

# INFRASTRUCTURE REPORT

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## THE SUPPLY OF ELECTRICITY IN BRAZIL

Over the course of the last 28 years electricity has achieved a marked dominance in the Brazilian matrix of energy final consumption, making it at present the principal type of energy consumed in the country. In 1998, electricity represented 39% of Brazil's total energy consumption, followed by petroleum byproducts (diesel fuel, fuel oil and gasoline) with a 23.9% market share.

ENERGY FINAL CONSUMPTION BY SOURCE - %

Source	1970	1980	1990	1997	1998
Total - 10 <sup>3</sup>	69,166	127,702	169,4	221,595	228,2
Diesel Oil	7.6	12.1	12.0	12.1	12.3
Fuel Oil	9.4	12.5	5.6	5.4	5.2
Gasoline	10.5	6.8	4.3	6.3	6.4
Natural Gas	0.1	0.7	1.8	2.2	2.2
<b>Electricity</b>	<b>16.6</b>	<b>27.9</b>	<b>37.3</b>	<b>38.6</b>	<b>39.0</b>
Coal	2.4	3.7	4.5	4.6	4.5
Wood and	42.7	20.2	12.6	7.7	7.5
Alcohol	0.4	1.3	3.6	3.3	3.1
Other	10.2	15.1	18.2	19.8	19.8

Source: *Balanco Energético Nacional - Sinopse - 1999.*

In spite of the fall in economic activity in Brazil in 1998, when GDP contracted by 0.12%, global energy consumption continued to grow, increasing by 3% in relation to 1997.

In line with the trend of the last few years, the energy segments with the highest growth in consumption were electricity, with the residential and business segments registering growth of 7.1% and 8.9%, respectively; followed by gasoline (5.1%), aviation fuel (10.6%) and diesel fuel (5.4%).

In the 1990-98 period, while GDP grew by an average of 2.6% per year, energy final consumption increased by 3.8% per year and electricity final consumption increased by 4.4% per year.

The dominance of electricity consumption in the Brazilian energy matrix, together with the clear choice for hydroelectricity and the size of the consumer energy market, gives Brazil the 10<sup>th</sup> largest generation capacity and the 3<sup>rd</sup> largest hydroelectric capacity worldwide<sup>1</sup>.

In December 1998, Brazil's total installed generation capacity was 61,219 MW<sup>2</sup>, divided as follows:

(i) **South/Southeast/Central-West Interconnected System:** installed capacity of 44,399 MW, including 6,300 MW from the Brazilian share of the Itaipu Hydroelectric Plant. Comprises 194 hydroelectric plants (40,818 MW) and 25 thermal electric plants (3,581 MW). The capacity of the sub-system accounts for 73% of Brazil's total installed capacity and in addition holds unexploited hydroelectric potential already catalogued of some 45,000 MW.

**(ii) North/Northeast Interconnected System:** installed capacity of 14,686 MW comprising 17 hydroelectric plants (14,387 MW) and 3 thermal electric plants (299 MW). The sub-system accounts for 24% of Brazil's total generation capacity, and the region served has unexploited hydroelectric potential already catalogued of some 61,000 MW.

**(iii) Isolated Systems:** are responsible for serving more than 300 locations in the interior of Brazil, most of which are located in the North Region. Total generation capacity is 2,134 MW, of which 582 MW comes from hydroelectric plants and 1,552 MW from thermal electric plants, the majority of which burn diesel fuel.

According to information from the SIESE<sup>3</sup>, during 1998, 2,237.4 MW in installed generation capacity were added to the national base. The principal projects concluded in the year were the Serra da Mesa Hydroelectric Plant in Goiás state (1,290 MW), the Miranda Hydroelectric Plant in Minas Gerais state (390 MW), and the Três Irmãos Hydroelectric Plant in São Paulo state (162 MW).

In addition, the Brazilian Electricity Agency (Aneel) requested approval for 6 new hydroelectric projects, with a total of 1,996 MW, as shown in the table below.

**ANEEL TENDER OFFERS - 1998**

Plant	Location	Capacity MW	Contractor
Santa Clara	BA	60	Queiroz Galvão
Ponte de Pedra	MT/MS	176	Inepar/Servix/Cigla/Constran
Campos Novos	SC	880	Campos Novos Consortium
Piraju	SP/PR	70	CBA
Irapé	MG	360	Cemig
Itapebi	BA	450	Coelba/Guaraniana
<b>Total</b>	-	<b>1,996</b>	-

Source: Aneel *Sinopse*, June 1999.

