



# Country Analysis Brief: Brazil

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## Overview

**Table 1. Brazil's energy overview, 2021**

	Crude oil and other petroleum liquids	Natural gas	Coal	Nuclear	Hydro	Other renewables	Total
Primary energy consumption (quads)	5.34	1.40	0.66	0.15	2.68	1.85	12.09
Primary energy consumption (percentage)	44.2%	11.6%	5.5%	1.3%	22.2%	15.3%	100.0%
Primary energy production (quads)	6.41	0.79	0.11	0.15	1.09	3.32	11.88
Primary energy production (percentage)	54.0%	6.7%	0.9%	1.3%	9.2%	27.9%	100.0%
Electricity generation (terawatthours)	22.39	96.18	26.81	14.70	362.82	139.69	662.60
Electricity generation (percentage)	3.4%	14.5%	4.0%	2.2%	54.8%	21.1%	100.0%

Data source: U.S. Energy Information Administration, International Energy Statistics; the International Energy Agency, *World Energy Statistics 2022*; and Energy Institute, *Statistical Review of World Energy 2023*

Note: Quads=quadrillion British thermal units.

- Brazil's energy mix is diverse; hydropower, fossil fuels, biofuels, wind energy, and solar power all make significant contributions (Table 1). Brazil's total energy production increased by an average annual growth rate of 1.5% from 2011 to 2021. Petroleum and other liquids accounted for most of the energy production increase, followed by natural gas. Brazil's energy production in 2021 accounted for 2.0% of global production and 48.8% of South America's total.
- Energy consumption in Brazil increased by an average annual growth rate of 0.5% between 2011 and 2021, compared with 3.3% between 2000 and 2010, driven by Brazil's real GDP per capita growth (Figure 4). Brazil remained one of the world's largest energy consumers, accounting for 2.0% of global consumption and 53.3% of South America's consumption. In Brazil, the industrial and transportation sectors use most of the energy.
- Crude oil and other petroleum liquids production contributes significantly to Brazil's total energy production, accounting for 54.0% of total energy production and 44.2% of total energy consumption in 2021 (Table 1). Brazil is the largest producer of petroleum and other liquids in South America and the ninth biggest in the world, accounting for 3.5% of global output in 2021.
- Brazil's natural gas and liquefied natural gas (LNG) market is expanding because of rising domestic consumption, infrastructure development, and market reforms. Natural gas

accounted for 7% of Brazil's total energy production in 2021, up from 5% in 2011, and natural gas accounted for 12% of total energy consumption in 2021, up from 8% in 2011. In 2021, Brazil implemented reforms in the natural gas sector to increase competition, among other goals. The New Gas Law, approved in 2020, aims to make the market more competitive, promote third-party access to infrastructure, and attract private investment in the sector.

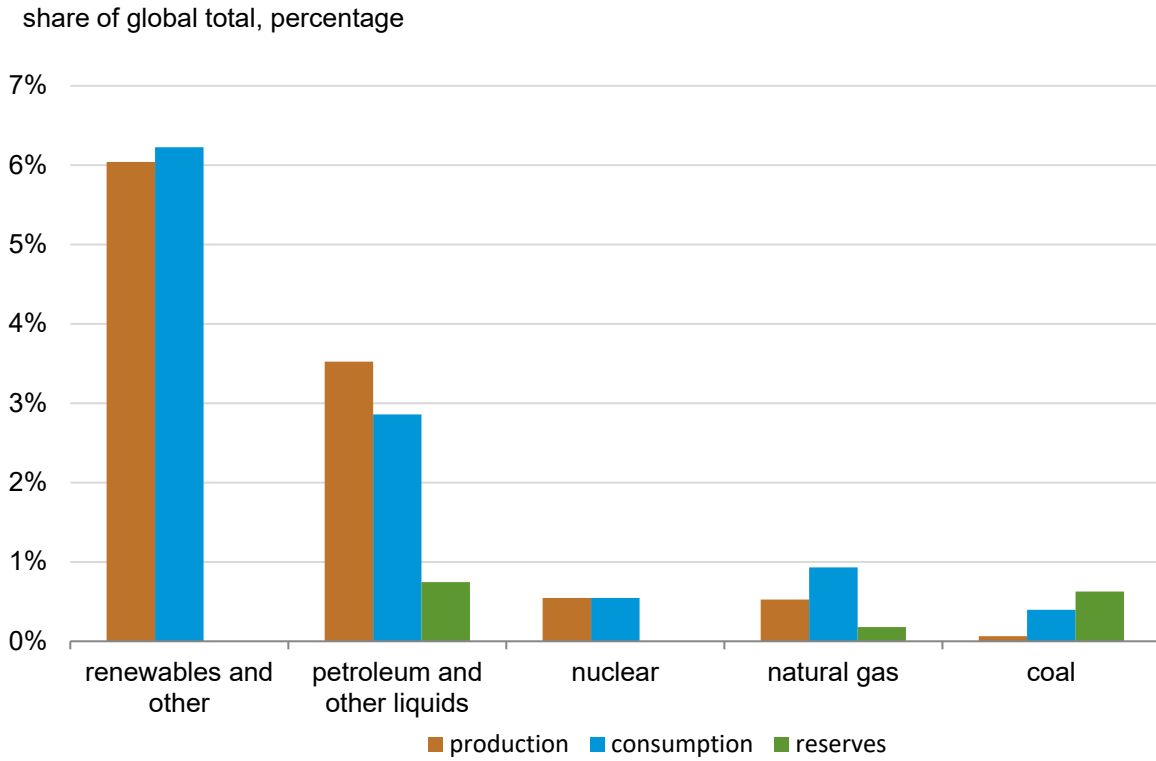
- Brazil is the world's third-largest hydropower producer, behind China and Canada. Brazil generated 363 terawatt-hours of electricity in 2021, accounting for 9% of global hydropower output.<sup>1</sup>
- In 2021, 20% of all global biofuels were produced and 21% of total global biofuels were consumed in Brazil. For 2023, the Brazilian government increased the national biodiesel blending mandate from 10% to 12%.<sup>2</sup> This change means increased domestic demand for biodiesel and upstream products, particularly soy oil, which accounts for about 70% of the feedstock used to produce biodiesel in Brazil.<sup>3</sup>
- Growth in Brazil's CO<sub>2</sub> emissions from fossil fuels has slowed (Figure 5). Between 2011 and 2021, CO<sub>2</sub> emissions in Brazil increased on average at an annual rate of 0.9%, compared with 1.8% between 2000 and 2010. Brazil's CO<sub>2</sub> emissions from fossil fuels have shifted from petroleum to cleaner-burning natural gas. Brazil has no laws or policies requiring the early retirement of carbon-based generation.<sup>4</sup> In 2022, Brazil's government published a decree that established the National System for Reducing Greenhouse Gas Emissions (SINARE) and the procedure for developing Sectoral Plans for Climate Change Mitigation.<sup>5</sup>

**Figure 1. Map of Brazil**



Data source: U.S. Central Intelligence Agency, [CIA World Factbook—Brazil](#)

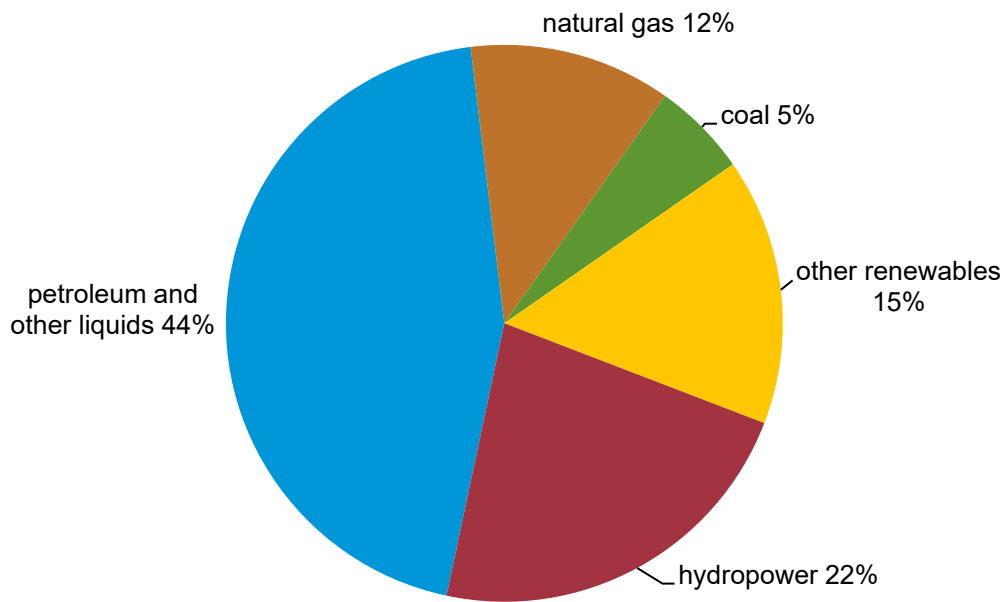
**Figure 2. Brazil energy production, consumption, and reserves, by source, 2021**



Data source: U.S. Energy Information Administration, International Energy Statistics  
Note: *Renewables and other* include hydropower, geothermal, tide, wave, fuel cell, solar, wind, and biomass and waste.

