

Green Hydrogen Potential in Brazil

Ricardo Cavalcante

President FIEC and Nordeste Forte Association

April 17th, 2023



Confederação Nacional da Indústria
PELO FUTURO DA INDÚSTRIA



Federação das Indústrias do Estado do Ceará
PELO FUTURO DA INDÚSTRIA



 (85) **4009.6300**

centralderelacionamento@sfiec.org.br



www.sfiec.org.br

WHY BRAZIL?

North
America

Central
America

South
America

Brazil

Europe

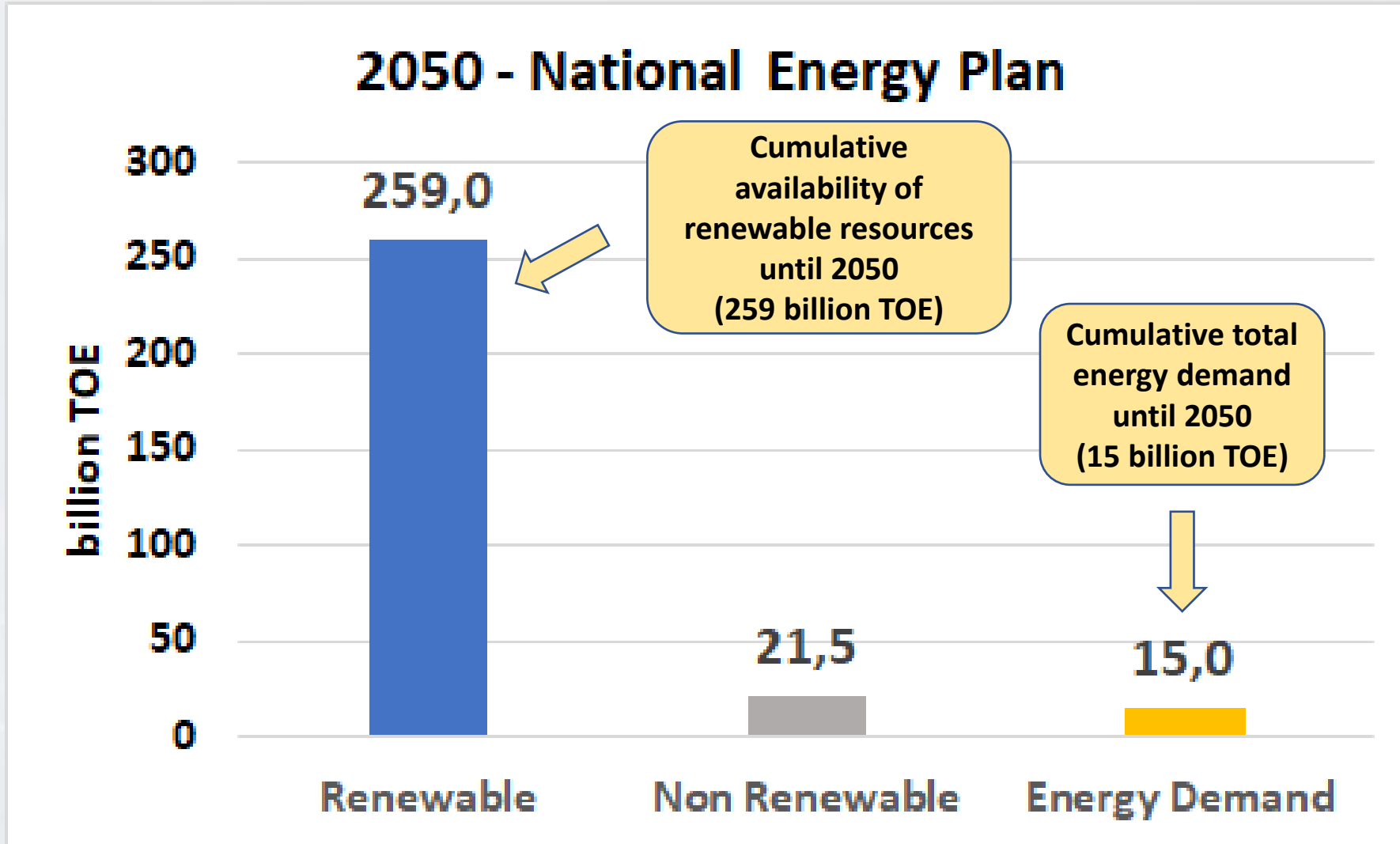
Africa

Brazil – The Cheapest Green H2

HUGE WIND AND SOLAR ENERGY POTENTIAL

- COMPLEMENTARITY WIND + SOLAR
- PRIVILEGED GEOGRAPHICAL LOCATION (DISTANCE BETWEEN BRAZIL AND EUROPE 4,016 NM)
- CLEANEST G20 ELECTRICITY PRODUCTION
- 3RD LARGEST WIND NEW INSTALLED CAPACITY IN 2022
- 4TH IN SOLAR PV CAPACITY
- STABLE ECONOMY

