BEN

Summary Report 2023

Reference year 2022

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Acknowledgement

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Ana Cristina Braga Maia
Arnaldo dos Santos Junior
Fernanda Marques Pereira Andreza
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The pictures and icons used throughout this report were obtained from the Flaticon.com platform.

Specific thanks to the authors Freepik, iconixar, wanicon and itim2101.

Content

Presentation

In compliance with its creation law, the Energy Research Office (EPE) prepares and publishes the Brazilian Energy Balance (BEB – BEN, in Portuguese) annually, maintaining a tradition initiated by the Ministry of Mines and Energy (MME). The purpose of the BEB is to present the accounting for the supply and consumption of energy in Brazil, covering the activities of extraction of primary energy resources, their conversion into secondary forms, import and export, distribution and energy end-use.

BEB is the result of extensive research, constituting itself as a broad and systematic database, updated in annual cycles. Of paramount importance for studies related to national energy planning, BEB has also proved to be an important research tool for sectoral studies, as it presents reliable statistics, often revealing trends in energy supply and consumption. The document is taken as a reference for the country's energy data. The Summary Report of the Brazilian Energy Balance 2023 - Reference Year 2022, presents consolidated information on how much and how energy was used in Brazil in 2022.

BEB's product portfolio

Tools for monitoring energy statistics

The product portfolio of the Brazilian Energy Balance has its origin in energy statistics and seeks to diversify the ways of consolidating, making available and visualizing this data according to the different audiences interested in statistics. This portfolio has recently gained new products, such as the Interactive Brazilian Energy Balance and BEN 50 Years. Now, we present the new version of the Summary Report of the Brazilian Energy Balance. A traditional EPE publication that has a new format, more modern, didactic and explanatory to the Brazilian and international society.

Total Energy Supply

In 2022, the domestic energy supply (total energy made available in the country) reached 303.1 Mtoe, registering a decrease of 0.03% when compared to the previous year. The share of renewables in the energy mix was marked by an increase in the supply of hydroelectric power, associated with an improvement in the water regime and a reduction in the use of thermoelectric plants based on fossil fuels such as natural gas, coal and oil products.

In addition, together with the expansion of hydroelectric power, the increase in wind and solar power generation (zero loss), as well as other renewables such as black liquor, biogas and other biomass, have contributed to Brazil's energy mix remaining at a renewable level of 47.4%, much higher than the rest of the world.

Electricity Supply

In the case of electricity, there was an increase in domestic supply of 10.9 TWh (+1.6%) compared to 2021.

The main highlights were:

- The share of renewables in the electricity mix achieved **87.9%** in 2022.
- Solar photovoltaic generation reached 30.1 TWh (centralized generation and MMDG), growing by 79.8%, and its installed capacity reached 24,453 MW, an expansion of 82.4% compared to the previous year.
- Hydroelectric generation contributed an additional 64.3 TWh and grew by 17.7% compared to 2021.
- Wind generation reached 81.6 TWh (12.9% increase) and its installed capacity reached 23,761 MW, an expansion of 14.3%.
- Thermoelectric generation fell by 32.3%.

Final Consumption

Final consumption (both energy and non-energy), dropped 2.0% in relation to the previous year.

Industry

The industrial sector had an increase of 1.3 million toe in absolute values. The 4.6% reduction in the use of mineral coal compared to 2021 due to the reduction in steel production through the coal coke reduction process is noteworthy. There was a 10.2% increase in the use of black liquor due to the almost 11% increase in pulp production. In addition, natural gas, used in various industrial segments, had an energy consumption 5.0% higher than in 2021.

Except for Other Industries, Pulp and Paper and Food and Beverages, which saw increases of 15.2%, 8.1% and 3.1% respectively, all other industrial segments saw a drop in energy consumption in 2022.

Transport

Energy consumption in 2022 in transportation increased by 5.0% compared to 2021. The main highlights were increases of 24.3% in aviation kerosene, 10.5% in anhydrous ethanol and 9.4% in gasoline.

In the light vehicle market, ethanol lost share compared to automotive gasoline, accounting for 39% of consumption, compared to 40% in 2021.

In the case of road freight transport, biodiesel consumption fell by 6.5%, which can be explained by the reduction in the percentage of blending with mineral diesel to 10% (B10) over the course of 2022.

As a result of these movements, Brazil's transport sector will have an energy mix made up of 22% renewable sources in 2022, compared to 23% the previous year.

Final Consumption by source

Electricity

Final electricity consumption in the country in 2022 grew by 2.3%. The sectors that contributed most to this growth in absolute terms were Commercial, which grew by 6.8 TWh (+7.5%), followed by Industrial, which increased its consumption by 5.2 TWh (+2.4%), Residential, which grew by 4.5 TWh (+3.0%) and the Public Sector, with an increase of 1.9 TWh (+4.3%).

Ethanol

The final consumption of ethanol in the country (m^3) increased by 1.6% compared to 2021 and reached around 30.4 million cubic meters in 2022.

Biodiesel

Final biodiesel consumption in the country (m^3) in 2022 fell by 6.5%. The mandatory blend percentage in petroleum diesel remained at 10% (in volume) throughout 2022.

Emissions

In 2022, the total anthropic emissions associated with the Brazilian energy mix reached 423 million tons of carbon dioxide equivalent (Mt $CO_{2\text{-eq}}$), the majority (210,4 Mt $CO_{2\text{-eq}}$) being generated in the transport sector.

In terms of emissions per inhabitant, each Brazilian, producing and consuming energy in 2022, emitted on average 2,0t $CO_{2\text{-eq}}$.

According to the latest data released by the International Energy Agency (IEA) for 2020, a year heavily impacted by the Covid-19 pandemic, each Brazilian emitted the equivalent of 14% of an American, 36% of a citizen of OECD Europe and 26% of a Chinese.

The carbon intensity in the economy was 0.14 kg CO_2/US$ppp [2010][1].

Also based on IEA data from 2020, the carbon intensity in the Brazilian economy is equivalent to 31% of the Chinese economy and 61% of the U.S. economy.

For each toe made available, Brazil emits the equivalent of 74% of the OECD Europe, 67% of the USA's, and 49% of China's emissions.

The Brazilian electric sector emitted, on average, only 61,7 kg CO_2 to produce 1 MWh, a very low rate when comparing with countries in OECD Europe, USA and China.

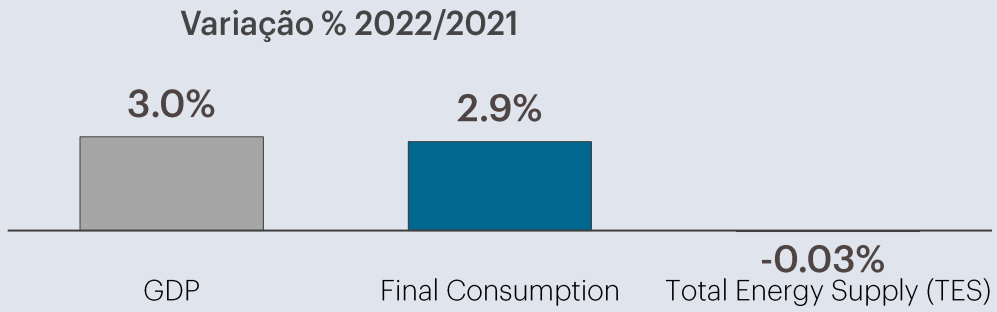
The digital version of this document can be accessed at: https://www.epe.gov.br

[1] In the concept of purchasing power parity.

How much Energy is used in Brazil?

The **Total Energy Supply (TES)** in Brazil registered, in 2022, a small decrease of 0.1% when compared to the previous year, below GDP growth.

Values in 10^6 toe		2021	2022
Total Energy Supply (TES)	↓	303.2	303.1
Final consumption	↑	263.8	271.3
Losses[1]	↓	39.4	31.8



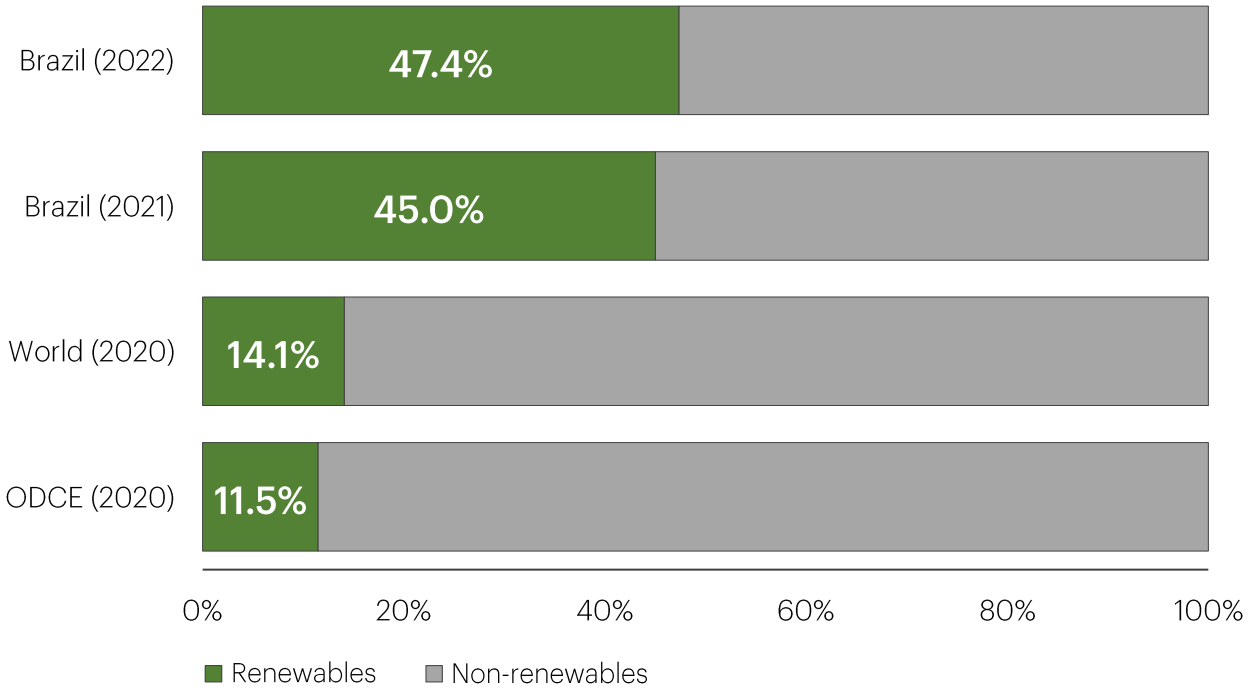
Losses:
refer to energy conversion losses in transformation centers + losses in energy distribution and storage.

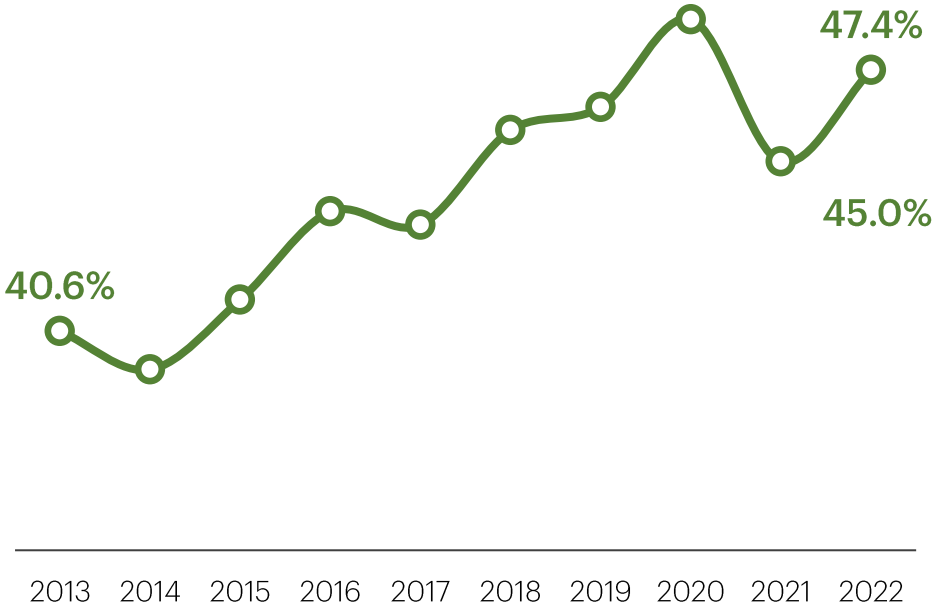
[1] Refer to energy conversion losses in transformation centers + losses in energy distribution and storage.

The **share of renewables in the energy mix**[1] was impacted by the increased supply of hydraulic energy, associated with a favorable water regime.

Share of renewables in the TES

Source: International Energy Agency and EPE for Brazil. Prepared by: EPE

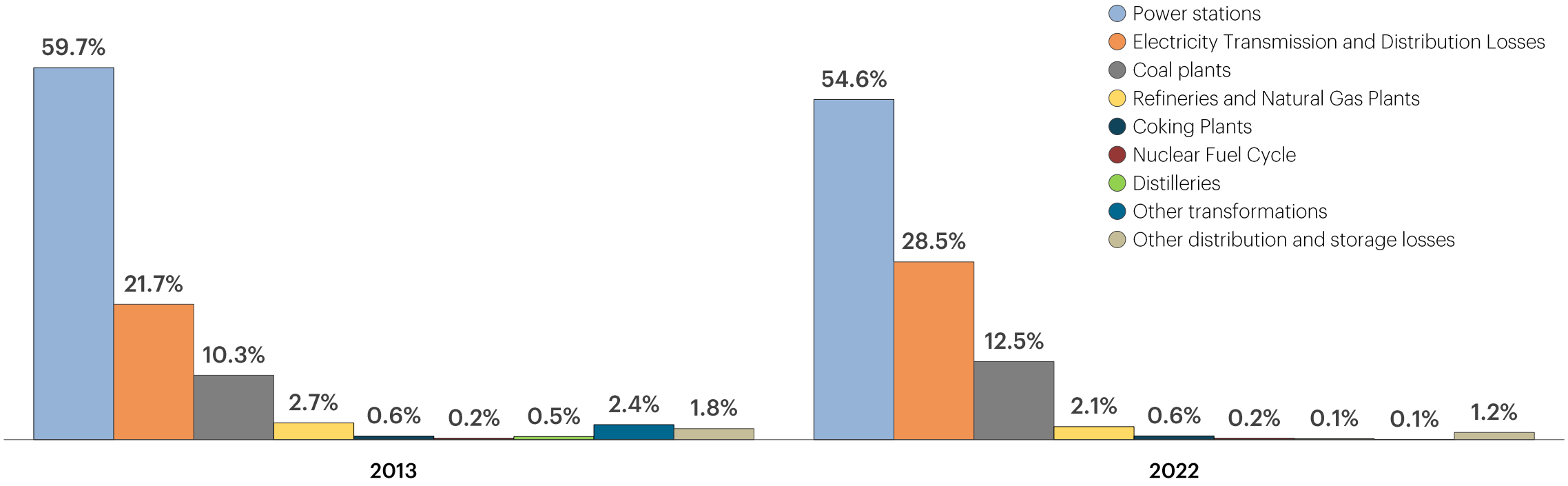




[1] Renewability is calculated based on the Total Energy Supply - TES

Evolution of total losses[1] over 10 years

Distribution of losses among segments

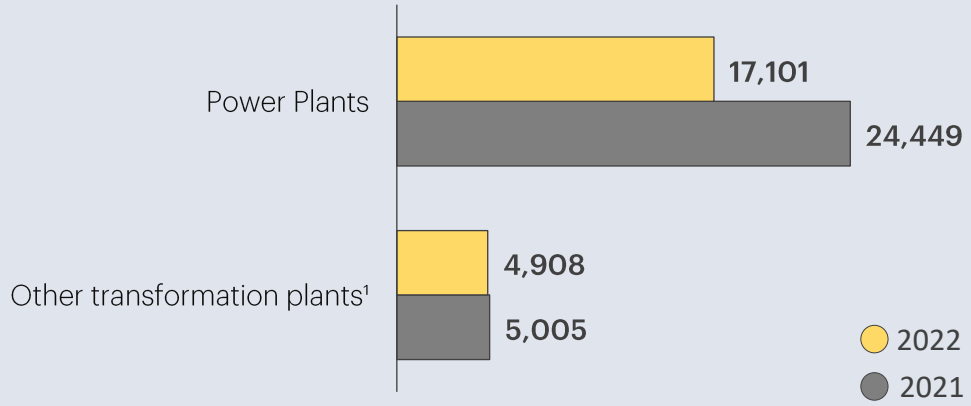


Over 10 years, three segments have been responsible for more than 90% of the losses that occur in the country: power stations, electricity transmission and distribution, and coal plants.

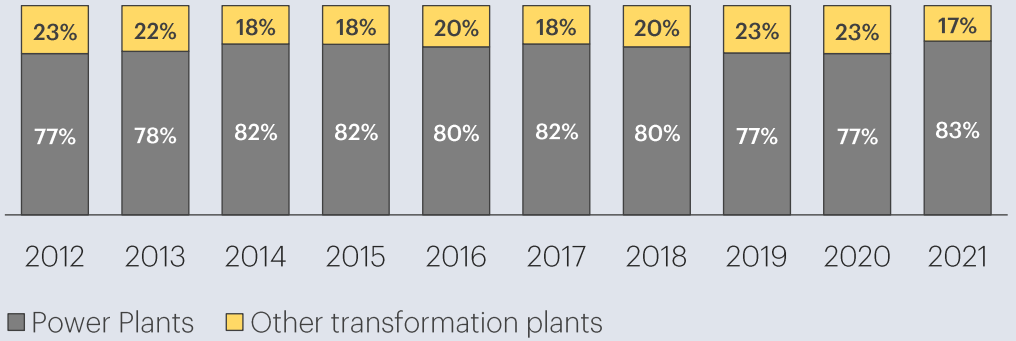
[1] Total losses correspond to losses in transformation centers, electricity transmission and distribution losses and other distribution and storage losses.

