

THE INVESTOR'S HANDBOOK FOR RENEWABLE ENERGY IN BRAZIL

AN INSIDER'S GUIDE



REA CONSULT

Preface

Favorable geographic conditions, growing electricity demand, progressive regulatory reform, and maturing supply chains, have made Brazil one of the most exciting countries in the world for renewable energy investment.

According to Bloomberg's **2019 Climatescope report**, Brazil ranks third most attractive in the world for clean energy investments. Brazil also ranks third globally in terms of installed capacity from renewable energy sources, after only China and the United States, according to **IRENA** analysis. Despite this, Brazil only ranks 7th in the world for installed wind power capacity and 22nd for solar.

The real renewable power in Brazil comes from hydroelectric, where it is only second to China. Large hydropower plants account for around 80% of domestic electricity generation, providing flexible and low-emission base power supply. However, further expansion is constrained by the remoteness and environmental sensitivity of remaining hydropower resources.

As a result, reforms in the Brazilian energy market over the last decade have focused on diversifying the country's energy mix. While natural gas plays a role in this new power landscape, the key focus has been to promote the development of wind and solar power generation by creating the technical, socio-economic, and political conditions required to encourage investment.

Transmission capacity and technology have improved to account for intermittent supply, new financing mechanisms have been put in place to suit a wide range of projects, and more supportive regulation has been established. From 2017 to 2020 (ytd) the average annual installed capacity growth of centralized solar power was approximately 35%. In the same period, distributed solar power grew by more than 120% on average, benefiting from the world's most progressive net metering regulation. The more mature wind sector saw an average increase in

the generation capacity of 8% per year, while total wind capacity is expected to double between 2017 and 2024.

There is a famous saying here, we say that "Brazil is not for beginners". Despite reform, Brazil is still an emerging market with many of the inefficiencies and cultural hurdles

you would expect of a populous Latin American country. However, those who can navigate Brazil's dense legal and regulatory jungle will discover a renewable energy market that is brimming with potential. Since I began working in the renewable energy sector, I have seen markets peak and stall. The conditions are right, now is the time for Brazil.

The Investor's Handbook for Renewable Energy in Brazil has been developed by REA Consult to support that journey. It serves as an insider's guide for those developing projects renewable energy in Brazil and anyone curious about the inner-workings of this lucrative market. A new chapter will be released every week, all free to read and share. See all the chapters published so far and **follow the evolving story here**



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Founding Partner at REA Consult

REA Consult is a management and consulting firm committed to building bridges for international sustainable investments. Born in Brazil with offices in Europe, Asia, and South America, REA Consult has a global track record of supporting successful projects.

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BRAZIL'S RENEWABLE ENERGY MARKET FUNDAMENTALS

BEYOND SUNLIGHT, WIND & WATER TO THE
POLITICS & SOCIO-ECONOMICS THAT TRULY
ENABLE RENEWABLE ENERGY GENERATION TO
COME ONLINE

△ Energy Infrastructure
△ Regulatory Bodies

△ Legal Framework
△ Energy Market

Brazil's renewable energy market fundamentals

Overview

Most conversations on renewable energy revolve around sustainability and climate change, or the availability of sunlight, wind, and other renewable energy resources. The reality, however, is that converting all these sources into capable electricity providers within the national energy matrix requires that many other important and complex factors also play favorably. These fundamentals go beyond natural and technical sciences into the politics and socio-economics that truly enable renewable energy generation to come online.

Beginning with costs and benefits, it is necessary to clearly identify the economic, social and environmental implications of each technology, while expanding the number of energy facilities available to the system. This, alone, is no easy task considering the criteria that adequately combine energy security, reasonable tariff rates, international agreements, and of course, environmental legislation, albeit greenhouse gas emission reduction targets. Brazil is no exception to this complexity.

