BRAZILIAN ENERGY REVIEW

2023 EDITION

MINISTÉRIO DE MINAS E ENERGIA

GOVERNO FEDERAL
BRASIL
UNIÃO E RECONSTRUÇÃO

Minister of Mines and Energy
Alexandre Silveira

Executive Secretary
Efrain Pereira da Cruz

National Secretary, Energy Transition and Planning
Thiago Vasconcellos Barral Ferreira

Special Advisor, National Secretariat for Energy Transition and Planning
Leandro de Oliveira Albuquerque

Director, Department of Information, Studies and Energy Efficiency
Gustavo Santos Masili

General Coordinator
Esdras Godinho Ramos

Coordinator
Cristiano Augusto Trein

Technical Team
Gilberto Kwitko Ribeiro
Nathália Akemi Tsuchiya Rabelo
Pedro Augusto de Menezes Filho
Sergio Luis Nogueira
Ubyrajara Nery Graça Gomes
William de Oliveira Medeiros

Participants
Alexandra Albuquerque Maciel
Claudir Afonso Costa
Liliane Ferreira da Silva
Samira Sana Fernandes de Sousa Carmo
Sergio Rodrigues Ayrimoraes Soares

Administrative support
Rayane Naiva de Sousa
Gabriel Rodrigues Rabelo

Data Sources

Agência Nacional de Energia Elétrica – ANEEL
Agência Internacional de Energia – AIE
Agência Nacional de Petróleo, Gás Natural e Biocombustíveis – ANP
Associação Nacional dos Fabricantes de Veículos Automotores – ANFAVEA
Câmara de Comercialização de Energia Elétrica – CCEE
Centrais Elétricas Brasileiras S.A – Eletrobras
Empresa de Pesquisa Energética – EPE
Entidades de Classe de Setores Industriais
Ministério de Minas e Energia – MME
Operador Nacional do Sistema Elétrico – ONS
Petróleo Brasileiro S.A – Petrobras
Sistema de Informações Energéticas – SIE Brasil

Ministério de Minas e Energia – MME

Esplanada dos Ministérios Bloco U – 5º Andar
70065-900 – Brasília – DF
Tel.: (55 61) 2032 5555

Acknowledgements:

The icons used in this review were obtained from the Flaticon platform.
Specifically from the authors: Freepik, Smashicons e Good Ware.

National Secretariat for Transition and Energy Planning
Department of Information, Studies and Energy Efficiency
www.mme.gov.br | diee@mme.gov.br

(+55 61) 2032 5986

Consult at:

SUMMARY

Presentation

Brazilian Energy Review

REFERENCE YEAR 2022

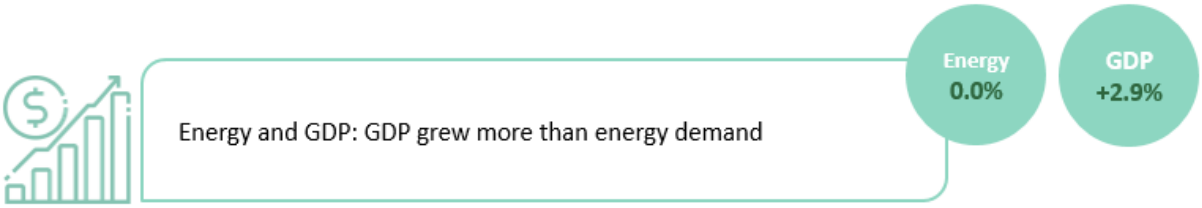
The Brazilian Energy Review is an annual publication of the Ministry of Mines and Energy. It presents an overview of the Brazilian energy sector in the previous year, with the aim of reviewing and documenting the evolution of energy supply and demand, infrastructure and several complementary data.

The document consolidates information on the Brazilian energy and electricity matrices, with emphasis on the generation and electricity installed capacity in Brazil. Furthermore, it compares greenhouse gas emissions from energy use in Brazil and around the world. In addition, it updates the values of the power transmission grid, universal access to energy, and electricity generation and transmission auctions. Finally, it evaluates the supply in the oil, gas and bioenergy sectors; oil and gas installations and reserves; the evolution of motor vehicle fleet, according to the energy source used; final energy consumption by source and sector; and consumer energy prices. In this process, it carries out several international comparisons.

The national data from the Brazilian Energy Review come, for the most part, from the compilations that the Energy Research Company – EPE carries out to construct the Brazilian Energy Balance. Various sector agents participate in these works, such as ANP, ANEEL, ANM, ONS, CCEE, Petrobras and Eletrobras. For international data, the main sources are the International Energy Agency – IEA and the World Bank. The international contextualization allows the reader to compare Brazil's position in relation to the world and to the countries of the Organization for Economic Cooperation and Development – OECD.

This year, this publication includes the theme Energy Efficiency. Furthermore, it provides a virtual platform for presenting data, in the format of interactive reports, accessed from the MME's electronic address.

Energy Matrix



In 2022, the Domestic Energy Supply – DES (or Total Energy Supply) was 303.1 million tons of oil equivalent (toe), or 303.1 Mtoe. It was stable in relation to 2021 (303.2 Mtoe), despite consumption having grown during this period. This effect was due to the reduction of losses at power plants, which enabled consumption growth even in a scenario of stable supply. In relation to 2014, the DES's record year (306.1 Mtoe), there was a decline of around 0.9%.

The DES stability also contrasted with the GDP growth, which was 2.9%. The services sector, which was already recovering in 2022, showed growth of 4.2%. In this recovery, the sector of other service activities stands out, which includes services related to tourism. In the industrial sector, the GDP of the subsector Electricity and Gas, Water, Sewage and Waste Management Activities stands out, with an increase of 10.1% compared to 2021.

The share of renewable sources in the Brazilian energy matrix increased by 2.4 p.p. (percentage points), from 45.0% to 47.4%. This increase is due to the increased participation of the Hydraulics and Electricity and Other Renewables groups. The increase in hydraulic generation resulted from the improvement in rainfall, which, together with the strategies adopted to manage the 2021 water shortage, enabled greater levels of storage in reservoirs and better management of water resources.

In the group of Other Renewables, which showed an increase of 20.0%, the highlights are Wind and Solar sources, which showed robust growth.

Table 1: Domestic Energy Supply (DES) – 2021 and 2022.

SPECIFICATION	ktoe		22/21 %	structure %	
	2021	2022		2021	2022
NÃO-RENOVÁVEL	**166,703**	**159,516**	**-4.3**	**55.0**	**52.6**
OIL & OIL PRODUCTS	103,625	108,070	*4.3*	*34.2*	*35.7*
NATURAL GAS	40,225	31,714	*-21.2*	*13.3*	*10.5*
COAL	16,945	13,986	*-17.5*	*5.6*	*4.6*
URANIUM (U3O8)	3,900	3,861	*-1.0*	*1.3*	*1.3*
OTHER NON-RENEWABLE (a)	2,007	1,884	*-6.2*	*0.7*	*0.6*
RENEWABLE	**136,456**	**143,559**	**5.2**	**45.0**	**47.4**
HYDRAULIC AND ELETRICITY	33,189	37,842	*14.0*	*10.9*	*12.5*
FIREWOOD AND CHARCOAL	27,407	27,283	*-0.5*	*9.0*	*9.0*
SUGARCANE	49,444	46,734	*-5.5*	*16.3*	*15.4*
OTHER RENEWABLE (b)	26,415	31,699	*20.0*	*8.7*	*10.5*
TOTAL	**303,158**	**303,074**	**0.0**	**100.0**	**100.0**
Which are fossil fuels	*162,802*	*155,655*	*-4.4*	*53.7*	*51.4*

(a) Blast furnace, steelworks and sulfur gas; (b) bleach, biodiesel, wind, solar, rice husk, biogas, wood waste, charcoal gas and elephant grass.

Table 1 shows the DES composition for the years 2021 and 2022. There is stability in the total DES variation. Fossil fuels showed a reduction of 4.3%, because the reduction in thermal energy generation, due to the increase in hydraulic generation and the growth in solar and wind power.

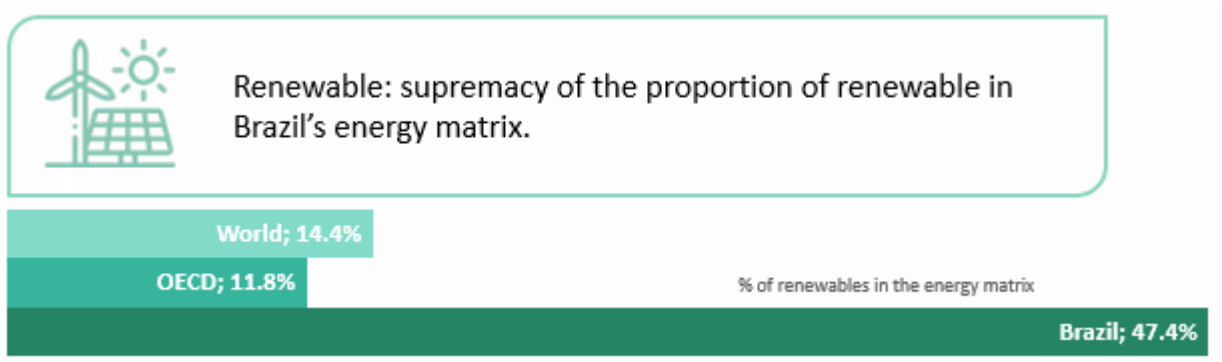
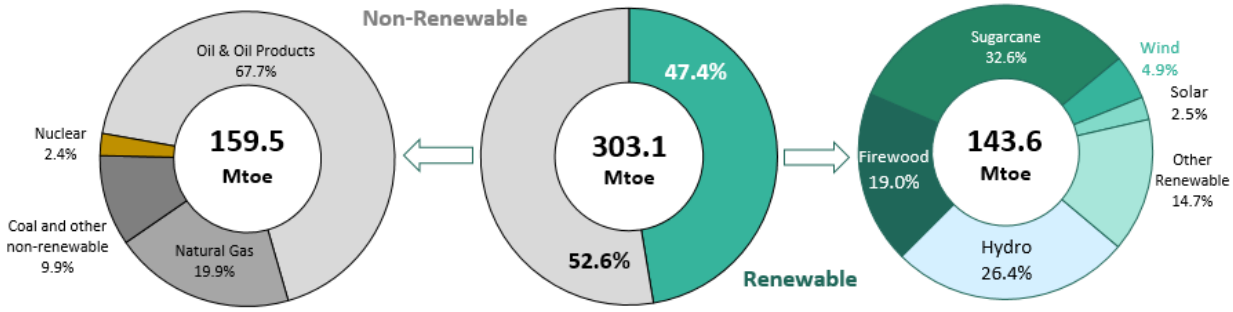


Figure 1 illustrates the DES structure for the year 2022. In the central graph, the 47.4% share of renewable sources in the Brazilian energy matrix can be seen. In OECD countries, in 2021, this proportion was 11.8%. On the global average, according to the IEA, this participation was 14.4%.

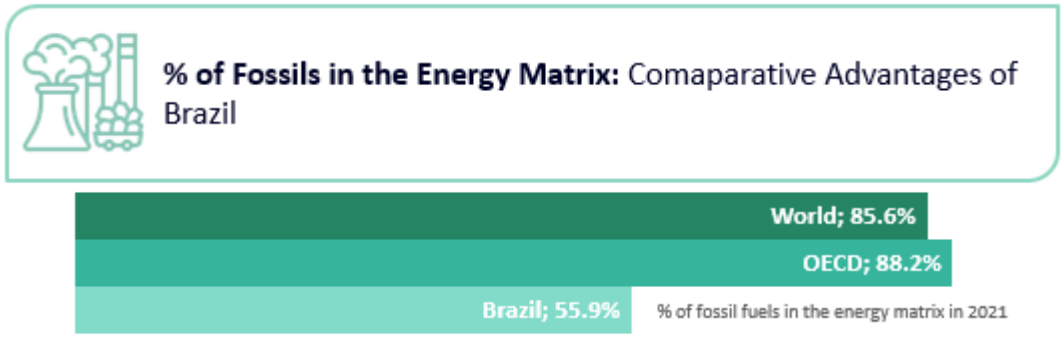


Renewables: World (14.0%) and OECD (11.8%)

Figure 1: Domestic Energy Supply – 2022 (%)

From 2021 to 2022, when considering renewable sources, the numbers show a small reduction in the share of firewood and charcoal, 0.5%, and sugarcane derivatives, 5.5%. On the other hand, there is an increase of 14.0% in the hydraulic source. Additionally, wind and solar sources increased by 12.9% and 51.5%, respectively, which resulted in a 20% increase in the group Other Renewables.

INTERNATIONAL COMPARISON



The global energy demand in 2021 was 14,759.5 Mtoe, according to the IEA. In 2020, this amount was 14,203.6 Mtoe. Over the last 50 years, the energy matrices of Brazil and other countries around the world have undergone significant structural changes. In Brazil, there was a strong increase in the hydraulic energy, liquid bioenergy and natural gas share. In several other countries, there are significant increases in gas and nuclear energy uses. In solid biomass, for example, the OECD shows expansion between the years 1973 and 2021. It is an opposite situation to what occurs in Brazil and other countries. In fact, in the OECD, firewood is no longer being replaced by fossil fuels, a movement that is still happening in the rest of the world. In the OECD, there is an expansion in the use of firewood in Paper, Pulp and Printing industry, and in environmental heating, mainly.

The reductions in the share of petroleum derivatives in energy matrices from 1973 to 2021 reflect the effort to replace these products. Such efforts result mainly from shocks in oil prices: in 1973, from US$3 to US$12; in 1979, from US$12 to US$40 and from 1998 onwards, when a new cycle of increases began. In Brazil, the maximum participation of oil and its derivatives in the energy matrix occurred in 1979, when it reached 50.4%.

Table 2: Domestic Energy Supply in Brazil and the World (% and toe).

Source	Brazil		OECD		Others		World	
	1973	2021	1973	2021	1973	2021	1973	2021
Oil Products	46.3	35.7	52.6	34.8	29.9	26.3	46.3	29.5
Natural Gas	0.2	12.3	18.9	29.8	12.9	20.5	16.1	23.6
Coal	2.8	5.7	22.6	13.5	31.1	35.7	24.6	27.2
Uranium	0.0	1.3	1.3	9.5	0.2	2.5	0.9	5.0
Other Non-Renewable	0.0	0.9	0	0.7	0	0.2	0.0	0.4
Hydro	6.1	10.4	2.1	2.4	1.2	2.3	1.8	2.5
Other Renewable	44.6	33.7	2.5	9.4	24.7	12.6	10.3	11.9
Solid Bioenergy	44.4	23.9	*2.4*	4.3	*24.7*	9.9	9.0	8.2
Liquid Bioenergy	0.2	7.0	*0*	1.6	*0*	0.3	1.2	0.9
Wind	0.0	2.1	*0*	1.6	*0*	0.8	0.0	1.1
Solar	0.0	0.8	*0*	1.0	*0*	0.8	0.0	0.9
Geothermal	0.0	0.0	*0.16*	0.8	*0*	0.7	0.1	0.8
Tide, wave and ocean	0.0	0.0	*0*	0.0	*0*	0.0	0.0	0.0
Total (%)	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Of which renewable	*50.7*	*44.1*	*4.6*	*11.8*	*26.0*	*14.9*	*12.2*	*14.4*
Total - Mtoe	**82**	**299**	**3,756**	**5,257**	**2,246**	**9,203**	**6,084**	**14,759**
% of the world	*1.3*	*2.0*	*61.7*	*35.6*	*36.9*	*62.4*		

Source: IEA - World Energy Statistics

The reduction of 22.8 p.p.in the consumption of oil and derivatives, between 1973 and 2021, shows that, similar to the global trend, Brazil also made a significant effort to replace these fossil energy sources. It is worth noting, in this case, the increases in hydraulic generation, biodiesel production and the increased use of sugarcane derivatives, such as fuel ethanol and bagasse, for thermal purposes. Wind and solar have also started to contribute in recent years.

Brazil has a renewability indicator for its energy matrix that is three to four times higher than that of other blocks of countries. In relation to the World, OECD countries, with only 17% of the population, account for 60% of the global economy (US$ PPP) and 36% of energy consumption. These data show higher per capita energy consumption and lower energy intensity in relation to GDP.

Energy Final Consumption

Final Energy Consumption – FEC, in 2022, was 271.3 Mtoe. The amount is 2.9% higher than in 2021 and 2.5% above the previous record, of 264.7 Mtoe, which occurred in 2014. This FEC represented 89.5% of the DES. The remaining 10.5% refer to transformation and distribution losses. In 2021, the share of losses in DES was 13.0%. This was due to the greater use of thermoelectric generation. Table 3 shows the FEC by source and table 4, the FEC by production sector.

Table 3: Final Energy Consumption, by source.

Source	ktoe		22/21 %
	2021	2022	
Oil Products	103,349	109,445	5.9
Natural Gas	16,672	17,077	2.4
Coal	13,174	12,542	-4.8
Electricity	49,264	50,403	2.3
Bioenergy	80,409	80,850	0.5
Solar Thermal	930	1,000	7.5
Total	**263,799**	**271,317**	**2.9**

Source: IEA

In 2022, the final consumption of coal showed a reduction of 4.8%, compared to the previous year. This reduction was a consequence of the hydroelectric generation resumption, which have had a strong reduction in 2021. Due to water scarcity that year, there was greater generation from gas, diesel and coal thermoelectric plants. Furthermore, the drop in steel production due to reduction to coal coke had reduced industrial demand for this source. Coal coke, which is responsible for around 74.7% of the coal and derivatives demand in the pig iron and steel industry, experienced a 6.1% drop in its consumption in the period.

The biggest expansions were observed in solar thermal (7.5%) and petroleum derivatives (5.9%), as shown in Table 3. In the case of solar thermal, most of this consumption was concentrated in the residential sector, with an increase of 7.1% compared to 2021 and was responsible for 80.0% of this consumption, and in the commercial sector, with 8.8% expansion compared to the previous year and responsible for 17.1% of the total. In the case of petroleum derivatives, the increase in demand was largely due to greater consumption in the transport sectors, with emphasis on diesel oil and automotive gasoline, with increases of 3.9% and 9.5%, respectively, in road transport. In the case of aviation kerosene, the air transport demand increased 24.3%. Another derivative that had an important expansion (25.4%) was naphtha, in non-energy uses, mainly used in the production of plastic, rubber, solvents and aromatics.

