
Brazil
2.3.3 Brazil
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Key facts

<table>
<thead>
<tr>
<th>Population</th>
<th>202,768,562(^1)</th>
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<tbody>
<tr>
<td>Area</td>
<td>8,515,692 km(^2)</td>
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<tr>
<td>Climate</td>
<td>The climate is mainly tropical, but temperate in the south and equatorial in the north. In the Amazonian region average temperatures reach over 26°C-28°C. The north-east region is humid, tropical and semi-arid with averages between 20°C and 28°C. In the south-east region average annual temperatures vary between 19°C and 24°C. However, in the south, the coldest regions are those with average temperatures below 20°C. During the winter, the average values in June vary between 11°C and 18°C.(^2)</td>
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<tr>
<td>Topography</td>
<td>The Brazilian territory basically consists of crystalline solid (36 per cent) and large sedimentary basins (64 per cent). Approximately 93 per cent of the Brazilian territory presents altitudes of below 900 m. Most of the geological structures are old, dating back to the Paleozoic and Mesozoic Eras in the case of sedimentary basins and the Precambrian Era in the case of solid crystalline.(^3)</td>
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<tr>
<td>Rain pattern</td>
<td>In the Amazonian region the annual atmospheric precipitation is 2,300 mm on average, but there are locations where precipitation exceeds 5,000 mm/year. The north-east region presents annual precipitation of between 300 mm and 2,000 mm. In the midwest, precipitation is well spread and is about 1,500 mm/year. In the south-east, rainfall ranges between annual averages of 1,250 mm and 2,000 mm, exceeding 4,500 mm in Bertioga, on the central coast of São Paulo state.(^3)</td>
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Electricity sector overview

In 2015, the total installed capacity of the power grid in Brazil was 142,158.5 MW (Figure 1). The generation capacity of hydropower, including imports, was 407.2 TWh. In total, the participation of renewable sources reached 74.6 per cent. Final power consumption was 531.1 TWh;\(^6\) electricity supply was 624 TWh, with 590 TWh from domestic generation and 33 TWh from net imports.\(^25\)

![FIGURE 1](image)

According to the 2010 Census, the electric grid covered 97.8 per cent of Brazilian households. The coverage varies between urban areas (99.1 per cent) and rural areas (89.7 per cent).\(^6\) In 2012 electric power transmission and distribution losses reached 17 per cent.\(^24\) In 2013, 99.7 per cent of the population had access to electric power. Most of the areas without access were composed of rural communities mostly located in remote and isolated regions within the Amazon Rainforest.\(^8\) The government’s Light for All Program is mainly responsible for providing electricity to the Brazilian population. Since its implementation 10 years ago, the programme has made over three million installations, representing 5 per cent of the total number of residential consumers in the country, totalling about 15 million people benefitting from access to electric power.\(^9\)

With regard to consumption per sector, in 2013, residential consumption was the largest (expanding 6.2 per cent above the number registered in 2013), followed by business and services (5.6 per cent rise from 2012). Together, these sectors consumed 209 TWh, representing...
about 45 per cent of the total electric energy consumed by the distribution network. In 2014, the commercial sector had the lowest energy consumption growth rate since 2009, when the total consumption declined 1.1 per cent due to the global economic crisis in late 2008. The industrial sector, which is a major energy user, is also responsible for the decline in consumption.

Policies for the energy sector, and specifically the electric power sector, are drafted by Federal Executive Power through the Ministry of Mines and Energy (MME), with advice from the National Council for Energy Policy (CNPE) and National Congress. The National Electricity Agency (ANEEL) acts as a regulatory agency and the Electric System National (ONS) is responsible for coordinating and supervising the centralized operations of the interconnected system. The Electric Sector Monitoring Committee (CMSE), in connection with the MME, was instituted to permanently keep track and evaluate the continuity and security of the electro-energetic demand in all of the national territory, aside from suggesting necessary actions. There are also other agencies like the Energy Research Company (EPE), linked to the MME, whose function is to carry out the necessary studies for planning the expansion of the electric system. Another is the Chamber of Electric Energy Commercialization (CCEE), which hosts energy trading in the free market.11