In addition to investments in generation, in 1998, 3,569 km in new transmission lines with voltages of between 69 kV and 750 kV were added to the system. Further, installation was concluded of the Imperatriz (Maranhão state)/Samanbaia (Brasília) Transmission Line - commonly referred to as the North-South Line - that will complete the link between the North/Northeast and the South/Southeast/Center-West sub-systems. The 500-kV transmission line with 1,280 km of length will make possible the exchange of 600 MW every year between the two sub-systems. The project will make available additional energy at an approximate cost of US\$ 15 per MWh, which before the link was not taken advantage of.

#### **MARKET PERFORMANCE - 1998**

In 1998, the amount of energy available (gross generation of concession holders, plus deliveries from non-utility generators, plus energy imports from Itaipu) was 341,828 GWh, a 3.5% increase over 1997. On the other hand, the total consumption of electricity, including purchases of interruptible electricity, was 287,392 GWh, a 4.1% increase over 1997.

**CONSUMPTION BY SEGMENT - GWh**

Segment	1997	%	1998	%	▲%
Residenti	74,071	26.8	79,353	27.6	7.1

<b>al</b>					
<b>Industrial</b>	124,645	45.1	124,699	43.4	0.0
<b>Business</b>	38,180	13.8	41,573	14.5	8.9
<b>Other</b>	39,290	14.2	41,767	14.5	6.3
<b>Brazil</b>	<b>276,186</b>	<b>100.0</b>	<b>287,392</b>	<b>100.0</b>	<b>4.1</b>

Source: SIESE Bulletin, 1998.

Repeating the performance of the last few years, consumption by the residential and business segments, although lower in relation to 1997, increased significantly as a percentage of total consumption. An important factor in the growth of consumption in the residential segment has been the expansion of the informal economy, which transfers to residences some activities previously held by the industrial and business segments, such as small offices and service-oriented establishments. The increase in electricity consumption in the business segment is linked to growth in shopping malls, the modernization of services in general and the expanded number of hours that establishments remain open.

In contrast, consumption by industry, which experienced a significant recovery in 1997, remained practically unchanged in 1998 as a result of the reduction in economic activity registered in the last two quarters of the year.

The Northeast Region grew at the highest rate of any other region in 1998, increasing its share of the total market from 15.8% in 1997 to 16.3%. Meanwhile, the region with the highest consumption, the Southeast, posted the lowest growth rate, with consumption actually contracting significantly in comparison to 1997, leading it to slightly reduce its percentage of the country's total market share. In the North, the weak performance by the industrial segment had negative repercussions on growth rates, in spite of the positive performance by the residential and business class in the region. In the Center-West, consumption grew at the second highest rate in the comparison period, driven by high growth in the business and residential segments, among others.

#### CONSUMPTION BY REGION - GWh

Region	1997	%	1998	%	▲%
<b>South</b>	42,015	15.2	43,937	15.3	4.6
<b>Southeast</b>	162,232	58.7	167,056	58.1	3.0
<b>Center-West</b>	13,871	5.0	14,806	5.2	6.7
<b>Northeast</b>	43,627	15.8	46,823	16.3	7.3
<b>North</b>	14,441	5.2	14,770	5.1	2.3
<b>Brazil</b>	<b>276,186</b>	<b>100.0</b>	<b>287,392</b>	<b>100.0</b>	<b>4.1</b>

Source: SIESE Bulletin, 1998.

#### OUTLOOK

Based on the forecast of electricity average annual consumption growth of 4.7% over the next ten years, the plan that outlines the electricity sector, the Ten-Year Expansion Plan, forecasts that Brazil's installed generation capacity must increase to 104,666 MW by 2008, a 71% increase over the capacity of 61,219 MW in 1998.

#### EXPANSION OF GENERATION CAPACITY - 1999-2008

System	Hydro MW	%	Thermal MW	%	Total MW	%
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S/SE/CW	20,570	71	11,071	76	31,641	73
N/NE	8,309	29	1,932	13	10,241	23
ISOLATED	-	-	1,565	11	1,565	4
<b>Total</b>	<b>28,879</b>	<b>100</b>	<b>14,568</b>	<b>100</b>	<b>43,447</b>	<b>100</b>
<b>Brazil</b>						

Even if the installation timetable for this expansion in capacity is strictly adhered to, forecasts signal the possibility of critical years materializing (especially in the South/Southeast/Center-West Interconnected System) when there will be risks of supply deficits in excess of the 5% limit considered appropriated for an electricity system such as that of Brazil, which is predominantly hydroelectric.