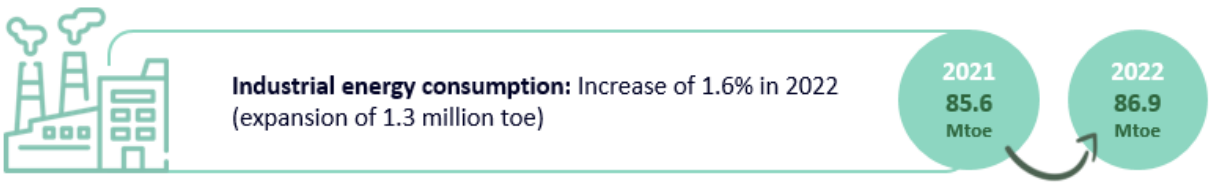


Table 4: Final Energy Consumption – by production sector.

sector	ktoe		22/21 %
	2021	2022	
Industry	85,618	86,949	1.6
Transport	85,187	89,426	5.0
Residential, Commercial and Public Sector	41,204	42,421	3.0
Energy Sector	24,863	23,496	-5.5
Non-Energy Use	13,785	15,942	15.7
Agriculture	13,143	13,082	-0.5
Total	**263,799**	**271,317**	**2.9**

Although energy consumption in the transport sector (total) increased significantly due to the use of oil derivatives, the important share of ethanol (hydrated and anhydrous) in road transport also stands out, which rose 2.1%. The expansion of the road transport sector consumption, which represents almost 93.4% of the total transport sector, is related to the reduction in federal and state taxes that occurred in 2022. The measure stimulated consumption. The panorama corroborates the fact that the consumption of hydrated ethanol (used directly by flex vehicles, replacing gasoline) has decreased 3.4% in its consumption, while anhydrous ethanol (used in mixture with gasoline) has shown an increase of 10.5%.

The industrial sector showed a smaller expansion than that observed in the previous year, with an increase in consumption of 1.6%, compared to 3.6% in 2021. Likewise, while in 2021 almost all sectors showed an expansion in consumption (with the exception of food and beverages), in the industrial sector the vast majority observed a drop, with the most significant in the textile and non-ferrous and other metallurgy sectors, of 6.9% and 5.2% respectively. Expansions occurred in other industries, with an increase of 15.2%, pulp and paper, with 8.1% and food and beverages, with 3.1%.

INTERNATIONAL COMPARISON

From 1973 to 2021, industrial energy consumption in OECD countries fell from 961.5 Mtoe to 834.7 Mtoe, despite total final energy consumption had increased from 2,827.7 Mtoe to 3,703.3 Mtoe (4,180.0 Mtoe in 2019). In developed countries, in addition to natural technological innovation, which increases the efficiency of equipment, there is a strong expansion in the use of scrap (replacement and maintenance exceed goods expansion), which significantly reduces the

primary transformation of metallic minerals, which are energy intensive. They are practically "built" countries, with little expansion in civil construction, compared to developing countries.

In terms of the sectoral structure of final energy consumption, in OECD countries, there is a sharp reduction in the share of industry and increases in the share of transport and services. These behaviors are consistent with the state of development of its member countries. In other countries, the Other Sectors aggregate lost 10.9 p.p. in the period. This result derives mainly from the urbanization movement, in which firewood and animal waste are replaced by cooking gas, which is 5 to 10 times more efficient.

The participation of the Energy Sector tends to stabilize, between 7.5 and 10.5%. In Non-Energy Use, the participation range is from 5.4 to 10.5%. Other Sectors tend to have a smaller relative share in tropical countries, since, in cold countries, 70% to 80% of energy for services and residential use is destined for environmental heating.

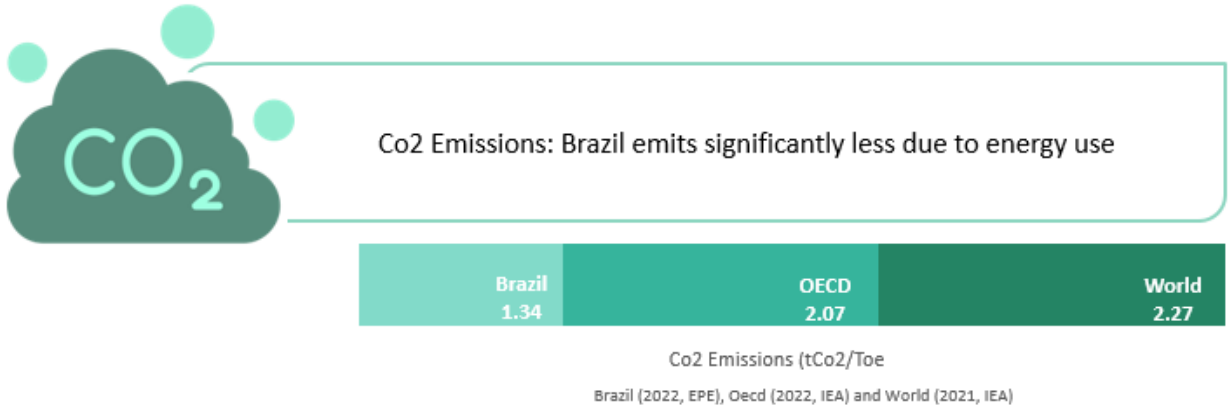
Brazil, in the 1980s, absorbed part of the world's "heavy industry" (energy-intensive). It became a major exporter of steel, ferroalloys and aluminum. Currently, it is still an exporter, but with a greater share of less energy-intensive products. The industry, with a record participation of 38% in the CFE in 2007, increased to 34.2% in 2021.

Table 5: Final Energy Consumption Matrix, by Sector (% and toe).

Setor	Brasil		OCDE		Outros (*)		Mundo	
	1973	2021	1973	2021	1973	2021	1973	2021
Indústria	29.8	32.0	31.2	20.0	33.1	31.5	30.6	26.2
Transportes (**)	25.0	33.0	22.6	31.0	10.8	18.5	21.5	26.5
Setor Energético	3.3	8.7	8.5	7.1	5.8	8.1	7.2	7.4
Outros Setores	38.7	20.5	30.6	33.4	46.6	32.9	35.0	31.5
Uso Não Energético	3.1	5.9	7.2	8.5	3.8	9.0	5.7	8.4
Total (%)	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Total - Mtep	**76**	**271**	**3,076**	**3,805**	**1,691**	**6,007**	**5,027**	**10,484**
% do mundo (**)	*1.5*	*2.6*	*61.2*	*36.3*	*33.6*	*57.3*		

(*) Exclusive Brasil e países da OCDE.

Greenhouse Gas Emissions from Energy Use



In 2022, Brazil's greenhouse gas emissions due to energy use were 404.9 million tons of carbon dioxide equivalent ($MtCO_2eq$). The value represents a reduction of 6.5% over 2021 emissions. This level is 16.4% below the record emissions (484.6 $MtCO_2eq$), which occurred in 2014, a year of high thermoelectric generation from fossil sources.

In 2022, there was a 5.5% increase in greenhouse gas emissions in the world, the largest increase in history: 1.96 $GtCO_2$ (1,960 $MtCO_2$). In 2021, the world reached 37.4 $MtCO_2eq$ (excluding emissions from industrial processes), according to the IEA's Global Energy Review report. In Brazil, in 2022, the relationship between CO_2 emissions from energy use and total energy supply was 1.34 tCO_2/toe. This indicator was 35.5% below what the OECD bloc presented, and 41.3% below that of the World.

Compared to 2021, when there was a severe drought and there was a need for greater activation of thermal plants, power generation emissions decreased by 49.0

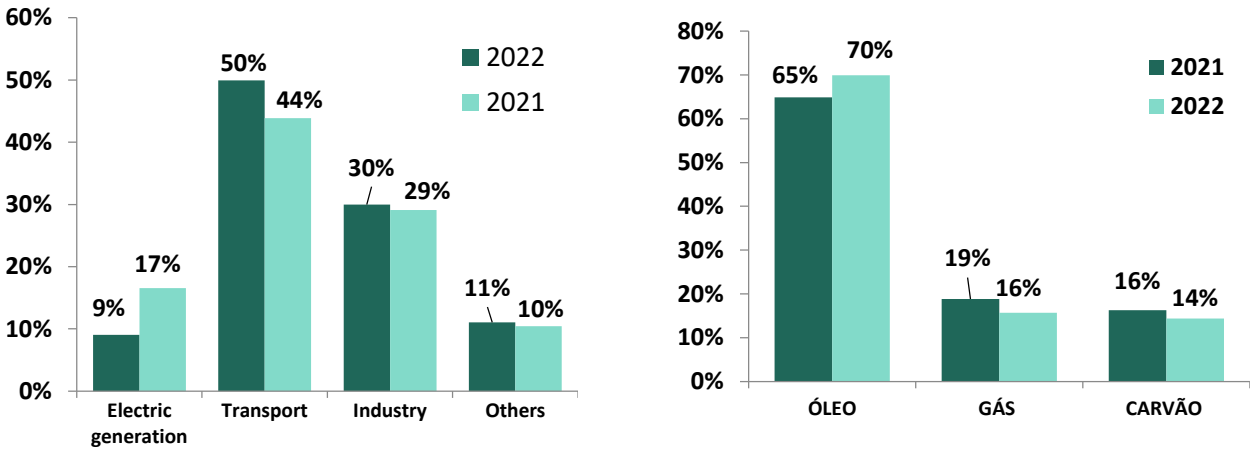


Figure 2: Brazilian CO_2 Emissions by Source and Sector – 2021 and 2022 ($MtCO_2eq$).

Foreign Energy Trade

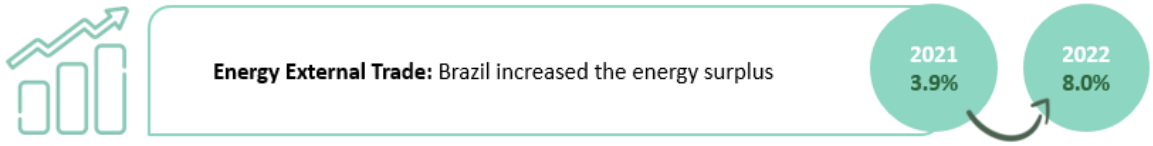


Table 6: External Dependence on Energy.

Sources	UNIT	2021	2022
TOTAL	**ktoe**	**- 12,557**	**- 26,368**
	%	**-3.9**	**-8.0**
OIL AND OIL PRODUCTS	kboe/d	-930	-985
	%	-43.4	-44.6
NATURAL GAS	millions m³	17,175	9,561
	%	40.5	29.1
COAL	kt	21,783	17,309
	%	76.5	74.2
ELETRICITY	GWh	23,103	12,908
	%	3.4	1.9

Note: negative values correspond to net exports and vice versa.

In 2022, Brazilian energy surplus increased 4.1 p.p.. Primary energy production exceeded total demand (final consumption and losses) by 8%, against 3.9% in the previous year. The 11.4 p.p. reduction in external dependence on natural gas and the reduction in the electricity and mineral coal deficit by 1.5 p.p. and 2.3 p.p. impacted the 2022 indicator. In oil and derivatives, net exports increased by 1.2 p.p..

Vehicles and Motorcycles Fleets

Light Vehicle Fleet: Expansion of 0.6% in 2022 (+0.25 million units)

2021 44.1 Millions of units → 2022 44.3 Millions of units

In 2022, 2.10 million national and imported vehicles were licensed. There was a drop of 0.7%, compared to 2021 (3.0% in 2021, -26.2% in 2020, 12.9% in 2019, 13.7% in 2018, 9.2% in 2017, -20.2% in 2016 and -25.6% in 2015). Light cars accounted for 74.5% of all licenses; light commercial vehicles, by 18.2%; trucks, by 6.0%; and buses, by 0.8%. Between 2012 and 2022, around 25 million flexfuel vehicles were licensed. Of the 2022 licensing, 49.3 thousand vehicles were electric or hybrid (2021: 35 thousand; 2020: 19.7 thousand; 2019: 11.8 thousand; 2013: 0.5 thousand). The circulating fleet of motor vehicles at the end of 2022 was estimated at 46.9 million units. Of this total, there were 44.3 million cars and light commercial vehicles (0.6% over 2021), according to the Automotive Component Industry National Union - Sindipeças. Figure 3 includes buses and trucks.

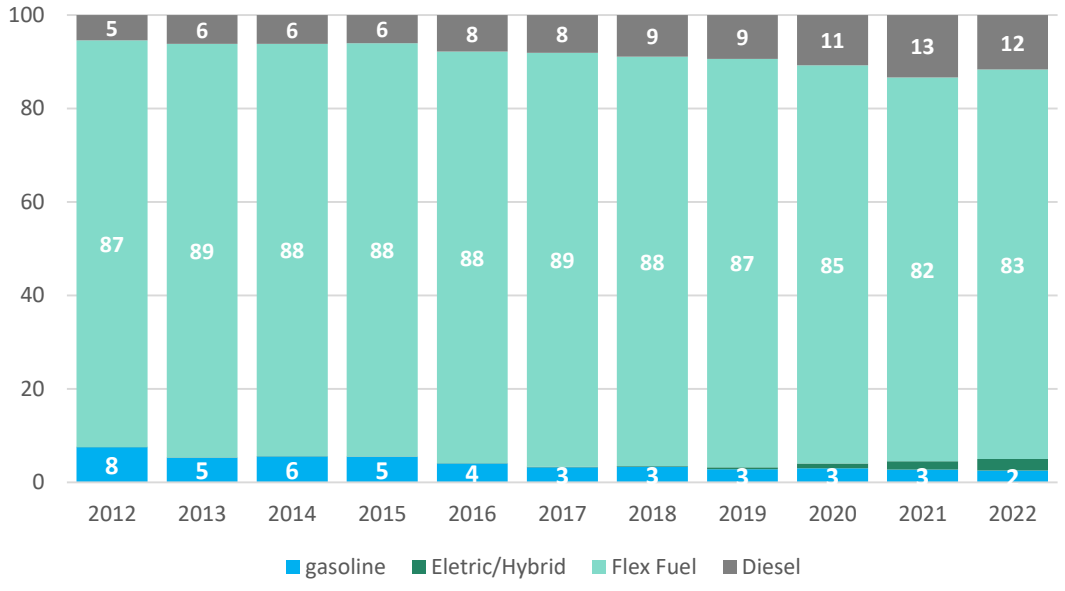


Figure 3: Vehicles by Fuel Type (%).

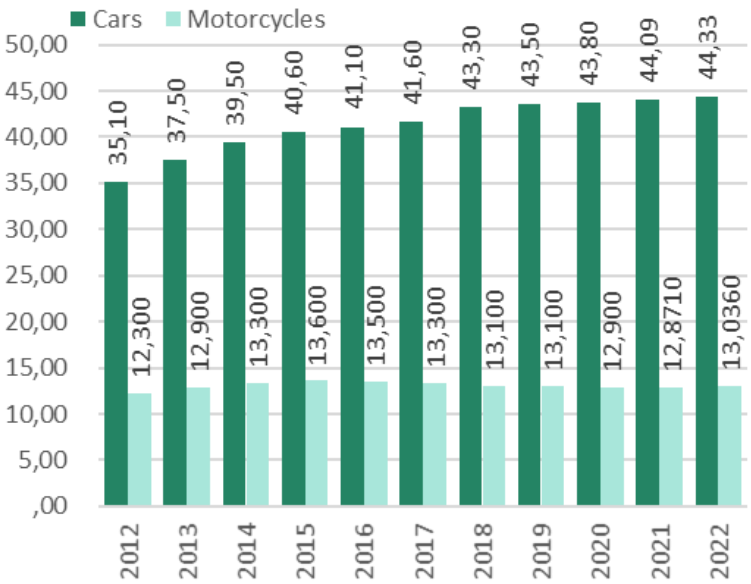


Figure 4: Cars and motorcycles circulating fleet (millions).

Industrial Production

Products	2021	2022	22/21%
physical Production (kt)			
STEEL	**36,071**	**33,964**	**-5.8**
OXYGEN	*27,696*	*25,982*	*-6.2*
ELETRICAL AND OTHERS	*8,375*	*7,981*	*-4.7*
PIG IRON	**33,778**	**31,856**	**-5.7**
INTEGRATED	*28,530*	*26,813*	-6.0
INDEPENDENT	*5,248*	*5,043*	-3.9
PAPER AND PULP	**31,171**	**36,009**	**15.5**
PAPER	*10,666*	*11,040*	3.5
PULP and PASTE	*22,505*	*24,969*	21.8
CEMENT	**64,800**	**63,100**	**-2.6**
ALUMINUM	**772**	**827**	**7.1**
SUGAR	**35,098**	**36,300**	**3.4**
CRUSHED SUGARCANE	**582,322**	**595,252**	**2.2**
EXPORT (K t)			
IRON ORE	**337,700**	**325,086**	**-3.7**
PELLETS	**19,692**	**19,372**	**-1.6**
FERROALLOYS	**765**	**765**	**0.0**
ALUMINA	**9,115**	**8,811**	**-3.3**
SUGAR	**27,249**	**27,458**	**0.8**

INTERNATIONAL COMPARISON – INDUSTRIAL ENERGY INTENSITY

Brazilian foreign trade data indicate that, in 1990, for every ton of durable and non-durable goods imported, it was necessary to export 1.9 tons, for value parity, in dollars. In 2000, the indicator rose to 2.7 and 3.7 in 2020. In 2015, it reached a record of 3.9, due to the primarization of Brazilian exports.

Still in the same train of thought, in 1980, the energy added to exported products, such as steel, pig iron, aluminum, alumina, ferroalloys, pellets, sugar, and cellulose, represented 9% of industrial energy consumption. In 2021, the indicator more than quadrupled. Cellulose and sugar began to have greater weight. The following figure 5 presents, for some years, the industrial energy intensity indices, which is the relationship between energy and the sector's added value (includes the Energy Industry Own Use energy consumption). Calculations show that the indicator fell 54% between 1973 and 2021 in the OECD countries. In Brazil, intensity grew 7.5 times in the same period.

