BRAZIL

(Updated 2013)

1. ENERGY, ECONOMIC AND ELECTRICITY INFORMATION

1.1 General Overview

1.1.1 Governmental system

No information provided.

1.1.2 Geography and climate

Brazil is a federal republic in South America, bounded on the north, west and south by every country of the continent except Chile and Ecuador, and on the east by the Atlantic Ocean, along 7,400 km (4,600 miles) of coastline. The country covers an area of 8,514,215.3 km^2, about half of all of South America, and is the world's fifth largest country in area. The single most important influence on Brazil's climate is its location on the equator. Temperatures seldom exceed 35°C in the tropics owing to the moderating effects of high atmospheric humidity. Most of Brazil receives a moderate rainfall of 1,000-1,500 mm (40-60 in), although the Amazon lowlands and several other areas receive more than 2,030 mm (80 in) of rainfall annually. The semi-arid northeastern interior, or "Sertao", frequently suffers from very long droughts. Tropical rain forest, or "Selva", is found in the wettest part of the Amazon Basin. Much of the south and southwest of Brazil is covered by savanna, or tropical grassland, and in the interior of the northeast, caatinga, a low and bushy scrub and thorn forest is characteristic.

Brazil's three major river systems are: the Parana-Paraguay-Plata in the south, the Sao Francisco in the east, and the Amazon in the north. The Amazon, the major river of South America, is the world's second longest river (6,440 km/4,000 miles), and most of its basin lies within Brazil. The Amazon river's major tributaries are the Tocantins-Araguaia, the Madeira, the Negro, the Xingu and the Tapajos.

1.1.3 Population

In 2010, when the last Brazilian Census occurred, the population of the country was about 190.8 million, corresponding to a population density of 22.43 inhabitants per km^2. The population growth rate from 2010 to 2012 was 0.81% per year. Most Brazilians live in high-density areas of eastern Brazil, along the coast or the major rivers. In 2010, about 84.4% of the people lived in urban areas. The historical population information is shown in table 1.

TABLE 1. POPULATION INFORMATION

							Average annual growth (%)
	1970	**1980**	**1991**	**2000**	**2010**	**2012 ***	**2000 to 2010**
Population (millions)	94.5	121.2	146.9	169.6	190.8	193.9	1.18

Population density (inhabitants/km²)	11.1	14.2	17.3	19.9	22.4	22.8	1.19
Urban population (% of total)	56.0	67.7	75.5	81.2	84.4	-	0.39
Area (1000 km²)						8,515.7	

*Estimate for July 1, 2012
Source: IBGE – Brazilian Institute of Geography and Statistic

1.1.4 Economic data

According the Brazilian Institute of Geography and Statistic, in 2011, the Gross Domestic Product (GDP) was 2,475,066 million of current US$ and the GDP per capita was 12,696 current US$. The increase of the GDP per capita in the period 2000-2010 happened simultaneously with income distribution. In this period, Brazilian social mobility was remarkable, since more than 40 million people left the condition of extreme poverty. This information is relevant because social mobility significantly increased the number of normal consumers and, as a consequence, the demand for all good and services, including energy.

TABLE 2. GROSS DOMESTIC PRODUCT (GDP)

							Average annual growth (%)
	1990	**1995**	**2000**	**2005**	**2010**	**2011**	**2000 to 2011**
GDP (millions of current US$)	469,318	770,350	644,984	882,439	2,143,921	2,475,066	13.0
GDP (millions of constant 2011 US$) *	1,314,727	1,529,207	1,689,232	1,937,916	2,409,227	2,475,066	3.53
GDP per capita (current US$)	3,202	4,849	3,766	4,812	11,094	12,696	11.7

*Updated to 2011 by using the Consumer Price Index
Sources: IBGE – Brazilian Institute of Geography and Statistic

1.2 Energy information

1.2.1 Estimated available energy

Brazil has one of the largest hydroelectric potentials in the world. The hydro resources located in the north-east, south-east and south of the country have already been thoroughly surveyed. The hydroelectric potential of north and central west regions, which cover practically Brazil's Amazon area, are being tapped to partially meet both regional and national electric needs. Brazilian estimated energy reserves are shown in table 3.

TABLE 3. ESTIMATED ENERGY RESERVES

Source[1]	**Oil**	**Natural Gas**	**Coal**[2]	**Hydraulic**[3]	**Uranium**[4]
Unit	10^3 m^3	10^6 m^3	10^6 t	GW	t U_3O_8
Measured/Indicated/ Inventoried	2,271,490	434,376	10,061	108,8	177,500
Inferred/Estimated	2,511,140	472,155	22,240	28,1	131,870
Total	4,782,630	906,531	32,301	136,9	309,370
Oil Equivalent[5] **(10^3 toe)**	2,026,169	431,335	2,746,520	81,949	1,254,681

1 Not including other renewable sources, besides Hydraulic.
2 Considers recovery of 70% and heating value of 3,900 kcal/kg.
3 Based on capacity factor of 55%. The oil equivalent value refers to one year generation.
4 Only losses due to mining and beneficiation are considered. The plutonium reprocessing was not considered.
5 Calculated using only measured, indicated and inventoried reserves.

1.2.2 Energy statistics

Historically, the expansion of the energy sector represented a dynamic aspect on the process of industrialization and modernization of economic and social structures in Brazil. This expansion has provided the energy needed for this process and has stimulated the development of productive sectors. During the last decades, Brazilian development was mainly induced by the State's direct action. Table 4 shows the historical energy statistics.

TABLE 4. ENERGY STATISTICS

Primary Energy Production

Energy values are in 10^6 t of oil equivalent (toe)

Sources	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Oil	74.9	77.2	76.6	84.3	89.2	90.8	94.0	100.9	106.6	109.0
Natural Gas	15.4	15.7	16.9	17.6	17.6	18.0	21.4	21.0	22.8	23.9
Steam Coal	1.9	1.8	2.0	2.3	2.2	2.3	2.5	1.9	2.1	2.1
Firewood	23.6	26.0	28.2	28.4	28.5	28.6	29.2	24.6	26.0	26.3
Sugar Cane	25.3	28.4	29.4	31.1	35.1	40.5	45.0	44.8	48.9	43.3
Hydraulic	24.6	26.3	27.6	29.0	30.0	32.2	31.8	33.6	34.7	36.8
Uranium	3.3	2.7	3.6	1.3	2.3	3.6	4.0	3.4	1.8	4.1
Other	5.1	5.7	6.0	6.5	6.8	7.8	8.7	9.6	10.4	11.2
Total	174.3	183.7	190.2	200.5	211.8	223.7	236.6	239.9	253.2	256.7

Annual Average Growth Rate of Primary Energy Production for the period 2002-2011 – 4,40 %
Source: 2012 Brazilian Energy Balance of the Ministry of Mines and Energy

Domestic Energy Supply

Energy values are in 10^6 t of oil equivalent (toe)

Sources	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Oil products	85.2	80.7	83.6	84.6	85.5	89.2	92.4	92.3	101.7	105.2
Natural Gas	14.8	15.5	19.1	20.5	21.7	22.2	25.9	21.3	27.5	27.7
Coal and Coke	13.0	13.5	14.2	13.7	13.5	13.6	14.6	11.7	14.5	15.2
Firewood and Charcoal	23.6	26.0	28.2	28.5	28.6	28.6	29.2	24.6	26.0	26.3
Sugar Cane Products	25.4	27.1	28.8	30.2	33.0	37.9	42.9	44.0	47.1	42.8
Hydraulic and Electricity	27.7	29.5	30.8	32.4	33.5	35.5	35.4	37.0	37.7	39.9
Electricity from Nuclear Generation	3.7	3.6	3.2	2.5	3.7	3.3	3.7	3.4	3.9	4.1
Other Renewable	5.1	5.7	5.9	6.3	6.8	7.7	8.5	9.5	10.4	11.1
Total	198.6	201.6	213.7	218.7	226.3	238.0	252.7	243.8	268.8	272.4

Annual Average Growth Rate of Domestic Energy Supply for the period 2002-2011 – 3,57 %
Source: 2012 Brazilian Energy Balance of the Ministry of Mines and Energy

External Dependence on Energy

Oil in 10^3 barrels of oil equivalent per day (boe/d)
Coal in 10^6 t
Electricity in 10^3 GWh
Total in 10^6 t of oil equivalent (toe)

Sources	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Oil	215	109	165	34	-18	19	41	-110	-58	9
Coal	15.1	16.1	16.1	15.4	14.9	16.4	17.2	12.9	17.7	19.8
Electricity	36.6	37.1	37.4	39.0	41.2	38.8	42.2	39.7	34.6	35.9
Total	29.2	23.4	28.6	23.3	19.2	19.6	22.2	10.9	20.6	23.3

Annual Average Decrease Rate of External Dependence on Energy for the period 2002-2011 – -2,48 %
Remark: The Domestic Energy Supply table shows the addition of primary and secondary energy supply data. Thus, the External Dependence table cannot be obtained from the difference between this table and the Primary Energy Production table.
Source: 2012 Brazilian Energy Balance of the Ministry of Mines and Energy

1.2.3 Energy Policy

At the end of the 1990s, the Brazilian energy sector faced deep changes, evolving two different fronts: (i) the privatization of state owned electric companies (nuclear generation and power transmission were not included); (ii) the restructuring of the electric sector as a whole (deregulation). The government has decided to focus the role of the state on policy-making and market regulation, phasing out its previous involvement as owner of the major economic agents.

