

annual wind energy report 2022



ONSHORE OFFSHORE

ABEEólica

BRAZILIAN ASSOCIATION OF WIND POWER AND NEW TECHNOLOGIES

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MESSAGE FROM THE CEO



Wind energy closed the year of 2022 with 904 powerplants and 25.63GW of wind power installed capacity, which represented a growth of 18.85% when compared to December 2021, when the installed capacity was 21.57GW.

109 new wind farms were installed in 2022, totaling 4.06GW of new capacity, a record for wind energy in Brazil. We were the third top country in terms of wind powerplant installations in the world, according to GWEC (Global Wind Energy Council) data.

In 2022, we generated wind power sufficient to supply, on average, 41.5 million domiciles monthly, representing near 124 million inhabitants. For comparison basis, it is worth mentioning that Southeast and South regions have together 120 million inhabitants.

According to BNEF (BloombergNEF), we closed the year with an investment of the wind energy industry amounting to USD 6.20 billion (R\$ 31.86 billion), representing 42% of the investments made in renewable energy (solar, wind, biofuels, biomass and waste, PCH, and others).

2022 was also the year we crossed the 25GW mark in terms of installed capacity, which is an important milestone. Another good news came from new agreements, with the free market being again in charge of most of the new wind power capacity traded over the year.

298MW of the new wind power capacity were contracted in 2022 in two auctions, and we estimate that additional 3GW were traded in the free market, under agreements that keep the production chain investing, operating and generating job positions. It is the fifth

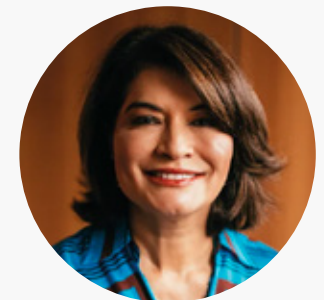
year in a row that wind power executes a greater number of agreements in the free market than in the regulated one.

The year of 2022 was also strongly characterized by discussions on the global warming effects. For the second year in a row, Global Wind Energy Council (GWEC) had a Pavillium at COP, and ABEEólica shared this space, collaborating and attending a full agenda of discussions. I've returned from COP27 with a very clear vision and mission: Brazil holds huge responsibility and representativeness in the energy transition process, and we have the opportunity and task for creating an investment scenario for renewable energy, which will not help Brazil only, but also other countries, to fight against global warming effects. And our 'fair winds' will be one of the most important forces in this process. This is a work that has already started and now has to be intensified. Shown in the next pages is the most important data of the year 2022 for your evaluation. And whenever more recent data of 2023 is required, please refer to our Infovento section, in ABEEólica web site.

Finally, I would like to comment our annual figures in ABEEólica: by the end of 2021, ABEEólica had 100 members. We closed 2022 with 127 members. We considered that a new restructuring was required and created two new areas: ESG and Relationship with Associates. We hired new collaborators, moved to a new office, changed our brand, and

have a new web site. We made all the changes by keeping an eye on a future that tends to require from us even greater dedication to make wind energy grow more and more."

Good reading!



Elbia Gannoum
CEO ABEEólica -
Brazilian Wind Energy and
New Technologies Association

INSTALLED CAPACITY IN BRAZIL, ALL SOURCES

109 new wind farms were installed in 2022, totaling 4.05GW of new capacity, and 10.9MW of re-powered capacity. It was a record year in new wind power installed capacity. It is worth mentioning that, in 2021, we had already broken the record by installing 3.83GW. And now, in 2022, we crossed the 4GW barrier of new installed capacity, by summing the commercial operation and testing powers.

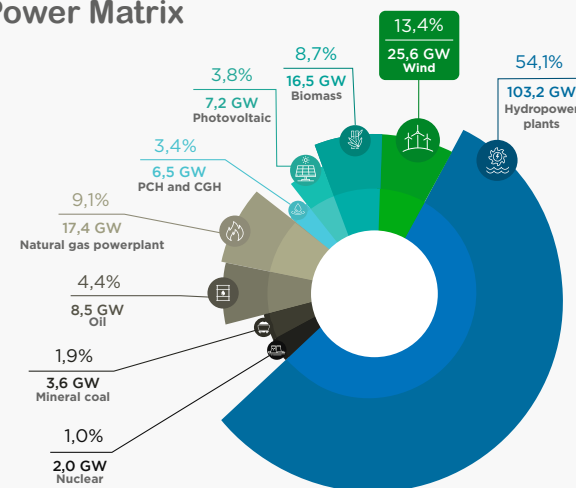
2022 ended with 904 powerplants and 25.63GW of wind power installed capacity, which represented a growth of 18.85% when compared to December 2021, when the installed capacity was 21.56 GW.

New installed capacity (MW) added in 2022, by state

	Power (MW)	Number of wind farms
BA	1.674,06	52
PI	1.086,80	24
RN	963,89	26
PE	164,40	4
PB	93,50	2
CE	71,40	1
Total	4.054,05	109

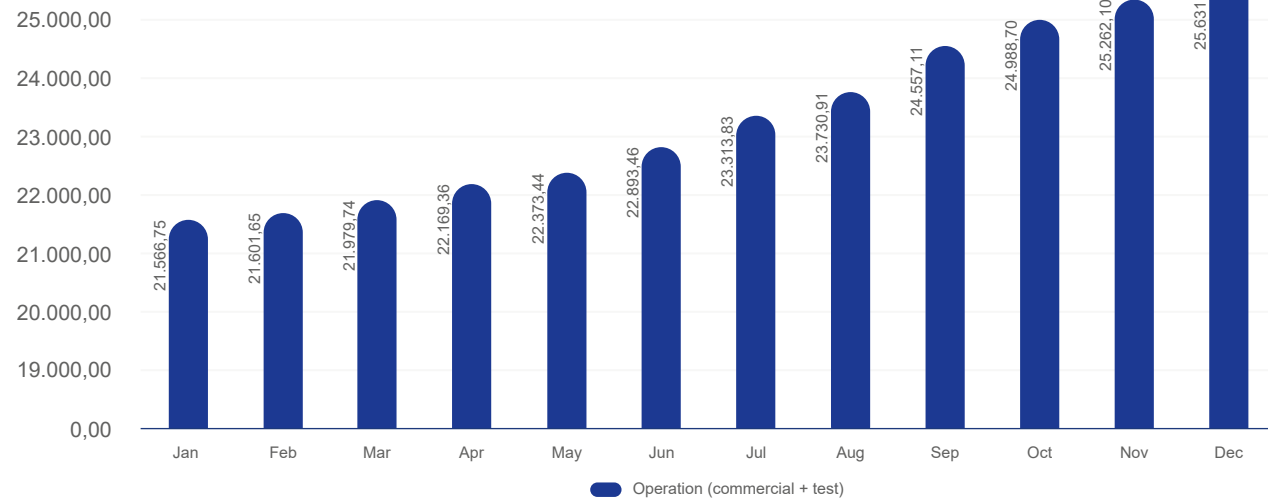
A total of 7.97GW of new power were added to the country's power grid in 2022 with wind energy growing faster than other sources, representing 51.03% of new installed capacity. The new wind power capacity installed in 2022 enabled wind energy to reach 13.4% share of the Brazilian power matrix, as shown in the chart on the side, which depicts the share of all the generation sources in the Brazilian power matrix at end of 2022.