Brazil – Renewable Energy Potential exceeds Demand in 2050

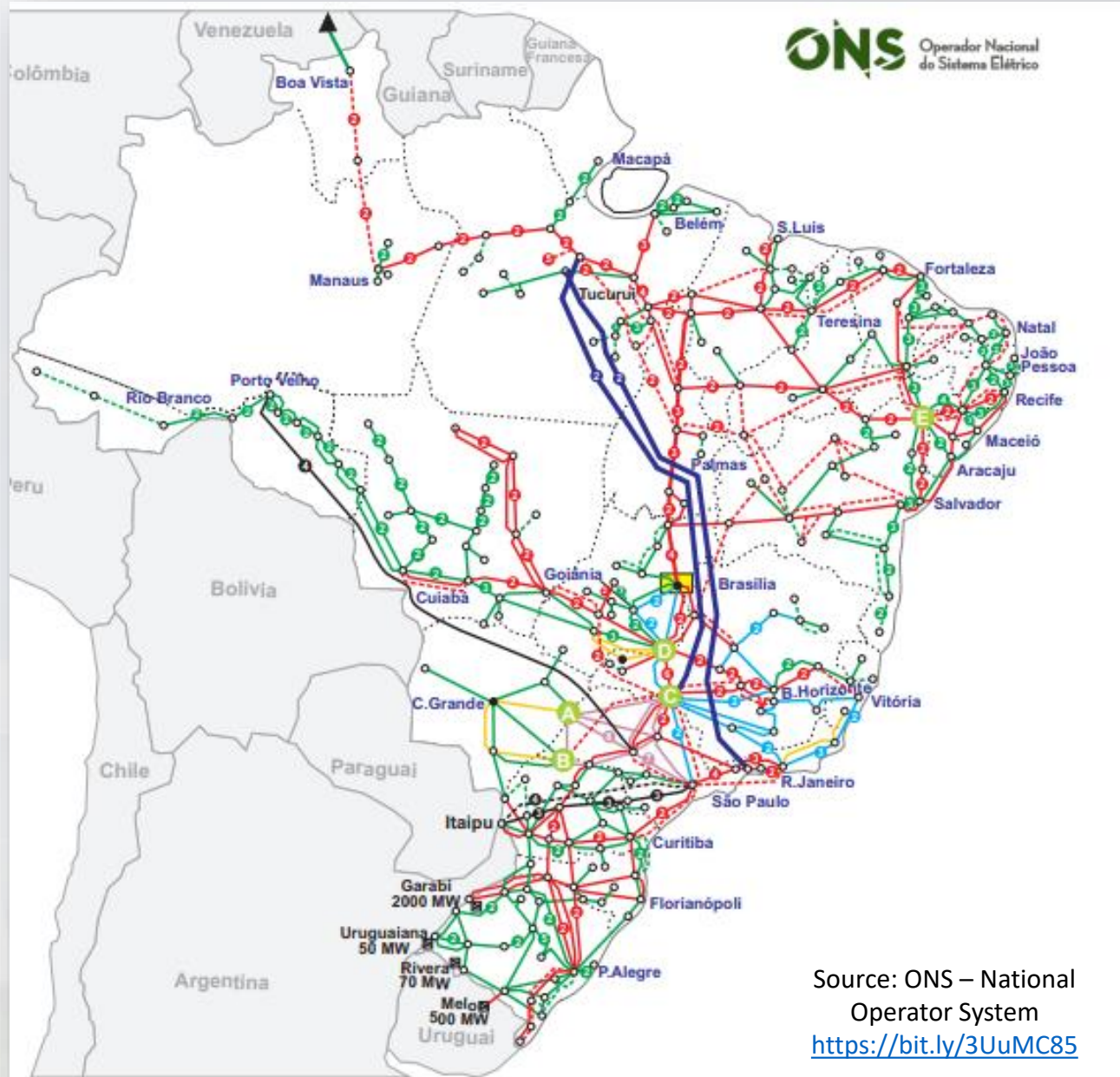


Brazil's Renewable Energy Potential is 17 times greater than its demand until 2050

TOE (Ton of Oil Equivalent)

Source: EPE/MME <https://bit.ly/3Eh2668>

Brazilian Electrical Power Grid (2024)



The Brazilian Electric Grid is Highly Interconnected

179,311 km of High Voltage Transmission Lines

Map Legend

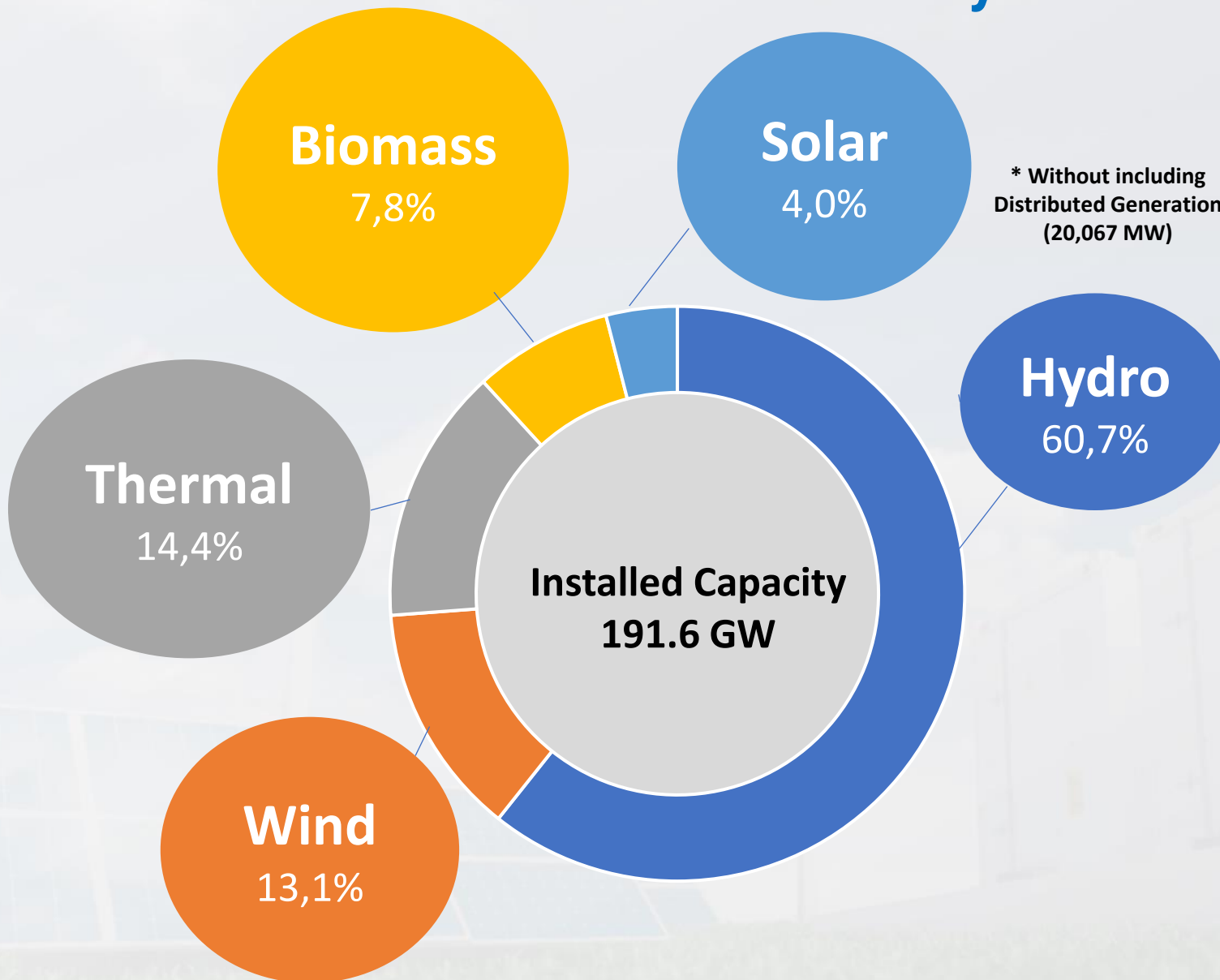
Voltage	In Operation	Planned
138 kV		
230 kV		
345 kV		
440 kV		
500 kV		
750 kV		
± 600 kV cc		
± 800 kV cc		

