AECL participation in the Argentine Nuclear Generation Program
Simposio LAS-ANS June 25th 2009
CNEA – Buenos Aires

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Presentation Objectives

- AECL Background
- Briefing on CANDU Technology and Projects
- CANDU 6
- AECL participation in the Argentine Nuclear Genereation Program
- ACR, the logical choice

AECL

Global Nuclear Technology Company

- Established in 1952 by Government of Canada
- More than 5,000 employees
- Around $600 Million annual revenues

Our Business –Two Divisions

- CANDU Reactor: New Build, Refurbishment and Services
- Research & Technology Development : Development CANDU Technology and Services, and Environmental Management

A Total Nuclear Solution Company

- Involved in all aspects of nuclear power design and construction
- World Class R&D facilities at Chalk River Laboratories
- Full lifecycle service packages
  - Design, build, service reactors, plant life management programs, waste management, in Canada and around world

Established Support Network

NA·SA

CANDU Owners Group Inc.
COG
"Strength Through Co-operation"

Bruce Power

TQNPC THIRD QINSHAN NUCLEAR POWER CO.,LTD.
秦山第三核电有限公司

KHNP

ONTARIO POWER GENERATION

Hydro Québec

NUCLEARELECTRICA

AECL

Énergie NB Power

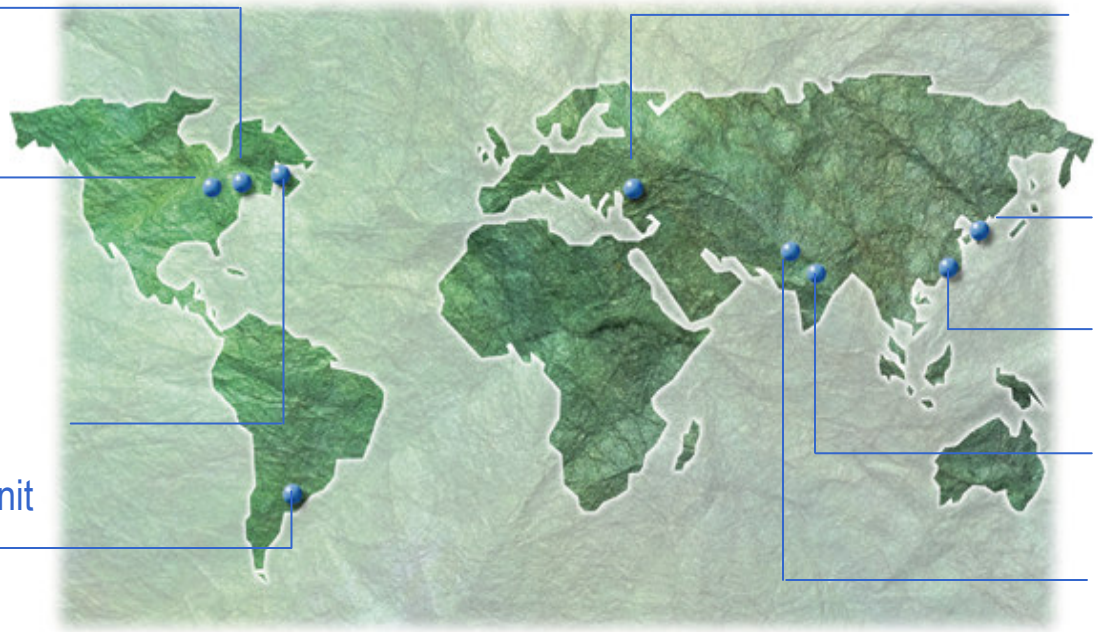
43 CANDU-Type Reactors Operating Worldwide, plus 9 Ongoing/Approved Projects = 52 reactors

