Country Perspective: Brazil

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1. Status Quo of Nuclear Energy in Brazil

Nuclear energy accounts for 1.8 per cent of the energy produced in Brazil's electrical energy grid, with an installed capacity of 2,007 MW. There are currently two nuclear plants in operation: Angra 1 and Angra 2. A third plant, Angra 3, is under construction and is expected to begin operating in 2015.

Table 1: Electrical energy grid production in Brazil

Source	%
Hydro power plants	72.3
Conventional Thermo power plants*	18.6
Nuclear power plants	1.8
Biomass power plants	6.6
Wind power plants	0.7

* Includes mineral coal, natural gas, petroleum-based derivatives;
Source: ANEEL – Power Generation Database, 2011.

The Angra dos Reis region, in the south of the state of Rio de Janeiro, was chosen for the installation of Brazil's nuclear complex because it has certain facilitating features. Chief among these is its proximity to large consumer centres, because this allows the plant to provide energy through relatively short power lines. Angra is 220 km from São Paulo, 130 km from the city of Rio de Janeiro, and 350 km from Belo Horizonte, all of which are large centres of electrical energy consumption in Brazil. Its proximity to the sea is another fundamental aspect, since PWR (pressurized water reactor) type plants use a large amount of circulating water to cool the steam that is produced to drive the turbine and to turn on the electrical generator. The construction of the first nuclear plant in Brazil (Angra 1) began in 1971. This plant was part of a turn-key[1] type contract developed by Westinghouse – a US-based company and General Electric subsidiary. With its installed capacity of 657 MW, it was connected to the grid in 1982 and began commercial operations in January of 1985. Its early years were characterised by frequent technical interruptions, resulting in an extremely low capacity factor of around 20 per cent. In 1975, while still under a military regime, Brazil signed a nuclear cooperation agreement with Germany. Based on the agreement, eight more reactors were to be set up in Brazil: two in Angra dos Reis, next to Angra 1, and another six along the southern coastline of the state of São Paulo. The people of São Paulo blocked construction of the plants by creating an environmental protection area precisely in the location where the nuclear plants were to be built. Thus, of the eight plants that had been planned, only Angra 2 was finalised, with an installed capacity of 1,350 MW. The project was developed by Germany's Siemens KWU-Kraftwerk Union AG company. Construction began in June 1976 and was marked by technical problems and constant schedule delays. It only began operating commercially in February 2001, at a final cost of close to 10 billion US dollars.

Another result of the Brazil-Germany nuclear agreement was the third nuclear plant, Angra 3, which applied the same technological standards as Angra 2. Angra 3 is a PWR-type plant developed by Siemens-KWU, with a 1,435 MW capacity. Work began in June 1984, but in April 1986 construction stopped. During this time, 750 million US dollars were invested in the purchase of equipment. Construction resumed in June 2010. During these 24 years, 20 million US dollars were spent per month to maintain equipment. Work on the Angra 3 plant is set to finish in December 2015 and requires a total of 6.5 billion US dollars for its completion. The BNDES (Brazilian Development Bank) will finance 60 per cent of the project (3.8 billion US dollars). A group of banks led by French bank Société Générale and including BNP Paribas, Crédit Agricole, Santander, and CNC will provide 1.6 million US dollars in financing to purchase equipment from ARENA, a company created by the merger of Germany's Siemens-KWU and France's Framatome. To facilitate the purchase of equipment, approval was given on 30 December 2010 for the creation of the Renuclear-Special Incentive Regime for the Development of Nuclear Plants with IPI (Incise Tax) and Import Tariff exemption. The final price tag for

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1. This is a type of operation employed in bidding processes where the company that is awarded the contract is required to deliver the project in full functioning condition. Both the price of the service as well as the deadline for delivery is defined within the process itself.

