

Annual wind energy report 2024



ONSHORE OFFSHORE

ABEEólica

ASSOCIAÇÃO BRASILEIRA DE ENERGIA EÓLICA E NOVAS TECNOLOGIAS

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MESSAGE FROM THE CEO



For the first time in the history of the wind sector, we ended 2024 with a decrease in new wind power installed capacity in Brazil. Despite the growth in the number of installed wind farms, totaling 1,103 and marking a 7.4% increase, the number of new farms was modest compared to 2023 - only 76 new plants were installed down from 123 in the previous year.

We totaled 33.7 GW, up 10.76% versus December of the previous year, when the volume reached 30.45 GW.

This means that we added 3.3 GW of new capacity in 2024, compared to the mighty 4.8 GW that until then had given us the record for wind power plants in Brazil for the third year in a row.

The world also set a record for the number of wind turbines installed onshore and offshore, with a total of 117 GW of installed capacity.

Against this backdrop, we have fallen two places in the number of wind turbines installed in the world. We were the fifth country with the most wind turbines installed, according to data from the GWEC (Global Wind Energy Council). On the other hand, Brazil has climbed one position and reached 5th place in the Ranking of Total Installed Capacity of Onshore Wind Energy in 2024.

Brazil's change of course towards global engagement in the fight against climate change and the necessary energy transition brings us favorable prospects in the medium and long term.

It's important to remember that 2024 was one of the most dynamic years we've ever experience, perhaps the most difficult in the history of this industry. We started to notice the crisis in the industry at the end of 2023. This effect of drops in contracts is becoming

more pronounced now that our industry has a contracting-to-operation cycle of around three years. It's a cascade effect that has reached from the manufacture of components to generation. Generation curtailments were also aggressive in 2024, a scenario that will continue throughout 2025 and has brought us many challenges.

In terms of wind power generation, in 2024 we produced enough megawatt hours to supply the combined electricity consumption of the states of Minas Gerais and Rio de Janeiro, representing 36 million inhabitants (IBGE, 2022). In terms of investments, data from BNEF (BloombergNEF) show that we ended the year with cumulative investments of US\$ 42 billion in the wind industry from 2015 to 2024.

Periods of crisis often provide opportunities for reflection and progress. It has been a year of study, learning and unity among our members. We had experienced an environment for dialogue and working together. We emerged more aware, united and reaffirming ABEEólica's role in the renewable energy industry.

We made very good progress in new business, with the publication of the Green Hydrogen and Carbon Market regulatory milestones. PATEN and

Offshore Wind Laws have been approved and we are closely monitoring the inclusion of battery storage in the next capacity auctions.

On the following pages, you will find a detailed overview of the data mentioned here, along with other key information about 2024.

Good reading!



Elbia Gannoum
 CEO of Abeeólica

INSTALLED CAPACITY IN BRAZIL, ALL SOURCES

In 2024, 76 new wind farms were installed, adding 3.3 GW of new capacity and 23 MW of repowered capacity. These figures reflect a challenging year, marked by a crisis in the industry.

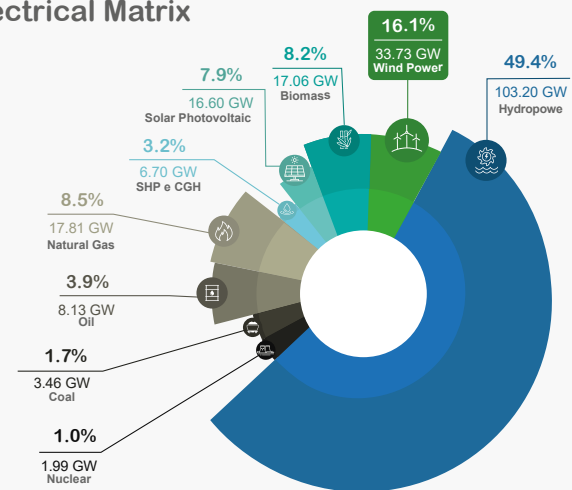
Although installed capacity in 2024 was lower than in the last three years, it was still the fourth best year in terms of capacity addition. 2024 ended with 1,103 wind farms and 33.7 GW of wind power installed, representing 10.8% growth compared to December 2023, when capacity was 30.4 GW. The states covered by new projects in 2024 are shown in the table on the side:

States with new wind farms in 2024

	Installed Capacity (MW)	Number of wind farms
BA	1,953.9	48
PI	364.8	8
RN	313.5	9
RS	302.4	3
PB	116.0	3
CE	112.5	3
PE	91.2	2
Total	3,254.3	76