Brazilian Power Matrix



The installed capacity of 25.63GW in December 2022 included 24.12GW of wind farms in commercial operation (94.13%) and 1.50GW of testing operation (5.87%). The chart alongside shows the evolution of the installed capacity over 2022.

Evolution of the installed capacity - 2022 (GW)

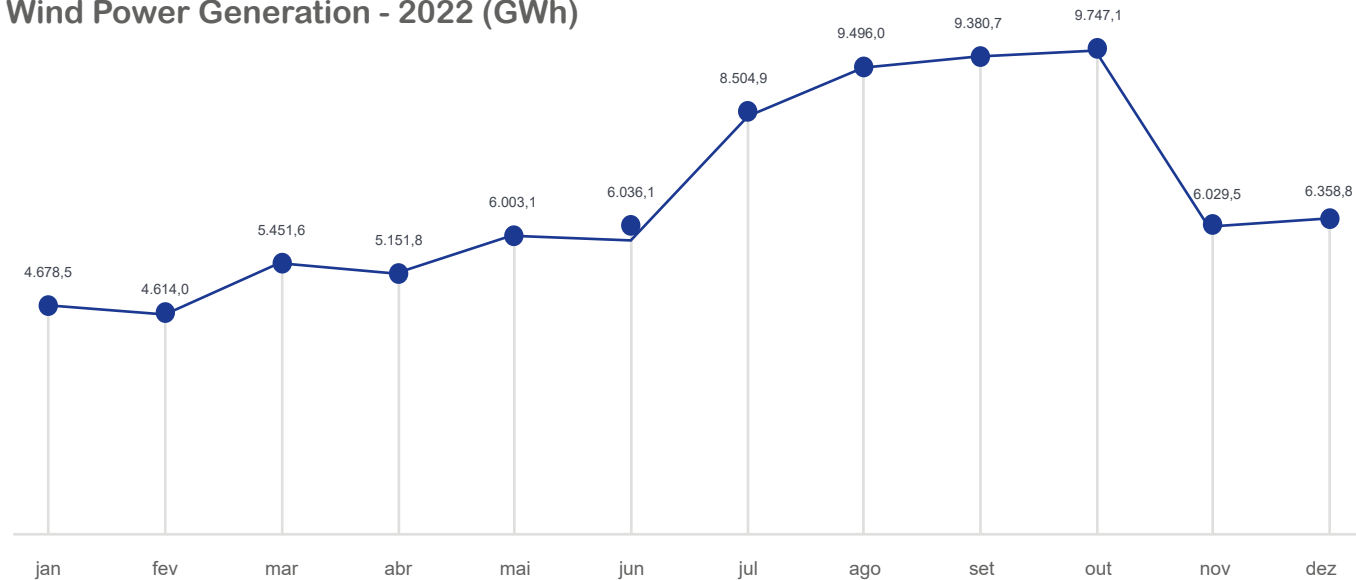


Source: ANEEL/ABEEólica

GENERATION

6.787,7 GWh of wind power was generated in 2022. The total sum amounts to 81.45 TWh of power generated. Shown in the chart on the side is the generation figures of the year.

Wind Power Generation - 2022 (GWh)



Source: CCEE/ABEEólica

1. Considers the value of the wind power generation at plants in testing and commercial operation, at the connection point.



In terms of representativeness and supply, wind power accounted for 13.52%, on average, of the whole generation added to the National Interconnected System - SIN. In the period of fair winds, which occurs in the second half of the year, wind energy representativeness increased and had its peak in September, reaching 19.18% of SIN's generation.

In 2022, wind energy generation broke a number of monthly records in the windier months. Below are the records for the year in each SIN subsystem.

NE 120,51%

of the power consumed in the Northeast subsystem came from wind powerplants, with a capacity factor of 71.18% and generation of 353.33 GWh. (10/11/2022)

S 16,96%

of the power consumed in the South subsystem came from wind powerplants, with a capacity factor of 92.29% and generation of 43.104 GWh. (09/07/2021)

N 6,70%

of the power consumed in the North subsystem came from wind powerplants, with a capacity factor of 96.97% and generation of 9.912 GWh. (09/04/2021)

SIN 24,48%

of the power consumed in SIN came from wind powerplants, with a capacity factor of 69.56% and generation of 385.08 GWh. (10/15/2022)

