

Electricity Basic Data in the PDE 2024

SPECIFICATION	2014	2024	24/14 % p.a.	Structure (%)	
				2014	2024
ENERGY CONSOLIDATED DATA (million toe)					
DOMESTIC ENERGY SUPPLY	305.6	399.5	2.7	100.0	100.0
DISTRIBUTION AND TRANSFORMATION LOSSES	39.7	46.0	1.5	13.0	11.5
FINAL CONSUMPTION (include non-energy use)	265.9	353.5	2.9	87.0	88.5
PRIMARY PRODUCTION	272.6	520.0	6.7		
EXTERNAL TRADE (a)	40.2	-102.5	-	13.2	-25.6
GENERAL DATA OF ELECTRICITY (TWh)					
TOTAL SUPPLY	624.3	940.8	4.2	100.0	100.0
PUBLIC INTERNAL GENERATION	537.3	823.5	4.4	86.1	87.5
CAPTIVE SELF-PRODUCER	53.2	100.0	6.5	8.5	10.6
IMPORTS	33.8	17.3	-6.5	5.4	1.8
FINAL CONSUMPTION	531.1	790.9	4.1	85.1	84.1
LOSSES IN DISTRIBUTION	93.2	149.9	4.9	14.9	15.9
SECTORAL ELECTRICITY CONSUMPTION (TWh) (b)					
TOTAL	531.1	790.9	4.1	100.0	100.0
INDUSTRIAL (includes Energy Sector)	237.1	355.7	4.1	44.6	45.0
RESIDENTIAL	132.0	197.2	4.1	24.9	24.9
COMMERCIAL AND PUBLIC	133.3	196.4	4.0	25.1	24.8
OTHERS	28.7	41.6	3.8	5.4	5.3
REGIONAL ELECTRICITY CONSUMPTION IN THE GRID (TWh) (c)					
BRAZIL	467.7	692.1	4.0	100.0	100.0
ISOLATED SYSTEM	5.3	3.5	-4.1	1.1	0.5
INTERCONNECTED SYSTEM	462.5	688.7	4.1	98.9	99.5
NORTH	34.8	58.6	5.3	7.5	8.5
NORTHEAST	67.1	111.0	5.2	14.4	16.0
SOUTHEAST AND MIDWEST	280.4	399.4	3.6	59.9	57.7
SOUTH	80.1	119.7	4.1	17.1	17.3
INTERCONNECTED AVERAGE LOAD (GW_{avg}) (c)					
INTERCONNECTED SYSTEM	65.8	94.5	3.7	100.0	100.0
NORTH	5.5	8.7	4.6	8.3	9.2
NORTHEAST	10.0	15.2	4.2	15.2	16.1
SOUTHEAST AND MIDWEST	39.3	55.0	3.4	59.8	58.1
SOUTH	11.0	15.7	3.7	16.7	16.6
PEAK LOAD (GW) (d)	84.5	125.0	4.0	1.28	1.32
ELECTRICITY INSTALLED CAPACITY (GW) (c)					
INTERCONNECTED SYSTEM	132.9	204.1	4.4	100.0	100.0
NORTH	18.2	45.4	9.5	13.7	22.2
NORTHEAST	21.6	45.5	7.7	16.3	22.3
SOUTHEAST AND MIDWEST	72.2	85.3	1.7	54.3	41.8
SOUTH	20.8	28.0	3.0	15.6	13.7
MARGINAL OPERATING COST (R\$/MWh)					
	2015	2024			
NORTH	226	141	-5.1		
NORTHEAST	228	140	-5.3		
SOUTHEAST AND MIDWEST	281	141	-7.4		
SOUTH	286	141	-7.6		

(a) Negative sign represents net exports.

(b) Include captive self-producers.

(c) Do not include captive self-producers and no included the Paraguayan part of Itaipu;

(d) Index over the average load.

Indicators in this report were obtained from the 2024 Brazilian Energy Plan (PDE 2024), whose studies were carried out by the Energy Research Company (EPE), and approved by the MME.