On a national level, hydroelectric electricity is still predominant in the Brazilian electricity matrix, representing two-thirds of all generating capacity

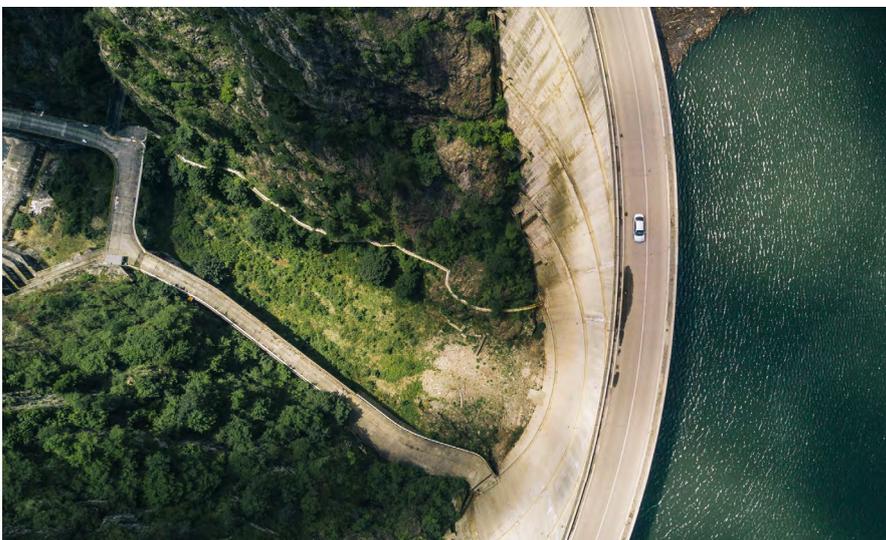
In recent years, biomass has been rapidly gaining ground thanks to the ethanol industry, which already accounts for 9% significant prospective potential: estimates indicate that its supply can rise threefold when considering centralized generation. That is not to say this source does not have its own challenges. In fact, each type of biomass faces its own individual set of restrictions.

The Brazilian power system is the largest in Latin America and ranks 7th in the world for size. Beyond hydro, the country's continental heft and geographic location render it optimal for wind and solar energy. Wind energy parks are scattered across many regions, benefitting from the diverse windscares Brazil has to offer. Additionally, there is a local and highly specialized wind supply chain that has enough expertise to provide quality components. Finally, Brazilian wind sites have consistently matched the best capacity factors worldwide.

Located in the tropics, Brazil is blessed with sun year-round. The high irradiation levels across most of the country give solar power generation huge potential. It's intermittent nature, however, requires minimum stability levels and supply guarantee that is still evolving. Much has already been done to smooth out additional transmission lines, energy storage technology, load management, and load flexibility.

Wind energy led by example, paving the way for solar to quickly increase its share in a country that has always opted for clean and cheap energy solutions. The emerging solar power industry benefits from much more supportive government incentives than early wind producers, for example, enabling faster, smoother growth.

On a national level, hydroelectric energy is still predominant in the Brazilian energy matrix, representing 2/3 of all generating capacity