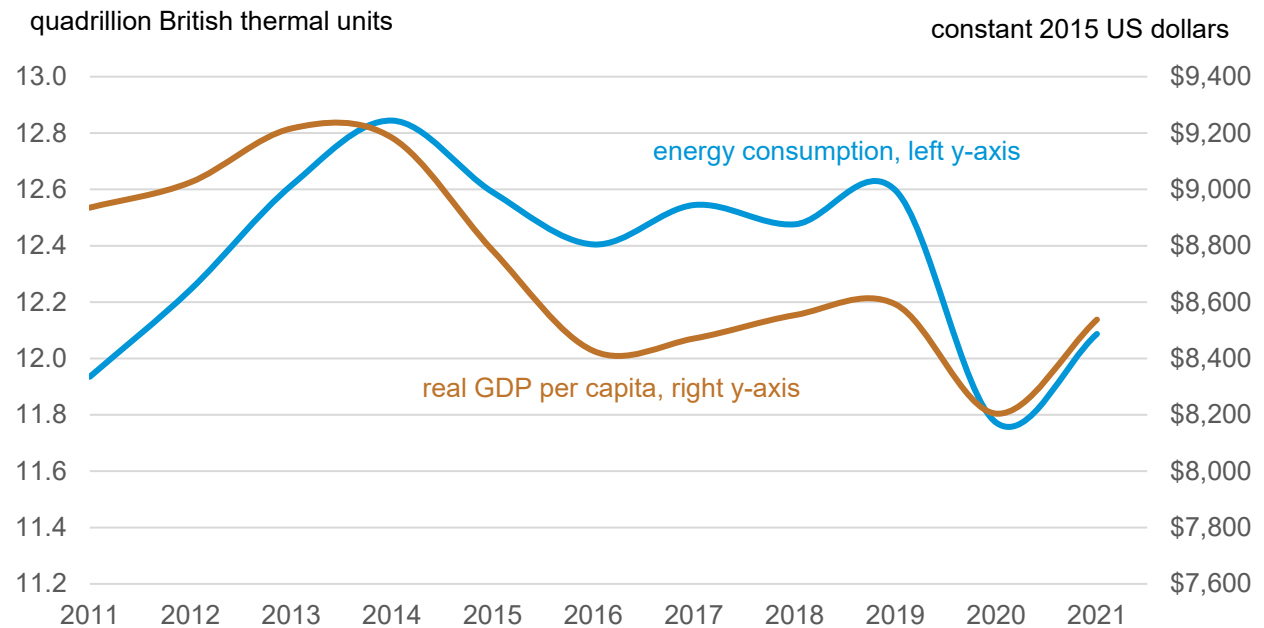
**Figure 3. Total primary energy consumption in Brazil by fuel type, 2021**

percentage of total energy consumption



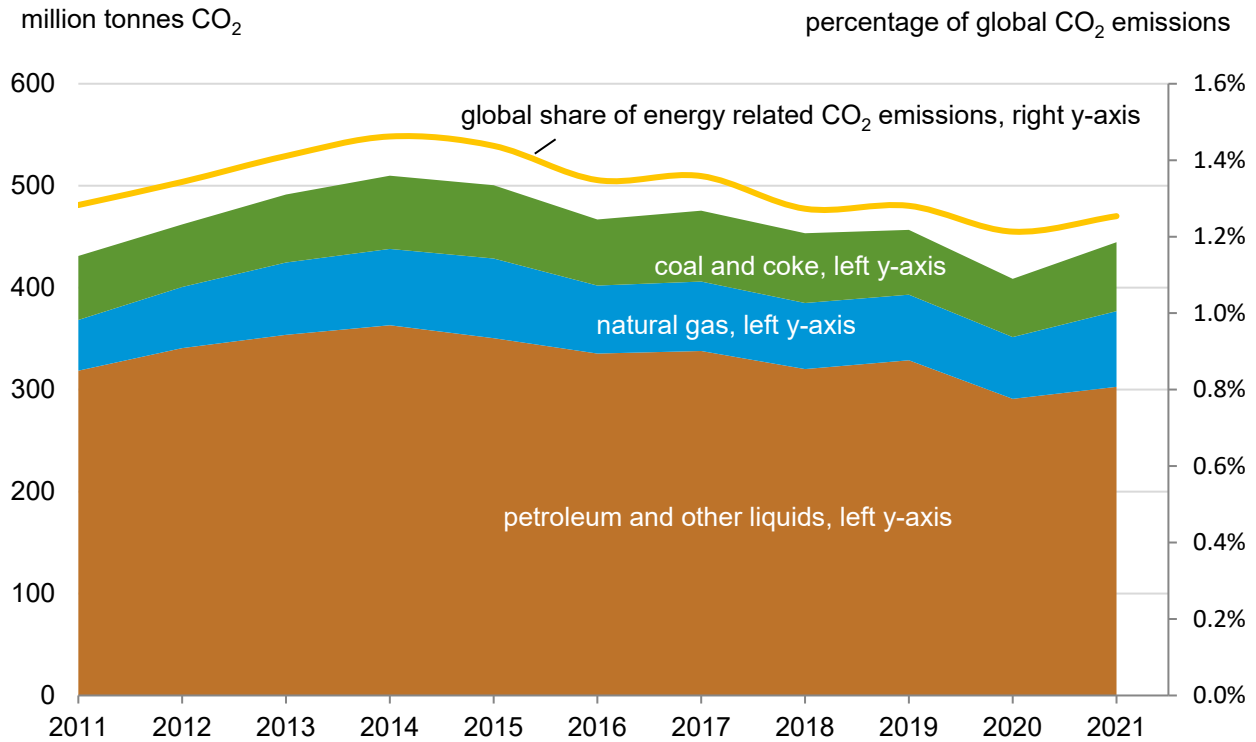
Data source: U.S. Energy Information Administration, International Energy Statistics  
 Note: Non-hydro renewables include geothermal, tide, wave, fuel cell, solar, wind, and biomass and waste.

**Figure 4. Brazil's total primary energy consumption and real GDP per capita, 2011–2021**



Data source: U.S. Energy Information Administration, International Energy Statistics and World Bank, *World Development Indicators*

**Figure 5. Brazil's energy related CO<sub>2</sub> emissions, 2011–2021**



Data source: U.S. Energy Information Administration, International Energy Statistics