Since 2004, the Brazilian electricity sector includes two trading environments: the Regulated Contracting Environment (ACR) having electricity generation and distribution agents, and the Free Trade Environment (ACL) having generators, distributors, traders, importers, exporters, and free and special consumers. There is also the spot (short term) market where the adjustment between the contracted and measured volume of energy is promoted. With the objective of reaching reasonable tariffs, auctions were incorporated in the current model, working as an instrument for distributors to purchase energy in the regulated environment. The auctions are held by CCEE, delegated by ANEEL, and follow a low tariff criterion in order to reduce the acquisition cost of energy to be passed on to retail consumers.11

In order to generate and transmit energy, the country counts on a principal system called the Interconnected System (SIN). This network covers most of the country and consists of connections made over time. These installations which were initially restricted to exclusive service for the region of origin: south, south-east, mid-west, north-east and part of the north. In addition, there are many smaller systems that are not connected to the SIN; these isolated systems are mainly found in the Amazonian region in the north. Due to the geographical characteristics of the region, which is dense and contrasted with extensive and rushing rivers, building long transmission lines to connect to the SIN is extremely difficult.11 Currently, the subsystems in the north are slowly being connected to the SIN.

In 2013, the average Brazilian tariff was R$254.17/MWh (US$67.20/MWh), the most expensive in the north and the least in the south. There are variations according to consumer class between R$286.09/MWh (US$75.74/MWh), (public authority) and R$161.27/MWh (public illumination). With regard to supply voltages, the average tariff ranged between R$272.38/MWh (US$72.03/MWh) for low voltage to R$142.94/MWh (US$51.23/MWh) for voltages above kW.9

Small hydropower sector overview and potential

As of the beginning of 2015, small hydropower (SHP) plants in Brazil are limited to those with an installed capacity above 1 MW and below 30 MW, as well as having a flooded area that does not exceed 3 km².13 Brazil has a SHP installed capacity of 5,518.50 MW. The SHP potential is 250,000 MW.

![FIGURE 2](image-url)

**SHP capacities 2013-2016 in Brazil (MW)**

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<tr>
<th>Year</th>
<th>Potential capacity</th>
<th>Installed capacity</th>
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<tr>
<td>2016</td>
<td>25,000</td>
<td>22,500</td>
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<tr>
<td>2013</td>
<td>22,500</td>
<td>4,106</td>
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Source: WSHDR 2013,13 Agencia Nacional de Energia Elétrica (ANEEL).6 Note: The comparison is between data from WSHDR 2013 and WSHDR 2016.

With Resolution 652 in 2003, the flooded area had authorization to reach 13 km², as long as it meets the equation A ≤ (14,3×P)/Hb, where P is the power of the project given in megawatts (MW) and Hb is the gross head available, given in metres (m); or when the reservoir has been scaled based on uses other than electricity generation.14 Hydropower projects with power below 1 MW are classified as Hydropower Generating Plants and receive simplified treatment from ANEEL in terms of registration procedures.1

Studies show that Brazil still has about 25,000 MW of SHP potential available. These estimates used a logistic growth curve as a model, based on the growth of SHP plants from 2005 to 2009, and considered inflexions to the growth of installed capacity of SHP after 2023. The growth rate in 2023 was predicted as less than 5 per cent per year since available power would increasingly become scarce and more expensive. The study points out that in the decade of 2030, SHP installed capacity should be about 8,500 MW and in 2050 about 12,000 MW. The growth rate of SHP installed capacity is projected to stagnate in the decade of 2070.16

According to ANEEL in April 2015, Brazil was operating 491 hydropower plants with capacities ≤ 1 MW (0.23 per cent of the total), totalling 317.4 MW, as well as 474 plants with capacities of 1-330 MW, corresponding to 4,772.1 MW (3.53 per cent of the total). Of these ventures, most grants are generally given to private equity.6
In mid-2015, 38 SHP projects were being built, totalling 429 MW of installed capacity. According to the 2023 10 Year Plan of Energy Expansion the Brazilian Government foresees that the energy matrix, with relation to SHP plants, will add 2,011 MW to the system between 2013 and 2023. While it is a large achievement for SHP development, it is a notably discrete growth with relation to the increments observed for large hydro, wind, biomass, and solar, with growths of 32,265 MW, 20,248 MW, 4,116 MW and 3,500 MW respectively.\(^{17}\)

**Legislation on small hydropower**

Among the renewable sources, SHP plants are losing ground to other sources, mainly wind. In the last few years, the auction prices for wind energy have shown to be lower than those of SHP. Compared to other sources, the cost of construction and operation of SHP has been shown to be more expensive. The costs for civil construction and electromechanical equipment are high and are not eligible for tax exemptions, unlike the equipment for wind parks. The equipment for wind parks are exempt from taxes such as Circulation of Merchandise and Services Tax and parts used for the wind generators are exempt from programmes such as the Social Integration Program/Public Service Asset Formation Program and the Contribution to Social Security Financing.