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Electricity in the 2024 Brazilian Energy Plan (PDE 2024)

Edition: 12/02/2015

Macroeconomic and Energy Indicators

In economic scenario of the PDE2024 studies, the Brazilian Gross Domestic Product (GDP) grows at 1.8% p.a. (per annum) between 2014 and 2019 and 4.5% p.a. over the period 2019-2024. In the second period, the rate is higher than expected for the world, of 3.8%, which places the country on the route the previous decade, when the Brazilian economy grew above the world average. From 2014 to 2024 Brazil's GDP grows 3.2% p.a.

Average GDP Growth Rates (% per annum)

Indicators	History		2014	Projection	
	2004-09	2009-14		2014-19	2019-24
World's GDP	4.9	3.2	3.3	3.8	3.8
Brazil's GDP	4.8	2.6	0.1	1.8	4.5
National Savings Rate (% of GDP)	17.8	18.7	16.0	17.2	21.6

In the sectoral structure of the national GDP, industry continues to losing share, which is common to countries with average development. Agriculture recovers recent structural losses as a result of improvements in the global economy.

GDP Sectoral Composition (%)

Sector	History		2014	Projection	
	2004-09	2009-14		2014-19	2019-24
Animal Agriculture	5.9	5.2	5.2	5.5	5.5
Industry	28.8	26.9	26.1	25.2	25.0
Services	65.3	67.9	68.7	69.3	69.5

Expected savings rates – considered the end of each year –, to achieve an economy growth close to 3.2% p.a., are higher than those seen in the recent past, 17.2% of GDP between 2014 and 2019, and 21.6% of GDP from 2019 to 2024.

For total energy demand is expected a growth rate of 2.7% p.a. from 2014 to 2024, that is below the GDP's. Contributes to this forecast the relative declining, more energy-intensive industry, in the economic sectoral structure.

In the expected demographic scenario for the studied period, is observed a higher population growth in the North (1.1% p.a.) and Midwest (1.2% p.a.) regions, with a 0.7% p.a. national average growth. In the same period, the number of households grows 1.6% p.a. as a result of a reduction from 3.4 to 2.9 persons per family, following a past trend.



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Population and Number of Dwellings (million)

Regions	2014	2024	24/14 % p.a.	Structure (%)	
				2014	2024
BRAZIL	203.6	217.8	0.7	100.0	100.0
NORTH	17.4	19.5	1.1	8.6	8.9
NORTHEAST	56.2	59.3	0.5	27.6	27.2
SOUTHEAST	85.5	90.7	0.6	42.0	41.6
SOUTH	29.1	31.0	0.6	14.3	14.2
MIDWEST	15.4	17.4	1.2	7.6	8.0
RESIDENCES BRAZIL	65.7	77.1	1.6		
Inhabitants/Dwelling	3.4	2.9	-1.5		

Thus, from 2014 to 2024, GDP per capita in Brazil will grow 2.5% p.a. (3.6% p.a. in PDE 2023), the Domestic Energy Supply (DES) *per capita* grows 2.0% p.a. and the electricity consumption *per capita*, 3.4% p.a. The indicators reveal that the DES grows slightly below GDP, with an income elasticity of 0.84 in the period.

Macroeconomy and Energy Indicators

Specification	2014	2024	% p.a.
GDP (billion US\$)	1,512	2,062	3.2
Population (million)	204	218	0.7
GDP <i>per capita</i> (US\$/inhab)	7,426	9,470	2.5
Domestic Energy Supply <i>per capita</i> (toe/inhab)	1.50	1.83	2.0
Domestic Energy Supply per GDP (toe/thous US\$)	0.2021	0.1937	-0.4
Electricity Final Consumption <i>per capita</i> (kWh/inhab)	2,608	3,632	3.4

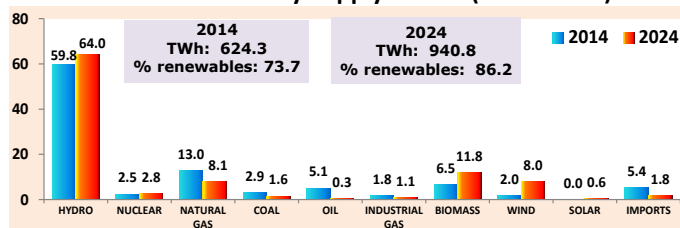
(*) The exchange rate adopted is R\$/US\$ 2.65.