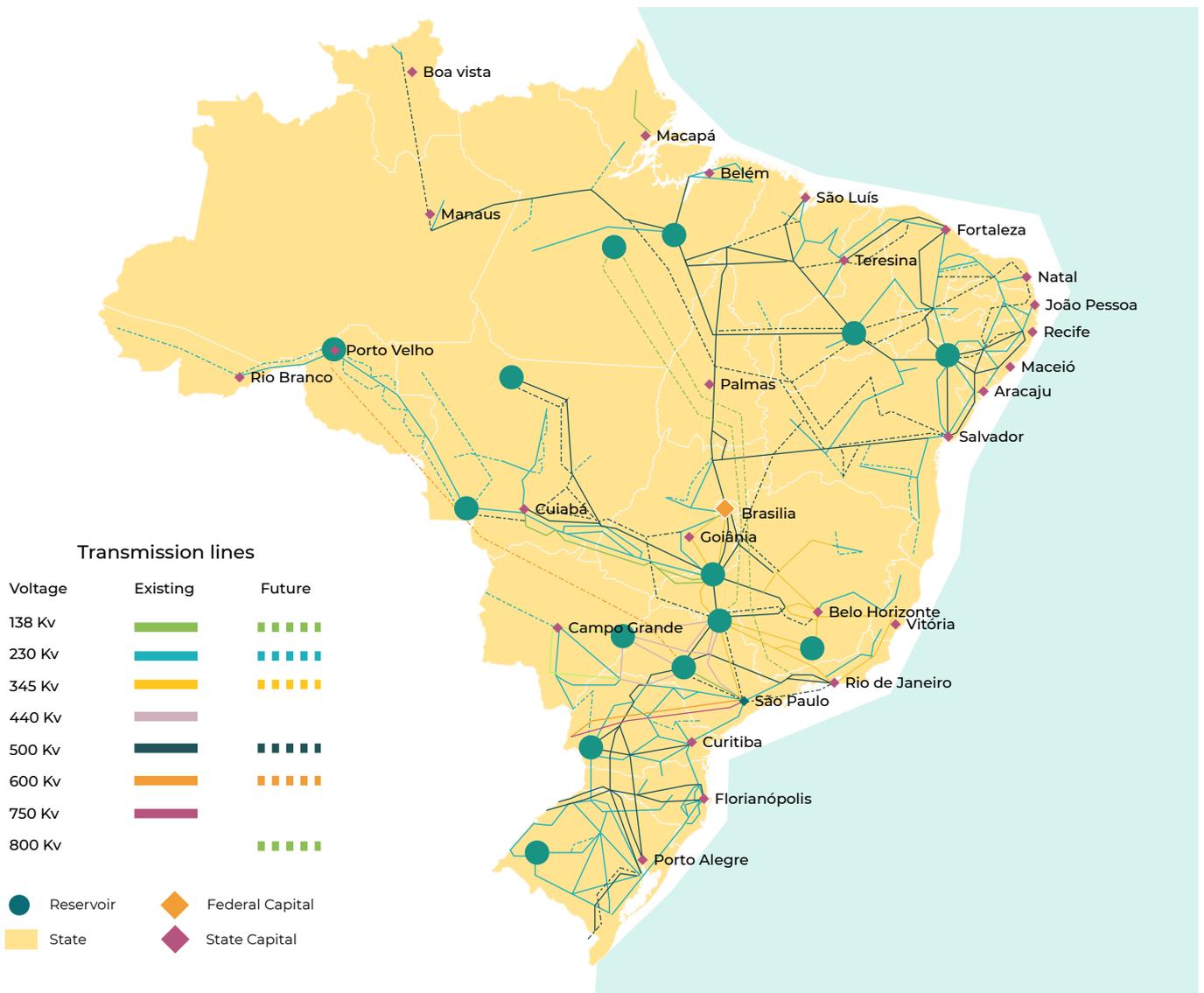


Energy Infrastructure

Energy in Brazil is dominated by hydroelectric power plants, which offer reliable electricity generation but also significant stabilizing capabilities. The diverse hydrographic basin that covers much of the country means that each region plays a complementary role to the overall power system.

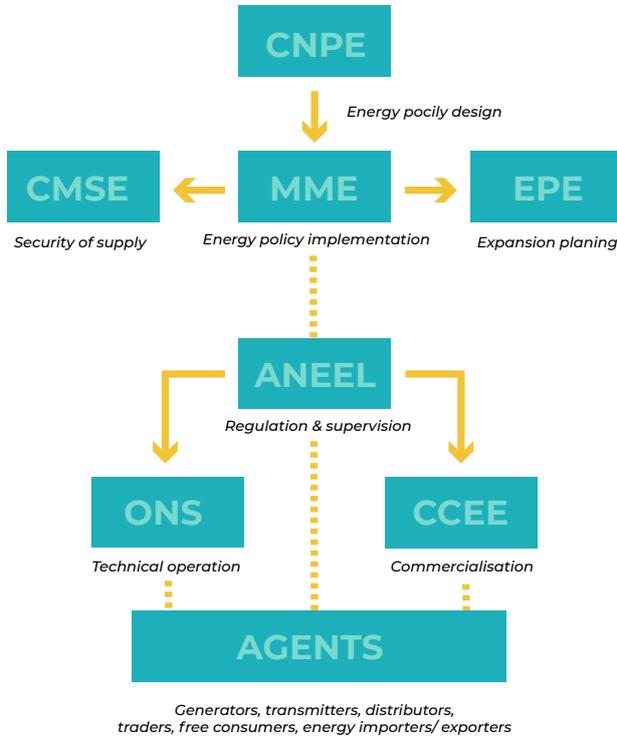
An extensive network of long-distance transmission lines has developed to connect reservoirs and other significant energy generation and storage elements to the grid. This structure is what comprises the National Interconnected System (SIN), where only the northern region of the country is not fully integrated to the national grid.