In that context, the Federal Government created two agencies responsible for regulation and inspection of the electricity sector - Brazilian Electricity Regulatory Agency (ANEEL) and the oil and gas sector - Brazilian Agency for Oil, Natural Gas and Biofuels (ANP).

As a consequence of the introduction of different private agents owning generation plants in the same river, it was necessary to create an organism that decides how much energy will be generated by each agent. With this responsibility, the private organism called Brazilian System Operator (ONS) was created.

As stated in the first article of law 9,478, the Brazilian energy policy is composed by 11 objectives, shown below.

I - Preserve the national interest.

II - Promote development, expand the labor market and enhance energy resources.

III - Protect the interests of consumers with regard to price, quality and availability of products.

IV - Protect the environment and promote energy conservation.

V - Ensure the supply of petroleum products throughout the national territory, in accordance with the Constitution.

VI - Increase the use of natural gas in economic bases.

VII - Identify the most appropriate solutions for the supply of electricity in different regions of the country.

VIII - Use alternative energy sources, through the economic use of inputs available and applicable technologies.

IX - Promote free competition.

X - Attract investment in energy production.

XI - Increase the country competitiveness in the international market.

According to the studies of the recent 2021 Brazilian Energy Plan, Domestic Energy Supply – the energy required to boost the economy – reaches 440.7 million toe in 2021, corresponding to a 4.9% growth per annum (p.a.) over 2011. This rate surpasses that predicted for the GDP, which corresponds to a 4.7% growth p.a. In fact, for the next decade, especially for the first 5 years, an expressive growth is expected concerning energy intensive sectors such as steel and cement, which are committed to the national market and/or exports. Three important events contribute to the expansion of those sectors: the 2014 FIFA World Cup, the 2016 Olympic Games and the beginning of Pre-Salt oil exploitation.

Renewable sources continue to increase their participation in the energy matrix, from 44.1% en 2011 to 45% in 2021. Bagasse, ethanol, wind, biodiesel and other renewables increase their participation in detriment of hydro and wood.

Greenhouse gas emissions related to energy usage are expected to reach 641 million tCO2 in 2021, resulting in 1.45 tCO2/toe of energy, which is 39% lower than the global number verified in 2010 (2.38 tCO2/toe). Brazil is very much concerned about greenhouse gas emissions and climate change. Even though approximately 90% of the country's electric power is generated by hydro, the country has signed the Kyoto Protocol.

Concerning to the non-renewable sources, oil is losing market share, mainly for natural gas. Coal participation growth refers to steel expansion and electricity generation.

1.3 The Electricity System

1.3.1 Electricity policy and decision making process

General description

Up to early 1960's, the Brazilian electric utilities had no central co-ordination. Operation and planning activities were limited to independent utility requirements, resulting in isolated or poorly integrated systems. Rapid growth in industrialization led to an inter-regional integration, creating expansion opportunities for the electric companies outside their geographical areas. This integration gave rise to increased supply reliability and provided great benefits due to economy of scale.

In 1962, the federal government established a holding company, ELETROBRAS, with the objectives of organizing, coordinating and planning all activities of the sector at the national level. ELETROBRAS is attached to the Ministry of Mines and Energy. ELETROBRAS is an open corporation with shares negotiated in the domestic and overseas capital markets. At that time, it co-ordinates the whole electricity sector concerning the technical, financial and administrative aspects. ELETROBRAS is the major shareholder of the federal companies and is a minor shareholder in the companies owned by Brazilian states. ELETROBRAS is also the main shareholder of ELETRONUCLEAR, the Brazilian nuclear utility.

A large generation company, ITAIPU Binational, was founded in 1973 by Brazil and Paraguay to manage the ITAIPU hydropower plant of 12,600 MW capacity located at the border of both countries. The majority of the energy produced by ITAIPU is consumed in the Brazilian market and is transmitted from there by two different transmission systems: a direct current (+- 600 kV) and a high voltage one high voltage AC (750 kV).

Institutional reforms and privatizations in the 90's caused the company to lose some of its functions and to have its profile changed. In this period, the company also started to operate, by legal and transitory order, in the distribution of electric power, through companies in the states of Alagoas, Piauí, Rondônia, Acre, Roraima and Amazonas.

During the 1990's, the electric sector was deregulated. Many generation and distribution units were privatized, so that a great part of this sector was reformulated. State owned Eletrobras still has the subsidiares: Eletrobras Chesf, Eletrobras Furnas, Eletrobras Eletrosul, Eletrobras Eletronorte, Eletrobras CGTEE and Eletrobras Eletronuclear. Many of these firms have generation units and transmission lines.

In 2004, new regulation of the sector excluded Eletrobras from the National Privatization Program (PND).

The Eletrobras Group also distributes electric energy in the Brazilian states of Alagoas, Piauí, Rondônia, Acre, Roraima e Amazonas. Today, the electric distribution in the more industrialized states or those with great population is made by private firms. Finally, the Eletrobras Group owns the greatest research center in electric energy of the southern Hemisphere (Eletrobras Cepel), a strategic participation firm (Eletrobras Eletropar) and half of the capital of the bi-national firm Itaipu.

Presently, nationwide, Eletrobras has installed capacity of 41,621 MW, including 50% of the power of the Itaipu plant belonging to Brazil, and has 56,179 km of transmission lines in operation, in high and extra-high voltage.

The Eletrobras companies operate in an integrated way, with policies and guidelines defined by the High Council of Eletrobras System (Consise), consisting of the presidents of the companies, who meet on a regular basis. Eletrobras supports government strategic programs, such as the program that fosters alternative electric power sources (Proinfa), the National Program for Universal Access To and Use of Electric Power (Luz para Todos) and the National Program for Electric Power Conservation (Procel).

In 2012, companies owned by Brazilian states and private companies, with the companies of Eletrobras Group, were responsible for the electric generation, transportation and distribution in different regions, which satisfied all the Brazilian demand.

The most important of these companies owned by Brazilian states are Companhia Energética de Minas Gerais (CEMIG) in Minas Gerais; Companhia Energética de São Paulo (CESP) in São Paulo; and Companhia Paranaense de Eletricidade (COPEL) in Paraná.

Today, 80% of these distribution companies, previously owned by Brazilian states are now owned by the private sector due to the privatization program. About 75% of the generating capacity in the country is still government owned.

Hydroelectric power plays a paramount role in the Brazilian electricity system, while thermal power plants (conventional and nuclear) are meager contributors to electricity supply. However, even considering the country's huge hydroelectric potential, one cannot suppose its plain use due to recent environmental restrictions against the construction of new hydro plants, especially those making use of large dams and located in the Amazonian region. In this context, the new energetic long range plan (PNE - 2030) is considering the possibility of using thermal base generation, including domestic sources, such as coal and nuclear. The nuclear power plant ANGRA 3 has been included in the middle range electricity plan and projected to be in operation by 2017.

1.3.2 Structure of the electric power sector

Deregulation, open electricity market and decision making process

The reform of the Brazilian Electric Sector began in 1993 with the enactment of Law 8.631, which extinguished the equalization of the tariffs that were in effect and created supply contracts between generators and distributors, and which was enhanced by the enactment of Law 9.074, of 1995, that created the Independent Producer of Electric Power and the concept of Free Consumer.

