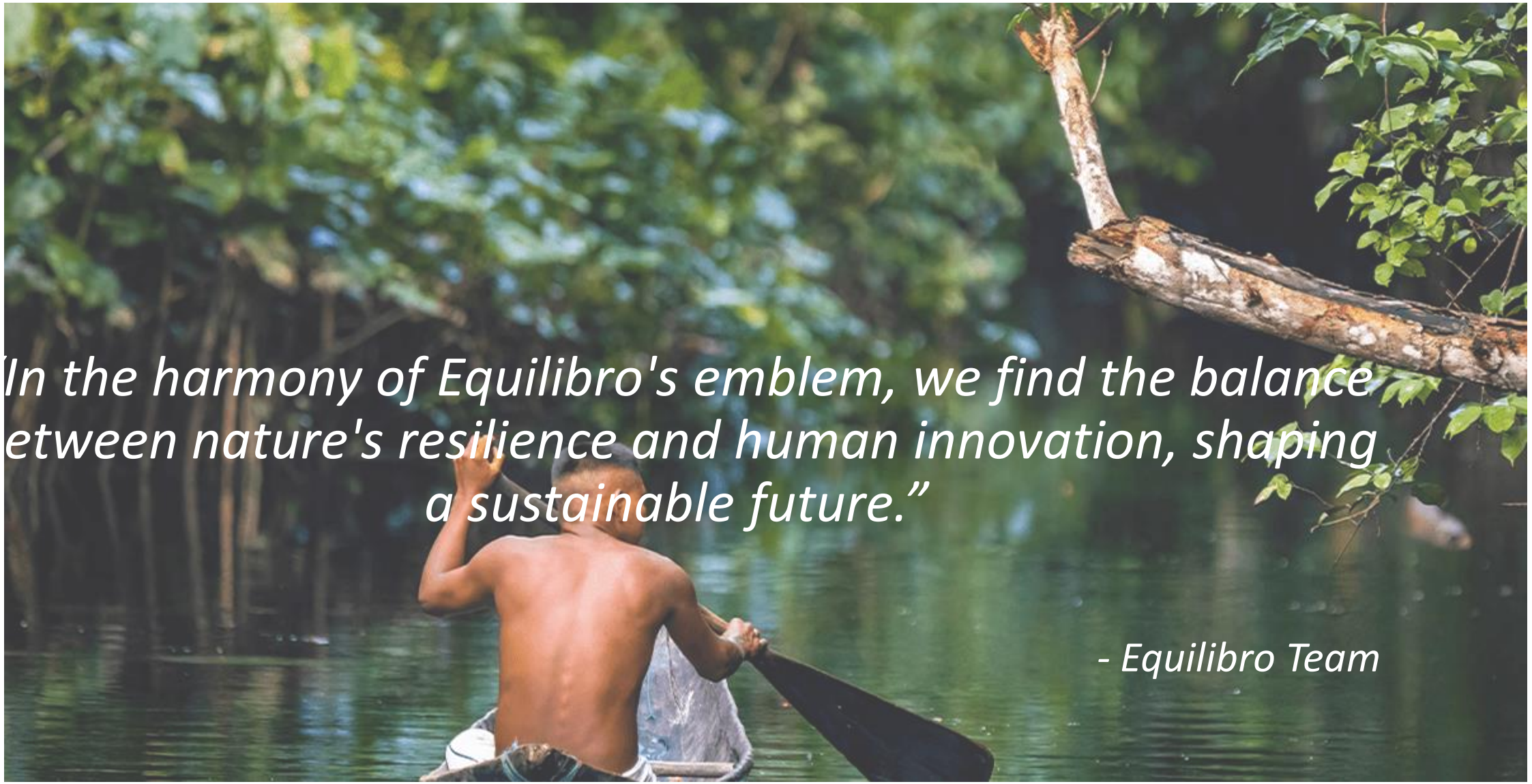
Business Challenge 3

Clear Energy for Ceara, Brazil

MBAN2 – Team “Equilibro”


"In the harmony of Equilibro's emblem, we find the balance
between nature's resilience and human innovation, shaping
a sustainable future."
- Equilibro Team

Our Team

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Sharayu Kasar

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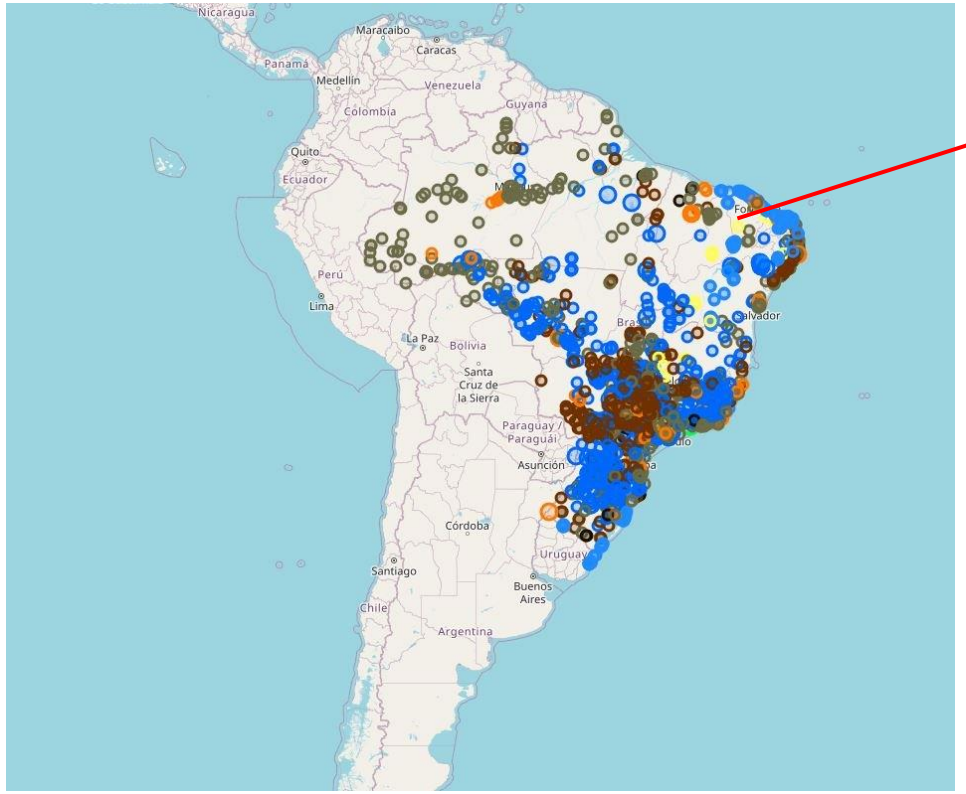
Introduction