Losses in Transformation Centers

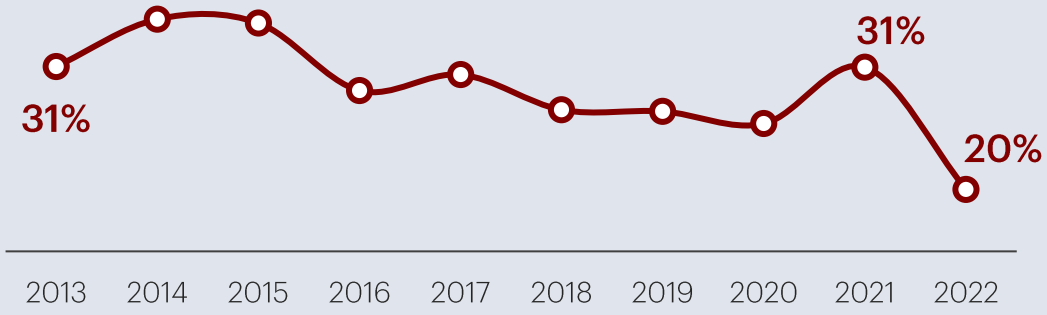
Distribution of losses (10³ toe)
Source: EPE



Distribution of losses



Share of thermal plants in generation



Other transformation plants

Include oil refineries, natural gas plants, coke plants, nuclear fuel cycle, coal stores, distilleries, other transformations.

Thermoelectric power plants (including nuclear power plants)

concentrate all losses in power plants. Therefore, the greater the participation of this type of plant in the generation mix, the greater the losses associated with power plants..

Which
Energy Resources are used in Brazil?

Breakdown of total energy supply – TES in 2022

RENEWABLES ▶ 47.4%

Sugarcane biomass

15.4%

Hydro power[1]

12.5%

Wind power

2.3%

Firewood and charcoal

9.0%

Black liquor and Other Renewables

7.0%

Solar[2]

1.2%

NON-RENEWABLES ▶ 52.6%

Oil and oil products

35.7%

Natural gas

10.5%

Coal

4.6%

Uranium

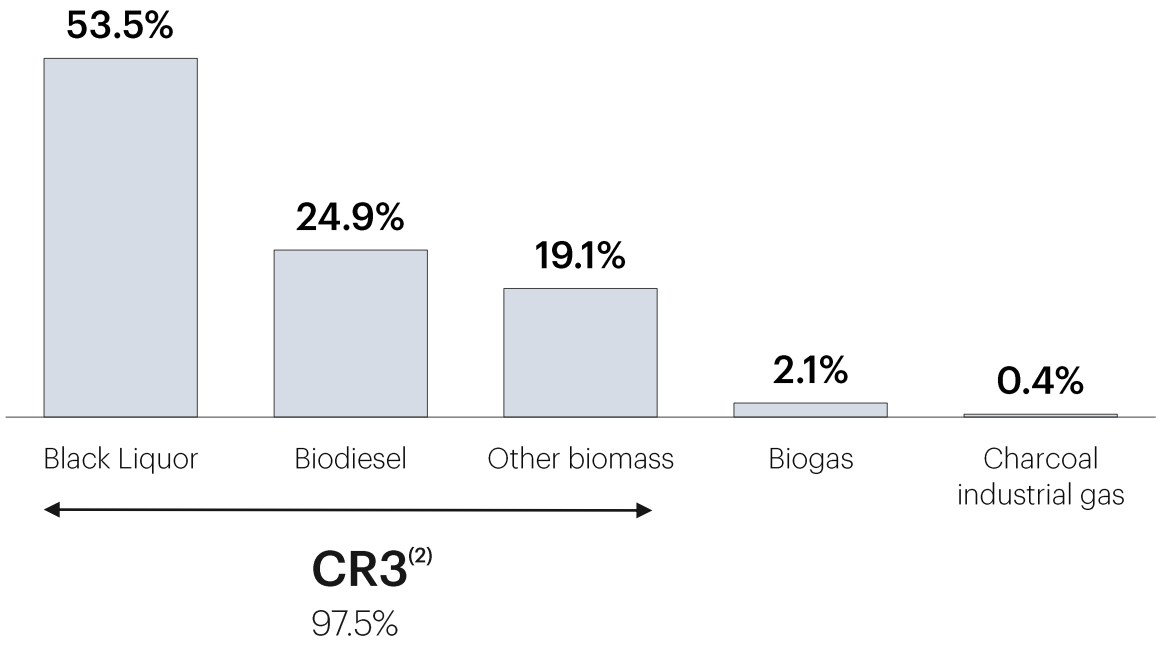
1.3%

Other non-renewable

0.6%

[1] Includes import of electricity from a hydraulic source.
[2] Includes solar photovoltaic and solar thermal sources

The **"Black Liquor and Other Renewables"** category is divided into 5 categories of energy sources with the largest shares of black liquor, biodiesel and other biomass, which together account for more than 95% of "Other Renewables".

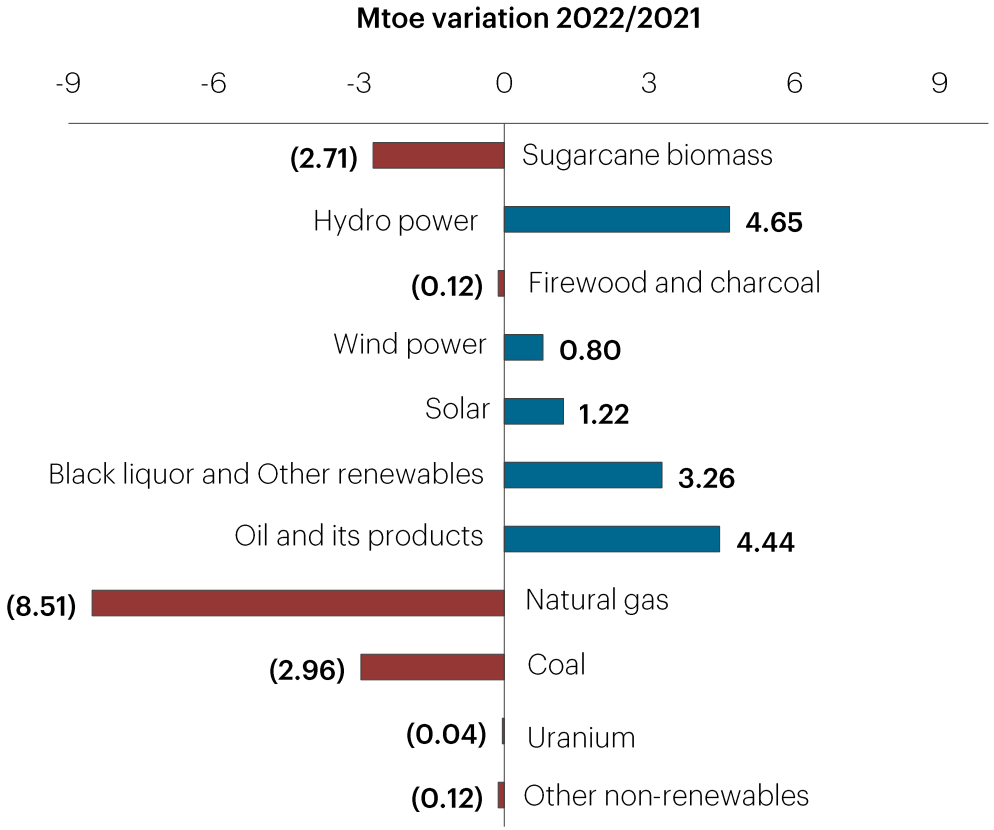


Black Liquor and Other renewables (10^6 toe)	2021	2022	Δ% 22/21
Black liquor	10.1	11.3	11.3%
Biodiesel	5.6	5.3	-5.7%
Other biomass[1]	1.6	4.0	153.1%
Biogas	0.4	0.4	16.5%
Charcoal industrial gas	0.2	0.1	-45.7%
Total	**17.8**	**21.1**	18.3%

[1] Includes rice husks, elephant grass and vegetable oils
[2] Concentration Ratio Index: CR3 is the representativeness of the 3 largest sources combined

Total Energy Supply 2021-2022

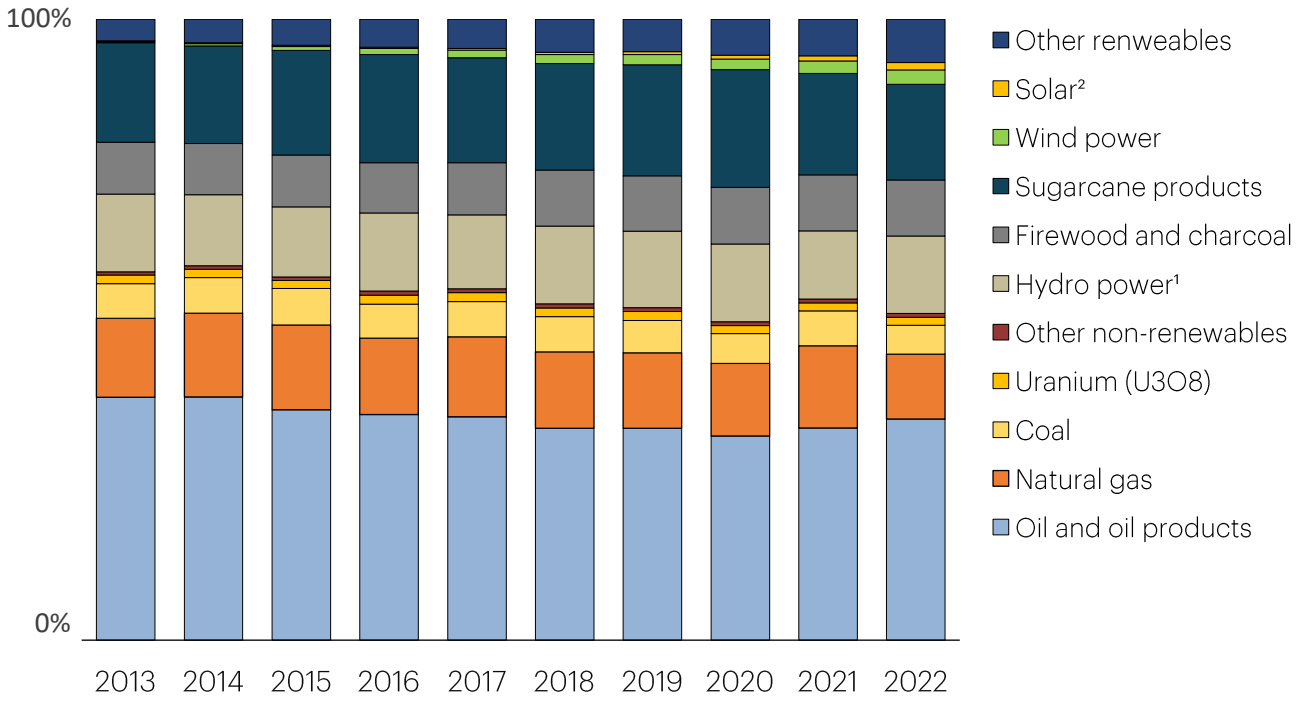
Source (Mtep)	2021	2022	Δ% 22/21
RENEWABLES	**136.5**	**143.6**	**5.2%**
Sugarcane biomass	49.4	46.7	-5.5%
Hydro power[1]	33.2	37.8	14.0%
Firewood and charcoal	27.4	27.3	-0.5%
Wind power	6.2	7.0	12.9%
Solar[2]	2.37	3.6	51.5%
Black liquor and Other renewables	17.8	21.1	18.3%
NON-RENEWABLES	**166.7**	**159.5**	**-4.3%**
Oil and oil products	103.6	108.1	4.3%
Natural gas	40.2	31.7	-21.2%
Coal and coke	16.9	14.0	-17.5%
Uranium (U_3O_8)	3.9	3.9	-1.0%
Other non-renewables	2.0	1.9	-6.2%



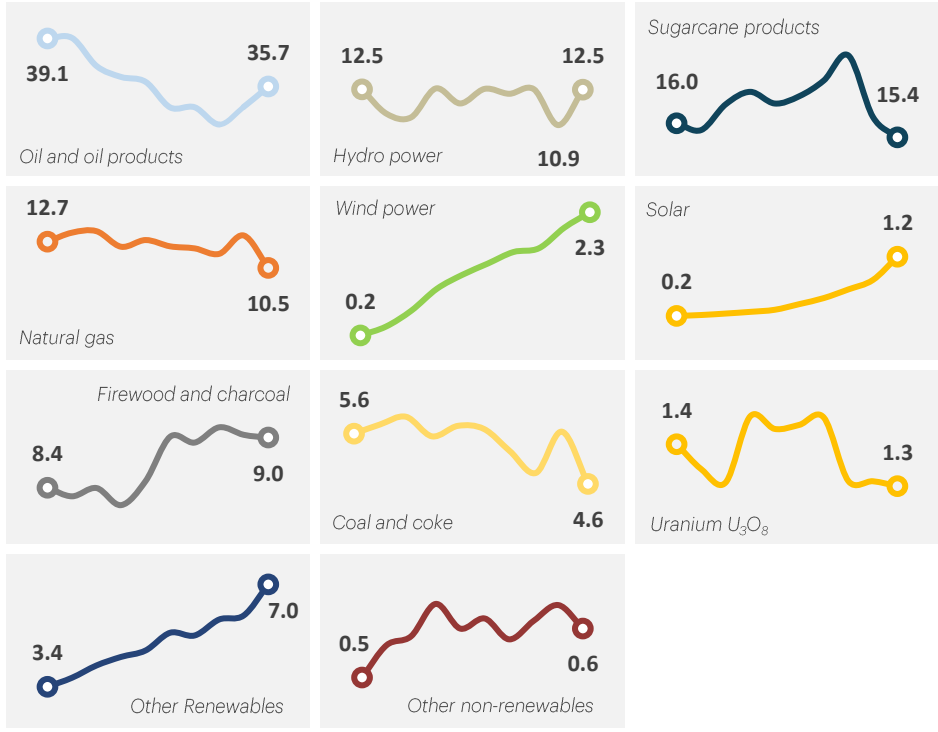
Main movements: reduction in biomass due to the fall in ethanol production in the sugar-alcohol sector; reduction in natural gas due to the decrease in thermoelectric plant dispatches and the fall in steel production impacting on the reduction of mineral coal.

[1] Includes import of electricity from hydro
[2] Includes Solar photovoltaic and solar thermal

Total Energy Supply 2013-2022



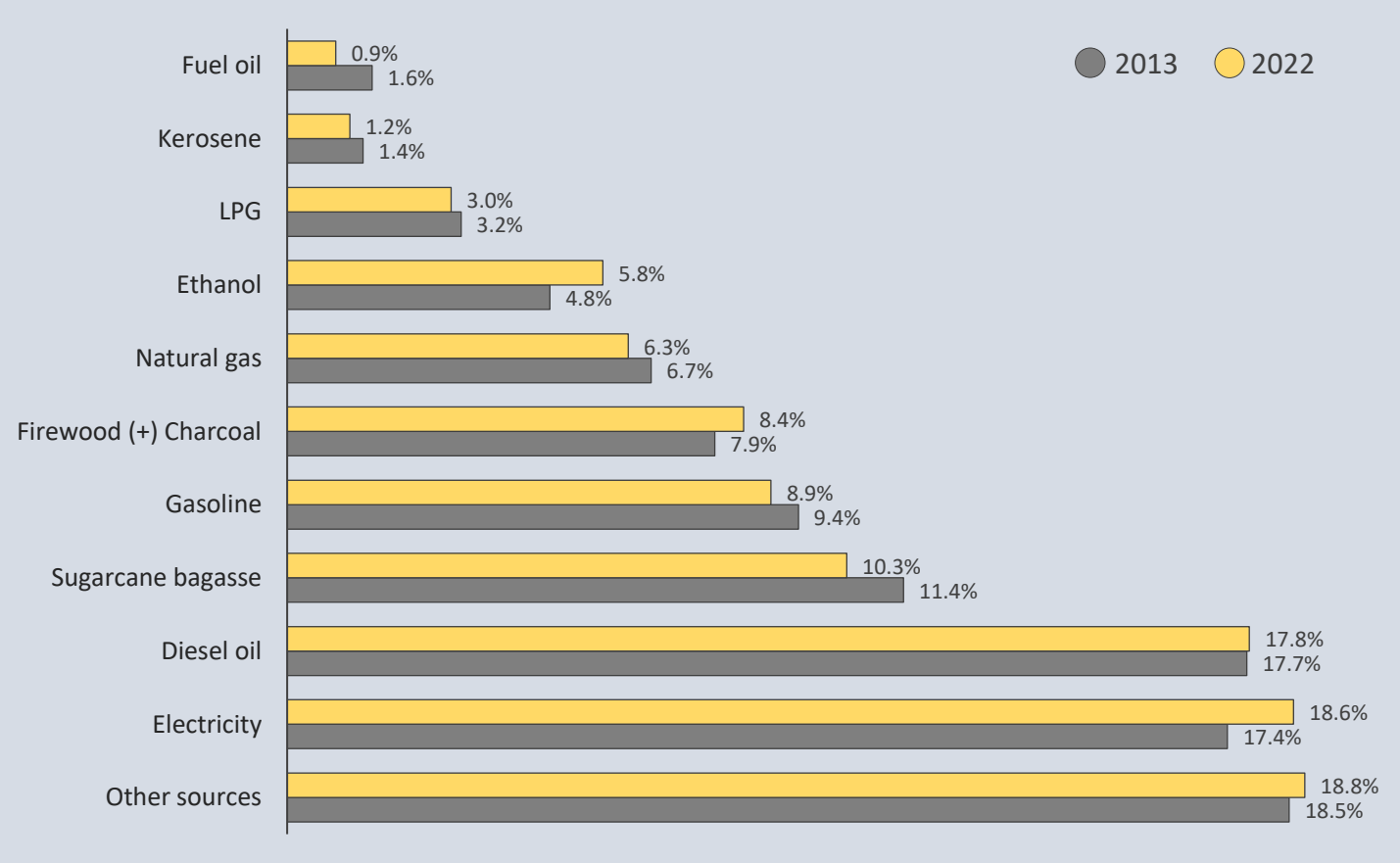
Share of sources in OIE (%) between 2013 and 2022



It can be seen that there was a reduction in the share of renewables in the energy mix between 2013 and 2014 due to the fall in hydroelectric supply. From 2015 onwards, renewable sources resumed their growth trajectory, reaching a 45% share in 2021 and 47.4% in 2022, mainly due to the increase in electricity generation from hydroelectric sources.

