Drivers and Impediments for Regional Cooperation on the Way to Sustainable NES

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1. NP Program in Brazil – Status & Prospectus

- Electricity generation
  - Eletrobrás Thermonuclear S/A – Eletronuclear
  - A government-controlled company that in-charged of operating and building thermal nuclear power plants in Brazil
- Fuel Cycle
  - Brazilian Nuclear Industries (INB)
  - INB act on the uranium productive chain, from mining to the production of the fuel that powers the reactors in the NNPs
- National Nuclear Authority
  - National Nuclear Energy Commission of Brazil (CNEN)
  - Formulation of the national energy policy
  - R&D, services in nuclear technology applications
  - Regulation, licensing, authorization, controlling and supervision

1. NP Program in Brazil – Status & Prospectus

- Electricity generation
  - Admiral Álvaro Alberto Nuclear Power Station

- Angra 1 NPP: 657 MWe PWR, Westinghouse, 1985
- Angra 2 NPP: 1350 MWe PWR, Siemens/KWU, 2002

1. NP Program in Brazil – Status & Prospectus

- Electricity generation
  - Nuclear Power Station Almirante Álvaro Alberto

  - Angra 3 NPP: 1350 MWe PWR, Siemens/KWU, 2015

    (a replica of Angra 2 NPP; it incorporates the technological advances since construction of the latter)

1. NP Program in Brazil – Status & Prospectus

- Electricity generation
  - National Energy Plan 2030 (PNE 2030)
    - Expansion of 130.1 GWe of installed electricity capacity
    - Hydropower energy shall contribute with 87.7 GWe
    - Nuclear energy shall contribute with 5.3 GWe

1. NP Program in Brazil – Status & Prospectus

- Electricity generation
  - 2030
    - 2 NPPs in the Northeast (2000 MWe)

    - 2 NPPs in the Southeast (2000 MWe)

1. NP Program in Brazil – Status & Prospectus

- Fuel Cycle
  - Mining (Brazil)

  - Milling (Brazil)

1. NP Program in Brazil – Status & Prospectus

Fuel Cycle

- Uranium concentrate (U_3O_8) production:
  - Caetité (State of Bahia)
  - Current production: 400 ton/year
  - 2013 production: 900 ton/year
  - Santa Quitéria (State of Ceará)
  - 2015 production: 600 ton/year

1. NP Program in Brazil – Status & Prospectus

- Fuel Cycle
  - Uranium conversion U_3O_8 / UF_6 :
    - Currently: Canada
    - 2013 start production: 1200 ton/year
    - 2018 increase production to 2400 ton/year

1. NP Program in Brazil – Status & Prospectus

- Fuel Cycle
  - Enrichment (Brazil and Europe)

1. NP Program in Brazil – Status & Prospectus

- Fuel Cycle
  - Uranium Enrichment in Brazil
    - Started in 2006
    - At the moment
      - 730 kg of 4% enriched uranium/year
      - Current capacity:115,000 SWU/yr (separative work unit/year)
    - Full stage 1
      - 60% of the fuel needs for Angra 1 & 2 NPPs
      - Capacity for 200,000 SWU/yr

1. NP Program in Brazil – Status & Prospectus

- Fuel Cycle
  - Reconversion (Brazil)

  - Pellets (Brazil)

1. NP Program in Brazil – Status & Prospectus

- Fuel Cycle
  - Fuel element (Brazil)

2. Drivers and Impediments

- Main Driving forces

  - Reserve of uranium
  - Reliable supply
  - Reduction of greenhouse gases emission
  - Price of petroleum and natural gas are increasing
  - Nuclear power is considered a strategic technology (industry, medicine, materials, navy and research)
  - Income distribution in Brazil has improved and the demand for electricity is increasing

2. Drivers and Impediments

- Major Impediments
  - Public acceptance
  - Governmental policies
  - Lack of definition of the national deposit for LLW (Low Level Waste) and ILW (Intermediate Level Waste)
  - Lack of definition of the national deposit for SNF (Spent Nuclear Fuel) and HLW (High Level Waste)

3. NE system in Brazil (2030 and 2050)

- 2030 Scenario - PNE 2030
  - Reactors: 7 NPPs in operation
    PWR technology
    Installed capacity of 7357 MWe
    (share of ~ 5% of total capacity)
  - Fuel Cycle: Domestic once-through (industrial scale)
    Deposit for LLW & ILW
    Intermediate deposit for SNF & HLW
- 2050 Scenario: Not yet defined

4. Nuclear Power by Foreigner Suppliers

- Angra 1, 2 and 3 NPPs were built with foreign technology
- Next 2 NPPs in the northeast (by 2022) shall be supplied by foreign vendors (EPR and AP1000 under consideration)
- Technology transfer expected from suppliers

5. Back-End Fuel Cycle Services

- Brazil masters the open fuel cycle
  - CNEN plans an intermediate deposit for the SNF and HLW storage
  - Final geological repository is not currently under consideration (*wait and see policy*)
  - National deposit for the LLW and ILW is an on-going government project
  - No legal provision regarding transit of return of SNF and HLW to other countries

6. Sustainable Nuclear Energy System

- Brazil adopts the Brundtland report (1987):

  " The development that meets the needs of the present without compromising the ability of future generations top meet their own needs"

- National on-going activities of analysis and assessment of NE system:
  - Long-term NE planning studies conducted by the Company of Energetic Planning of the Ministry of Mines and Energy
  - Application of INPRO methodology for Innovative Nuclear Energy systems (INSs)

6. Sustainable Nuclear Energy System

- Priority areas regarding nuclear energy system sustainability:

1. Economics
2. Safety
3. Waste management
4. Environment
5. Infrastructure
6. Physical protection
7. Proliferation resistance

7. Energy Independence & Security of Supply

- Belmonte Hydroelectric
  - State of Pará (Altamira)
  - Capability: 11200 MW
  - Average/year: 4500 MW
  - Public opinion: against

- Wind energy
  - Low average power per year

8. Cooperation in Energy Projects

- Itaipu Bi-national Co. (Brazil – Paraguay)
  - Hydropower – 14000 MWe installed capacity

9. Cooperation in Nuclear Power Projects

- Brazil – United States: Angra 1 NPP
- Brazil – Germany: Angra 2 & Angra 3 NPPs
- Brazil – Argentine: ABBAC, research reactor

- Licensing

- Research
  - The intermediate deposit for the SNF and HLW
  - National deposit for LLW and ILW

10. Indicators of Cooperation in NP projects

- Number of bi-lateral and multi-lateral agreements for transference of nuclear power technology (reactor and fuel cycle technologies)
- Number of participation in international initiatives for development of nuclear energy systems (Gen IV Intnl Forum and INPRO/IAEA)
- Number of bi-lateral and multi-lateral agreements for R&D on nuclear power technology

Thank you for your attention

- CNEN
- National Nuclear Energy Commission