Source: ONS

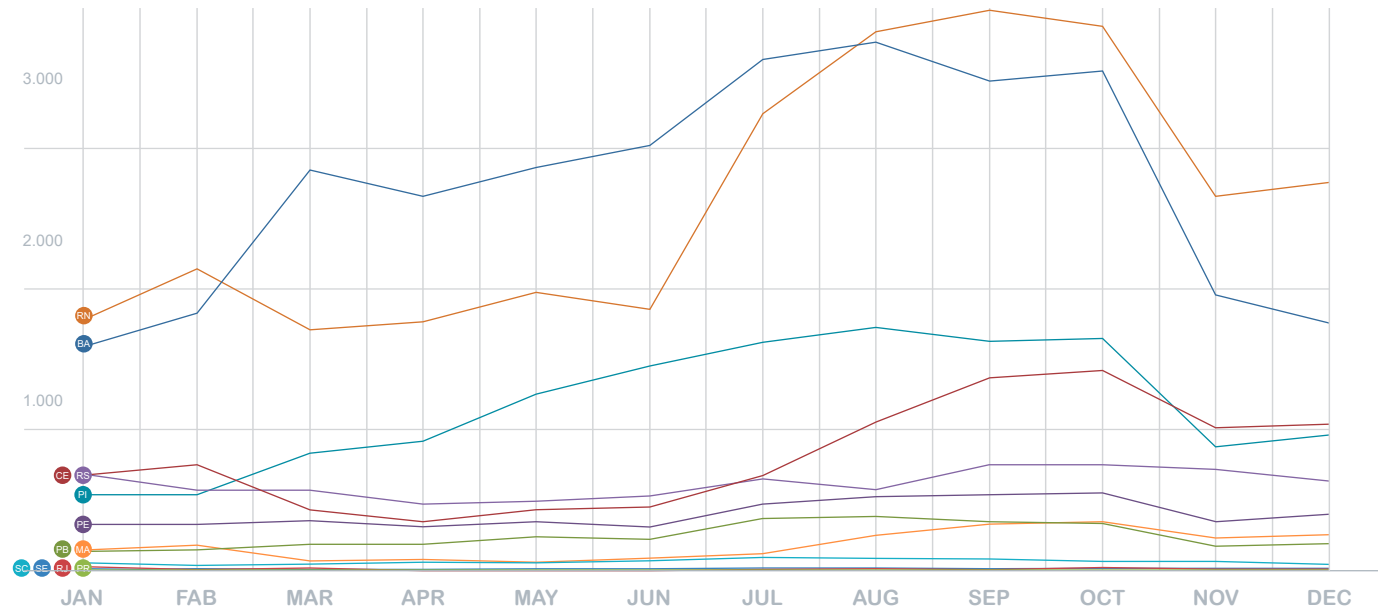
GENERATION AND REPRESENTATIVENESS OF WIND ENERGY

The chart below shows that the Northeast subsystem's wind power capacity is close to the total for the system, accounting for 90.3% in 2022.

Region	2021		2022		% growth
	Generation (TWh)	Share	Generation (TWh)	Share	
Southeast	0,06	0,1%	0,06	0,1%	16%
South	6,20	8,7%	5,95	7,6%	-4%
Northeast	63,20	88,7%	70,48	90,3%	12%
North	1,76	2,5%	1,59	2,0%	-10%
Total	71,22	100%	78,08	100%	9,6%

the2. SIN is comprised by four subsystems: Northeast, North, Southeast/Midwest and South. Their division does not match geographical one. In the case of wind powerplants, the figures shown in the North subsystem refer to the ones located in the state of Maranhão

Generation by State - 2022 (GWh)



REGIO	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
RN	1.367,6	1.450,0	1.267,4	1.288,0	1.486,9	1.343,8	2.442,3	2.838,4	2.839,6	2.897,6	1.909,9	2.072,6
BA	1.233,5	1.228,6	2.111,2	1.922,4	2.102,5	2.163,9	2.703,7	2.793,9	2.510,1	2.641,2	1.427,0	1.328,0
PI	423,0	372,2	613,9	657,8	937,0	1.049,0	1.219,3	1.283,7	1.159,4	1.231,2	625,1	719,3
RS	473,2	394,2	435,4	349,9	367,6	385,9	477,4	438,2	506,8	547,3	518,7	474,1
CE	458,8	500,4	312,0	257,1	324,3	336,1	500,5	789,9	990,6	1.050,7	724,4	815,5
PE	243,5	219,9	266,0	233,2	256,8	223,4	359,4	379,9	379,3	404,6	248,3	298,0
MA	109,1	124,9	56,1	60,0	52,4	67,5	84,3	184,9	242,8	254,8	161,5	187,2
PB	106,3	105,0	141,7	137,6	179,0	166,0	275,6	281,3	247,9	253,8	130,5	147,6
SC	37,9	29,2	41,2	43,6	51,8	55,5	70,2	64,4	60,7	47,5	46,6	36,1
SE	4,0	5,3	3,8	3,7	5,9	6,2	8,7	8,1	5,9	6,8	7,0	6,1
RJ	6,7	4,0	6,6	2,6	3,2	2,8	5,6	6,9	5,7	7,8	6,2	6,7
PR	0,2	0,2	0,2	0,2	0,2	0,1	0,0	0,0	0,0	0,0	0,0	0,0

The five states with the greatest amount of energy from wind in 2022 were Bahia (24.17 TWh), Rio Grande do Norte (23.20 TWh), Piauí (10.29 TWh), Ceará (7.06 TWh) and Rio Grande do Sul (5.37 TWh). The chart below shows the amount of wind power generated.

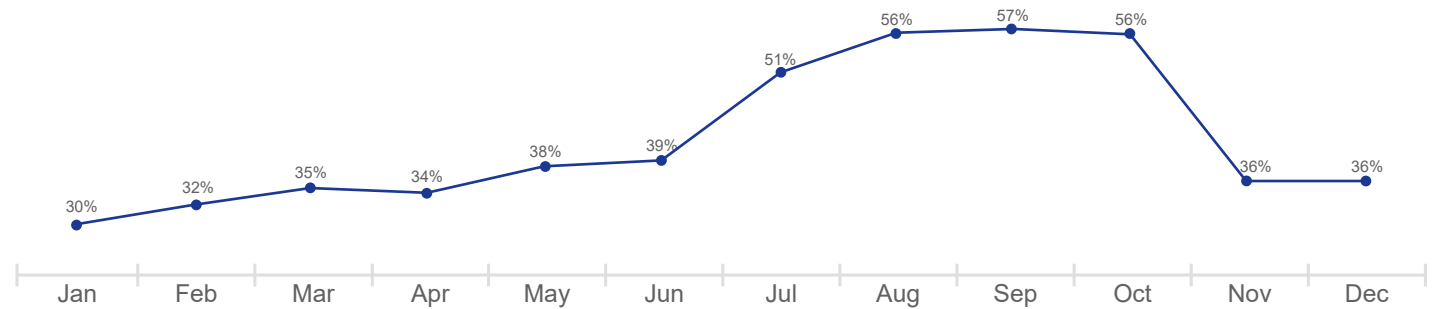
Source: CCIEE/ABEEólica



CAPACITY FACTOR

The capacity factor for wind power is calculated as the ratio of the plant's actual generation to its total capacity over the same period. The average in 2022 was 41.5%, peaking in September at 56.5%.