[1] Includes import of electricity from Hydro power
[2] Includes Solar photovoltaic and solar thermal

Energy consumption[4] by source (share)



Lower share in 2022 compared to 2013

LPG, Natural gas, Kerosene, Sugarcane bagasse, Fuel oil Gasoline

Higher share in 2022 compared to 2013

Electricity, Ethanol, Firewood, Diesel oil, Other sources

5 energy sources

5 energy sources

[1] Includes biodiesel
[2] Includes aviation gasoline
[3] Includes refinery gas, coal coke, charcoal, tar, naphtha, mineral coal, other secondary products, asphalt, lubricants and solvents
[4] Does not include use in transformation centers.

Highlight: Biodiesel final consumption

The growing consumption of biodiesel in Brazil is favored by the policy of adding this fuel to fossil diesel, as shown in the graph. In terms of production, Brazil is among the world's largest producers of this biofuel. The most widely used raw material for its manufacture in Brazil is soybean oil.

2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1	66	391	1,111	1,543	2,272	2,439	2,612	2,742	3,189	3,769	3,719	4,183	5,270	5,762	6,280	6,615	6,801

Who uses Energy in Brazil?

65% of the country's energy consumption in 2022 will go to **freight and passenger transportation** and the **industrial sector**...

Transport
33.0%

Industries
32.0%

Households
10.7%

Energy Sector
8.7%

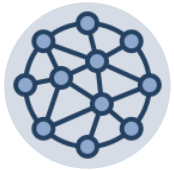
Agriculture and Livestock
4.8%

Services
5.0%

2022
271.3 Mtoe

2021
263.8 Mtoe

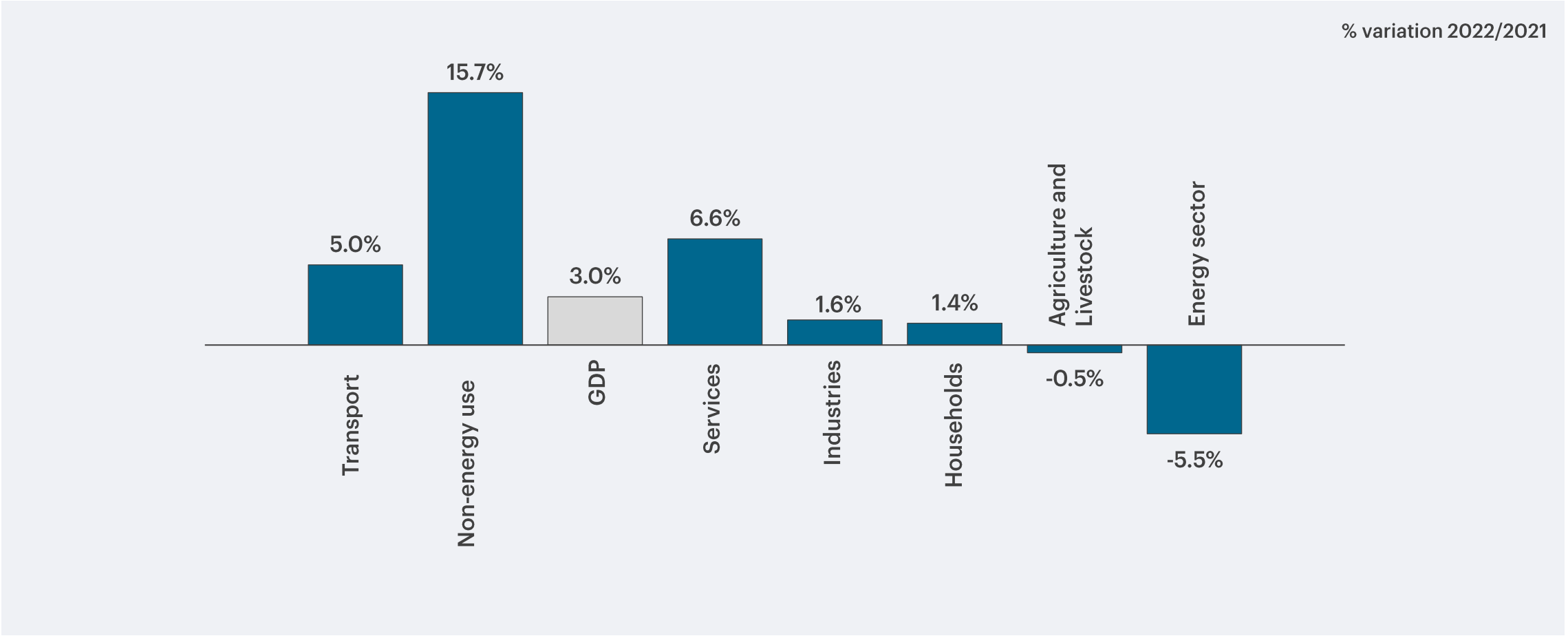
2.9% increase



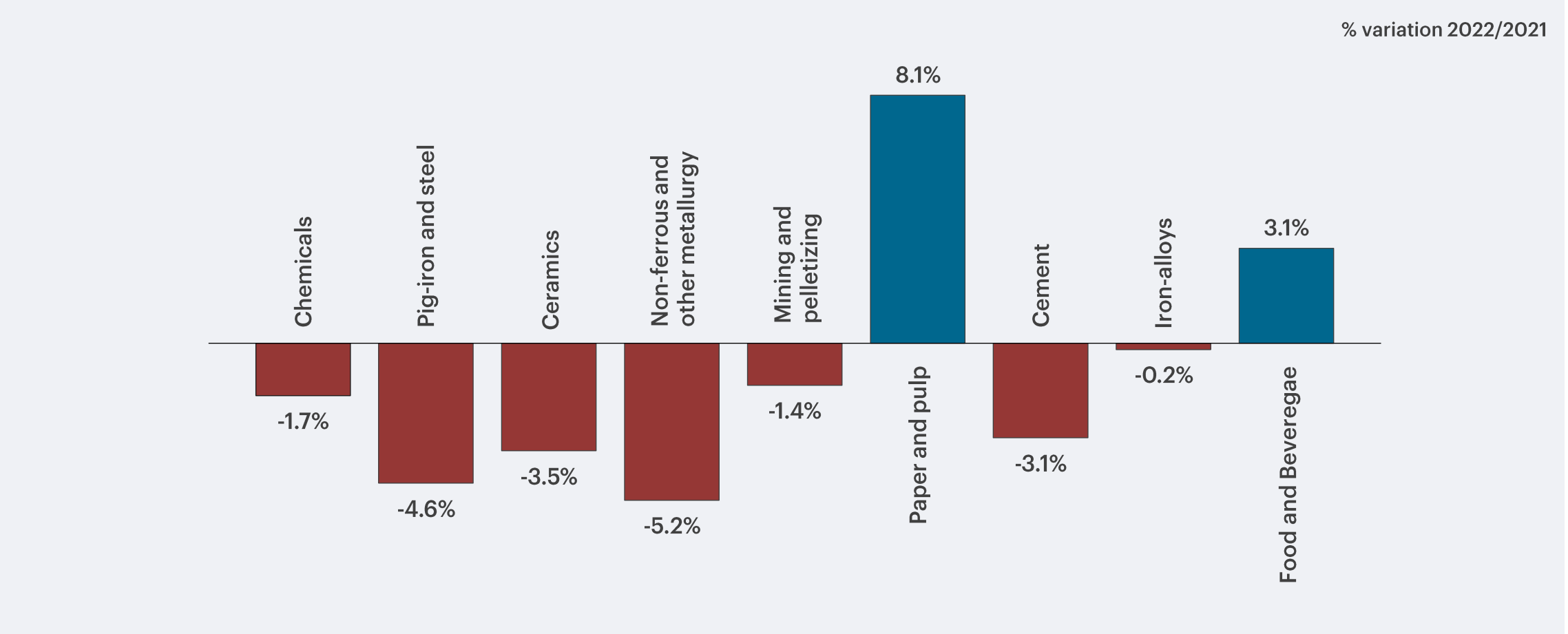
Non-energy use
5.9%

There was a 2.9% increase in energy use in 2022 compared to 2021. In this scenario, the transportation sector had the largest share of all sectors and once again became the country's leader in terms of energy consumption.

...but **how did energy consumption vary in Brazil (2021-2022)** when we compare all sectors of the Brazilian economy?

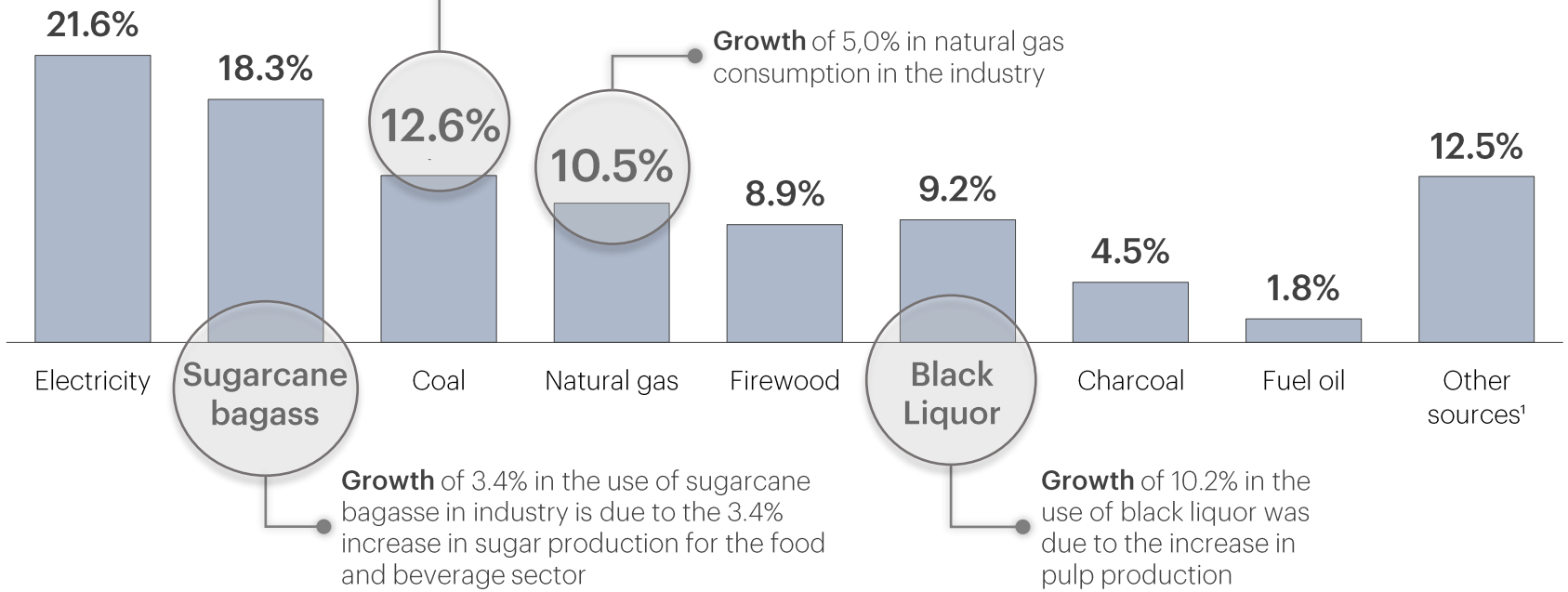


As a noteworthy sector, **energy consumption in the energy-intensive segments of industry** showed the following changes.



Energy consumption in industry, besides presenting a 1.6% growth compared to 2021, had 62% renewability in its mix, as represented by the following energy sources:

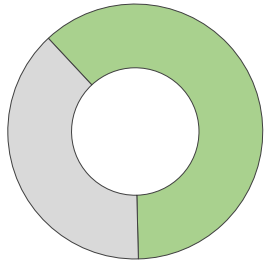
Share of energy sources sources in industry:



2022
86.9 Mtoe

2021
85.6 Mtoe

1.6% increase



62%
renewable

Note: In the case of Electricity, only its share generated from renewable sources is considered, which corresponded to 87.9% of total electricity generation in 2022 (see page 36)

"Other sources" include diesel, LPG, naphtha, kerosene, coke oven gas, tar, refinery gas, petroleum coke, among other renewable and non-renewable.

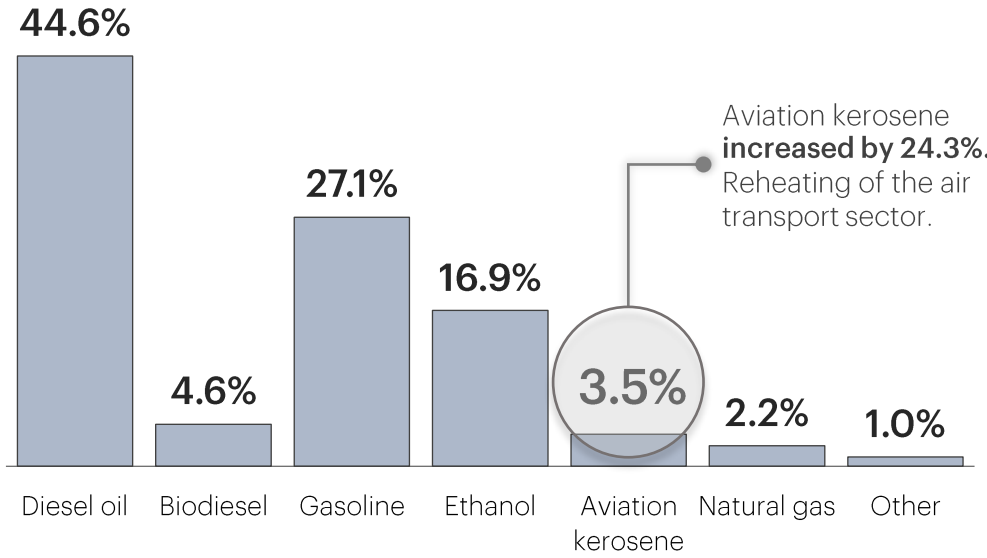
Energy consumption in 2022 in transportation[1] showed an increase of 5.0% compared to 2021. The main highlights were the 24.3% increase in aviation kerosene and the 10.5% increase in anhydrous ethanol.

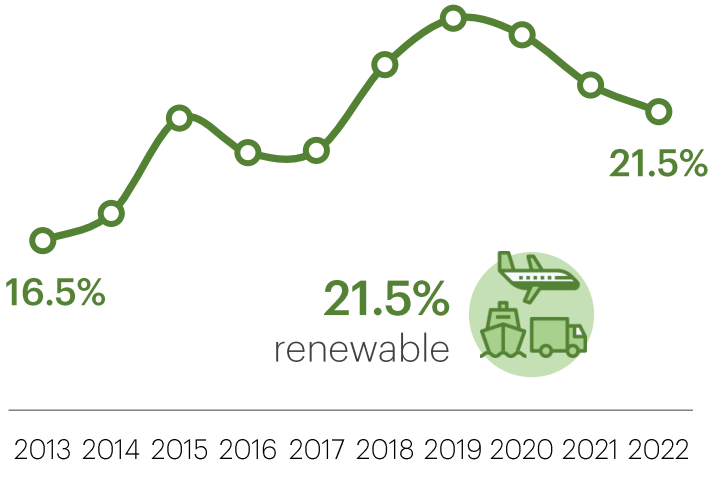
Share of energy sources sources in transports:

2022
89.4 Mtoe

2021
85.2 Mtoe

5.0% increase





Ethanol consumption increased by 2.1% compared to 2021, while Biodiesel fell by 6.5%. During 2022, the mandate for adding biodiesel to fossil diesel was 10% by volume (B10). For more information, see page 21.

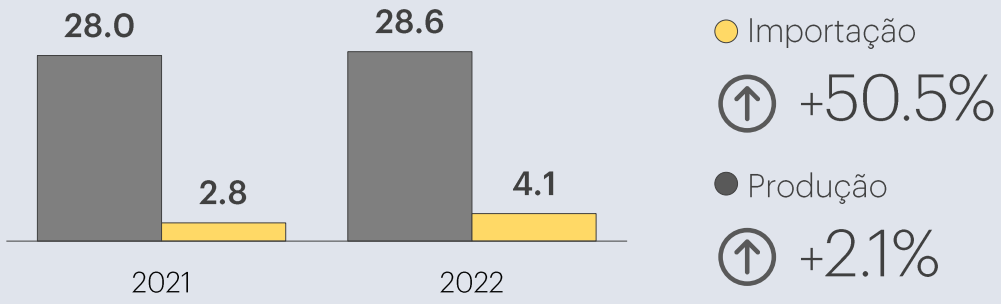
[1] The percentage variation in consumption is expressed on an energy basis, not a volumetric one.

Highlights: Energy consumption in transport

Post-pandemic effect In 2022, the main movements are related to the production and import of gasoline A **(Box 1)**, changes in diesel oil consumption and value added in transport services **(Box 2)**, and the share of ethanol consumption in the light vehicle market **(Box 3)**.

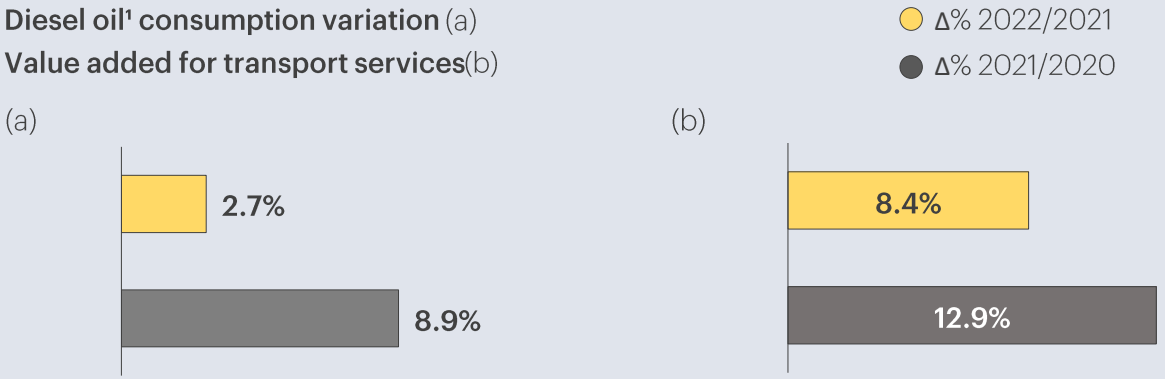
Box 1

Percent variation in the production and import of gasoline A (10^6 m³)



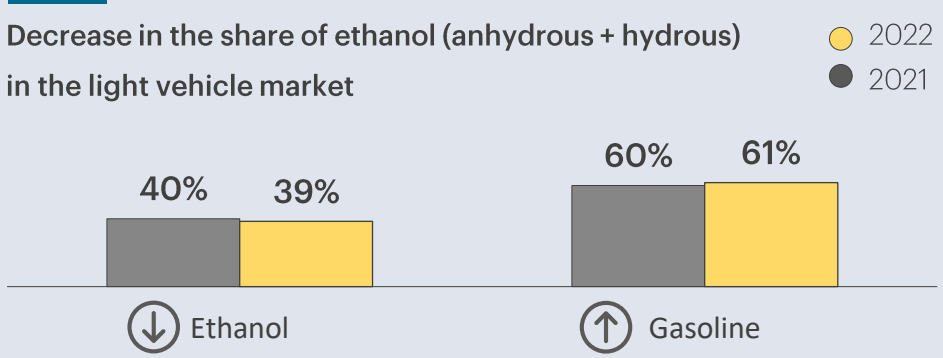
Box 2

Diesel oil[1] consumption variation (a)
Value added for transport services(b)



Box 3

Decrease in the share of ethanol (anhydrous + hydrous) in the light vehicle market



Hydrated ethanol used in flexfuel engines saw its share fall. Gasoline A, on the other hand, showed a positive trend.