The increase in Australia's intensity indicator, until 2000, is due to the strong expansion of the energy industry's own consumption, with a focus on the coal export at unattractive prices. From 2000 onwards, there was a strong recovery in commodity prices in general, which reversed the upward trend in energy intensity. Australia exports energy equivalent to one and a half times the energy it consumes, which places its energy sector with great weight in the economy.

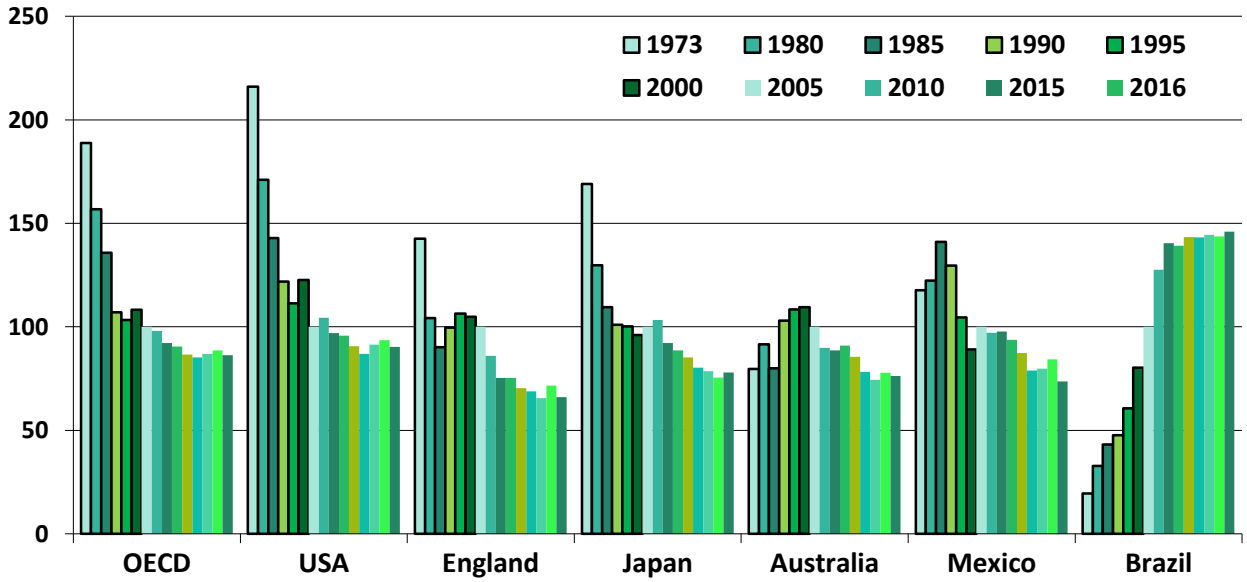


Figure 5: Industry energy intensity indices (2005=100).

In Brazil, there is a strong presence of the steel, pellets, ferroalloys, nickel, aluminum, cellulose and sugar industries, which is associated with higher energy intensities. In Mexico, from 1980 onwards, there was a marked expansion in oil exports, which explains the increases in the intensity indicator until 1990.

Figure 6 presents the industry's energy intensity values for 2021. The difference between the two bars shows the weight of the energy sector's own energy consumption, in relation to other industrial activities. Mexico, although with a relative weight of oil activity in the economy, has low intensity, due to the strong presence of vehicle assembly activity destined for the United States, with a low energy intensity and a high labor presence.

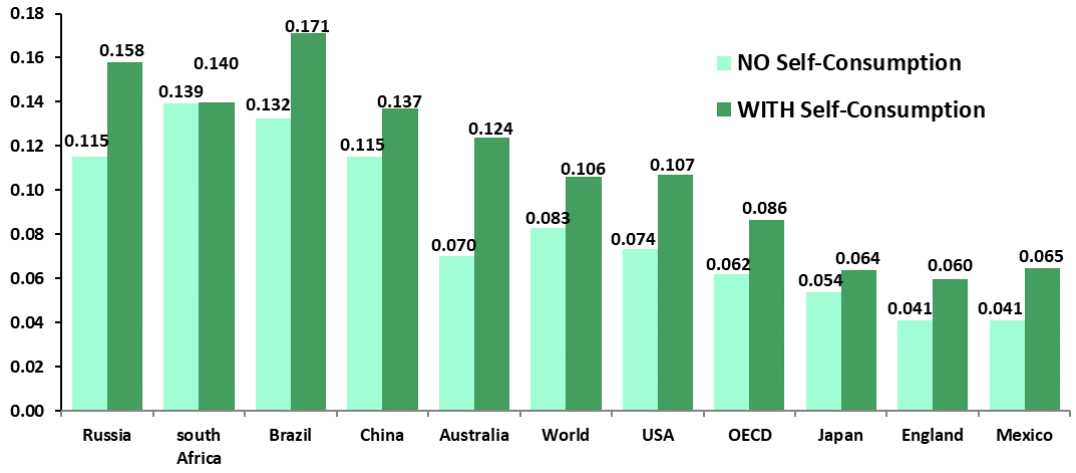


Figure 6: Industry Energy Intensity in 2021, without and with the Energy Sector's Own Energy Consumption (toe/thousand US$ PPP 2017).

It is also observed, in figure 6, that developing countries, such as China, Russia, South Africa and Brazil, have greater industry's energy intensity than developed countries. This is because these countries still have a lot to expand and little to replace and maintain, in addition to being commodities exporters, except China. In 2021, the energy industry own use in the United States increased the industry's energy intensity by 46%, 45% in England and 77% in Australia. In Brazil, this increase was 29%, closer to the world average of 28% (approximate values).
Figure 7 shows the variations in the industrial sector energy intensities between 1980 and 2021. It includes the energy industry own use. It is observed that, in this sample, Brazil is the only one with an increase in the indicator.

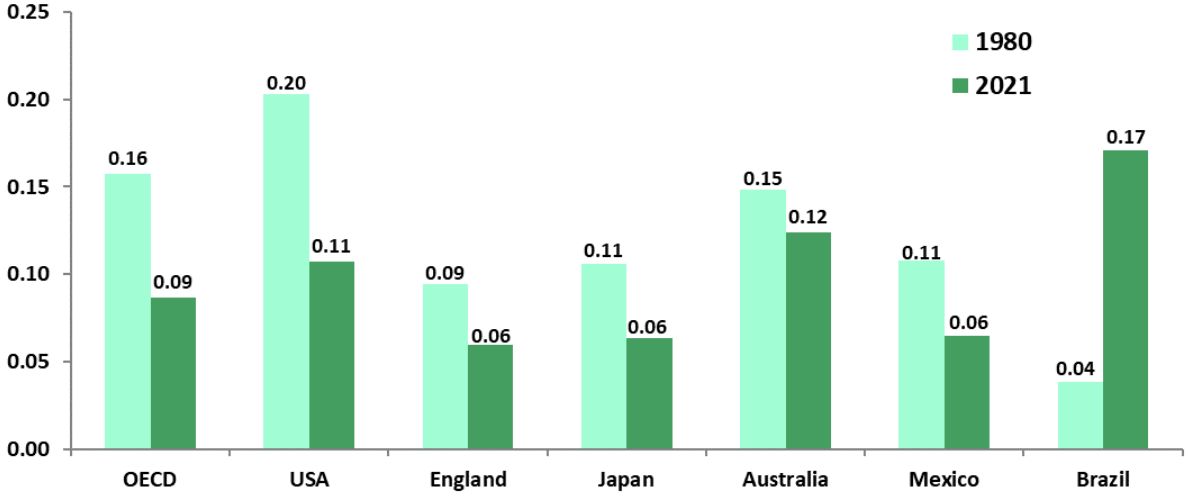


Figure 7 - Industrial Energy Intensity in 1980 and 2021 (toe/thousand PPP dollars 2017).

Oil & Gas

SUPPLY AND DEMAND

In 2022, the total demand for oil derivatives was 2,258.5 thousand barrels of oil equivalent per day (boe/day). This result was around 3.8% higher than what had occurred in the previous year. Oil production (including natural gas liquids – NGL) and shale oil expanded by almost 4.0%. It reached 2,528 thousand barrels (bbl) per day. In this context, oil (crude oil and shale oil) ended the year with a surplus of 57.5% and derivatives with a deficit of 9.4%. In total, oil and derivatives net exports were in the order of 885.8 thousand boe/day. This result is almost the same as the previous year, with an increase of just 0.4%. However, it reinforced a growth trend that had been occurring since 2015. The exception was 2021, when there was a decrease of around 23.3%.

Refinery load in 2022 - oil, NGL, shale oil and other loads - was 2,218.5 thousand boe/day, an increase of 19.4% (1.9% in 2021). Figure 8 illustrates the deficits and surpluses of petroleum products in relation to the total demand for each source. It should be noted that negative values indicate the percentage or derivatives net export. In energy accounting, exports tend to reduce the domestic supply of a given source, while imports, conversely, increase supply. Therefore, positive values indicate net imports.

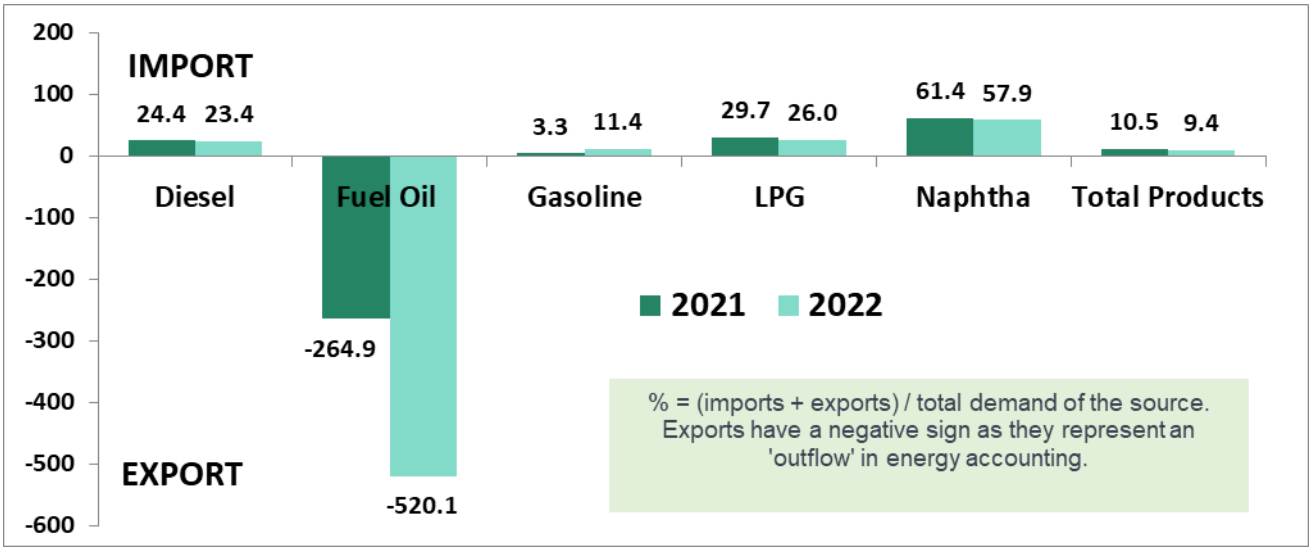


Figure 8: Net foreign trade of oil derivatives (%)

In 2022, when deducting the volumes of reinjected and unused gas, the available gas supply for different uses decreased by 21.2%. In the composition of gas supply, production grew 3.1%, imports fell 47.9% and the sum of unused and reinjected goods grew 11.9%.

INSTALLATIONS

Refining capacity showed a slight increase in 2022, with an increase of 1.7% compared to 2021.

Petroleum derivatives and ethanol pipelines totaled 6.3 thousand km at the end of 2022. Of this total, 78.0% refer to transportation and 22.0% to transfer. The oil transfer pipelines totaled 2,100 km in length (the length was revised in 2020). At the end of 2022, the Brazilian gas transport pipeline network had 9,400 km, practically the same as in 2021. Abroad, so that imported gas can reach the borders with Brazil, there are 450 km in Argentina (24"); 557 km in Bolivia (32") and 362 km in Bolivia (18"). Distribution gas pipelines totaled 41.5 thousand km at the end of 2022, an increase of 1.25 thousand km over 2021 (+3.1%).

Natural gas processing units in Brazil totaled 101.8 million m³ per day (Mm³/d) of installed capacity at the end of 2022. This value is 2.8% lower than in 2021, due to the withdrawal of amount relating to the Atalaia hub, in Aracaju. The distribution by state, in 2022, was: 29.6%, in Rio de Janeiro; 22.1%, in São Paulo; 20.2%, in Espírito Santo; 11.9%, in Amazonas; 8.3%, in Bahia; and 7.7%, in Ceará, Rio Grande do Norte and Alagoas.

Brazil has 5 natural gas regasification terminals: in Guanabara Bay (RJ), with 20 Mm³/day of capacity and beginning of operation in April 2009; at the Port of Pecém (CE), with a capacity of 7 million m³/d and starting operations in January 2009; in Salvador (BA), with 20 Mm³/day (14 million m³/day until 2018) and beginning of operation in January 2014; at the Port of Sergipe, owned by Celse, with 21 Mm³/d and starting operations in November 2019; and the most recent, from May 2021, at Porto do Açu (RJ), with an installed capacity of 14 Mm³/d. The total installed capacity, in 2021, was 82 Mm³/d.

At the end of 2022, there were 362 oil fields in production. The states of Bahia, Rio Grande do Norte, Espírito Santo, and Rio de Janeiro accounted for 81.5% of these fields. In terms of oil production, Rio de Janeiro, São Paulo, and Espírito Santo contributed to 97.6%.

Out of the total production of oil and shale oil, which amounted to 175.5 million m³ in 2022, 97.0% occurred offshore. Rio de Janeiro held 84.5% of the production (72.0% in 2013 and 80.6% in 2021); São Paulo had 8.5% (3.4% in 2013 and 9.4% in 2021); and Espírito Santo accounted for 4.6% (15.0% in 2013 and 7.2% in 2021). Two producing states experienced significant increases: Rio de Janeiro (+9.0%) and Alagoas (+30.7%).

In the national natural gas production, which reached 50.3 billion cubic meters (85.3% offshore) in 2022, the state of Rio de Janeiro held 69.1% (40.0% in 2015 and 63.9% in 2021), followed by São Paulo (11.7%), Amazonas (10.1%), and Bahia (3.6%). Notable expansion occurred in RJ, RN, and AL, the only states with increases.

Table 7: Oil and Natural Gas.

Years	BA	RN	ES	RJ	SE	AL	CE	AM	SP	PR	MA	Total
Oil Fields (nº)												
2022	97	87	53	58	21	11	2	8	17	1	7	**362**
% n	*26.8%*	*24.0%*	*14.6%*	*16.0%*	*5.8%*	*3.0%*	*0.6%*	*2.2%*	*4.7%*	*0.3%*	*1.9%*	***100.0%***
Oil Production (Thousand m³)												
2021	1,302	1,944	12,223	135,880	462	107	39	847	15,776	198	5	**168,783**
2022	1,148	1,907	7,994	148,245	217	140	35	780	14,871	192	2.3	**175,531**
2022/2021	*-11.8%*	*-1.9%*	*-34.6%*	*9.1%*	*-53.0%*	*30.8%*	*-10.3%*	*-7.9%*	*-5.7%*	*-3.0%*	*-54.0%*	***4.0%***
2022%	*0.7%*	*1.1%*	*4.6%*	*84.5%*	*0.1%*	*0.1%*	*0.02%*	*0.4%*	*8.5%*	*0.1%*	*0.001%*	***100.0%***

Natural gas production (millions m³)

2021	1,983	245	1,997	31,223	18	202	0.31	4,957	6,057	-	2,141	**48,824**
2022	1,789	337	1,244	34,776	9	274	0.29	5,068	5,909	4.13	928	**50,338**
2022/2021	*-9.8%*	*37.6%*	*-37.7%*	*11.4%*	*-50.1%*	*35.7%*	*-8.8%*	*2.2%*	*-2.4%*	*-*	*-56.7%*	***3.1%***
2022%	*3.6%*	*0.7%*	*2.5%*	*69.1%*	*0.02%*	*0.5%*	*0.001%*	*10.1%*	*11.7%*	*0.01%*	*1.8%*	***100.0%***

RESERVES

At the end of 2022, proven oil reserves were at 14.9 billion barrels. This represented an increase of 11.5% from 2021 and was sufficient to cover 13.1 years of 2022's production (oil, NGL, shale oil). Natural gas reserves in 2022 were at 406.5 billion cubic meters, marking a 6.6% increase from the previous year, equivalent to sustaining production for 8.1 years based on the 2022 observed output."

Nearly 97.0% of the proven reserves consist of offshore oil reserves, primarily concentrated in three states: Rio de Janeiro, São Paulo, and Espírito Santo, accounting for about 99.4% of this exploration environment. Among these states, only RJ showed an increase in reserves, approximately 14.3%, reaching nearly 12.5 billion barrels.

Regarding onshore reserves, 73.6% of the total is concentrated in the states of Rio Grande do Norte, Bahia, and Sergipe. Sergipe was the only state with an increase compared to 2021, rising by 10.4%. There's also a notable advancement in the state of Alagoas, with a percentage increase of 1,142% from 2021, reaching reserves of 25.2 million barrels.

When it comes to natural gas, on the continental shelf, the largest proven reserves are located in the state of Rio de Janeiro, amounting to 255.1 billion m³, roughly 2.6% higher than in 2021. This represents almost 83.0% of the total maritime reserves. In São Paulo, there are 29.8 billion m³, accounting for 9.7% of the total, but experiencing a decline of 3.4%.