CAPACITY FACTOR - 2022

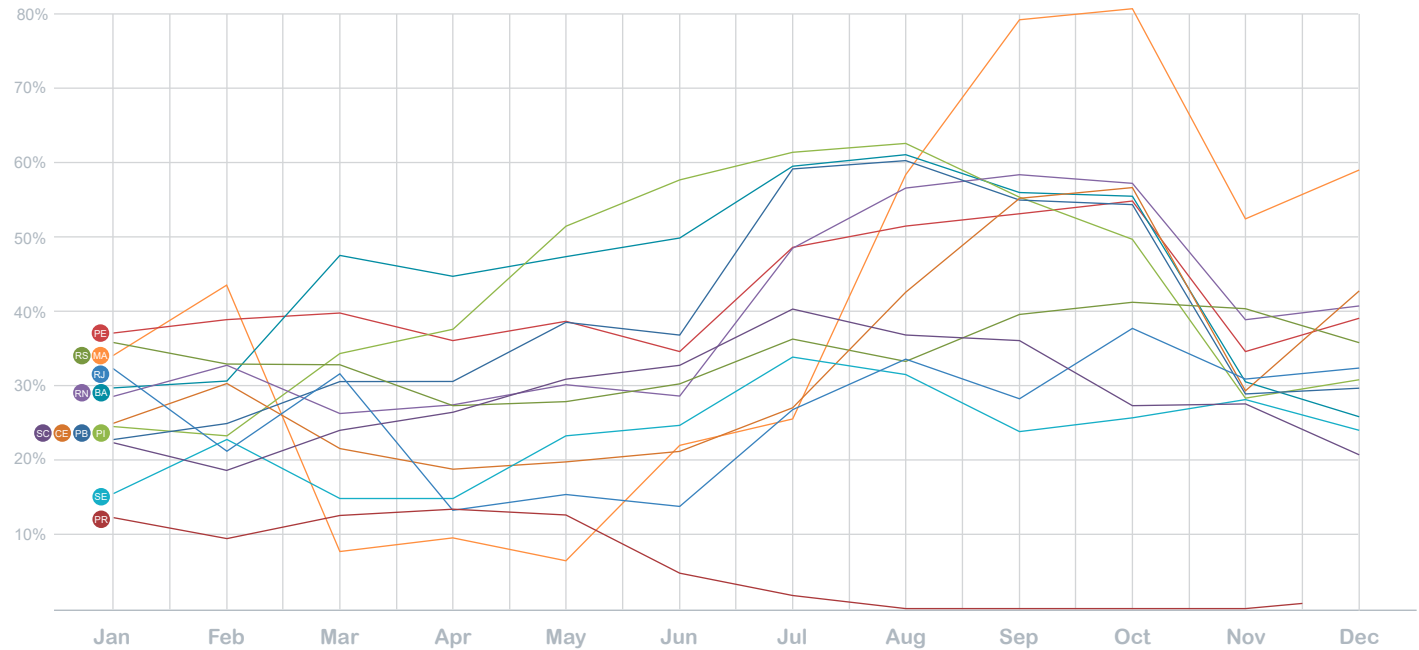


Source: ANEEL/CCEE/ABEEólica



The five states with the largest average capacity factor in 2022 were Bahia (44.9%), Piauí (43.1%), Maranhão (42.5%), Pernambuco (42.3%) ad Rio Grande do Norte (39.4%). Shown in the chart below are the capacity factors for each Brazilian state:

Capacity Factor by State - 2022 (%)



REGIO	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
MA	34,4%	43,6%	17,7%	19,6%	16,5%	22,0%	26,6%	58,3%	79,2%	80,4%	52,6%	59,1%
PE	37,7%	38,9%	39,8%	36,1%	38,5%	34,6%	42,4%	51,6%	53,2%	59,4%	34,8%	39,1%
BA	29,8%	31,4%	47,5%	44,8%	47,2%	49,9%	59,4%	61,1%	56,0%	55,4%	30,4%	25,8%
PI	24,4%	23,3%	34,2%	37,4%	51,6%	57,8%	61,4%	62,8%	55,3%	49,7%	28,3%	30,9%
RN	28,4%	32,7%	26,2%	27,3%	30,4%	28,5%	48,5%	56,4%	58,3%	57,2%	38,7%	40,7%
PB	22,8%	24,9%	30,4%	30,5%	38,4%	36,8%	59,1%	60,3%	55,0%	54,4%	28,9%	29,6%
RS	35,7%	32,9%	32,8%	27,3%	27,8%	30,1%	36,1%	33,1%	39,5%	41,3%	40,4%	35,8%
CE	25,0%	30,2%	21,6%	18,8%	19,6%	21,1%	27,0%	42,6%	55,3%	56,7%	39,2%	42,8%
SE	15,4%	22,7%	14,9%	14,9%	23,1%	24,9%	33,9%	31,6%	23,9%	26,6%	28,1%	24,0%
RJ	32,2%	21,2%	31,5%	13,1%	15,2%	13,7%	26,9%	33,3%	28,2%	37,6%	30,9%	32,3%
PR	12,3%	9,5%	12,4%	13,3%	12,7%	5,9%	1,8%	0,0%	0,0%	0,0%	0,0%	0,7%
SC	22,3%	18,5%	24,0%	26,2%	30,8%	32,8%	40,1%	36,8%	35,9%	27,2%	27,5%	20,7%

Considers the value of the wind power generation at plants in commercial operation, at the gravity center.
 Considers the value of the wind power generation and the installed capacity at plants in commercial operation, at the connection point.