In 1996, the Restructuring Project for the Brazilian Electric Sector was implemented (Project RE-SEB), coordinated by the Ministry of Mines and Energy.

The paramount conclusions for the project were the need to implement the deverticalization of the electric power companies, that is, to split them up into the generation, transmission and distribution segments, to incentivize competition in the segments of generation and commercialization, and to keep the segments of distribution and transmission of electric power under regulation, considered to be natural monopolies under control of the State.

The need to create a regulating agency was identified (Brazilian Electricity Regulatory Agency - ANEEL), as well as to create an operator for the national electric system (National Operator of the Electric System - ONS), and an environment to accomplish electric power purchase and resale transactions - the Wholesale Market for Electric Power (MAE).

Concluded in August of 1998, the RE-SEB Project defined the conceptual and institutional frame of the model to be implemented for the Brazilian Electric Sector.

In 2001, the electric system underwent a serious supply crisis which culminated in a electric power rationing plan. This event generated a series of questionings about the course the electric sector was taking. Purporting to adapt the model being implemented, the Committee for the Revitalization of the Electric Sector Model was instituted in 2002, whose work resulted in an agglomerate of change proposals for the Brazilian electric sector.

During 2003 and 2004, the Federal Government set the foundations for a new model for the Brazilian Electric Sector, supported by Laws nos. 10.847 and 10.848, dated March 15, 2004, and by Decree no. 5.163, dated July 30, 2004.

In this sense, the changes introduced by Law 10.848/2004, have the following objectives: promote low tariffs, ensuring security of supply, and create a stable regulatory framework. The main instrument for low tariffs is the auction for procurement of power by distribution, with a lowest rate criterion. Security of supply is based on the following principles: all agents consumption must hire 100% of its load, each power sales contract must have a physical ballast generation, so that there are no contracts without a corresponding physical capacity supply.

The efficient construction of new projects is made possible through the following measures: specific auctions for hiring new ventures for generation of energy; bilateral long-term contracts between the distribution and the winners of auctions, with guaranteed transfer of acquisition costs energy tariffs to final consumers, and preliminary environmental license of hydro candidates.

The creation of a stable regulatory framework requires a clear definition of roles and responsibilities of institutional actors. In particular, the model explains the strategic role of the Ministry of Mines and Energy, as the body representative of the Union, reinforces the functions of regulation, supervision and mediation of the ANEEL, and organizes the planning functions of expansion, operation and marketing.

The Brazilian Power Sector

The New Model establishes a number of measures to be followed by the Agents, such as a requirement for distributors and free consumers to contract for their entire demands; a new methodology to calculate physical coverage of power sale contracts; a way of contracting for hydro and thermal energy so that a better balance between supply cost and safety is assured; a permanent supply safety monitoring structure to detect possible imbalances between supply and demand.

Distributors have to purchase electricity at the regulated contracting environment through least-price auctions, in order to minimize the acquisition costs of electricity to be passed on to the tariffs of captive consumers.

The New Model also includes social insertion initiatives, by promoting the universalization of access and use of electricity to those citizens who do not enjoy this benefit yet, as well as by ensuring subsidies to low income consumers so that they can bear the costs of their power bills. These initiatives are to be funded by the Energy Development Account (CDE).

1.3.3 Main indicators

Electricity generation and consumption

The Brazilian electric system's main peculiarities are a large extension of transmission lines and a predominantly hydraulics electricity generation system. The consumer market is concentrated in the more industrialized region of the country, the Southeast (53.3%), but the South (17.2%) and the Northeast (16.6%) regions also have some participation. The North region is supplied mainly by small generating plants, the majority being thermoelectric (oil).

Tables 6 and 7 show the more relevant data concerning Brazilian electricity production and installed capacity. Electricity output in 2011 amounted to 532.9 TWh – 80.4% - originated from hydroelectric sources, 9.1 % from fossil fuelled plants and 2.9 % from nuclear plants.

Electricity consumption per capita increased from 1,653 kWh in 2006 to 2,049 kWh in 2011, and the nuclear energy share over the total electricity production increased from 1% to 2.6% during the same period.

During the last decade, residential, rural and commercial electricity consumption has had an expansive increase; however, the industrial segment experienced a much lower growth, mainly due to the use of more efficient technologies and rationalization measures imposed on the use of electricity.

TABLE 5. ELECTRICITY PRODUCTION AND INSTALLED CAPACITY

Energy values are in 10^3 GWh (except where indicated)							**Annual Average Growth Rate (%)**	
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2006 to 2011**	**Part % (2011)**
Electricity Production								
- Total	419.3	445.0	463.1	463.0	515.8	532.9	4.9	100,0
- Fossil Fuel (1)	35.7	33.9	51.1	31.1	60.8	48.5	6.3	9.1
- Hydro	348.8	374.0	369.6	389.9	403.3	428.6	4.2	80.4
- Nuclear	13.8	12.4	14.0	13.0	14.5	15.7	2.6	2.9
- Biomass (2)	14.4	17.2	19.2	20.6	31.5	32.2	17.5	6.0
- Wind	0.3	0.7	1.2	1.2	2.2	2.7	55.2	0.5
- Others	6.3	6.9	8.1	7.2	3.5	5.2	-	1.0
Capacity values are in 10^3 MW(e) (except where indicated)								
Capacity of electrical plants								

- Total	96.3	100.4	102.9	106.6	113.3	117.1	4.0	100.0
- Hydro	72.0	74.9	74.9	75.5	77.1	78.4	1.7	67.0
- Thermal	20.4	21.2	23.0	25.4	29.7	31.2	8.8	26.6
- Nuclear	2.0	2.0	2.0	2.0	2.0	2.0	0.0	1.7
- Small Hydro	1.7	1.9	2.6	3.1	3.6	4.1	19.3	3.5
- Wind	0.2	0.2	0.4	0.6	0.9	1.4	47.6	1.2

(1) Includes natural gas, oil and coal
(2) Includes firewood, bagasse and charcoal

TABLE 6. ENERGY RELATED RATIO

							Annual Average Growth Rate (%)
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2006 to 2011**
Energy consumption per capita (toe/capita) (1)	1.24	1.29	1.35	1.29	1.41	1.42	2.75
Electricity per capita (1) (kWh/capita)	2,300	2,413	2,482	2,454	2,703	2,770	3.79
Electricity consumption/Energy consumption (%)	15.9	16.1	15.8	16.3	16.5	16.8	--
Nuclear/Total electricity (%)	3.29	2.79	3.02	2.81	2.81	2.95	--
Ratio of external dependency (%) (2)	8.48	8.24	8.79	4.47	7.66	8.55	--
Load factor of electricity plants (%)						**2012**	
Total						47.6	
Thermal						17.9	
Hydro						59.6	
Nuclear						91.2	

(1) The population values for 2006, 2007, 2008, 2009 and 2011 were obtained with interpolation.
(2) Net import / Total energy consumption.

Source for population data: Brazilian Institute of Geography and Statistic
Sources for energy data: (1) Brazilian Energy Balance of the Ministry of Mines and Energy and (2) 2012 Statistical Yearbook of Electric Energy of the Ministry of Mines and Energy

2. NUCLEAR POWER SITUATION

2.1 Historical development and current nuclear power organizational structure

2.1.1 Overview

In 1970, a decision was made to build Brazil's first nuclear power station through an international bid. The contract of a turn-key project for a 626 MW(e) PWR reactor (ANGRA 1) was awarded to Westinghouse Electric Corporation of the United States of America. ANGRA 1 construction started in 1971, and first criticality was achieved ten years later.

In 1975, in an effort to become self-sufficient in nuclear power generation, Brazil signed an agreement with the Federal Republic of Germany to build eight 1,300 MW(e) reactors (PWR Biblis B type) over a period of 15 years. Under this agreement, two of these units (ANGRA 2 and ANGRA 3) were scheduled for construction on the following year, with most of their components imported from Kraftwerk Union's (KWU) shops in Germany. According to this agreement, the rest of the plants were to contain 90% Brazilian-made components. The Brazil-Germany agreement created the Empresas Nucleares Brasileiras (NUCLEBRAS) as the Brazilian stated-owned nuclear holding company. Additionally, several subsidiaries (joint companies) were established to achieve nuclear technology transfer from Germany.