Table 8: Oil and natural gas reserves

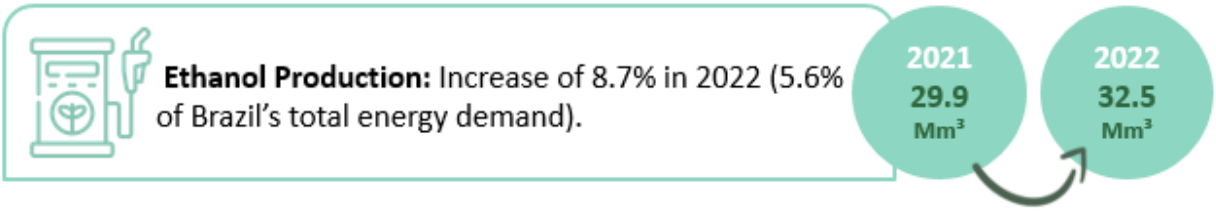
NATIONAL RESERVES OF OIL AND NATURAL GAS.							
Product	**Local**	**2021**		**2022**		**% 2022/2021**	
		Proven	**Total**	**Proven**	**Total**	**Proven**	**Total**
Oil (billions of barrels)	Onshore	0.4	0.7	0.5	0.7	5.8	-7.1
	Offshore	12.9	23.6	14.4	26.3	11.7	11.1
	TOTAL	**13.3**	**24.3**	**14.9**	**26.9**	**11.5**	**10.6**
Natural Gas (billions of m³)	Onshore	77.6	96.7	99.0	118.6	27.5	22.7
	Offshore	303.5	465.9	307.5	469.2	1.3	0.7
	TOTAL	**381.2**	**562.6**	**406.5**	**587.9**	**6.6**	**4.5**

Note 1: The data follows the new Technical Regulation for the Estimation of Oil and Natural Gas Resources and Reserves (RTR), established through ANP Resolution No. 47/2014, which replaces ANP Ordinance No. 09/2000

Note 2: Total reserves include 'contingent resources'

Onshore, Amazonas presents the largest proven reserves, totaling 42.0 billion m³ (42.4% of the total and a 2.3% increase from 2021), followed by Maranhão with 29.7 billion m³ (approximately 30.0% and a 9.8% increase), and Bahia with 12.6 billion m³. Bahia observed a significant increase of 118.4% compared to the previous year and now represents 12.7% of the total. Along with the state of Alagoas, similar to the oil reserves, experienced a substantial surge of 3,067.4% in gas reserves. These two states were the main contributors to the 27.5% increase in proven natural gas reserves.

Bioenergy



The total supply of bioenergy in 2022 was 95.1 Mtoe (1,902.4 thousand boe/day). This amount represents 31.4% of Brazil's energy matrix (31.2% in 2021 and 29.3% in 2015). Sugarcane products (bagasse and ethanol), accounting for 46.7 Mtoe, represented 49.1% of bioenergy and 15.4% of the matrix (DES). Wood fuel, totaling 27.3 Mtoe, accounted for 28.7% of bioenergy and 9.0% of the matrix. Other bioenergies (black liquor, biogas, wood residues, agro-industrial residues, and vegetable oils), amounting to 21.1 Mtoe, accounted for 22.2% of bioenergy and 7.0% of the matrix.

In the composition of sugarcane products, ethanol accounted for 16.9 Mtoe (36.1%), while sugarcane bagasse accounted for 29.8 Mtoe (63.9%). In Brazil's energy matrix, sugarcane bagasse represented 9.8%, and ethanol, 5.6%.

In 2022, ethanol production reached 32.5 million cubic meters (Mm³), marking an increase of 8.7% compared to 2021 (-8.3% in 2021, -7.3% in 2020, +5.6% in 2019, +19.9% in 2018, -2.1% in 2017). Road consumption, at 29.1 Mm³, increased by 2.0% compared to the previous year. Brazil experienced a 26.2% increase in ethanol exports and a 77.1% decrease in imports in 2022, maintaining its status as a net exporter of the fuel, with 2,259 thousand cubic meters (1,435.9 thousand cubic meters in 2021, 1,068.0 thousand cubic meters in 2020, and 496.0 thousand cubic meters in 2019).

Biodiesel production in 2022 reached 6.26 million cubic meters, a 7.5% decrease from 2021 (+5.2% in 2021, +8.6% in 2020, +10.7% in 2019, and +24.7% in 2018), accounting for 9.9% of the total diesel consumption (11% in 2021).

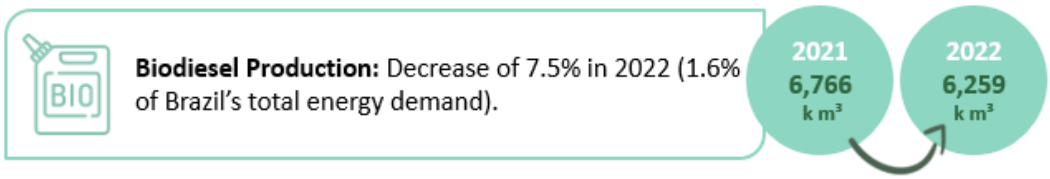


Table 9: Biodiesel Production, by State (thousand m³).

Year	RS	GO	MT	PR	BA	SC	MS	SP	RJ	MG	TO	PI	PA	RO	Others	Total
2021	1,856	965	1,322	1,225	410	102	275	175	138	112	141	42	0	4	0	**6,766**
2022	1,526	1,104	1,065	844	577	283	190	186	134	128	95	54	50	19	4	**6,259**
% 22/21	*-17.8*	*14.4*	*-19.4*	*-31.1*	*40.7*	*178.3*	*-31.0*	*6.2*	*-2.7*	*14.2*	*-32.7*	*28.1*	*-*	*398.2*	*-*	***-7.5***
% 22 State	*24.4*	*17.6*	*17.0*	*13.5*	*9.2*	*4.5*	*3.0*	*3.0*	*2.1*	*2.0*	*1.5*	*0.87*	*0.79*	*0.30*	*0.06*	**100.0**

Source : EPE and ANP

In terms of volume, the most significant production decline occurred in Paraná, with 380.5 thousand cubic meters, followed by Rio Grande do Sul, with 329.9 thousand cubic meters, and Mato Grosso, with 256.2 thousand cubic meters. However, in percentage terms, the most considerable decline took place in Tocantins, dropping by 32.7%, followed by Paraná and Mato Grosso do Sul, both experiencing around a 31% decrease.

INTERNATIONAL COMPARISON – SECTORAL CONSUMPTION OF BIOENERGY

The percentage structure of bioenergy use in non-OECD countries is expected to resemble that of OECD countries due to the former's relatively higher economic growth. The use of solid bioenergy, primarily wood, tends to decrease in developing countries both relatively and absolutely. The absolute reduction in wood usage in the non-OECD block results from its substitution with gas for cooking purposes. Meanwhile, bioenergy usage in other sectors is expected to grow in absolute terms. In developed countries, there is no longer solid bioenergy to replace. However, there is an expansion of liquid bioenergy: ethanol and biodiesel. In terms of total energy consumption per capita, the OECD block presents a value almost three times higher than that of the non-OECD block. Regarding final bioenergy consumption per capita, the OECD block's indicator surpasses that of the non-OECD block by approximately 27.5%

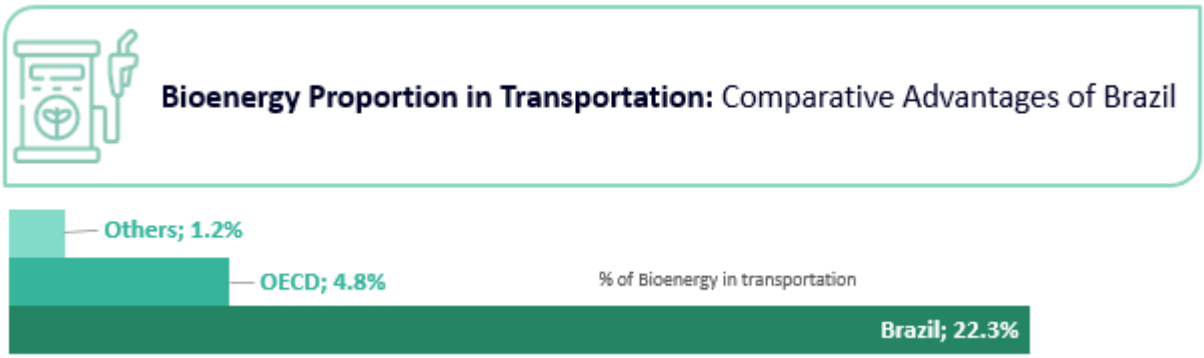
In developing countries, the greater need for primary transformation of metallic minerals implies a higher utilization of coal, a primary input in pig iron production. Within OECD countries, more refined fuels such as electricity and gas, extensively used in high-value-added industries, show the most substantial increases in their shares, displacing petroleum derivatives and coal. Moreover, the use of electricity is on the rise across all stages of development in countries.

Table 10: Sectoral Bioenergy Consumption in 2021 (Mtoe and %).

Sources	Mtoe			%		
	Brazil	OECD	Não OECD	Brazil	OECD	Non OECD
Paper and Pulp	10.1	48.7	12.0	15.3	22.0	1.5
Other industries	24.8	32.3	153.6	37.6	14.6	18.6
Transport	19.2	57.3	36.4	29.1	25.8	4.4
Residential	7.9	68.7	592.1	11.9	31.0	71.9
Others	3.1	14.5	29.5	6.1	6.6	3.6
Total (Mtoe and %)	**66.1**	**221.5**	**823.6**	**100.0**	**100.0**	**100.0**
% of World	**6.3**	**21.2**	**78.8**			

Source : IEA.

INTERNATIONAL COMPARISON – BIOENERGY IN TRANSPORTATION



Brazil is one of the countries with the highest presence of liquid bioenergy in the transportation matrix. In 2021, the share of ethanol and biodiesel in the matrix reached 22.3% (up from 19.8% in 2017). In OECD countries, bioenergy accounted for only 4.8% in 2021. The consumption of ethanol in the United States significantly influenced this percentage. In other countries, the contribution is relatively minor (1.2%). Petroleum derivatives in these country groups remain close to 91% in terms of share.

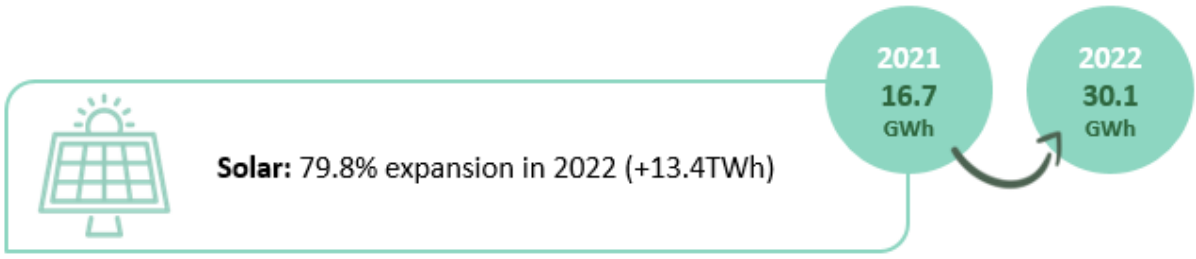
Table 11: Transport sector Energy Matrix (% and toe).

Source	Brazil		OECD		Others (*)		World	
	1973	2021	1973	2021	1973	2021	1973	2021
Oil Products	98.7	76.0	95.7	91.4	83.2	88.2	94.4	90.9
Natural Gas	0.0	2.2	2.4	2.7	0.4	7.9	1.6	4.4
Coal	0.01	0.0	1.1	0.0	13.5	0.0	3.0	0.0
Electricity	0.3	0.2	0.7	0.9	2.8	2.5	0.9	1.4
Bioenergy	1.0	21.5	0.0	5.0	0.08	1.4	0.06	3.4
Total (%)	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Total - Mtoe	**19**	**89**	**695**	**1.178**	**183**	**1.111**	**1.081**	**2.778**
% of World (**)	*1.8*	*3.2*	*64.3*	*42.4*	*16.9*	*40.0*		

(*) Exclusive Brazil and OECD countries **(**)Bunker, included only in the world, reaches 100%..**

The low participation of natural gas in the transportation matrix of OECD countries may signal the impracticality of adopting policies favoring its use in vehicles. In fact, as gas is a finite, valuable, non-renewable resource, and less polluting than other fossil fuels, promoting its use in vehicles doesn't seem advisable. This is because the combustion engine's conversion efficiency is around 30%, while in the industrial sector, efficiencies of up to 80% can be achieved. Even in electricity generation, cogeneration processes manage to increase efficiency to 70%.

Brazilian Electricity Matrix



In 2022, the Domestic Electricity Supply (DELS) stood at 690.1 terawatt-hours (TWh). This amount marked a 1.6% increase from 2021. Among renewables, solar generation once again presented the highest growth rate, largely driven by distributed generation in the total solar output. The annual expansion rates of solar energy, which consistently showed a decreasing trend—875.6% in 2017, 316.1% in 2018, 92.2% in 2019, 61.5% in 2020, and 55.9% in 2021—experienced a new upsurge in 2022 (79.8%). This outcome reflects public policies incentivizing renewable energy sources and Micro and Mini Distributed Generation (DG), such as Law No. 13,203/2015 and Law No. 14,300/2022. The latter, considered the legal milestone for GD, ensured an exemption from the Distribution System Usage Tariff (TUSD) until 2045 for systems implemented or with access requests filed by January 7, 2023. Additionally, it allowed a partial exemption, gradually transitioning according to the established rules, for systems implemented until December 31, 2028.

Hydroelectric generation maintained its supremacy. Its share in the electricity matrix increased from 56.8% in 2021 to 63.8% in 2022. These indices include imports.

Table 12: Domestic Electricity Supply – 2021 and 2022.

Specification	GWh		22/21 %	STRUCTURE (%)	
	2021	2022		2021	2022
HYDRO	362,818	427,114	17.7	53.4	61.9
SUGARCANE BAGASSE	34,342	32,262	-6.1	5.1	4.7
WIND	72,286	81,632	12.9	10.6	11.8
SOLAR	16,752	30,126	79.8	2.5	4.4
OTHER RENEWABLE (a)	21,382	22,772	6.5	3.1	3.3
OIL (Diesel + FUEL)	17,327	7,056	-59.3	2.6	1.0
NATURAL GAS	86,957	42,110	-51.6	12.8	6.1
COAL	17,585	7,988	-54.6	2.6	1.2
NUCLEAR	14,705	14,559	-1.0	2.2	2.1
OTHER NON-RENEWABLE (b)	11,955	11,554	-3.3	1.8	1.7
IMPORT	23,103	12,908	-44.1	3.4	1.9
TOTAL (c)	**679,212**	**690,081**	**1.6**	**100.0**	**100.0**
OF WHICH ARE RENEWABLE	*530,684*	*606,813*	*14.3*	*78.1*	*87.9*

(a) Bleach, biogas, rice husk, elephant grass, wood residues, and vegetable coal gas; (b) Blast furnace gas, steel mill gas, coke oven gas, refinery gas, sulfur gas, and tar; (c) Includes captive autoproducer (not using the basic grid)

According to the "2023 | 72nd edition Statistic Review of World Energy," in 2022, Brazil ranked as the second-largest producer of electricity from hydro sources, behind only China. Furthermore, it stood as the fourth-largest producer of electricity from wind sources, following China, the United States, and Germany.

In 2022, renewable sources accounted for 87.9% of the Internal Electricity Energy Supply (DELS) matrix. This figure was 9.8 percentage points higher than in 2021. Solar energy surpassed the total electricity generation from oil-based sources (diesel and fuel oil). It is noteworthy that while solar generation increased by almost 80.0%, oil-based generation experienced a reduction of 59.3 percentage points. This reduction is attributed to the decreased operation of thermal power plants in 2022 due to improved rainfall patterns and the growth of renewable sources, especially solar and wind.

In the case of sugarcane bagasse, out of the 32.3 terawatt-hours (TWh) generated, 13.8 TWh were for self-consumption, and 18.5 TWh corresponded to surpluses for the market. It is also worth mentioning an 11.8% increase in biogas generation (from 1,606.2 gigawatt-hours in 2021 to 1,796.4 gigawatt-hours in 2022).

The Figure 9 displays the DELS matrix. The central graph illustrates the 87.9% share of renewable sources in the Brazilian electricity matrix, compared to the global average of 28.0% and the OECD bloc's 29.7%.

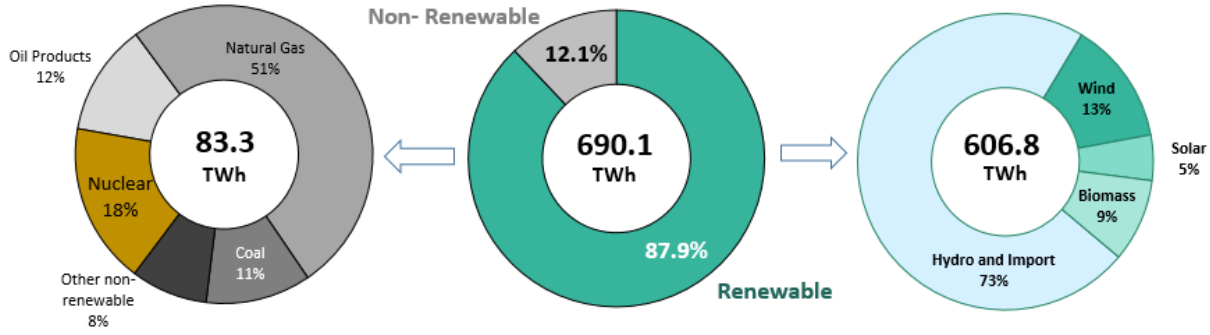


Figure 9: Internal Electricity Energy Supply - 2022 (%).

According to data from the National Energy Balance, wind power generation increased by 12.9%. The data indicates that in 2022, Bahia was the state with the highest wind power generation in Brazil, accounting for approximately 31.0% of the country's total generation.

Table 13: Wind Generation by Brazilian State (GWh) – 2021 e 2022.