Domestic Electricity Supply

In 2024, the Domestic Electricity Supply reaches 941 TWh (934 TWh in PDE 2023), with an average annual increase of 4.2% over 2014 figures, greater than the expected rate for GDP (income-elasticity of 1.3).

In the electricity supply matrix, hydropower remains supreme in 2024, accounting for 65.8% of the total, against 65.2% in 2014 (including import). The wind, solar and biomass generations, with significant expansion, including hydro generation, remains high the renewable share in the electric matrix, at significant 86.2% in 2024.

Domestic Electricity Supply Matrix (% and TWh)



Final Electricity Consumption Highlights

The electricity consumption per capita reaches 3,632 kWh in 2024, indicator still much lower than 8,200 kWh in 2012, in OECD countries. The final electricity consumption grows at 4.1% p.a. from 2014 to 2024, with a recoil in the participation of industry in the demand sectoral structure.

Key Transmission Lines (Map2)

Projects	States	km	Conclusion
1 Interconnection Xingu - SE	PA, TO, GO, MG and SP		
2 Interconnection N-NE and N-SE	AC, RO, AM, PA, TO, MA, PI, CE, PE, BA		
3 Interconnection Teles Pires - SE	PA, MT, GO, SP		
4 Interconnection Xingu-Imperatriz	PA, TO, PI		
5 Reinforcement in Southeast Region	MG, SP, RJ, MT, GO		
6 Interconnection S - SE	RS, SC, PR, SP		

(a) Manaus and Boa Vista, (b) Xingu, (c) AC/RO, (d) Belo Monte, (e) Teles Pires and Tapajós, (f) Itaipú, (g) Ivaiporã, (h) Imperatriz
Note: km equivalent to simple circuits.

Hydroelectric Projects for 2021 to 2024 (map 1)

Project	River	MW (goal)	State	Operation
1 São Luiz do Tapajós	Tapajós	8,040	PA	2021
e Apertados	Piquiri	139	PR	2021
a Tabajara	Jiparaná	350	RO	2021
f Telêmaco Borba	Tibagi	118	PR	2022
e Comissário	Piquiri	140	PR	2023
1 Jatobá	Tapajós	2,338	PA	2023
c Itapiranga	Uruguai	725	SC/RS	2024
b Castanheira	Arinos	192	MT	2024
9 Bem Querer	Branco	708	RR	2024
Outros	vários	247	vários	2022/24
Total		12,997		2021/24

Others: Foz Piquiri, Paranhos and Ercilândia

Infrastructure Investments

Infrastructure investments for the electricity sector, about US\$ 142 billion, represent almost 27% of total energy investments until 2024, that accomplish the total of US\$ 531 billion.

Infrastructure Investments – Total Energy

Sector	billion US\$ (*)	
	2014-24	%
Electricity	142	26.7
Generation	101	19.1
Transmission	41	7.7
Oil and Gas	375	70.6
Biofuel	14	2.7
Total	531	100.0
% of the accumulated GDP in the period		2.8
% of the accumulated GFCF in the period		14.4

(*) The exchange rate adopted is R\$/US\$ 2.65.

Investments in hydropower expansion account for 27.2% of total investments in generation. Alternative sources – small hydropower plants, biomass, wind and solar –, assume a greater proportion in the generation investments, of 58.0% (52% in PDE 2023).

Investments in Power Plants, by Source

Source	billion US\$ (*)	
	2014-24	%
Hydro	27.6	27.2
Thermo	14.9	14.7
Nuclear	4.2	4.1
Natural Gas	9.9	9.8
Coal	0.9	0.9
Fuel Oil and Diesel	0.0	0.0
Small Hydro, Wind, Biomass, and Solar	58.8	58.0
TOTAL	101.3	100.0

(*) The exchange rate adopted is R\$/US\$ 2.65.