Quebec, Canada
Gentilly 2 1 unit

Ontario, Canada
Darlington 4 units
Pickering 6 units
Bruce 6 units
2 refurb

New Brunswick, Canada
Point Lepreau 1 unit

Argentina
Embalse 1 unit



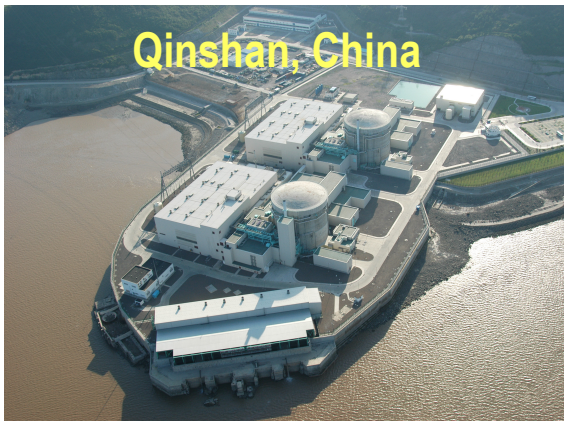
Romania
Cernavoda: 2 units

Republic of Korea
Wolsong 4 units

China
Qinshan 2 units

India
15 units, 3 under const, 4 approved

Pakistan
KANUPP 1 unit



OPERATING CANDU 6 PLANTS

Qinshan 1/2

Cernavoda 1/2

Embalse

Gentilly 2

Point Lepreau

Wolsong 1/2/3/4

What the Future Holds

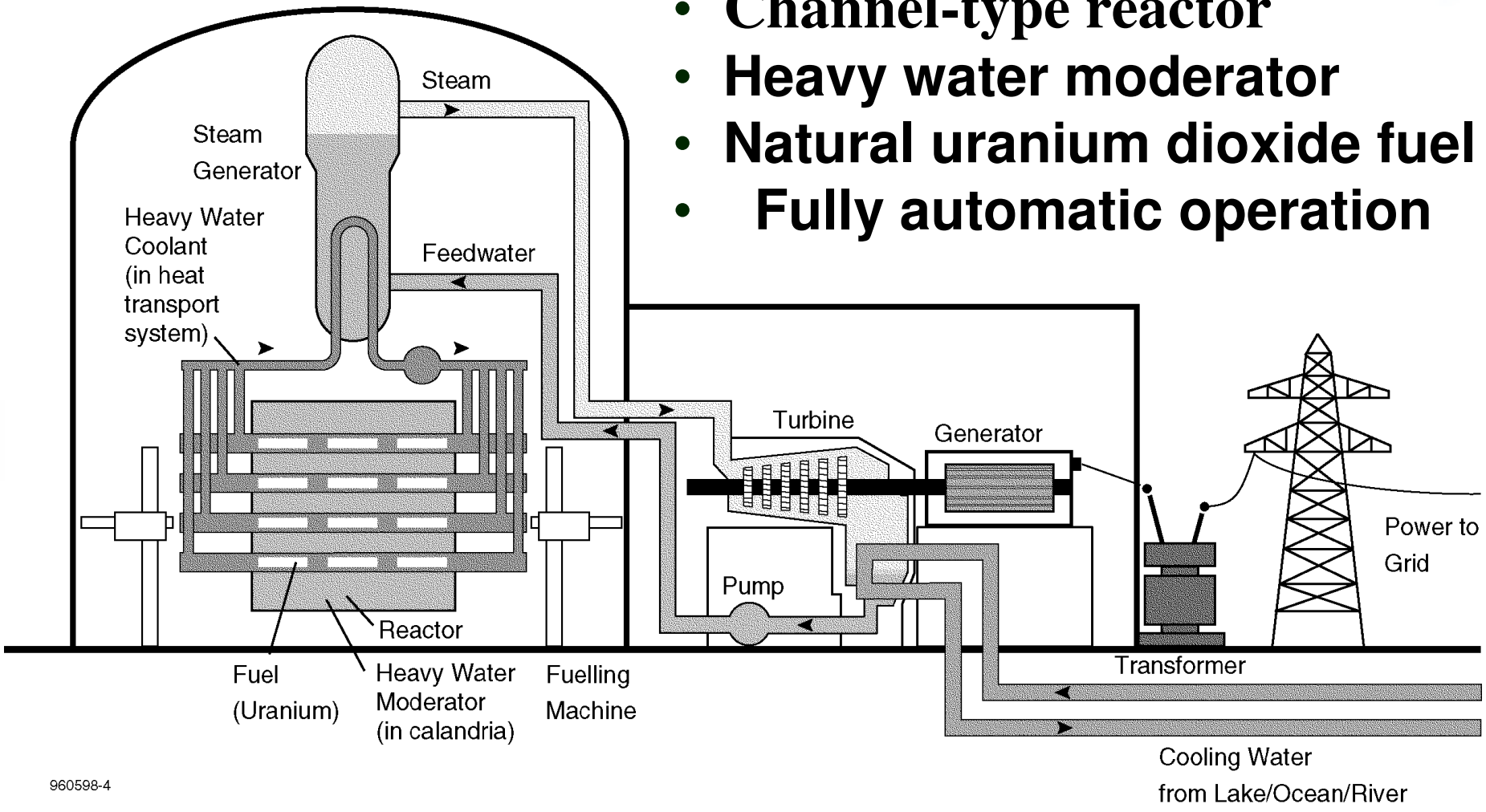
Global Nuclear Renaissance is here

- 439 nuclear power plant units operating worldwide
- 30 nuclear power plant units under construction
- 222 planned or proposed
- Driven by environment – no GHG, economics, security of supply

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

CANDU Plant Overview

- Channel-type reactor
- Heavy water moderator
- Natural uranium dioxide fuel
- Fully automatic operation



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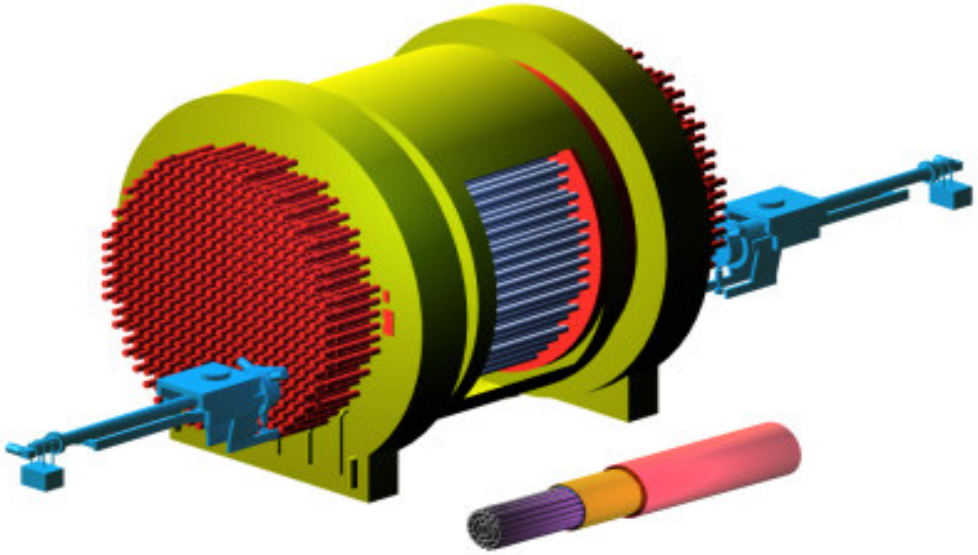
CANDU Technology -

- **Internationally, CANDU is one of the most attractive, commercially available nuclear power technologies**

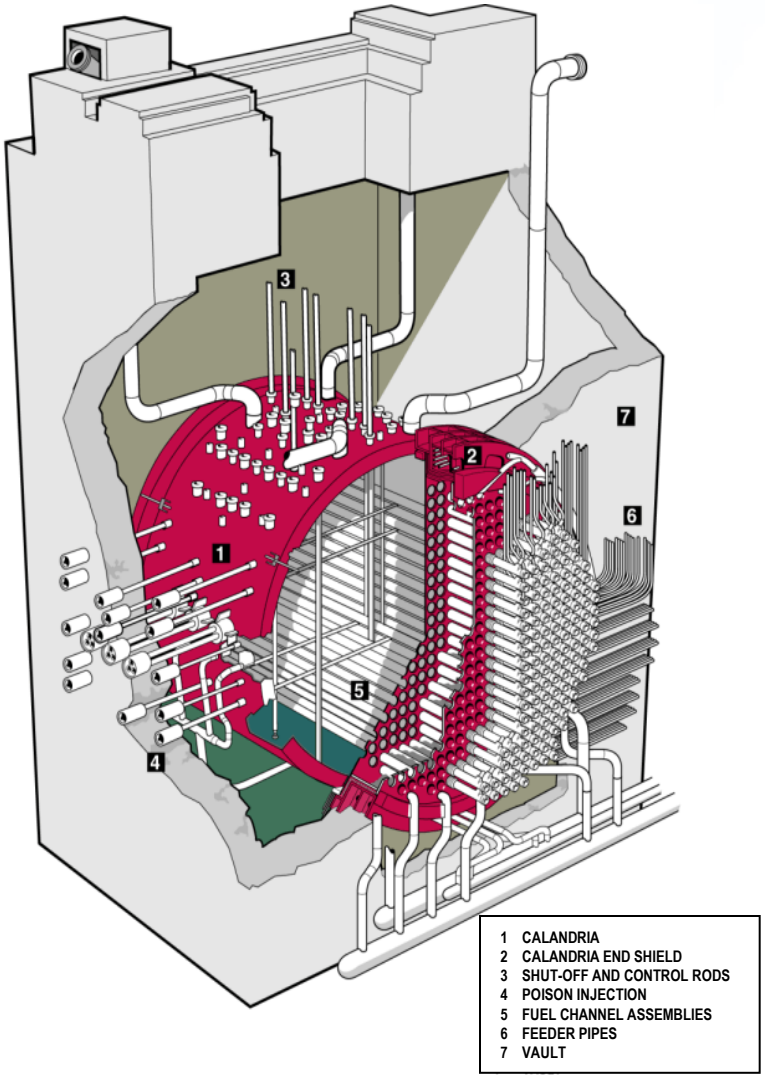
  - **Natural uranium fuel**
  - Heavy water moderator
  - Channel-type reactor
  - Fully automated operation



