# *Winds of change*

Brazilian wind power could provide three times more energy than all other electricity sources put together; it currently supplies 22 million homes

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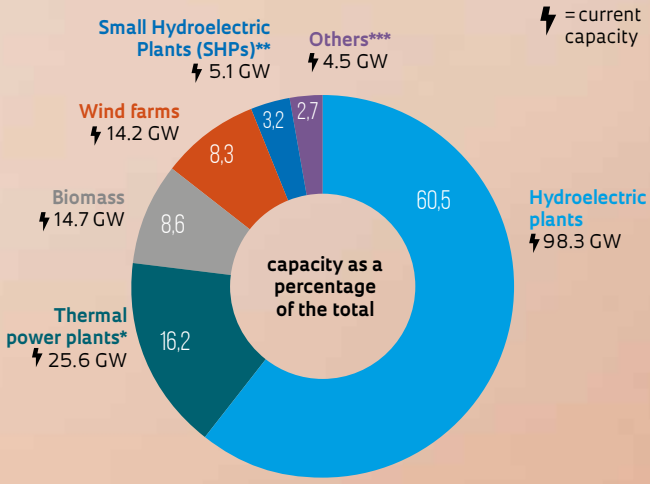
The Bons Ventos Wind Farm in Aracati, Ceará state

CPFL RENOVÁVEIS

# Power grid

Brazil has 7,166 electricity generation facilities in operation, with a total installed capacity of 162.5 GW




*Includes natural gas, oil, and coal

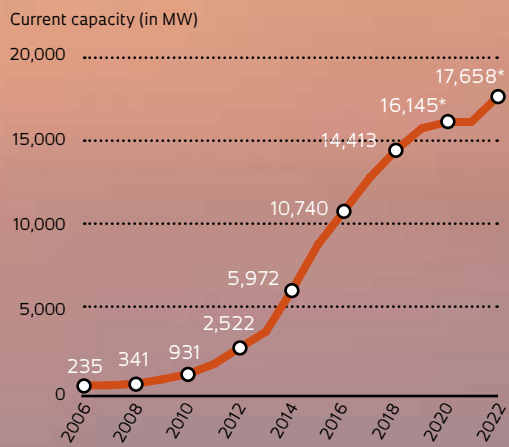
**Plants between 5 and 30 MW

***Nuclear, solar, and hydroelectric stations that generate between 0 and 5 MW

**SOURCE** BRAZILIAN ELECTRICITY REGULATORY AGENCY (ANEEL); DECEMBER 2018

# Upward curve

Wind power continues to rise in Brazil




*Based on contracts already agreed upon at energy auctions

**SOURCE** BRAZILIAN WIND ENERGY ASSOCIATION (ABEEÓLICA)

The Brazilian Association of Wind Energy (ABEEólica) estimates that Brazil has the potential to generate 500 gigawatts (GW) of wind power, enough to supply three times the country's current energy demand, which is currently met by a range of sources including wind, hydroelectric, biomass, natural gas, oil, coal, and nuclear. In December 2018, the national energy capacity totaled 162.5 GW according to the Brazilian Electricity Regulatory Agency (ANEEL). Of this total, wind power accounted for 14.2 GW, equivalent to the capacity of the 14-GW Itaipu dam and enough to supply 22 million homes. Wind is the fourth-largest energy source in Brazil (*see infographic, left*).

ABEEólica CEO Elbia Gannoum explains that the potential estimate of 500 GW is based only on onshore generation by 150-m wind turbines with a current standard capacity of 2 to 3 megawatts (MW) each. The energy industry, however, has been making efforts to increase the capacity of wind turbines to approximately 5 MW. Such turbines would be capable of generating twice the amount of energy in the same physical space while reducing operating costs. "Technological advances could greatly increase Brazil's wind power potential," says Gannoum.

American multinational General Electric (GE) began selling a 4.8 MW turbine worldwide in 2017. The model has three blades, each 77 m long, resulting in a total diameter of 158 m. The maximum height of the turbine—including the tower and one of the blades pointing upward—is 240 m, which is more than the length of two football fields.

The combination of a larger rotor and a taller tower, explains Vitor Matsuo, analytics leader at GE Renewable Energy in South America, allows the turbine to take advantage of stronger winds and generate more power: approximately 90% more than the 2.5 MW of the previous GE model sold in Brazil. A 4.8 MW turbine could meet the energy demand of 7,500 homes.