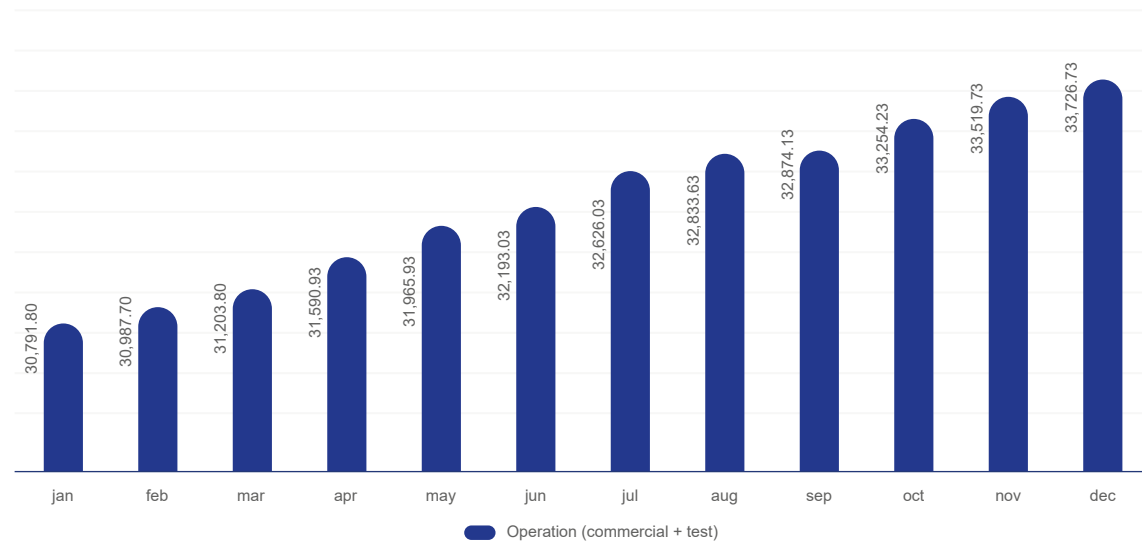
Considering all sources of energy generation, 3.3 GW of capacity was installed in 2024 and wind power was the second fastest growing source, accounting for 10.8% of the new capacity added in the year. New wind capacity installed in 2024 has brought the wind power to a 16.1% share of the Brazilian energy matrix, as shown in the graph on the right, which illustrates the share of all generation sources in the Brazilian energy matrix at the end of 2024.

Brazilian Electrical Matrix



The 33.73 GW of installed capacity at the end of December 2024 is made up of 32.98 GW of wind farms in commercial operation (97.79%) and 744.60 MW in test operation (2.21%). The graph on the right shows the evolution of installed capacity in 2024.

Evolution of Installed Capacity - 2024 (GW)

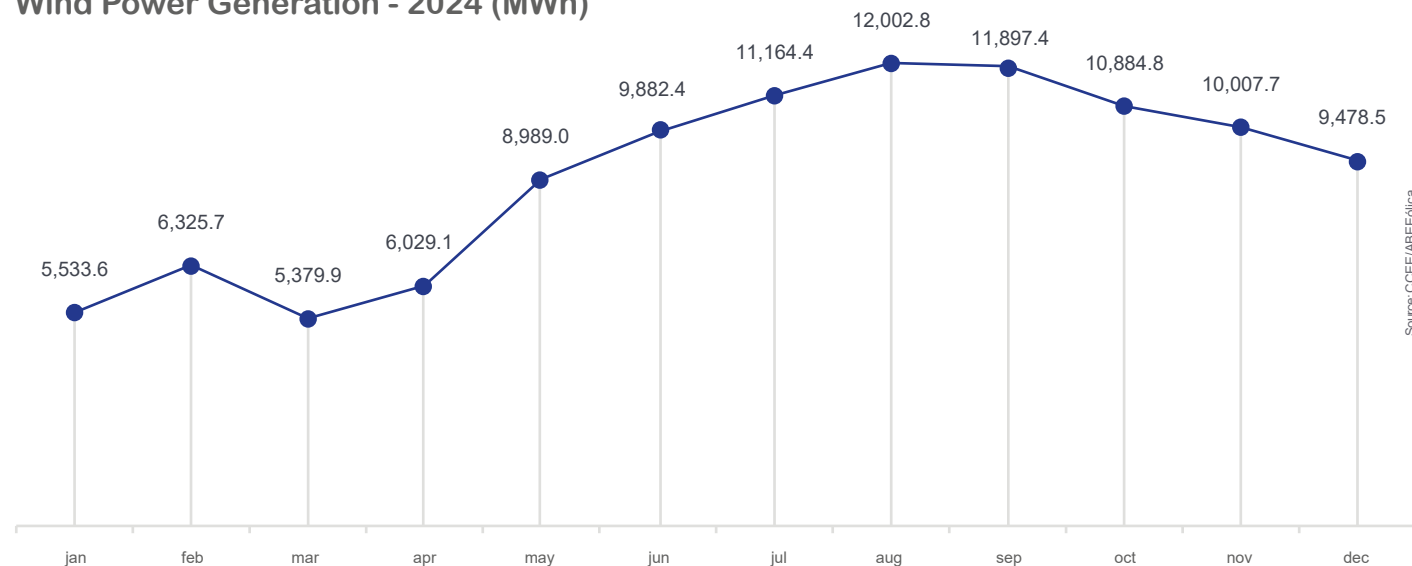


Source: ANEEL/ABEEólica

GENERATION

A total of 107.58 TWh of wind energy was generated over the course of 2024. Wind energy production was 12% higher compared to 2023. The graph on the right shows the generation figures of the year.

Wind Power Generation - 2024 (MWh)



Source: CCEE/ABEEólica

1. Includes the amount of wind generation from plants in test and commercial operation, at the point of connection.



In 2024, wind generation supplied 16.7 % of the average electricity injected into Brazil's National Interconnected System (SIN). During the windiest season, on second half of the year, this share rose, peaking at 22.6 % of SIN generation in August.