Map of the SIN and its main interconnections



Eletrobras currently maintains a 52% share of the transmission infrastructure, but the once vertically integrated state electricity monopoly is expected to be privatized further.

Distribution is more evenly divided. A private firm Eletropaulo (now belonging to ENEL), serving both São Paulo and Rio de Janeiro states, has the biggest share of distribution (by consumption), with just 10.5%.



Regulatory Bodies

A system of regulatory bodies coordinates the energy sector:

- △ **National Energy Policy Council (CNPE)** – aids the country's presidency in setting energy policy and guidelines
- △ **Ministry of Mines and Energy (MME)** – among its many roles, it funds research, implements CNPE's policies and attracts investments in order to guarantee both a cyclical and a structural balance between energy supply and demand
- △ **National Agency of Electric Energy (ANEEL)** – subordinated to the MME, the agency deals directly with sector agents, setting tariffs, resolving disputes and granting authorizations as it implements policies and oversees participants
- △ **Electric Energy Trading Chamber (CCEE)** – accounts for and settles all energy trading activity in the country. Additionally, calculates and publishes a spot reference price for the whole sector, known as PLD
- △ **National System Operator (ONS)** – an independent agent, it is in charge of managing the SIN, with a defined set of goals: minimize the dispatch of thermal plants, meet demand at the lowest possible cost and, maintain reservoirs at adequate levels. It also plans operating plants for the isolated (northern) region of the country, on ANEEL's behalf.
- △ **Energy Research Company (EPE)** – conducts planning studies and research for the MME, in areas including electric energy, oil and gas, as well as biofuels.
- △ **The Electric Sector Monitoring Committee (CMSE)** – maintains the function of permanently monitoring and evaluating the continuity and security of the electric energy supply throughout Brazil.



Legal Framework

Brazil's legal framework revolves around:

- △ **ANEEL's Normative Resolution 414/10** – establishes general rules for electric energy supply
- △ **ANEEL's Normative Resolution 614/14** – contains the norms concerning plant unavailability once connected to the SIN, as well as ascertainment of physical coverage
- △ **Law 5,899/73** – regulates Itaipu's plant energy purchase, as agreed with the government of Paraguay (through a quota system)
- △ **Decree 5,163/04** – sets conditions for energy trading, as well as the regulatory process for obtaining electric energy concession grants and authorizations
- △ **Law 10,438/02** – one of the sector's most comprehensive law, regulates emergency energy supply expansion, unscheduled tariff reviews, creates both the Alternative Energy Incentive Program (Proinfa) and

the Energy Development Account (CDE) and, establishes electric energy universal access, while updating other relevant laws (9,427/96, 9,648/98, 3,890-A/61, 5,655/71, 5,899/73, and 9,991/00)

- △ **Decree 5025/04** - rules on Proinfa's first stage
- △ **Resolutions 482/12 and 687/15** - regulates general access conditions for decentralized micro and mini-generation, as well as a net metering system.

Renewable Energy Sector

The Brazilian renewable energy market is composed of:

- △ 5,867 operational sites, totaling 127 GW of installed capacity
- △ An additional 4 GW in generation capacity underway, resulting from 154 projects under construction and 387 projects yet to be built.