The new turbine will be produced by the GE plant at the Camaçari Industrial Complex in Bahia, with the blades being built by its subsidiary, LM Wind Power, at a plant in Ipojuca, Pernambuco. The blades will be made of carbon fiber, which is stronger and lighter than traditional fiberglass. The


Technicians perform maintenance work on a WEG turbine at the Cutia Wind Farm in São Bento do Norte, Rio Grande do Norte state

technology was developed in the USA, but Brazil participated by providing data on wind characteristics, logistical limitations, and availability of machinery, such as cranes, to enable assembly and operation of the turbines in Brazil.

In October 2018, Danish manufacturer Vestas announced plans to produce its 4.2 MW wind turbines in Ceará. The company is studying whether to revitalize its plant in Aquiraz, where it currently produces 2 MW turbines, or move elsewhere in the state. It plans to invest roughly €23 million (approximately R$100 million) and create 200 jobs.

The only Brazilian wind turbine manufacturer is WEG, which plans to launch its 4 MW turbines on the market in the second half of this year. The company began as a parts supplier in the wind power sector in 1996 and started manufacturing its own turbines in 2010. In 2012, it formed a partnership with Northern Power Systems, based in Vermont, USA, and in 2016, it acquired the American company's wind turbine division. Engineers from Northern designed WEG's current line of 2.1 MW and 2.2 MW wind turbines, of which 308 units have been sold. The new 4 MW turbine was designed by a joint team of 15 American and 20 Brazilian engineers.

**WEG, the only Brazilian wind turbine manufacturer, plans to launch a new 4 MW turbine this year**

João Paulo Gualberto da Silva, director of new energy resources at WEG, says one of the main challenges of developing the 4 MW turbines was the load calculations. "It was only possible with the aid of simulations performed by supercomputers," he says. The manufacturers had to determine the mechanical force required to maintain a structure with a 147 m rotor turning 14 times per minute, with three blades completing one rotation every 10 seconds. Each blade will weigh 23 tons and will be 74 m long and 3 m wide at its widest point.

Material fatigue, logistics, and economic viability are other issues that need to be considered. One example of the potential difficulties, according to Gualberto da Silva, is assembly. The towers of the 2.2 MW turbines are 120 m long, but they need to be reinforced to support the 4 MW machines. The cranes used to assemble the towers cannot operate with structures any larger than this. "We are calculating how to reinforce the steel and concrete so that the current towers are able to support the required force of the new turbines."

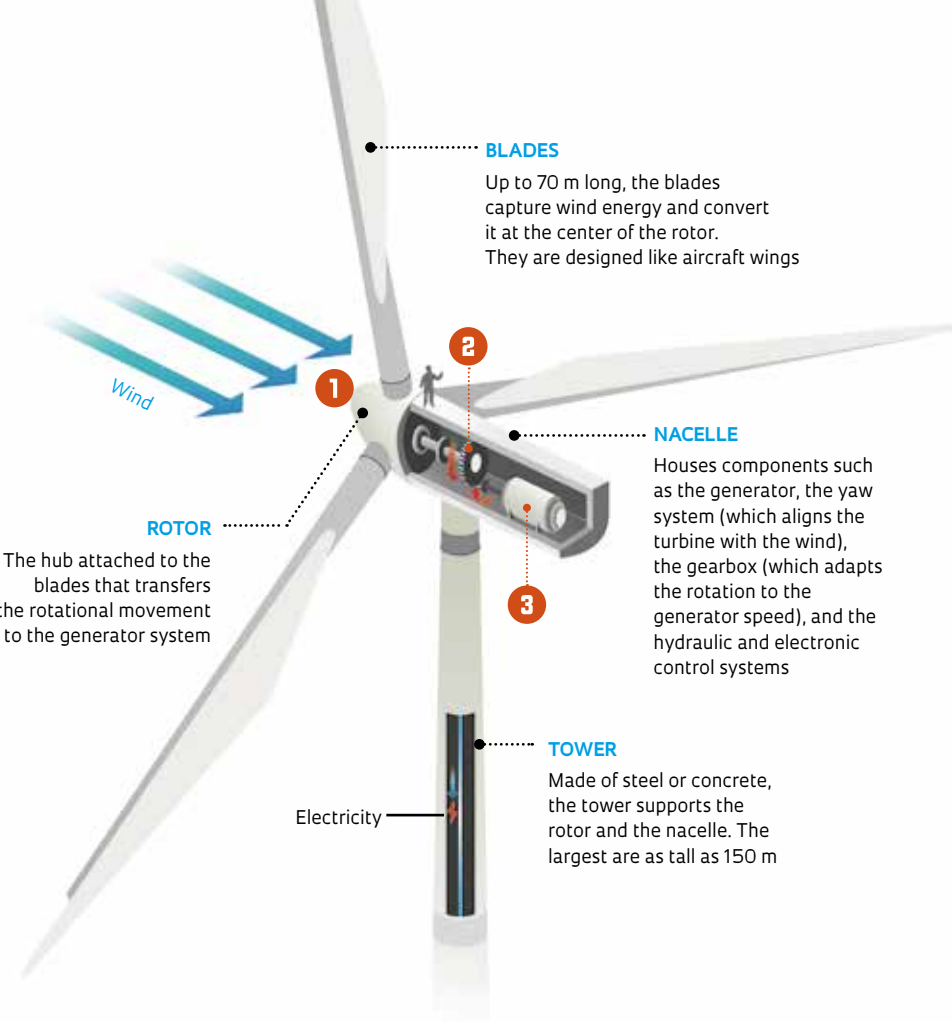
Unlike GE, which makes its blades out of carbon fiber, WEG intends to continue using fiberglass and epoxy resin, which are both cheaper materials. The new blades are being designed with the help of European and Chinese mold designers and manufacturers.