The figures on the side illustrate the records for the year in each subsystem and SIN:

NE 129.41%

Wind generation met 100% of the NE's consumption and exported 29.41% to other regions of SIN, with generation of 424.73 GWh. (08/22/2024)

S 16.96%

of the energy consumed in South subsystem came from wind farms, generating 43.10 GWh. (09/07/2021)

N 6.70%

of the energy consumed in North subsystem came from wind farms, generating 9.91 GWh. (09/04/2021)

SIN 22.89%

of the energy consumed in SIN came from wind farms, generating 455.42 GWh. (11/04/2024)

Source: ONS

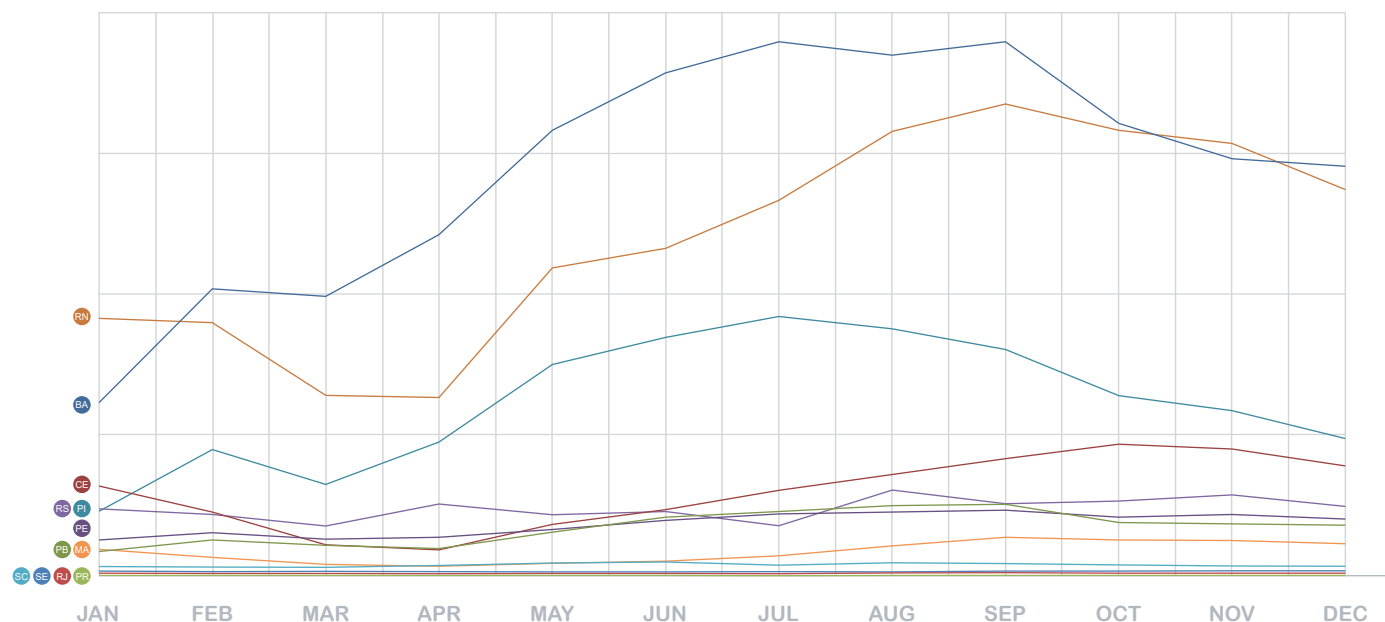
GENERATION AND WIND POWER SHARE

The table below shows that Northeast subsystem accounted for 92.2% of total wind generation in 2024, a share very close to the system's overall generation.

Region	2023		2024		% growth
	Generation (TWh)	Share	Generation (TWh)	Share	
Southeast	0.06	0.1%	0.05	0.1%	-12%
South	5.50	6.1%	6.22	6.0%	13%
Northeast	83.52	92.0%	95.25	92.2%	14%
North	1.72	1.9%	1.76	1.7%	3%
Total	90.80	100%	103.28	100%	13,7%

2. SIN is made up of four subsystems: Northeast, North, Southeast/Midwest and South. Their division is not the same as that established geographically. For wind farms, what is represented in the North subsystem is what is located in Maranhão.

Generation by State - 2024 (GWh)



REGION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
RN	1,891.1	1,738.5	1,316.5	1,258.5	2,266.4	2,334.2	2,769.2	3,283.9	3,375.9	3,291.9	3,090.6	2,850.1
BA	1,262.2	1,974.5	2,055.1	2,432.4	3,291.7	3,600.4	3,951.6	3,851.8	3,824.6	3,342.7	2,980.9	3,023.6
PI	452.8	854.8	652.6	938.3	1,547.0	1,692.5	1,905.4	1,811.5	1,605.1	1,315.0	1,164.1	995.0
RS	471.2	401.7	343.5	491.7	428.0	437.0	344.7	611.4	491.8	529.6	556.5	488.1
CE	641.3	418.1	203.8	159.8	355.1	450.2	608.2	727.2	818.5	952.2	888.0	790.6
PE	239.1	274.9	244.7	251.3	318.1	372.6	434.0	447.1	446.8	408.6	414.6	395.1
MA	168.4	103.0	56.6	42.5	66.3	78.1	120.9	194.5	250.4	239.8	227.8	210.9
PB	154.0	224.7	199.4	169.4	296.2	396.6	452.1	495.3	487.9	368.3	347.4	348.6
SC	41.5	34.4	34.8	46.9	68.0	73.5	52.1	68.5	60.9	53.6	44.2	43.5
SE	6.5	4.0	4.4	2.9	1.4	1.9	4.1	1.7	6.2	7.9	8.2	8.9
RJ	4.6	3.6	3.2	1.8	2.8	3.5	2.3	6.4	9.4	5.3	6.0	4.4
PR	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.3	0.3	0.3	0.2	0.2