Expansion of Transmission Lines and Substations

Facilities	Unity	2014	2024	Increment 2014-24	% 2014-24
TRANSMISSION LINES (SIN)	thous km	125.7	201.4	75.7	60.2
SUBSTATIONS (SIN and border)	GVA	305.6	493.8	188.2	61.6

Expansion of Transfers between Subsystems (MWavg)

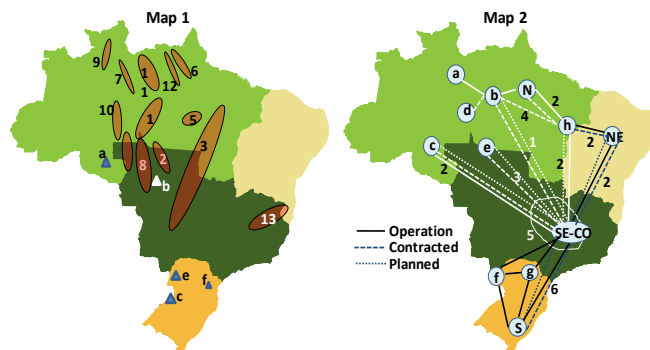
Stretch	MW promed	Year	Stretch	MW promed	Year
TP->SE/CO	2,120	2015	Imp. SUL	2,000	2020
AC/RO->SE/CO	150	2015	Exp. SUL	2,000	2020
Imp.->SE/CO	1,051	2016	Exp. NE	6,000	2020
Exp. NE	3,000	2016	Imp. NE	5,100	2020
Imp.->SE/CO via N/N	5,350	2016	Exp. SE via N/NE	3,730	2020
AC/RO->SE/CO	874	2016	Imp. SE via N/NE	6,000	2020
Imp. SUL	836	2017	AC/RO->SE/CO	700	2020
AC/RO->SE/CO	682	2017	Exp. SE via N/NE	4,600	2020
Imp. SE via N/NE	1,970	2018	Imp. SE via N/NE	8,120	2020
Imp. SUL	957	2018	T.PIRES/TP->SE/CO	2,000	2020
Exp. SUL	874	2018	Imp. SE via N/NE	12,631	2022
T.PIRES/TP->SE/CO	1,480	2018	T.PIRES/TP->SE/CO	2,000	2022
AC/RO->SE/CO	129	2018	Imp. Sul	1,700	2023
Imp. SUL	983	2019	Exp. SUL	1,700	2023
Exp. SUL	1,269	2019	T.PIRES/TP->SE/CO	2,000	2023
Exp. SE via N/NE	5,720	2019	T.PIRES/TP->SE/CO	2,200	2024
Imp. SE via N/NE	7,501	2019			

Note: IMP: Imperatriz; AC: Acre; RO: Rondônia; MAN: Manaus; AP: Amapá; BM: Belo Monte; TP: Tapajós; Imp.: Imports; Exp.: Exports.

Hydroelectric Inventory Studies 2006/14 (Map 1)

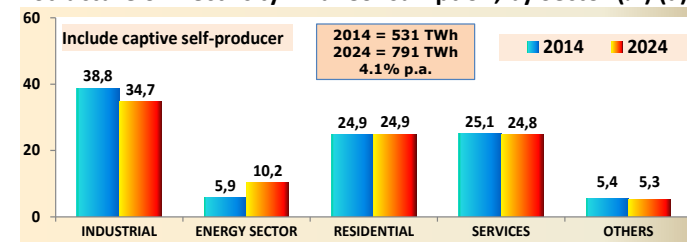
River Basin	MW	States	Situation
2 Teles Pires and Apiacas (7 projects)	3,825	MT/PA	2006
1 Tapajós e Jamanxim (7 projects)	14,245	PA/AM	2009
8 Juruena and Tributaries (22 projects)	8,946	AM/MT	2011
6 Jari (3 projects)	1,363	AP/PA	2011
9 Branco e Mucajai (4 projects)	1,049	RR	2011
3 Araguaia e Mortes (1 project)	310	GO/MT/PA/TO	2011
13 Jequitinhonha	761	MG	2011
4 Aripuanã e Roosvelt (7 projects)	2,530	AM/MT/RO	2012
10 Sucunduri	650	AM	2013
12 Paru (6 projects)	1,705	PA	2014
11 Trombetas (New Inventory)	3,000	PA	in execution
9 Negro	...	AM/RR	in execution
Total	38,384		

Notes: 5, in the map, refers to Itacaiúnas - PA (200 MW); 7, refers to Jatapu - AM (650 MW), in the design stage.