#### NOISE AND BIRDS

A number of research groups are investigating wind energy in Brazil, including at the federal universities of Ceará (UFC), Santa Catarina (UFSC), and Rio Grande do Sul (UFRGS), as well as at the University of São Paulo (USP). The

# Wind Turbines

The main components of a wind turbine, and how they convert wind energy into electricity




## HOW IT WORKS

1 The blades, moved by the force of the wind, activate the rotor, generating a mechanical force

2 The gearbox allows the rotor to turn the generator shaft

3 The power converter and the generator transform the mechanical energy into electricity

**SOURCE** INTERVIEWEES

Poli Wind group was formed by four researchers at the USP Polytechnic School in 2016, among them postdoctoral researcher Joseph Youssif Saab Jr., head of the mechanical engineering course at the Mauá Institute of Technology. Saab has applied for a patent for a quieter turbine blade design, which represents a genuine Brazilian contribution to the development of wind turbine technology. "Noise is a real problem for those who live near wind farms. It's like having an airplane flying over your house 24 hours a day, and the noise will only get worse as wind turbines get bigger," says the researcher. The group is looking for manufacturers willing to test the new airfoil design.

Saab has also created a tool that can predict the amount of noise emitted by a blade, allowing the team to make adjustments during the design process. The tool is freely available online and has been downloaded more than 36,000 times worldwide. The new design involves three wind turbines with diameters of 100, 180, and 220 m.

The Poli Wind group is also tackling another problem created by large wind turbines: the risk to birds and bats. National and international guidelines recommend building wind farms away from migration routes, but according to Saab, this is not always observed in Brazil. One possible solution suggested by the group is to create a narrow airfoil section that generates a high-pitched whistle in the 1–3 kilohertz (kHz) range, which would warn off birds without significantly affecting the noise levels heard by humans.

Another innovative approach that could potentially reduce operational costs is being developed by Eolic Future Tecnologia, based in São José dos Campos. The project, funded by the FAPESP Technological Innovation in Small Businesses (PIPE) program, is designing a wind turbine with a horizontal rotor axis, as is normally used in wind farms, but with a difference: the nacelle—the part that holds the generator—is located at the base of the tower, instead of its usual position at the top.

According to William Menezes, from Fatec São José dos Campos university and lead researcher at Eolic Future, analytical calculations have proven the system technically feasible for 80-m towers, and the next step is to build a prototype. An advantage of installing the nacelle at the base of the tower is a potential 15% annual reduction in maintenance costs. The total cost of a wind turbine usually includes maintenance costs—somewhere in the region of R$2.5 million per year after the fifth year of operation. There is also a greater risk of accidents when maintaining equipment installed high above the ground. Eolic Future plans to market the technology with the help of investors and wind turbine manufacturers.