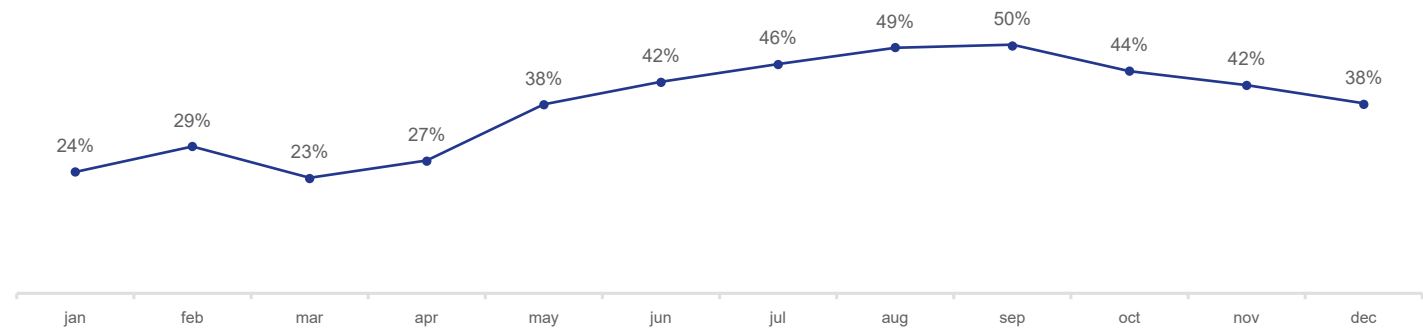
The five states with the highest generation in 2024 were Bahia (35.59 TWh), Rio Grande do Norte (29.47 TWh), Piauí (14.93 TWh), Ceará (7.01 TWh) and Rio Grande do Sul (5.60 TWh). The amount of generation in each Brazilian state with their respective shares are shown in the graph.



CAPACITY FACTOR

The capacity factor of wind power represents the ratio between the plant's actual generation over a period of time and its total capacity over the same period. In 2024, the average capacity factor was 38%, reaching a peak monthly average of 50% in September.

CAPACITY FACTOR - 2024



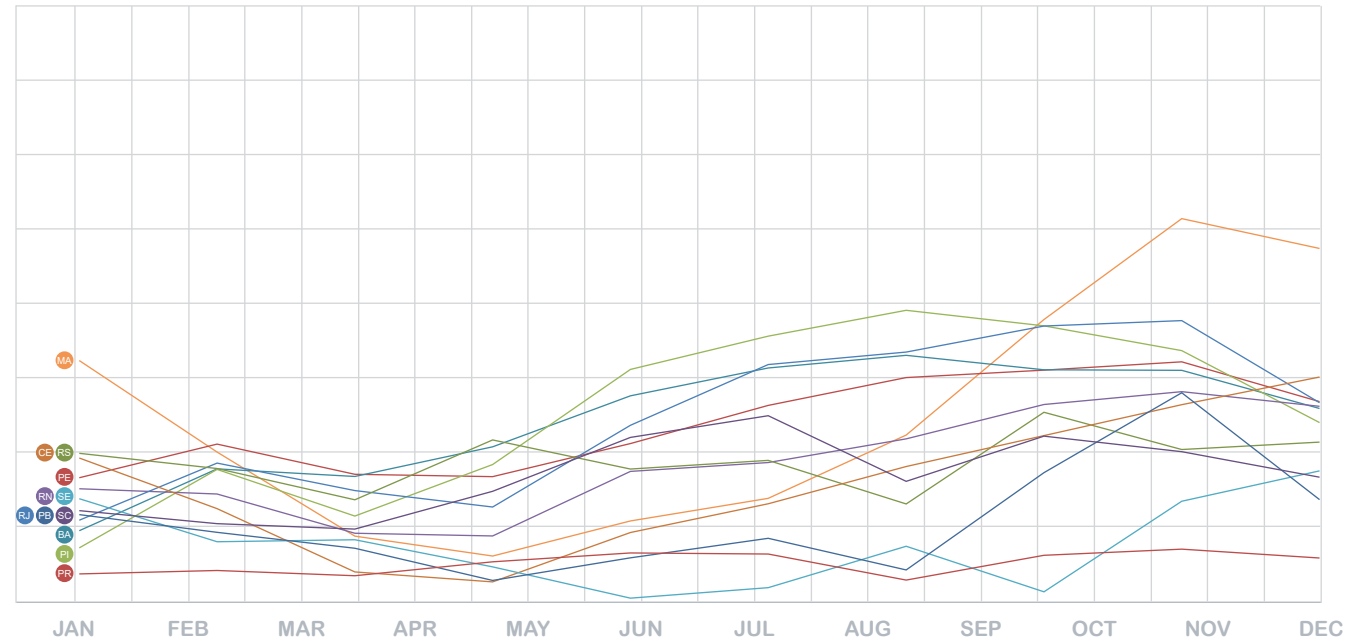
Source: ANEEL/CCEE/ABEEólica

The Capacity Factor was impacted by the effects of generation cuts implemented by the regulatory body. Some generating companies recorded cuts of around 60%, a figure reflected throughout the system which has generation time as one of the components for this calculation.



The five states with the highest average capacity factor in 2024 were Maranhão (47.0%), Paraíba (41.9%), Piauí (41.4%), Pernambuco (41.1%) and Bahia (40.9%). The graph shows the capacity factor figures for each Brazilian state with their respective wind power shares:

Capacity Factor by State - 2024 (%)