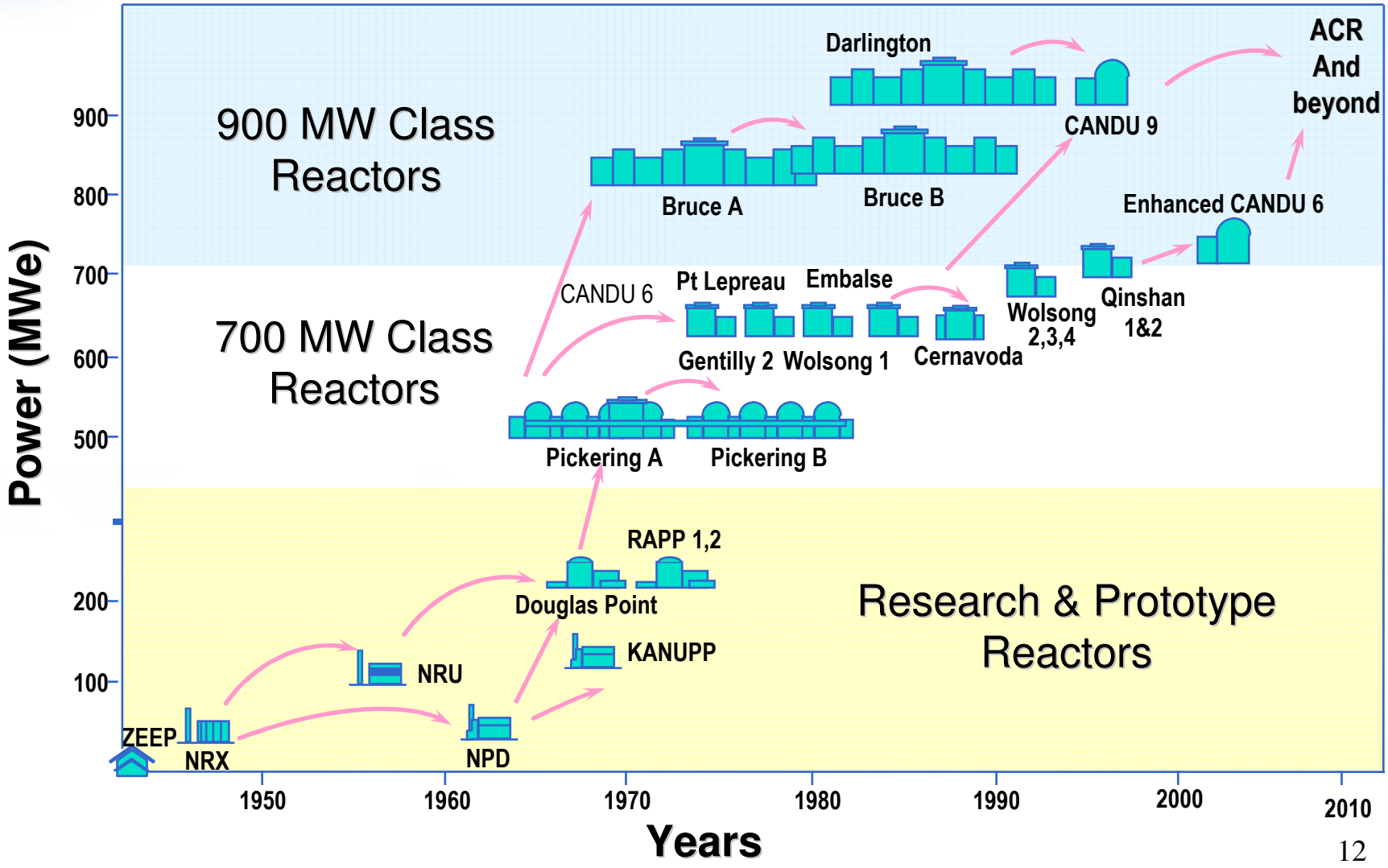
CANDU Calandria and Fuel Channel

REACTOR ASSEMBLY

- Fuel channels and moderator are contained in Calandria
- Low pressure and low temperature Calandria houses reactor
- Set in a light water-filled, concrete, shielding vault
- Reactivity control systems operating at low temperature and pressure.

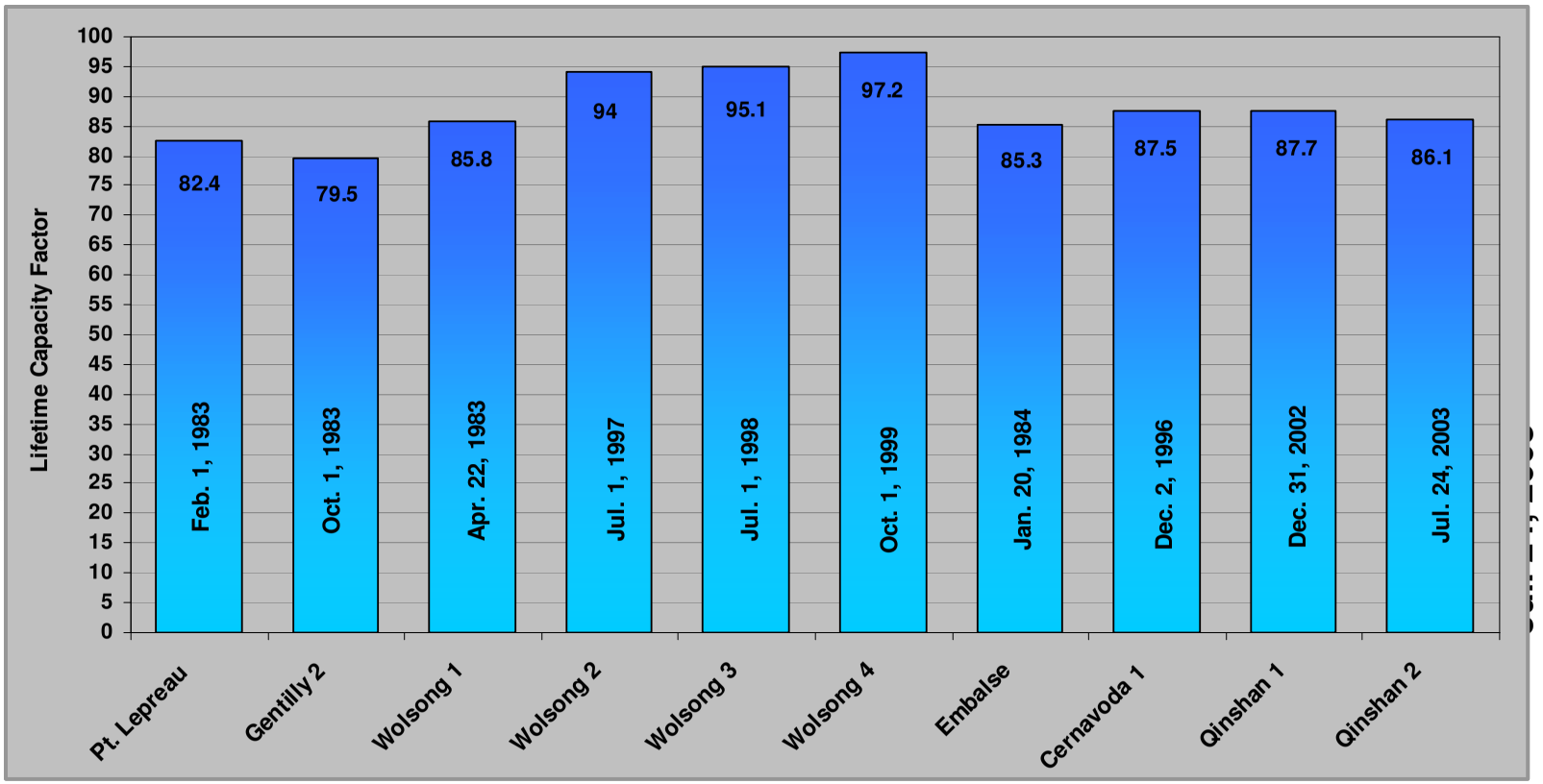


CANDU Development Builds on a Strong History



CANDU 6: Performance Excellence

- **All units perform exceptionally well**



90% Capacity Factor

- Wolsong 2/3/4 reactors have achieved 5 year capacity factor (CF) of over 90%
- Wolsong 3 has already achieved 19 day outage duration
- Gentilly 2 implementing 2 year outages
- 90% achievable due to reduced forced and shorter outages and longer intervals between plus more on power testing and redundant robust equipment
- Embalse achieved 454 days of continuous operation without forced outage
- Lifetime availability factor 87,21%.

Comparison of C6 with other Power Reactors

Vendor	Size (MWe)	Lifetime Capacity Factor
AECL - CANDU 6 (Design by AECL)	600-730	~ 88 %
Ontario Hydro Designed Multi Unit - Darlington, Bruce B (Reactor Core by AECL)	900	~ 82 %
AREVA / Framatome	600 - 1000 > 1000	71.1 % 67.2 %
Westinghouse	600 - 1000 > 1000	73.9 % 76.7 %
General Electric	600 - 1000 > 1000	70.2 % 69.1 %

Source: NEI Magazine, June 2007, supplemented by COG Station Performance figures to end of 2006

CANDU 6

Proven Technology for the 21st Century

- Proven technology in service since 1983
- Continued evolution
- Global success
  - Today there are 11 CANDU 6 reactors licensed and operating worldwide: Argentina, Canada, Korea, Romania, China
  - Construction to be re-started in two units in Romania
  - One twin plant (Atucha III) planed to start in 2010
  - Interest in mid size natural uranium reactor by Jordan, Turkey, Morocco, Egypt…….