The positive atmosphere in the Brazilian wind power industry was heralded by aeronautical engineer Bento Koike, founder of São Paulo–based company Tecsis. The company was started in 1995 to manufacture wind turbine blades based on its own unique technology and designs. The blades were

**PHOTO** CHAN/WEG **INFOGRAPHIC** ANA PAULA CAMPOS **ILLUSTRATION** FABIO OTUBO

# Among global leaders

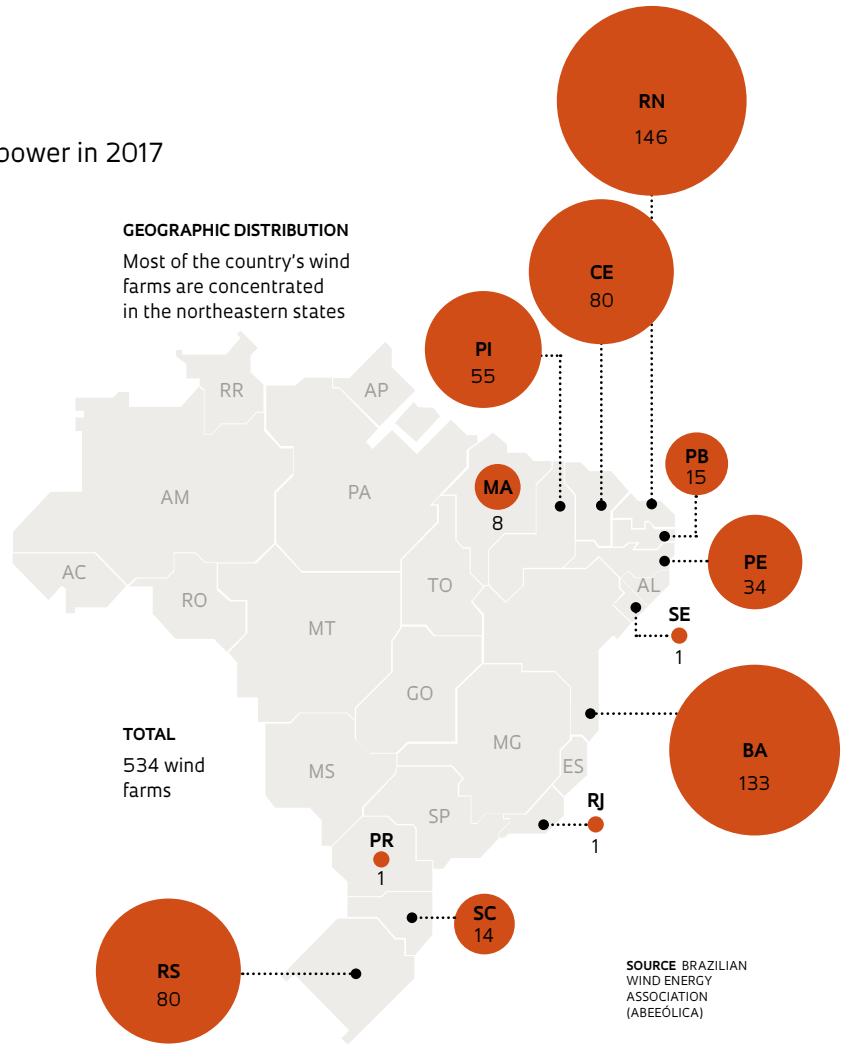
Brazil was the eighth-largest producer of wind power in 2017

| | COUNTRY | GENERATION (in GW) | % GLOBAL TOTAL |
|---|---|---|---|
| 1 | China | 188.2 | 35 |
| 2 | USA | 89.1 | 17 |
| 3 | Germany | 56.1 | 10 |
| 4 | India | 32.8 | 6 |
| 5 | Spain | 23.2 | 4 |
| 6 | UK | 18.9 | 3 |
| 7 | France | 13.8 | 3 |
| 8 | **BRAZIL** | **12.7** | **2** |
| 9 | Canada | 12.2 | 2 |
| 10 | Italy | 9.5 | 2 |
| | Other countries | 83 | 15 |
| | **TOTAL** | **540** | |

**SOURCE** GLOBAL WIND ENERGY COUNCIL (GWEC)

**GEOGRAPHIC DISTRIBUTION**

Most of the country's wind farms are concentrated in the northeastern states




**TOTAL**

534 wind farms

**SOURCE** BRAZILIAN WIND ENERGY ASSOCIATION (ABEEÓLICA)

initially exported to Germany and later to other countries. By 2016, it had sold more than 50,000 blades of 23 different models, serving both the domestic and international markets. Since 2017, GE, Tecsis's largest customer, has reduced orders, having acquired one of its competitors, LM Wind Power. This and the economic crisis Brazil has been suffering since 2014 have led to financial difficulties for the company. In September 2018, it agreed to an extrajudicial financial recovery plan.