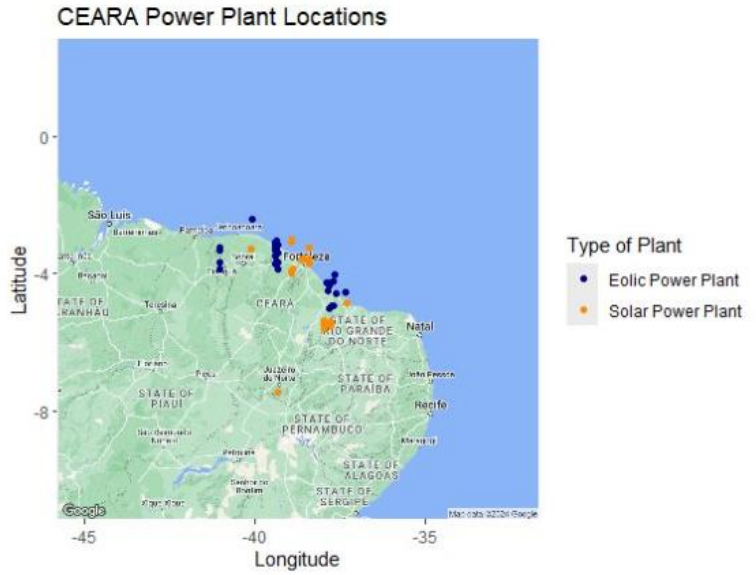
- Brazil: largest country in South America, both in area and population
- Rich in natural resources, with diverse ecosystems (Amazon forest)
- Heavy reliance on hydroelectric power, complemented by oil and natural gas
- Need to diversify energy sources and reduce dependency on hydropower
- Opportunities for growth in bioenergy, solar, wind, and other renewables

Overview of energy distribution in Brazil

- Wind Turbine
- Solar
- Nuclear
- Hydro
- Gas
- Coal
- Geothermal
- Oil



Ceara closer view:



Our Goal, Our Commitment

To recommend technologies for power energy generation in Ceara

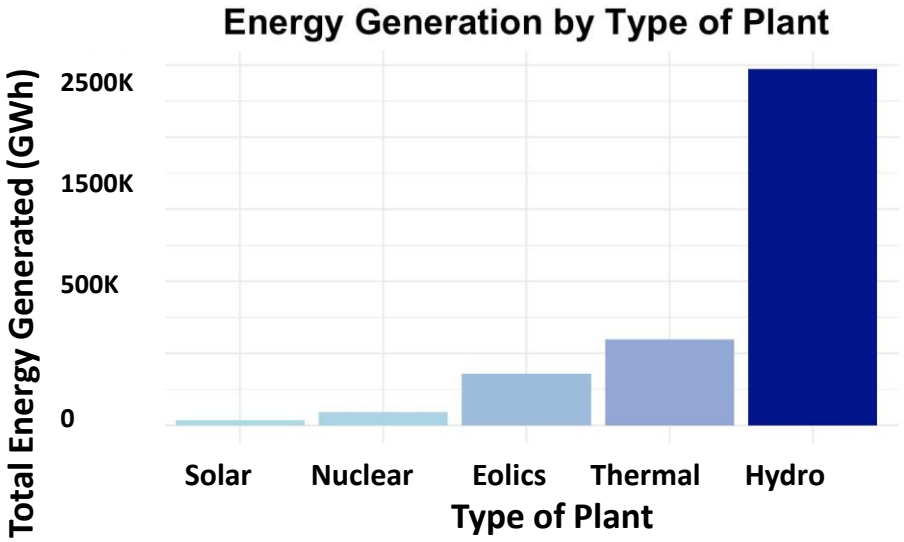
To supply renewable energy to North Brazil

