Reform Group Meeting
Climate Policy after Fukushima

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# Nuclear Power in Brazil

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- Angra I first Brazilian nuclear reactor for electric generation (Westinghouse) → former technical difficulties resolved

- One of the problems with Angra I was the corrosion of the steam generators, due to a the metal alloy used by Westinghouse.

- Angra I steam generators were replaced recently

- 1975 → the Brazil-Germany Nuclear Agreement
- This Agreement included plans to step up nuclear power establishing a nuclear industry in Brazil
- Broad range of reactions

The areas of cooperation of Germany with Brazil were:

- Prospecting, mining and processing uranium - OK
- Producing 8 nuclear reactors until 1990 and 50 forecasted for 2000 - only one reactor built – Angra II
- Uranium enrichment using jet nozzle - did not work
- Fabrication of nuclear fuel rods - OK
- Reprocessing spent fuel – never implemented

The Brazilian Society of Physics warn to take care of the environmental risks of nuclear technology:

a) Safety of nuclear reactors

b) The radioactive wastes

Some years later there were nuclear reactors accidents of TMI and Chernobyl as well as the radioactivity accident with Cs 137 in Goiânia, Brazil

- In the years 80 Brazil's last military President implemented the Parallel Nuclear Programme under the argument that it was necessary to develop the technology that had not been transferred through the Nuclear Agreement with Germany

- To seek fuel cycle autonomy for Brazil, this Parallel Programme included uranium enrichment as top priority and the Navy developed ultracentrifuge technology for nuclear-propelled submarine

- 1986 → a newspaper revealed the existence of an extremely deep shaft drilled by the Air Force at the Cachimbo Air Base in Brazil
- A report issued by the Brazilian Physical Society concluded that it had all the characteristics and dimensions required to test a nuclear bomb of ten to twenty kilotons
- This conclusion prompted many denials
- In the years 90s, the civilian Government acknowledged the existence of an underground nuclear explosion facility, and symbolically sealed this shaft

- Argentina and Brazil ratified the Treaty of Tlatelolco on the denuclearisation of Latin America

- ABACC, an agency for mutual inspections of nuclear facilities in Brazil and Argentina was established

- Argentina and Brazil signed the Non-Proliferation Treaty and Brazil joined a coalition for a new agenda in TNP

# Difference between Argentina and Brazil Nuclear Choices

Reactor Technology

Argentina =Natural Uranium + Heavy Water

Siemens and Candu Medium Size Units

Brazil = Enriched Uranium + Light Water

Westinghouse (650 MW) and Siemens (1300 MW)

Uranium Enrichment

Argentina = Gaseous Diffusion

Brazil = Jet Nozzle → Ultracentrifugation

Argentina has two power reactors operating (Atucha I and Cordoba) and another one in construction – Atucha II

Brazil has two PWR operating (Angra I and II) and other one in construction (Anga III)

- The uranium enrichment activities are currently being transferred to a civilian industry, the INB

- The ultra-centrifuge technology developed by the Brazilian Navy for nuclear-propelled submarine project will be used to Angra I and II

- I do not believe that this uranium enrichment project is intended to endow Brazil to produce nuclear weapons

- The Angra II nuclear reactor was completed after more than 20 years, despite costs that soared from an initial estimate of US$ 500/kW in 1975 to more than US$ 4000/kW. It is the only reactor completed so far under the agreement with Germany

- The Brazilian Government is now returning to the nuclear power deciding to forge ahead with the second reactor of the Nuclear Agreement, Angra III

- US$ 700 million of its components were imported from Germany and are stored in Brazil for decades.

- To finish Angra III a further US$ 5.8 billion would be necessary, total US$ 6.5 bi for 1300 MW → - Investment cost = US$ 5000 / kW - too expensive

- Part must be financed by the French as the current controllers of the nuclear arm of Siemens.

- A study group set up by COPPE compared nuclear power costs with hydro and thermal energy : Hydro-power proved the least expensive, followed by natural gas thermo-power and then nuclear power

- The comparison between the two latter options indicates a marked sensitivity to the rate of return (very high for privately-owned thermo-power projects and generally lower for nuclear projects by the Federal Government)

- There are uncertainty on future natural gas price due to the very high increase of oil price and the effect of World economy crisis after 2008

- Global warming → nuclear power offers the argument that it does not emit greenhouse gases, in contrast to massive carbon dioxide emissions produced by the fossil fuels – coal, oil and natural gas

- Although hydro-power plants emissions are rated as negligible, power dam studies carried out by a research group of COPPE show that hydro reservoirs give rise to methane and carbon dioxide emissions, but generally at levels far lower than thermo-power plants

# Summary of Nuclear Energy in Brazil:

Electric Energy Generation – about 2% of installed capacity

Angra I (600 MW) + Angra II (1300 MW) in operation

Angra III in construction

4 new reactors - planned

Environmental Risks – the impact of Fukushima → the decision on 4 new reactors is postponed

Military Uses – development of nuclear submarine

Other uses – construction of multipurpose research reactor

- Nowadays, Brazil has 4 research reactors

- 1 - The largest research reactor in Brazil is a pool reactor of 5 MW, with light water as the coolant and moderator, and graphite and beryllium as reflector. It uses 20% enriched uranium

- 2 – Another one is located at the Nuclear Technology Development Center – at the campus of Federal University of Minas Gerais in Belo Horizonte. It is a TRIGA research reactor, of 100kW

- 3 - The third Brazilian research reactor is the Argonauta (100 kW), at the Institute of Nuclear Engineering on the campus of the Federal University of Rio de Janeiro

- 4 - The most recent Brazilian research reactor was developed by the Brazilian Navy in the nuclear submarine project

- There is now a project of a multipurpose research and radioisotopes production reactor in cooperation with Argentina

# Possible Cooperation
# Argentina + Brazil/ Reactor Technology

- Argentina works to finish Atucha II while Brazil decided to retake Angra III construction

  Both reactors use Siemens technology now under the control of French Areva

  Atucha II uses natural uranium while Angra III uses enriched uranium

- Proposal of small modular reactors

  Caren Argentina design

  Brazilian Navy design → recent cooperation agreement with France

- Proposal of joint venture Argentina + Brazil to build a reactor

- Argentina produces very small research reactors, exported to Peru, Egito and Australia

, Brazil has three small research/ radioisotope production reactors and intends to construct a new one

# Possible Cooperation
# Argentina + Brazil/ Fuel Cycle Technology

- Argentina has the technology to produce zircalloy used in nuclear fuel rods:

  Export Argentina → Brazil

- Tandem Cycle – proposal of using spent fuel from LWR enriched uranium reactors in natural uranium reactors, through new zircalloy rods without reprocessing

  LWR spent fuel has about 0.9% of U235

  0.7% in natural uranium

  Case of Brazil → Argentina ?