## Petroleum and Other Liquids

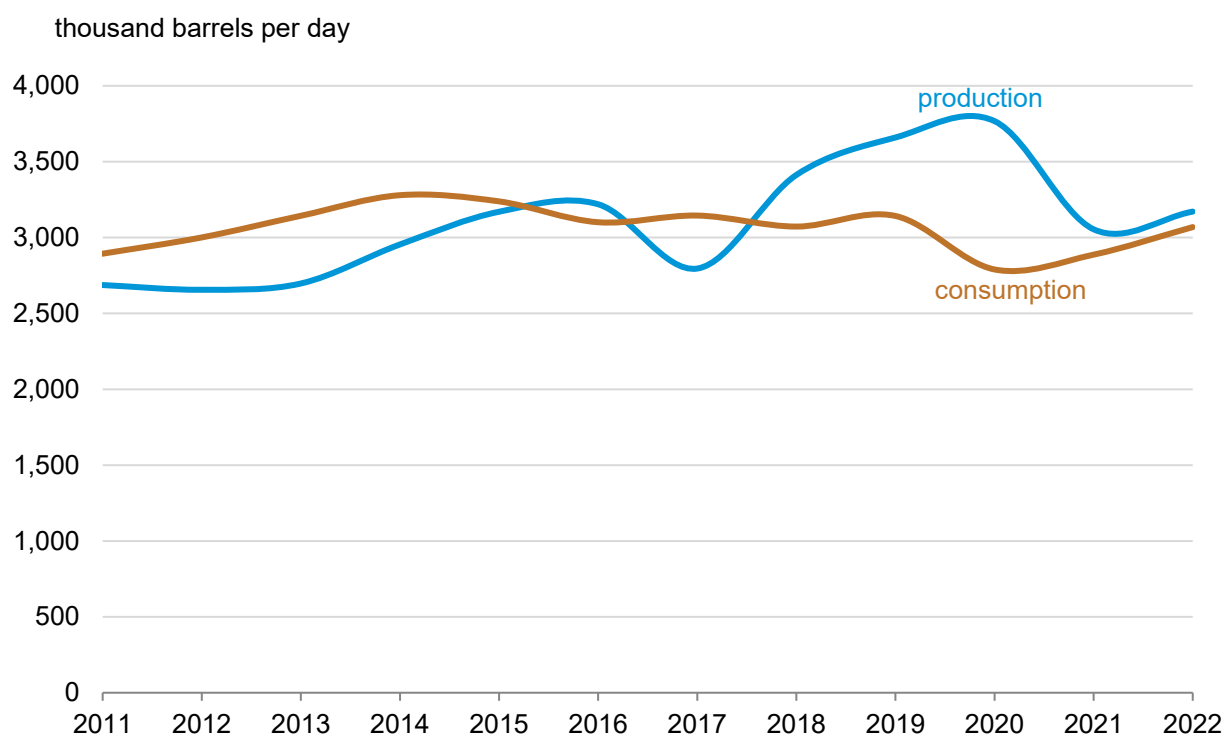
- Brazil held the second most crude oil reserves in Central America and South America in 2022, behind Venezuela, with approximately 13.24 billion barrels.<sup>6</sup> Since 2006, vast offshore oil reserves have been discovered deep beneath a layer of salt known as the pre-salt layer off the coast of Brazil, significantly boosting the country's crude oil production. These oil deposits include the pre-salt fields of Tupi, Buzios, and Sapinhoá in the Santos Basin, as well as other deposits in the Campos Basin in the South Atlantic, south of Rio de Janeiro.<sup>7</sup> Brazil's reserves will likely continue to grow as exploration and development drilling continue. Baker Hughes's International Rig Count showed 18 active rigs at the end of July 2023, up from 11 the previous year.<sup>8</sup>
- Petrobras (Petroleo Brasileiro S.A.), Brazil's state-owned oil and natural gas company, has been the primary operator in charge of exploring and developing the pre-salt reserves. In 2010, Brazil introduced the Pre-Salt Law. The legislation established primary guidelines for exploration and production, including the use of production-sharing agreements (PSAs) rather than concession agreements. Petrobras was designated as the operator in the pre-salt oil region, with a minimum 30% stake. It also appointed the public company Pré-Sal Petróleo SA (PPSA) as the manager of all PSAs in 2013 and required all foreign companies wishing to drill in the area to join a consortium with Petrobras and PPSA. Following criticism, the Pre-Salt Law was amended in 2016 to

relieve Petrobras of its obligation to hold a 30% operating interest in future projects, but it also granted the company an optional right of preference.<sup>9</sup>

- In 2018, Brazil reduced requirements for using locally produced goods and services, or local content, which had previously contributed to delays. Brazil also has restored a regular schedule of annual licensing sales. Shell, BP, TotalEnergies, Repsol, Chevron, Galp Energia, Equinor, Sinopec, and Sinochem are among the international oil companies participating in the PSA with deepwater operations experience. Petrobras, PetroRio, and other domestic companies are also involved in the PSAs.<sup>10</sup> The goal of this market liberalization is to increase efficiency, stimulate innovation, and increase crude oil production. As of July 2023, Petrobras produced nearly 63% of Brazil's crude oil.
- Brazil's crude oil production has been steadily increasing because of the development of pre-salt reserves. In 2022, Brazil produced approximately 3.2 million barrels per day (b/d) of petroleum and other liquids, up from 2.7 million b/d in 2012 (Figure 6). Oil production from Brazil's pre-salt fields exceeded that of the country's other fields for the first time in 2018. In 2020, output from pre-salt fields reached a new high of 2.8 million b/d, accounting for 70% of Brazil's output. As of 2023, Brazil ranks among the top 10 global oil producers.<sup>11</sup>
- Petrobras, which controls more than 90% of the domestic market, has increased pre-salt well productivity by 30% since 2010, while reducing both the number of wells required to reach capacity and the time required to build them. Pre-salt breakevens have fallen from \$70 per barrel in 2014 to less than \$35 in 2022, attracting greater private sector participation. Favorable regulatory and tax reforms, the pooled expertise of Petrobras and joint venture partners, and technological advancements in subsea and topsides infrastructure have resulted in a sharp decrease in costs.<sup>12</sup>
- Brazil's refinery portfolio consists of 19 refineries (Table 2) with a combined processing capacity of approximately 2.4 million b/d.<sup>13</sup> The refineries produce a variety of oil products, including diesel, gasoline, naphtha, jet fuel, liquefied petroleum gas, and lubricants, as well as other substances used as feedstock for a variety of other products.<sup>14</sup> Since 2016, Petrobras has used a competitive pricing scheme to set wholesale prices at its refineries.
- To reduce debt and focus on its core upstream business, Petrobras announced plans to sell a series of refineries in 2019, initiated by the company's previous management under former President Jair Bolsonaro. As of August 2023, Petrobras has completed the sale of Potiguar Clara Camarão Refinery (RPCC) to 3R Potiguar SA, Paraná Xisto SA (Unidade de Industrializacao do Xisto) to Forbes & Manhattan Resources Inc, Refinaria de Mataripe (RLAM) to Acelen (Mubadala Capital), Refinaria Lubrificantes e Derivados do Nordeste (LUBNOR) to Grepar Participações, and Refinaria Isaac Sabba (REMAN) to Ream Participações SA.<sup>15, 16, 17</sup> Petrobras's new management decided to halt the divestment process under Brazil's current President Luiz Inacio Lula da Silva. As of 2023, Petrobras operated 78% of Brazil's refining capacity, with refineries located primarily in the country's southeastern industrial heartland.



**Figure 6. Brazil's total petroleum and other liquids production and consumption, 2011–2022**



Data source: U.S. Energy Information Administration, International Energy Statistics and the Short-Term Energy Outlook

**Table 2. Brazil's oil refineries**

Refinery	Operator	Crude oil distillation capacity (thousand barrels per day)	Location
Refinaria Paulínia (REPLAN)	Petroleo Brasileiro SA	434	Paulinia, Sao Paulo
Refinaria de Mataripe (RLAM)	Acelen	377	Mataripe, Bahia
Refinaria Duque de Caxias (REDUC)	Petroleo Brasileiro SA	252	Rio de Janeiro
Refinaria Henrique Lage (REVAP)	Petroleo Brasileiro SA	252	Sao Jose dos Campos, Sao Paulo
Refinaria Alberto Pasqualini (REFAP)	Petroleo Brasileiro SA	220	Canoas, Rio Grande do Sul
Refinaria Getúlio Vargas (REPAR)	Petroleo Brasileiro SA	214	Araucaria, Parana
Refinaria Presidente Bernardes (RPBC)	Petroleo Brasileiro SA	179	Cubatao, Sao Paulo
Refinaria Gabriel Passos (REGAP)	Petroleo Brasileiro SA	166	Minas Gerais
Refinaria Abreu e Lima (RNEST)	Petroleo Brasileiro SA	115	Ipojuca, Pernambuco
Refinaria Capuava (RECAP)	Petroleo Brasileiro SA	63	Maua, Sao Paulo

Refinaria Isaac Sabba (REMAN)	Ream Participações SA	46	Manaus, Amazonas
3R Potiguar	3R Potiguar SA	45	Guamaré, Rio Grande do Norte
Refinaria de Petróleo Riograndense	Refinaria de Petróleo Riograndense SA	17	Rio Grande, Rio Grande do Sul
Manguinhos	Refinaria de Petróleos de Manguinhos SA	14	Rio de Janeiro
SSOIL Energy	SSOIL Energy SA	12	Coroados, São Paulo
Refinaria Lubrificantes e Derivados do Nordeste (LUBNOR)	Grepar Participações	10	Fortaleza, Ceara
Univen	Univen Refinaria de Petroleo Ltda	5	Itupeva, São Paulo
Dax Oil	Dax Oil Refino SA	4	Polo Petroquímico de Camaçari
Paraná Xisto (Unidade de Industrializacao do Xisto)	Paraná Xisto SA	...	São Mateus do Sul, Paraná
<b>Total</b>		<b>2,426</b>	