Proven Constructability

Unparalleled Delivery Capability

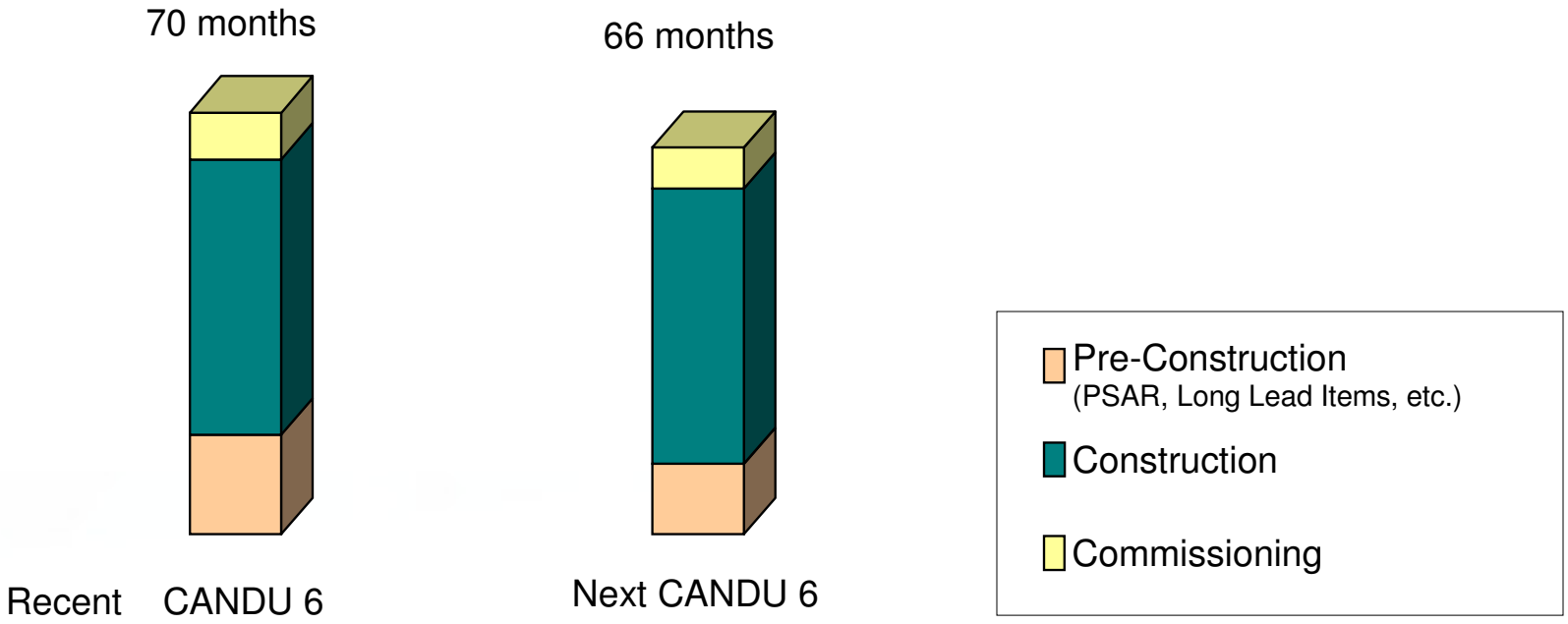
In-Service	Plant	Status
1996	Cernavoda Unit 1, Romania	On budget, on schedule*
1997	Wolsong Unit 2, S. Korea	On budget, on schedule
1998	Wolsong Unit 3, S. Korea	On budget, on schedule
1999	Wolsong Unit 4, S. Korea	On budget, on schedule
2002	Qinshan Phase III, Unit 1, China	Below budget, 6 weeks ahead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

Qinshan Construction

(*) As per completion contract of 1992

Aug.07: Completed, on schedule

Advancements in Project Schedule



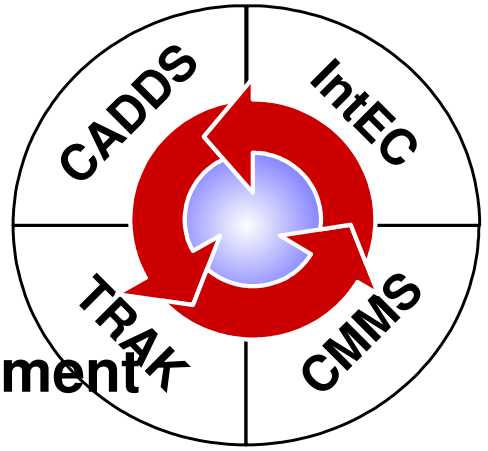
Based on the design, equipment procurement, and construction experience from recent projects

Features to Reduce Schedule

- Pre-project and pre-construction activities - localization has impact
- Expected to achieve 54 months first concrete to in service
- Additional modularization and prefabrication
- Open Top
- Continued advances in Project Management tools
- Expert construction & commissioning management team

Proven Implementation Systems

- **Project execution based on four highly integrated core systems:**
  - **Intergraph's 3D plant modelling and schematic design suite**
  - **AECL's Supply Chain management system (CMMS)**
  - **AECL's Electronic Document Management System (TRAK)**
  - **AECL's IntEC equipment design and management, cable & wiring and DCC/DCS signal management system**



Experience

- Continuous NEW BUILD program ensures we can deliver to schedule
- Proven electronic documentation – multi parties and locations
- Strong and Experienced Project Team in:
  - Engineering
  - Procurement
  - Construction
  - Licensing
  - Quality Assurance
  - Commissioning
  - Project Management

The CANDU 6 Advantage

- **Size**
  - **700 MWe class CANDU 6 is more suitable for smaller grids**
- **Proven Technology**
  - **reducing construction risks, schedule delays, costs overruns, operational performance**
- **Fuel flexibility**
  - **Natural Uranium and other nuclear fuels (SEU, RU, MOX, Th) that can be used**
  - **Simple fuel bundles are currently manufactured by all CANDU countries**
- **On-power refueling**
  - **contributes to high performance, lower operating costs and maintenance schedule flexibility**
- **Load following capability for grid stability**

CANDU Life Extension

- Current CANDU reactors operate economically and reliably for up to 60 years
  - After approximately 25-30 years, core component replacement increases plant life by 25 to 30 years
- Benefits of Refurbishment
  - Ongoing reliable operation
  - Economic competitiveness

CANDU Life Extension

- Lepreau outage started April 2008 - Fuel channel, feeder tubes replacement
- Retubing tooling tested and shipped to training site in New Brunswick
- Plan to train Argentine staff at Point Lepreau (Phase 1 performed in 2008)
- Wolsong 1 outage scheduled for April 2009. Contract with AECL signed in May 2006
- Bruce Units 1 and 2. Contract signed in October 2005 under execution; units 3 & 4 in discussion
- Gentilly 2 scheduled for 2011. Contract signed in July 2008

Embalse Argentina

Collaboration with Argentina

- Embalse connected to grid in 1983
- Embalse has had an impressive lifetime load factor performance record of 85%
- Embalse included technology transfer, training of Argentine staff, transfer of design codes, training of commissioning and operation staff
- AECL worked closely in Argentina to develop local suppliers. Several equipments were manufactured in Argentina (airlocks, heat exchangers, moderator pumps, instrumentation, valves, etc.)
- AECL worked with local firms: Techint in the civil design and MacKee in the mechanical and electrical design; construction by local contractors – Argatom, Nuclar, etc.