REGIÃO	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
MA	53.1%	34.8%	17.9%	13.9%	20.9%	25.5%	38.2%	61.4%	81.6%	75.7%	74.3%	66.5%
PB	21.1%	32.5%	37.0%	23.7%	40.1%	52.3%	54.8%	60.1%	61.1%	44.7%	43.5%	42.3%
PE	29.6%	36.4%	30.3%	29.8%	36.4%	44.1%	49.7%	51.2%	52.9%	44.9%	45.5%	42.0%
BA	19.0%	31.4%	29.8%	35.8%	46.1%	51.6%	54.2%	51.3%	51.2%	43.5%	39.1%	38.1%
PI	15.5%	31.2%	21.9%	32.2%	51.3%	58.0%	63.2%	60.1%	55.1%	40.7%	36.6%	30.3%
RN	27.4%	26.3%	18.4%	17.9%	30.8%	32.7%	37.4%	44.3%	46.9%	43.9%	42.6%	38.0%
RS	34.5%	31.4%	25.2%	37.2%	31.3%	33.1%	24.3%	42.7%	35.3%	36.8%	39.9%	32.8%
CE	33.6%	23.4%	10.7%	8.6%	18.6%	24.6%	31.8%	38.1%	44.3%	49.8%	48.0%	41.6%
SE	25.4%	16.7%	17.1%	11.7%	5.4%	7.5%	15.8%	6.7%	24.9%	31.0%	33.1%	34.7%
RJ	22.2%	18.6%	15.4%	9.0%	13.5%	17.4%	11.1%	30.6%	46.7%	25.2%	29.6%	20.9%
PR	10.2%	10.9%	9.9%	12.7%	14.5%	14.3%	9.0%	14.0%	15.2%	13.5%	12.6%	10.5%
SC	23.0%	20.4%	19.3%	26.9%	37.7%	42.1%	28.9%	38.0%	34.8%	29.7%	25.3%	24.1%

in commercial operation, at the gravity point.
Includes wind generation amount and installed capacity of plants in commercial operation, at the point of connection.

HOW MUCH ENERGY IS GENERATED?

Wind generation in 2024 would have been enough to supply the electricity Gerais and Rio de Janeiro in 2023, benefiting an estimated 36 million people, according to 2022 data from IBGE.

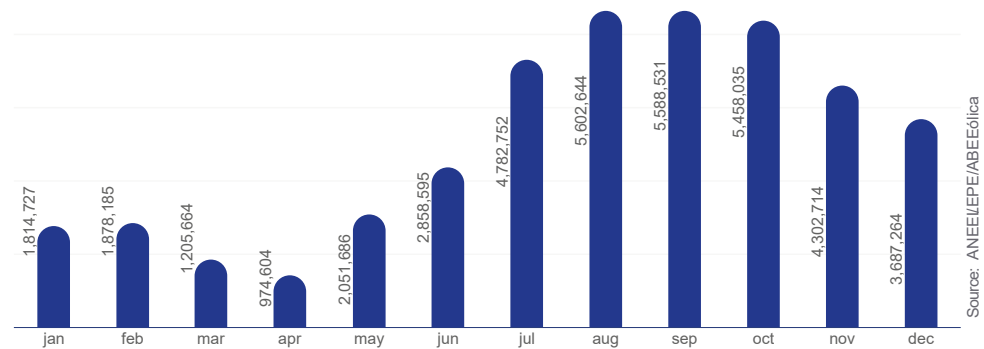


WIND POWER CONTRIBUTION TO REDUCE CO₂ EMISSIONS

In addition to being a source with reduced impact throughout its implementation, wind power produces no CO₂ emissions during operation, thus replacing other sources of energy generation that do emit CO₂ emissions. The graph on the right shows the amount of CO₂ emissions avoided by wind power each month. A total of

30.03 million tons of CO₂ was avoided in 2024, equivalent to the emissions of around 27.6 million passenger cars. For comparative purposes, it is worth noting that the city of São Paulo has a fleet of around 10 million passenger cars.

CO₂ emissions avoided per month (Tons)



Source: ANEEL/EPE/ABEEólica

SOCIAL AND ENVIRONMENTAL CONTRIBUTION OF WIND POWER

Benefits of Wind Energy



Wind energy generates income and improves the lives of landowners with leases for the implementation of the towers.



One of the most cost-effective energy tariffs.



Wind farms do not emit CO₂ during their.



It allows the land owner to continue planting crops or raising animals.

It is renewable, does not pollute, and contributes to Brazil meeting its targets under the Climate Agreement.



Training of local labor.



The installation of wind farms contributes to increasing the municipality's Gross Domestic Product (GDP) and Human Development Index (HDI), according to a study by GO Associados. A comparison was made between a group of municipalities that received wind farms and others that did not. Based on this comparison, we identified that in the municipalities that received the installation of wind farms:



Actual GDP increased 21.15% (period from 1999 to 2017).



MHDI grew around 20% (from 2000 to 2010).

Wind energy takes up little land, allowing people to continue raising animals or planting crops. Considering the area allocated to a wind farm, the turbines take up around 8% of the area, and this figure can be even lower, reaching around 6%.

Another study, prepared by economist Braúlio Borges, associate researcher at FGV-IBRE and senior economist at LCA Consultores, showed the importance of wind power for generating jobs and investments:

Between **2011 and 2020**
wind farms

had an impact of

R\$ 321 billion

in the economy

R\$ 110.5 billion

Of direct investments in the construction of wind farms and

R\$ 210.5 billion
as indirect effects.

Each **R\$1.00**

invested in wind farms increased Brazilian GDP by around

R\$ 2.90.

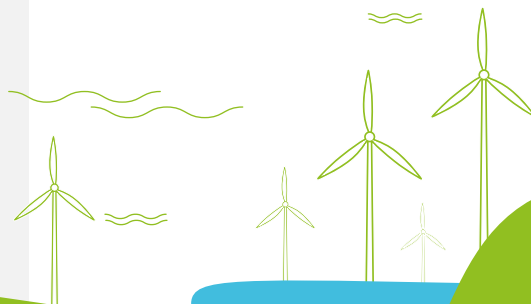
And there are also environmental benefits. From **2016 to 2024** Brazilian wind sector will have avoided greenhouse gas emissions worth between **R\$ 60 and 70 billion**

From **2011 to 2020**
the construction of wind farms created almost

196 thousand

jobs or

10.7 Jobs per
MW generated



In addition to the benefits highlighted throughout this document across various indicators, wind power have an important positive impact on the communities in where it operates operate due to the implementation of social, cultural, health and environmental projects aimed at supporting local development. Examples of projects implemented by companies are, among others:



Actions that promote water security, enabling access to water for production and human consumption, reaching isolated populations.