WIND POWER CONTRIBUTION TO RESIDENTIAL SUPPLY

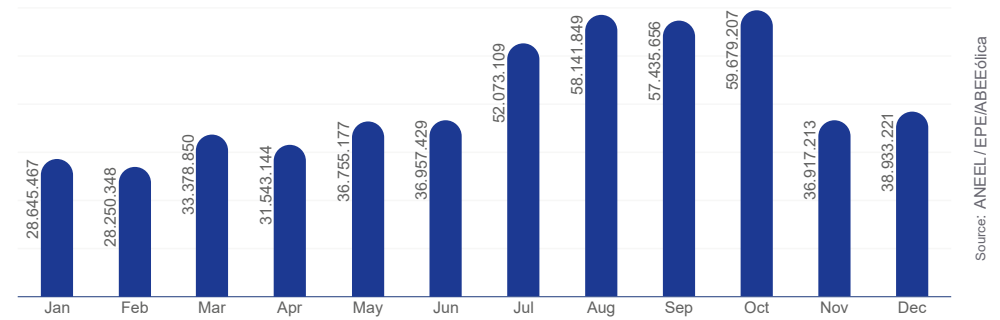
Wind energy can also be represented as generation compared to average home use of electric energy in Brazil. According to the monthly review published by EPE (Empresa de Pesquisa Energética), average residential consumption in Brazil was 163kWh per month in 2022.

Therefore, average wind power generation in 2022, (see Generation) is equivalent to the average power consumed by 41.5 million households,

representing near 124 million inhabitants. For comparison basis, the Southeast and South regions have together 120 million inhabitants.

Shown in the chart on the side is the number of households supplied by wind power generation in 2022.

Number of households powered by wind in 2022

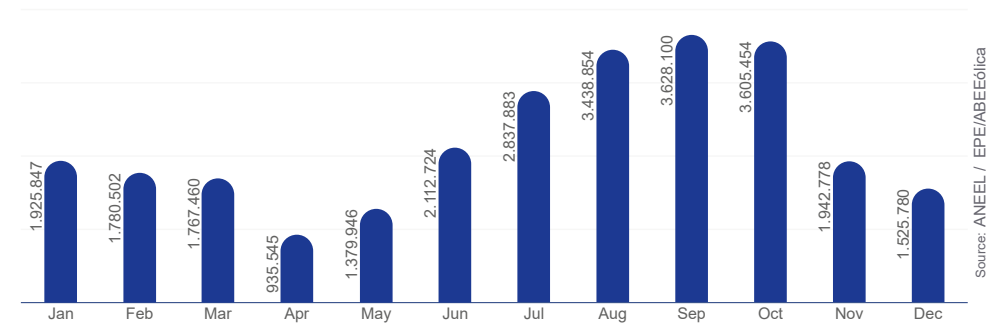


WIND POWER CONTRIBUTION FOR CO₂ EMISSIONS REDUCTION

In addition to be a source with reduced impact during its deployment, wind energy does not emit CO₂ in its operation, thus replacing other CO₂ emitting sources. Shown in the chart on the side is the amount of CO₂ emissions avoided by wind energy per month. Total emissions avoided in 2022

amounted to 26.88 million tons of CO₂, equivalent to the annual emission of near 22 million automobiles. For comparison, the city of São Paulo has a fleet of approximately 10.2 million automobiles.

Avoided CO₂ emissions per month (million tons)



Tons of CO₂ eliminated in 2022: 26.88 million.

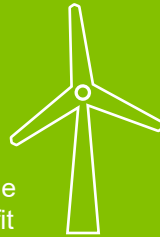
We consider a mean figure of three inhabitants per domicile. IBGE data – Estimated population in domiciles in Brazil and in the Brazilian states with reference date on July 1, 2021.

SOCIAL-ENVIRONMENTAL CONTRIBUTION OF WIND ENERGY

Wind Power Benefits



Generates income and improves the quality of life for landowners who lease their land for wind tower placement.



Offers one of the best cost-benefit in terms of energy prices.



Wind farms do not emit CO₂ in their operations.



Enables the landowner to proceed with agricultural or livestock activities.

It is renewable, does not pollute, contributes for Brazil to achieve its objectives in the UN Framework Convention on Climate Change.



Local labor qualification.



The installation of wind farms contributes to increase the Gross Domestic Product (GDP) and the Human Development Index (HDI) of the Municipality, according to study by GO Associates. A group of cities with wind farms was compared to a group of cities without. This is what the cities with wind farms experienced:



Real GDP increased by 21.15% (1999 to 2017).



HDI grew by near 20% (2000 to 2010).

Wind power requires small land areas, enabling the farmers to continue agricultural and livestock activities. Turbines occupy near 8% of the area, and this value may decrease even more, reaching near 6%.

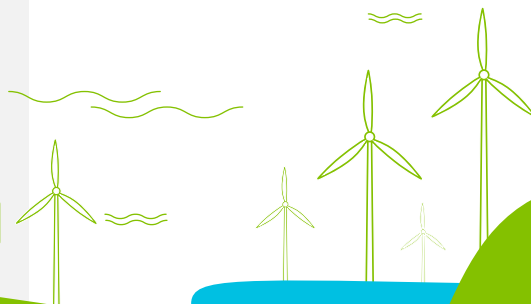
Another study, prepared by the economist Bráulio Borges, associate researcher at FGV-IBRE and senior economist at LCA Consultores, demonstrated the importance of wind power for job generation and investments:

Between
2011 and 2022
wind farms
performed
R\$ 321 billion
transactions in the economy
R\$ 110,5 billion
of direct investments in the
construction of wind farms and
R\$ 210,5 billion
as indirect effects.

Between 2011
and 2020
the construction
of wind farms
created almost
196 thousand
job positions or
10,7
jobs per
MW installed.

Every
R\$ 1,00
invested in wind
farms increased the
Brazilian GDP by near
R\$ 2,90.

And there are also environment
benefits.
2016 a 2024
the Brazilian wind power industry
will have avoided greenhouse gas
emissions valued in
R\$ 60 e 70 billion



In addition to the benefits mentioned throughout this document, wind energy has a major positive impact in the communities where it is deployed due to the conduction of social, cultural, health and environmental projects undertaken for development of the local population. Below are examples of projects performed by companies (among others):



Measures that promote water security and enable access to water for production and human consumption, reaching isolated communities.



Activities to encourage sports, alongside help for schoolwork.



Fostering regional tourism, art, gastronomy, and culture with festivals, courses, training, and contests.



Digital inclusion activities, training youth and adults, and fostering employability and enterprise.



Encouraging local artisans.