There are difficulties found in the environmental licensing processes. According to CONAMA Resolution 01/86, Article 2, construction activities for power generation are potentially impacting to the environment, and are therefore subject to Environmental Impact Studies (EIA) and Environmental Impact Reports (RIMA). This applies to any power plant, regardless of source, with power above 10 MW. Under this regulation, the EIA is required for all hydropower plants with power of 10-30 MW.\(^{17}\) SHP plants are also classified as ventures with high impacts to the environment graded at 3 in a classification that ranges from 1 to 5. However, SHP plants with less than 10 MW can meet the requirement through the Simplified Environmental Report.\(^{19}\)

However, in 2015, with the changes in auction rules, especially in terms of cap prices, it was possible to recover the sale of SHP energy in a significant way. In addition, with the provisions of Law 13.097/2015, it is likely that many projects with installed capacities of 1-3 MW will have their processes simplified and made less expensive. They will then be able to come into operation.

In the future, as SHP plants are built in the country, the location for greater heads and better flows will be exploited first over smaller heads and flows, thus, in most cases, making them economical. While the market should continue to grow with the current measures, it is likely to be slower growth, and converge for saturation. SHP plants should continue to be part of the composition of the clean and renewable energy matrix in Brazil, but in a small fraction.\(^{16}\)

In Brazil, SHP investments are financed by banks, mainly the National Bank of Social Development (BNDES), whose main line of credit provides a grace period up to six months after the project begins commercial operation, with amortization up to 20 years. The bank finances up to 70 per cent of the value of financeable items, except for hydropower plants above 30 MW, in which case BNDES finances up to 50 per cent of the financeable costs.\(^{19}\)

**Renewable energy policy**

According to the 10 Year Plan elaborated by the Brazilian Energy Research Company, by 2023, the participation of renewable sources in the Brazilian energy matrix will increase from 41 in 2013 to 42.5 per cent. The evolution of the installed capacity of renewable sources in the Brazilian energy matrix will increase from the current 82.9 per cent to 83.8 per cent in 2023. Wind energy with current 1.8 per cent in the energy matrix will rise to 11.6 per cent in 2023, due to the expansion of 20 MW within the time period.\(^{17}\)

Concerned with climate change, Brazil was first to sign the United Nations Framework Convention on Climate Change for the United Nations Conference event on Environment and Development, held in Rio de Janeiro in 1992. Two years later, the National Brazilian Congress ratified the Convention, which officially came into effect in the country in March 2009, through Law 12.187 of 29 December 2009. The country instituted the National Police on Climate Change (PNMC) establishing principals, objectives, guidelines and instruments on the matter.\(^{22}\)

**Barriers to small hydropower development**

During the process of evolution, the Brazilian hydropower sector acquired significant experience and knowledge in the areas of design, manufacturing and assembly of electromechanical generating equipment, which have been enhanced and consolidated. The remaining hydropower potential is found in environmentally delicate regions, like the Amazon Rainforest. Development of these resources requires the project to be small and without any reservoirs. However, the increasing energy demand pushes for large hydropower installations.

Since the Brazilian energy sector model favours the sale of low cost energy, SHP is left at a disadvantaged position in comparison to other renewable sources, mainly because it does not have the same amount of tax incentives as other sources do. With reformulations in the energy auction rules in 2015, which establishes larger cap costs and makes sources more equally competitive, SHP plants are seen to be recovering in the regulated market. In addition, environmental barriers are common during the licensing process. There are hopes that Law No. 13.097/2015 will make the formalities of projects with installed capacities of 1-3 MW easier. Generally speaking, the difficulties are more present in the regulated market and there are more opportunities in the free market.
References

18. CONAMA, Resolução CONAMA Nº 001, de 23 de janeiro de 1986.