Source: ONS – National Operator System
<https://bit.ly/3UuMC85>

FIEC

Federação das Indústrias do Estado do Ceará
PELO FUTURO DA INDÚSTRIA

Brazilian Electricity Installed Capacity

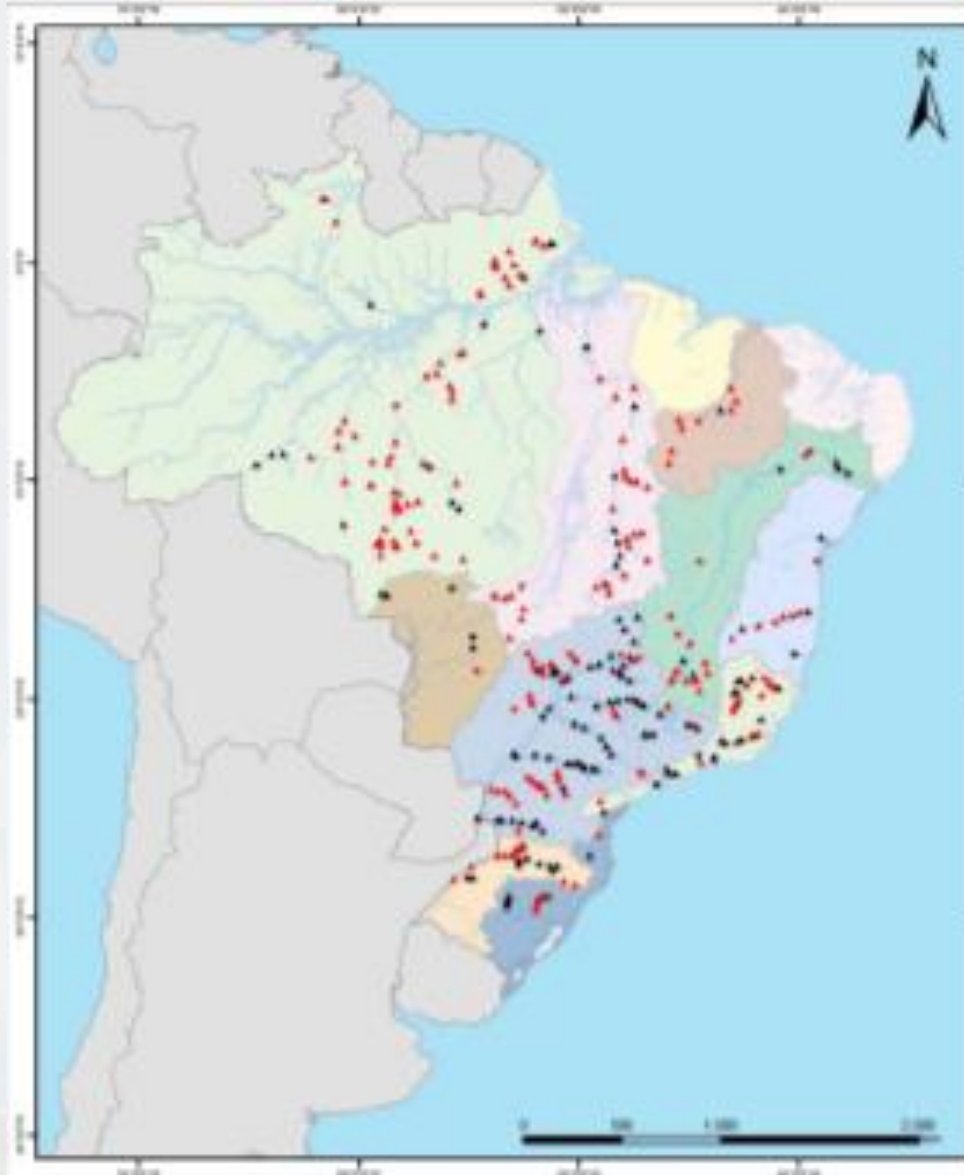


**Brazilian Electricity Matrix:
85,6 % Renewable
(World average 38%)**

**In 2022, Renewable
Energies accounted for
92,0 % of the electricity
produced in the country**

**In 2022, in the Northeast
Region, Renewable
Energies accounted for
97,7 % of the electricity
produced**

Brazil - Hydroelectric Potential



- Total hydroelectric potential: 176GW
- In Operation: 108GW
- Additional Mapped Potential: 68GW

60,7% of Brazil's electricity matrix is hydroelectric

- ▲ Hydroelectric Power Plants in operation or construction
- ▲ Mapped Hydroelectric Power Plants