YEAR	BA	RN	PI	CE	RS	PE	PB	MA	SC	SE	RJ	PR	OTHER	Total
2021	20,850	22,099	8,904	8,287	5,850	2,951	892	1,782	535	61	55	20	1	72,286
2022	25,317	23,955	11,088	7,614	5,581	3,558	2,231	1,561	569	72	65	19	1	81,632
% 22/21	21.4	8.4	24.5	-8.1	-4.6	20.6	150.0	-12.4	6.4	17.3	17.6	-4.1	6.3	12.9
% 22 STATE	31.0	29.3	13.6	9.3	6.8	4.4	2.7	1.9	0.7	0.1	0.1	0.02	0.0	100.0

Source : EPE

ELETRICITY SUPPLY MATRICES – SIN, ISOLETED SYSTEMS, AND CAPTIVE AUTOPRODUCER

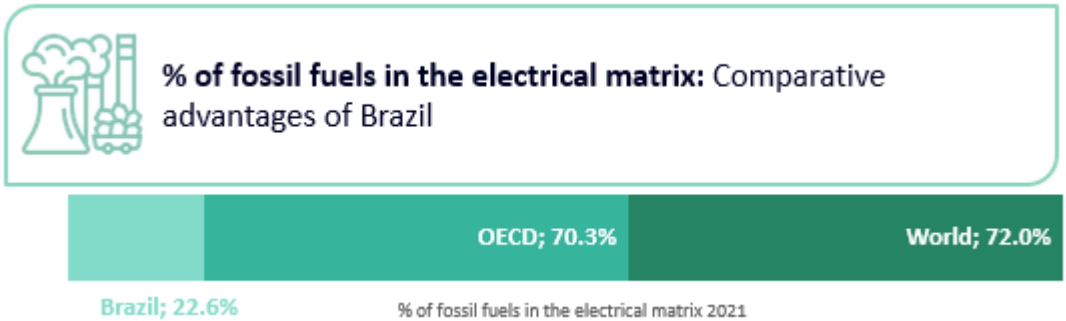
Table 14 presents the share of sources according to different configurations: in the National Interconnected System (SIN), in Isolated Systems, by Autoproducer of Energy (APE Captive), and in Brazil's total supply. There's an observed recovery in hydroelectric generation compared to 2021, both in the SIN (from 59.3% to 69.3%) and the overall total (from 53.4% to 61.9%). This outcome is a result of the more favorable hydrological conditions in 2022. This recovery, together with the growth in wind and solar energies by 1.2 percentage points and 1.9 percentage points, respectively, compared to 2021, mitigated the participation of non-renewable thermal sources, which decreased from 19.7% to 10.0%. This configuration contributed significantly to the increased share of renewables in the electricity matrix, advancing from 78.1% to 87.9%. Net electricity imports, nuclear generation, and renewable thermal sources (biomass) maintained a similar configuration to the previous year, with only slight variation.

Table 14: Electricity Supply Configurations by Source – 2022 (GWh).

source	SIN	Isolated	Auto producer	Brazil
Hydro	69.3%	1.34%	3.7%	61.9%
Thermal	9.3%	98.7%	85.3%	17.9%
Fossil	*6.5%*	*92.8%*	*34.4%*	*10.0%*
Renewable	*2.8%*	*5.9%*	*50.9%*	*8.0%*
Nuclear	2.4%			2.1%
Wind	13.3%		0.008%	11.8%
Solar	3.6%		10.9%	4.4%
Import*	2.1%			1.9%
Total (%)	100.0	100.0	100.0	100.0
Total (TWh)	612.4	4.0	73.7	690.1
% renewable	*91.2%*	*7.2%*	*65.6%*	*87.9%*

*Import refers to the balance of electrical energy export and import, meaning, import minus export. When this balance is negative, it indicates a net export; when positive, a net import.

INTERNATIONAL COMPARISON



In 2021, global electricity demand stood at 28,402 GWh according to the IEA, up from 26,758 GWh in 2020, marking an increase of +6.1%. Over the past 50 years, the electricity supply matrices of Brazil, OECD, and "Other" countries have exhibited similar trends. There have been reductions in the shares of oil and its derivatives and hydroelectric power, while the shares of other sources have increased, except for coal. OECD countries have been reducing their consumption of coal, which has decreased by 17.4 percentage points from 1973 to 2021

Table 15: Domestic Electricity Supply in Brazil and Worldwide (% and TWh).

Fonte	Brazil		OECD		Others		World	
	1973	2021	1973	2021	1973	2021	1973	2021
Oil and Oil Products	7.2	3.1	25.4	1.8	24.1	3.1	24.6	2.6
Natural Gas	0.0	13.3	11.6	30.2	14.0	18.7	12.2	23.1
Coal	2.2	3.7	37.8	20.4	40.6	48.0	38.3	36.1
Uranium	0.0	2.2	4.2	17.0	0.9	5.3	3.3	9.9
Other non-renewable	0.0	0.4	0	0.8	0	0.1	0.1	0.4
Hydro	89.4	55.3	20.7	13.0	18.8	15.0	21.0	15.1
Other Renewables	1.2	22.1	0.3	16.8	1.5	9.8	0.6	12.9
Solid Biomass	1.2	8.0	*0.1*	2.3	*0.1*	1.6	0.5	2.0
Liquid Biomass	0.0	0.5	*0*	0.8	*1*	0.1		0.3
Wind	0.0	11.0	*0*	8.7	*0*	5.0	0.0	6.6
Solar	0.0	2.6	*0*	4.6	*0*	3.1	0.0	3.6
Geothermal	0.0	0.0	*0.15*	0.5	*0*	0.2	0.1	0.3
Tides, Waves, and Ocean	0.0	0.0	*0*	0.0	*0*	0.0	0.0	0.0
Total (%)	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Of which are renewable	*90.6*	*77.4*	*21.0*	*29.7*	*20.4*	*24.8*	*21.5*	*28.0*
Total (TWh)	**65**	**656**	**4,484**	**11,230**	**1,582**	**16,516**	**6,131**	**28,402**
% of World	*1.1*	*2.3*	*73.1*	*39.5*	*25.8*	*58.2*		

Fonte: IEA - World Energy Statistics

In 2021, despite the severe drought, the share of hydroelectric power in Brazil's electricity matrix remained significantly higher than that of other countries worldwide (more than triple). Brazil also stands out in solid bioenergy, with an 8.0% share (due to significant generation from sugarcane bagasse and black liquor). Wind and solar power also stand out with substantial expansion.

Autoproducer Generation

Table 16 displays the total autoproducer energy generation (APE) in 2022. Until the second half of the 1990s, autoproducer electricity was primarily intended for self-consumption, largely without using the public grid. Legislative advancements enabled autoproducers to sell surplus energy to the market and acquire energy, wholly or partially, from hydroelectric plants located outside the area of consumer establishments that required the use of SIN's basic network. In the calculations for APE generation, considerations encompass partial or total equity interests in hydroelectric plants by companies such as Vale, Companhia Siderúrgica Nacional (CSN), and Companhia Brasileira de Alumínio (CBA); self-consumption (without using the public grid); and surpluses (sales) from sugarcane and other sectors' plants, which includes the injection of Distributed Generation (DG)

Of the total Distributed Generation (18.4 TWh), 55.1% were injected into the grid, amounting to 10.1 TWh. Within this portion, 92.7% (9.4 TWh) originated from photovoltaic solar sources. In absolute terms, this outcome indicates that only the injected portion of Solar DG nearly reached the total amount of DG in 2021 (9.8 TWh). Concerning economic segments, noteworthy emphasis is placed on residential and commercial sectors, jointly representing 78.5% of the total DG injected into the grid. This substantial highlight is directly linked to the legal framework change for DG, under Law 14,300/2022 – the "DG Legal Framework.".

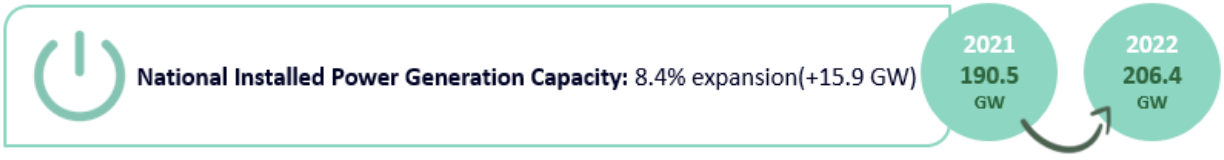
In regards to APE, an estimated total generation of 125.6 TWh is anticipated in 2022. This value represents 21.4% of Brazil's final electricity consumption (20.0% in 2021, and 19.7% in 2020). Out of the total APE generation, 58.6% was intended for self-consumption (captive use without utilizing the public grid), 12.2% corresponded to equity participation in distant hydroelectric plants (grid usage), and 29.1% were sold to the market (surplus). The most significant highlight is the sugarcane and alcohol sector, the only one with a surplus. This sector generated 183.9% more than its own consumption (124.3% in 2021), reaching a 31.2% share in total APE electricity generation (31.1% in 2021). All sectors, except for the steel industry, witnessed increases in the generation-to-consumption ratio compared to the previous year. This phenomenon occurred due to the increasing protagonism and market options for autoproducers to generate and trade their energy.

Table 16: Generation* and Consumption of Electricity, by Autoproducer – 2022 (GWh).

Sector	Captive Use	Grid Use**	Subtotal Self-Use	Surplus	Total Generation (TG)	Total consumption (TC)	Ratio TG/TC
Sugarcane ethanol production	20,841		20,841	18,412	39,253	21,341	183.9%
Mining	330	2,175	2,505	162	2,667	11,767	22.7%
Steel industry	8,475	3,191	11,666	1,135	12,801	28,403	45.1%
Non-ferrous metals	2,572	8,021	10,592	228	10,820	27,165	39.8%
Oil	19,832		19,832	356	20,188	22,927	88.1%
Paper and pulp	15,369		15,369	4,171	19,541	26,050	75.0%
Chemical industry	2,408		2,408	100	2,508	23,532	10.7%
Agriculture and livestock	2,087	365	2,452	2,782	5,234	32,288	16.2%
Others	1,750	1,571	3,321	9,286	12,606	392,614	3.2%
Total	**73,663**	**15,323**	**88,987**	**36,632**	**125,619**	**586,086**	**21.4%**

*Includes distributed generation **Generation corresponding to the sectors' ownership in hydroelectric plants. Portions of the generation might have been traded in the market.

Installed Generation Capacity



In 2022, the net expansion of the national installed capacity for electricity generation was 15.9 GW, as indicated in Table 17. Renewable sources accounted for 95.4% of this expansion, reaching 84.6% of the national installed power capacity for generation.

The most significant expansion occurred with photovoltaic solar energy, reaching 11.0 GW. This increase represented nearly 70.0% of the total net expansion. The robust participation of solar energy is a result of the substantial growth observed in Distributed Generation (DG). This modality allows consumers to install solar panels for electricity generation, associated with compensation from local distributors. Independently, solar DG represented 52.2% of the capacity expansion in 2022. The consolidation of the legal framework for DG under Law 14,300/2022 led to a significant surge in photovoltaic energy installations in the residential and commercial sectors, as observed

in Figure 10. This was facilitated by consumers maintaining the existing conditions for access to the distribution system and the financial compensation system enabled by ANEEL Normative Resolution No. 482/2012, rather than adopting the new configuration that would come into effect in the year following the Law's publication date.

Table 17 - Installed Capacity of Electric Generation (% and MW).

source	2021	2022	structure % de 2022	Expansion n-(n-1) MW
Hydropower (*)	**109,350**	**109,720**	**53.1**	**370**
Large Hydroelectric Plants	*103,003*	*103,195*	*50.0*	*192*
Small and Mini Hydroelectric Plants	*6,347*	*6,525.0*	*3.2*	*178*
Biomass	**15,900**	**16,584**	**8.0**	**684**
Sugarcane Bagasse	*11,681*	*11,862*	*5.7*	*181*
Biogas	*228*	*236*	*0.1*	*8*
Lye and others	*3,991*	*4,486*	*2.2*	*495*
Wind	**20,771**	**23,744**	**11.5**	**2,973**
Solar	**4,632**	**7,387**	**3.6**	**2,755**
Uranium	**1,990**	**1,990**	**1.0**	**0**
Gas	***18,074***	***19,286***	***9.3***	***1,212***
Natural Gas	*16,219*	*17,437*	*8.4*	*1,218*
Industrial Gas	*1,855*	*1,849*	*0.9*	*-6*
Oil Products	**7,663**	**7,185**	**3.5**	**-478**
Fuel Oil	*3,118*	*3,213*	*1.6*	*95*
Coal	**3,203**	**3,203**	**1.6**	**0**
Unknown	**27**	**27**	**0**	**0**
Subtotal	**181,610**	**189,126**	**91.6**	**7,516**
Distributed Generation	**8,964**	**17,325**	**8.4**	**8,361**
Solar	*8,771*	*17,066*	*8.3*	*8,295*
Wind	*15*	*17*	*0.0*	*2*
Hydro	*63*	*86*	*0.0*	*23*
Thermal	*115*	*156*	*0.1*	*41*
Total National	**190,574**	**206,451**	**100**	**15,877**
Of which renewable	*159,611*	*174,757*	*84,6*	*15.146*

GD: BEN EPE. Table I.2. b Capacidade Instalada de Geração Elétrica Mini e Micro GD.

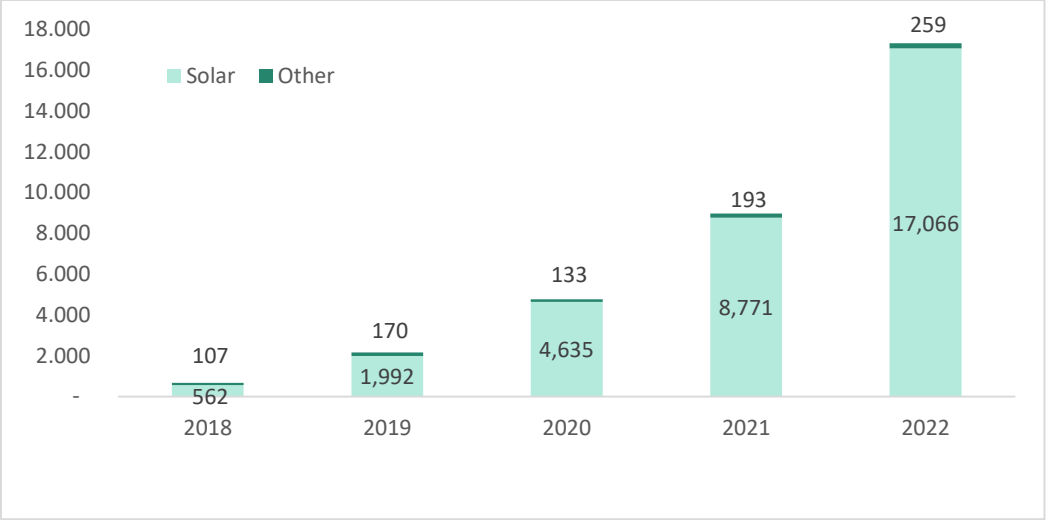


Figure 10: Evolution of Distributed Generation 2018-2022.

The installed power capacity for electricity generation in Brazil reached 206.4 GW (including DG) in 2022, showing an increase of 8.3% compared to 2021. The expansion of installed capacity in Solar DG was particularly notable, increasing by 94.6% and reaching 17.1 GW. This level represents 8.3% of the installed power capacity in the national electricity generation matrix.

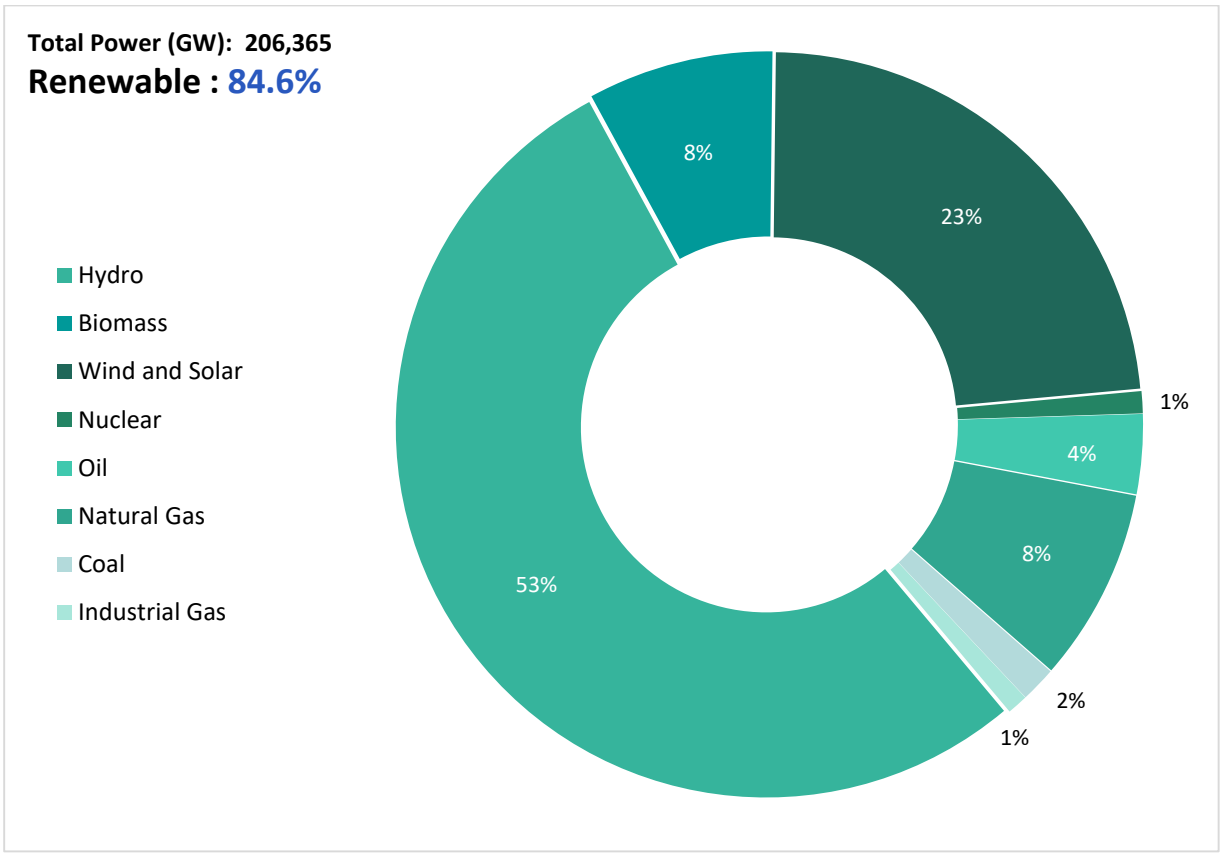


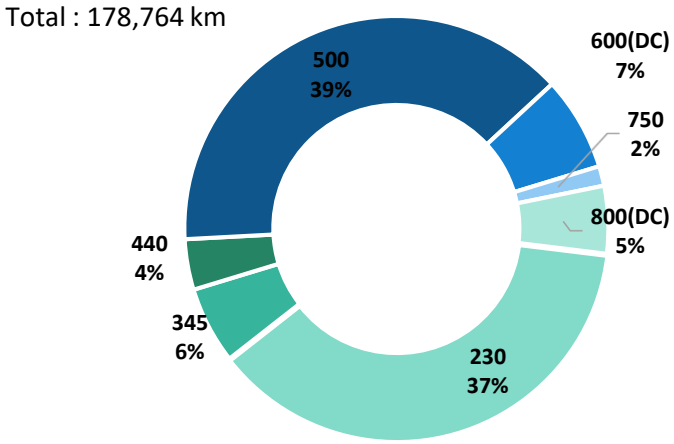
Figure 11: Electric Generation Capacity with Imports – 2022 (%).