5,867

Operational sites, totaling **127 GW** of installed capacity

154

Projects **under construction**

387

Projects **yet to be built**

An additional 4 GW in generation capacity is expected to be added from confirmed future projects

Brazil's Renewable Energy Sector in Numbers

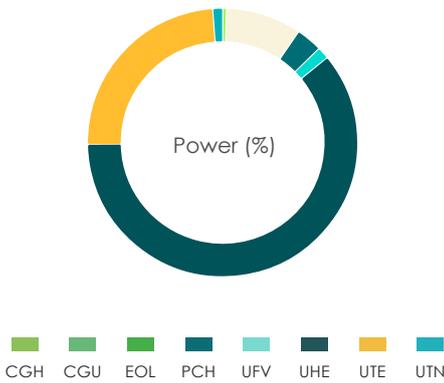
Projects in Operation

Brazil has almost nine thousand renewable projects in operation, with a combined approved capacity of over 173 GW. Large hydropower plants represents the majority of committed capacity with over 60% coming from its 217 units around the country. Wind and solar have 629 and 3870 operating units

corresponding to more than 15,3 GW and 2,5 GW respectively.

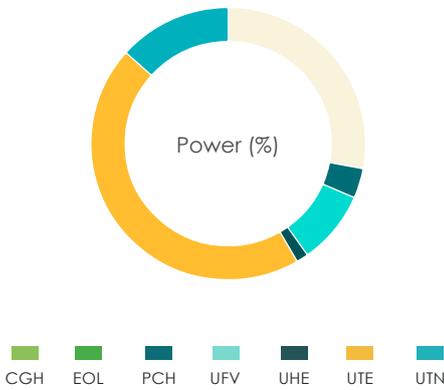
Projects in Planning & Construction

The number of projects in planning and construction phases presents a picture of how the sector is likely to grow in the short to medium term.

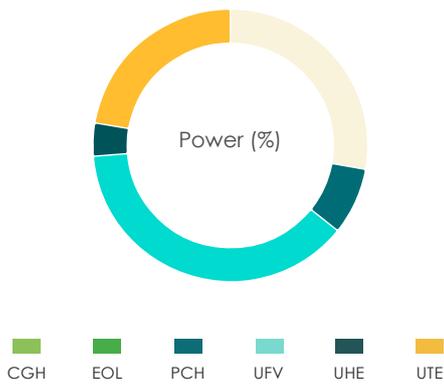


Projects in Operation				
Type	Units	Approved Capacity (kW)	Committed Capacity (kW)	%
CGH	728	783,280	783,094	0.46
CGU	1	50	50	0
EOL	629	15,396,749	15,377,853	9.04
PCH	422	5,363,780	5,289,363	3.11
UFV	3870	2,481,532	2,473,532	1.45
UHE	217	102,964,008	102,998,876	60.56
UTE	3040	42,758,155	41,173,677	24.21
UTN	2	1,990,000	1,990,000	1.17
Total	8909	171,737,554	170,086,445	100

Percentage values refer to the committed capacity.



Project under Construction			
Type	Units	Approved Capacity (kW)	%
CGH	4	6,512	0.06
EOL	97	2,820,505	27.9
PCH	28	356,449	3.53
UFV	24	883,258	8.74
UHE	1	141,900	1.4
UTE	82	4,550,866	45.02
UTN	1	1,350,000	13.35
Total	237	10,109,490	100



Projects Approved but not under Construction			
Type	Units	Approved Capacity (kW)	%
CGH	1	2,100	0.01
EOL	140	4,675,000	27.8
PCH	94	1,333,931	7.93
UFV	152	6,389,768	38
UHE	6	659,000	3.92
UTE	46	3,756,727	22.34
Total	439	16,816,526	100

CGH	Hydropower plants < 1MW	UFV	Solar power plant
CGU	Wave power plant	UHE	Hydropower plants
EOL	Wind power plant	UTE	Thermal power plant
PCH	Hydropower plants < 30MW	UTN	Nuclear power plant