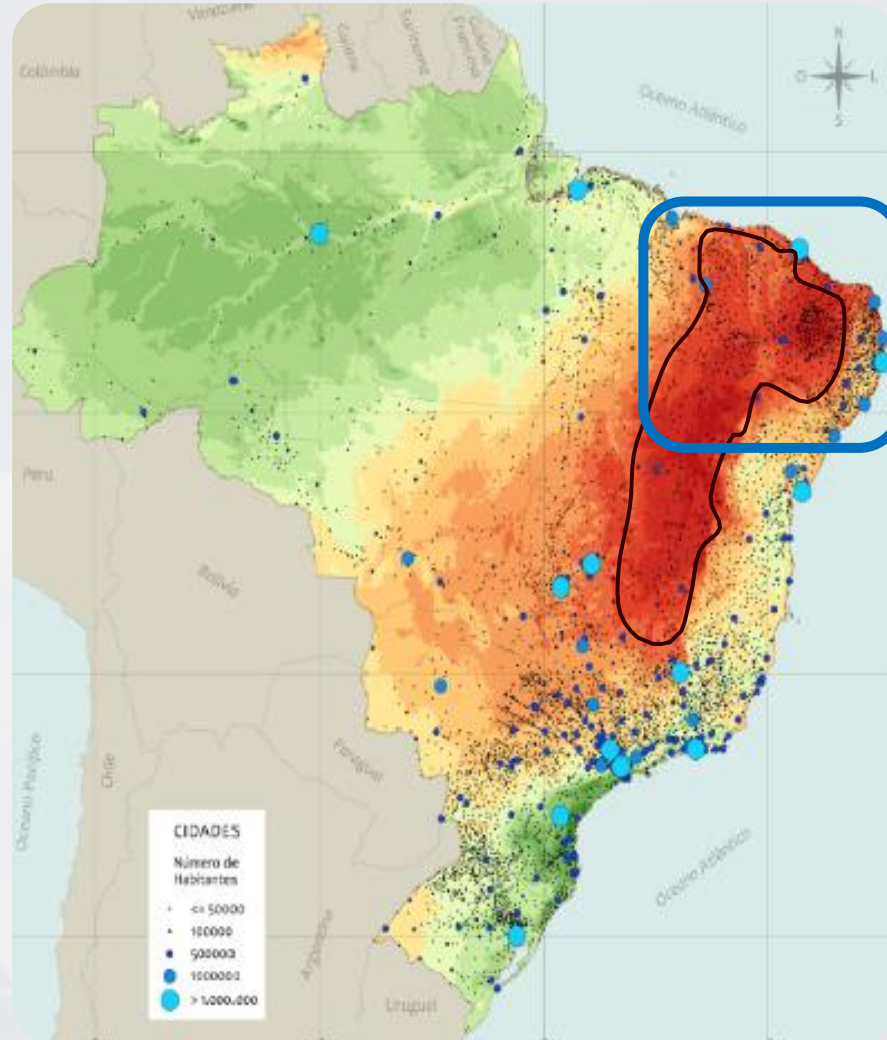
Brazil – Potential for Solar Energy

Potential for Solar Energy

Brazil 28,500 GW
Northeast Region 6,730 GW
(23.6%)



The solar energy potential is equivalent to more than 160 times the current installed capacity of power plants (all sources) for electricity generation in Brazil

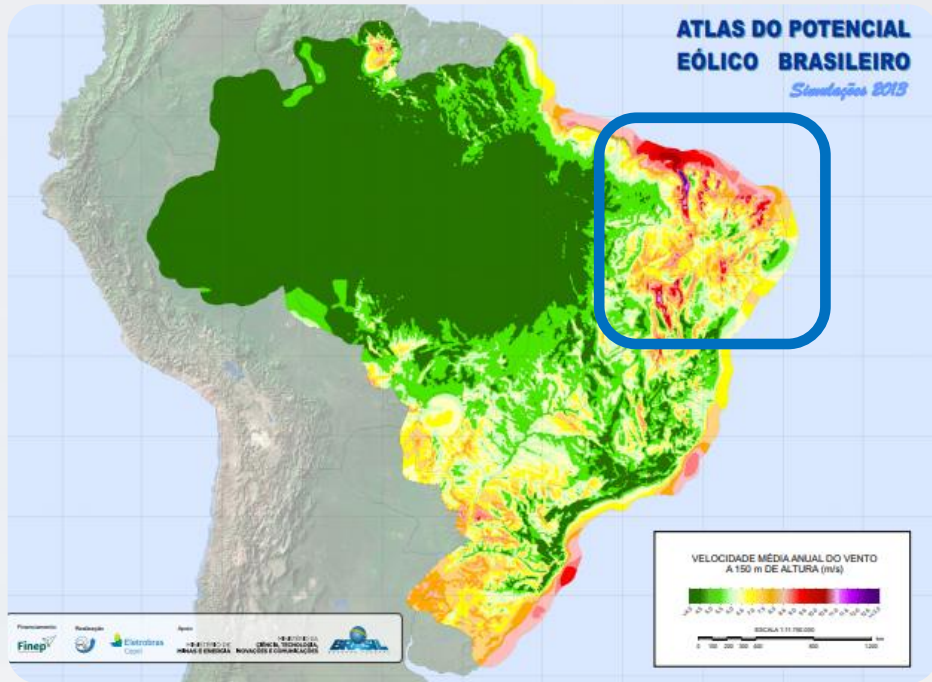


The Brazilian Northeast has an average irradiation of 5.5 kWh/m²/day (almost twice than Europe).