## CHEAPER ENERGY

Analysts note that the increasing use of wind power worldwide is driven by its low environmental impact and falling investment costs. A report by the International Renewable Energy Agency (IRENA) states that the levelized cost of electricity (LCOE) of wind energy fell by 22% between 2010 and 2017—today it is US$0.06 per kWh. The LCOE is calculated by dividing all the costs expected over the lifetime of a power plant by its output in kWh for the same period of time. The price of turbines, which accounts for 70% of the investment on average, fell by 40% over this period.

The Global Wind Energy Council, an international forum representing the sector, reported that in 2017, global wind power capacity grew by 52 GW to a total of 539 GW. The projected global capacity for 2022 is 840 GW. Brazil is the eighth-largest wind power generator in the world and accounts for 2% of global production. The country has 568 wind farms that comprise more than 7,000 wind turbines according to 2017 data from ABEEólica. Based on new contracts that have already been agreed upon, national capacity will reach 17.6 GW in 2022.

Elbia Gannoum estimates that wind power will be the most sold energy source at energy auctions promoted by ANEEL over the coming years. This is helped by the fact that wind power has become competitively priced in Brazil, at a cost of R$90 per MWh. At the last auction in April 2018, hydroelectric power was priced at R$198 per MWh.

Offshore wind farms could provide further options for Brazil. Based on a 2011 study, the Brazilian National Institute for Space Research (INPE) estimates that Brazil could harness up to 606 GW of wind power from its territorial waters, 57 GW of which would be from within 10 kilometers of the coast, where infrastructure is easier to build. However, ABEEólica does not foresee wind farms expanding offshore in the near future due to the expense, with costs as much as five times higher than on land. Petrobras announced in 2017, however, that it was drawing up plans to build Brazil's first offshore wind farm off the coast of Guamaré in the state of Rio Grande do Norte. The aim is for the farm to begin operating in 2022. ■

### Project

Development of a horizontal axis wind turbine with vertical transmission system aimed at reducing downtime and maintenance costs (no. 16/21569-0); **Grant Mechanism** Technological Innovation in Small Businesses (PIPE) program; **Principal Investigator** William Marcos Muniz Menezes (Eolic Future Tecnologia); **Investment** R$130,879.48.

# A brief history

The wind sector gained momentum in Brazil in 2009 with the first exclusive wind energy auction

Brazil began paying greater attention to the potential of wind energy in 2001, when the country was suffering a major energy crisis that became known as "the blackout." It needed to diversify its range of energy sources, and wind power was an option that could be quickly implemented. Later that year, the Proeólica Emergency Wind Energy Program was created, the goal of which was to sign wind power contracts worth 1,050 megawatts (MW) by the end of 2003. However, the initiative was not successful.

In 2002, the government instituted the Proinfa Alternative Energy Sources Incentive Program to encourage the emergence of a national industry; however, local production was incipient and expensive, and wind power was not competitive at energy auctions—the new procurement system established by the Brazilian Electricity Regulatory Agency (ANEEL) in 2004.

It was only from 2009 onward, when the first exclusive wind power auction was held, that the sector began to gain momentum, according to Elbia Gannoum, president of the Brazilian Association of Wind Energy (ABEEólica). At that time, contracts were agreed upon for 1.8 gigawatts (GW). The following year, wind power began to compete at renewable energy auctions, and in 2011, at general energy auctions.

According to Jorge Boeira, head of renewable energies at the Brazilian Industrial Development Agency (ABDI), the growth of the sector has also been aided by the Brazilian Development Bank (BNDES), which in 2012 started supporting the industry via the FINAME Machinery and Equipment Funding program.

According to ABDI data, there are currently six wind turbine manufacturers in Brazil with a joint production capacity of 1,500 units per year—enough to generate 3.5 GW. Blade production capacity is 7,000 per year. In total, the sector's production chain comprises more than 70 companies with a nationalization rate of 80%. "It is a complete production chain capable of competing for any project in Latin America," says Boeira.

NUNO GUIMARÃES / FRAME / FOLHAPRESS

Wind farm in the municipality of Galinhos, Rio Grande do Norte state