Strengthening and expanding local production chains such as coconut, manioc, corn, beans, honey and milk, among others to improve the population's income and promote sustainable development.



Educational projects such as day-care centers and schools, with initiatives to increase the quality of life of students in public schools, with citizenship activities, educator training, and better school environments, promoting discussions on sustainable development and renewable energy.



Health promotion projects including oral health and nutrition, for instance.

RENEWABLE ENERGY CERTIFICATION PROGRAM

Launched in Brazil seven years ago, the Renewable Energy Certification Program has grown consistently ever since. REC Brazil, or the Renewable Energy Certification Program, is a joint initiative of ABEEólica (Brazilian Wind Energy Association) and Abragel (Brazilian Clean Energy Association). It has the support of the CCEE (Electric Energy Trading Chamber), ABRACEEL (Brazilian Energy Traders Association), and ABIOGÁS (Brazilian Biogas and Biomethane Association). The goal is to foster energy generation from renewable sources, and those that have a major impact in terms of sustainability.

The program was created in 2011 by a technical group appointed by Abragel and ABEEólica and comprised of experts with experience in energy, sustainability, market, and certification, who jointly defined the concepts involved in sustainable ventures.

Within this program, the Totum Institute certifies renewable energy generators using the I-REC criteria, and renewable energy generators based on additional sustainability criteria with the additional stamp of approval of RECBrazil. The Totum Institute also issues RECs (Renewable Energy Certificates).

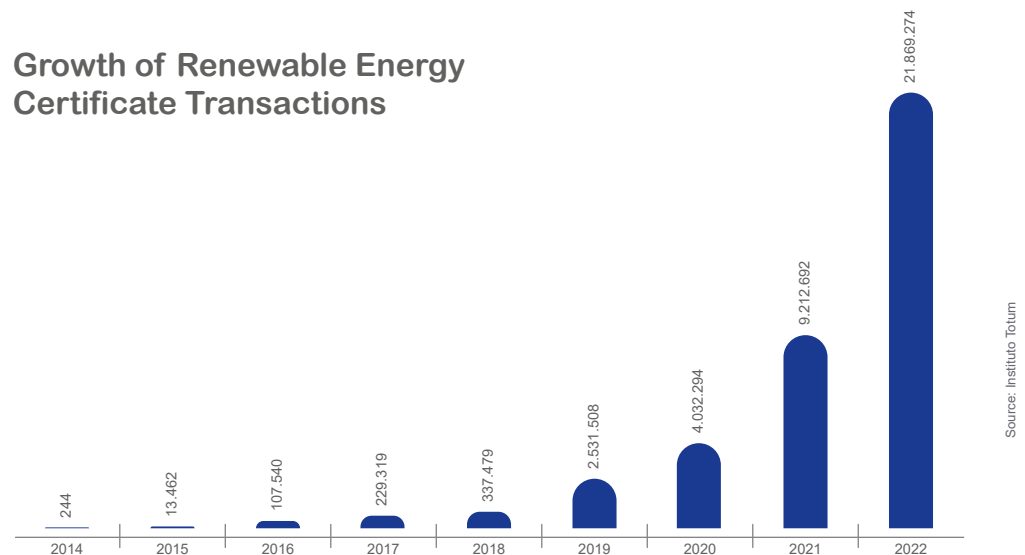
The year 2022 brought good news about Renewable Energy Certificates:

I-REC market is growing, Brazil is assuming outstanding position in the global market, and the future perspectives are the best ones possible. The number of Brazilian powerplants with Renewable Energy Certificates is growing. In the end of 2021, there were 148 powerplants registered, and 2022 ended with 430 powerplants. This places Brazil at the top of the I-RECPlatform. The International REC Standard (I-REC) is a global system that enables registered power plants to trade renewable energy certificates. We can also look at the year based on the number of renewable certificates issued.

In 2021, over 9 million certificates were issued. In 2022, this figure jumped to 21.9 million, making Brazil the world's second-largest market for I-RECs, behind only China. Almost half the I-RECs issued in Brazil were for wind energy.



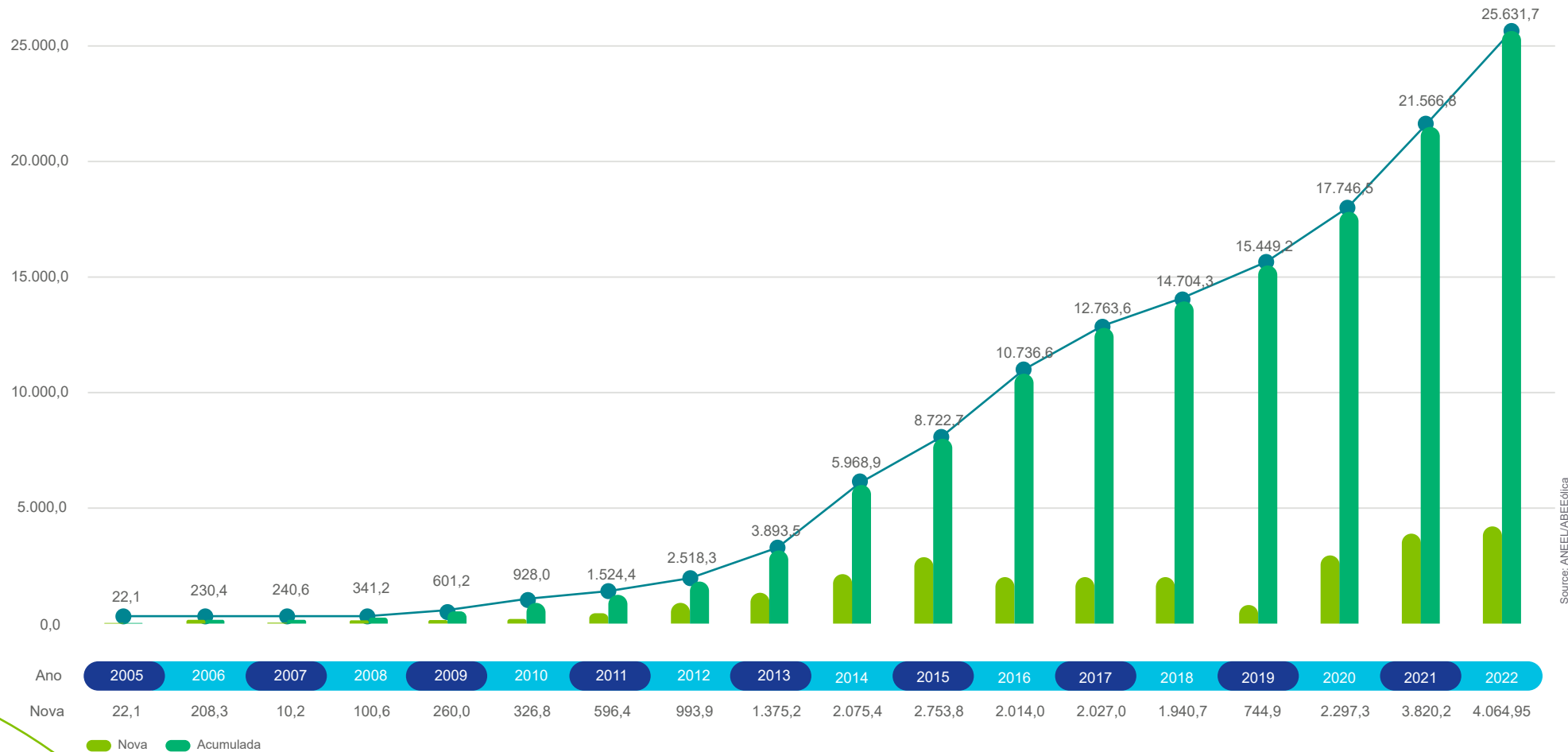
Growth of Renewable Energy Certificate Transactions