*Source ANEEL 2020

Installed Capacity by Generation Type

Source			Installed Capacity			Total		
Source	Type	Input	Units	(KW)	%	Units	(KW)	%
Biomass	Agroindustrials	Sugarcane Bagasse	405	11,445,902	64,210	423	11,538,886	64,732
		Biogas	3	7,951	0,0045			
		Grass	2	31,700	0,0178			
		Rice husk	13	53,333	0,0299			
	Liquid Biofuels	Ethanol	1	320	0,0002	3	4,670	0,0026
		Vegetable Oils	2	4,350	0,0024			
	Forestry	Biogas - Forest	1	5,000	0,0028	104	3,241,553	18,185
		Charcoal	8	48,197	0,0270			
		Blast Furnace Gas	12	127,705	0,0716			
		Firewood	7	82,215	0,0461			
		Black Liquor	18	2,530,719	14,197			
		Forest Waste	58	447,717	0,2512			
	Animal Waste	Biogas	14	4,481	0,0025	14	4,481	0,0025
	Urban Solid Waste	Biogas	22	168,599	0,0946	26	181,127	0,1016
		Coal	3	8,250	0,0046			
Urban Solid Waste		1	4,278	0,0024				
Wind			629	15,337,853	86,268	629	15,377,853	86,268
Fossil	Mineral coal	Process Heat	2	28,400	0,0159	23	3,596,830	2,0178
		Coal	13	3,202,740	17,967			
	Natural Gas	Blast Furnace Gas	8	365,690	0,2051	166	13,431,505	7,5349
		Process Heat	1	40	0,0224			
		Natural Gas	165	13,391,505	7,5125			
	Other fossils	Blast Furnace Gas	4	165,970	0,0931	4	165,970	0,0931
	Petroleum	Blast Furnace Gas	1	1,200	0,0007	2277	9,008,654	5,0538
		Refinery Gas	6	319,530	0,1793			
		Fuel Oil	75	3,301,595	1,8522			
		Diesel Oil	2178	4,363,001	2,4476			
Others		17	1,023,328	0,5741				
Hydropower			1367	109,071,333	61,1879	1367	109,071,333	61,1879
Nuclear			2	1,990,000	1,1164	2	1,990,000	1,1164
Solar			3870	2,473,532	1,3876	3870	2,473,532	1,3876
Wave power			1	50	0	1	50	0,0000
Import	Paraguay			5,650,000	31,685			4,5832
	Argentina			2,250,000	12,622			
	Venezuela			200,000	0,1121			
	Uruguay			70,000	0,0392			
Total			8909	178,256,444	100	8909	178,256,444	100

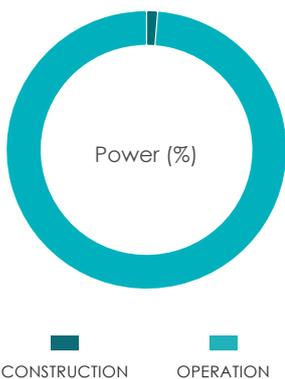
*Source ANEEL 2020

Project Summary

The energy sector is a dynamic landscape with projects in development, under construction, or in operation. Together, these projects in their various phases give an overview of the entire sector, now and in the foreseeable future.

Consolidated Project Summary		
Source	Status	Capacity (kW)
140 wind project	Development	4,675,000
97 wind projects	Construction	2,820,505
629 wind projects	Operation	15,377,853
152 solar projects	Development	6,389,768
24 solar projects	Construction	883,258
3870 solar projects	Operation	2,473,532
107 hydropower projects	Development	2.84.231
33 hydropower projects	Construction	504,861
1367 hydropower projects	Operation	109,071,333
1 wave power project	Operation	50
49 thermal power projects	Development	3,834,227
83 thermal power projects	Construction	5,900,866
3042 thermal power projects	Operation	43,163,677

*Source ANEEL 2020



Thermal Plants with Qualified Cogeneration

Cogeneration units struction			
Type	Units	Approved Capacity (kW)	%
Construction	1	7,902	0,28
Operation	72	2,776,834	99,72
Total	73	2,784,736	100

*Source ANEEL 2020

National bodies openly admit that foreseen scenarios for the next decades highlight the importance of enhancements, as well as a consolidated effort in regulation, in order to promote the growth of sustainable results, both on national and regional levels.

In Chapter 2, we will discuss electricity sales under Brazil's duel model with both free and regulated market contracts, the auction system, and weekly spot reference price

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Please note that the energy field is dynamic, and the material and data presented herein could change.

Sources

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ABSOLAR	Canal Energia	EPE	MME
ANEEL	CBFT	EXAME	ONS
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