TRANSMISSION LINES

Transmissions Lines: Expansion of 8.9 Thousand km, or 5.2%

2021 169.9 k km → 2022 178.7 k km

By the end of 2022, the total extension of the electric power transmission system, in terms of transmission lines (LT), reached a length of 178,763 kilometers. This measurement includes the basic network of the National Interconnected System, connections from power plants, international interconnections, and 190 kilometers from the isolated systems in Boa Vista-RR. Additionally, 23.7 thousand megavolt-amperes (MVA) were added in transformer capacity in 2022, marking an increase of 31.24%, bringing the total to 434.6 thousand MVA.



Out of the total length of transmission lines, 67 thousand km are at 230 kV. In this class, there was a 4.0% expansion (2,700 km). At the 500 kV level, the total length of lines is 69.7 thousand km. There was an 8.6% expansion (5,964 km). The networks at 230 kV and 500 kV together amount to 136.7 thousand km, or 76% of the total grid. Capacity at substations reached 434.5 thousand MVA, with a 5.7% expansion (23.7 thousand MVA)

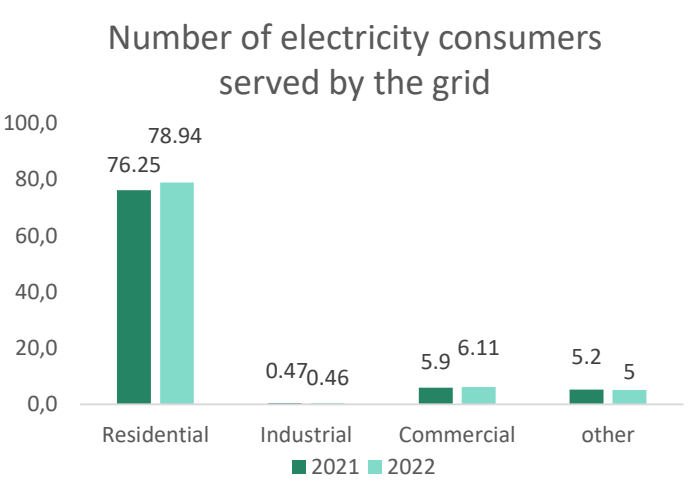
Figure 12: Transmission lines Structure by Voltage– 2022.

Universal Access to Energy

Electricity Consumers: 3.1% Expansion (+2.8 millions)

2021 87.8 millions → 2022 90.6 millions

According to data from the Energy Research Company - EPE, it's estimated that the number of electricity consumers served by the grid in 2022 reached approximately 90.6 million. This figure represented a 3.1% increase compared to the previous year. In the Industrial and Other sectors, there was a decrease of 2.8% and 2.9%, respectively. Despite a 1.1% increase in overall electricity consumption in 2022, with a notable rise in the residential (4.6%) and commercial (1.5%) classes, reductions were observed in the Industrial (1.0%) and Other (1.4%) sectors. Figures 13 and 14 present the total number of consumers and the electricity consumption by sectors, respectively.



Total number of electricity consumers on the grid reached 90.6 million in 2022, marking a 3.1% increase compared to 2021 (+2.7 million). Despite an overall consumption increase (476.2 GWh), there was a decrease in the Industrial (1.0%) and Other sectors (1.4%)

Figure 13: Electricity Consumers (millions).

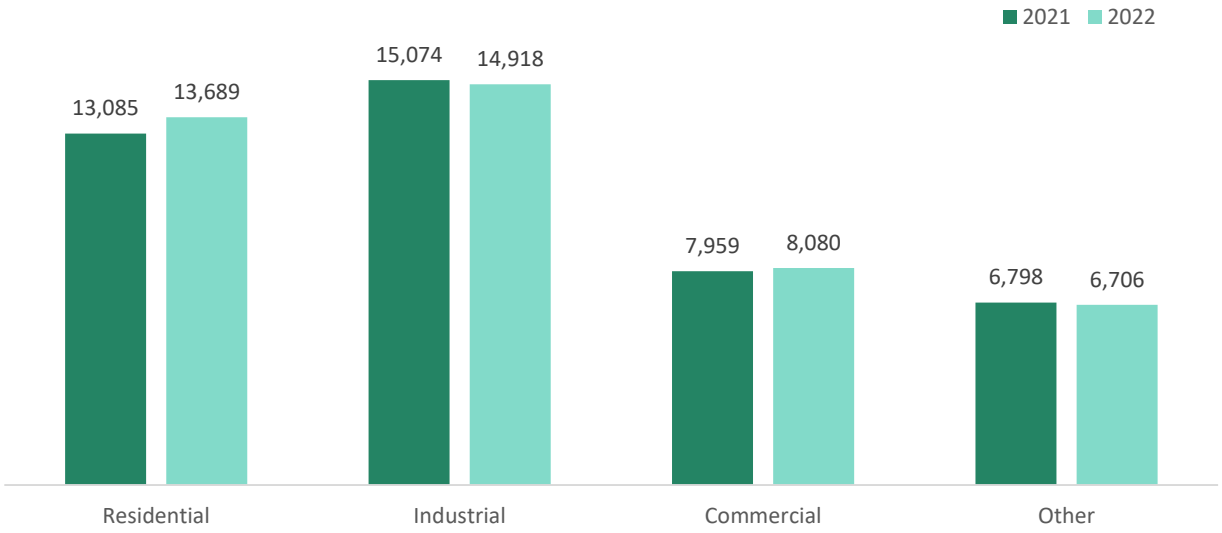


Figure 14: Electricity Consumption (GWh).

Electric Power Sector Auctions

In 2022, two auctions for new energy were conducted: the 36th LN (A-4) and the 37th LEN (A-5). These events enabled the contracting of 1,505 MW and attracted investments totaling R$ 9.99 billion, with average discounts of 9.4% and 26.4%, respectively.

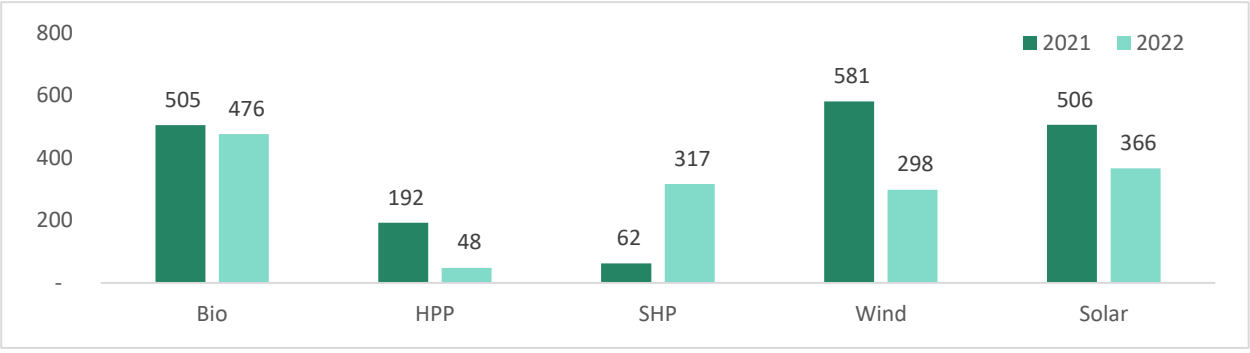


Figure 15: MW contracted.

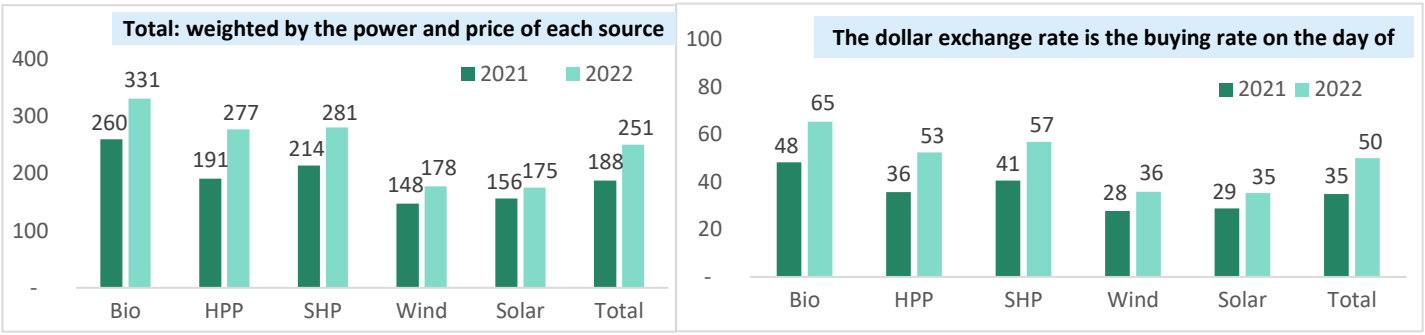


Figure 16: Average Price (R$/MWh and US$/MWh).

For transmission lines, there were 2 auctions. Through these auctions, 5,999 km of new transmission lines and 9,830 MVA of substation capacity were contracted. These results covered 16 states and are expected to generate about 39 thousand jobs. They will start operating in 2027 and 2028, respectively. The estimated investments for the first auction were R$ 15.3 billion, with an average discount[1] of 46.2%. The second auction had an estimated investment of R$ 3.3 billion, with an average discount of 38.2%.

In December 2022, the forecast for power expansion was 2.6 GW for 2023, 4.3 GW for 2024, and 3.7 GW for 2025. For transmission lines, the Ministry of Mines and Energy (MME), through Normative Ruling No. 67/GM/MME dated August 21, 2023, scheduled 6 auctions between 2023 and 2025.

Consumer Energy Prices

In 2022, except for residential electricity, all products in Figure 17 showed price increases. Three products had increases below the 2022 inflation rate (5.8%): gasoline C (5.7%), hydrated alcohol (2.2%), and industrial electricity (0.8%). Residential electricity experienced a price reduction of 2.4%. The largest increase was seen in imported coal: 120.3%. Other increases included: residential LPG (21.3%), industrial natural gas (44.1%), fuel oil (29.3%), and diesel (44.2%).

Among the prices associated with household consumption, residential electricity, gasoline C, and hydrated alcohol increased below the 2022 inflation rate. On the other hand, cooking LPG, diesel (used in transportation), and automotive natural gas saw increases above the inflation rate. On average, prices in the residential sector are higher than those in other sectors, primarily due to higher distribution costs.

In industry, natural gas has been more competitive than fuel oil over the past 3 years. Despite the greater ease and efficiency of using gas, prices and a greater expansion of low-consumption sectors

[1] Discount on Allowed Annual Revenue (RAP)

of the product (such as sugar in 2020) resulted in a decline in its share of total energy consumption in the industrial sector, from 10.5% in 2019 to 8.8% in 2020. However, there was a recovery in 2021, reaching 10.2%, due to a significant reduction in the share of sugarcane bagasse from 22.1% in 2020 to 18.2% in 2021. In 2022, GN IND regained its 2019 share (10.5%).

The reduced price of imported petroleum coke compared to natural gas and fuel oil, used in industries, explains its proportion of 57.7% in the total energy consumption of the cement industry.

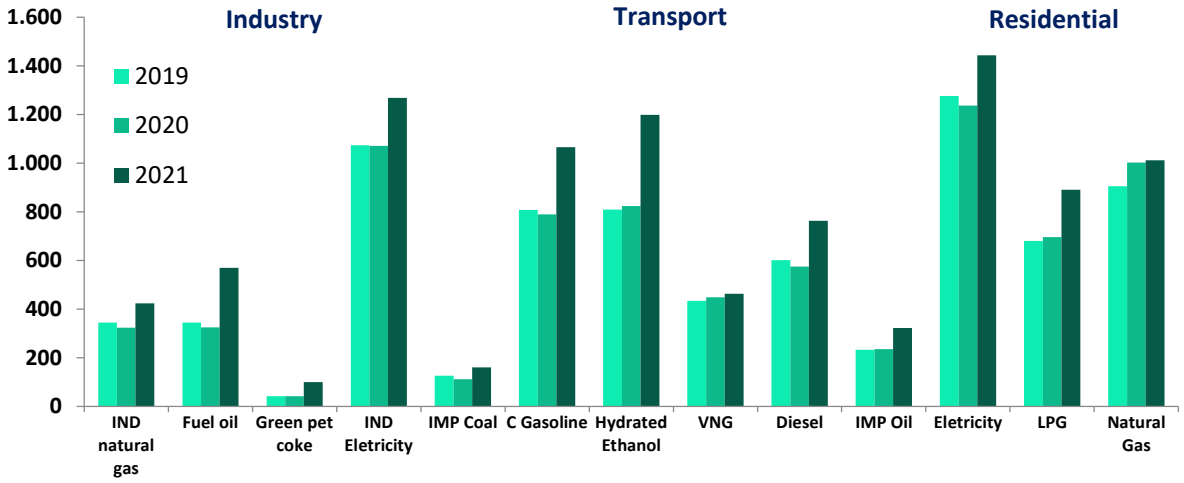


Figure 17: Consumer Prices and Tariffs (R$/boe).

General Energy Data

Specification	Unit	2021	2022	22/21%	Structure (%) 2021	Structure (%) 2022
DOMESTIC ENERGY SUPPLY	**Thousand Toe**	**303,158**	**303,074**	**-0.03**	**100.0**	**100.0**
LOSSES IN DISTRIBUTION AND TRANSFORMATION	Thousand Toe	*39,359*	*31,757*	-19.3	*13.0*	*10.5*
FINAL CONSUMPTION	Thousand Toe	*263,799*	*271,317*	2.9	*87.0*	*89.5*
CRUDE OIL AND SHALE OIL PRODUCTION	**Thousand m³**	**168,784**	**175,531**	**4.0**	**100.0**	**100.0**
NET EXTERNAL TRADE OF PETROLEUM AND DERIVATIVES	**Thousand m³**	**-47,237**	**-47,002**	**-0.5**	**100.0**	**100.0**
NATURAL GAS PRODUCTION	**millions m³**	**48,819**	**50,338**	**3.1**	**100.0**	**100.0**
NATURAL GAS IMPORTS	**millions m³**	**16,856**	**8,775**	**-47.9**	**100.0**	**100.0**
LIQUID NATURAL GAS PRODUCTION	**Thousand m³**	**5,269**	**5,321**	**1.0**	**100.0**	**100.0**
TOTAL ELECTRICITY SUPPLY	**GWh**	**679,212**	**690,081**	**1.6**	**100.0**	**100.0**
PUBLIC INTERNAL GENERATION	**GWh**	**542,141**	**551,554**	**1.7**	**79.8**	**79.9**
HYDROELECTRIC	*GWh*	*346,816*	*406,653*	17.3	*51.1*	*58.9*
THERMAL AND NUCLEAR	*GWh*	*115,442*	*50,708*	-56.1	*17.0*	*7.3*
WIND	*GWh*	*72,242*	*81,583*	12.9	*10.6*	*11.8*
SOLAR	*GWh*	*7,641*	*12,611*	65.0	*1.1*	*1.8*
SELF-PRODUCER INTERNAL GENERATION	**GWh**	**113,968**	**125,619**	**10.2**	**16.8**	**18.2**
HYDROELECTRIC	*GWh*	*16,002*	*20,461*	27.9	*2.4*	*3.0*
THERMAL	*GWh*	*88,811*	*87,594*	-1.4	*13.1*	*12.7*
WIND	*GWh*	*44*	*49*	11.0	*0.0*	*0.0*
SOLAR	*GWh*	*9,111*	*17,515*	92.2	*1.3*	*2.5*
IMPORTS	**GWh**	**23,103**	**12,908**	**-44.1**	**3.4**	**1.9**
TOTAL ELECTRICITY ENERGY SUPPLY	**GWh**	**679,212**	**690,081**	**1.6**	**100.0**	**100.0**
LOSSES IN DISTRIBUTION	*GWh*	*106,374*	*103,995*	-2.2	*15.7*	*15.1*
FINAL CONSUMPTION	*GWh*	*572,838*	*586,086*	2.3	*84.3*	*84.9*
ETHANOL PRODUCTION	**Thousand m³**	**29,898**	**32,485**	**8.7**	**100.0**	**100.0**
ANHYDROUS	Thousand m³	*11,553*	*13,233*	14.5	*38.6*	*40.7*
HYDRATED	Thousand m³	*18,345*	*19,252*	4.9	*61.4*	*59.3*
ETHANOL EXPORTS (net)	**Thousand m³**	**-1,436**	**-2,259**	**57.3**	**4.8**	**7.0**
BIODIESEL PRODUCTION	**Thousand m³**	**6,766**	**6,259**	**-7.5**		
FINAL ENERGY CONSUMPTION	**Thousand Toe**	**263,799**	**271,317**	**2.9**	**100.0**	**100.0**
INDUSTRIAL	**Thousand Toe**	*85,618*	*86,949*	1.6	*32.5*	*32.0*
TRANSPORTATION	**Thousand Toe**	*85,187*	*89,426*	5.0	*32.3*	*33.0*
RESIDENTIAL	**Thousand Toe**	*28,577*	*28,963*	1.4	*10.8*	*10.7*
OTHERS	**Thousand Toe**	*64,417*	*65,978*	2.4	*24.4*	*24.3*
ROAD CONSUMPTION - OTTO CYCLE	**Thousand Toe**	**38,848**	**41,339**	**6.4**	**100.0**	**100.0**
DIESEL CONSUMPTION (includes power genera	**Thousand m³**	**54,599**	**58,415**	**7.0**	**100.0**	**100.0**
FINAL ELECTRICITY CONSUMPTION	**GWh**	**572,838**	**586,086**	**2.3**	**100.0**	**100.0**
INDUSTRIAL	*GWh*	*213,535*	*218,743*	2.4	*37.3*	*37.3*
RESIDENTIAL	*GWh*	*151,130*	*155,599*	3.0	*26.4*	*26.5*
COMMERCIAL AND PUBLIC	*GWh*	*133,047*	*141,676*	6.5	*23.2*	*24.2*
OTHERS	*GWh*	*75,126*	*70,068*	-6.7	*13.1*	*12.0*
NATURAL GAS USAGE	**millions m³**	**65,874**	**59,113**	**-10.3**	**100.0**	**100.0**
NOT UTILIZED AND REINJECTION	millions m³	*23,440*	*26,229*	11.9	*35.6*	*44.4*
E&P AND PETROLEUM REFINING (Energy Sector)	millions m³	*5,156*	*4,730*	-8.3	*7.8*	*8.0*
ELECTRIC GENERATION	millions m³	*19,455*	*10,216*	-47.5	*29.5*	*17.3*
ABSORBED IN UPGN, HYDROGEN, AND LOSSES	millions m³	*4,238*	*3,469*	-18.2	*6.4*	*5.9*
INDUSTRIAL	millions m³	*9,887*	*10,381*	5.0	*15.0*	*17.6*
TRANSPORTATION	millions m³	*2,168*	*2,263*	4.4	*3.3*	*3.8*
NON-ENERGY, RESIDENTIAL, SERVICES, AND AGRICU	millions m³	*1,530*	*1,825*	19.3	*2.3*	*3.1*

(*) If negative, it represents net export, and vice versa

Energy Efficiency

Energy efficiency refers to the rational and optimized use of available energy resources, aiming to achieve maximum benefit with minimal consumption. It involves a set of practices, technologies, and strategies aimed at reducing energy waste, improving energy productivity, and minimizing the environmental impacts associated with energy generation and use.

