontario's annual electrical energy needs with high reliability (90%) and low \$/kWh operating cost.

Background

In February 2010 Ontario Power Generation announced that it would extend the life of the plant by another 30 years at a projected cost of between \$6B to \$10B (around \$80/MWh over lifetime)

Work has already started on planning for this larger and complex project – first unit refurbishment work starts in 2016

Market Divers

AECL and its suppliers expects to take a major role in retubing the four reactor units and in upgrading / replacing key nuclear components



Conclusions

- **Worldwide market for nuclear power is strong**
- **Strong possibility that a new CANDU project will be announced in Ontario in the next 18-24 months**
- **AECL / CANDU also poised to win orders in existing offshore markets as well as new markets**
- **Planning for the large Darlington Refurbishment Project is underway**
- **Strong CANDU Supply Chain is key to success**