NUCLEBRAS SUBSIDIARIES

COMPANY	ACTIVITY
NUCLEP*	Heavy Components Manufacture
NUCLEI*	Enrichment by Jet-Nozzle Process
NUCLEN*	Nuclear Power Plant Architect and Engineering
NUCLAM*	Uranium Prospection
FEC	Fuel Elements Manufacture
CDTN	Nuclear Technology R&D Centre
NUCON	Nuclear Power Plant Construction
NUCLEMON	Rare Earth's Production
CIPC	Mining and Yellow Cake Production
**Joint Brazilian-German Companies*	

The Brazilian nuclear regulatory body is the National Nuclear Energy Commission (CNEN), responsible for licensing nuclear power plants and nuclear facilities; performing regulatory activities; and training and organizing personnel, according to Law 4,118 of 1962. In the early 1980's, the Brazilian Navy started a nuclear propulsion program. The Navy's main activity has been the development of uranium enrichment by using the ultracentrifuge process. Success was achieved by the end of the decade, which has continued through the 1990's.

Due to several factors (especially financial problems) the Brazilian-German technology transfer program was forestalled. ANGRA 2 and ANGRA 3 construction was interrupted several times, resulting in further delay in the Brazilian nuclear program. Due to Brazil's foreign debt and high inflation, with added pressures from the privatization program and budget cuts, the Brazilian nuclear program was reorganized at the end of the 1980's.

In 1988, a new company, Indústrias Nucleares do Brasil SA (INB) replaced NUCLEBRAS and its subsidiaries, with limited authority. INB became responsible for rare earths, mining of nuclear minerals, and yellow cake and nuclear fuel production assuming FEC, NUCLEMON and CIPC activities. FEC, renamed as Nuclear Complex of Resende, was transformed in an INB Directorate. Both INB and NUCLEP, responsible for heavy equipment fabrication, became CNEN's subsidiaries. However, both companies, INB and NUCLEP, report directly to the Ministry of Science and Technology and are administratively independent from CNEN. Responsibility for the construction of nuclear power stations was transferred to the state-owned utility, FURNAS/ELETROBRAS, incorporating NUCON activities. NUCLEN was maintained responsible as nuclear power plant architect and engineer.

In 1997, the architect engineering company NUCLEN, merged with the nuclear directorate of FURNAS, a utility responsible for the bulk supply of electricity for most developed region of Brazil. The new company, named ELETRONUCLEAR - ELETROBRAS Termonuclear S/A., is responsible for design, procurement & follow-up of Brazilian and foreign equipment's, management of construction, erection and commissioning of nuclear power plants and is the sole owner and operator of nuclear power plants in the country. Siemens sold its 25% holding in NUCLEN to ELETROBRAS when ELETRONUCLEAR was formed. NUCLEI and NUCLAM were disbanded.

2.1.2 Current Organizational Chart

The organizational structure of Brazil's nuclear sector and the relationships among different organizations are shown in Figure 1. The National Nuclear Energy Commission (CNEN), is the regulatory body, which reports to the Ministry of Science and Technology (MCT). ELETROBRAS, responsible for planning and coordinating all activities of the electrical sector at national level, is under the Ministry of Mines and Energy. The remaining organizations are discussed in the following sections.

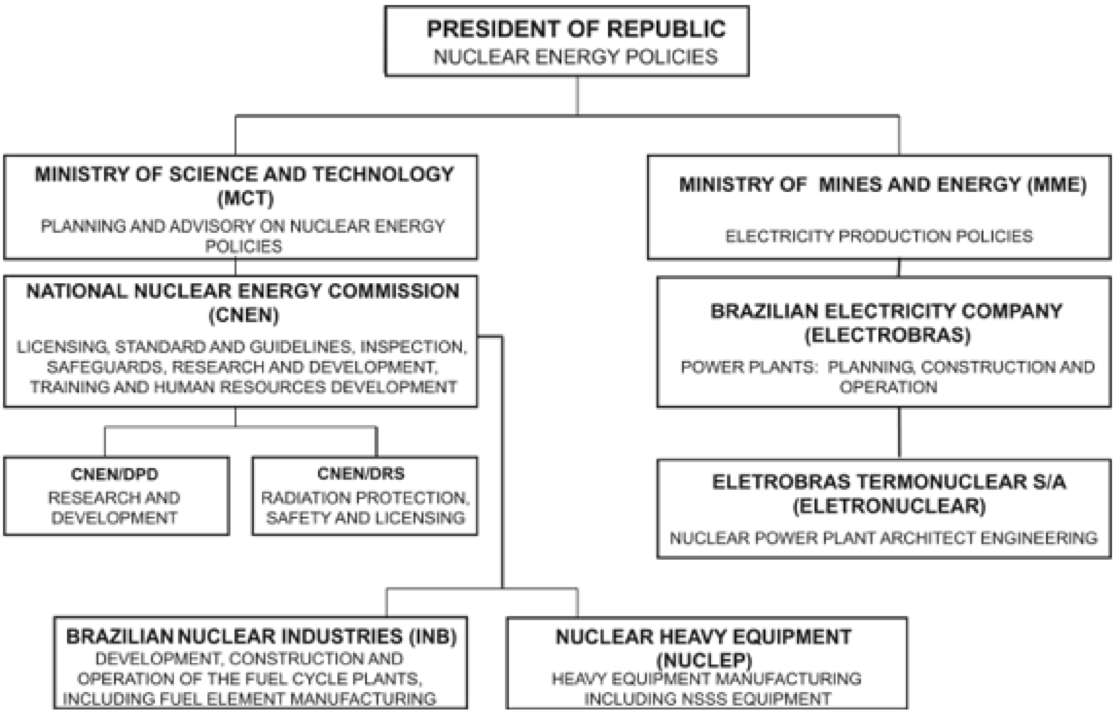

FIG. 1. Organization Structure for Nuclear Energy Development in Brazil

2.2 Nuclear Power Plants: Status and Operations

2.2.1 Status and performance of nuclear power plants

Hydroelectric power plays a paramount role in the Brazilian electricity system while thermal power plants (conventional and nuclear) are lower contributors to national electricity supply. The status of the Brazilian NPPs is shown in Table 7.

The ANGRA 1 nuclear power plant located between Sao Paulo and Rio de Janeiro, has a net capacity of 626 MW(e). It started commercial operation in December 1984. During the period 1985-1989, the plant experienced two unscheduled outages due to problems on the main condenser and emergency diesel electric generator.

TABLE 7. STATUS OF NUCLEAR POWER PLANTS

Station	**Type**	**Net Capacity (MW)**	**Operator**	**Status**	**Reactor Supplier**
ANGRA-1	PWR	609	Eletronuclear	Operational	WESTINGHOUSE
ANGRA-2	PWR	1275	Eletronuclear	Operational	KWU
ANGRA-3	PWR	1330	Eletronuclear	Under Construction	AREVA

Construction of ANGRA 2 nuclear power plant began in January, 1976, but due to financial problems the construction of the unit was slowed down and was halted several times. The economic recovery of the second half of the 90's led to the acceleration of the unit's construction. This reactor became critical on July 14, 2000. On July 21st, 2000, at 10:16 pm, ANGRA 2 was synchronized for the first time to the Brazilian interconnected electrical grid. ANGRA 2 trial operation (a test phase of continuous operation at a 100% power level) was successfully completed on December, 2000. In February, 2001 Angra 2 started commercial operation. After successive renewals of the authorization of the initial operation, Angra 2 obtained its Permanent Operating License in June, 2011.

The third nuclear station (ANGRA 3), a 1,330 MW(e) PWR reactor, and similar to ANGRA 2, was acquired from Siemens/KWU together with ANGRA 2. ANGRA 3 has about 70 per cent of the design work completed and 70 per cent of the imported major equipment already manufactured and stored on site. The civil works and electro-mechanical assembly activities were postponed in 1991. ELETRONUCLEAR and several independent consulting firms developed technical and economic feasibility studies for ANGRA 3, which were submitted to government authorities. Finally, on July 1st 2010, the construction of ANGRA 3 was resumed with the first concrete pouring in the Reactor Building. So far 43% of the engineering work has been completed. It is expected that Angra 3 will be connected to the grid in 2016, by which time it will add 1330 MW to the Brazilian electrical output.