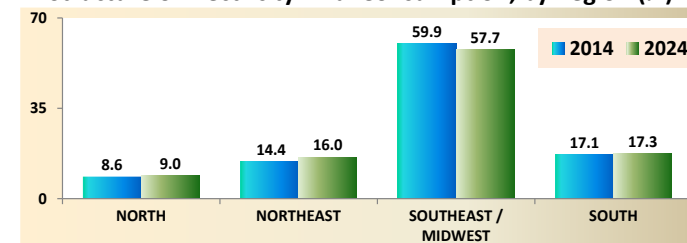
The energy sector raises the proportion in the total consumption of electricity, due mainly to the expansion of oil exploration and production. The electricity consumption in the production of ethanol and the thermoelectric also grows above the average of other sectors.

Structure of Electricity Final Consumption, by Sector (%) (a)



Only the Southeast/Midwest region lose share of final consumption of electricity in the period, consistent with the global situation, where from 1973 to 2013, consumption grew at 5.2% p.a. in developing countries, and only 2.3% p.a. in developed countries.

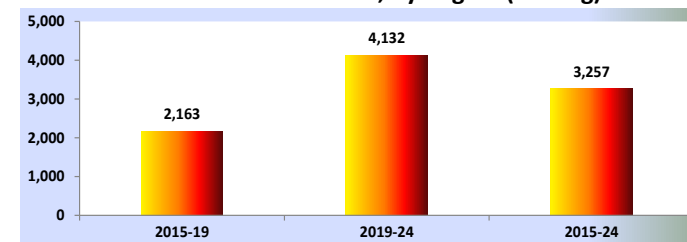
Structure of Electricity Final Consumption, by Region (%)



Deficit Risk

The balance between load and planned power supply, in the National Interconnected System (SIN), presents positive energy balance of throughout the study period, excluding reserve energy. In an average regional approach, SE/MW and S regions are importers, while N and NE regions are exporters.

Annual Load Increment, by Region (GWavg)



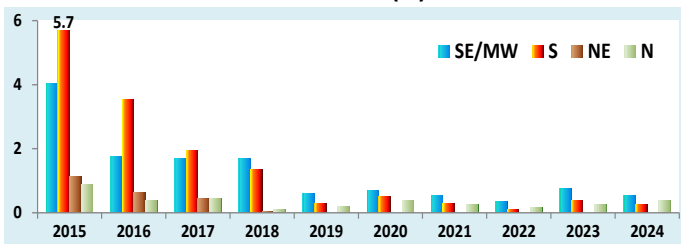
The maximum available power calculation, in order to meet the peak demand, was done differently for storage hydro plants, for the run-of-river power plants and for thermal power plants (TPPs). For storage plants, it was considered the final stored energy, resulting

from the system operation simulation, in order to be obtained the net head for each simulated series. For the run-of-river plants subsystems with a strong seasonality, as Acre/Rondonia, Teles Pires/Tapajós and Belo Monte, it was took into account the average generation, at the peak level, for the chosen affluent natural energy series. In the case of the run-of-river plants of other subsystems, which include Itaipu, the maximum available power and the effective power are the same. Regarding to the TPPs, the maximum power is the available one.

The results show that, due to the existing surplus power, the low probabilities and the depth of the observed deficits, the electro-energetic expansion of SIN is properly sized to meet the maximum power demand, projected by 2024.