Δ% 2022/2021
Hydrous Ethanol
-3.4%

Δ% 2022/2021
Gasoline A[2]
+9.5%

Source: EPE; IBGE. Prepared by EPE

[1] Includes biodiesel; [2] Gasoline A is the one produced by oil refineries and does not have anhydrous ethanol in its composition.

Final consumption in the Energy Sector reduced when compared to 2021, meaning that less energy was used to transform sources of energy in Brazil in 2022.

Source (10^3 toe)	2021	2022	Δ 22/21
Sugarcane bagasse	12,875	12,084	-6.1%
Natural gas	4,718	4,345	-7.9%
Oil products	3,721	3,816	2.5%
Electricity	3,342	3,079	-7.9%
Coke oven gas	207	172	-16.6%
Total	**24,863**	**23,496**	**-5.5%**

But, what is this transformation?

Transforming energy is carrying out processes to change the way energy presents itself.

For example, to transform oil into gasoline, diesel oil, kerosene and other oil products in the refinery, it is necessary to expend energy.

Sugarcane bagasse consumption in the energy sector fell by 6.1% compared to 2021. This was mainly due to the drop in ethanol production in the sugar and alcohol sector in 2022.

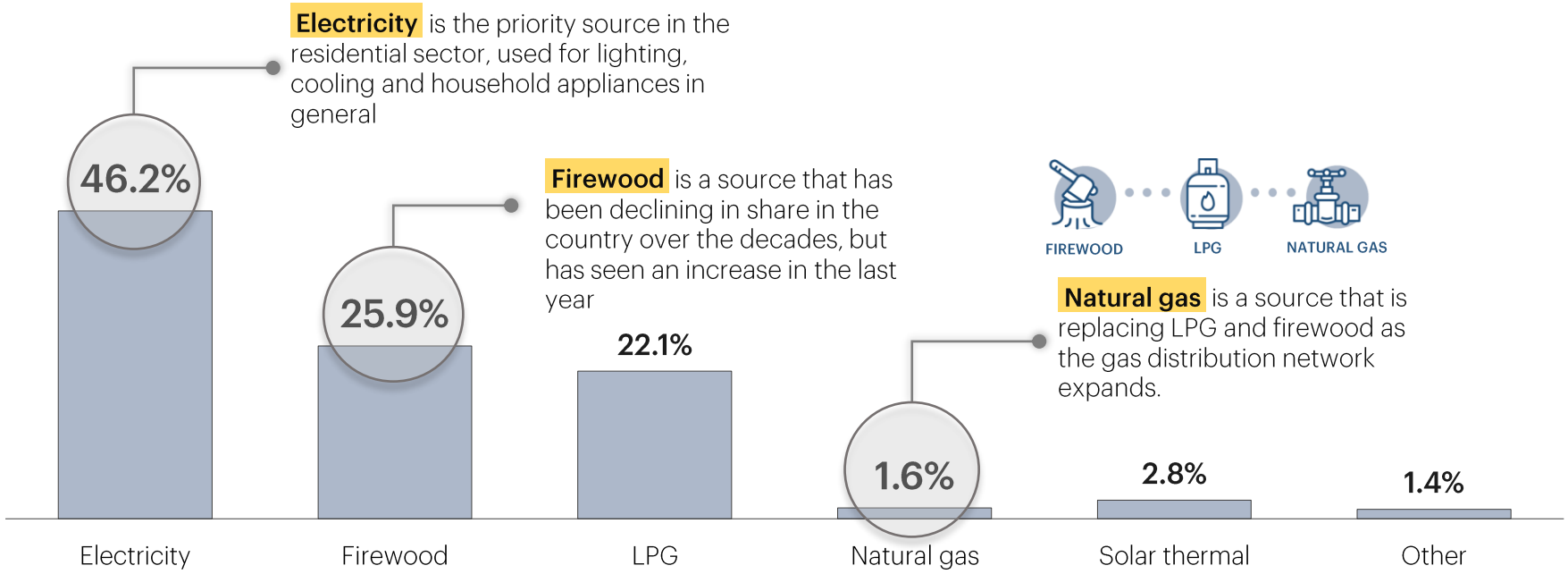
Residential energy consumption showed a discreet growth of 1.4% compared to 2021 and showed the following distribution in the use of energy...

Share of energy sources sources in households:

2022
29.0 Mtoe

2021
28.6 Mtoe

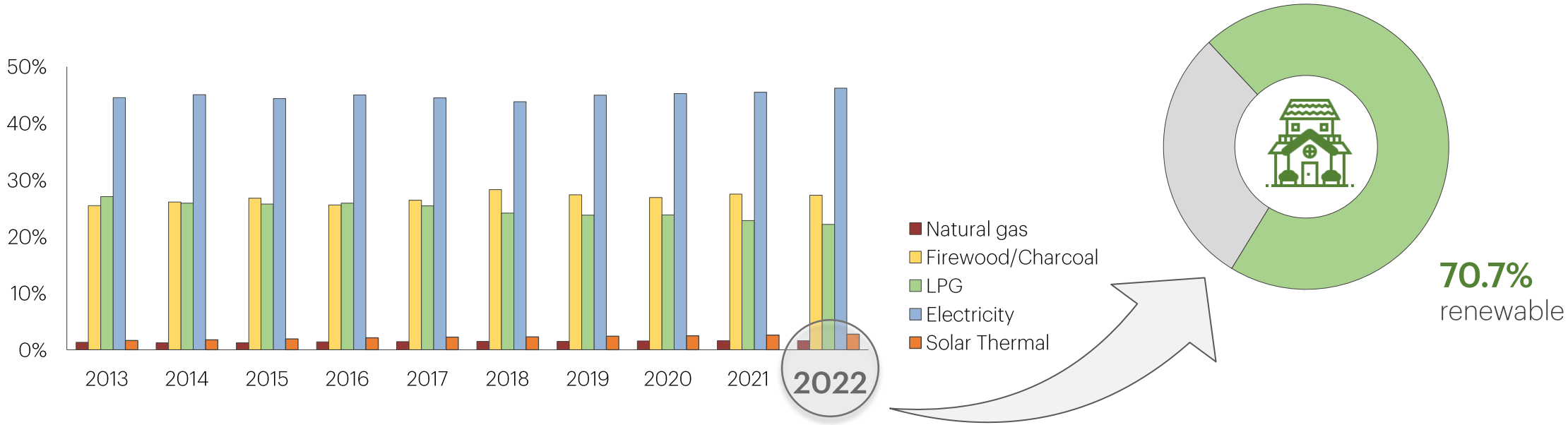
1.4% increase



Residential consumption of **electricity, firewood, natural gas and solar thermal** energy **grew by 3.0%, 0.9%, 2.1% and 7.1%** in relation to 2021. LPG, on the other hand, fell by 1.8% in residential consumption in 2022. From 2022 onwards, the National Energy Balance incorporates solar thermal into its mix. It can be seen that this source has a greater share than natural gas in the residential energy mix.

[1] Other sources include kerosene and charcoal

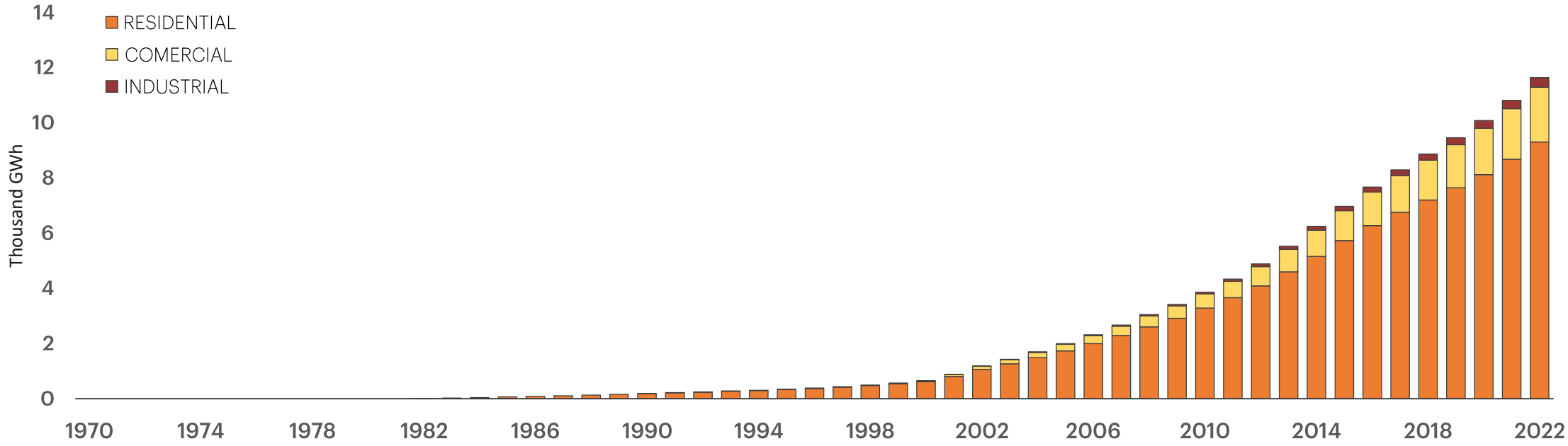
The distribution[1] of **sources in the energy mix of the residential sector** has been characterized over the last ten years by the use of electricity, firewood and LPG, with a small but growing participation of natural gas.



Most of Brazil's electricity comes from renewable sources. Therefore, the share of sources such as firewood and charcoal, which reached 27% in 2022, combined with the growing use of electricity (over 45%), allows the residential sector to have a renewability **index of around 71%. Note: wood-burning stoves are around a tenth as efficient as gas stoves.**

[1] History does not yet include solar thermal.

The **Solar Thermal** source, used for heating water in open, closed and vacuum tube collectors, reached 11,632 GWh equivalent in 2022, the result of growth over the years with a greater contribution from consumption by the residential sector.



In 2022, consumption of the solar thermal source in the residential sector represented around 80% of the total in Brazil, in second place the commercial sector was responsible for around 17% of consumption and, lastly, industry with less than 3%.

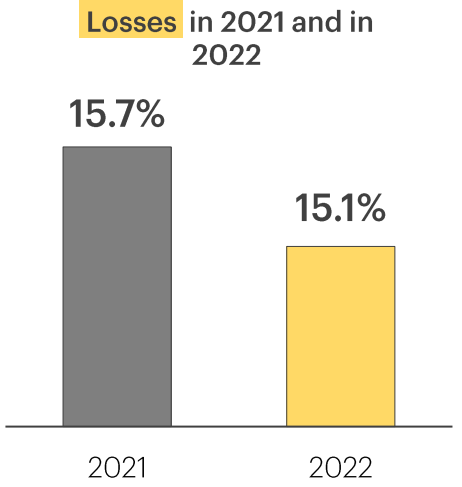
The use of **electricity**

Electricity in Brazil has seen an increase in consumption and, consequently, an increase in the domestic supply made available to the population.

Values in TWh		2021	2022	Δ 22/21
Total Electric Power Supply[1]	↑	679.2	690.1	1.6%
Power plants PS[2]	↑	542.1	551.6	1.7%
Power plants APE[3]	↑	114.0	125.6	10.2%
Electricity imports[4]	↓	23.1	12.9	-44.1%
Final consumption[5]	↑	572.8	586.1	2.3%
Losses (commercial + technical)	↓	106.4	104.0	-2.2%

↑ **1.6% increase** in the electricity made available to the society

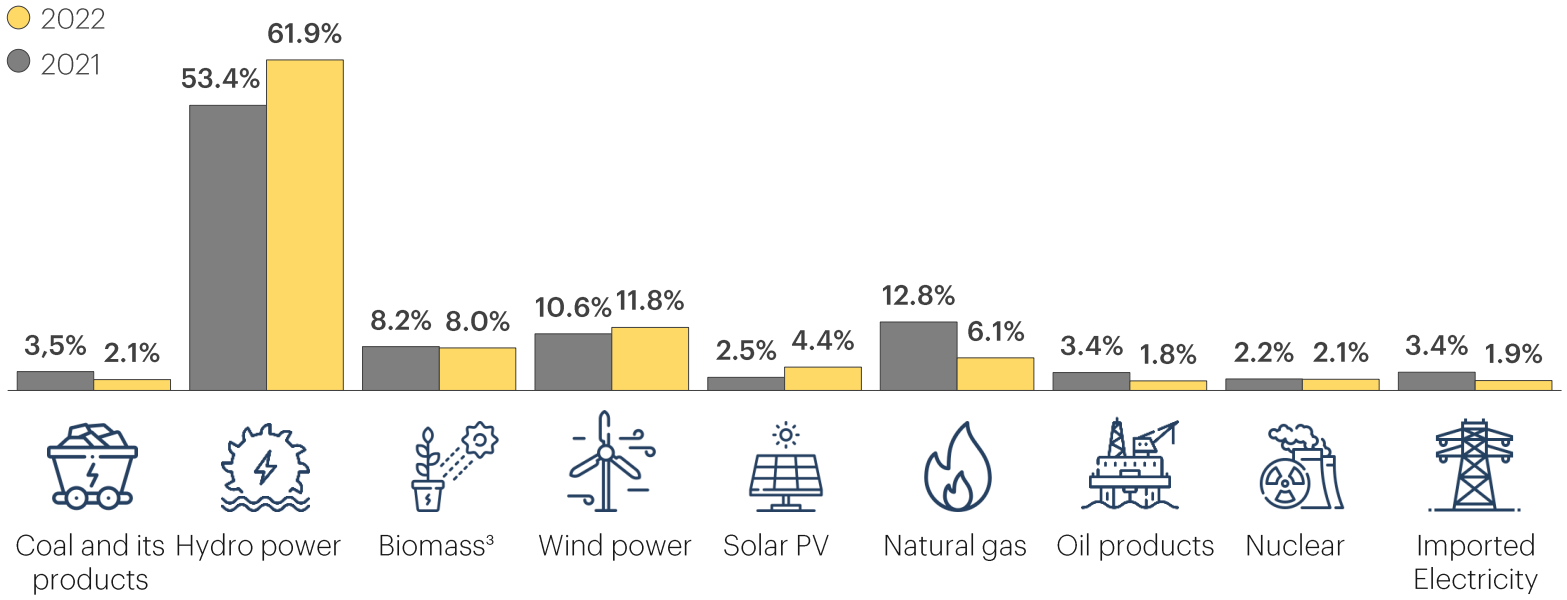
↑ **2.3% increase** in final electricity consumption



Losses (commercial + technical) fell by 0.6 percentage points compared to 2021.

[1] TPES; [2] Public Service; [3] Autoproducers; [4] Import (-) export
[5] Final electric power consumption refers to the total: National Interconnected System + Isolated Systems + Autoproduction

The Brazilian electricity mix in 2022 changed as a result of the increase in hydroelectric dispatch over the course of the year.



2022 (TWh)
Total supply²: 690.1
Hydro power² supply: 440.0

2021 (TWh)
Total supply²: 679.2
Hydro power² supply: 385.9

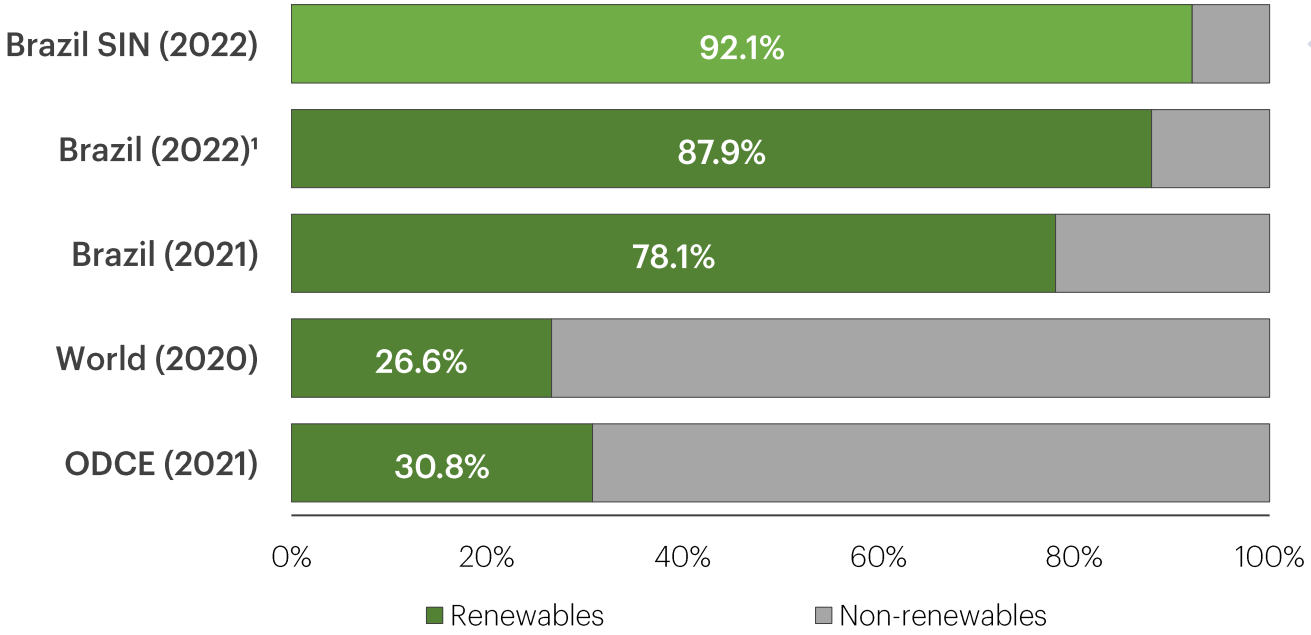
1.6% increase
in the Total supply

14.0% increase
in the Hydro power supply

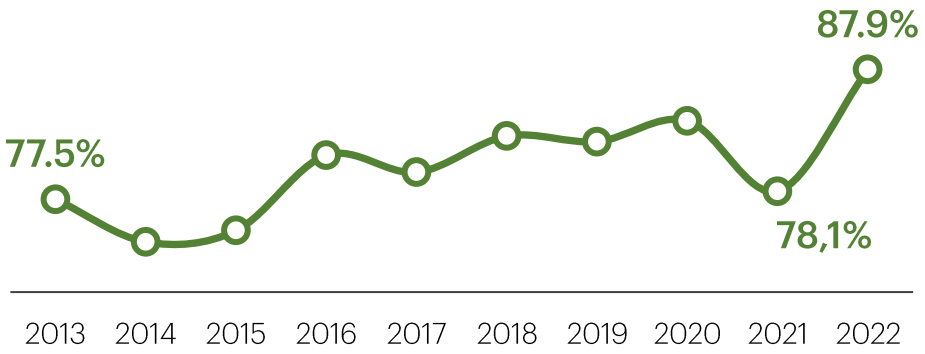
The rainfall in 2022 led to an increase in the reservoir levels of the country's main hydroelectric plants and a consequent increase in the supply of hydroelectricity. This offset the fall in the supply of electricity from other sources, mainly fossil fuels, such as coal and derivatives (-40.8%), natural gas (-51.6%) and oil derivatives (-45.8%).

