AECL: Opportunities in International Cooperation

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Outline

• AECL Profile
• CANDU™ products and services
• AECL partnerships, customer support and cooperation
• AECL localization activities
• Canadian education and training programs
• Infrastructure assessment and development
Canadian Nuclear Industry

- Canada is a successful nuclear pioneer, developer and operator of nuclear facilities
  - 60 years of nuclear technology development
  - Invented CANDU™ power reactor and cancer therapy
- 20 CANDU reactors in Canada
  - CANDU generates ~50% of Ontario’s power
- World’s largest exporter of uranium

Bruce, ON
Gentilly, PQ
Pt. Lepreau, NB
Darlington, ON
Atomic Energy of Canada Limited

• Established in 1952 to lead the Canadian nuclear industry.
• 33 CANDU reactors in-service worldwide
• Over 5,000 employees
• CANDU recognized as one of the top 10 major engineering achievements of the past century in Canada.
• World records in construction and commissioning.
• Advanced R&D Facilities
• **Nuclear power design and construction**
  – Developer/ designer/ builder of the CANDU nuclear power reactor

• **Full lifecycle service packages**
  – Design, build, and service reactors in Canada and around world

• **Support services**
  – O&M support, plant life management programs, waste management

• **Comprehensive R&D facilities at Chalk River Laboratories**
  – Research reactors, hot cells, flow testing, metallurgy, heavy water, etc.
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

Wolsong, S. Korea
Pickering, Canada
Qinshan III, China
The CANDU Reactor is AECL’s flagship product:

– Enhanced CANDU 6™ (EC6™)
– ACR-1000™

AECL also delivers CANDU/PWR solutions:

– MACSTOR™ (Waste Mgmt.)
– ECC Strainers
– Pump Seals
– Hydrogen Recombiners
AECL’s Power Reactor Products

ACR-1000™ (Advanced CANDU Reactor™)
- 1200 MWe class reactor
- Generation III+ technology
- Combines experience of CANDU 6 with new CANDU concepts
- Light water cooling & low enriched fuel
- Enhanced safety, economics, operability

EC6 (Enhanced CANDU 6)
- 740 MWe class
- Heavy water moderated and cooled, natural uranium fueled
- Based on the Qinshan project
- Enhanced to meet current regulatory requirements in Canada and internationally, and the Gen III guidelines
CANDU Services

- Design, construction and commissioning of reactors
- R&D support to CANDU designs and basic R&D work
- Refurbishment of CANDU operating reactors
- Retubing of CANDU operating reactors
- Maintenance assistance to operating CANDU reactors
- Operational safety assistance to CANDU utilities
- Licensing services (pre-project and project) for new build CANDU projects, operating CANDU reactors and refurbishment of CANDU reactors
AECL’s Customer Support & Cooperation

- Partnerships initiatives
- Localization initiatives
- AECL participation in the University Network of Excellence in Nuclear Engineering (UNENE) program
- Training programs at AECL and at customer locations
- Customer staff visits and exchange programs
- AECL staff secondments at customer sites (in all phases of a plant lifetime)
- Ownership programs
AECL: Powered through Partnerships

- AECL draws on an extensive network of partners from around the world
- Partnerships play a key role in every aspect of AECL’s business
  - Allows us to leverage experience and expertise
  - Ensures our products and services meet our customers’ high expectations
Team CANDU

- Canada’s leading private sector companies in the nuclear power plant field.
- Robust and dynamic team to ensure new builds are completed on budget and on schedule.
- Synergies provide best risk profile and resources for nuclear new build.
AECL Localization Policy

- AECL is committed to share technology
- Four decades of experience
- CANDU plants exported to six countries & operate in over six languages
- High localization in most “CANDU” countries
- AECL has no manufacturing facilities- therefore ready to partner with local companies
Localization Objectives

- **Autonomy - self-reliance**
  - ability to implement program without undue dependence on others

- **Economic development**
  - local companies to benefit from economic activity

- **Scientific & Industrial Development**
  - strengthens centres of excellence that support other industries

- **Shorten the supply chain**
  - suppliers closer to customers
  - eliminate language barriers