ANGRA 1, since December 1984, has operated at full capacity, in several occasions, when it was necessary. In March 1993, the plant experienced problems with some fuel rods. It resumed energy production in December 1994. From 1994 on, the performance of ANGRA 1 followed a more reliable path, reaching its generation record in 1999, 3,976.9 GWh, with an availability factor of 96%. However, due to the restriction to operate at a maximum of 80% capacity, to ensure the safe operation of its Steam Generators, ANGRA 1 had unsatisfactory performance until 2009, when the steam generators were replaced. Since then the plant has operated at a level of excellence, having broken its generation records, consequently, in 2010, 2011 and 2012.

In July, 2002, the National Electric Power Agency approved the new installed capacity value of 1,350 MW for ANGRA 2. ANGRA 1 and ANGRA 2 play an important role in the reliability of the southeast electric system (predominantly of hydro origin), assuring continuous electric power supply to the states of Rio de Janeiro and Espírito Santo, where local water resources are virtually exhausted and power supply depends on long transmission lines. In 2012, ANGRA 1 and ANGRA 2 generated 16,040,790.5 GWh, with load factors of 96.0 and 89.8%, respectively.

The operating experience of ANGRA 1 and 2 is given in Tables 8a and 8b.

TABLE 8.a. OPERATING EXPERIENCE OF ANGRA 1

Year	Energy GWh	Average Load Factor (%)	Year	Energy GWh	Average Load Factor (%)
1991	1441.6	25.0	2003	3137.0	57.8
1992	1752.3	30.4	2004	3890,2	71.5
1993	441.8	7.7	2005	3520,4	64,2
1994	54.9	1.0	2006	3205,2	58,4
1995	2520.7	43.8	2007	2553,5	56,0
1996	2428.9	42.1	2008	3314,5	76,8
1997	3161.4	54.9	2009	2668,9	50,9
1998	3265.3	56.7	2010	4076,7	76,4
1999	3976.9	69.1	2011	4452,5	83,5
2000	3423.3	59.3	2012	5134,9	96,0
2001	3853.5	67.0			
2002	3775.2	69.0			
Source: ELETRONUCLEAR Information System - ACM.OIAEA Power Reactor Information System (PRIS)					

TABLE 8.b. OPERATING EXPERIENCE OF ANGRA 2

Year	Energy GWh	Average Load Factor (%)
2000	2421.2	
2001	9905	83.8
2002	9238.2	82.7
2003	10,009.9	84.6
2004	7,427.3	62.6
2005	6,121.7	51.8
2006	9778,3	87,5
2007	9096,9	81,4
2008	9894,3	88,3
2009	9554,6	85,5
2010	9697,4	86,8
2011	10342,5	92,6
2012	10035,5	89,6
Source: ELETRONUCLEAR Information System - ACM.O IAEA Power Reactor Information System (PRIS)		

2.3 Future development of nuclear power sector

A study on a revision of the former Brazilian Nuclear Program, for the period from 2010 to 2022, has been performed by the country nuclear institutions and is presently under government analysis.

2.4 Organizations involved in construction of NPPs

Two companies related to nuclear power plant engineering and component supply are active in the nuclear sector: NUCLEP and ELETRONUCLEAR - ELETROBRAS Termonuclear S/A.

NUCLEP was established to design and fabricate heavy nuclear power plant components, especially those used in the reactor primary circuit. NUCLEP is specialized on fabrication of large components made from steels, nickel, and titanium alloys. It maintains modern quality control laboratories, outfitted with precision instruments, qualified and certified according to international standards, for mechanical, chemical and metallurgical testing.

ELETRONUCLEAR is responsible for design, procurement & follow-up of Brazilian and foreign equipment, management of construction, erection and commissioning of nuclear power plants and is the sole owner and operator of nuclear power plants in the country.

2.5 Organizations involved in operation of NPPs

ELETRONUCLEAR is the only utility responsible for construction and operation of Brazilian nuclear power plants ANGRA 1 and 2. The ANGRA site has a PWR/ANGRA 2 type simulator in operation since 1985. The simulator has provided operator-training services for utilities from countries such as Spain, Switzerland, Germany and Argentina, which operate nuclear power plants supplied by KWU.

During 2012, Eletronuclear finished the Periodic Safety Review (PSR), in compliance with condition No. 20 Authorization Operation Permanent (AOP) of Angra 2 issued by CNEN Resolution No. 106 of 14 June, 2011. This work was conducted from August 2011 to October 2012, by a multidisciplinary team of Eletronuclear. Based on the results of the PSR, Angra 2 has operated in a safe manner during the last 10 years, without any safety issue of great relevance. The few deficiencies found as well as the set of opportunities for improvement identified, should be integrated into the continuous improvement program through Plant Action Plans, prioritized as to their relevance to safety.

2.6 Organizations involved in decommissioning of NPPs

No information provided.

2.7 Fuel Cycle including Waste Management

Indústrias Nucleares do Brasil S.A. - INB, a state company which has succeed NUCLEBRAS, has as its main goal the implementation of industrial units related to nuclear fuel cycle for NPPs. Nowadays, in Brazil, there are industrial units for: uranium mining and milling, isotopic enrichment, reconversion, pellet production and fuel element assembly. The mineral exploration program carried out in the last decades resulted in the discovery of new deposits that projected Brazil to be the sixth geological resource in the world, responsible for 11% of that total. It should be taken into account that only 25% of the Brazilian territory has been prospected.

Mining and milling

Systematic prospecting and exploration of radioactive minerals in Brazil began in 1952. The exploration was accelerated by the availability of funds for this purpose from 1970 onwards. There was active exploration and many occurrences were identified through the use of geological, geophysical and geochemical surveys, and related research. From 1974 to 1991, the total amount spent in uranium exploration was equivalent to US$ 150 million. With changes in nuclear policies and, consequently, uranium requirements, investments fell sharply. Since 1991, all uranium prospecting has stopped.

Brazilian uranium resources occur in a number of geological environments and, consequently, belong to several deposit types; some of them hosted in near surface. In addition to known resources, there is a high potential for further discovery of economic uranium deposits. Areas favorable for uranium resources not yet explored cover 50% of the Brazilian territory.

Brazil has been producing uranium since 1982. Between 1982 and 1995 the cumulative uranium production was 1,030 tU from the Poços de Caldas Unit and 540 tU from the Caetité Unit, the only commercial plant currently in operation. Since March 2000, Brazilian short term uranium concentrate production capability has been 400 tU/year.

Expansion of milling capacity on Caetité to 670 tU/year has been studied. After the planned expansion of Caetité, INB will concentrate on the development of Santa Quiteria deposits. However, since uranium will be a co-product of phosphate, the feasibility of the project depends mainly on the phosphate market. Direct employment in Brazilian uranium industry is rising. Losses caused by closure of the Poços de Caldas Unit were offset by increases associated with the beginning of operation and planned expansion of Caetité Unit.

Uranium production in Brazil is only for domestic use. All uranium concentrate produced is shipped to other countries for conversion and enrichment and then returned to Brazil for fuel fabrication.

Brief information on main uranium sites is given below:

a) Poços de Caldas Site

The Poços de Caldas Site is located at one of the biggest alkaline intrusions in the world. Discovered in 1948, this deposit was developed into an open pit mine. Poços de Caldas Unit started production in 1982 with a design capacity of 425 tU/year.

Since the exploration of the uranium deposit was no longer economically feasible, the Poços de Caldas Unit ceased operations in 1995. After two years of standing by, it was finally shut down in 1997. The closure planning and rehabilitation actions are still under development.

The closure of Poços de Caldas Unit in 1997 brought to an end the exploitation of a low grade ore deposit, which produced vast amounts of waste rock. Studies for proper decommissioning are being conducted by INB. The operational costs of collecting, pumping, and treating acid drainage were estimated to be US$ 610,000 per year. With the end of the mine exploitation, INB proposed the use of industrial facilities for other projects such as monazite chemical processing and rare earth production. For these activities, an environmental license adjustment was signed and the licensing process at CNEN is ongoing.

b) Lagoa Real Site (Caetité Unit)

Caetité is currently the only operating uranium site in Brazil. The deposits were discovered in 1977 and its known resources were estimated to be 85,000 tU in the below US$ 80/KgU cost category, averaging 0.30% U3O8. There are 35 occurrences detected, 12 of which were considered uranium ore deposits. Cachoeira deposits are mined by open pit methods. Surface acid heap leaching methods are used. The plant has a design capacity to produce 400 t/year of uranium concentrate (which is enough to meet the needs of both Angra 1 and Angra 2 nuclear power plants) and there are plans for expansion.