EVOLUTION OF WIND POWER INSTALLED CAPACITY

The chart below shows the evolution of the wind energy installed capacity in function of agreements already executed in regulated auctions and in the free market.

Evolution of the installed capacity (MW)



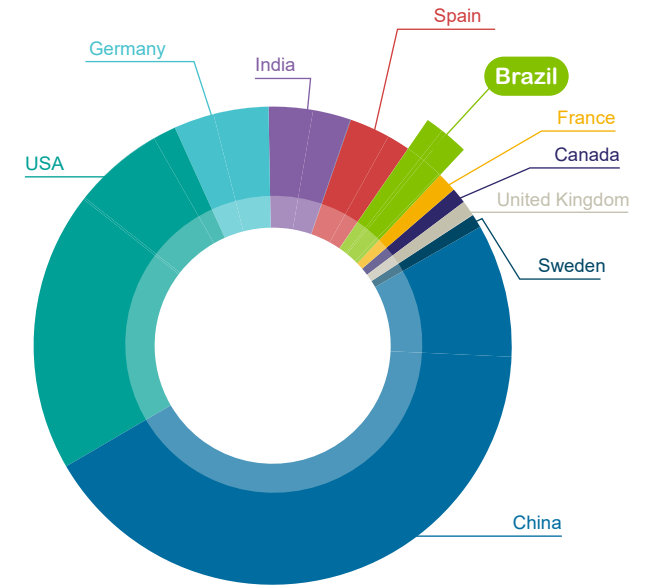
GLOBAL FIGURES

In 2022, Brazil kept its position in the accumulated wind power capacity World Ranking, prepared by GWEC (Global Wind Energy Council).

In the year's new installed capacity list Brazil ranks third, for the third consecutive year.

Top 10 cumulative capacity 2022

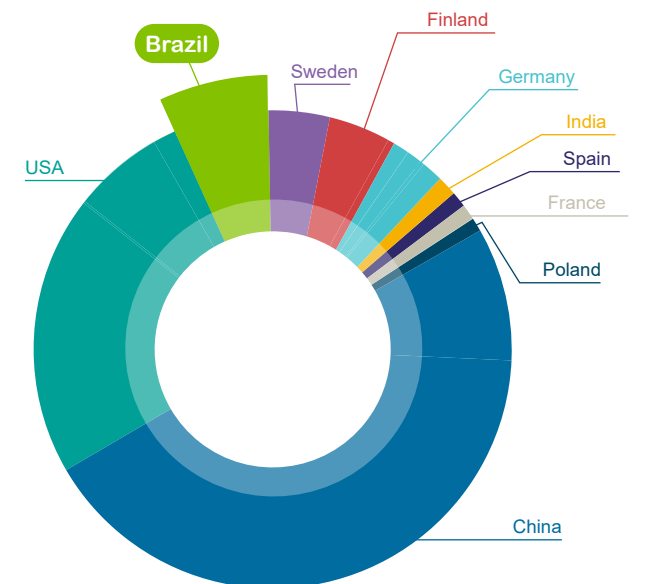
RANKING POSITION	COUNTRY	POWER (GW)
1	China	334,0
2	USA	144,2
3	Germany	59,0
4	India	41,9
5	Spain	29,8
6	Brazil	25,6
7	France	20,7
8	Canada	15,3
9	United Kingdom	14,6
10	Sweden	14,4



Source: GLOBAL WIND REPORT 2022, GWEC

Top 10 new installed capacity 2022

RANKING POSITION	COUNTRY	POWER (GW)
1	China	32,6
2	USA	8,6
3	Brazil	4,1
4	Sweden	2,4
5	Finland	2,4
6	Germany	2,4
7	India	1,8
8	Spain	1,7
9	France	1,6
10	Poland	1,5