Angra 3 is 7.25 billion US dollars. Investment costs are 5,300 US dollars/kW installed, which is very high when compared to the average international cost of around 3,000 US dollars/kW. The operating licence for the Angra 3 plant depends on the proposal for a place for final disposal of high-intensity radioactive waste. It is worth mentioning that, in the cases of Angra 1 and 2, this waste has remained in the pools at these two plants. The electrical energy produced by the Angra 1 and 2 plants is acquired by the government-run Furnas company for 84 US dollars/MWh; the company then resells it to distribution companies for 53 US dollars/MWh. This difference represents annual losses of 315 million US dollars for this state-owned company.[2] The National Energy Plan projects additional installation of 4,500 MW (three to four new plants) for 2030, which could reach 33,000 MW (25 to 33 new plants). This would account for 4.9 per cent of the total electrical energy production forecast for the country in 2030.

In the short term, construction of two nuclear power plants is currently being planned in Brazil's northeast region. The location chosen is the city of Itacuruba, in the state of Pernambuco, where two plants (of approximately 1,000 MW each) are to be built on the banks of the São Francisco River with the chance for future expansion to hold up to six plants with the same capacity. According to the Brazilian Decennial Energy Plan (2011-2020), the first north-eastern plant will start operating only after 2020. Five days after the nuclear accident in Fukushima, the Minister of Science and Technology, Aloizio Mercadante, called it an »incident« that should provide an opportunity for a review of the safety policy at Brazilian plants. Yet nothing is being done for now.[3] During the weeks following the accident, Brazil's media was overpowered by the nuclear lobby. Several technicians from Brazil's nuclear industry and university academics were interviewed. They characterised Brazil's nuclear plants as being safer than Japanese plants, moreover indicating that Brazil is subject neither to earthquakes of the same magnitude as Japan nor to tsunamis with 10-metre-high waves that hit the nuclear installations at Fukushima. Little attention was given to critics of the nuclear programme, who warned of the problem that the Fukushima accident highlighted: the dependence on pumping water in order to cool the reactor so as to prevent the fuel rods from melting.

Only in late March 2011, did the Eletronuclear company[4] present a plan for construction of small hydroelectric plants that would supply the nuclear plants of Angra dos Reis, in Rio, in cases of emergency, thus increasing the security of their operations. Another measure for increasing the security of the installations would be construction of a dedicated power transmission line for the plants. The energy produced by the hydroelectric power plants would be directed to the nuclear power plant in cases of supply system failure. The Angra 1 and 2 plants currently rely on twelve diesel generators that are able to feed the reactor cooling pumps, which are similar to those being used at the Fukushima plants in Japan. The power from the hydroelectric plants would be yet another security item in addition to the generators. The company also announced that it has a contract with an outside consultant to review monitoring of the shoreline near the three plants located in Angra dos Reis. Built near the shore, the plants also run the risk of landslides damaging auxiliary facilities, such as waste deposits.[5] Brazil has no contingency plan for evacuation of the city of Angra dos Reis if a problem similar to what happened at Japan's Fukushima nuclear power plant were to occur. The Angra emergency plan establishes removal of the population – a total of 12 thousand people – in a 5 km radius from the plants, which is the minimum required by the International Atomic Energy Agency. According to the President of the National Nuclear Energy Commission (CNEN), removal of the population within a 20 km radius, as in Japan, »starts to include the city of Angra and is more complicated«. The Brazilian government is »going to think« about revising the emergency plan.[6] However, it is worth noting that the Fukushima accident was played down by Brazil's nuclear authorities. Government initiatives were evasive and plans for construction of new nuclear plants did not undergo any changes.

2. Socio-Political Discourse on Nuclear Energy

The experience gleaned from the design, construction, and operation of Angra 1, 2, and 3 – as well as having one of the largest uranium reserves in the world, estimated

2. *Folha de São Paulo*, 30 September 2010.

3. Ibid., 16 March 2011.

4. Eletronuclear is a subsidiary of Eletrobras, and was established in 1997 for the purpose of operating and building thermal nuclear power plants in Brazil.

5. Ibid., 29 March 2011.

6. Ibid., 15 March 2011.

at around 309 thousand tonnes (fifth largest reserve worldwide), which adds to the technological mastery of the fuel cycle – are the reasons given by the Brazilian government for presenting nuclear energy in Brazil as a highly competitive energy alternative that allows the country to guarantee energy self-sufficiency. The anti-nuclear movement in Brazil operates through actions by NGO's as Greenpeace in Brazil and through local movements such as SAPE (Environmental Protection Society of Angra), which is headquartered in Angra dos Reis. It also operates through social movements such as the Movement of the Victims of the Nuclear Accident of Goiania (1987) and GAMBA (Environmentalist Group of Bahia), which operates in the city of Caetité, where uranium is currently being mined.