Mining activities, decommissioning planning, and area rehabilitation are done simultaneously. Monitoring programs are implemented to demonstrate compliance with regulatory requirements. As part of the regulatory licensing process, INB has done an independent hydrogeological assessment of the local aquifer.

Feasibility studies for Caetité Unit expansion have been carried out. The expansion will increase annual production capacity, which will double current production levels. The cost of expansion is estimated to be US$ 3.5 million.

c)Santa Quiteria Site

Discovered in 1976, Itataia deposits account for almost 50% of the total known low cost (<US$80) resources in Brazil. A radiometric aerial survey identified 273 anomalies on the project area. The deposit is suitable for open pit mining with uranium recovery estimated at 70%.

Conversion

As part of Brazilian Navy nuclear propulsion programme, a UF_6 pilot plant with a nominal production capacity of 40 tU/year is under construction at the Navy Research Institute (CTMSP), located in Iperó (100 Km from São Paulo). There are no plans to install a commercial plant in the near future.

Enrichment

As part of its nuclear propulsion program, the Brazilian Navy installed in Iperó (100 km from São Paulo) a demonstration enrichment centrifuge pilot plant. Subsequently, the Brazilian Government decided to start an industrial plant in Resende, Rio de Janeiro, using the technology developed by the Navy. The first cascade was inaugurated in May 2006 and the complete set of cascades is intended to be in operation in five years, in order to partially meet the ANGRA 1 and ANGRA 2 needs.

In December 2008, the second cascade of the first module of the industrial plant began operation. The operation of the third and fourth cascades, completing the first module, began in June, 2010. The construction of the second module of the industrial plant, with a new set of cascades, began in 2011.

The enrichment facility in operation has an installed capacity that accounts for 6% of the fuel used in the two power plants. Whereas full capacity in the enrichment process at national level has not yet been achieved, the goal of the Nuclear Industries of Brazil (INB) continues to be achieving self-sufficiency, as is already the case in the subsequent phases of the nuclear fuel cycle.

A future increase of the capacity will depend on technical evaluations and financial resources availability.

Fabrication

The Nuclear Fuel Factory (FCN) is located at Resende, state of Rio de Janeiro, comprising three units, i.e. UO_2 powder reconversion, pellet manufacturing and nuclear fuel assembly. The annual capacity for each plant is 160 metric tons for UO2 powder, 120 tons for pelletizing units and 240 tons for fuel manufacturing. The reconversion and pelletizing units started commercial operation in 2000, while the assembly plant has been in operation since 1982. The FCN plant also produces components for nuclear fuel, such as top and bottom nozzles, for its own needs and for export. The fuel engineering capacity for supporting the activities of INB has been developed and culminated in the design of a new advanced fuel for Angra 1 reactor, in a joint program with KNFC - Korea and Westinghouse - USA.

Spent Nuclear Fuel and Reprocessing

The technical solution regarding reprocessing or disposal of spent fuel has not been found in Brazil. The solution may take some time, until international consensus is reached. Meanwhile, Brazil continues to monitor the international situation. Currently, there is no decision about final storage of the spent fuel assemblies.

The current Brazilian policy for spent fuel management is the storage at the reactor site. A compact storage rack was installed in ANGRA 1, in 2002, with a capacity of 1,252 fuel assemblies, increasing the storage capacity of the on-site reactor basin . As of December 2012, 814 fuel elements are stored at the spent fuel pool of Angra 1.

Similarly, the Angra 2 spent fuel pool may store 1092 fuel assemblies. And, by December 2012, 496 fuel elements are under storage.

Considering that the internal spent fuel pools have a limited storage capacity and the final decision about destination in Brazil will take some time, ELETRONUCLEAR has started to design a complementary storage unit on site, called UFC. This unity will be erected in 2 phases, and will complement the storage for the 3 units for the whole operational life. The first phase shall be operational in 2018 and will have a storage capacity for 2400 assemblies. The second phase will add another 2400 assembly storage capacity and should be defined according to the Brazilian strategy for spent fuel back end.

There are no facilities or studies on reprocessing in the country. Irradiated fuel is not considered nuclear waste.

Currently, there is no decision about final storage of high level waste.

Waste management

Concerning national legislation, Law 10,308 enacted on November 20, 2001, establishes rules for radioactive waste deposit site selection, construction, licensing, operation, control, compensation, civil responsibilities and warranties. CNEN is responsible for regulation and final disposal of the radioactive waste.

Brazil signed the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management on October, 1997 and deposited the instrument of ratification on February, 2006. The National Reports describing the measures taken to implement each of the obligations of the Convention, including description of the policies and practices related to spent fuel management and inventory of related material and facilities were issued on May, 2008 and May, 2011. These Reports are available at:

http://www.cnen.gov.br/seguranca/seguranca.asp

In order to manage waste safety issues more efficiently, the creation of a company dedicated exclusively to waste management is a possibility to be considered. Brazil has two final repositories for the waste generated during the recovery actions of the Goiania accident in 1997. A final repository for Angra power plants low and intermediate level waste is under study. Elaboration on regulation on decommissioning safety by CNEN and the adequate provision of funds by the operators are issues also being considered for the near future.

2.8 Research and Development

2.8.1 R&D Organizations

In Brazil, all nuclear R&D activities are developed by government institutions. They are carried out mainly by CNEN's six R&D Institutes, which are under the Ministry of Science and Technology, and by the military institutes, which are under the Ministry of Defense. These ministries are responsible for the establishment of the country nuclear R&D policies and strategies, as well as for the provision of the necessary budget and financing mechanisms to make the corresponding R&D projects feasible.

Five nuclear research centers have been established for carrying out R&D in nuclear sciences, and engineering. Research reactors, accelerators and several R&D laboratories, including pilot plant facilities, were progressively set up in these centers. These research centers belong to the Directorate of Research and Development (DPD) of the CNEN and are listed below:

IPEN (São Paulo/SP) - Institute for Energy and Nuclear Research - Research Reactors: 2 (one 5 MW/pool type and one zero power reactor/tank type) - Cyclotron - Radioisotopes Production (^{99m}Tc; ^{131}I; ^{123}I; ^{18}F, etc.) - Research on fuel cycle and materials; reactor technology; safety; fundamentals; radiation and radioisotope applications; biotechnology; environmental and waste technology.

IEN (Rio de Janeiro/RJ) - Institute for Nuclear Engineering - Research Reactor: 1 (100 kW, ARGONAUTA) - Cyclotron - Radioisotopes production (^{123}I; ^{18}F, etc.) - Research on instrumentation, control and man-machine interfaces; chemistry and materials; safety; reactor technology.

CDTN (Belo Horizonte/MG) - Centre for Nuclear Technology Development - Research Reactor: 1 (250 kW, TRIGA) - Research on mining; reactor technology; materials, safety; chemistry; environmental and waste technology.

IRD (Rio de Janeiro/RJ) - Institute for Radiation Protection and Dosimetry - Research on radiation protection and safety; environmental technology; metrology; medical physics.

CRCN (Recife/PE) - Nuclear Sciences Regional Centre - R&D on radiation protection, dosimetry, metrology and reactors technology.

CRCN-CO (Goiânia/GO) - Nuclear Sciences Regional Centre of the Centre-west - R&D on underground water and environmental technology.

Brazil has an on-going project to build a Multipurpose Research Reactor (RMB). With a maximum power of 30 MW and powered by uranium silicite enriched up to 20%, it has a neutron flux of over $2x10^{14}$ neutrons/$cm^2 \cdot s$. Upon completion of its conceptual project, the reactor's site was chosen and environmental impact assessments were already conducted. The basic engineering projects are under way, benefiting from the cooperation with Argentina.

Besides CNEN's institutes, nuclear R&D activities are also performed in military institutes such as the Navy Technological Center, the Air Force Institute of Advanced Studies and the Army Technological Centre and in some universities.

2.8.2 Development of Advanced and New Generation Nuclear Reactor Systems

Brazil has actively participated on the Generation IV International Forum since its beginning until the conclusion of the road map. From that point on, the country became a non-active member.