[1] Includes coke oven gas, blast furnace gas, steelmaking gas and tar; [2] Includes import;
[3] Includes firewood, sugarcane bagasse, black liquor, biodiesel and other primary sources

The **share of renewables in the Brazilian electricity mix** (including the entire "National Interconnected System (SIN)", the "Isolated Systems" and "Self-production not injected into the grid") reached 87.9% renewability in 2022...



The National Interconnected System (SIN) excludes Isolated Systems and Self-Production not injected into the grid.

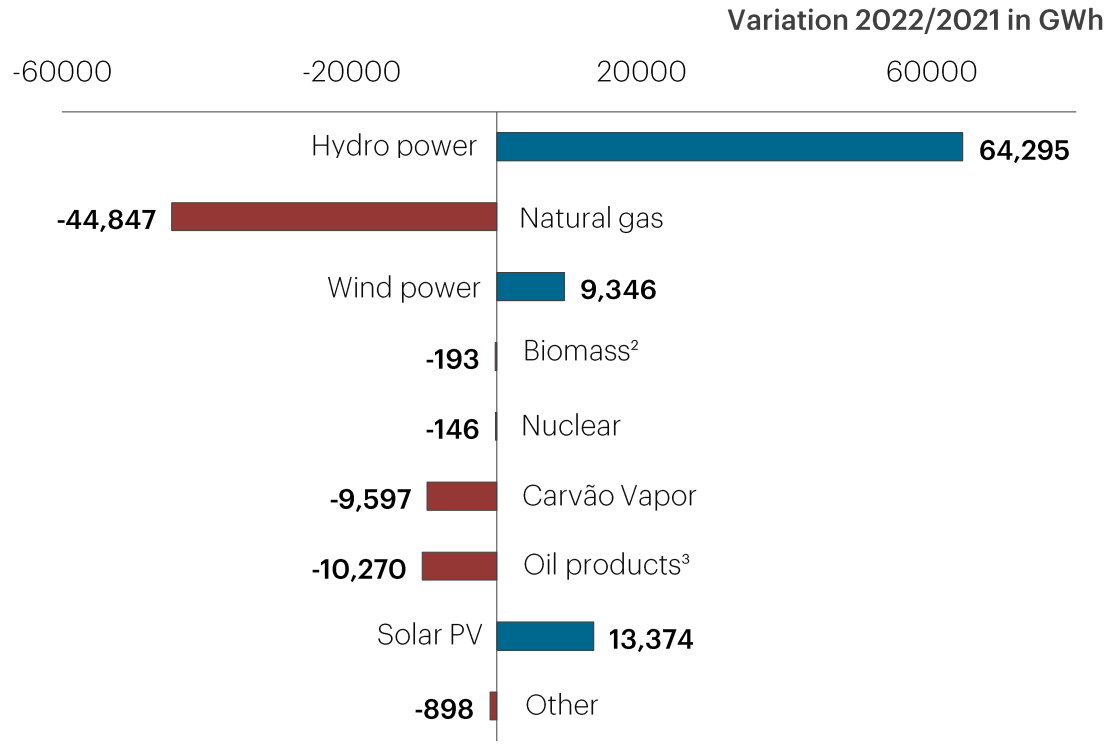


It is important to note that, considering only the National Interconnected System (SIN), which excludes Isolated Systems and Self-Production not injected into the grid, renewability was above 92%. The positive variation in renewability in 2022 was due to an increase in the country's hydroelectric supply, combined with a reduction in thermoelectric generation.

[1] Renewability is calculated based on the Internal Electricity Supply, i.e. all domestic generation plus net imports, which includes the portion imported from Itaipu.

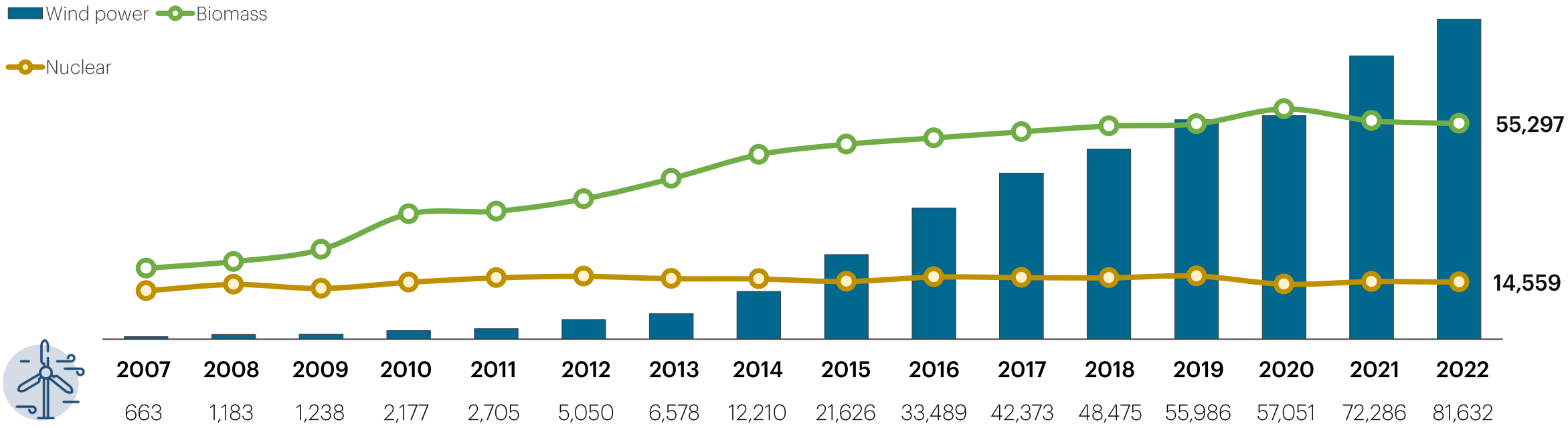
... and in fact, when analyzing **electricity generation[1] (GWh)** in 2022, it is possible to identify this combination of factors that have increased the renewability of the electricity mix.

Source	2021	2022	Δ 22/21
Hidro power	362,818	427,114	17.7%
Natural gas	86,957	42,110	-51.6%
Wind power	72,286	81,632	12.9%
Biomass[2]	52,416	52,223	-0.4%
Nuclear	14,705	14,559	-1.0%
Steam Coal	17,585	7,988	-54.6%
Oil products[3]	17,327	7,056	-59.3%
Solar PV	16,752	30,126	79.8%
Other[4]	15,263	14,364	-5.9%
Total generation	**656,109**	**677,173**	**3.2%**



[1] Includes distributed generation
[2] Includes firewood, sugarcane bagasse, biodiesel and back liquor
[3] Includes diesel oil and fuel oil
[4] Includes other primary sources, coke plant and other secondary sources

More than 9 TWh more than in 2021 is due to the **evolution of wind power generation (GWh)**, which has seen successive increases over the years.



Wind generation grew by 12.9% compared to 2021, consolidating its leadership among the three sources.

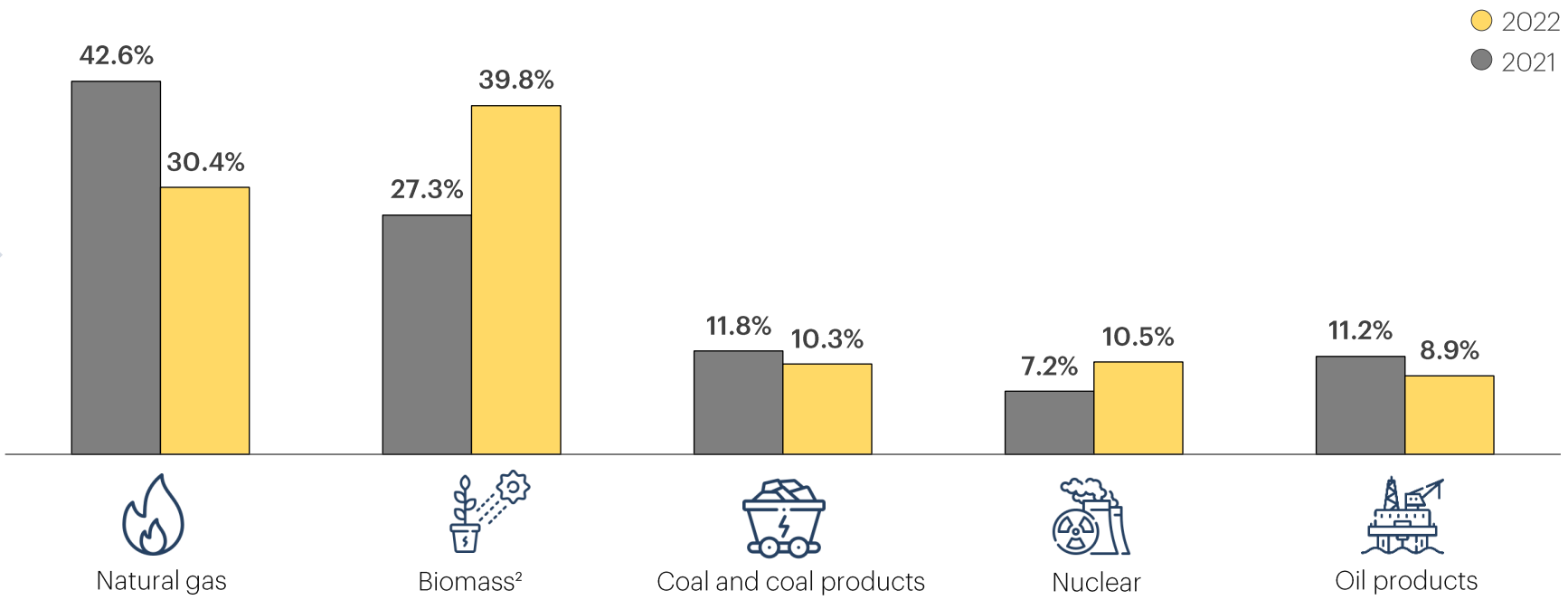
In 2022, there was a 32.3% reduction in **thermoelectric generation**. As a result, its **share on electricity generation**[1] fell from 31.1% in 2021 to 20.4% in 2022.

Share of thermal plants in total generation:

2022
20.4%

2021
31.1%

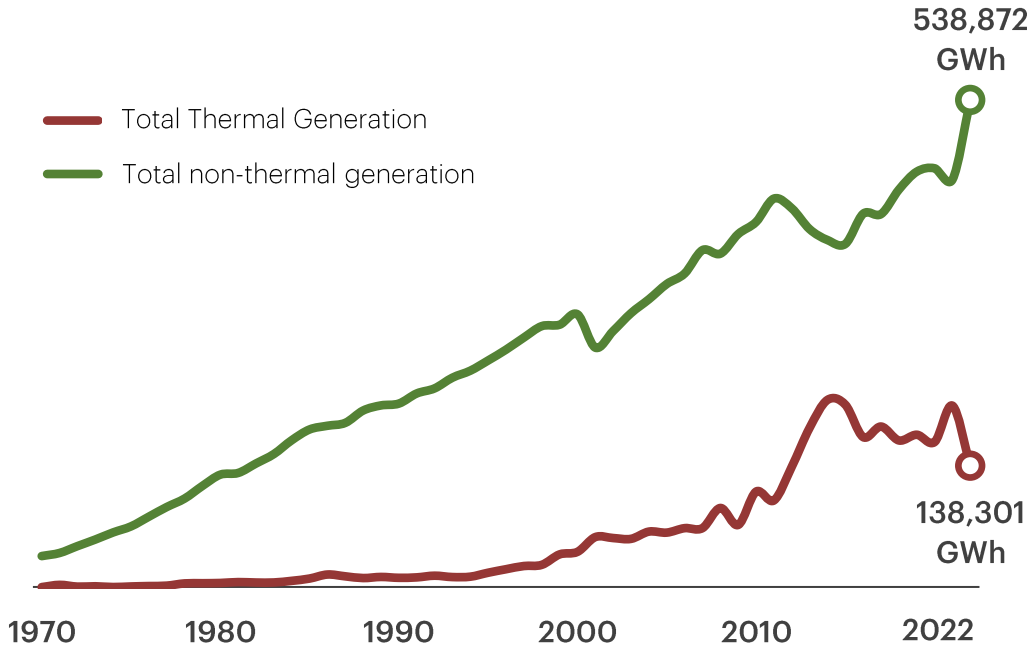
32.3% decrease
In thermal generation

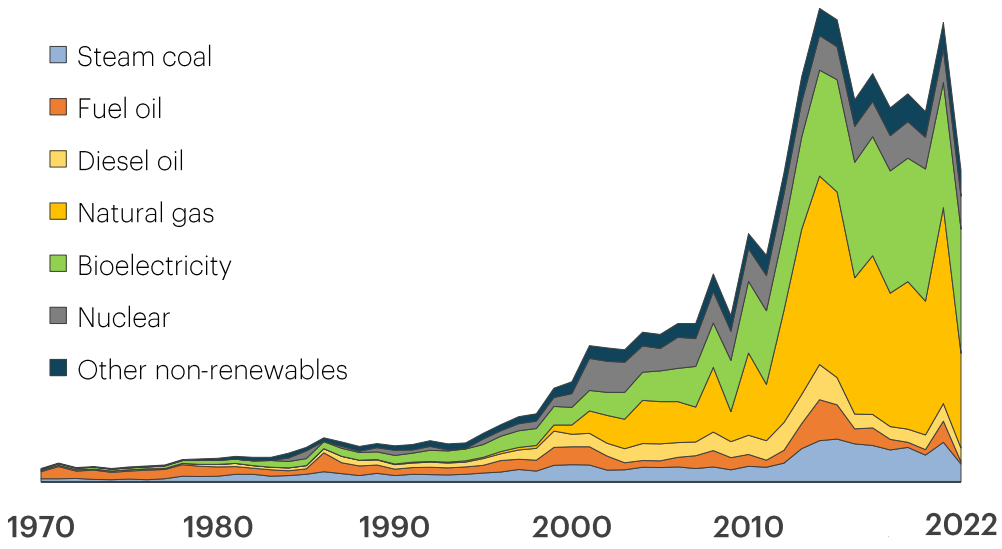


The year 2022 was marked by a reduction in thermoelectric generation, with the emphasis on reducing the use of natural gas, coal and oil derivatives.

[1] Does not include imports (hydro) in total electric power generation
[2] Includes firewood, sugarcane bagasse, black liquor, firewood and other primary sources

Thermal generation was responsible for 138.3 TWh generated in 2022, a share of around 20% of total electricity generation.

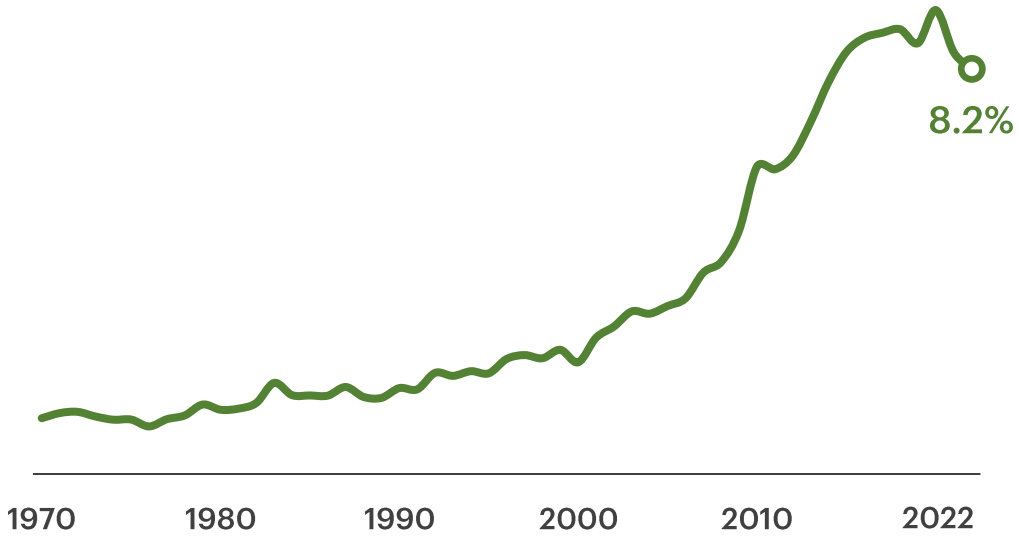


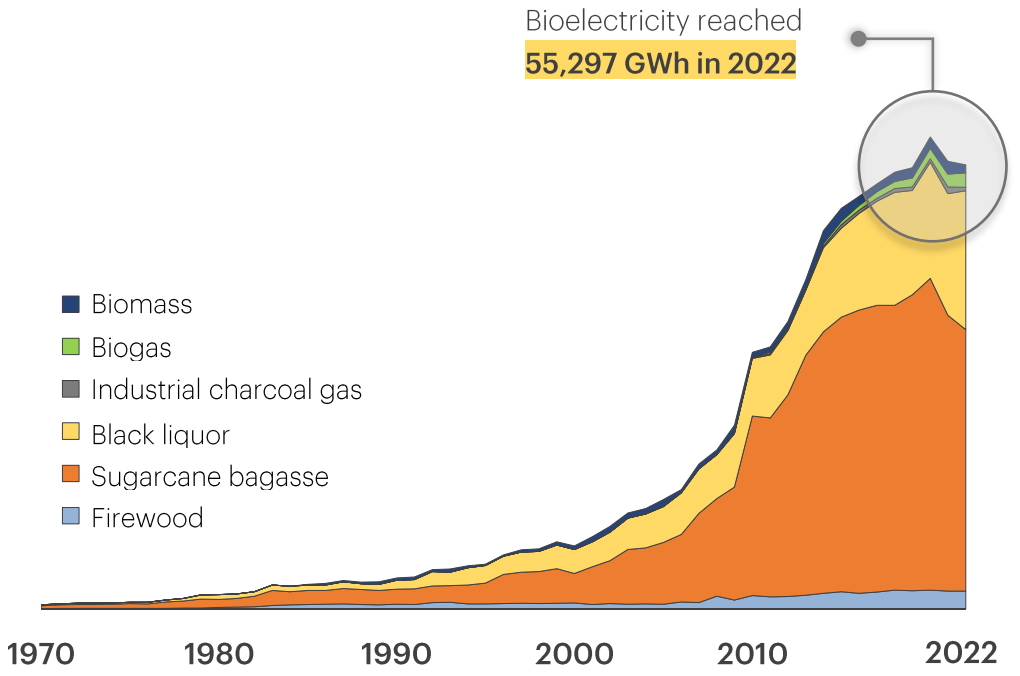


Natural gas and bioelectricity stand out among the thermal sources.