ODEX INDEX

The ODEX Index reflects the progress of energy efficiency in a country or in a specific economic sector, such as industrial, residential, or transportation. To calculate it, the year 2005 is set as a reference (value = 100), and the real energy consumption (E) in year t is compared to the energy consumption (E) that would occur without energy efficiency improvements, in other words, without energy savings (Ee):

$$ODEX = \frac{E}{E + Ee} \times 100$$

In its interpretation, a decrease in the ODEX Index from the value of 100 to 80, for example, would represent a gain in energy efficiency of 20%. The Energy Efficiency Atlas - Brazil - 2022, prepared by EPE, shows that Brazil, in 2021, was 12% more energy-efficient than it was in 2005 (see Figure 18)).

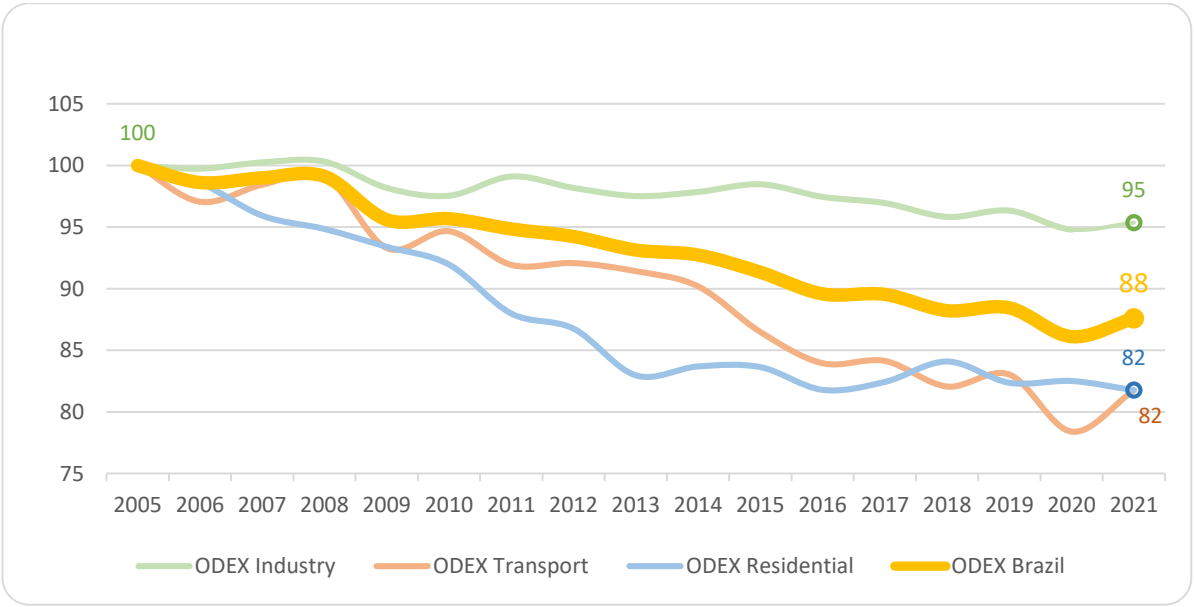


Figure 18 – ODEX Index Evolution.

ACTIONS AND PROGRAMS

In the current scenario, Energy Efficiency emerges as a crucial pillar for promoting the responsible and sustainable use of natural resources. In Brazil, initiatives involve smart solutions and measures aimed at the rational use of energy and the consequent reduction of emissions.

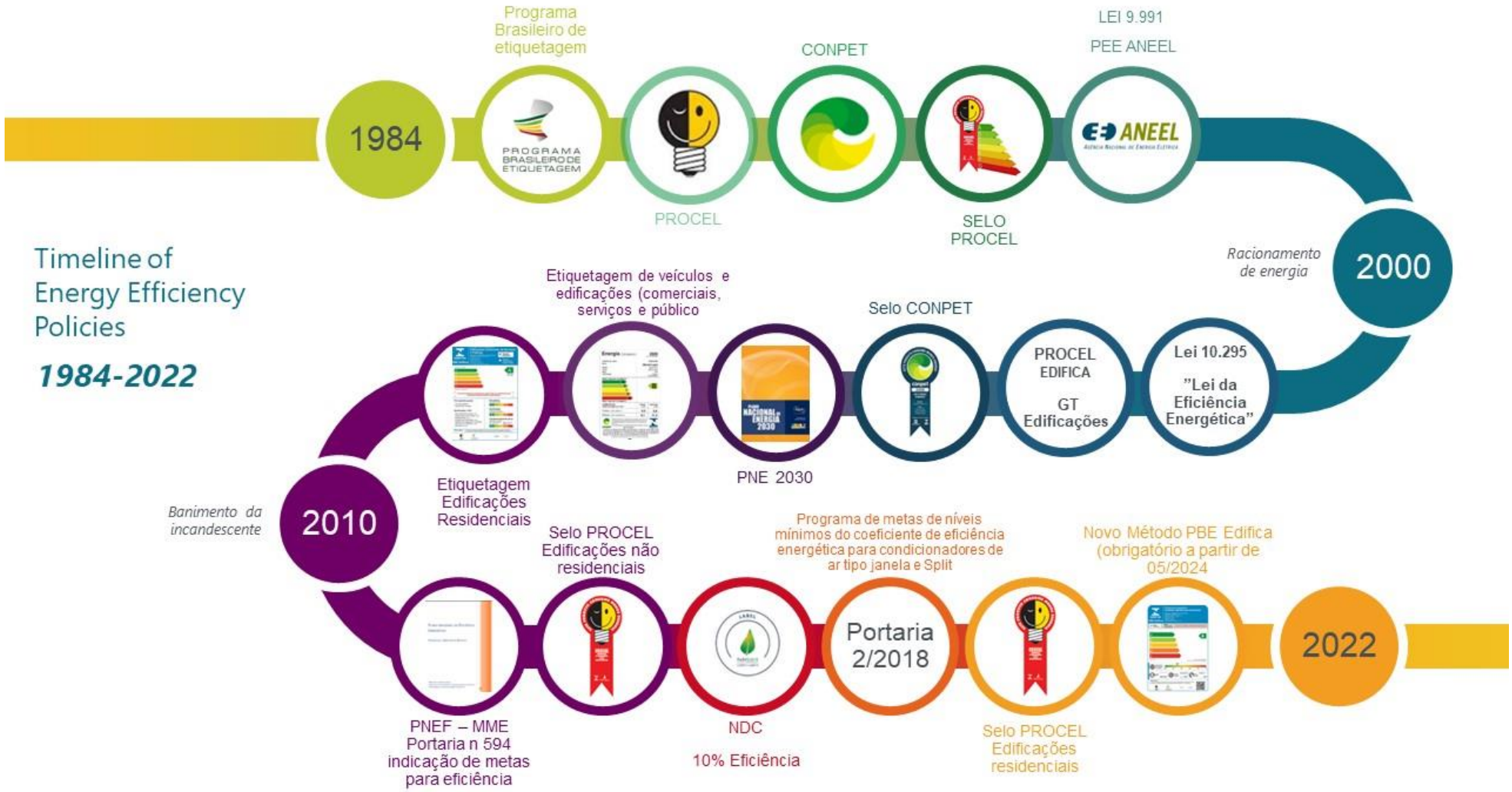


Figure 19 – Evolution of Energy Efficiency actions in Brazil (source: PROCEL).

PROCEL

The National Program for Energy Conservation - PROCEL plays a prominent role in the Brazilian context. It promotes energy efficiency through measures that encompass optimizing goods and services, contributing to improving the quality of life for the population, enhancing the country's competitiveness, and reducing environmental impacts.

According to the Procel 2023 Report, since 1986, Procel has invested approximately R$ 4.22 billion in energy efficiency. These investments have utilized resources from Eletrobras, the Reversion Global Reserve - RGR, international funds, and more recently, Law No. 9,991/2000, based on the provisions of Law No. 13,280/2016. Between 1986 and 2022, Procel's actions have resulted in a total energy savings of around 240 billion kWh. Starting in 2018, Procel's annual actions have generated an energy gain of approximately 22 billion kWh per year.

Figure 20 presents the total investments made since 2018.

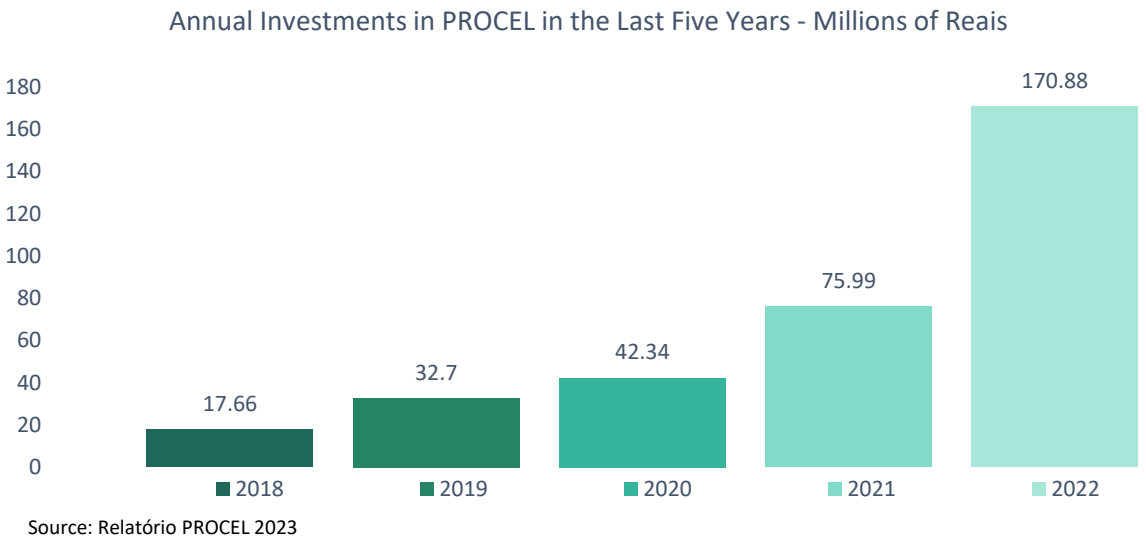


Figure 20 – Evolution of PROCEL Investments (source: PROCEL).

PEE ANEEL

The National Electric Energy Agency – ANEEL plays a pivotal role in promoting energy efficiency through the Energy Efficiency Program – PEE. This program mandates distribution concessionaires and permit holders to invest a portion of their net revenues in research and development to foster more efficient energy use across various sectors of the economy. Consequently, PEE contributes to the dissemination of efficient practices and raises consumer awareness.

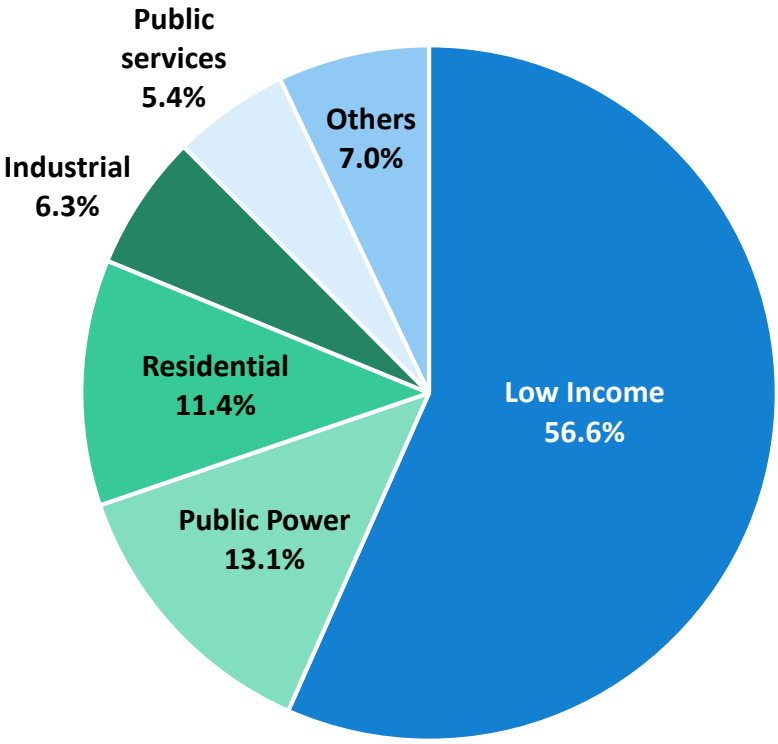


Figure 21 -Projects by typology – PEE ANEEL (source: Aneel)

OTHER PROGRAMS

The Brazilian Labeling Program - PBE, coordinated by Inmetro, provides information about the energy efficiency of products. This assists consumers in making more informed decisions and encourages the industry to enhance the efficiency of their products, fostering competitiveness and contributing to a more sustainable market.

Energy efficiency efforts also extend to the building sector through PBE Edifica, which establishes technical efficiency requirements for various types of constructions. It contributes to reducing energy consumption in commercial, service, public, and residential buildings, promoting sustainability across the construction chain.

Beyond domestic actions, Brazil engages in international initiatives, showcasing its commitment to addressing the energy challenges of the 21st century through innovation, collaboration, and sustainability.

Consolidated Energy Balance

Table 18: Consolidated Energy Balance - Brazil 2022 (thousand toe).