Brazil has been involved in the IAEA INPRO Project, being a member of the Steering Committee and is presently performing two assessment studies based on the INPRO methodology. The country is also taking part on the IRIS (International Reactor Innovative and Secure) program, a consortium aiming at the development of a small-to-medium power (335 MWe) integral type pressurized water reactor. The CNEN's R&D institutes are participating in specific design activities and some matching researches.

2.8.3 International Co-operation and Initiatives

Under the sponsorship of IAEA, Brazil has been participating in many technical assistance programs, advisory groups and symposium meetings. As shown in ANNEX, Brazil has several technical co-operation agreements with many countries to exchange information on the various fields of peaceful uses of nuclear energy such as, reactor technology, materials, nuclear applications in industry, health and environment, nuclear safety and radiological protection, computer code development and assessment, training, radioactive waste management and radioactive materials transportation.

2.9 Human resources development

Presently, the human resources of CNEN total 2,570 persons, with 1,800 working on nuclear R&D activities. Some other 1,200 professionals hold jobs on the power generation and fuel cycle nuclear industries (Eletronuclear and INB). R&D staff of the National Nuclear Energy Commission is composed of high qualified personnel, with half of them holding university degree and from these 18% are Ph.D. and 20% are M.Sc.

2.10 Stakeholder communication

No information provided.

3. NATIONAL LAWS AND REGULATIONS

3.1 Safety Authority and the Licensing Process

The governmental organization responsible for the licensing of nuclear power plants (NPPs) and other nuclear installations in Brazil is the National Nuclear Energy Commission (CNEN).

CNEN, created in 1956, has the mission to promote, orient and co-ordinate research and development in all areas related to peaceful uses of nuclear energy. CNEN comprises three directorates, whose responsibilities are:

1. Directorate of Institutional Management (DGI): human resources, administration and information management, financial reporting and control;
2. Directorate of Research and Development (DPD): fuel cycle and materials; reactor technology; radiation utilization and radioisotopes application in health, industry, agriculture and environment; radioisotopes and radiopharmaceuticals production; instrumentation & control and man-machine interface; nuclear safety; nuclear physics and chemistry, etc.;
3. Directorate of Radiation Protection and Safety (DRS): Radiation protection, safety, control and licensing of nuclear power plants and other nuclear and radioactive installations, safeguards and normalization.

In August, 1962, with the enactment of Law No. 4,118, a National Policy on Nuclear Energy was established with the Government monopoly of nuclear materials and nuclear minerals.

In the early 1970's, due to the needs of the Brazilian Nuclear Power Program, nuclear safety standards started to be used. An extensive set of rules and standards, as listed under section 3.2, regulate the nuclear activities in Brazil. CNEN regulatory staff amounts to more than 300 qualified professionals. The regulatory process involves the issuance of five licenses or authorizations as listed below:

1. Site Approval;
2. Construction Permit;
3. Nuclear Material Utilization Authorization;
4. Initial Operation Authorization; and,
5. Permanent Operation Authorization.

Standard CNEN-NE-1.04 establishes the requirements for the licensing process of nuclear installations. The Initial Operation Authorization is issued after safety analysis approval and for a limited period of time to fulfill other minor information with operational experience. The Permanent Operation Authorization is limited to 40 years. A Periodic Safety Reassessment is conducted every ten years of operation, when the conditions of authorization can be modified or extended. A program of inspections and audits is implemented and regular meetings with operators are held.

During the operational phase of nuclear facilities, periodic safety reports are required. Regulatory safety assessment is conducted by CNEN through the review of the licensee's reports as well as through periodic inspections. On-site resident inspectors are assigned for permanent supervision of operational safety.

In January, 1999, a law establishing fees and taxes for license and operating authorization was approved by the National Congress and signed by the President of Brazil (Law 9.765/99). It establishes the fees for a NPP operating license as well as annual fees for operating units. These fees are directed to a special account to be used by CNEN in its licensing and inspection activities.

In 1981, the Environmental Policy Law was promulgated and, from 1983 to 1989, CNEN was also responsible for conducting the environmental licensing of nuclear installations. In 1989, the Brazilian Institute of Environment (IBAMA) was created and designated to conduct the environmental licensing of all installations, including nuclear facilities. CNEN is the co-authority on radiation aspects related to environmental licensing of nuclear facilities. This co-authority role means that a CNEN assessment and review has to be considered in the final decision by IBAMA. These organizations elaborate regulations according to their attributes and fields of competence and follow their implementation.

Concerning public communication, CNEN listens to public concerns and makes available information and standards through the internet, distributes printed material, responds to e-mails and participates in professional association exhibits, meetings and events. CNEN is permanently open for interviews with the media. CNEN also participates in public hearings and meetings whenever invited. Public representatives, such as parliamentarians and officers of the Public Prosecutor's Office, receive timely and factual answers to all questions.

3.2 Main National Laws and Regulations

The Brazilian National Congress approves the legislation related to nuclear activities. CNEN's regulations and standards are based on IAEA standards, commonly used by many nations. The main laws and standards used in Brazil are:

1. Law No. 4,118: National Policy on Nuclear Energy, 1962.
2. Law No. 6,189: CNEN's Set-up as Regulatory and Licensing Federal Authority, 1974.
3. Law No. 2,464: Nuclear Sector Reorganization, 1988.
4. Law No. 7,781: Revision of Law No. 6,189, 1989.
5. Law No. 9,765: Licensing, control and inspection tax for nuclear and radioactive materials and utilities, 1999

CNEN's main national standards are available at www.cnen.gov.br. Among these standards, the following can be mentioned:

1. CNEN-NE.1.04: Licensing of Nuclear Installations, 1984.
2. CNEN-NN.1.16: Quality Assurance for Nuclear Power Plants, 1999.
3. CNEN-NE.1.01: Licensing of Nuclear Reactors Operators, 1979 (under revision).
4. CNEN-NN.1.28: Qualification of Independent Technical Supervisory Organization, 1999.
5. CNEN-NE.1.13: Licensing of Uranium and Thorium Mining and Milling Facilities, 1989.
6. CNEN-NE.1.14: Operating Reports of Nuclear Power Plants, 2002.
7. CNEN.NE.2.01: Physical Protection of Operational Units of Nuclear Installations, 1996.
8. CNEN-NN.2.02: Nuclear Material Control and Safeguards, 1999.
9. CNEN-NE.2.03: Fire Protection in Nuclear Power Plants, 1999
10. CNEN-NE.2.04: Fire Protection in Fuel Cycle Nuclear Installations, 1997.
11. CNEN-NE.3.01: Basic Guidelines for Radiological Protection, 2005 (under revision).
12. CNEN-NE.3.02: Radiation Protection Services, 1988
13. CNEN-NN.3.03: Certification of Qualification of Radiation Protection Officers, 1999.
14. CNEN-NE.5.02: Transport Storage and Handling of Nuclear Fuels, 2003

REFERENCES

[1]	IAEA Energy and Economic Data Base, (EEDB).
[2]	IAEA Power Reactor Information System (PRIS).
[3]	Brazilian Institute for Geography and Statistics, www.ibge.gov.br.

APPENDIX 1: INTERNATIONAL, MULTILATERAL AND BILATERAL AGREEMENTS

AGREEMENTS WITH THE IAEA		
• IAEA Statute	Signature:	26 October 1956
• Amendments to the Article VI and XIV of the IAEA Statute	Acceptance of amendment of Article VI	01 June 1973
• Agreement on privileges and immunities	Entry into force:	13 June 1966
• Quadripartite safeguards agreement INFCIRC/435	Entry into force:	4 March 1994
• Additional protocol	Not signed	
• Safeguards agreement Brazil/Germany INFCIRC/237	Suspension signed:	16 October 1998
• Safeguards agreement Brazil/USA INFCIRC/110	Entry into force:	31 October 1968
• Amendment to the safeguards agreement Brazil/USA	Signature:	27 July 1972
• Supplementary agreement on provision of technical assistance by the IAEA	Entry into force:	27 February 1991
• ARCAL	Entry into force:	September 1984
• New ARCAL Agreement	Signed:	4 August 1999
MAIN INTERNATIONAL TREATIES		
• NPT	Entry into force:	18 September 1998
• Tlatelolco Treaty	Signed:	29 January 1968
• Amendment of the Treaty	Ratified:	30 May 1994
• Convention on the physical protection of nuclear material	Entry into force:	8 February 1987
• Convention on early notification of a nuclear accident	Entry into force:	4 January 1991
• Convention on assistance in the case of a nuclear accident or radiological emergency	Entry into force:	4 January 1991
• Vienna convention on civil liability for nuclear damage	Entry into force:	26 June 1993
• Paris convention on civil liability for nuclear damage	Not applicable	