#### RISK OF ENERGY DEFICIT (%)

Year	South	SE/CW	North	Northeast
1999	5.8	5.4	1.4	2.4
2000	9.9	9.8	4.7	5.1
2001	4.0	6.4	4.0	4.7
2002	2.1	3.0	3.0	2.9
2003	0.9	1.5	2.0	2.0
2004	1.1	1.6	2.1	2.0
2005	1.2	1.8	2.3	2.6
2006	0.7	1.5	2.1	3.2
2007	0.8	1.1	2.1	2.9
2008	0.9	1.6	2.6	4.1

Source: Ten-Year Expansion Plan 1999-2008 - GCPS.

Note: Annual risk of energy deficits in excess of 5% of the market.

As shown in the table above, the critical period for the operation of the interconnected systems, especially in the Southeast and Center-West, will last until 2001. This means that any postponement of the scheduled investments that results in a delay of the initial operation dates of these plants will represent an increase in the risks of these shortfalls occurring. In this period, 10,728.4 MW in capacity is expected to be added to the system, which will require investment of R\$ 11.4 billion.

#### PLANTS OF THE INTERCONNECTED SYSTEMS WITH OPERATION EXPECTED BY 2003 - MW

Year	Hydro	Thermal	Total	%	Cumulative total	Cumulative total (%)
1999	2,254.2	1,389.0	3,643.2	20.8	3,643.2	20.8
2000	1,080.3	970.0	2,050.3	11.7	5,693.5	32.5
2001	2,199.9	2,835.0	5,034.9	28.7	10,728.4	61.2
2002	3,677.3	851.0	4,528.3	25.8	15,256.7	87.0
2003	1,479.2	800.0	2,279.2	13.0	17,535.9	100.0
<b>Total</b>	<b>10,690.9</b>	<b>6,845.0</b>	<b>17,535.9</b>	<b>100.0</b>	<b>-</b>	<b>-</b>

Analysis of the growth rates of the Brazilian electricity sector show that, although generation capacity increased at an average annual rate of 11.8% in the 1970s, in the 1980s, this rate fell to 4.1%, reducing even further in the 1990s to 2.6% per year.

This progressive reduction in the level of investment, especially in the last 5 years, was reflected in the increase in the utilization level of the existing electricity system, which at present is operating beyond its capacity limit.

Further, the characteristics of the Brazilian electricity system make it extremely dependent on rainfall, thus requiring water reservoirs in order to be prepared for variations in consumption. When a system that does not have these reserves faces a period of low rainfall, it becomes

vulnerable to any variation in consumption and can no longer meet all of the growth requirements of the market.

The delay in the expansion of Brazil's generation capacity and its transmission network, together with growing consumption and seasons marked by low rainfall, have led the safety margin of the operational system (especially beginning in the mid-1990s) to narrow, particularly during peak consumption hours.

Clear signs that the sector is currently operating at its capacity limit is shown by recent actions in the sector, such as (i) the operation of thermal electric plants on the line of the consumption curve; (ii) the recent alteration of Aneel Resolution No. 268 of 1999 that establishes the rules for the voluntary reduction of industrial consumption during peak hours; and, (iii) the announcement of the purchase by Eletrobrás of excess energy produced by co-generators.

#### **GOVERNMENT MEASURES**

The Mining and Energy Ministry, anticipating the outlook that the supply of electricity could become an obstacle for economic growth, has taken the initiative to begin the process of identifying measures considered fundamental for stimulating investment in the expansion of Brazil's generation and transmission base, with a view to providing a more favorable environment for the rapid increase of supply. These measures focus on eliminating the obstacles that may compromise the attractiveness of the sector in its current transition phase.