Actions to encourage the practice of sport combined with school support.



Digital inclusion actions, with training for young people and adults, encouraging employability and entrepreneurship.



Promotion of regional tourism, art, gastronomy and culture through festivals, courses, training and competitions.



Strengthening and expanding production chains such as coconut, cassava, corn, beans, honey, milk, among others, with the aim of improving the population's income and promoting sustainable development.



Encouraging the production of local.



Health promotion projects, with actions for oral health and nutrition, for example.



Educational projects with nurseries and schools, through initiatives aimed at increasing the student life of public school pupils, using citizenship actions, training educators and improving the school environment, and promoting discussions on sustainable development and renewable energies.

RENEWABLE ENERGY CERTIFICATION PROGRAM

Launched in Brazil seven years ago, the Renewable Energy Certification Program has recorded consistent growth numbers in recent years. Renewable Energy Certification Program "REC Brazil" is a joint initiative of the Associação Brasileira de Energia Eólica e Novas Tecnologias (Brazilian Association of Wind Energy and New Technologies - ABEEólica) and Associação Brasileira de Geração de Energia Limpa (Brazilian Association of Clean Energy Generation - Abragel), with support from the Electric Energy Trading Chamber (CCEE), Associação Brasileira dos Comercializadores de Energia (Brazilian Association of Energy Traders - ABRACEEL) and Associação Brasileira do Biogás e do Biometano (Brazilian Association of Biogas and Biomethane - ABIOGÁS), and aims to promote the market for energy generated from renewable sources and with high performance in terms of sustainability.

The program was prepared in 2011 by a technical group appointed by ABRagel and ABEEólica, involving several specialists with experience in the areas of energy, sustainability, market and certification, who were responsible for defining the concepts involved for sustainable projects.

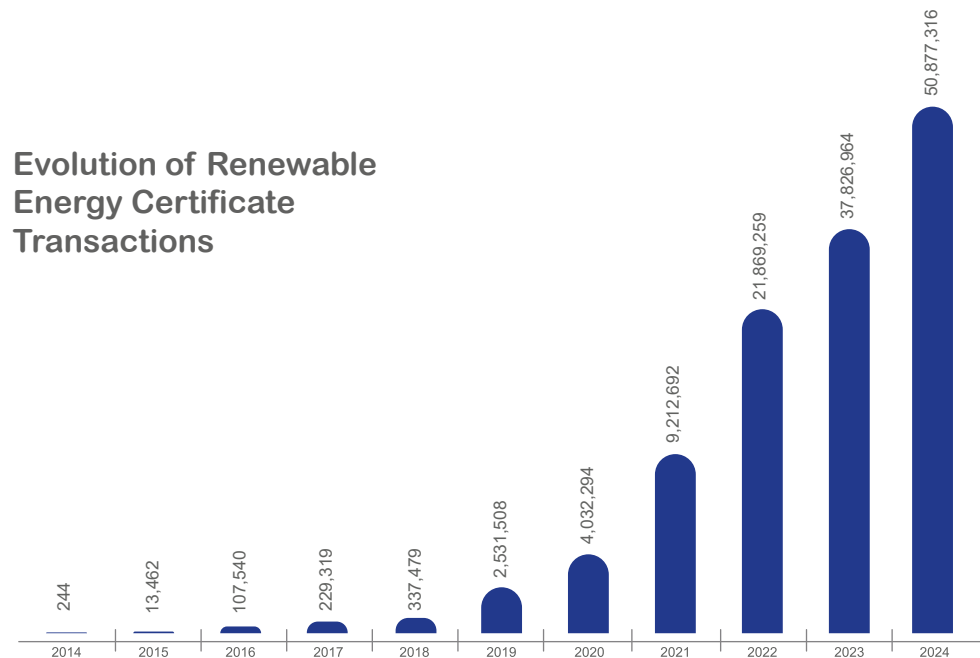
Within the program, Totum Institute certifies renewable energy generators according to I-REC standards. Generators that meet additional sustainability criteria receive the REC Brazil seal. The Totum Institute is also responsible for issuing this seal.

2024 brought positive developments for Renewable Energy Certificates: I-RECs market is expanding, Brazil is standing out globally and the future prospects are highly promising. The number of Brazilian power plants with Renewable Energy Certificates is steadily increasing. At the end of 2023, 581 plants were registered and we ended 2024 with 660 plants. This means that Brazil is now the leader on the I-REC platform, the International REC Standard (I-REC), a global system for trading renewable energy certificates, in terms of registered plants. Another way to assess the year is by examining the number of certificates issued.

In 2023, 37,8 million certificates were issued. In 2024, this figure reached 50.9 million. As for the wind power, it accounted for around 25% of all I-RECs issued in Brazil.