• Joint Protocol	Non-Party	
• Protocol to amend the Vienna convention on civil liability for nuclear damage	Not signed	
• Convention on supplementary compensation for nuclear damage	Not signed	
• Convention on nuclear safety	Entry into force:	2 June 1997
• Joint convention on the safety of spent fuel management and on the safety of radioactive waste management.	Signature:	31 October 1997
OTHER RELEVANT INTERNATIONAL TREATIES		
• ZANGGER Committee	Non-member	
• Improved procedures for designation of safeguards inspectors	Not accepted	
• Nuclear suppliers group	Member	
• Nuclear export guidelines	Adopted	
• Treaty for prohibition of experiences with nuclear weapons in the atmosphere, cosmic space and under water	Signature:	5 August 1963
• Partial test ban treaty	Entry into force:	15 December 1964
• ILO Convention	Signature:	7 April 1964
• Technical assistance agreement between UN, its specialized agencies and the IAEA	Signature:	29 December 1964
• Treaty on the prohibition of the installation of nuclear weapons and other lethal weapons in the seabed, deep ocean floor and sub-seabed.	Signature:	3 September 1971
• Convention on civil liability in the field of maritime carriage of nuclear material	Signature:	17 December 1971
• Convention on prevention of marine pollution by dumping of wastes and other materials	Signature:	29 December 1972
MULTILATERAL AGREEMENTS		
• Antarctica Treaty	Signature:	1 December 1959
BILATERAL AGREEMENTS		
• Co-operation agreement concerning peaceful uses of nuclear energy	Paraguay	18 August 1961
• Co-operation agreement concerning peaceful uses of nuclear energy	Bolivia	11 January 1966
• Co-operation agreement in the field of peaceful uses of nuclear energy	Ecuador	11 June 1970
• Agreement concerning nuclear ships in Brazilian waters	Germany	7 June 1972
• Co-operation agreement concerning peaceful uses of nuclear energy	Germany	27 June 1975
• Co-operation agreement concerning peaceful uses of nuclear energy between CNEN and the Nuclear Research Centre in Karlsruhe	Germany	8 March 1978

• Special agreement between CNEN and the Research Centre in Jülich	Germany	8 March 1978
• Assistance in establishing the conditions of the application of uranium hexafluoride	France	6 January 1981
• Agreement for the co-operation on the peaceful uses of nuclear energy	Colombia	12 March 1981
• Co-operation agreement concerning peaceful uses of nuclear energy	Peru	26 June 1981
• Co-operation agreement in the field of peaceful uses of nuclear energy	Italy	29 July 1981
• Memorandum of understanding	Great Britain	2 December 1981
• Co-operation agreement in the field of peaceful uses of nuclear energy	Spain	12 May 1983
• Co-operation agreement concerning peaceful uses of nuclear energy	Venezuela	30 November 1983
• Technical co-operation agreement	USA	6 February 1984
• Memorandum of understanding on co-operation in the field of peaceful uses of nuclear energy	China	29 May 1984
• Co-operation agreement concerning peaceful uses of nuclear energy	China	11 October 1984
• Agreement concerning early notification and mutual assistance in case of nuclear accident or radiological emergency	Argentina	18 July 1986
• Agreement concerning peaceful uses of nuclear energy	Argentina	18 July 1991
• Application of safeguards	Argentina	13 December 1991
• Agreement on the privileges and immunities	ABACC	27 March 1992
• Co-operation agreement in the field of peaceful uses of nuclear energy	Russian Federation	15 September 1994
• Agreement concerning peaceful uses of nuclear energy	USA	14 October 1997
• Agreement concerning cooperation in the peaceful uses of nuclear energy	Chile	20 March 2002
• Agreement concerning cooperation in nuclear energy	USA	20 June 2003

APPENDIX 2: MAIN ORGANIZATIONS, INSTITUTIONS AND COMPANIES INVOLVED IN NUCLEAR POWER RELATED ACTIVITIES

NATIONAL NUCLEAR ENERGY COMMISSION	
Comissão Nacional de Energia Nuclear (CNEN) Rua General Severiano 90, BOTAFOGO 22290-901 - Rio de Janeiro-RJ, Brazil	Tel: (5521) 2173 2100 Fax: (5521) 2173 2104 http://www2.cnen.gov.br
NATIONAL NUCLEAR ENERGY COMMISSION INSTITUTES	
Centro de Desenvolvimento da Tecnologia Nuclear (CDTN) Rua Prof. Mário Werneck, S/No, Cidade Universitária 30161-970 - Belo Horizonte-MG, Brazil	Tel: (5531) 3499 3261 Fax: (5531) 3499 3440 http://www2.cdtn.br
Instituto de Engenharia Nuclear (IEN) Av. Brig. Trompowiski, s/n Cidade Universitária Ilha do Fundão 21945-970 - Rio de Janeiro-RJ, Brazil	Tel: (5521) 2209 8052 Fax: (5521) 2590 2692 http://www.ien.gov.br
Instituto de Pesquisas Energéticas e Nucleares (IPEN) Av. Prof. Lineu Prestes, 2242 Cidade Univesitária - Pinheiros 05508-000 - São Paulo - SP, Brazil	Tel: (5511) 3816 9100 Fax: (5511) 3812 3546 http://www.ipen.br
Instituto de Radioproteção e Dosimetria (IRD) Av. Salvador Allende, S/No, Barra da Tijuca 22780-160 - Rio de Janeiro - RJ, Brazil	Tel: (5521) 2442 1927 Fax: (5521) 2442 1950 http://www.ird.gov.br
Centro Regional de Ciências Nucleares (CRCN) R. Cônego Barata, 999 - Tamarineira 51200-010 - Recife-PE, Brazil	Tel: (5581) 34417168 Fax: (5581) 34417196 http://www.cnen2.gov.br
OTHER NUCLEAR ORGANIZATIONS	
Indústrias Nucleares do Brasil (INB) Av. João Cabral de Mello Neto, 400 – 101 a 304 Barra da Tijuca 22775-057 – Rio de Janeiro – RJ – Brazil	Tel: (55-21)37971600 Fax: (5521) 25379391 http://www.inb.gov.br
Eletrobrás Termonuclear S/A	Tel: (5521) 2588 7000

(ELETRONUCLEAR) Rua da Candelária 65 20091-020 - Rio de Janeiro - RJ, Brazil	Fax: (5521) 2588 7200 http://www.eletronuclear.gov.br
Nuclebrás Equipamentos Pesados S/A (NUCLEP) Av. Gal. Euclides de Oliveira Figueiredo, 200 - Itaguaí 23825-410 - Rio de Janeiro-RJ, Brazil	Tel: (5521) 2688 2056 Fax: (5521) 2688 3011 http://www.nuclep.gov.br
Agência Brasileiro-Argentina de Contabilidade e Controle de Materiais Nucleares (ABACC) Av. Rio Branco, 123 - 5º andar - Centro 20040-005 - Rio de Janeiro-RJ, Brazil	Tel: (5521) 2221 3464 Fax: (5521) 2507 1857 http://www.abacc.org
Associação Brasileira de Energia Nuclear (ABEN) Rua Mena Barreto, 161 - Botafogo 2271-100 - Rio de Janeiro-RJ, Brazil	Tel: (5521) 2536 1751/1869 Fax: (5521) 2286 6646 http://www.aben.com.br
Centro de Energia Nuclear na Agricultura (CENA) Av. Centenário, 303 13400-961 Piracicaba-SP, Brazil	Tel: (5519) 3429 4600 Fax: (5519) 3429 4610 http://www.cena.usp.br
Laboratório Nacional de Luz Síncroton (LNLS) Caixa Postal 6192 13084-971, Campinas - SP, Brazil	Tel: (5519) 3512 1010 Fax: (5519) 3512 1004 http://www.lnls.br

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[1] Some statistical tables in this profile have been updated with data as of the December 2012 from IAEA databases, namely the Power Reactor Information System (PRIS) and Energy and Economic Data Bank (EEDB), and the World Bank's World Development Indicators (WDI).