To protect the nature and ecosystem of the beautiful land of Brazil

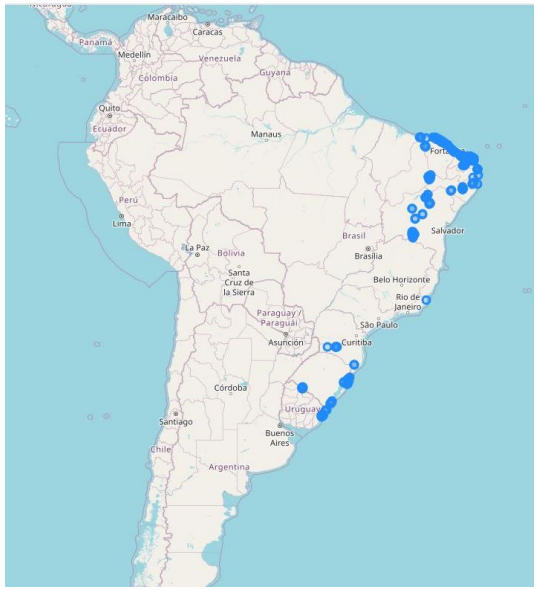
Main Solutions

1) Wind Turbine
2) Green Hydrogen & Biomass
3) Nuclear

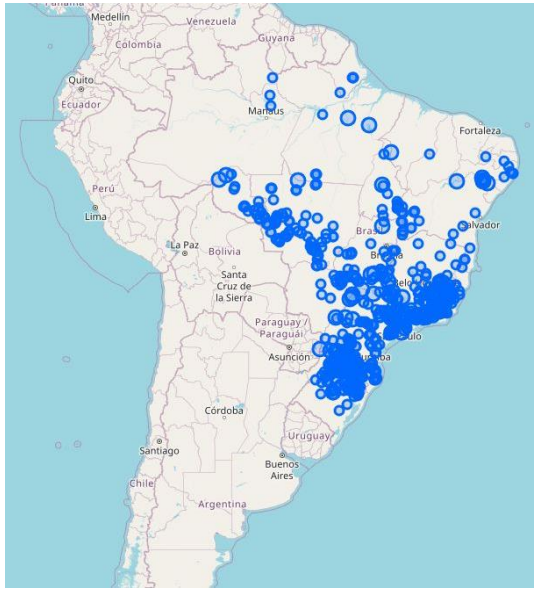
Current Scenario



Solar



Wind



Hydro

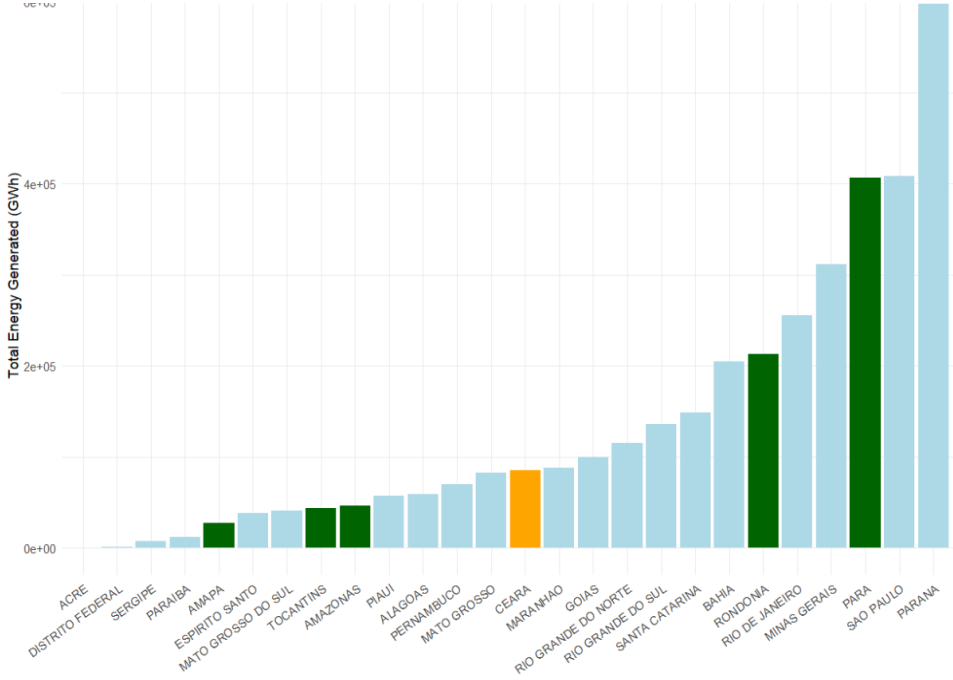
- Energy Generation by Type of Plant shows a dominant share for hydroelectric power.
- High concentration of hydro plants in the southeastern region.
- Solar and wind energy show potential for growth with scattered presence across the country.

Observatory Data Analysis

- Both graphs illustrates the demand and the generation of power by different states in Brazil
- Green color highlights the North states of Brazil
- Orange color highlights Ceara State
- Blue color highlights other Brazilian states

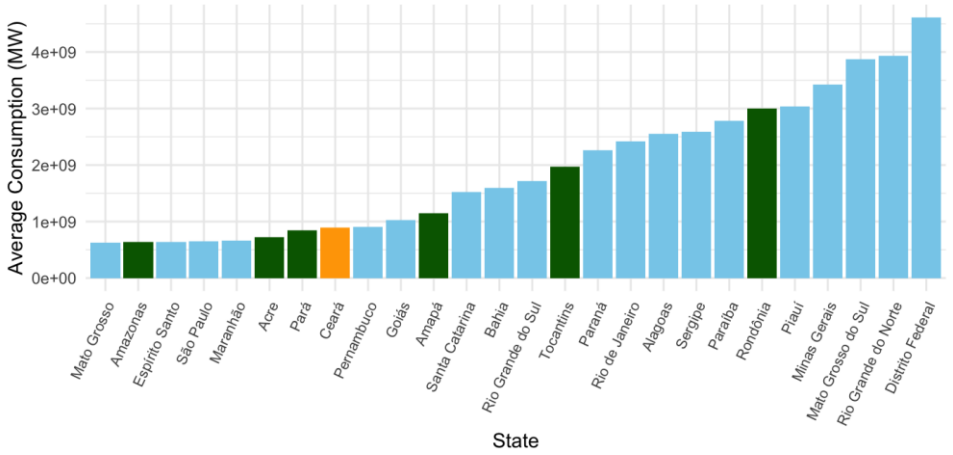
Total Energy Generated by Brazilian States