Evolution of Renewable Energy Certificate Transactions

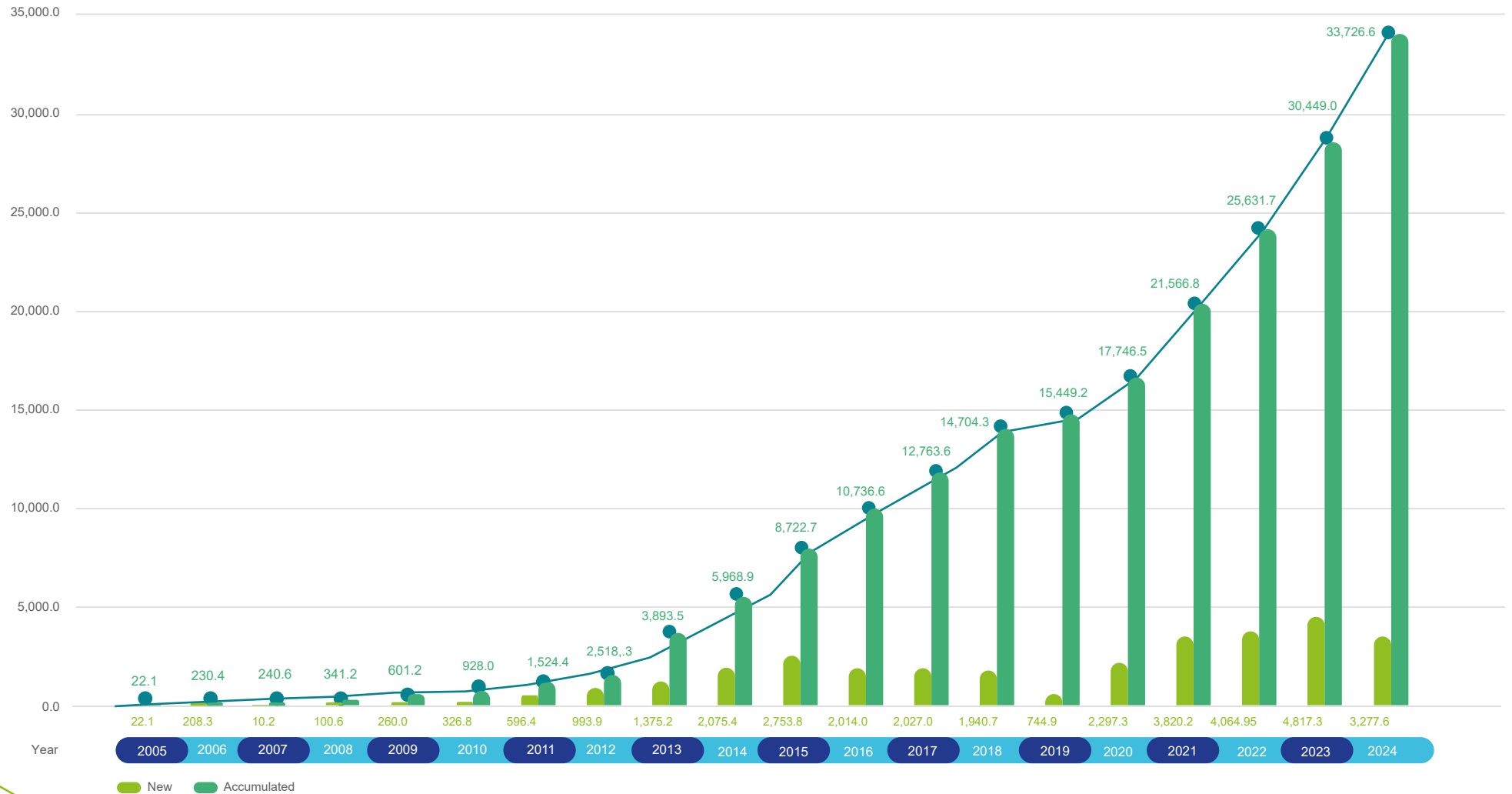


Source: Instituto Totum

EVOLUTION OF WIND SOURCE INSTALLED CAPACITY

The evolution of installed capacity and the growth of wind power as a result of contracts already signed in regulated auctions and on the free market are shown in the graph below.

Evolution of Installed Capacity (MW)



Source: ANEEL/ABEEólica

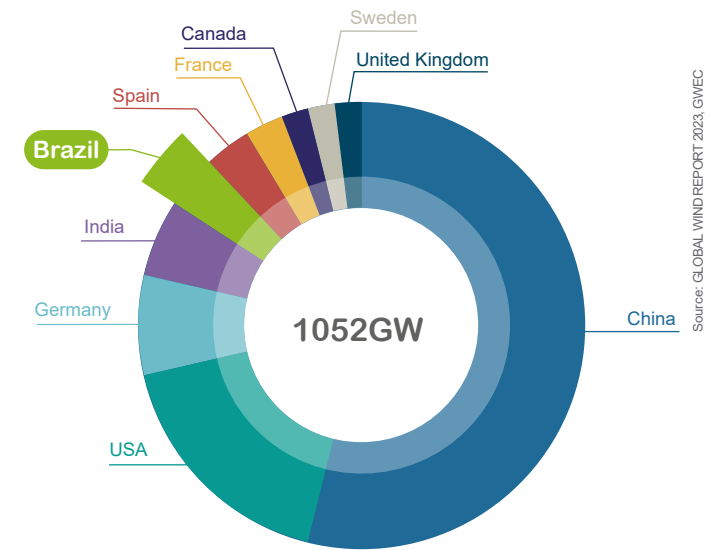
GLOBAL DATA

Brazil has climbed one position and reached 5th place in the Ranking of Total Installed Capacity of Onshore Wind Energy in 2024.

Considering only new installations, the country also ranked 5th in 2024 with 3.27 GW of added capacity, dropping two positions from 2023 - behind India (3.4 GW) and Germany (3.29 GW).