The set of measures announced by the Mining and Energy Ministry also includes measures aimed at creating the basic conditions necessary for the signing of Power Purchase Agreements (PPAs) for the expansion of capacity to serve the market, which are:

- total or partial purchase guarantees by Eletrobrás of the energy generated by new projects;
- guarantees by Eletrobrás of the payments to be made by distributors in the PPAs for gas-burning thermal electric plants;
- proof and guarantees by distribution concession holders that they possess the necessary conditions to meet demand in their consumer market in the long term;
- details of the composition of the Normative Value (VN)<sup>4</sup> by Aneel;
- the relaxation of the weighting percentages of the VN for natural gas-burning thermal electric plants, making it possible to absorb variations in the exchange rate and in fuel prices;
- automatic transfer of the increases in the cost of energy generation to supply tariffs;
- a reduction of the average price of natural gas used in thermal electric generation to US\$ 2.26/MMBTU in 20 year contracts;
- conclusion of regulations for access and transportation of energy through the revision of Aneel Ministerial Order No. 459 of 1997, assuring conditions for free access to the transmission and distribution system;
- conclusion of regulations for the purchase of supplementary backup energy for non-utility electricity generators and independent energy generators; and
- the availability, by the Energy Secretariat, of the PPA model, with a view to facilitating financial operations.

The BNDES, with the objective of also contributing to the installation in the short term of projects to expand the installed capacity of the Brazilian electricity system, created the Program to Financially Support Priority Investments in the Electricity Sector.

The financial conditions of the Program (detailed below) apply exclusively to projects already identified as a priority by the Mining and Energy Ministry, and are restricted to projects for the installation and expansion of generation - hydroelectric plants (including PCH), thermal electric plants (natural gas, coal and shale burning), cogeneration projects (natural gas, coal, petroleum waste products and biomass) and electricity transmission.

- i. **Basic cost of the operation:** TJLP, exchange rate variation and basket of currencies;
- ii. **Basic spread:** 2.5% per year, falling to 1.0% per year in cases of international competition for the acquisition of equipment sold by Brazilian suppliers;
- iii. **Risk spread:** up to 2.5% per year or negotiated with the accredited financial institution in the case of operations carried out with Financial Agents;
- v. **BNDES Support:** financing of 100% of local expenditures, limited to 80% of the total investment;
- vi. **Amortization and grace period:** varies in accordance with the term of each project.

Still within the context of ministerial orders, some thermal electric plants that are able to enter into operation before the beginning of 2003 have received priority status. These projects (shown in the table below) will increase the generation system by 7,465 MW and represent an investment of some R\$ 5.0 billion.

#### THERMAL ELECTRIC PLANTS EXPECTED TO START OPERATION BEFORE 2003

Region	Thermal electric plant	Average capacity (MW)	Fuel	Natural gas consumption '000 (m <sup>3</sup> /day)
South	Gaúcha (1 <sup>st</sup> Phase)	480	Natural Gas	1,920
	REFAP	160	Natural Gas	640
	Catarinense (Joinville-1 <sup>st</sup> phase)	300	Natural Gas	1,200
	Araucária	480	Natural Gas	1,920
	Pitanga	20	Natural Gas	80
	Figueira	100	Coal	-
	REPAR	600	RASF	-
Southeast	Paulínia/Carioba (1 <sup>st</sup> Phase)	720	Natural Gas	2,880
	RPBC (Cubatão)	240	Natural Gas	960
	Santa Branca (1 <sup>st</sup> Phase)	480	Natural Gas	1,920
	REDUC (Duque de Caxias)	480	Natural Gas	1,960
	Norte Fluminense	480	Natural Gas	1,920
	Cabiúnas	480	Natural Gas	1,920
	Vitória	480	Natural Gas	1,920
	REGAP (Belo Horizonte)	240	Natural Gas	960
	Cachoeira Dourada	125	Natural Gas	240
	REVAP (S.J. dos Campos)	160	RASF	-
Center-West	Campo Grande (1 <sup>st</sup> Phase)	240	Natural Gas	960
Northeast	Termobahia	280	Natural Gas	1,120
	Termopernambuco	260	Natural Gas	1,040
	Vale do Açu (RN)	330	Natural Gas	1,320
	Pecém	240	Natural Gas	960
	Sergipe	90	Natural Gas	360
Total generation of the S/SE/CW Interconnected System		6,265	-	21,400
Total generation of the N/NE Interconnected System		1,200	-	4,800
Total generation - Brazil		7,465	-	26,200

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1 The first and second are USA and Canada, in this order.

2 Does not include self-producers.

3 SIESE - Business Information System for the Electricity Sector.

4 VN - the Reference Value that establishes the limits for the transfer of electricity purchase prices to concession holder's tariffs and distribution licenses.