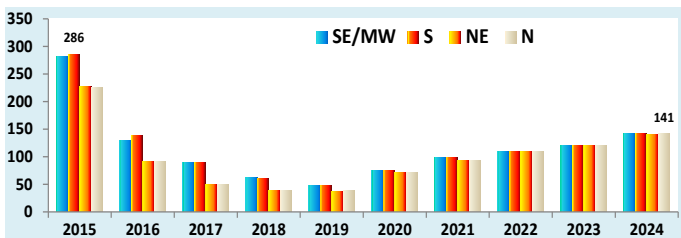
The logistics of fuel oil supply, natural gas and coal has been extensively tested and improved in 2014 and 2015, when the thermal power generated virtually at maximum availability. Regardless of low current hydrological regime, this aspect is of relevance to the end of the period, when the proportion of run-of-river plants get much more significance in the total installed capacity, with a load factor below 20% during the dry season. There must be enough flexibility in the natural gas foreign trade and its storage, mainly in order to meet the abrupt changes in the volumes of thermoelectric consumption.

Deficit Risk (%)



The deficit occurrence probability, associated with the generation expansion, meets the planning criterion in which the Operating Marginal Cost is equal to the Expansion Marginal Cost. Studies show that deficit risks are below 4.0% in all regions (excluding 2015), which meets the supply security criteria.

Marginal Operation Cost (R\$/MWh)



Electricity Infrastructure Highlights

Brazil's installed power generation capacity reaches 212.5 GW in 2024, with an expansion of 78.6 GW over 2014, distributed as follows: 73.5 GW in the National Interconnected System; decrease of 1.7 GW in isolated systems and; 6.8 GW in the captive self-producer, registered in ANEEL.

Generation Installed Capacity Expansion (GW)

Sources	2014	2024	Increment 2014-24	Structure (%)	
				2014	2024
HYDRO	84.1	111.5	27.4	58.9	49.8
NUCLEAR	2.0	3.4	1.4	1.4	1.5
NATURAL GAS	12.6	23.2	10.6	8.8	10.4
COAL	3.4	3.9	0.5	2.4	1.7
OIL	7.9	6.5	-1.4	5.5	2.9
INDUSTRIAL GAS	1.7	1.9	0.3	1.2	0.9
SMALL HYDRO	5.1	8.5	3.4	3.6	3.8
BIOMASS	12.3	21.1	8.7	8.7	9.4
WIND	4.9	24.2	19.3	3.4	10.8
SOLAR	0.0	8.3	8.3	0.0	3.7
TOTAL (*)	133.9	212.5	78.6	93.9	94.9
Oil E&P	2.9	6.7	3.8	2.0	3.0
TOTAL BRAZIL	136.8	219.2	82.4	95.9	97.9
IMPORTS	5.9	4.7	-1.1	4.1	2.1
TOTAL SUPPLY	142.7	223.9	81.2	100.0	100.0

(*) 2014: Registered in ANEEL's Generation Information Databank, 12/31/2014.

Taking into account the National Interconnected System, with captive bagasse self-production, the power supply reaches 204.1 GW in 2024 (196 GW in PDE 2023), with a total expansion of 72.3 GW and a decline of 1.2 GW in imports. Hydro accounts for 41% of the expansion (29 GW), while biomass, wind and solar, for 44%, or 31.6 GW (27.8 GW in PDE2023). From the total expansion, 41 GW (55%) are already contracted.

Power Supply Expansion of SIN (GW)

Sources	2014	2019	2024	Increment 2014-24	Structure (%)	
					2014	2024
HYDRO	82.8	102.0	110.0	27.2	65.8	55.2
NUCLEAR	2.0	3.4	3.4	1.4	1.6	1.7
NATURAL GAS	11.0	14.9	21.2	10.2	8.8	10.6
COAL	3.1	3.4	3.4	0.3	2.4	1.7
OIL	4.8	4.3	4.3	-0.5	3.8	2.2
INDUSTRIAL GAS	0.7	0.7	0.7	0.0	0.5	0.3
SMALL HYDRO	4.8	5.2	8.1	3.3	3.8	4.1
BIOMASS	11.8	13.5	17.3	5.5	9.4	8.7
of which: self producer	5.3	5.3	5.3			
WIND	4.9	13.5	24.0	19.1	3.9	12.0
SOLAR	0.0	4.0	7.0	7.0	0.0	3.5
TOTAL NATIONAL	125.9	164.9	199.4	73.5	100.0	100.0
IMPORTS	5.9	5.6	4.7	-1.2		
TOTAL	131.8	170.5	204.1	72.3		

Contracted and Planned Expansion (GW)