Embalse Life Extension

- **Embalse:**
  - **Condition Assessment of structures and equipment:**
  - **Phase 1 completed and performed by NA-SA with AECL assistance**
  - **Safety assessment performed by NA-SA**
  - **AECL provided reference changes made in Point Lepreau**
  - **SAR revision and update will be done by NA-SA with AECL assistance**
  - **Study underway with NA-SA and Ansaldo for power uprate (approx. 6%)**

Embalse Life Extension

- **Localization:**
  - **NA-SA is the project manager and responsible for implementation**
  - **Retubing, AECL supplying the technology, tooling, procedures, and site technical assistance**
  - **Initial training of NA-SA staff being implemented in Point Lepreau**
  - **Contract negotiation completed (Project Law)**
  - **Supplier qualification and component manufacturing development of CONUAR being implemented with AECL assistance. Main components include Pressure Tubes, Calandria Tubes, Lower Feeders, End Fittings**
  - **Replacement of the Steam Generators. IMPSA with support from B&W has submitted a bid to NA-SA**

Feasibility Study For New Build in Argentina

- Replica of the Qinshan twin unit (2 x 740 MWe gross)
- Local Argentine participation plan- 65%
- Several sites were reviewed by NA-SA
- AECL and NA-SA to complete negotiations in 2009-2010

Model Selected

- Development of Argentina's nuclear structure, allowing self-sufficiency and future participation in AECL CANDU international markets
- NA-SA Project Director
- AECL Support:
  - Supply of Qinshan Design of NSP and design authority
  - Technical and project management support for implementation
  - Procurement of selected Canadian equipment

Localization

- **Localization of Engineering in Argentina:**
  - **NA-SA to receive full technology, including design codes**
  - **NA-SA to select BOP supplier and to set interfaces**
  - **NA-SA to establish a design organization with the support of Argentine engineering companies. AECL to supply the design authority and key technical staff. The scope includes:**
    - **A) Revision of design to local conditions, new codes and licensing requirements**
    - **B) Preparation of equipment procurement packages and support during manufacturing**
    - **C) Provision of engineering support during construction and commissioning (resident engineering)**
    - **D) Licensing support**

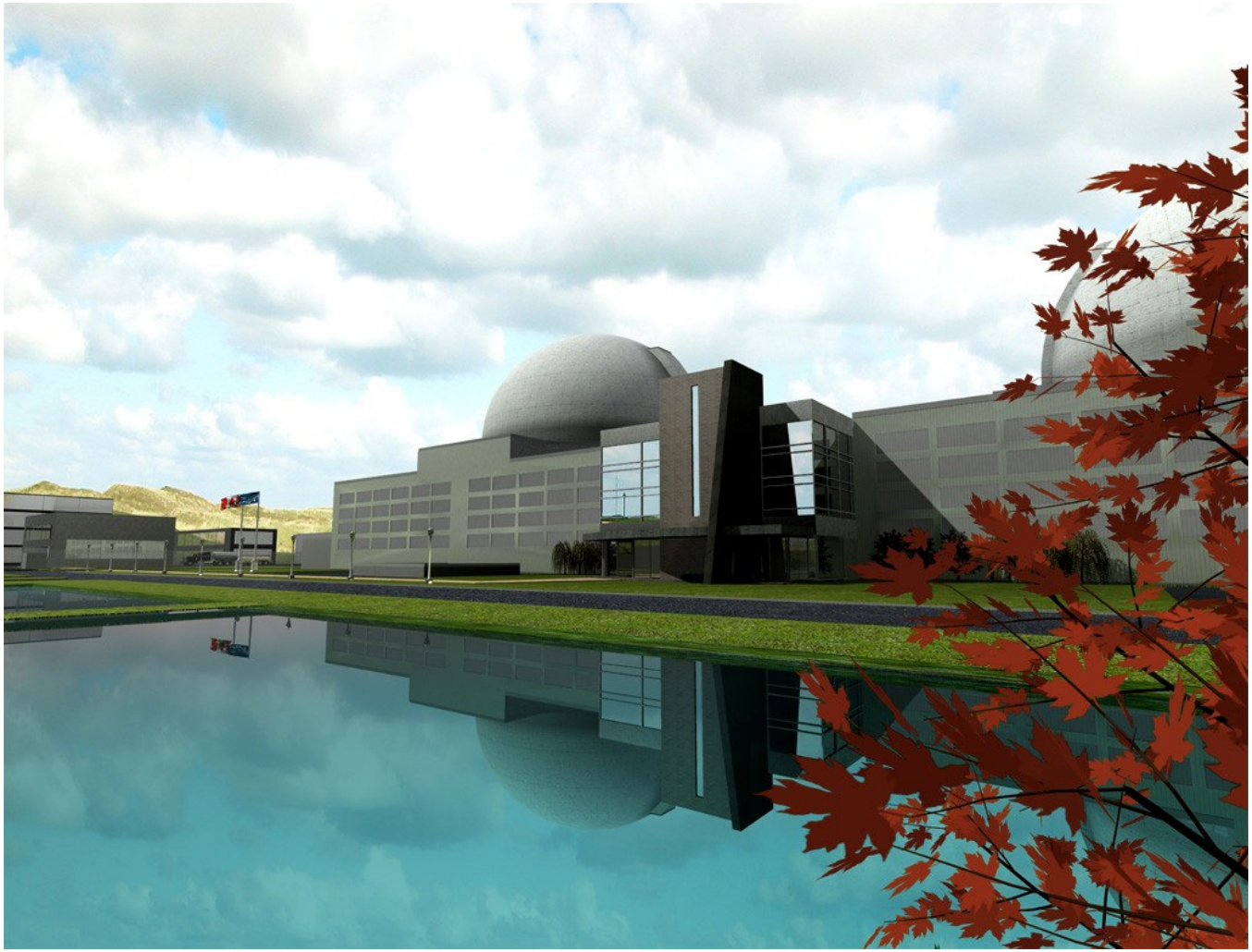
Localization

- **Procurement of local equipment**
- **NA-SA to receive full reference procurement packages and procedures**
  - **NA-SA to establish a procurement organization. AECL to supply key technical staff. This scope includes:**
    - **A) Selection and qualification of local suppliers**
    - **B) Localization of 65% of scope**
    - **C) Preparation of tender documents**
    - **D) Performance of Post Order Engineering, QA, and Procurement Administration**