Highlighting Ceara as the generation and North States distribution

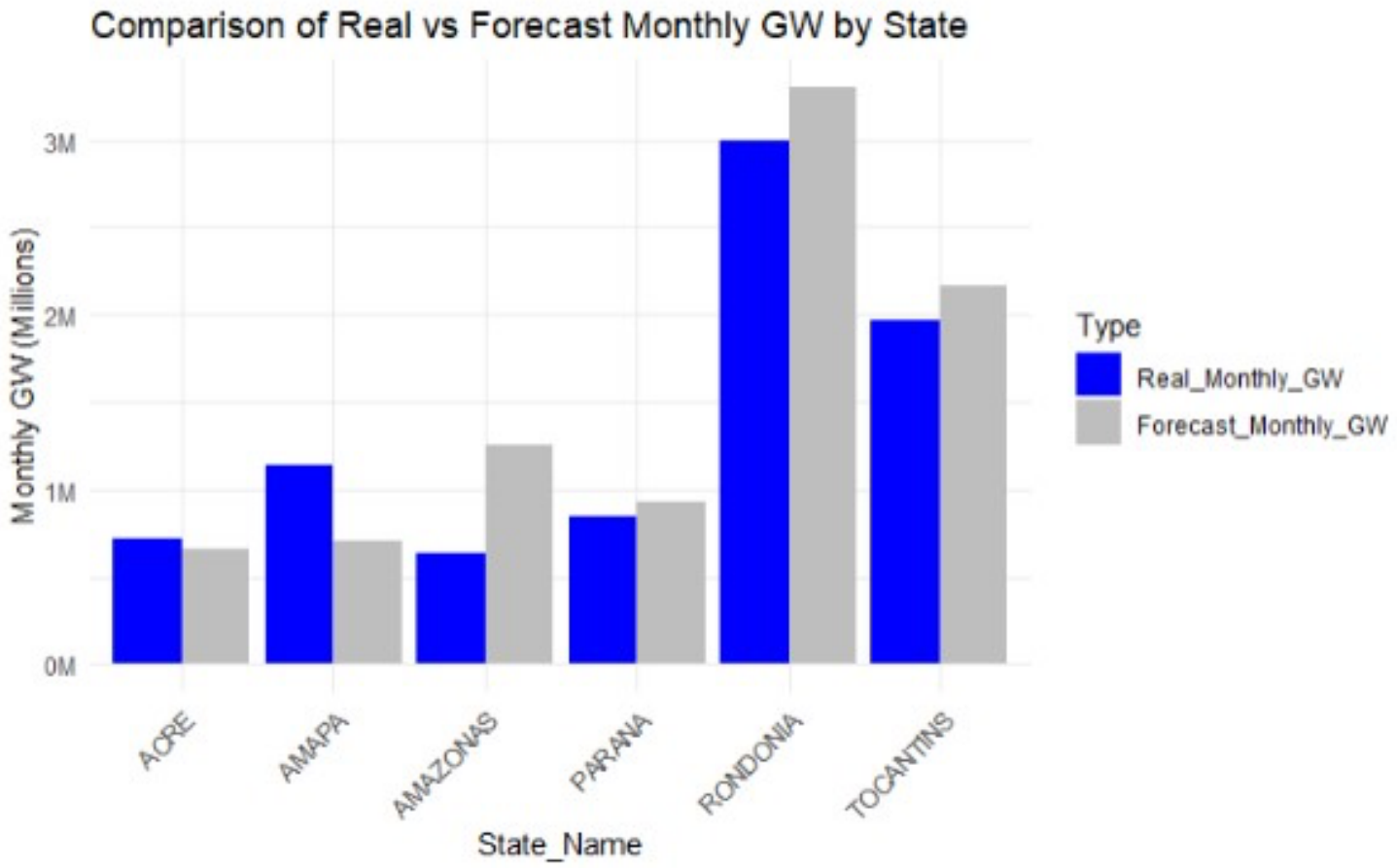


Average Energy Consumption by Brazilian States

Highlighting Ceara as the generation and North States distribution



Future scenario for 2024



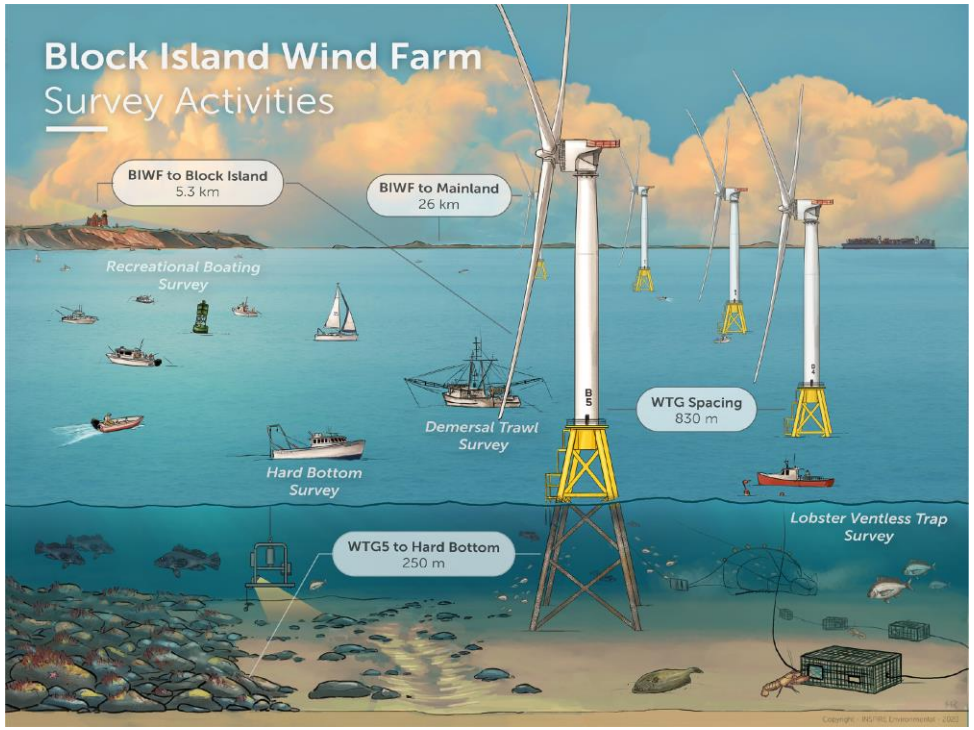
- Substantial increase in energy generation for Amazonas and Tocantins.
- A significant gap between forecast and real data suggests room for investment and improvement.

Generation Forecast according to Brazil CCG

Category	Energy Source	2019 TWh	2019 %	2024 TWh	2024 %	2029 TWh	2029 %
Centralized Generation	Hydroelectric power	418	64	514	65	538	57
	Natural Gas	36	6	33	4	42	4
	Coal	6	1	7	<1	6	1
	Nuclear	15	2	15	2	26	3
	Biomass	38	6	33	4	40	4
	Wind power	65	10	95	12	155	16
	Solar (centralized)	5	1	10	1	21	2
	Others	4	1	8	1	10	1
Subtotal (meets Load)		**587**	**90**	**715**	**90**	**838**	**89**
Auto-production & Distributed Generation	Biomass (biogas, sugar cane bagasse, black liquor and firewood)	31	5	38	5	47	5
	Solar power	1	<1	5	1	13	1
	Hydroelectric power	0.1	0	0.2	0	0.3	<1
	Wind power	3	<1	4	<1	7	1
	Non-renewable sources	27	4	31	4	38	4
Subtotal (auto-prod. & DG)		**62**	**10**	**79**	**10**	**104**	**11**
Total		**649**	**100**	**794**	**100**	**942**	**100**

Wind Turbine off-shore

References	Description
Cost	$300 million
Capacity	30 MW (t turbines)
Area	3 miles southeast of Block Island, Rhode Island, and covers an area of approximately 1 square mile. The turbines are spaced about 0.5 miles apart from each other.