Data source: *Oil & Gas Journal*, 2022 Worldwide Refining Survey; and the National Agency for Petroleum, Natural Gas and Biofuels (ANP)

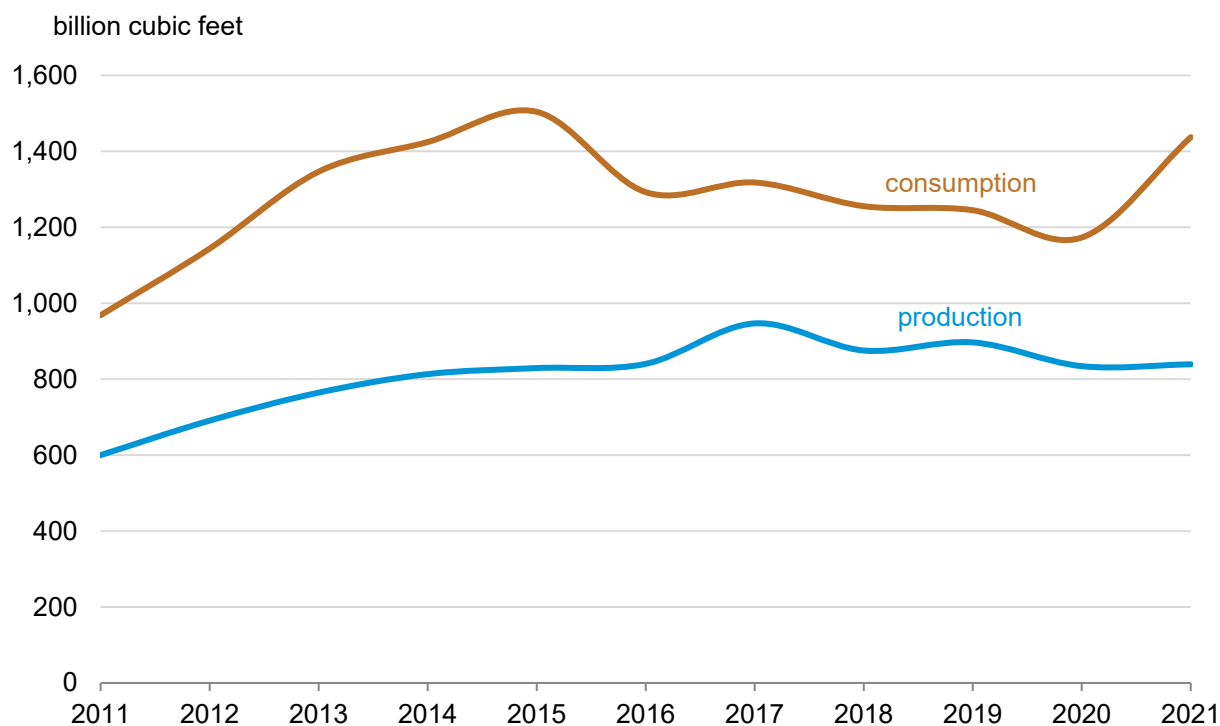
## Natural Gas and LNG

- Brazil had 13.4 trillion cubic feet (Tcf) of natural gas reserves as of January 2023, the fourth highest in Central America and South America. Associated gas from oil fields makes up most of the proven natural gas reserves in the country, particularly pre-salt reserves, with 76% located offshore, mostly in the Santos Basin. The remaining 24% of proven natural gas is located onshore, primarily in the Solimões Basin and Paranaíba Basin.<sup>18</sup>
- Brazil's natural gas supply is made up of domestic production, Bolivian imports, and LNG cargoes. Brazil's natural gas production reached 839 billion cubic feet (Bcf) in 2021, up by 1% from 2020. Three basins drive the country's natural gas production: Santos, Campos, and Espirito Santo.
- Most of Brazil's natural gas output is reinjected rather than sold in the domestic market. Reinjection is used to improve oil recovery. Petrobras is Brazil's largest natural gas producer. As of July 2023, Petrobras produced 64.8% of Brazil's natural gas, according to Brazil's energy regulator called the National Agency for Petroleum, Natural Gas and Biofuels (ANP). Other producers of natural gas include the domestic company, Eneva, and three major international companies: Shell, Galp, and Repsol.
- Routes 1 and 2 are the two main offshore routes for natural gas pipelines in Brazil. Route 1 primarily transports natural gas from the Tupi, Sapinhoá, and Mexilho fields to Petrobras's Caraguatatuba processing unit in São Paulo state.<sup>19</sup> Route 2 transports natural gas from Búzios, Tupi, Atapu, Sururu, and other fields to Cabiúnas Gas Treatment Terminal in Macaé, Rio de Janeiro state.<sup>20</sup> The Route 3 pipeline is currently under construction and is scheduled to be operational in 2024.<sup>21</sup> This pipeline will supply natural gas to the GasLub complex in Rio de Janeiro state.<sup>22</sup>
- Brazil's natural gas market faces some challenges including the far distances between offshore natural gas fields and the coast as well as limited natural gas pipeline

infrastructure.<sup>23</sup> The New Gas Law of 2021 seeks to gradually unbundle the market, creating the foundation for a more competitive natural gas market in Brazil. The law aims to improve the physical flexibility of the natural gas system, allow for faster delivery of natural gas, foster competition, and make it easier to integrate a greater share of intermittent renewables into Brazil's energy system. The ANP now has more authority to promote competition and reduce market concentration. However, the liberalization process is still in its early stages. Petrobras still owns most upstream natural gas projects, natural gas processing units, and other natural gas infrastructure.  
<sup>24, 25, 26</sup>

- Brazilian industries, thermal power plants, refineries, and fertilizer plants account for most natural gas demand. As of 2020, the industrial sector consumed most of Brazil's natural gas (67% of total natural gas consumption).<sup>27</sup> Natural gas is used in industries such as petrochemicals, fertilizers, steel, ceramics, and food processing for process heating, power generation, and as a feedstock.<sup>28</sup> The southeastern region has the highest demand, followed by the northeastern region. A large portion of Brazil's territory does not yet have access to the pipeline grid, which is mainly concentrated in coastal states, where most of the demand is located.
- Brazil has increased the number of natural gas-fired power plants over recent years. They are high efficiency, low emissions facilities. Brazil's heavy reliance on hydropower means it needs to have a natural gas-fired power backup for when water levels are low.<sup>29</sup>
- Natural gas is increasingly used as a transportation fuel in Brazil, increasing from a 17% share of consumption in 2010 to 26% in 2020. The natural gas-powered automotive fleet consists primarily of light commercial and passenger vehicles. Residential and commercial demand account for a minor portion of total demand, representing a 5% share of natural gas consumption in 2020. Most of the demand is concentrated in the country's southeastern region, where the pipeline distribution system is more developed.<sup>30</sup>

**Figure 7. Brazil’s dry natural gas production and consumption, 2011–2021**



Data source: U.S. Energy Information Administration, International Energy Statistics

**Table 3: Brazil’s operating natural gas pipelines**

Name	Operator	Start year	Capacity (billion cubic feet of natural gas per year)	Start location	End location
NTS Gas Pipeline Network	Brookfield Infrastructure Partners (unknown %)	...	2,039	São Bernardo do Campo, São Paulo, Brazil	Cabiúnas, Rio de Janeiro, Brazil
Gasene Gas Pipeline	Engie (65%); Caisse de dépôt et placement du Québec (35%)	2007	391	Cabiúnas, Rio de Janeiro, Brazil	Catu, Bahia, Brazil
Gasbol Gas Pipeline	Petrobras (51%); Fluxys (37%); YPFB (12%)	1999	388	Río Grande, Santa Cruz, Bolivia	Canoas, Rio Grande do Sul, Brazil
Route 2 Gas Pipeline	Petrobras (55%); Shell (25%); Galp Energia (100%); Repsol (10%)	2016	258	Tupi field, Rio de Janeiro, Brazil	Cabiúnas, Rio de Janeiro, Brazil
Carmópolis-Pilar Gas Pipeline	Engie (65%); Caisse de dépôt et placement du Québec (35%)	2006	194	Carmópolis, Sergipe, Brazil	Pilar, Alagoas, Brazil
Paraná-Uruguayana Gas Pipeline	CGC (Compañía General de Combustibles) (15.77%); CMS Energy (unknown %); Petronas	2000	194	Paraná, Entre Ríos, Argentina	Uruguaiana, Rio Grande do Sul, Brazil