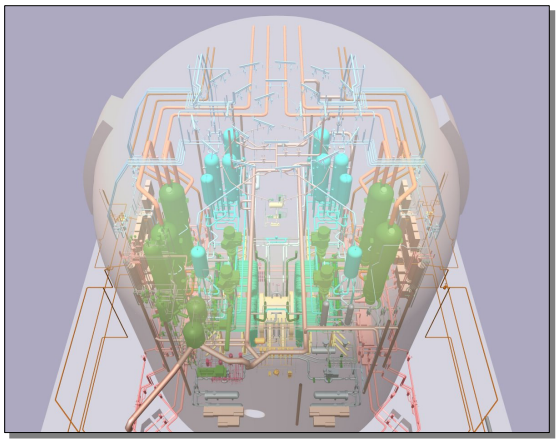
Summary

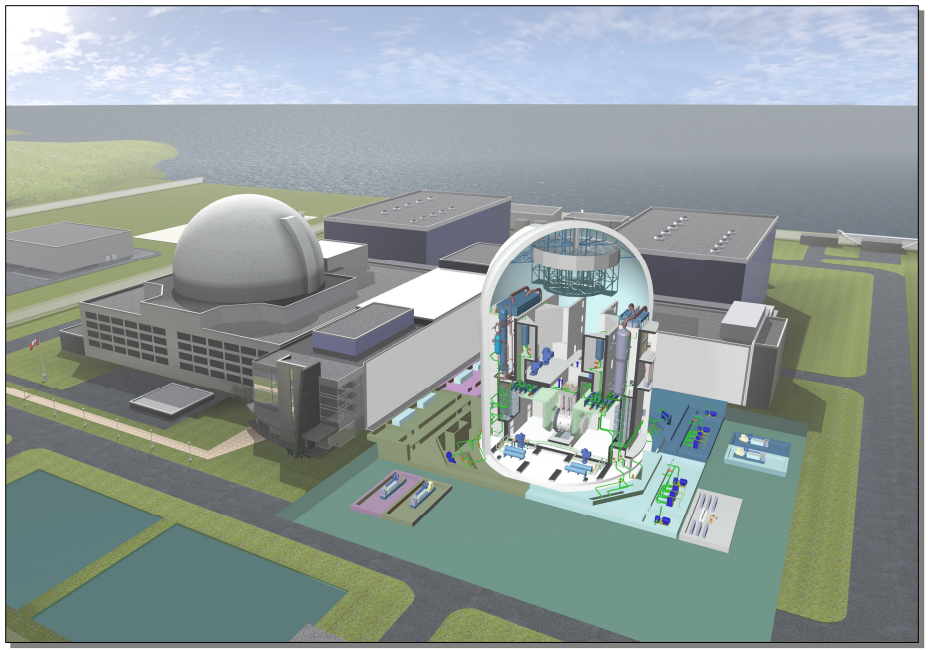
- **AECL and NA-SA/CNEA working in a partnership model for the Refurbishment of Embalse and in the Fourth Station, thus providing an opportunity for the development of Argentina's nuclear sector, allowing self-sufficiency and exports from Argentina.**

ACR-1000 Plant



ACR-1000: Advanced CANDU Reactor





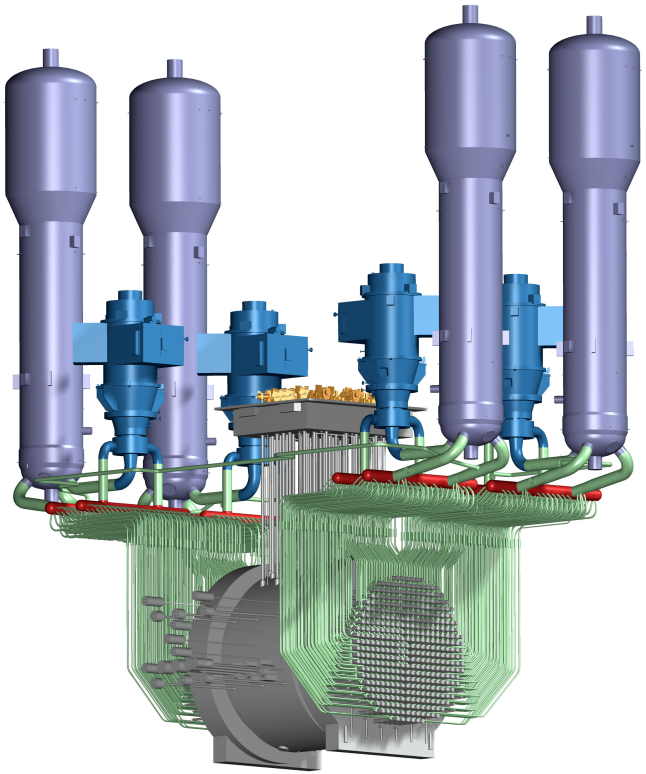
- **1200 MWe class**
- **Generation III+**
- **Combines best of CANDU 6 and Gen III LWR**
  - Light water cooling & low enriched fuel
  - 80% of plant features are proven on CANDU 6
- **Enhanced safety, economics, operability**
- **Meets and exceeds IAEA NS-R-1 safety requirements**

Keeping the CANDU Tradition…

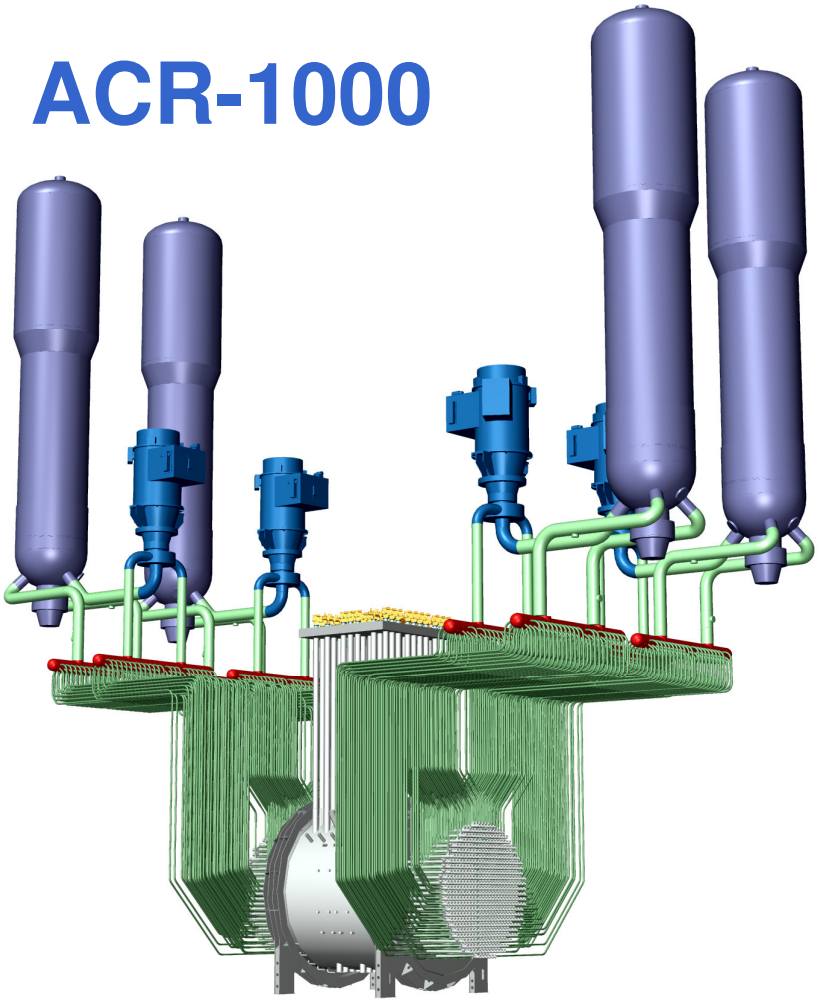
- Modular horizontal fuel channels
- Simple, economical fuel bundle design
- Separate, low temperature and pressure heavy water moderator
- Water-filled reactor vault
- Reactivity mechanisms operate in low temperature, low pressure environmental
- Two independent, passively-driven safety shutdown systems
- On-power fuelling
- Reactor building access for on-power maintenance