Solar PV installed capacity 28.6 GW (only 0.1% of the potential in the country)

* Including Distributed Generation (20,067 MW)

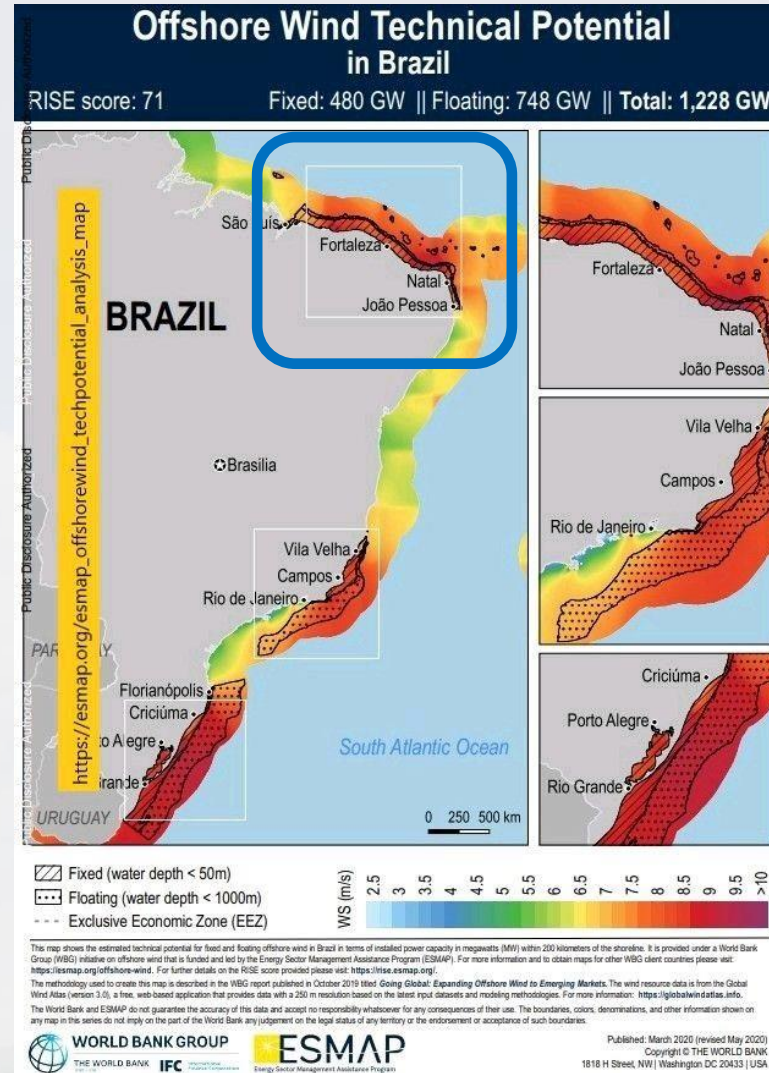
Brazil – Potential for Wind Energy



Onshore Wind Generation Potential

Brazil 880 GW

Northeast Region 309 GW (35.1%)



Offshore Wind Generation Potential

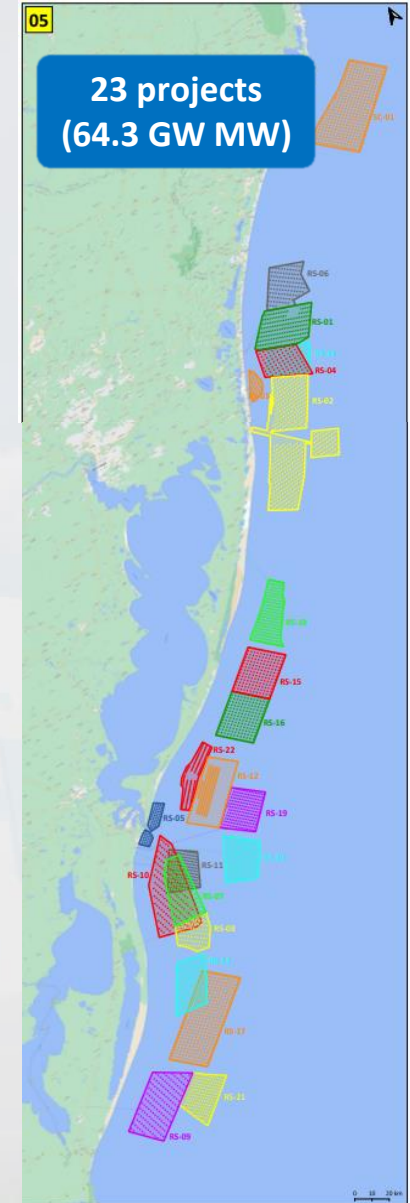
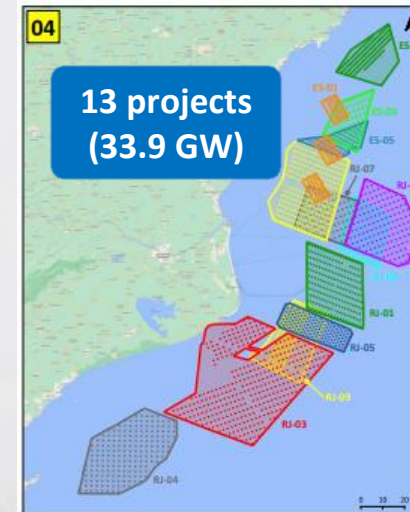
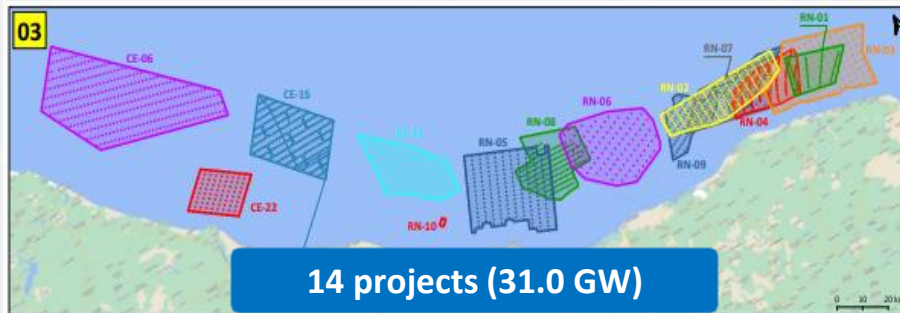
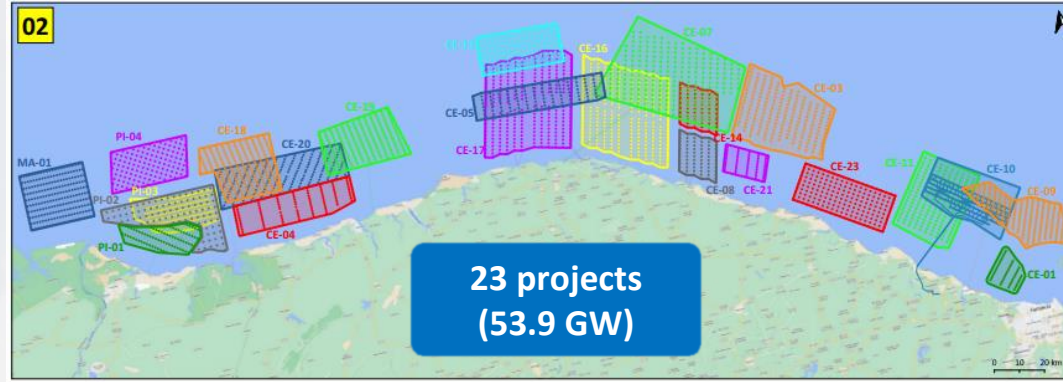
Brazil 1,228 GW