	(unknown %); Techint (unknown %); TotalEnergies SE (unknown %)				
Itaporanga-Carmópolis Pipeline	Engie (65%); Caisse de dépôt et placement du Québec (35%)	2006	162	Itaporanga, São Paulo, Brazil	Carmópolis, Sergipe, Brazil
Route 1 Gas Pipeline	Petrobras (65%); Shell (25%); Galp Energia (10%)	2011	129	Tupi field, Rio de Janeiro, Brazil	Monteiro Lobato Gas Treatment Unit
Catu-Itaporanga Gas Pipeline	Engie (65%); Caisse de dépôt et placement du Québec (35%)	2007	117	Pojuca, Bahia, Brazil	Itaporanga, São Paulo, Brazil
Urucu-Manaus Gas Pipeline	Engie (65%); Caisse de dépôt et placement du Québec (35%)	2009	87	Urucu, Amazonas, Brazil	Manaus, Amazonas, Brazil
Cuiabá Pipeline	Grupo J&F (100%)	2002	36	San José de Chiquitos, Santa Cruz, Bolivia	Cuiaba, Mato Grosso, Brazil
Uruguaiiana-Porto Alegre Gas Pipeline	Ipiranga Produtos de Petróleo SA (25%); Petrobras (25%); Repsol (25.00%); TotalEnergies SE (25%)	...	36	Argentina-Brazil border	Uruguaiiana, Rio Grande do Sul, Brazil
GASALP Pipeline	Engie (65%); Caisse de dépôt et placement du Québec (35%)	2001	32	Alagoas, Brazil	Cabo de Santo Agostinho, Pernambuco, Brazil
Nordestão Gas Pipeline	Engie (65%); Caisse de dépôt et placement du Québec (35%)	1986	29	Guamaré, Rio Grande do Norte, Brazil	Cabo de Santo Agostinho, Pernambuco, Brazil
GASFOR Pipeline	Engie (65%); Caisse de dépôt et placement du Québec (35%)	1998	26	Guamaré, Rio Grande do Norte, Brazil	São Gonçalo, Rio de Janeiro, Brazil
GASEB Pipeline	Engie (65%); Caisse de dépôt et placement du Québec (35%)	1974	18	Catu, Bahia, Brazil	Atalaia, Alagoas, Brazil
Uruguaiiana-Porto Alegre Gas Pipeline	Ipiranga Produtos de Petróleo SA (25%); Petrobras (25%); Repsol (25%); TotalEnergies SE (25%)	...	16	Triunfo, Rio Grande do Sul, Brazil	Canoas, Rio Grande do Sul, Brazil
<b>Total</b>			<b>4,152</b>		

Data source: Global Energy Monitor, Latin America Energy Portal, January 2023

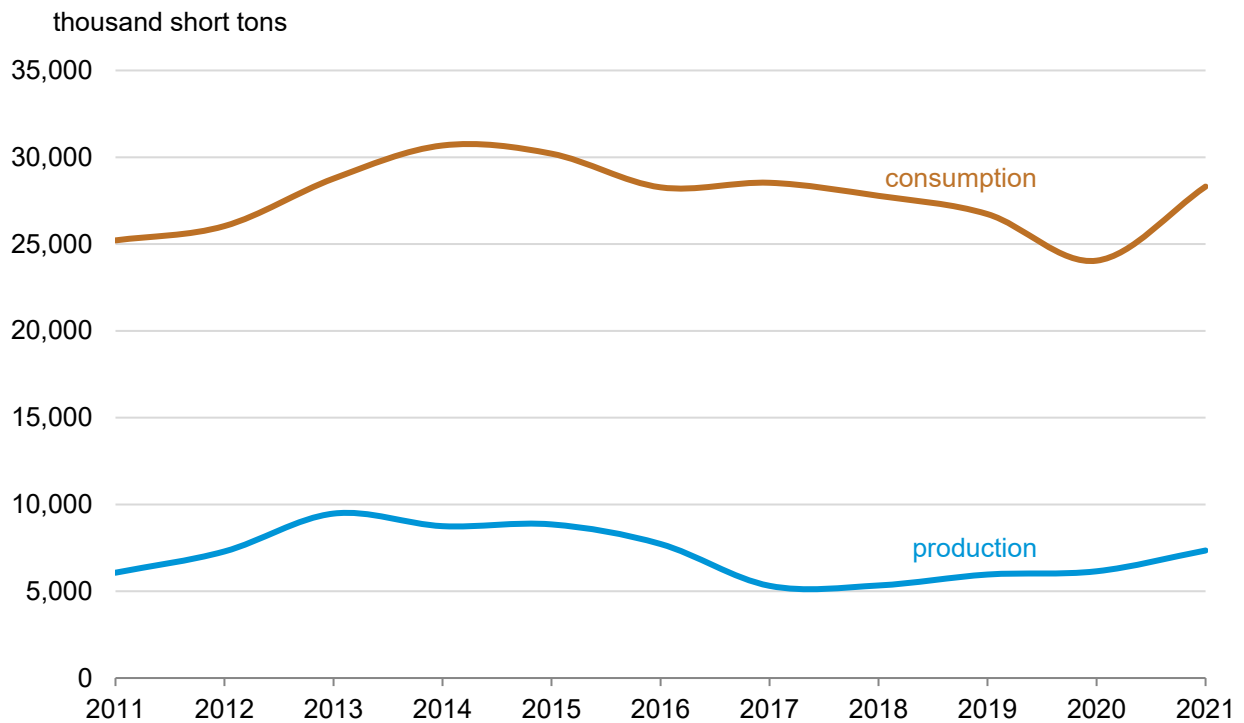
## Coal

- Brazil has the most coal reserves in Central America and South America, with 7.3 billion short tons as of 2021, amounting to 0.6% of the world's coal reserves. This amount equals 257 times the annual consumption in Brazil. The Paraná Basin has eight large coal deposits associated with Permian sedimentary successions. Seven of these deposits are in Rio Grande do Sul, and the remaining one is in Santa Catarina. Rio Grande do Sul has

most of the total coal resources.<sup>31</sup> Brazil’s reserves are primarily made up of bituminous and subbituminous coal.

- Brazil was the second-largest coal producer in Central America and South America in 2021, after Colombia.
- Brazil's coal mining industry is controlled by small-scale mining operations. The country produced approximately 7.3 million short tons of coal in 2021, representing a 19% increase over the previous year. Coal accounted for 0.9% of Brazil’s total energy production in 2021 (Table 1). About 70% of coal produced in Brazil in 2021 was subbituminous, 28% was lignite, and 2% was bituminous.<sup>32</sup>
- Brazil was the highest coal consumer in Central America and South America in 2021. Brazil consumed approximately 28.3 million short tons of coal in 2021, an 18% increase from 2020. In 2021, coal consumption in Brazil was the third-highest nonrenewable source, accounting for approximately 5.5% of the country's total nonrenewable consumption. Most of the coal produced (98% of total) is used in industrial processes.<sup>33</sup> Brazil’s coal is unsuitable for use in the steel industry because of its high ash content and low calorific content.<sup>34</sup> As a result, only 26% of domestic coal production is consumed, and the remainder is exported.