A study was conducted by the IBOPE intelligence agency in Brazil in cooperation with the WIN-Worldwide Independent Network of Market Research agency from 21 March to 10 April 2011 in 47 countries to assess the repercussions of the nuclear accident at Fukushima on international public opinion. It found that 54 per cent of Brazilians are »against« the use of nuclear energy as a means of generating electricity for the world, compared to a global average of 43 per cent. It is important to note that prior to the Fukushima accident, the proportion of Brazilians against nuclear energy was 49 per cent.The study also showed that 57 per cent of Brazilians are concerned about the possibility of a nuclear incident in the country, compared to a global average of 49 per cent. The anti-nuclear movement in Brazil is currently proposing a moratorium on the Brazilian nuclear programme and the debate is heating up in the media. Yet, it has not been able to achieve a change in current plans to expand the use of nuclear energy in the country. It is worth noting that although there is an anti-nuclear movement in Brazil, it does not have the same importance as in European countries.

3. Alternative Energy Paths

A breakdown of the electrical energy grid in Brazil shows hydro power accounting for 72.3 per cent, conventional thermoelectric plants (coal, natural gas, and petroleum derivatives) for 20.4 per cent, biomass (mostly sugarcane bagasse) for 6.6 per cent, wind power for 0.72 per cent, and photovoltaic solar panels for 15 MW. Although hydroelectricity is considered to be a renewable energy, the massive hydroelectric plants already built in Brazil have resulted in the compulsory relocation of around 200 thousand families in order to form reservoirs and have also irreversibly altered ecosystems. Around 65 per cent of the hydroelectric potential to be explored in coming years is located in the Amazon Region, a biome that is characterised by significant fragility. The small hydroelectric plants could increase their share, which is today around just 2.9 per cent, provided that their construction does not bring about social and environmental problems.On the other hand, a mere 794 MW of wind energy has been installed, compared to an estimated potential of around 143 GW. In turn, the potential for co-generation using sugarcane bagasse is estimated at around 8 GW, in addition to the possibility for using biogas for electrical energy generation. Furthermore, the potential for using solar energy, both thermal and photovoltaic, is extraordinary.

Plans to increase the share of renewable energies, with the exception of hydroelectric power, are still quite insignificant. Insertion of solar energy into the grid has yet to be regulated and the cost of acquiring photovoltaic panels is still an obstacle to greater use of this source. Wind power has shown better conditions for growth, in pace with international trends. The latest auctions[7] held by the government have reduced costs, increasing the competitiveness of wind power in Brazil's electrical energy supply.

Technical losses in the Brazilian power grid reached 15 per cent. It would be possible to reduce this rate to 10 per cent, although as of yet there is no knowledge on where these losses occur (in the transmission and/or distribution grid). The ANEEL (National Electrical Energy Agency) does not set loss-reduction targets for companies. This 5 per cent drop in losses could add around 46 thousand GWh per year to Brazil's electrical grid. Another alternative is in repowering/modernising hydroelectric plants that have been operating for more than 20 years. Although Brazil's government has presented data that overestimate the capacity for the country's current hydroelectric system to produce energy, studies point to a theoretical potential to gain around

7. The regulatory model for electrical energy in Brazil defines the type of auction in the bids in order to increase the energy supply. The criteria are based on price of generation, and the companies (public and private) compete among themselves or in consortiums to win the auction.

3,400 MW of power, which could reach 8,000 MW with repowering.[8] For this to happen and provide incentives for power companies, a change is necessary to the standards that define remuneration of energy gains produced using repowering, which is currently considered to be a surplus energy whose value is much lower than the energy it would provide.

Thus, nuclear energy would become absolutely unnecessary as an alternative for satisfying Brazil's energy demands. Regarding its medical and industrial uses, it shows relative usefulness, which may be ensured by low-power nuclear research reactors.

8. WWF Brazil, Repowering Hydroelectric Utility Plants As an Environmentally Sustainable Alternative to Increasing Energy Supply in Brazil, 2004.