**Northeast Region
681 GW (55.5%)**



Brazil – Offshore Wind Projects (under development)

Brazil, 74 projects, 183 GW



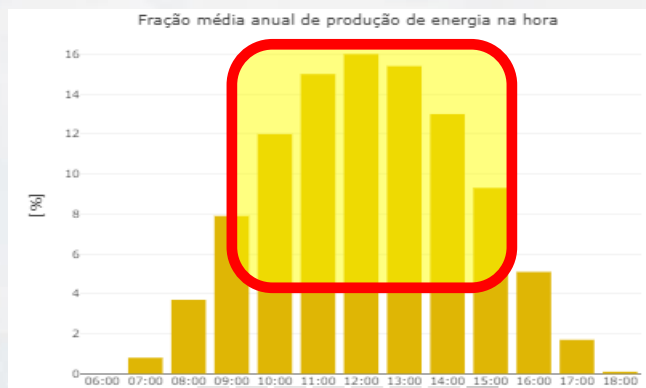
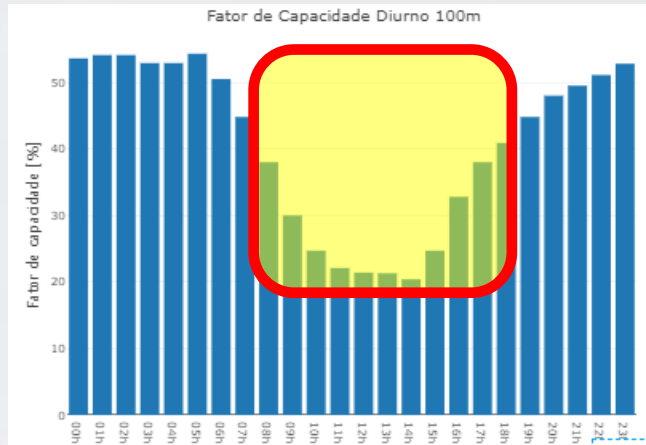
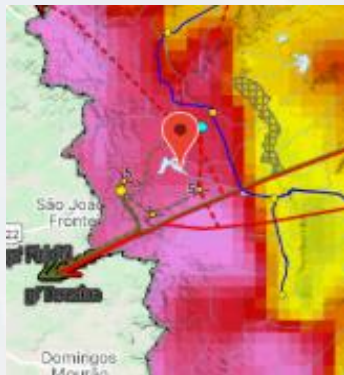
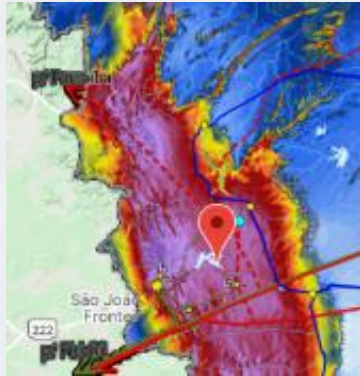
- Rio Grande do Sul, 22 projects (58,679 MW)
- Ceará, 22 projects (56,585 MW)
- Rio de Janeiro, 9 projects (27,498 MW)

Source: [IBAMA \(28/03/23\)](#)