COUNT	Primary Energy Sources										Secondary Energy Sources																	Total secondary	TOTAL
	OIL	Natural Gas	Steam Coal	metallurgical coal	URANIUM U3O8	HYDRO	Firewood	Sugarcane	Other Primaries	TOTAL Primaries	Biodiesel	Diesel Oil	Fuel Oil	Gasoline	LPG	Naphtha	Kerosene	Coke Gas	Coal Coke	Uanium UO2	Electricity	Charcoal	Ethanol	Other petroleum secondary products	Non-energy petroleum products	Other mineral coal		
PRODUCTION	150,386	48,462	2640	0	343	31,202	27,407	49,425	28,437	338,302	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**338,302**
IMPORT	7,247	14,833	5372	7,893	4,723	0	0	0	0	40,069	0	12,242	595	2,121	2,454	6,052	307	0	1,153	3,129	1,991	0	231	2,898	1,711	0	34,885	**74,953**
STOCKS VARIATION	-308	176	42	59	-787	0	0	0	0	-818	-14	-7	-442	-201	-64	108	-54	0	-214	-3,507	0	0	755	-25	-8	0	-3,673	**-4,491**
TOTAL SUPPLY	157,325	63,471	8054	7,953	4,279	31,202	27,407	49,425	28,437	377,553	-14	12,235	153	1,921	2,391	6,160	254	0	939	-378	1,991	0	986	2,873	1,703	0	31,211	**408,764**
EXPORT	-64,722	0	0	0	0	0	0	0	0	-64,722	0	-501	-12,238	-1,382	0	-231	-1,089	0	0	0	-4	0	-967	-841	-385	0	-17,637	**-82,359**
NOT UTILIZED	0	-1,221	0	0	0	0	0	0	0	-1,221	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**-1,221**
REINJECTION	0	-22,025	0	0	0	0	0	0	0	-22,025	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**-22,025**
GROSS INTERNAL SUPPLY	**92,602**	**40,225**	**8054**	**7,953**	**4,279**	**31,202**	**27,407**	**49,425**	**28,437**	**289,584**	**-14**	**11,734**	**-12,084**	**539**	**2,391**	**5,929**	**-835**	**0**	**939**	**-378**	**1,987**	**0**	**19**	**2,032**	**1,317**	**0**	**13,574**	**303,158**
TOTAL TRANSFORMATION	**-92,549**	**-23,366**	**-4416**	**-7,941**	**-4,279**	**-31,202**	**-9,119**	**-21,147**	**-18,557**	**-212,577**	**5,211**	**34,559**	**14,554**	**21,636**	**5,872**	**-230**	**3,353**	**1,434**	**6,946**	**378**	**56,425**	**4,632**	**15,525**	**7,186**	**5,393**	**249**	**183,123**	**-29,454**
PETROLEUM REFINERIES	-91,825	0	0	0	0	0	0	0	-4,539	-96,365	0	36,339	16,479	19,603	4,422	3,558	3,353	0	0	0	0	0	0	7,521	4,706	0	95,982	**-383**
NATURAL GAS PLANTS	0	-3,480	0	0	0	0	0	0	889	-2,591	0	0	0	116	1,322	0	0	0	0	0	0	0	0	0	920	0	2,357	**-234**
GASIFICATION PLANTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
COKE OVENS	0	0	0	-7,941	0	0	0	0	0	-7,941	0	0	0	0	0	0	0	1,818	6,946	0	0	0	0	-1,289	0	259	7,733	**-208**
NUCLEAR FUEL CYCLE	0	0	0	0	-4,279	0	0	0	0	-4,279	0	0	0	0	0	0	0	0	0	4,211	0	0	0	0	0	0	4,211	**-68**
PUBLIC SERVICE ELECTRIC GENERATION	0	-13,252	-4200	0	0	-29,826	-56	0	-7,132	-54,466	-141	-1,224	-1,694	0	0	0	0	0	0	-3,832	46,624	0	0	-75	0	0	39,658	**-14,808**
SELF-PRODUCING ELECTRIC GENERATION	0	-4,277	-216	0	0	-1,376	-371	-5,780	-5,683	-17,703	-6	-557	-230	0	0	0	0	-384	0	0	9,801	0	0	-551	0	-10	8,063	**-9,640**
CHARCOAL PLANTS	0	0	0	0	0	0	-8,691	0	0	-8,691	0	0	0	0	0	0	0	0	0	0	0	4,632	0	0	0	0	4,632	**-4,059**
DISTILLERIES	0	0	0	0	0	0	0	-15,367	-158	-15,525	0	0	0	0	0	0	0	0	0	0	0	0	15,525	0	0	0	15,525	**0**
OTHER TRANSFORMATIONS	-723	-2,358	0	0	0	0	0	0	-1,934	-5,015	5,359	0	0	1,918	128	-3,788	0	0	0	0	0	0	0	1,579	-233	0	4,963	**-53**
DISTRIBUTION & STORAGE LOSSES	**0**	**-242**	**-7**	**-11**	**0**	**0**	**0**	**0**	**0**	**-260**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-41**	**0**	**-9,148**	**-68**	**-58**	**0**	**0**	**0**	**-9,316**	**-9,576**
FINAL CONSUMPTION	**0**	**16,672**	**3630**	**0**	**0**	**0**	**18,288**	**28,279**	**9,879**	**76,748**	**5,239**	**46,300**	**2,470**	**22,137**	**8,298**	**5,550**	**2,520**	**1,453**	**7,843**	**0**	**49,264**	**4,564**	**15,550**	**8,995**	**6,620**	**249**	**187,051**	**263,799**
NON-ENERGY FINAL CONSUMPTION	0	753	0	0	0	0	0	0	0	753	0	0	0	0	0	5,550	2	0	0	0	0	0	701	0	6,620	158	13,032	**13,785**
ENERGY FINAL CONSUMPTION	0	15,919	3630	0	0	0	18,288	28,279	9,879	75,995	5,239	46,300	2,470	22,137	8,298	0	2,518	1,453	7,843	0	49,264	4,564	14,848	8,995	0	91	174,019	**250,014**
ENERGY SECTOR	0	4,718	0	0	0	0	0	12,875	0	17,593	0	510	135	0	0	0	0	207	0	0	3,342	0	0	3,076	0	0	7,270	**24,863**
RESIDENTIAL	0	456	0	0	0	0	7,441	0	747	8,643	0	0	0	0	6,522	0	2	0	0	0	12,997	413	0	0	0	0	19,933	**28,577**
COMMERCIAL	0	116	0	0	0	0	82	0	157	356	4	34	16	0	404	0	0	0	0	0	7,769	77	0	0	0	0	8,303	**8,659**
PUBLIC	0	21	0	0	0	0	0	0	0	21	1	5	8	0	260	0	0	0	0	0	3,673	0	0	0	0	0	3,947	**3,968**
AGRICULTURE	0	0	0	0	0	0	3,158	0	0	3,158	722	6,264	9	0	26	0	0	0	0	0	2,947	9	9	0	0	0	9,985	**13,143**
TRANSPORTATION - TOTAL	0	1,908	0	0	0	0	0	0	0	1,908	4,391	38,430	795	22,137	0	0	2,516	0	0	0	172	0	14,840	0	0	0	83,279	**85,187**
ROAD	0	1,908	0	0	0	0	0	0	0	1,908	4,283	37,160	0	22,100	0	0	0	0	0	0	0	0	14,840	0	0	0	78,383	**80,291**
RAILWAY	0	0	0	0	0	0	0	0	0	0	108	934	0	0	0	0	0	0	0	0	172	0	0	0	0	0	1,213	**1,213**
AIR	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	0	2,516	0	0	0	0	0	0	0	0	0	2,552	**2,552**
WATER	0	0	0	0	0	0	0	0	0	0	0	336	795	0	0	0	0	0	0	0	0	0	0	0	0	0	1,130	**1,130**
INDUSTRIAL - TOTAL	0	8,701	3630	0	0	0	7,607	15,404	8,975	44,317	122	1,057	1,508	0	1,087	0	1	1,246	7,843	0	18,364	4,065	0	5,919	0	91	41,301	**85,618**
CEMENT	0	6	51	0	0	0	68	0	749	874	3	28	7	0	14	0	0	0	4	0	627	106	0	2,688	0	0	3,478	**4,352**
IRON AND STEEL	0	1,291	2412	0	0	0	0	0	0	3,703	4	35	3	0	29	0	0	1,246	7,400	0	1,650	3,013	0	41	0	91	13,513	**17,216**
FERROALLOYS	0	3	0	0	0	0	76	0	0	79	1	8	42	0	25	0	0	0	85	0	871	904	0	66	0	0	2,003	**2,082**
MINING AND PELLETIZING	0	262	146	0	0	0	0	0	0	408	45	394	92	0	33	0	1	0	33	0	1,094	0	0	196	0	0	1,889	**2,297**
NON-FERROUS AND OTHER METALLURGICAL	0	566	716	0	0	0	0	0	0	1,282	1	13	902	0	41	0	0	0	321	0	2,376	11	0	441	0	0	4,105	**5,387**
CHEMICAL	0	1,997	131	0	0	0	49	0	85	2,261	2	19	68	0	217	0	0	0	0	0	1,983	18	0	1,926	0	0	4,233	**6,494**
FOOD AND BEVERAGES	0	885	22	0	0	0	2,448	15,368	11	18,735	24	207	47	0	259	0	0	0	0	0	2,480	0	0	86	0	0	3,104	**21,839**
TEXTILE	0	180	0	0	0	0	62	0	0	242	0	1	4	0	38	0	0	0	0	0	569	0	0	0	0	0	612	**854**
PAPER AND PULP	0	1,042	97	0	0	0	2,031	36	8,050	11,254	27	232	268	0	65	0	0	0	0	0	2,104	0	0	0	0	0	2,695	**13,949**
CERAMIC	0	1,393	51	0	0	0	1,977	0	55	3,475	2	19	36	0	161	0	0	0	0	0	321	0	0	95	0	0	635	**4,110**
OTHER INDUSTRIES	0	1,078	3	0	0	0	895	0	26	2,003	12	101	38	0	204	0	0	0	0	0	4,290	13	0	379	0	0	5,037	**7,039**
UNIDENTIFIED CONSUMPTION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
STATISTICAL ADJUSTMENTS	**-54**	**56**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**42**	**6**	**0**	**-39**	**36**	**-149**	**2**	**19**	**0**	**0**	**0**	**0**	**63**	**-223**	**-89**	**0**	**-331**	**-330**

Table 19: Consolidated Energy Balance - Brazil 2022 (thousand toe).

COUNT	Primary Energy Sources										Secondary Energy Sources																	
	OIL	Natural Gas	Steam Coal	metallurgical coal	URANIUM U3O8	HYDRO	Firewood	Sugarcane	Other Primaries	TOTAL Primaries	Biodiesel	Diesel Oil	Fuel Oil	Gasoline	LPG	Naphtha	Kerosene	Coke Gas	Coal Coke	Uanium UO2	Electricity	Charcoal	Ethanol	Other petroleum secondary products	Non-energy petroleum products	Other mineral coal	Total secondary	TOTAL
PRODUCTION	156,398	49,971	2311	0	516	36,732	27,283	47,740	33,597	354,548	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	354,548
IMPORT	12,724	7,722	3257	7,405	3,160	0	0	0	0	34,267	0	12,198	202	3,193	2,144	6,451	1,064	0	1,082	2,781	1,538	0	53	2,941	1,533	0	**35,180**	69,447
STOCKS VARIATION	-470	0	55	56	535	0	0	0	0	175	-14	-507	-567	-568	-38	-52	-148	0	-180	-3,130	0	0	176	28	-61	0	**-5,061**	-4,885
TOTAL SUPPLY	168,651	57,692	5624	7,460	4,210	36,732	27,283	47,740	33,597	388,991	-14	11,691	-365	2,624	2,106	6,399	916	0	902	-349	1,538	0	229	2,969	1,473	0	**30,119**	419,110
EXPORT	-69,580	0	0	0	0	0	0	0	0	-69,580	0	-547	-14,592	-420	0	-379	-1,772	0	0	0	-428	0	-1,235	-820	-282	0	**-20,478**	-90,058
NOT UTILIZED	0	-1,253	0	0	0	0	0	0	0	-1,253	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	-1,253
REINJECTION	0	-24,725	0	0	0	0	0	0	0	-24,725	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	-24,725
GROSS INTERNAL SUPPLY	**99,072**	**31,714**	**5624**	**7,460**	**4,210**	**36,732**	**27,283**	**47,740**	**33,597**	**293,433**	**-14**	**11,144**	**-14,957**	**2,204**	**2,106**	**6,020**	**-857**	**0**	**902**	**-349**	**1,110**	**0**	**-1,006**	**2,148**	**1,190**	**0**	**9,641**	**303,074**
TOTAL TRANSFORMATION	**-98,819**	**-14,848**	**-2035**	**-7,450**	**-4,210**	**-36,732**	**-8,843**	**-19,722**	**-22,829**	**-215,488**	**4,871**	**37,132**	**17,450**	**22,078**	**6,126**	**982**	**3,997**	**1,356**	**6,516**	**349**	**58,237**	**4,479**	**16,885**	**6,557**	**6,227**	**237**	**193,478**	**-22,010**
PETROLEUM REFINERIES	-97,457	0	0	0	0	0	0	0	-5,692	-103,149	0	38,609	17,724	20,326	4,702	4,466	3,997	0	0	0	0	0	0	7,660	5,379	0	**102,863**	-286
NATURAL GAS PLANTS	0	-3,714	0	0	0	0	0	0	1,001	-2,713	0	0	0	0	1,304	0	0	0	0	0	0	0	0	0	1,034	0	**2,338**	-375
GASIFICATION PLANTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0
COKE OVENS	0	0	0	-7,450	0	0	0	0	0	-7,450	0	0	0	0	0	0	0	1,705	6,516	0	0	0	0	-1,209	0	245	**7,257**	-194
NUCLEAR FUEL CYCLE	0	0	0	0	-4,210	0	0	0	0	-4,210	0	0	0	0	0	0	0	0	0	4,143	0	0	0	0	0	0	**4,143**	-67
PUBLIC SERVICE ELECTRIC GENERATION	0	-5,148	-1830	0	0	-34,972	-103	0	-8,399	-50,452	-81	-779	-9	0	0	0	0	0	0	-3,794	47,434	0	0	0	0	0	**42,770**	-7,681
SELF-PRODUCING ELECTRIC GENERATION	0	-4,258	-205	0	0	-1,760	-337	-5,430	-6,527	-18,515	-6	-569	-192	0	0	0	0	-350	0	0	10,803	0	0	-584	0	-8	**9,095**	-9,420
CHARCOAL PLANTS	0	0	0	0	0	0	-8,403	0	0	-8,403	0	0	0	0	0	0	0	0	0	0	0	4,479	0	0	0	0	**4,479**	-3,924
DISTILLERIES	0	0	0	0	0	0	0	-14,292	-2,636	-16,929	0	0	0	0	0	0	0	0	0	0	0	0	16,885	0	0	0	**16,885**	-44
OTHER TRANSFORMATIONS	-1,362	-1,729	0	0	0	0	0	0	-576	-3,667	4,957	-130	-73	1,752	119	-3,483	0	0	0	0	0	0	0	690	-185	0	**3,648**	-18
DISTRIBUTION & STORAGE LOSSES	**0**	**-178**	**-7**	**-11**	**0**	**0**	**0**	**0**	**0**	**-196**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-41**	**0**	**-8,944**	**-66**	**-64**	**0**	**0**	**0**	**-9,115**	**-9,311**
FINAL CONSUMPTION	**0**	**17,077**	**3578**	**0**	**0**	**0**	**18,440**	**28,018**	**10,769**	**77,882**	**4,903**	**48,188**	**2,431**	**24,227**	**8,211**	**6,959**	**3,134**	**1,357**	**7,372**	**0**	**50,403**	**4,413**	**15,814**	**8,580**	**7,208**	**235**	**193,436**	**271,317**
NON-ENERGY FINAL CONSUMPTION	0	975	0	0	0	0	0	0	0	975	0	0	0	0	0	6,959	2	0	0	0	0	0	649	0	7,208	150	**14,968**	15,942
ENERGY FINAL CONSUMPTION	0	16,103	3578	0	0	0	18,440	28,018	10,769	76,907	4,903	48,188	2,431	24,227	8,211	0	3,132	1,357	7,372	0	50,403	4,413	15,165	8,580	0	86	**178,468**	255,375
ENERGY SECTOR	0	4,345	0	0	0	0	0	12,084	0	16,429	0	582	116	0	0	0	0	172	0	0	3,079	0	0	3,118	0	0	**7,067**	23,496
RESIDENTIAL	0	466	0	0	0	0	7,510	0	800	8,776	0	0	0	0	6,407	0	4	0	0	0	13,381	395	0	0	0	0	**20,187**	28,963
COMMERCIAL	0	143	0	0	0	0	82	0	171	396	4	43	12	0	446	0	0	0	0	0	8,351	77	0	0	0	0	**8,934**	9,330
PUBLIC	0	22	0	0	0	0	0	0	0	22	0	4	7	0	262	0	0	0	0	0	3,833	0	0	0	0	0	**4,106**	4,128
AGRICULTURE	0	0	0	0	0	0	3,118	0	0	3,118	671	6,463	8	0	27	0	0	0	0	0	2,777	9	10	0	0	0	**9,963**	13,082
TRANSPORTATION - TOTAL	0	1,991	0	0	0	0	0	0	0	1,991	4,104	39,909	743	24,227	0	0	3,127	0	0	0	170	0	15,155	0	0	0	**87,435**	89,426
ROAD	0	1,991	0	0	0	0	0	0	0	1,991	4,005	38,595	0	24,192	0	0	0	0	0	0	0	0	15,155	0	0	0	**81,948**	83,940
RAILWAY	0	0	0	0	0	0	0	0	0	0	99	954	0	0	0	0	0	0	0	0	170	0	0	0	0	0	**1,224**	1,224
AIR	0	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	3,127	0	0	0	0	0	0	0	0	0	**3,161**	3,161
WATER	0	0	0	0	0	0	0	0	0	0	0	359	743	0	0	0	0	0	0	0	0	0	0	0	0	0	**1,101**	1,101
INDUSTRIAL - TOTAL	0	9,135	3578	0	0	0	7,730	15,934	9,797	46,174	123	1,188	1,544	0	1,070	0	1	1,185	7,372	0	18,812	3,932	0	5,462	0	86	**40,775**	86,949
CEMENT	0	3	132	0	0	0	66	0	787	988	4	39	11	0	10	0	0	0	20	0	610	103	0	2,431	0	0	**3,229**	4,217
IRON AND STEEL	0	1,373	2263	0	0	0	0	0	0	3,635	3	34	11	0	28	0	0	1,185	6,950	0	1,559	2,895	0	38	0	86	**12,789**	16,425
FERROALLOYS	0	3	0	0	0	0	74	0	0	77	1	11	43	0	27	0	0	0	80	0	884	893	0	62	0	0	**2,001**	2,078
MINING AND PELLETIZING	0	272	135	0	0	0	0	0	0	407	44	424	133	0	33	0	1	0	30	0	1,012	0	0	182	0	0	**1,858**	2,265
NON-FERROUS AND OTHER METALLURGICAL	0	492	679	0	0	0	0	0	0	1,171	1	14	843	0	45	0	0	0	292	0	2,336	10	0	396	0	0	**3,938**	5,109
CHEMICAL	0	1,978	139	0	0	0	49	0	85	2,251	2	21	61	0	199	0	0	0	0	0	2,024	18	0	1,807	0	0	**4,131**	6,382
FOOD AND BEVERAGES	0	883	34	0	0	0	2,542	15,895	12	19,366	24	236	57	0	249	0	0	0	0	0	2,501	0	0	86	0	0	**3,153**	22,519
TEXTILE	0	168	0	0	0	0	59	0	0	226	0	0	3	0	29	0	0	0	0	0	536	0	0	0	0	0	**568**	794
PAPER AND PULP	0	1,037	100	0	0	0	2,132	39	8,832	12,141	30	292	312	0	69	0	0	0	0	0	2,240	0	0	0	0	0	**2,944**	15,085
CERAMIC	0	1,313	55	0	0	0	1,925	0	53	3,346	2	18	33	0	167	0	0	0	0	0	313	0	0	86	0	0	**618**	3,965
OTHER INDUSTRIES	0	1,615	40	0	0	0	882	0	29	2,566	10	100	39	0	213	0	0	0	0	0	4,798	13	0	373	0	0	**5,546**	8,112
UNIDENTIFIED CONSUMPTION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0
STATISTICAL ADJUSTMENTS	**-252**	**389**	**-5**	**1**	**0**	**0**	**0**	**0**	**0**	**132**	**47**	**-88**	**-62**	**-55**	**-20**	**-43**	**-7**	**2**	**-5**	**0**	**0**	**0**	**0**	**-126**	**-210**	**-2**	**-568**	**-436**

BRAZILIAN ENERGY REVIEW

2023 EDITION

MINISTÉRIO DE MINAS E ENERGIA

GOVERNO FEDERAL
BRASIL
UNIÃO E RECONSTRUÇÃO