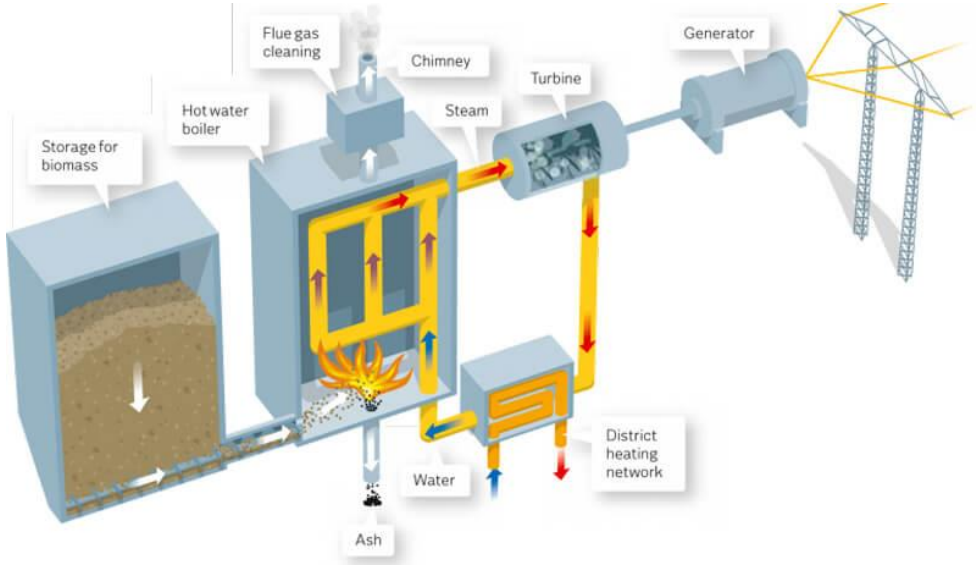
Biomass

Reference	Description
Cost	$2,500 to $4,000 per kilowatt of capacity, i.e. 10 MW plant will cost $25 million to $40 million
Power capacity	10 MW plant can produce 70 million kWh annually. This can power 6,500 average homes per year
Area	10 MW plant- 10 to 50 acres
Challenges	Carbon Dioxide emission 2.3 g/KW

Brazil achieves record Biomass Energy Generation in 2023

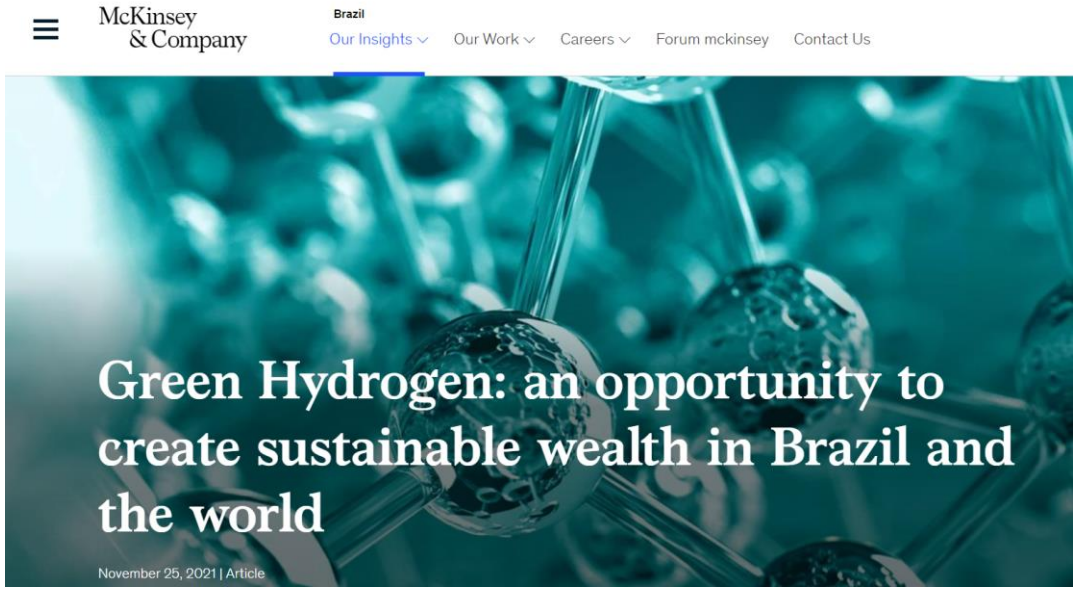
By **BioEnergyTimes** March 4, 2024

Biomass-Fired Power Plant Operation

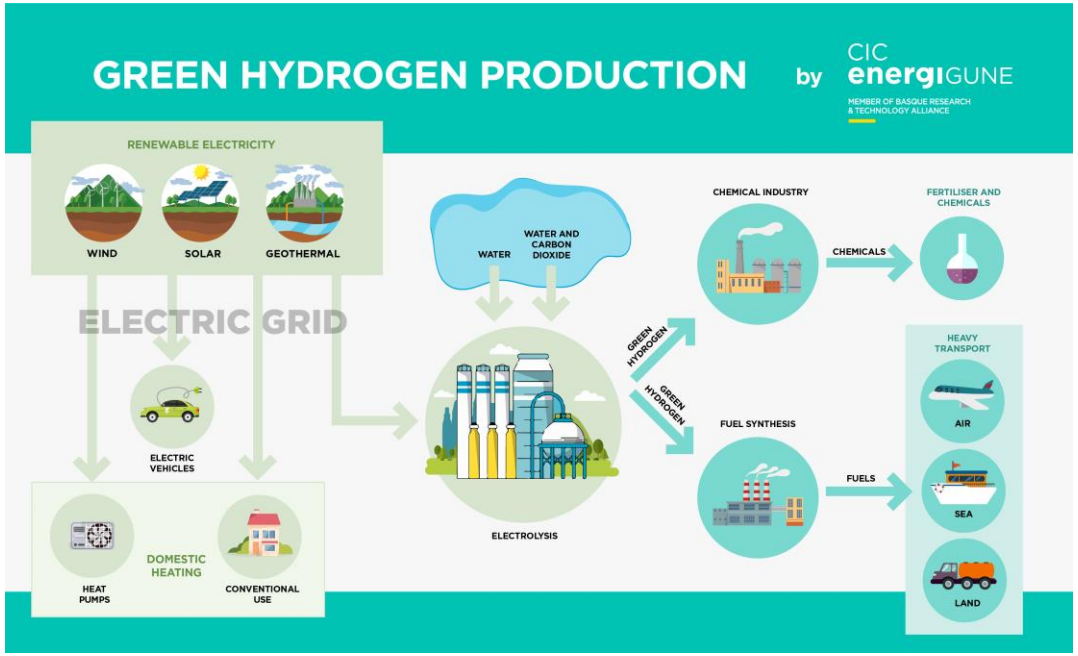


Green Hydrogen

Reference	Description
Cost	$6 Bn USD
Power capacity	403.28 MW plant
Area	5 to 7 acres per MW
Carbon dioxide emission ~0	assuming green electricity mix[2]
Carbon dioxide	captured is 2 M ton/year