**Figure 8. Brazil’s coal production and consumption, 2011–2021**

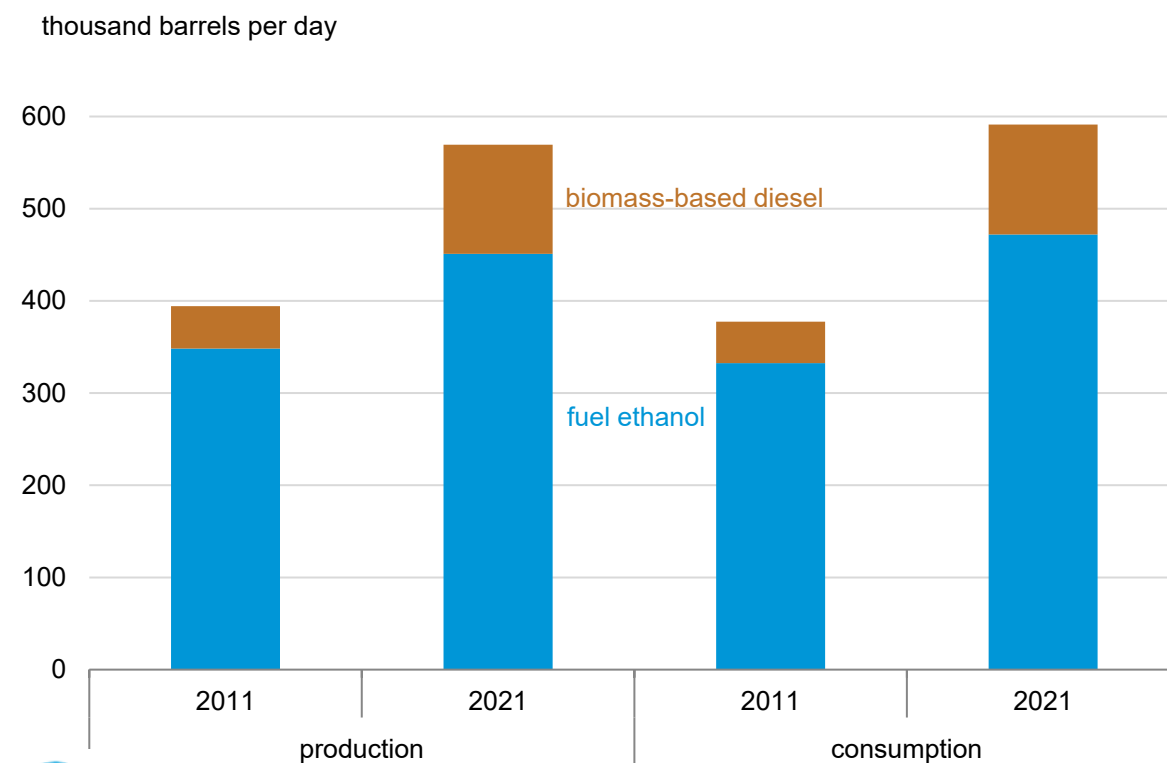


Data source: U.S. Energy Information Administration, International Energy Statistics

## Biofuels

- Brazil is the second-largest producer of biofuels in the world behind the United States, accounting for a global share of 20% in 2021.<sup>35</sup> From 2011 to 2021, Brazil's biofuel production increased at an average annual growth rate of 3%, while biofuel consumption increased at an average annual growth rate of 4%. However, Brazil's seasonal production of biofuels results in seasonal consumption of biofuels, necessitating imports from abroad during the offseason for biofuels output. In 2021, Brazil consumed 569,000 b/d of biofuels: 79% was bioethanol, and 21% was biodiesel.<sup>36</sup>
- Brazil's primary biofuel is fuel ethanol, primarily derived from sugarcane (about 96% of total ethanol production). Brazil is the world's largest producer of sugarcane. Brazil produced 451,000 b/d of fuel ethanol in 2021, accounting for 26% of global output.<sup>37</sup> During the crop production cycle in 2021, Brazil experienced a drought and low temperatures. These conditions limited the productivity of key sugarcane-producing regions.<sup>38</sup> As a result, fuel ethanol production fell by 15% in 2021 compared to 2020. The country has approximately 350 sugarcane ethanol plants, the majority of which are concentrated along the coast.
- The plentiful and cheap supplies in Brazil's Center-West region attracted investment in the corn ethanol sector in recent years. Corn has been used to produce a small but growing portion of Brazilian ethanol since 2014. Brazil currently has 16 corn ethanol plants in the Center-West states of Mato Grosso, Goias, and Mato Grosso do Sul. At least four units are corn-only plants, and the remaining flex plants can produce ethanol from both sugarcane and corn.<sup>39</sup>
- Brazil's biodiesel production has increased significantly over the last decade. Brazil produced 118,000 b/d of biodiesel in 2021, a 6% increase over the previous year.<sup>40</sup> As of 2022, approximately 79% of biodiesel produced is made from soybean oil and 15% is made from animal fat. As of 2021, the country has 57 biodiesel production plants, and 60% of them are in the central-western region, which has a surplus of soybeans.<sup>41</sup> More than 4.9 million cubic meters of soybean oil were used for biodiesel production in 2021.<sup>42</sup>
- Biofuels account for 25% of Brazil's transportation fuels, a higher percentage than in most other countries.<sup>43</sup> Brazil has the largest fleet of flex-fuel vehicles in the world, which can run on any combination of gasoline and ethanol, or up to 100% ethanol. Flex-fuel vehicles account for 85% of all cars on the road in Brazil and 83% of all new light vehicle sales in 2022.<sup>44</sup> Since 1977, Brazil has had a mandatory ethanol-use mandate that requires a certain percentage of ethanol to be blended with gasoline. The current national blending mandate is 27% ethanol (E27) in regular gasoline and 12% ethanol (E12) in premium gasoline. Brazil has a biodiesel blending mandate at 12%.<sup>45</sup>

**Figure 9. Brazil’s biofuels production and consumption, 2011–2021**



Data source: U.S. Energy Information Administration, International Energy Statistics

## Electricity

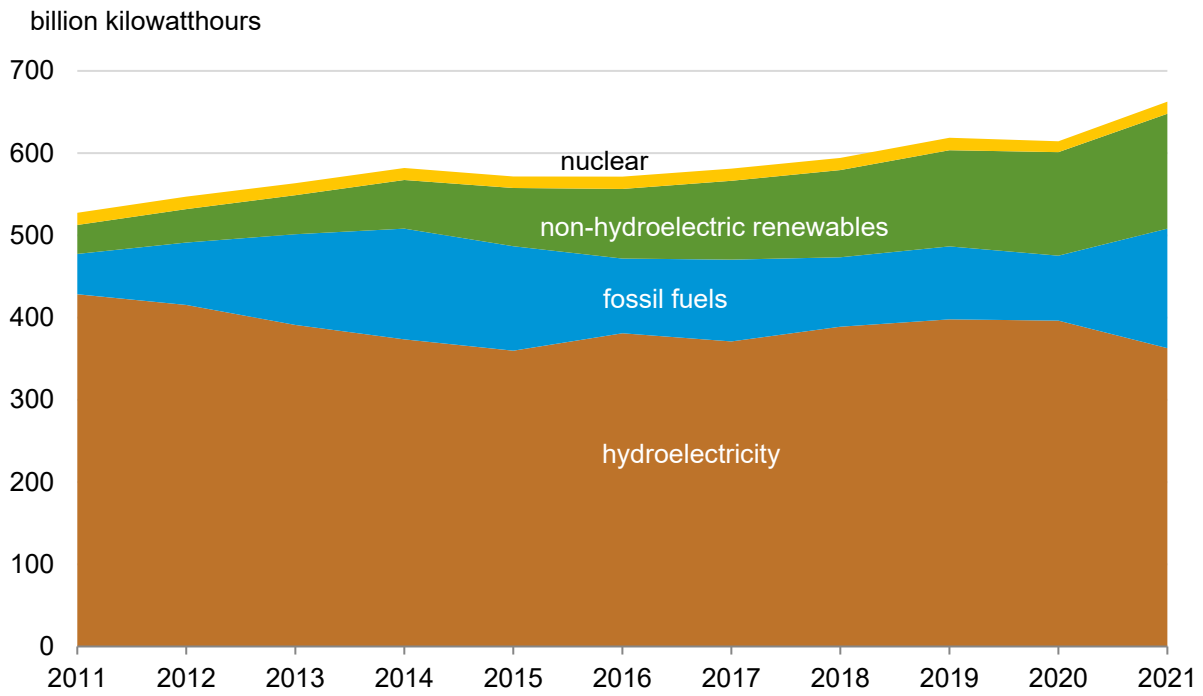
- Brazil was the world's sixth-largest electricity generator in 2021, with 663 terawatt-hours generated, an 8% increase from 2020. Brazil's generation in 2021 represented 2% of total global electricity generation.<sup>46</sup> From 2011 to 2021, Brazil's electricity generation increased by an average growth rate of 2.4% per year. This average annual growth was largely driven by solar power (up by 199%), wind power (up by 40%), and fossil fuels (up by 13%) over the same period. The most important sources of electricity generation in Brazil in 2021 were hydropower (55% of total electricity), natural gas (15% of total electricity), and wind (11% of total electricity).<sup>47</sup> Industrial (39% of total electricity consumption), residential (29%), and commercial and public services (25%) consumers use most of Brazil's electricity.
- To deliver electricity throughout the country, Brazil has a vast transmission and distribution network. Brazil's National Interconnected System (SIN) is a large network that serves 98% of the electricity market in Brazil. The SIN is made up of several individual power systems that communicate via a network of tie lines, ensuring that electricity from various sources is available<sup>48</sup> and can be coordinated by Brazil's 102 power distribution companies.<sup>49</sup> The distribution of electricity in Brazil is nearly universal; 99% of the population has access to some form of electricity (Figure 12). Brazil's top 10 electricity distribution companies accounted for about 57% of the total distributed electricity.<sup>50</sup>