Similar configuration & equipment to CANDU 6

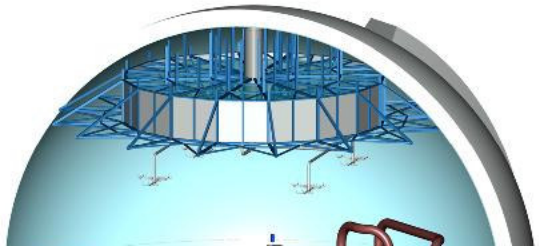
CANDU 6



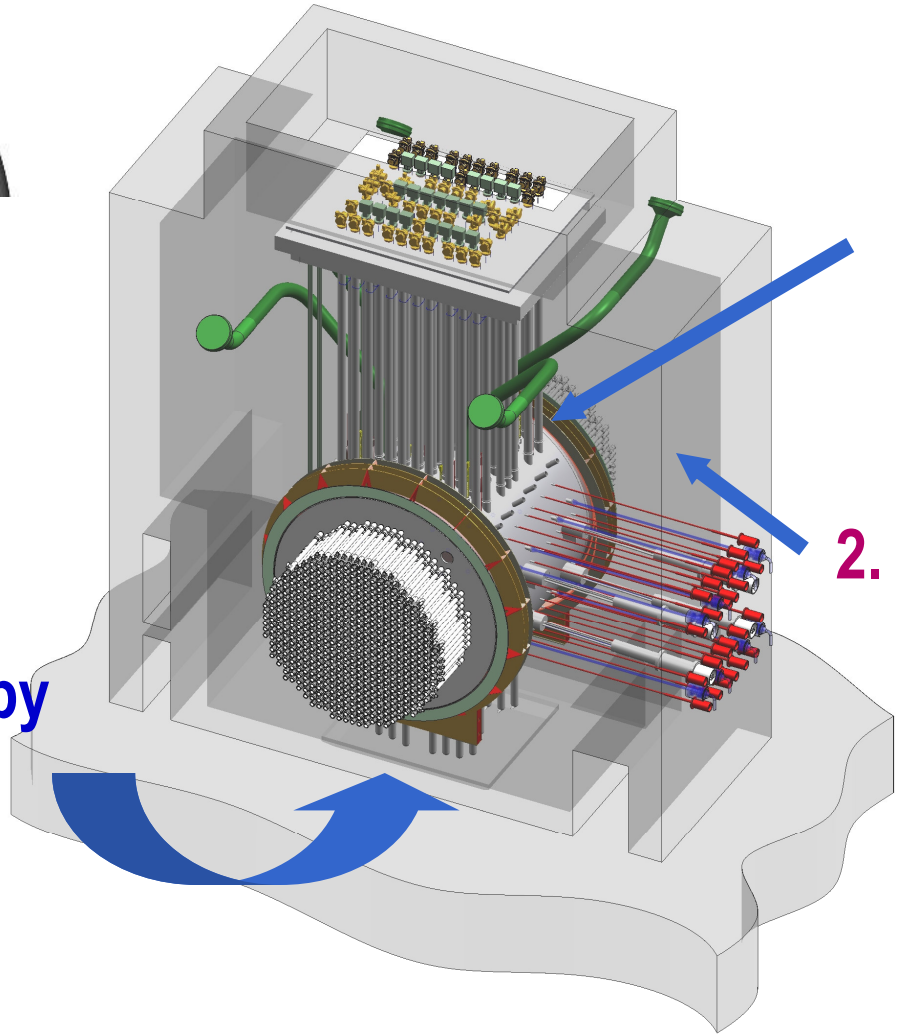
ACR-1000



Major Passive Heat Sinks for Severe Accident Mitigation & Management



3. Water from Reserve Water Tank fills fuel channels, calandria, and shielding vault by gravity

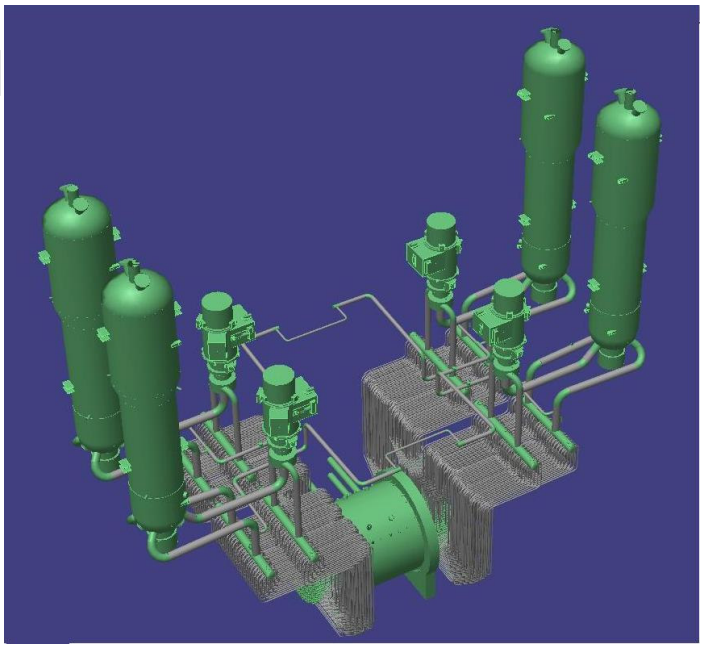


1. Calandria Water

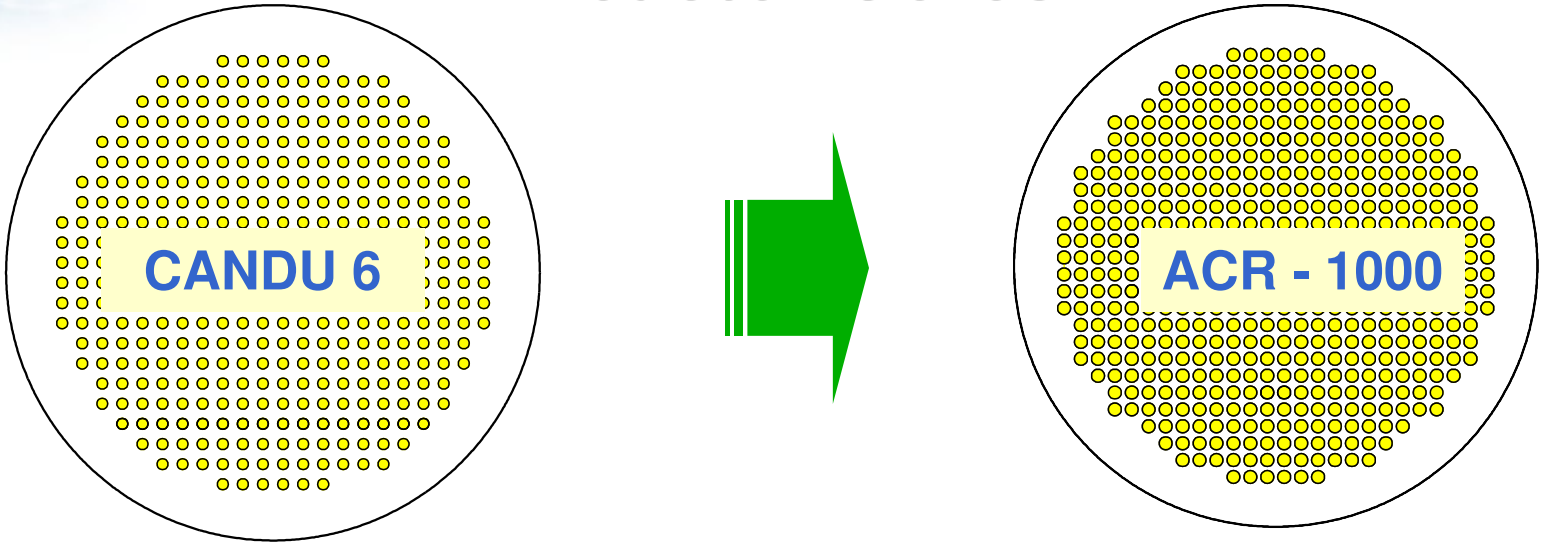
2. Shielding Vault Water

…. While Embracing Innovation

- Compact core
- Light water coolant - reduces heavy water inventory for lower costs, reduced emissions
- Thicker pressure tubes; thicker and larger calandria tubes
- Stainless steel feeders and headers
- Improved thermal efficiency
- Further-enhanced passive safety features
- Steel-lined robust containment building