[1] Hydro, Wind and Solar PV

Bioelectricity reached the share of 8.2% in electricity generation in 2022, mainly made up of sugarcane bagasse and black liquor.

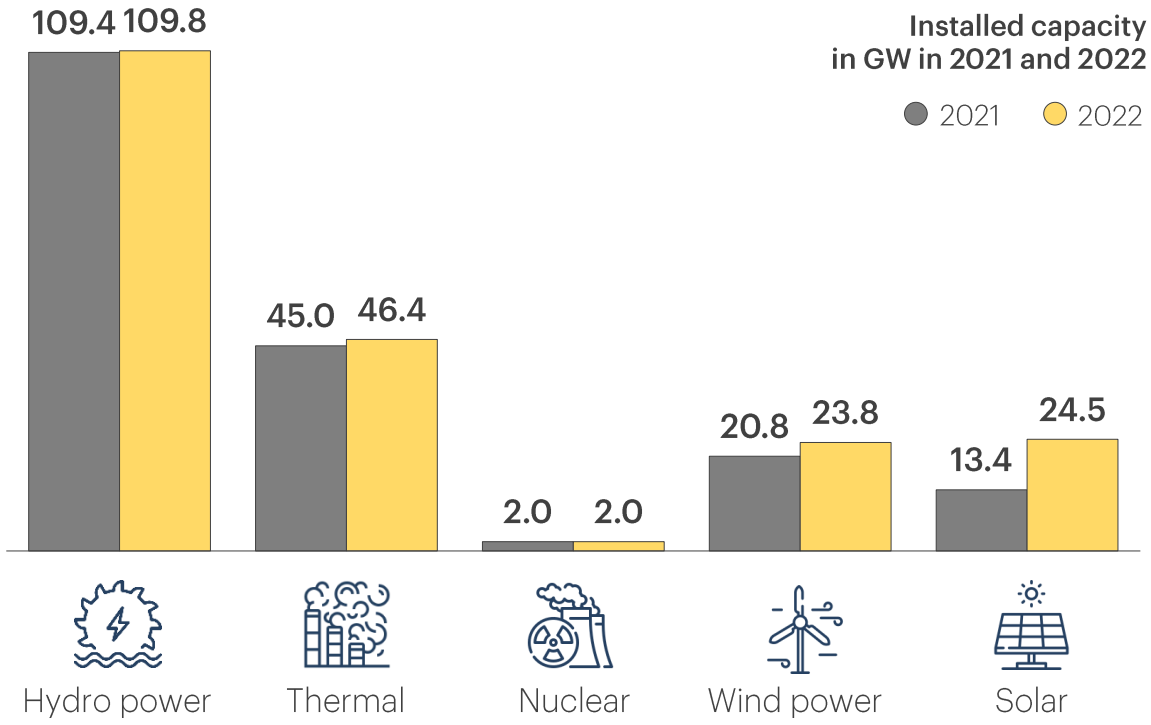




Bioelectricity generation peaked in 2020, when it reached 58,742 GWh, but remained at high levels of 55,297 GWh in 2022.

[1] Does not include imports (hydro) in total electricity generation
[2] Includes sugarcane bagasse, bleach, firewood, and other primary sources

The **Installed Capacity**[1] in 2022 showed an increase of 8.3% compared to 2021, with wind power and solar standing out.



Variation of installed capacity (MW) between 2021 and 2022 by source

Source	2021	2022	Δ %22/21
Hydro power	109,413	109,807	0.4%
Thermal[2]	44,982	46,440	3.2%
Nuclear	1,990	1,990	0.0%
Wind power	20,786	23,761	14.3%
Solar	13,404	24,453	82.4%
Available capacity	**190,574**	**206,451**	**8.3%**

[1] Does not include distributed micro and mini-generation
[2] Includes biomass, gas, oil and coal

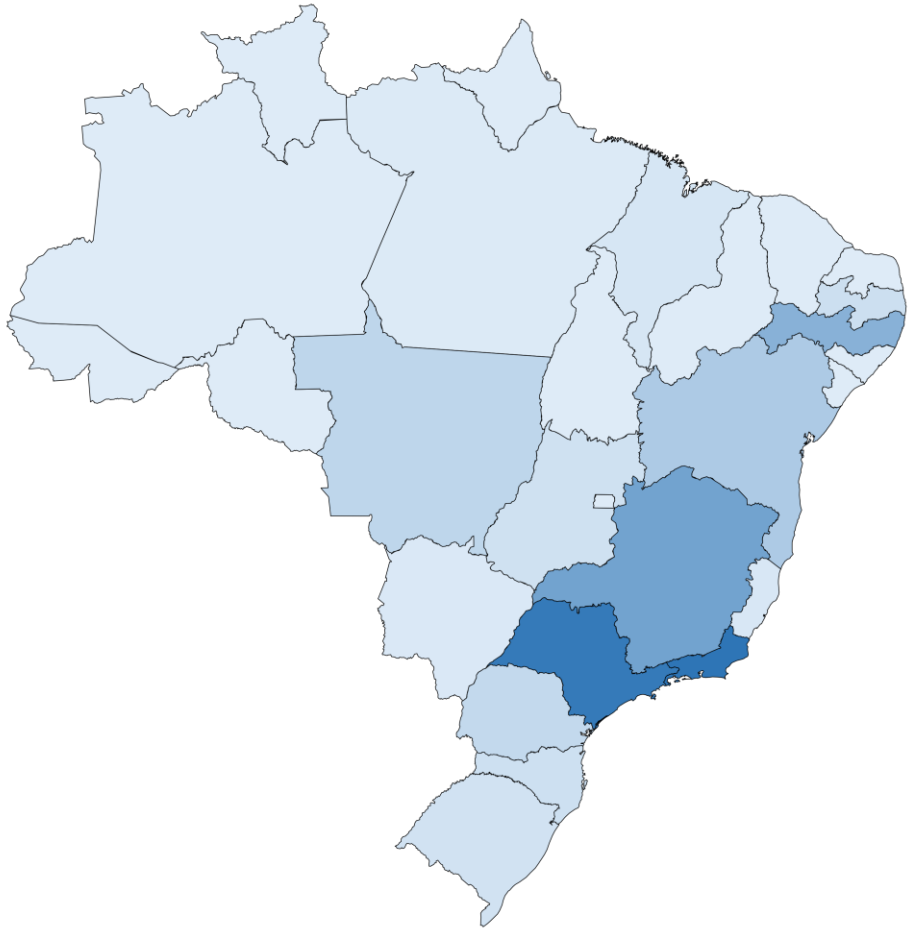
The **Installed Capacity of Biogas generation by state (MW)** is more concentrated in the regions with greater potential for organic matter production, agricultural, urban, industrial, and forestry waste.

Did you know?

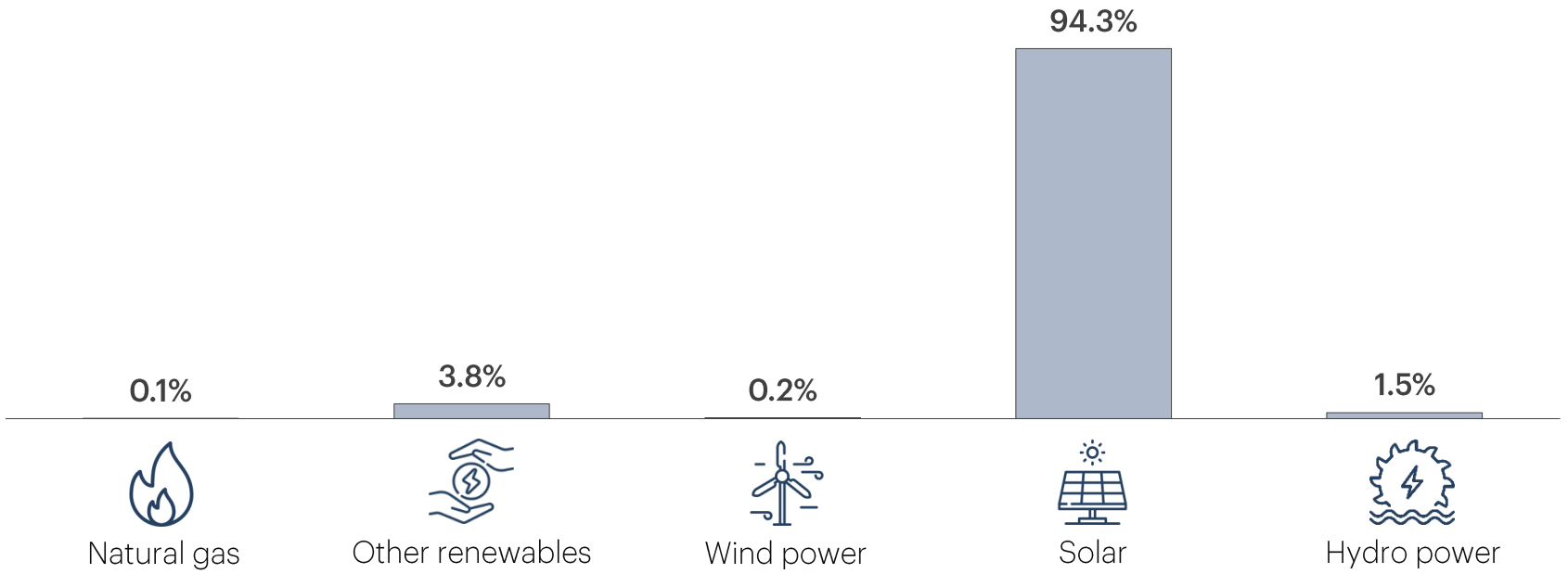
Biogas is an energy source produced by bacteria active in the decomposition of organic matter, agricultural, urban, industrial and forest residues, among others.

Present in the Brazilian energy mix, it is a renewable biofuel and has a good calorific value and can be used for electricity generation.

The map on the side shows the installed capacity for generating electricity from biogas in the states of Brazil.



Micro and Mini Distributed Generation (MMDG)[1] in 2022 showed an increase of almost 88% compared to 2021, maintaining the following configuration of the participation of sources in energy generation:



2022
18,423 GWh

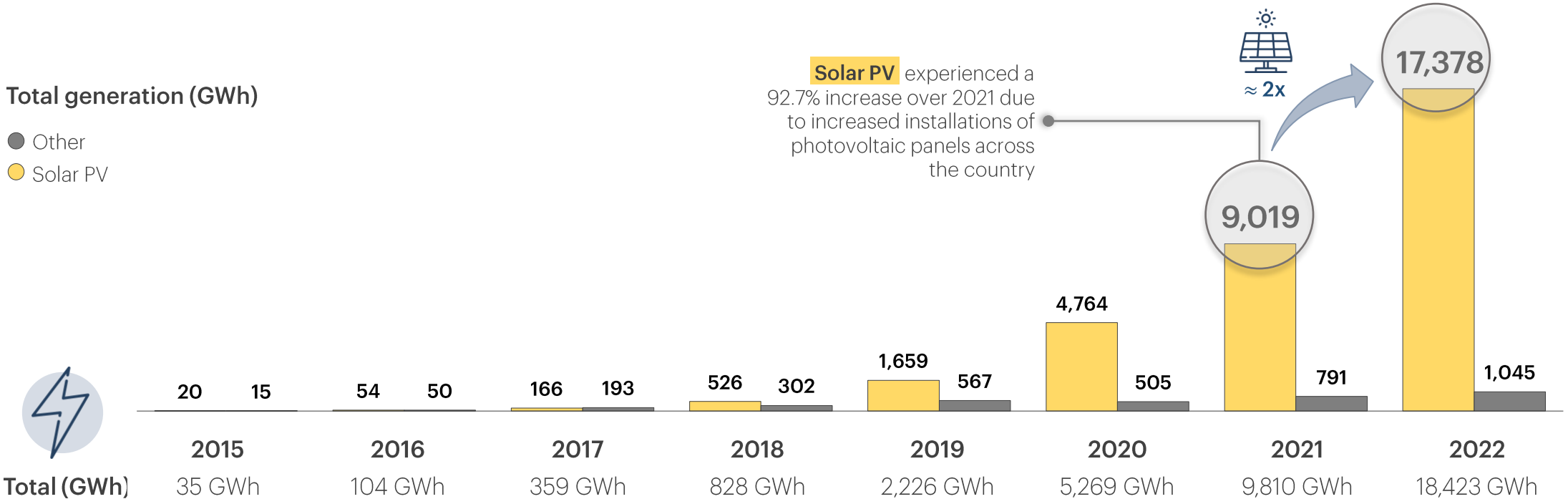
2021
9,810 GWh

87.8% increase

Solar PV represented 94.3% of generation in 2022 and was the **source predominantly responsible for the increase recorded in micro and mini distributed generation.**

[1] ANEEL Normative Resolution No. 482/2012; [2] Includes biogas from agricultural and urban waste, rice hulls, blast furnace gas (biomass) and forest waste.

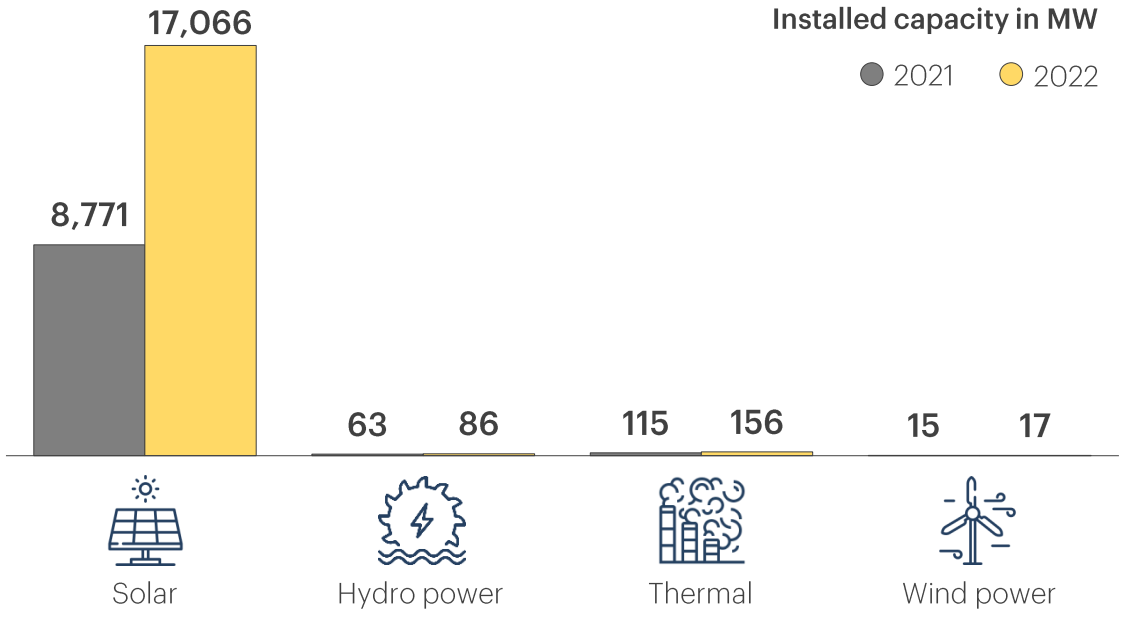
This fact has been built up over time, note that the evolution of **MMDG**[1] indicates the continuous growth trajectory of **solar PV generation** at a higher rate than other sources...

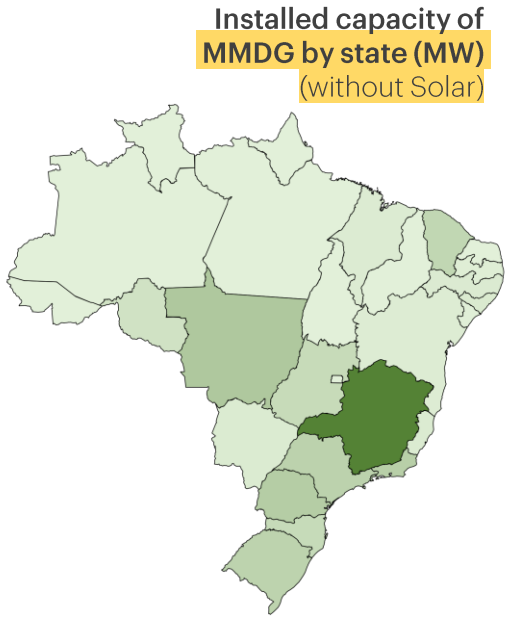


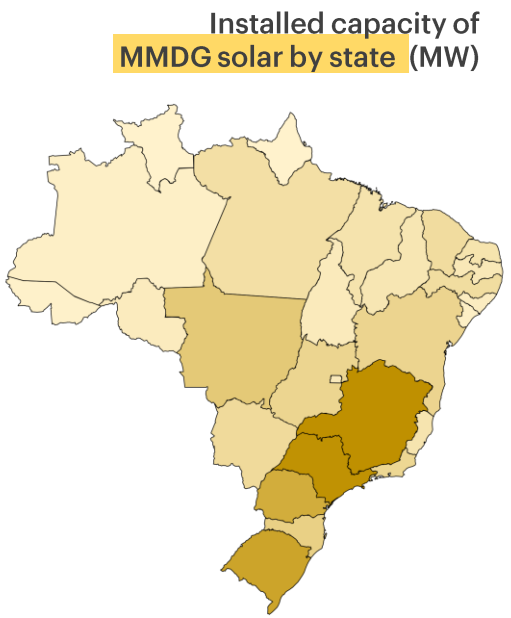
Micro and mini distributed generation in Brazil was heavily reliant on solar photovoltaic generation, which reached **17,066 MW of installed capacity** and **17,378 GWh of generation** in 2022.