Total Onshore Installed Capacity Ranking

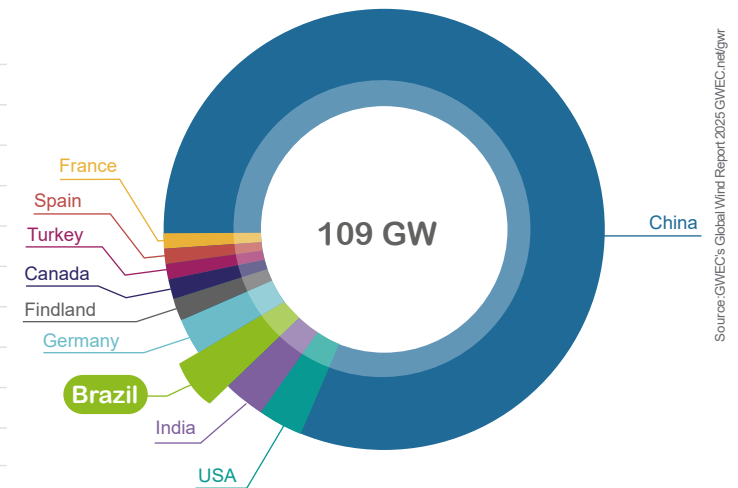
POSITION	COUNTRY	Total onshore installed capacity (GW)
1	China	478.8
2	USA	154.1
3	Germany	63.7
4	India	48.2
5	Brazil	33.7
6	Spain	31.3
7	France	23.1
8	Canada	18.3
9	Sweden	17.2
10	United Kingdom	15.6



Source: GLOBAL WIND REPORT 2023, GWEC

New installed capacity 2024

POSITION	COUNTRY	New onshore capacity installed in the year
1	China	75.8
2	Others	12
3	USA	3.9
4	India	3.4
5	Brazil	3.3
6	Germany	3.3
7	Finland	1.4
8	Canada	1.4
9	Turkey	1.3
10	Spain	1.2
11	France	1.1



Source: GWEC's Global Wind Report 2025, GWEC.net/gwr

INVESTMENT IN WIND SECTOR

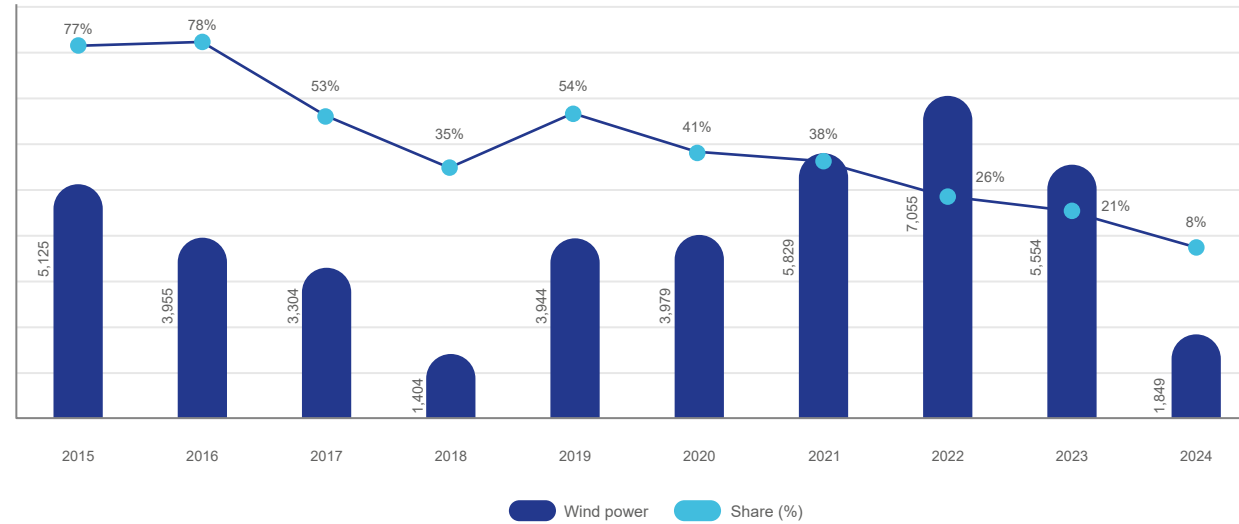
2024 ended with US\$ 1.8 billion (R\$ 10.1 billion) invested in the wind sector, representing 8% of the investments made in renewables (solar, wind, biofuels, biomass and waste, SHPPs and others) in Brazil.

Considering the period from 2015 to 2024, the total investment in the wind sector are around US\$ 42 billion.

The graph on the right shows investment data and the share of wind power in total renewable energy investments since 2015, based on calculations by BNEF, which also provides data analysis.

*exchange rate 1 US\$ is equal to R\$ 5.47

Investments in new projects in the Wind sector (In US\$ million)*





CLOSING REMARKS

As we have seen in this report, 2024 was indeed a year of struggles, achievements, reassessments of processes and, why not, satisfactory results despite the crisis. Looking at Brazil, we have seen that the country has embraced the energy transition agenda, recognizing its capacity to lead this issue. We will be hosting COP-30 and renewable energies are Brazil's showcase to the world.

We will keep on with the goal of turning our studies and analyses into concrete action, and we will move forward with the regulation of laws that have come off the drawing board, such as the auction process for offshore wind farm area allocation and the hydrogen law. We will start the upturn with a lot of work and a strong sense of responsibility towards climate change.

We worked hard in 2024 and everything indicates that we will work even harder in 2025. We haven't come out of the wind crisis, but it will be a new angle, a new look with a new perspective.

Elbia Gannoum
Chief Executive Officer
ABEEólica – Associação Brasileira de Energia Eólica e Novas
Tecnologias



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ABOUT ABEEÓLICA


Founded in 2002, ABEEólica – Associação Brasileira de Energia Eólica e Novas Tecnologias (Brazilian Wind Energy and New Technologies Association) is a nonprofit institution that brings together and represents the wind energy industry in the country. Representing companies belonging to the production chain of the wind power industry, ABEEólica has been an effective contributor, since its foundation, to the development and recognition of wind energy as a clean, renewable, low environmental impact, competitive and strategic source for the national energy matrix.

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Find out about the benefits of being a member and read the ABEEólica bylaws in the "Join" menu on the website or send an e-mail to: patricia@abeeolica.org.br

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