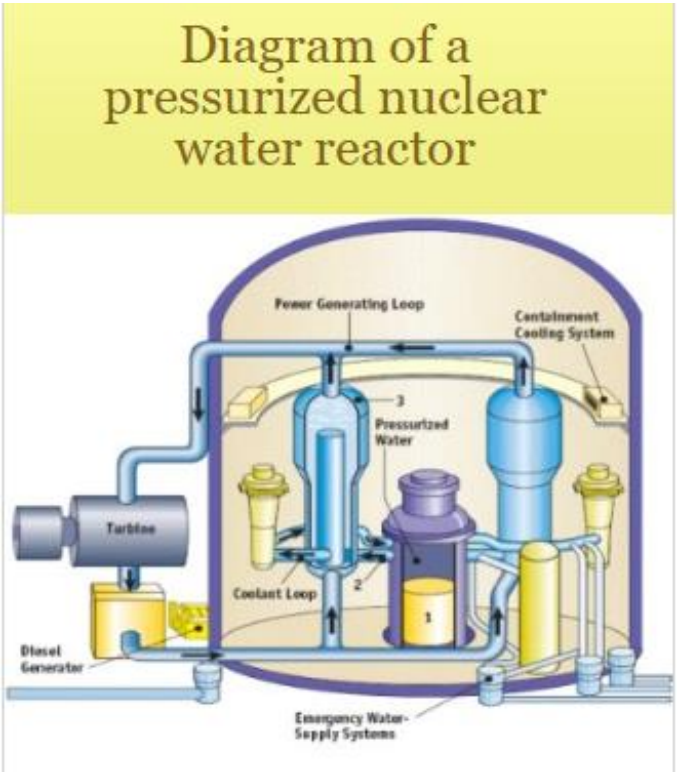


Basque Hydrogen Corridor



Nuclear

Reference	Description
Reactor Type	PWR
Model	PRE KONVOI
Reference Unit Power (Net Capacity)	1275 MW
Construction Start Date	Jan, 1976
Commercial Operation Date	Feb, 2001
Uranium Cost	$25-35 per pound
Option Available	Small Modular Reactor 10 to 300 megawatts (MW) per
Model	Rolls-Royce SMR, Hitachi
Cost	Dependent on the Government Policy



Solar

Reference	Description
Cost	$60 million to $85 million for 100 MW capacity
Power capacity	A 100 MW plant to meet the energy demands of Ceará
Area	Approximately 400 to 600 hectares
Storage	4 to 6 hours of thermal storage capacity to provide energy supply after sunset
Water Usage	Incorporating dry-cooling technologies to minimize water use
Job Creation	An estimated 200 to 300 jobs during the construction phase

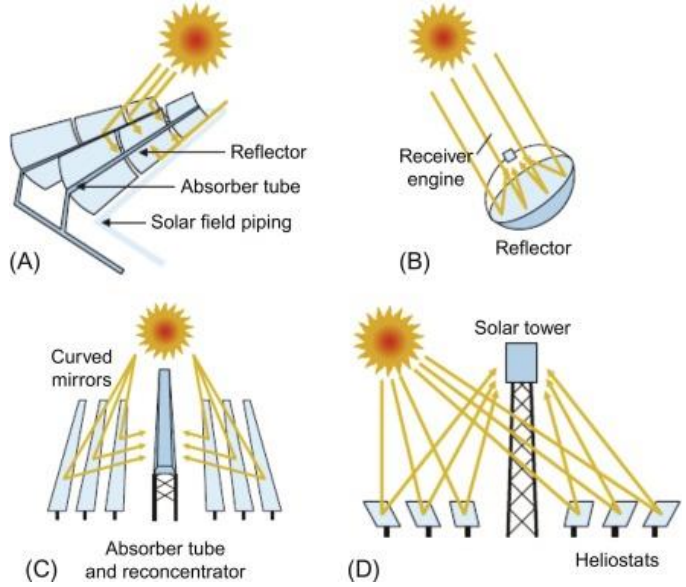
Largest PV plant in Americas goes online in Brazil

Elera Renováveis has commissioned the 1.2 GW Janaúba solar complex. The facility, which went online this week, consists of 20 solar parks spread across 3,000 hectares.

JULY 6, 2023 LÍVIA NEVES

MARKETS UTILITY SCALE PV BRAZIL

Concentrating Solar Power (CSP)



Future of Renewable Energy in Brazil

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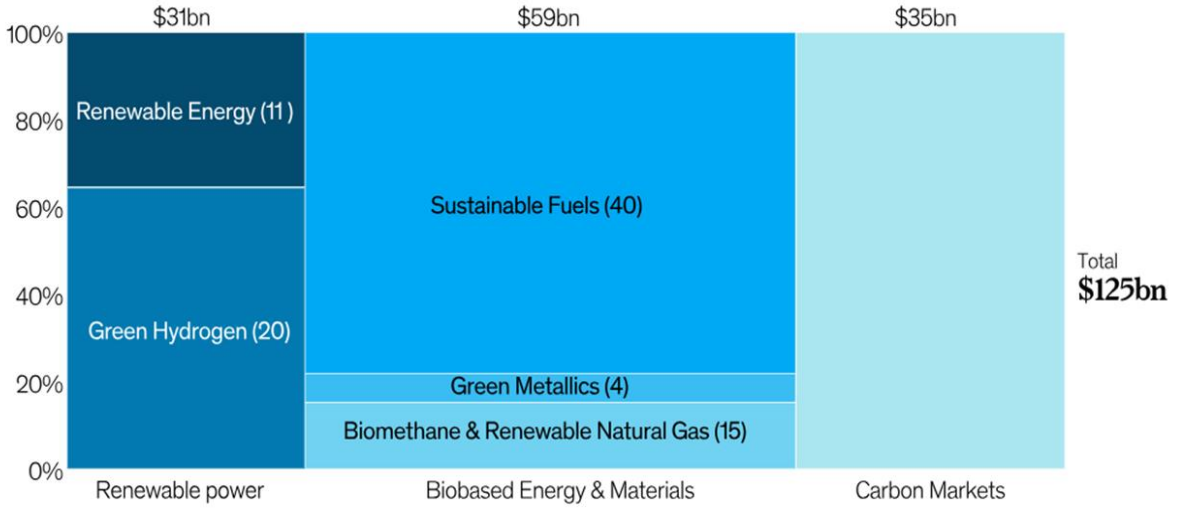
Brazil plans to become climate neutral by 2060. It makes strong use of hydropower and is developing other reliable renewable energy sources, but deforestation and forest fires are strongly limiting its ability to reach Net Zero.