Reactor Cores

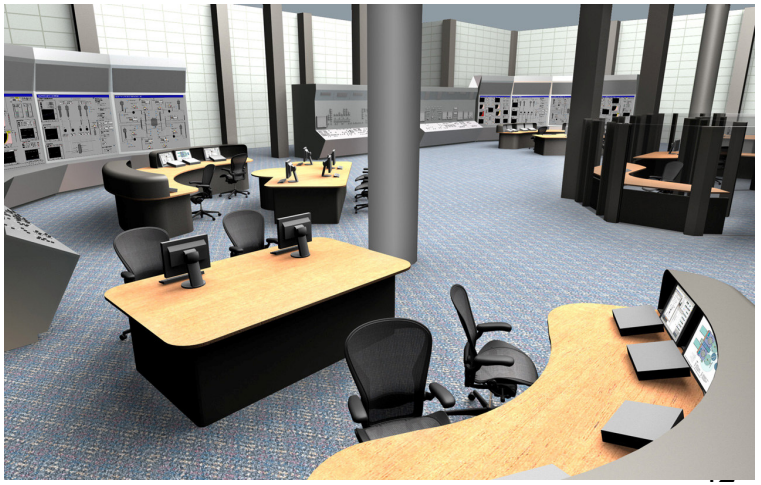


ACR:

- 520 vs. 380 channels
- Tighter channel pitch
- Same overall reactor diameter
- 45% less heavy water

Improved Operations/Maintenance

- ACR-1000: >90% lifetime capacity factor; >95% year-to- year, over 60 years
- Performance based on proven CANDU 6 track record: 87.4% lifetime
  - & improved Bruce B/Darlington multi-unit stations performance (>90%)
- One planned outage every three years
  - 21 days duration
  - flexible timing
- Planned mid-life retubing outage

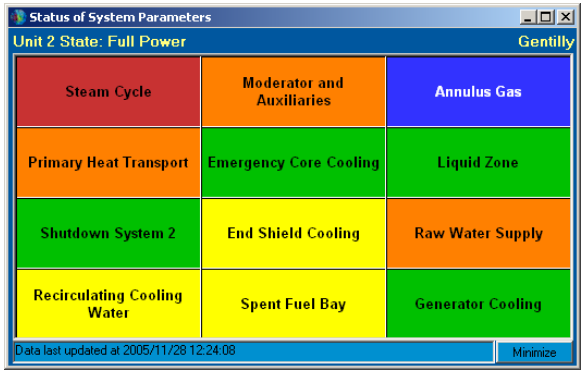


Improved Operations/Maintenance

- On-power maintenance strategy
- Improved plant layout: permanent elevator, walkways, platforms; provision for electrical, water, air to facilitate maintenance
- Increased shielding in radiologically-controlled areas: reduced worker exposure
- Customer-driven improvements in operability and maintainability e.g. Mechanical zone control rods; solid-rod guaranteed shutdown state
- Computerized testing of major safety systems/automatic calibration of in-core detectors
- Modern control centre

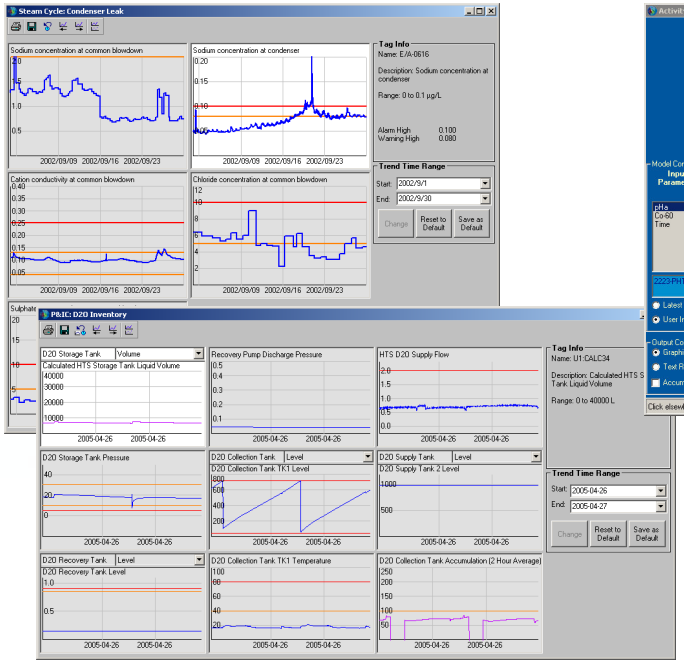
Plant Information, Diagnostics and Analysis

Status



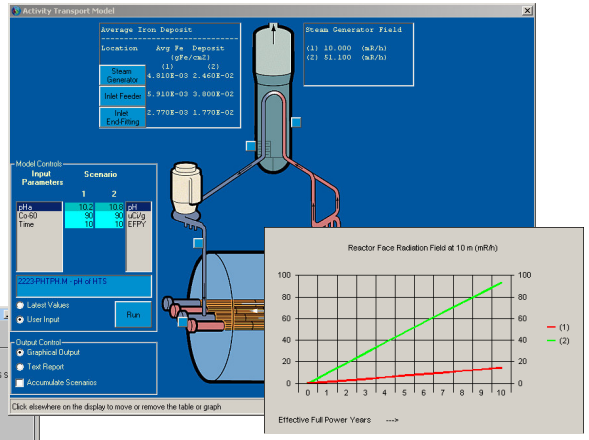
- Current value and trend of most recent values compared to user-defined limits
- Colour indicates status of all monitored parameters

Trends



- Trends of correlated parameters help with diagnostics and analysis
- Support proactive decisions

Analysis



- Activity transport
- SG fouling
- Thermal performance
- Deuterium ingress
- Thermal fatigue

Large equipment localization

Calandria

- **Largest nuclear component**
- **25 mm shell thickness**
- **Design pressure ~1 atm**
- **Similar size as for CANDU 6**
- **No forgings**

Calandria shell

Localization

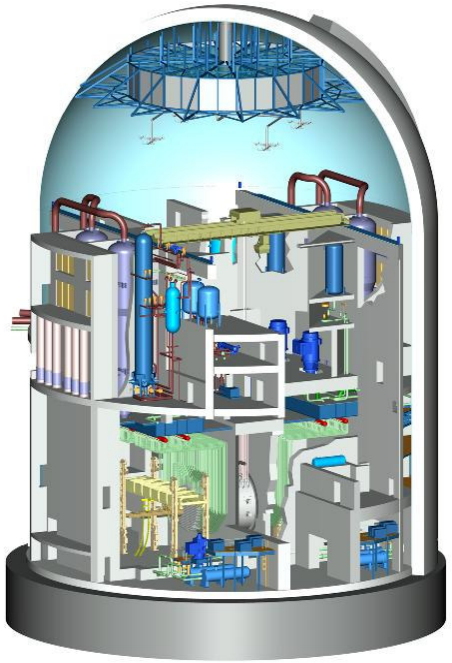
- **Construction**
  - **Similar approach to construction of C6 and ACR will make for a low risk transition**
  - **All of your C6 experience will be valid, including use of AECL's advanced construction systems and C6 modules**
- **Commissioning & Operations**
  - **All the appropriate skills are already in Argentina**
  - **Embalse refurb. & C6 new build will enhance them**
  - **The only new skills required will be for handling enriched fuels**

CANDU fuel fabrication in Argentina

- Completely localized
- CONUAR produces all Embalse fuel
- Current production can be extended to ACR fuel
- CONUAR has already partnered with AECL for CANDU fuel technology transfer in Turkey

ACR-1000: Argentina's natural Gen III choice

- Low risk project delivery
- High localization built on CANDU experience
- Builds on current licensing expertise
- Uses existing operational skills
- Unit size suits grid
- Spent fuel recycle potential
- Competitive costs



ACR-1000 Reactor Building Cutaway


AECL
EACL