[1] ANEEL Normative Resolution No. 482/2012; [2] Includes biogas from agricultural and urban waste, rice hulls, blast furnace gas (biomass) and forest waste.

The additional installed capacity for MMDG[1] was concentrated in the center and south of Brazil, influenced by the expansion of the solar source in federal units such as Minas Gerais, São Paulo, Santa Catarina, Rio Grande do Sul, and Mato Grosso.







Although the installed capacity from thermal and wind sources have shown some growth in 2022, **the majority share of installed capacity through solar panels is what currently defines the MMDG generation segment in Brazil.**

[1] ANEEL Normative Resolution nº482/2012

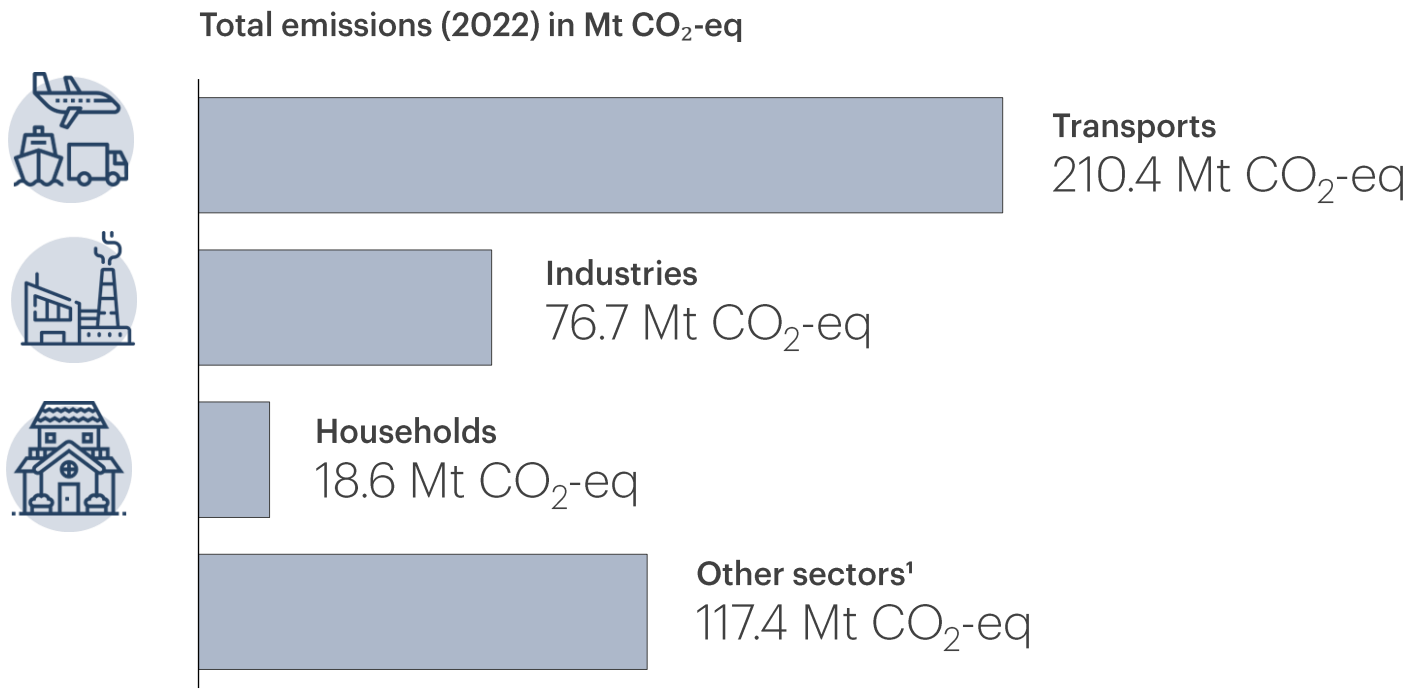
Emissions in Energy Production and Use

In 2022, the total anthropogenic CO_2 **emissions** associated with the Brazilian **energy mix** reached 423 million tons of CO_2 equivalent, a reduction of 5.1% compared to 2021.

2022
423 Mt CO_2-eq

2021
446 Mt CO_2-eq

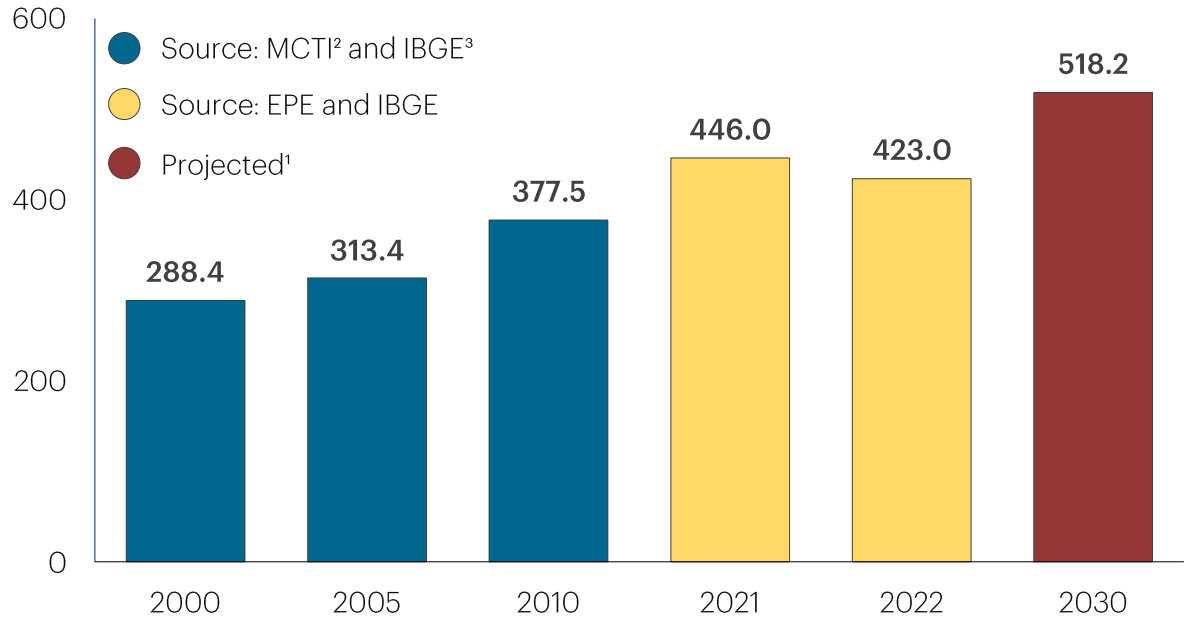
5.1% decrease



[1] Includes the agricultural, services, energy, electric and fugitive emissions sectors

Evolution of CO_2 emissions - Energy mix

Total emissions growth ($MtCO_2$-eq)		
Indicator	Performed	Projected[1]
	2000 to 2022	2022 to 2030[1]
Average annual growth rate	1.8%	2.6%

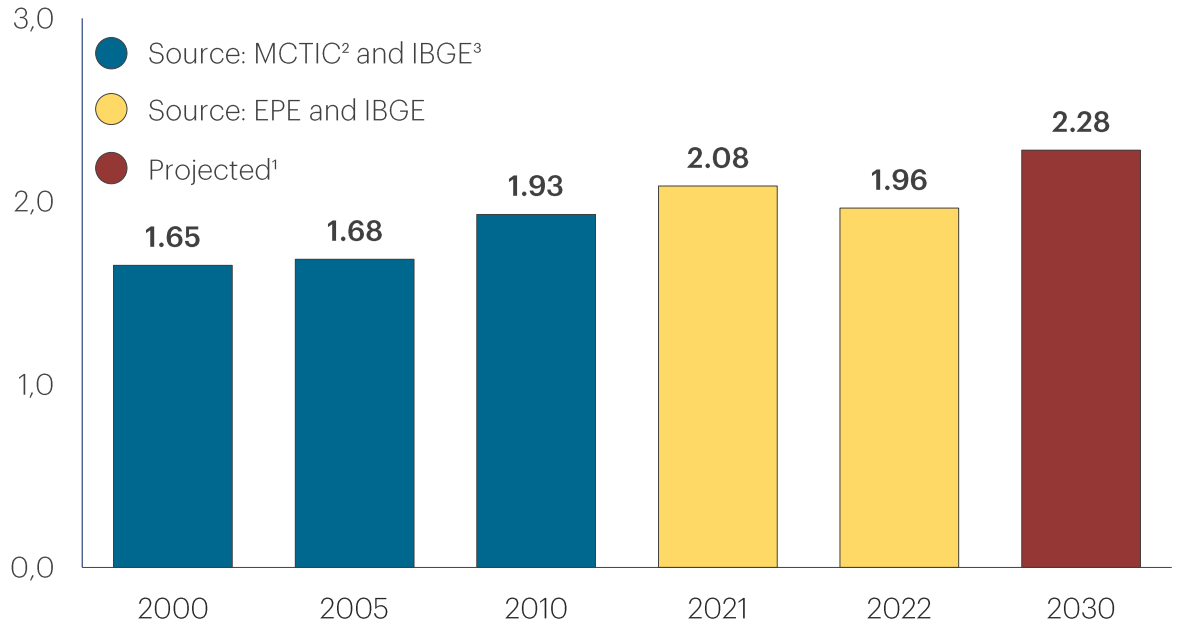


Reduction in **total anthropic emissions associated with the Brazilian energy mix** in 2022 due to the favorable water regime and the consequent reduction in thermal generation.

[1] PDE 2031: Ten Year Energy Expansion Plan 2031
[2] Ministry of Science, Technology and Innovation
[3] Brazilian Institute of Geography and Statistics

Evolution of per capita emissions of CO_2

Emissions per capita growth – t $CO_{2\text{-eq}}$/inhabitant		
Indicator	Performed	Projected[1]
	2000 to 2022	2022 to 2030[1]
Average annual growth rate	0.8%	1.9%

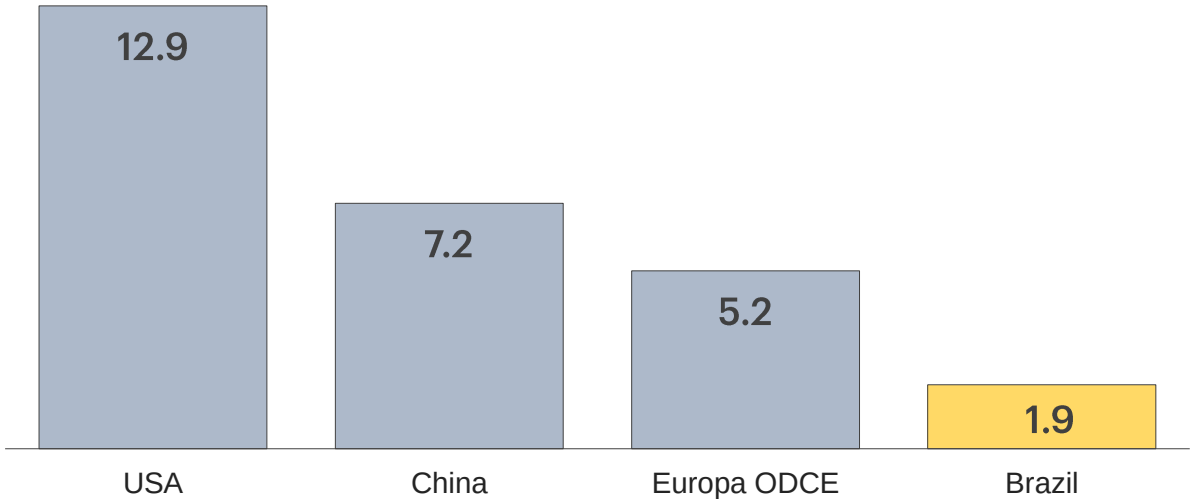


Reduction in **per capita CO_2 emissions associated with the Brazilian energy mix**, reflecting the good performance of renewable sources in 2022.

[1] PDE 2031: Ten Year Energy Expansion Plan 2031
[2] Ministry of Science, Technology and Innovation
[3] Brazilian Institute of Geography and Statistics

CO_2 emissions per capita

CO_2 emissions per capita (2020) in t CO_2/inhabitant
Source: International Energy Agency. Prepared by EPE



2022
Brazilian emissions per capita

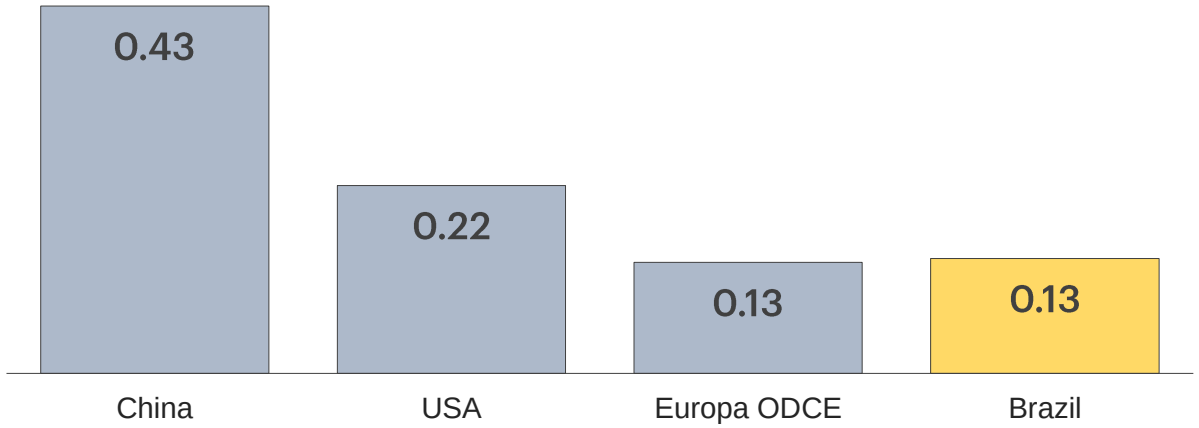
2.0 t CO_2-eq/hab.

Source: EPE

On average, in energy production and consumption, **each Brazilian emits the equivalent of 14.5% of an American, 36% of an OECD citizen and 26% of a Chinese citizen. In 2020, the world was impacted by COVID-19.**

Carbon intensity in the economy

Carbon intensity (2020) in kg CO_2/US$_{ppp\ [2010]}$
Source: International Energy Agency. Prepared by EPE



2022
Carbon intensity in the Brazilian economy

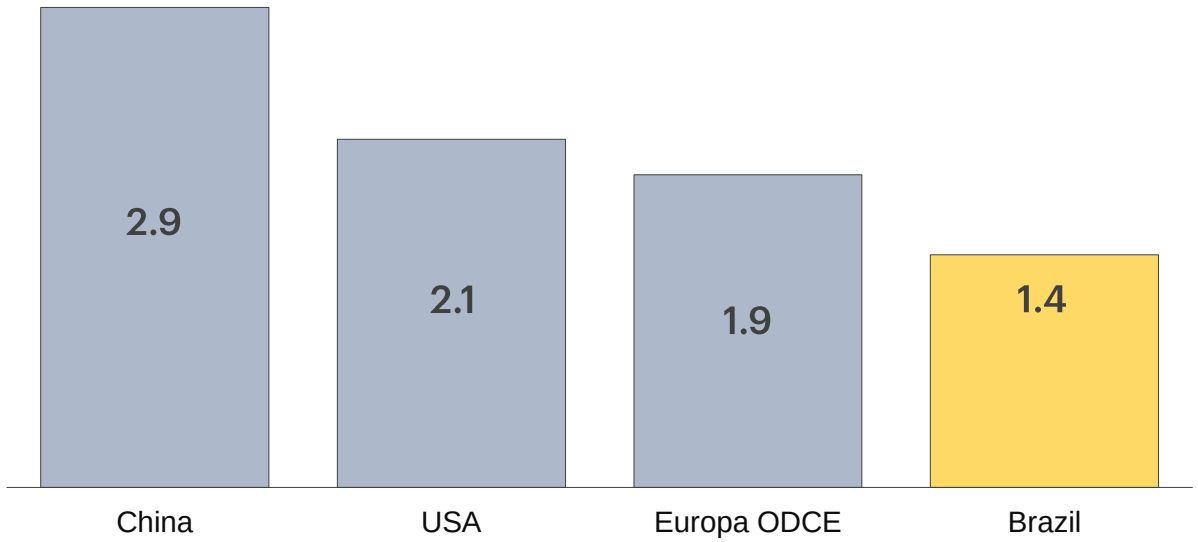
0.14 Kg CO_2-eq/US$_{ppp\ [2010]}$

Source: EPE

To generate one unit of product, the Brazilian economy emits the equivalent of **31% of the Chinese economy and 61% of the American economy in energy production and consumption. In 2020, the world was impacted by COVID-19.**

Emissions per unit of Total Energy Supply

CO_2 emissions (t) per toe (2020)
Source: International Energy Agency. Prepared by EPE