By 2040, the total estimated opportunity for Brazil is USD ~125bn



Source: McKinsey: The green hidden gem –Brazil's opportunity to become a sustainability powerhouse

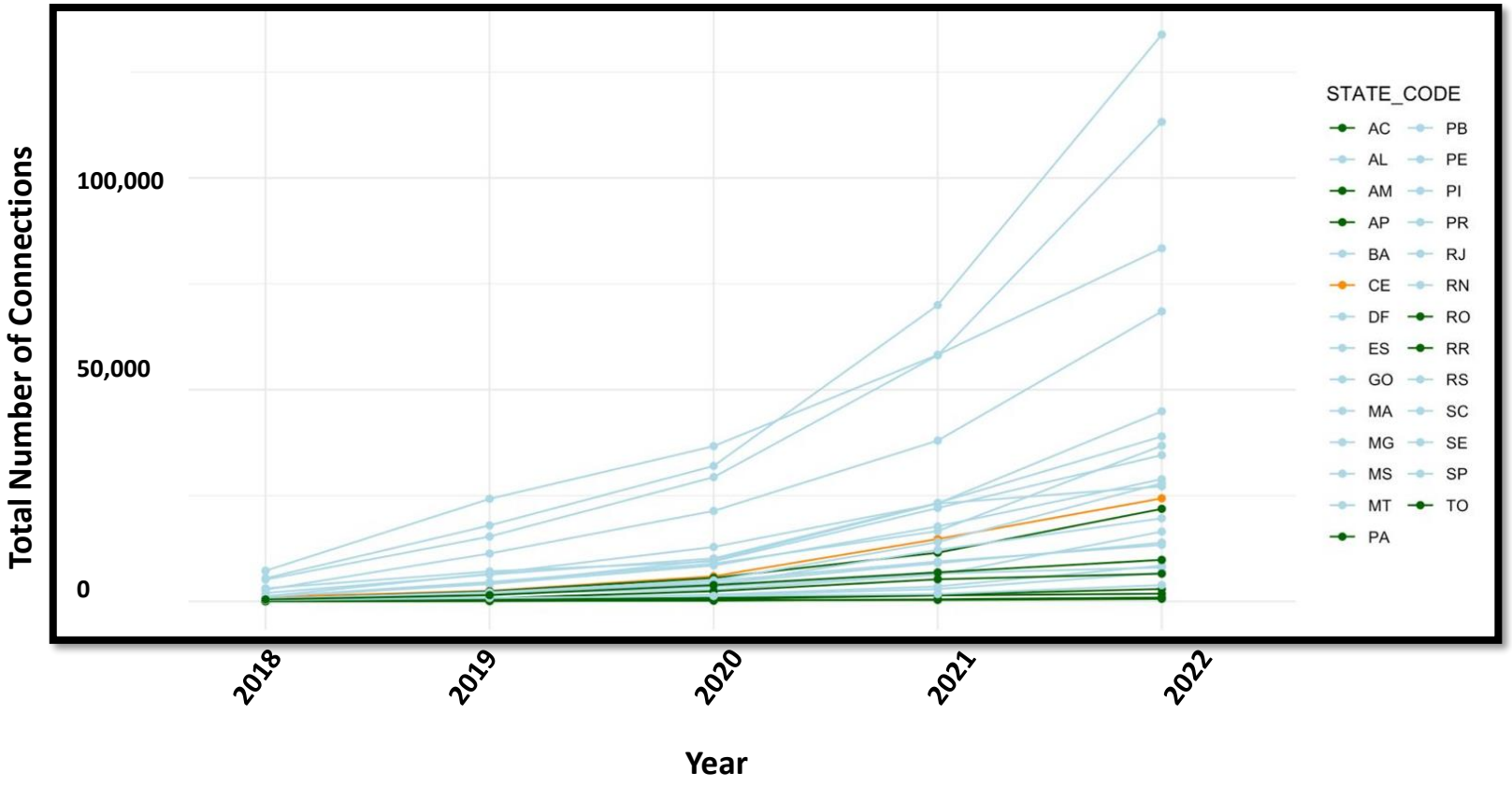
McKinsey & Company

Main Solutions

1) Wind Turbine
2) Green Hydrogen & Biomass
3) Nuclear

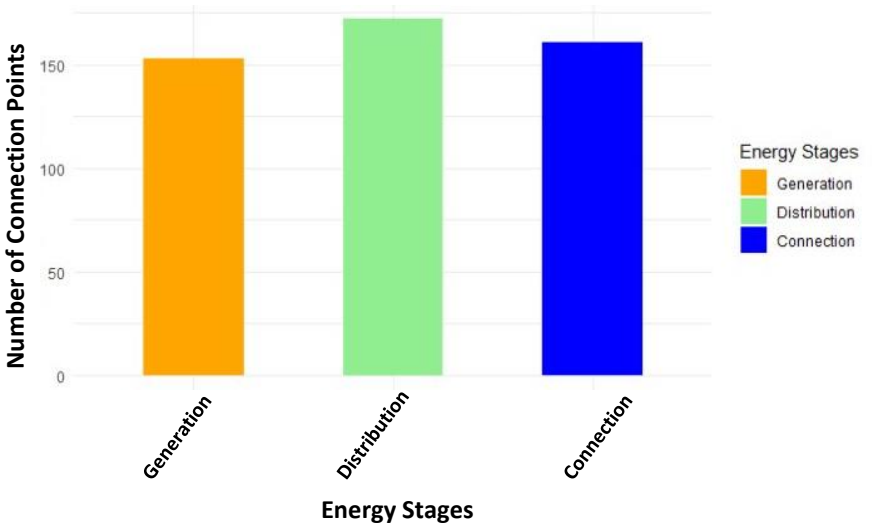
Distribution and Storage

Annual Growth of Electricity Connections by Region

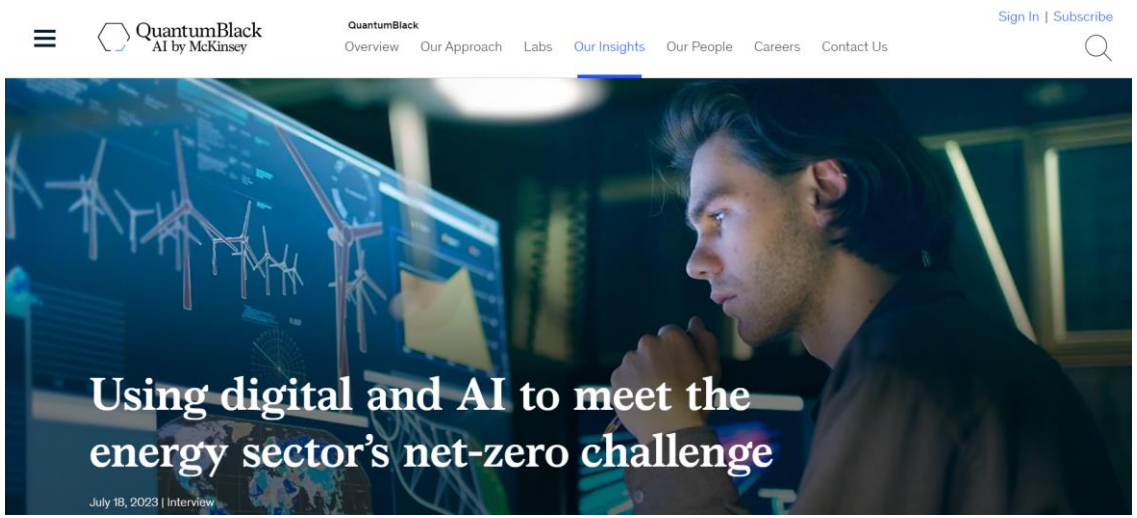


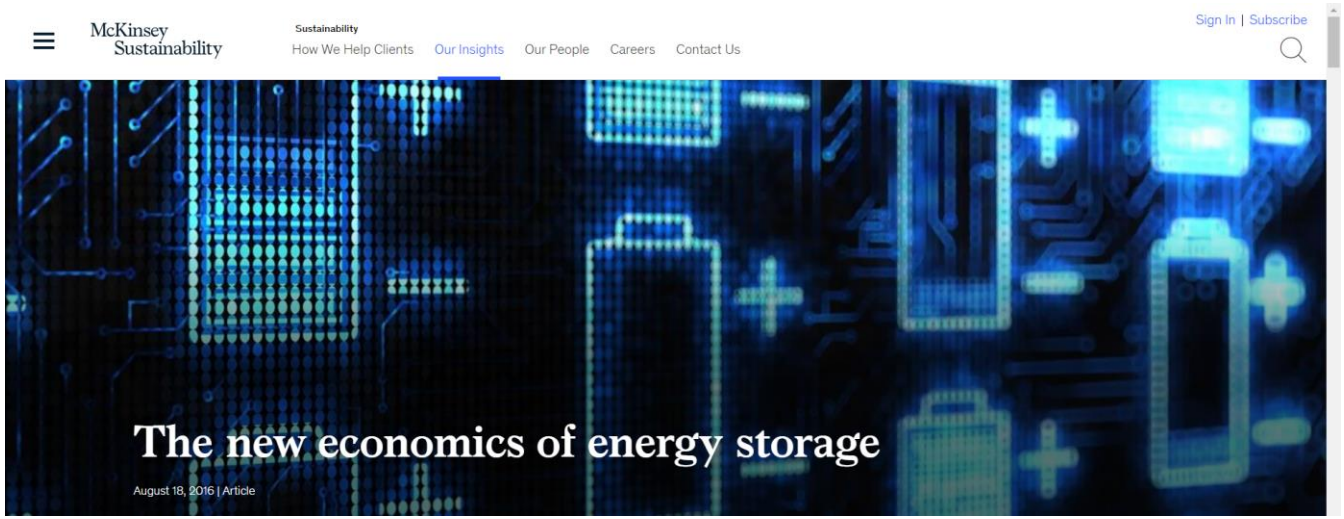
Data Text Mining on 'Distribution Limiting Factors'

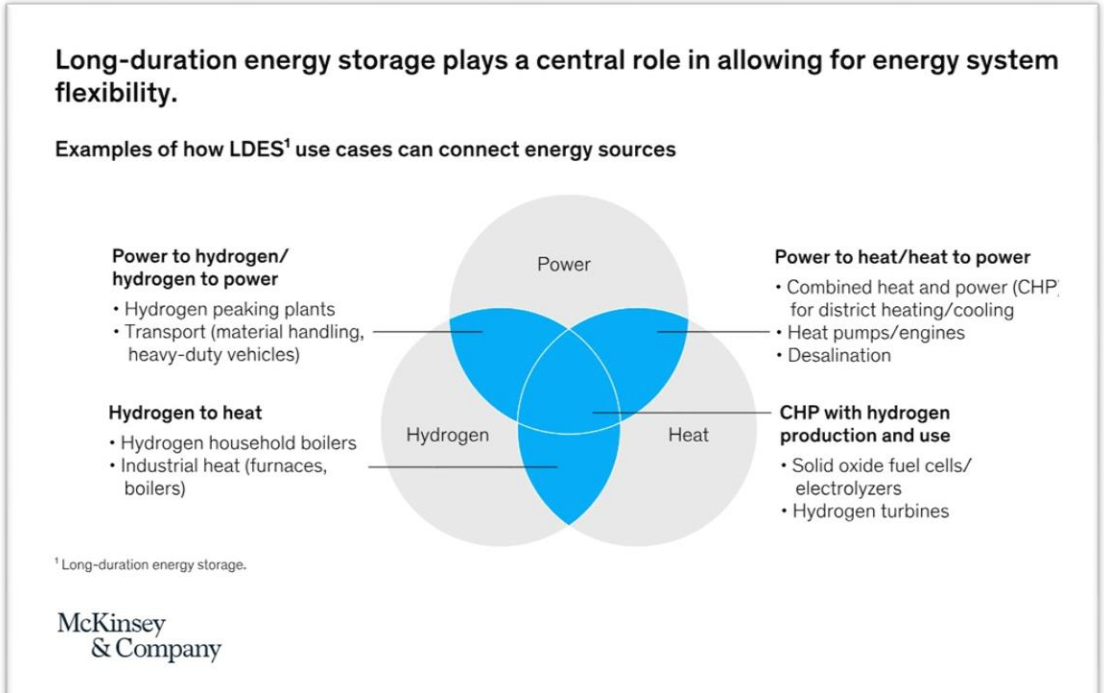
Number of Connection Points by Energy Stages



AI in Renewable Energy







Conclusion

- **Renewable Energy Integration:** Our recommendation for the integration of wind power, green hydrogen combined with biomass, and nuclear energy will help to diversify and strengthen Ceará's energy portfolio.

- **AI-Driven Optimization:** By leveraging AI, we can optimize renewable energy integration, predict energy demand, and improve grid efficiency, fostering a greener and more resilient energy ecosystem for Ceará.

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Thank you