Northeast – Daily and Monthly Complementarity Wind + Solar

Daily Complementarity

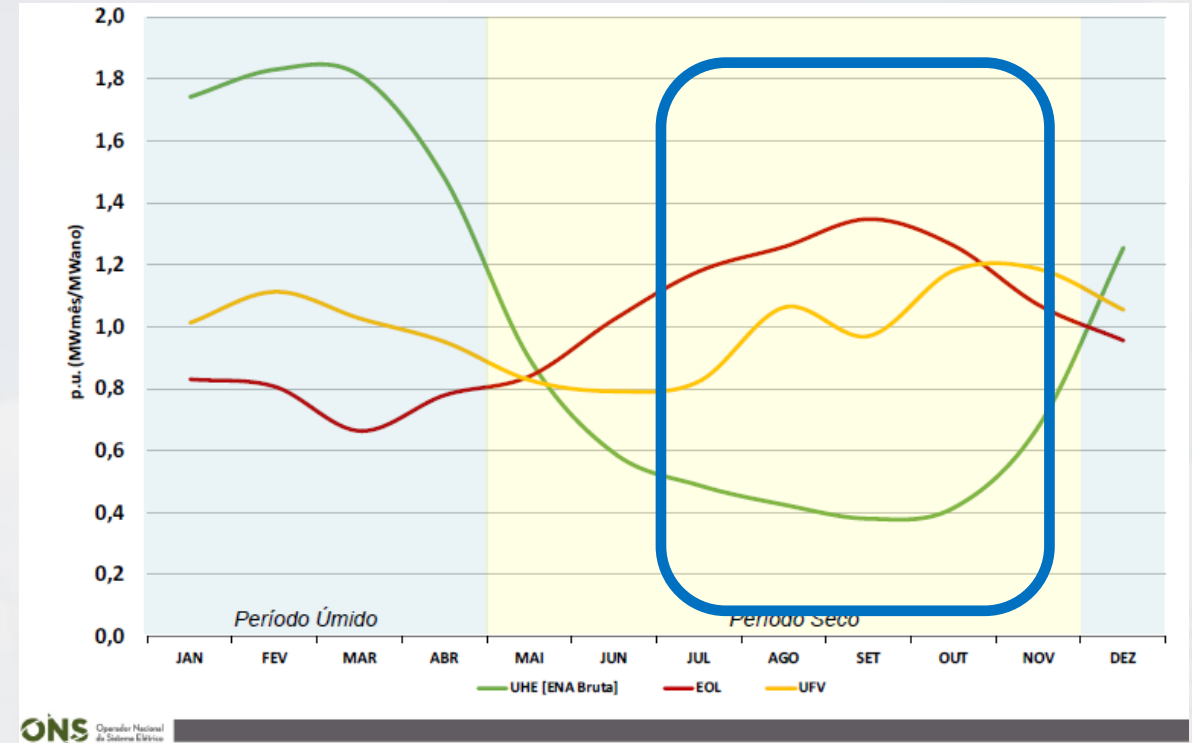
Ubajara/CE



High Capacity Factors in wind and solar

Lowest Cost for Green H2 Production

Monthly Complementarity



When hydroelectric dams are in lowest level, wind and solar can supply high amount of energy to the grid

Source: Ceará's wind and solar atlas <http://atlas.adece.ce.gov.br>

Brazilian Renewable Energies Prices

Wind and Solar Energy Prices (Brazil)



Electricity prices near US\$ 30/MWh in the last Federal Auctions for Wind and Solar

Further reduction is expected using Hybrid plants

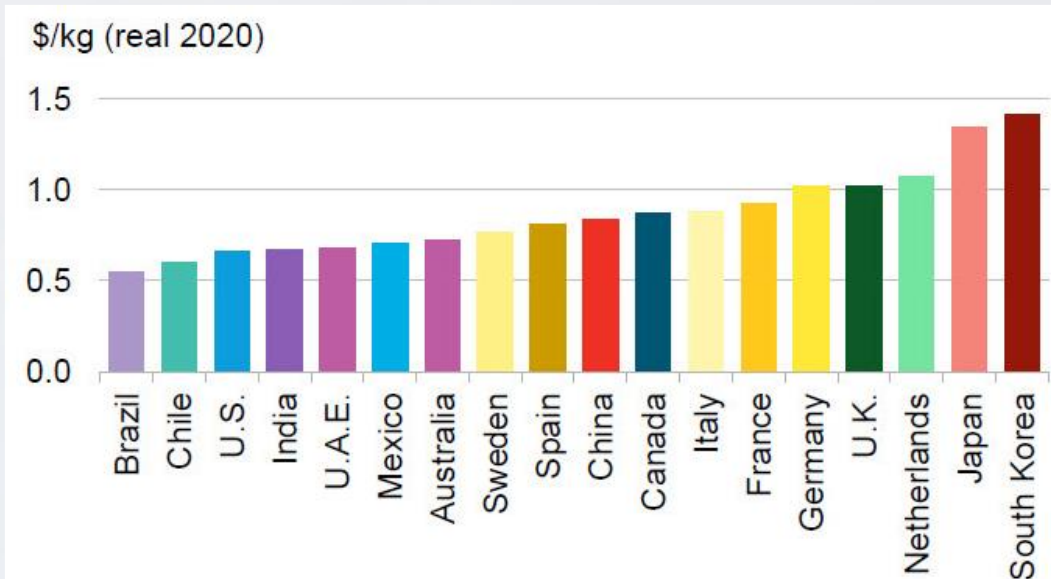
Projections to reach US\$ 20/MWh by 2025

Source: Adapted from ONS/EPE/ANEEL/Mckinsey

FIEC

Federação das Indústrias do Estado do Ceará
PELO FUTURO DA INDÚSTRIA

Brazil: Cheapest Green H2



Source: BloombergNEF. Assumes our optimistic alkaline electrolyzer cost scenario.

BloombergNEF
 Brazil global lowest LCOH2 in 2030 and 2050

LCOH2 - Levelized Cost of Hydrogen



IRENA
 Brazil Green H2 cheaper than Blue H2 in 2024

Source: IRENA <https://bit.ly/33FWoh8>

42 Announced Hydrogen Projects in Brazil 2021 - 2022

Projects for H₂ Production in Brazil

Green hydrogen Applications



AMAZONAS
SENAI e
Eletronorte

**BAHIA / PIAUÍ /
PERNAMBUCO**
Casa dos Ventos e Comerc

CEARÁ
EDP Energias de Portugal; Qair;
Fortescue; LINDE/White Martins;
TransHydrogen Alliance; AES Brasil;
Casa dos Ventos/Nexway; ENGIE;
Total Eren; Eneva, Hytron/NEA Group,
Neoenergia/Iberdrola, Cactus,
Diferencial Energia, Gold Wind, H2
Helium, Mitsui, ABB, Alupar, Green
Power.