2022
Emissions associated with total energy supply

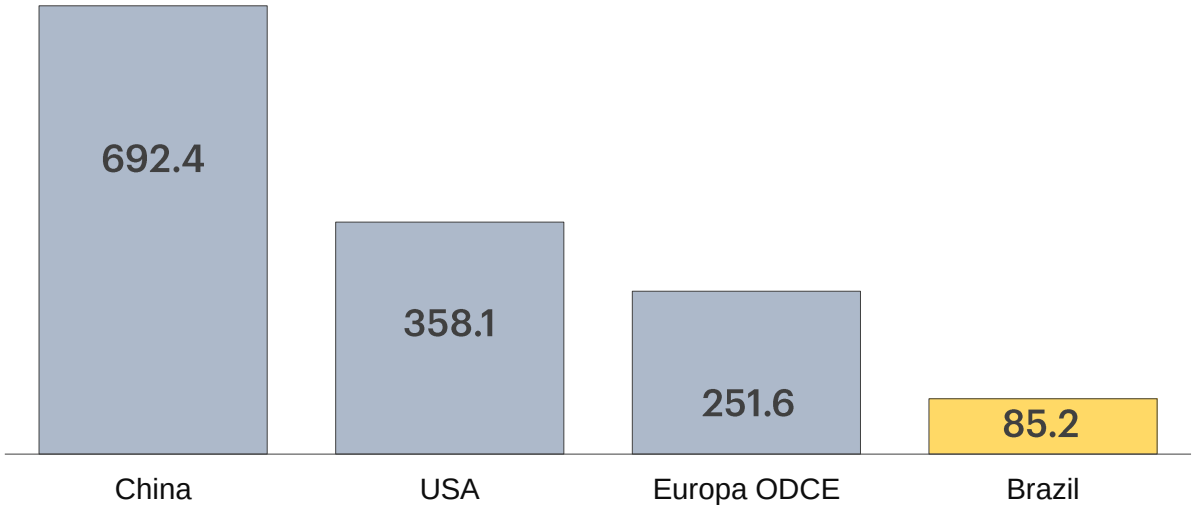
1.4 t CO_2-eq/tep

Source: EPE

For every tonne of oil equivalent (toe) made available, Brazil emits the equivalent of **74% of what the European OECD countries emit, 67% of what the United States (US) emits and 49% of what China emits. In 2020, the world was impacted by COVID-19.**

Emissions in electricity production

CO_2 emissions (kg) per MWh (2020)
Source: International Energy Agency. Prepared by EPE



2022
Carbon emissions in Brazilian power generation

61.7 Kg CO_2-eq/MWh

Source: EPE

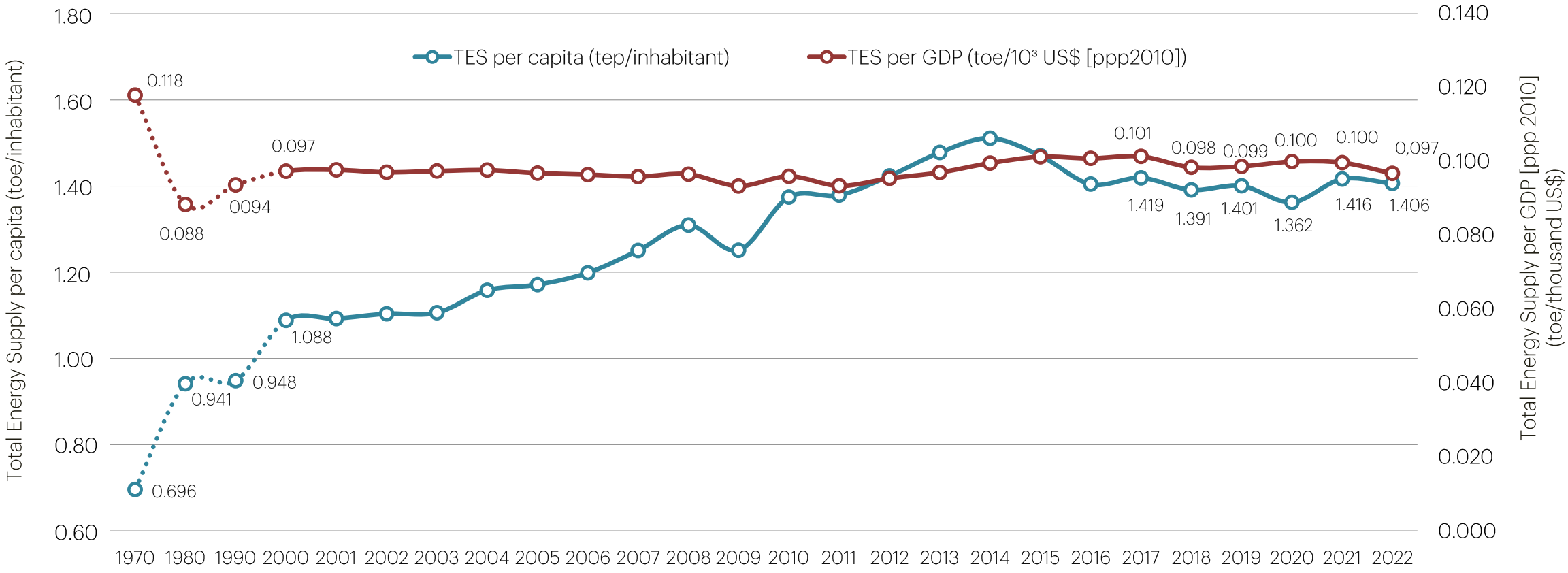
To produce 1 MWh, the Brazilian electricity sector emits around **34% of the amount emitted by OECD Europe, 24% of what is emitted by the American electricity sector and 12% of what is emitted by the Chinese electricity sector. In 2020, the world was impacted by COVID-19.**

Annexes

Evolution of indicators: energy

Total Energy Supply per capita vs. Total Energy Supply per GDP

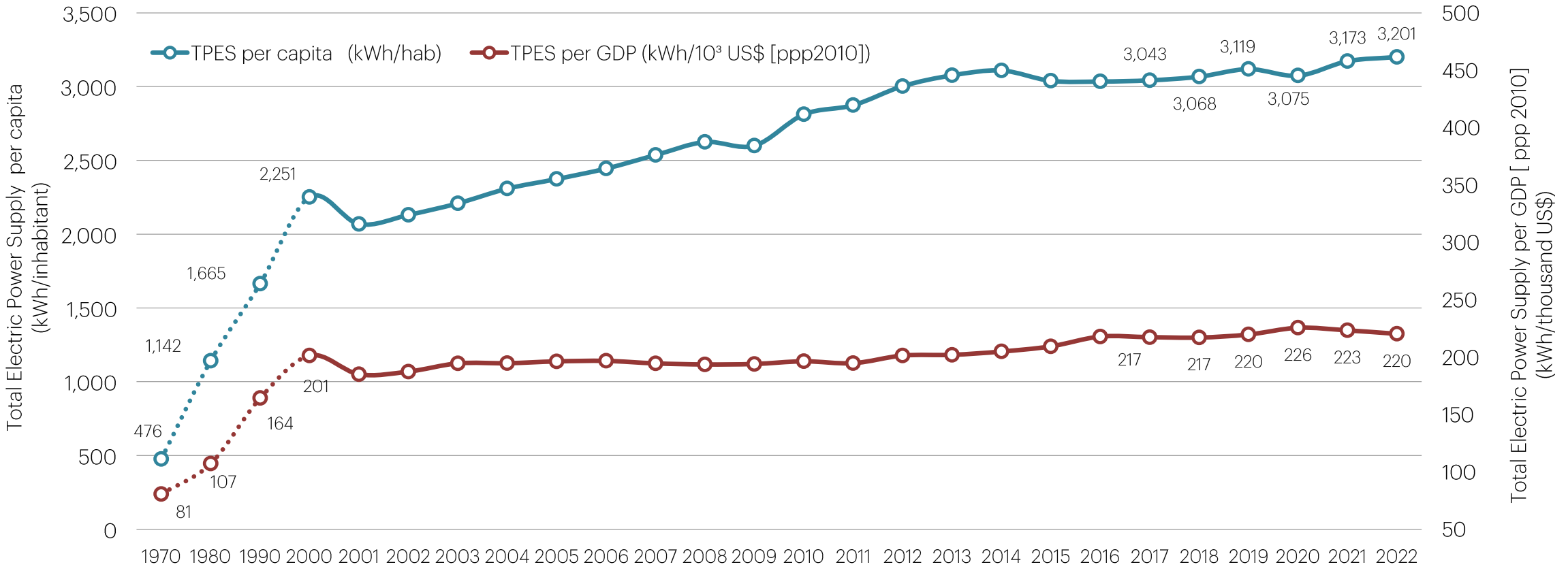
Source: EPE



Evolution of indicators: electricity

Total Electric Power Supply per capita vs. Total Electric Power Supply per GDP

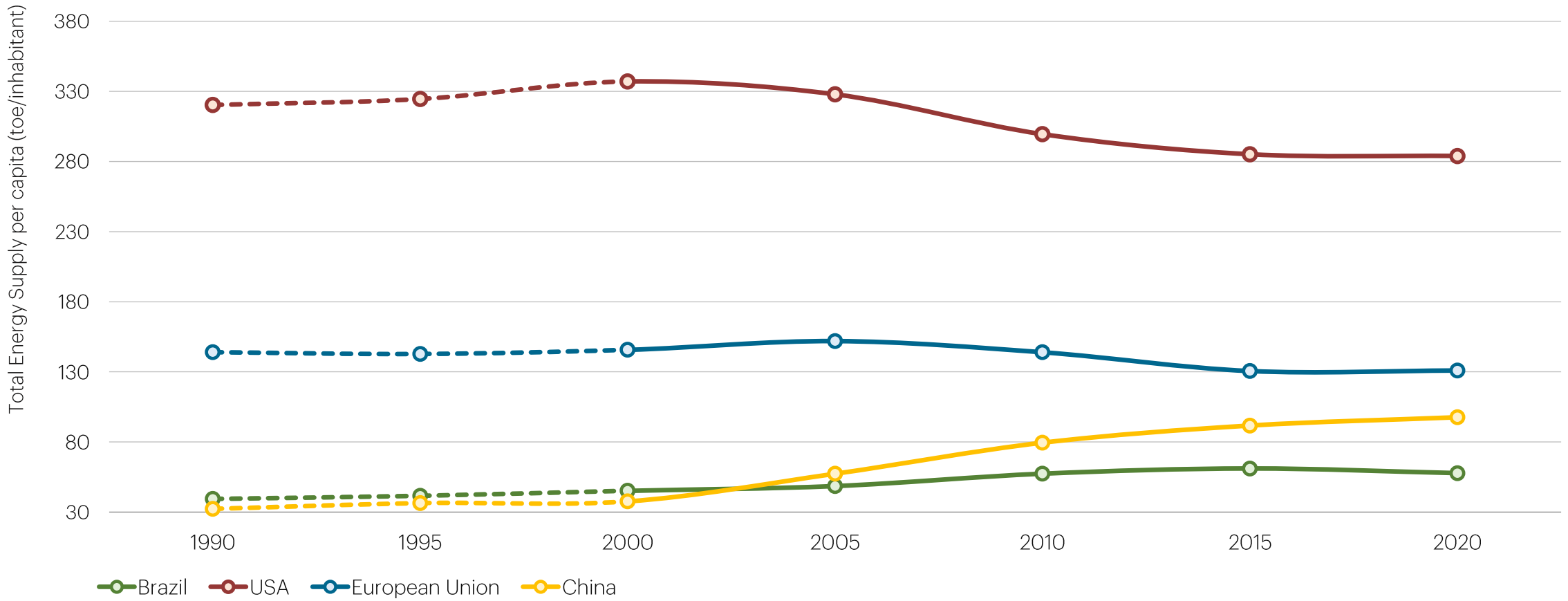
Source: EPE



Evolution of indicators: Brazil and the World

Total Energy Supply per capita

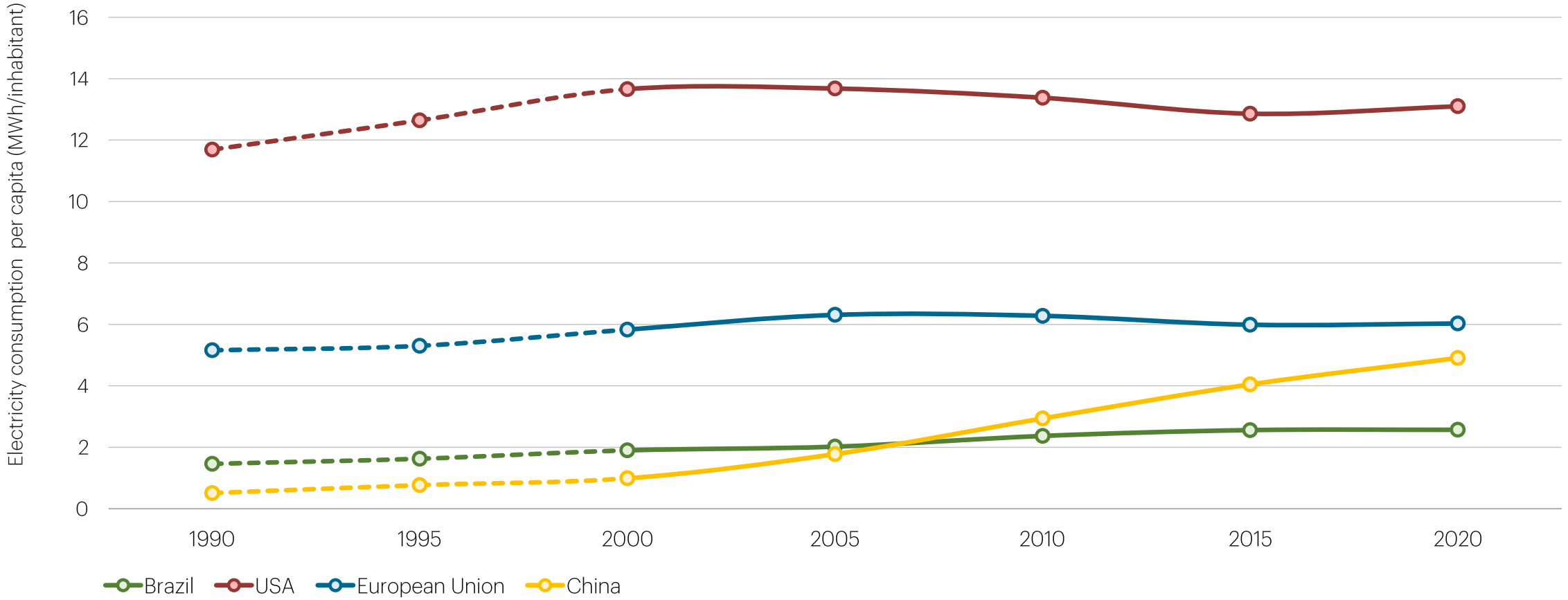
Source: International Energy Agency. Prepared by EPE



Evolution of indicators: Brazil and the World

Electricity Consumption per capita

Source: International Energy Agency. Prepared by EPE



Key Statistics

Source	Unit	2021	2022	Δ % 22/21
Oil Production[1]	10^3 bbl/day	2,908.3	3,024.6	4.0%
Natural Gas Production	10^6 m^3/day	133.8	137.9	3.1%
Electric Power Generation	TWh	656.1	677.2	3.2%
Consumption of Liquid Fuels	10^6 l/day	377.5	393.0	4.1%
Electric power consumption	TWh	572.8	586.1	2.3%
Total Energy Supply (TES)	10^6 toe	303.2	303.1	-0.03%
Total Electric Power Supply (TEPS)[2]	TWh	679	690	1.6%
Population	10^6 inhab.	214.1	215.6	0.7%
GDP [2010][3]	10^9 US$	3,041.9	3,133.1	3.0%

[1] bbl = barrel; includes liquids of natural gas and LPG
[2] Includes import and autoproduction
[3] Values in 2010 constant Reais converted to dollars in 2010 purchasing power parity (ppc).

Final energy consumption by source[1]

Unit: 10^3 toe

Source	2021	2022	Δ % 22/21
Diesel Oil[2]	51,538	53,091	3.0%
Electricity	49,264	50,403	2.3%
Sugarcane Bagasse	28,279	28,018	-0.9%
Gasoline[3]	22,137	24,227	9.4%
Natural Gas	15,919	16,103	1.2%
Firewood	18,288	18,440	0.8%
Ethanol	14,848	15,165	2.1%
LPG	8,298	8,211	-1.0%
Black liquor	7,294	8,039	10.2%
Fuel oil	2,470	2,431	-1.6%
Kerosene	2,518	3,132	24.3%
Other Sources[4]	29,160	28,115	-3.6%
TOTAL	**250,014**	**255,375**	**2.1%**

[1] Exclusive non-energy final consumption;
[2] Includes biodiesel;
[3] Includes gasoline A and aviation gasoline;
[4] Includes refinery gas, coal coke and charcoal, among others

Selected indicators

Indicators	Unit	2021	2022	Δ % 22/21
GDP per capita	US$/inhab.	14,209	14,535	2.3%
TES per capita	toe/inhab.	1.416	1.406	-0.7%
TES per GDP [2010]	toe/10^3 US$	0.100	0.097	-2.9%
TEPS per capita	kWh/inhab.	3,173	3,201	0.9%
TEPS per GDP [2010]	kWh/10^3 US$	223	220	-1.4%

Evolution of indicators

Parameters	Unit	1970	1980	1990	2000	2010	2021	2022
Total Energy Supply (TES)	10^6 toe	66.9	114.7	141.9	190.1	268.8	303.2	303.1
Total Electric Power Supply (TEPS)[1]	TWh	45.7	139.2	249.4	393.2	550.4	679.2	690.1
Population	10^6 inhab.	95.7	122.2	148.1	174.7	196.4	214.1	215.6
GDP [2010][2]	10^9 US$	567.3	1,297.7	1,517.1	1,953.0	2.,03.6	3,041.9	3,133.1
Indicators	**Unit**	**1970**	**1980**	**1990**	**2000**	**2010**	**2021**	**2022**
GDP per capita	US$/inhab.	5,928	10,619	10,244	11,179	14,275	14,209	14,535
TES per capita	toe/inhab.	0.699	0.939	0.958	1.088	1.369	1.416	1.406
TES per GDP [2010]	toe/10^3 US$	0.118	0.088	0.094	0.097	0.096	0.100	0.097
TEPS per capita	kWh/inhab.	478	1,139	1,684	2,251	2,802	3,173	3,201
TEPS per GDP [2010]	kWh/10^3 US$	81	107	164	201	196	223	220

[1] Includes import and autoproduction.; [2] Values in 2010 constant Reais converted to dollars in 2010 purchasing power parity (ppc).

Matrices

The matrices are available on the EPE portal by clicking on the QR code below or by clicking on the following link:

https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas

The matrices can be obtained directly by going to:

Séries Históricas e Matrizes

[1] Includes coke; [2] Includes ethanol;

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Ministério de Minas e Energia

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