- **Costs**
  - reduce costs in a multi-unit new build program
CANDU Readily Localized

- Developed and built by Canada, a medium sized country with modest heavy industry
- Many identical, small components, no massive forgings
- High level of modularization
- Low capital cost for manufacturing plants
- 70% of plant equipment is similar to PWR
- India, Korea, Argentina and Romania have localized CANDU to varying extents of up to 100%
India

- AECL built RAPP-1 220 MWe PHWR prototype in 1973
- AECL work on RAPP-2 construction halted in 1974
- India completed RAPP-2 and built 8 more similar units
  - based on AECL technology transfer on first two units
Korea:

- **Unit 1**
  - 14% Local Content (excl. construction) (1976 to 1982)
  - bulk material & equipment supply
- **Unit 4**
  - 75% Local Content (1998)
  - material & equipment, design engineering, construction, procurement, project management and commissioning
  - CANDU fuel manufacturing
Romania:

- similar approach as in Korea
- progress limited by financing difficulties for Cernavoda Units 1 & 2
  - Cernavoda Unit 3 & 4 completion contract now under negotiation
    - Romanian companies and partnerships will take lead roles
- CANDU fuel manufacturing and heavy water manufacturing
Argentina:
- Planning Embalse CANDU 6 NPP life extension and 2 x CANDU 6 Atucha 3 new build
- Localization under way for steam generators, fuel channels
- CANDU fuel technology to CANDU customers
- CANDU fuel manufacturing and heavy water manufacturing
AECL’s Localization Record

China: Qinshan Phase 3

- 25% local content including:
  - construction and commissioning
  - major conventional plant equipment

Localization limited by request of PR China

- 100% financing requested
- no local finance available

Technology transfer

- modern construction management
- extensive operations technology
- AECL has agreed in principle to technology transfer for future plants

CANDU fuel manufacturing technology
University Education Programs

- McMaster University Graduate Diploma Program
  - Nuclear engineering graduate courses
  - AECL students and lecturers
  - Semester course format

- University Network of Excellence in Nuclear Engineering (UNENE) Program
  - Joint universities graduate program
  - Designed for nuclear industry participation
  - Graduate courses in key disciplines given in two year cycles
  - Weekend classroom format

- International training programs
National Position

- There should be confidence in the market for the vendors and the investors/lenders
- Government commitment to safe, secure and peaceful implementation
- Public consultative process
- Bilateral agreements in place with vendor countries (at government and organization level)

Regulatory

- Establishment of regulatory framework
- Use of qualified personnel through consultants, other nuclear regulatory bodies and international organizations
- Vendors and lenders/investors need to clearly see that the licensing process is well defined and achievable
- Effective regulatory/licensing process to manage the overall cost of project
Grid

- The size of the grid and the impact of expected additional capacity should be understood
- Any required enhancements agreed by owner/government
- Grid specifications need to be clearly included

Site and Supporting Facilities

- All siting requirements assessed
- Any political, legal or public acceptance issues resolved
- Clear delineation of responsibility for access, security, local infrastructure
Human Resources

- Plans that address adequate staffing and training for all areas including regulatory, bid preparation and assessment, support during construction phase and operations and maintenance
- Legislation and programs that support the health and safety of workers during construction, commissioning and operations

Environmental Protection

- Environmental Impact Assessment completed.
- Vendors must understand environmental sensitivities during construction phase
Industrial Involvement

- The upfront assessment of the local capacity to support implementation especially in the construction area
- Use of local resources will lower overall cost of implementation
- More economical to purchase a technology that can be aligned with local resources rather than a “black box” approach
- Procurement/local supply of equipment and materials
- Selected vendor can assist with development of Quality Assurance and Control process and evaluation of local resources
Conclusions

- CANDU has been successfully adopted in six countries beyond Canada
- AECL has advanced the CANDU design with two new Gen III and Gen III+ products: EC6 and ACR-1000
- AECL is ready to collaborate with host countries on various ownership and localization programs
- CANDU has unique features that make it very attractive for localization
- Selection localization priorities depends on a careful assessment of local infrastructure
- AECL localization track record is exemplary
Questions?

Thank you for your attention