- The National Electric Energy Agency (ANEEL) regulates Brazil's electricity market, establishing rules and regulations, promoting competition, and regulating the electricity sector.
- To finance investments and provide better services, Brazil's largest electric power holding company, Eletrobras, was privatized in 2022. Brazil's government previously owned 72% of the company. The privatization was the largest in the country in over two decades. Eletrobras subsidiaries control approximately 40% of Brazil's generation capacity and 69% of the National Interconnected System.<sup>51</sup>
- Brazil increases new generation capacity through auction-based renewable procurement, and contracts typically last 15 to 30 years. Auctions are used to award power purchase agreements (PPAs) to various generators, including renewable energy projects, in the market.<sup>52</sup> These auctions serve as a venue for project developers to compete for contracts to sell electricity to distribution companies. The framework includes contracts to reduce risk for investors.<sup>53</sup>
- In 2021, hydropower accounted for an estimated 9.2% of Brazil's total energy production and 54.8% of total electricity generation (Table 1). Hydropower is the second most common type of energy consumed in Brazil, accounting for an estimated 22.2% of total energy consumption. Brazil has an abundance of rivers and has built many large-scale hydroelectric plants, with a total installed capacity of 99,828 megawatts (MW) (Table 4). The Itaipu Dam, located on the Paraná River between Brazil and Paraguay, has the world's third-highest installed hydroelectric capacity with 14,000 MW. Brazil and Paraguay have each an installed capacity of 7,000 MW.<sup>54</sup> Another notable hydroelectric project in Brazil is the Belo Monte Dam, located on the Xingu River in the state of Pará. It has the fifth-highest installed hydroelectric capacity of around 11,233 MW.<sup>55</sup> Because of its impact on the Amazon rainforest and local indigenous communities, the Belo Monte Dam has raised some environmental and social concerns.<sup>56</sup> Droughts and reduced water availability can lower reservoir levels and, as a result, limit hydroelectric power generation. Brazil has experienced periods of low water levels in its reservoirs, which have hampered the country's ability to ensure a sufficient supply of electricity solely from hydroelectricity.<sup>57</sup> Despite the challenges, Brazil continues to increase hydroelectric capacity and invest in new projects.<sup>58</sup>
- In 2021, the country's installed capacity from fossil fuels was 43.2 gigawatts (GW), accounting for 21% of total electric capacity. Brazil generated 145,386 gigawatthours (GWh) of electricity from fossil fuels in the same year, accounting for 22% of total electricity generation. During periods of low water availability or high electricity demand, electricity from fossil fuels is frequently used to supplement hydroelectric power. The share of electricity from natural gas among fossil fuels increased from 48% in 2011 to 66% in 2021. Coal-fired power plants play a smaller role in Brazil's electricity generation, accounting for 4% of total electricity generation in 2021. Coal is primarily used in regions with coal deposits, such as the southern Brazilian states of Rio Grande do Sul and Santa Catarina. The share of coal among fossil fuels has decreased from 25% in 2011 to 18% in 2021, reflecting efforts to transition to cleaner energy sources.<sup>59</sup> Brazil has a small number of oil-fired power plants that help to keep the electricity grid flexible and stable, accounting for 3.4% of total electricity generation. However, because of higher costs and environmental concerns, the use of oil for electricity generation is limited.

- Brazil is the world's fifth-largest generator of wind energy.<sup>60</sup> With 21 GW of installed capacity, Brazil generated 71,500 GWh of wind power in 2021, accounting for 11% of the country's total electricity generation. Wind power is Brazil's third-largest source of electricity generation after hydropower and natural gas.<sup>61</sup> Wind power generation in Brazil has grown in recent years. This expansion was the result of government initiatives and private-sector investments.<sup>62</sup> Brazil only has onshore wind farms as of 2022 because onshore wind farms are less expensive and more flexible than offshore projects.<sup>63</sup> As of 2022, Brazil has 801 onshore wind farms, most of which are in the northeastern region of the country, with 219 of them in Bahia, 217 in Rio Grande do Norte, and 101 in Ceará.<sup>64</sup> In 2022, the Brazilian Senate passed a bill that proposes a regulatory framework for the implementation of offshore wind projects.<sup>65</sup>
- With 13 GW of installed solar power capacity, Brazil was the 10th-largest solar electricity generator in 2021.<sup>66</sup> Solar power's share of total electricity generation in Brazil increased from 0% to 3% between 2011 and 2021.<sup>67</sup> As of 2022, Brazil had 168 solar projects in operation, all with photovoltaic (PV) systems, primarily in the central and northeastern regions.<sup>68</sup> To encourage the development of solar power, the Brazilian government has implemented tax breaks, financing programs, and net metering regulations.<sup>69</sup>
- Brazil's biomass and waste market generated 8% (approximately 51,435 GWh) of total electricity generation in the country in 2021.<sup>70</sup> As of 2020, approximately 92% of biomass and waste electricity generation was generated by primary solid biofuels, 4% by industrial waste, 3% by biogases, and 1% by liquid biofuels.<sup>71</sup> The biomass power sector in Brazil is inextricably linked to the production of sugarcane ethanol. The same sugarcane feedstock used to produce ethanol also produces significant amounts of biomass residues, such as bagasse, which are then used to generate electricity. This integration of the biofuels and biomass power sectors helps to make resources more sustainable and efficient.<sup>72</sup> Brazil's installed capacity from biomass and waste was 16 GW in 2021.<sup>73</sup> Brazil was the world's third-largest biomass and waste electricity generator in 2021, accounting for 8% of the world's total. Biomass is less competitive than wind and solar generation.<sup>74</sup> As such, the share of biomass and waste electricity generation among non-hydroelectric renewables has declined from 92% in 2011 to 37% in 2021, trailing wind.<sup>75</sup> As of 2022, Brazil had 230 biomass and waste power plants in operation with 12 additional plants announced to open.<sup>76</sup>
- Brazil was the top generator of electricity from nuclear power plants in Central America and South America with 15 billion kilowatthours generated in 2021.<sup>77</sup> Eletrobras Eletronuclear SA operates two nuclear power plants in Angra dos Reis, Rio de Janeiro state, known as Angra 1 and Angra 2. Angra 1 has been in operation since 1985, and Angra 2 began in 2001. These plants have a total installed capacity of around 2 GW and contribute significantly to Brazil's electricity generation. Angra 3 is a third nuclear power plant that has been under construction since 1984 because several delays and challenges have hampered its completion. Angra 3 is scheduled to begin operating in 2028 with an installed capacity of around 1.4 GW.<sup>78</sup>
- Brazil's nuclear power plants provide a consistent source of baseload electricity, which contributes to overall energy security and grid stability. Brazil has significant uranium reserves and is capable of mining, processing, and enriching uranium for use in nuclear reactors.<sup>79</sup> The only uranium producer is the state-run Industrias Nucleares do Brasil (INB). In 2022, the Brazilian Lower House approved a constitutional amendment that allowed the private sector to enter the uranium industry.<sup>80</sup>

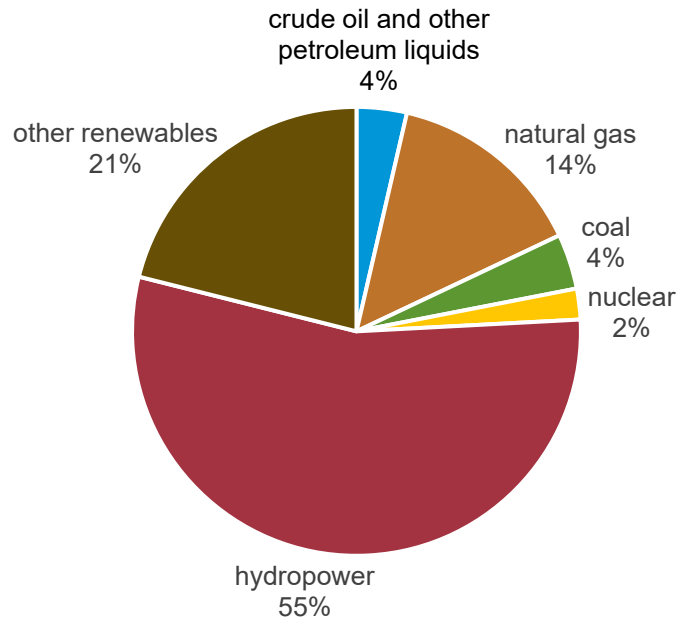
**Figure 10. Brazil's electricity generation by source, 2011–2021**



Data source: U.S. Energy Information Administration, International Energy Statistics