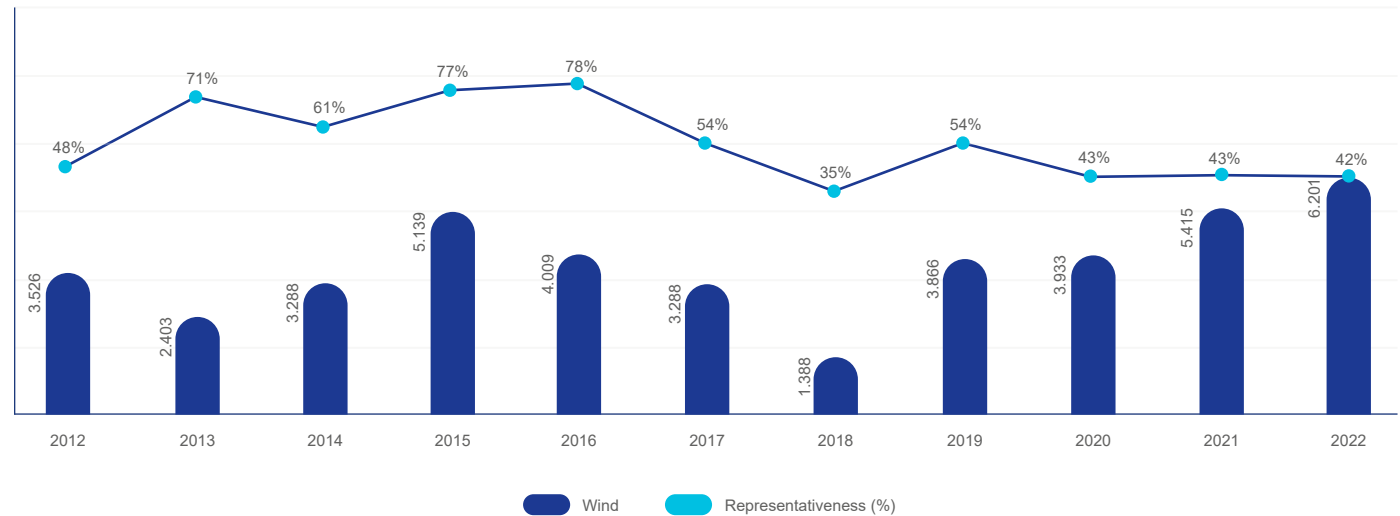


Source: Fonte: GLOBAL WIND REPORT 2022, GWEC

INVESTMENTS IN THE WIND POWER INDUSTRY

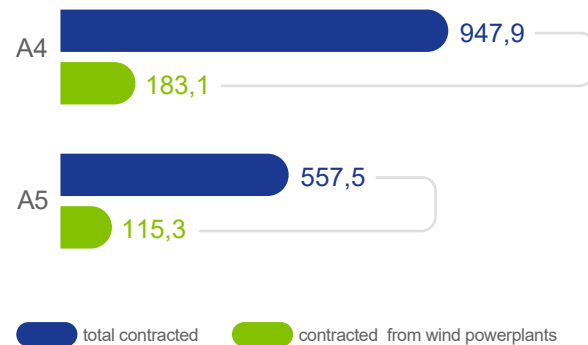
2022 ended with USD 6.2 billion (R\$ 31.85 billion) invested in the wind power industry, representing 42% of the investments made in renewable sources (solar, wind, biofuels, biomass and waste, PCHs and others) in Brazil. By considering the period 2012-2022, the total was around USD 42.46 billion. The chart below shows investments in renewable energy and the amount invested in wind energy since 2012, as calculated by Bloomberg New Energy Finance - BNEF, which also publishes an analysis of this data.

Investments in new wind energy project (US\$ Million)



AUCTIONS

298 MW of installed capacity were contracted in two auctions in 2022. The table shows the total contracted per auction, and how much of this was wind power:



Wind energy had a share of 19.3% in the total contracted in the auction.

Wind energy had a share of 20.7% in the total contracted in the auction.

We also had a good year in the free market. These numbers are not consolidated in any database as these transactions are not necessarily public, however we estimate that in general wind farms sold some 2.5 GW to the free market in 2022. More wind energy was sold in the free market than in the regulated market for the fifth consecutive year.

FINAL CONSIDERATIONS

As presented, 2022 was a year of good results, new installation records, which must be celebrated. However, this celebration should not take much time, as we have big work ahead. Offshore wind, green hydrogen, new technologies and the need for at least quadruplicating the speed of wind power expansion to assisting us in the contention of the global warming effects.

Under the specific perspective of renewable energies, COP27 reaffirmed what we already knew: the path to meet the decarbonization goals passes by the energy transition by sources of low environmental impact. The Russia vs. Ukraine conflict made this scenario even more evident as it added the energy security ingredient. Investing in renewable energies is also a path to provide to countries greater independence of the large coal and oil suppliers.

In addition, the technological innovations make renewable energies more and more competitive. When we look ahead, there is no doubt that it will be made of energy with low environmental impact, but the concern is that the speed of this transformation should be greater. To do that, we must think in structured policies for renewable energies and create proper environment for investments in the industry.

How do I see Brazil in this scenario? First, we must understand that Brazil has a different 'problem': we have an excess supply of renewable energy and a demand with slow growth to absorb the great potential for investment, which the country is able to attract. The search for investments in renewable technologies has brought a gain of scale for emerging technologies, like onshore and offshore wind, and solar energy; and has enabled strong investments in new technologies

such as batteries for large storage and green hydrogen production. It is in this context that Brazil is strongly inserted, by considering the competitiveness and wealth of its renewable resources for power production, which represents 70% of green hydrogen production. Although several questions related to the gain of scale in the storage and transport of this molecule must be cleared, green hydrogen will be soon a form of energy storable and transportable among global economies, enabling its production by countries with wealth of renewable resources, like Brazil.

Thus, we may foresee a scenario of strong demand growth for electric power in Brazil in the next years, with the supply being attended largely by onshore and offshore wind, in addition to solar and other renewable sources.

And how green hydrogen and offshore wind match each other? Although there is not necessarily a cause-effect relation, it is important to consider that the potential for offshore generation is very large and could easily supply green hydrogen production plants for export or internal consumption in a sustainable way, in easier port operations, with very low environmental and social impact. This is a real low-impact energy mine in our hands. And the companies are already aware of this. Green hydrogen "race" has already started with the signing of memorandums of agreement between companies and the government for investments in hydrogen production poles at ports. The future of this marriage is promising and we, by the other side, have much work ahead.

Elbia Gannoum
 CEO
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ABOUT ABEEÓLICA

Founded in 2002, ABEEólica – Brazilian Association of Wind Power and New Technologies is a non-profit institution, which congregates and represents the wind power industry in Brazil. Representing companies belonging to the wind power industry production chain, ABEEólica contributes, since its foundation, in an effective way, for the development and acknowledgment of wing energy as a clean and renewable source, with low environmental impact, competitive and strategic for the composition of the national energy matrix.

JOIN US

Learn of the advantages of being a member and read the association statues on the ABEEólica website at "Join us", or send an e-mail to: patricia@abeeolica.org.br

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