RIO GRANDE DO NORTE
Neoenergia/Iberdrola
Enterprise Energy

PERNAMBUCO
Qair
Neoenergia

BAHIA
UNIGEL Camaçari; UNIGEL
ThyssenKrupp; Bahia Green
Hydrogen Programme
Acker/Statkraft/Sowitec

MINAS GERAIS
Minas Hydrogen Programme
Federal University Itajubá
(UNIFEI)
GIZ Project

ESPÍRITO SANTO
Energy Hub Porto Central

**RIO DE JANEIRO / ESPÍRITO
SANTO**
Fortescue Future Industries
Pty Ltd (FFI) and Porto do Açú
Operations SA
LINDE/White Martins

RIO DE JANEIRO
CSN bei Companhia
Siderúrgica Nacional (CSN)

RIO GRANDE DO SUL
LINDE/White Martins

SÃO PAULO
Repsol Sinopec Brasil (RSB),
Gas Innovation Research
Center (RCGI), Chemical
Engineering Department USP,
CetiQ Senai Hytron / NEA,
Fraunhofer
SAE Brasil & Ballard Student
H2 Challenge Competition;
Biogas Raizen/Yara; Raizen e
YARA

Source: Adapted from ABH2 – Brazilian Association of Hydrogen

H2Brasil Project – €34 million investments

Energy Partnership among GIZ and the Brazilian Federal Government

Structural Conditions



- ✓ 10 studies, workshops and technical tours

Dissemination



Professional Training



- ✓ Training of 300 teachers
- ✓ Establishment of laboratories at SENAI (CE, RN, BA, PR, SP and SC)
- ✓ Support for Professional Education networks (SENAI Network and Federal Network)

Innovation



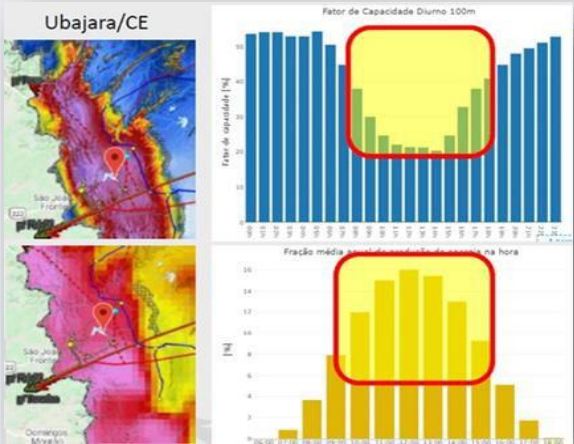
Green Hydrogen Market Development



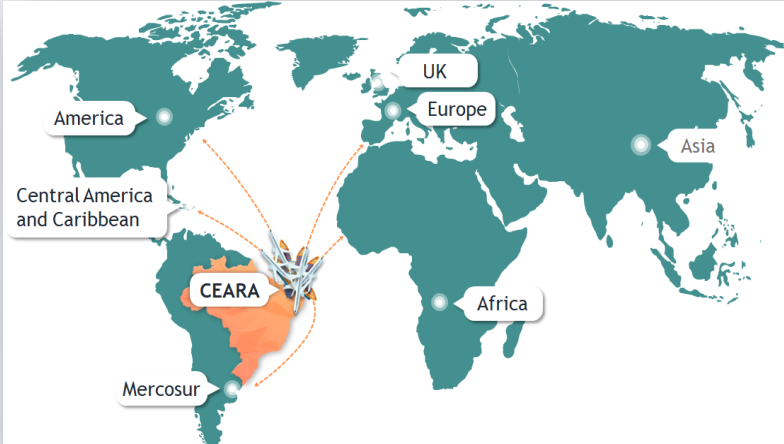
Ceará – Competitive Advantages



**Renewable Energy
great potential**



**Solar + Wind
Daily Complementarity**



Lowest Logistic Cost



ZPE - Free Trade Zone



Industrial Área



Port



**Joint-venture with the
Port of Rotterdam**

Companies that signed MoUs with the Ceará State



Source: SEDET – Government of the State of Ceará

Green Hydrogen Hub of Ceará

Announced Investments

Company	Country	Electrolyser Power (GW)	Announced Investment US\$ (billion)
Fortescue	Austrália	2,00	6,00
Qair	France	2,24	6,95
Comerc/Casa dos Ventos	Brazil	2,40	7,00
Energix	Australia	3,40	5,40
AES Brasil	United States	1,00	2,00
Transhydrogen Alliance	Netherlands	3,00	2,00
ENGIE	France	0,10	0,30
EDP	Portugal	1,25 MW	0,05
Total		14,1	29,70

MOUs with not annouced sizing

Company	Country
Hytron	Germany
Linde/W. Martins	Germany
Cactus Energia	Brazil
Alupar	Brazil
Diferencial	Brazil
Eneva	Brazil
H2 Green	Brazil
H2 Helium	Brazil
Nexway	Brazil
Goldwind	China
NEOENERGIA	Spain
HDF Energy	France
Total Eren	France
Enel Green Power	Italy
Mitsui/Caetano Bus	Japan
ABB Automation	Switzerland

US\$ 29,7 billion of investments in 24 Memorandum of Understandings

Source: SEDET – Government of the State of Ceará

Pecém Green Hydrogen HUB

Companies that announced Start of Operation



PROJECT IN OPERATION

A dark teal box on the left contains the EDP logo and project details. To the right, text describes the project's scale, investment, and objective.

1.25 MW H2V Pilot Plant In Operation

EDP ENERGIAS DE PORTUGAL
Pilot plant to be escalated to 150 MW until 1 GW
US\$ 8 million investment
3 MW dedicated Solar PV generation

OBJECTIVE: To test decarbonization of EDP's 720 MW coal thermal power plant and simulate the green hydrogen production chain.

Sources: CIPP and ArcelorMittal



Invitation to the FIEC Summit 2023 Green Hydrogen October, 25th and 26th

- **2.148** Subscribers
- **688** In-person participants
- **24** Participating countries
- **23** Participating states



Thank You Very Much!

Ricardo Cavalcante
presidencia@sfiec.org.br



Federação das Indústrias do Estado do Ceará
PELO FUTURO DA INDÚSTRIA

    www.sfiec.org.br