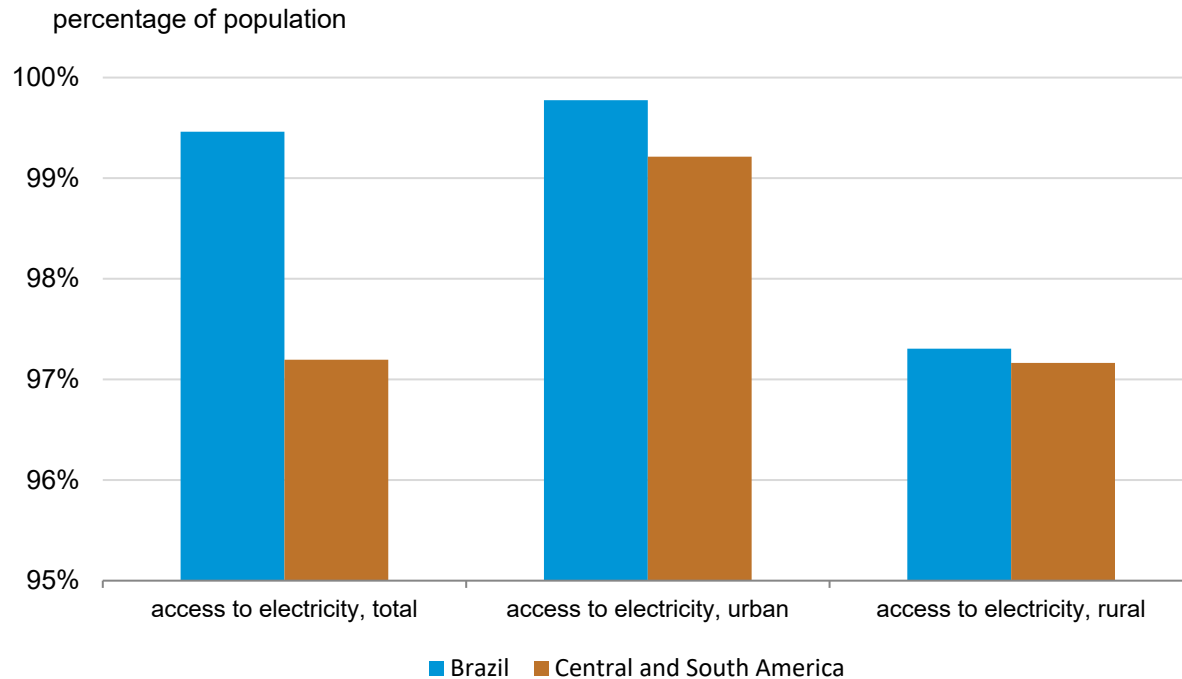
**Figure 11. Brazil's electricity generation supply, 2021**

percentage of total electricity generation



Data source: U.S. Energy Information Administration, International Energy Statistics, and International Energy Agency, *Electricity Information 2022*

**Figure 12. Brazil's access to electricity, 2021**



Data source: World Bank, *World Economic Indicators*

Note: *Central and South America* is an average that includes Antigua and Barbuda, Argentina, Aruba, the Bahamas, Barbados, Belize, Bolivia, Brazil, British Virgin Islands, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Curacao, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Nicaragua, Panama, Paraguay, Peru, St. Kitts and Nevis, St. Lucia, St. Martin (French part), St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos, Uruguay, and Venezuela.



**Table 4. Brazil's operating hydroelectric plants**

Name	Operator	Start year	Capacity (megawatts)	Type	Location
Usina Hidrelétrica Belo Monte	Norte Energia SA	2016	11,233	Conventional storage	Pará
Usina Hidrelétrica Tucuruí	Eletrobras Eletronorte	1984	8,535	Conventional storage	Pará
Central Hidroeléctrica Itaipú, Usina Hidrelétrica de Itaipu	Itaipu Binacional	1984	7,000	Conventional storage	Paraná
Usina Hidrelétrica Jirau	Energia Sustentável Do Brasil SA	2013	3,750	Run-of-river	Rondônia
Usina Hidrelétrica Santo Antônio	Santo Antônio Energia SA	2012	3,568	Run-of-river	Rondônia
Usina Hidrelétrica Ilha Solteira	Rio Paraná Energia SA	1973	3,444	Conventional storage	Mato Grosso do Sul
Usina Hidrelétrica Xingó	Companhia Hidro Elétrica do São Francisco SA (CHESF)	1994	3,162	Run-of-river	Alagoas

Usina Hidrelétrica Paulo Afonso IV	Companhia Hidro Elétrica do São Francisco SA (CHESF)	1979	2,462	Run-of-river	Bahia
Usina Hidrelétrica Itumbiara	Furnas-Centrais Elétricas SA	1980	2,082	Conventional storage	Minas Gerais
Usina Hidrelétrica Teles Pires	Companhia Hidrelétrica Teles Pires	2015	1,820	Run-of-river	Pará
Other conventional storage	Other conventional storage	1991 (average)	31,318	<b>63</b> conventional storage	<b>14</b> Minas Gerais; <b>9</b> Paraná; <b>40</b> Other
Other run-of-river	Other run-of-river	1987 (average)	20,806	<b>51</b> run-of-river	<b>11</b> São Paulo; <b>10</b> Minas Gerais; <b>30</b> Other
Other conventional and run-of-river	Other conventional and run-of-river	1988 (average)	648	<b>2</b> conventional and run-of-river	<b>1</b> Goiás; <b>1</b> Espírito Santo
<b>Total</b>			<b>99,828</b>		

Data source: Global Energy Monitor, Global-Hydropower-Tracker, May 2023

## Energy Trade

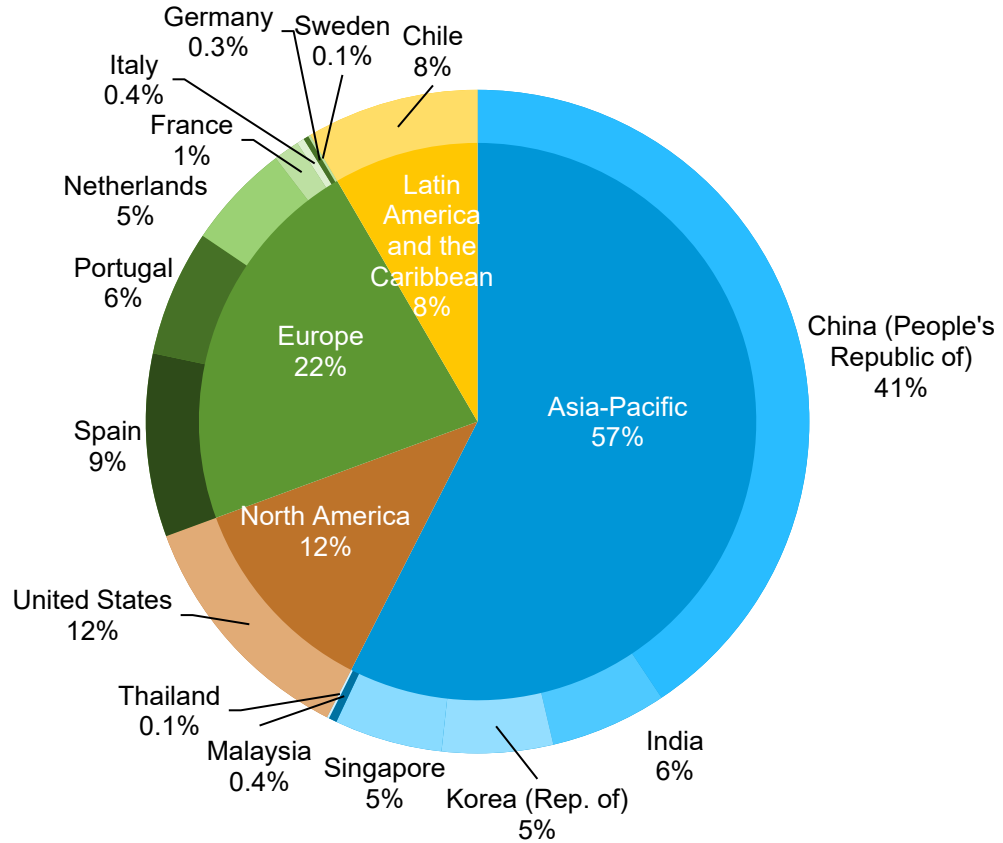
- Brazil has been a crude oil net exporter since 2006. The share of crude oil exports increased from 5% of total export volume in 2012 to 9% in 2022, ranking third in Brazil's commodity basket.<sup>81</sup> Brazil's crude oil is primarily exported to Asian countries (57%), particularly China (41%), as well as Europe (22%) and the United States (12%) (Figure 13). To meet domestic demand, the country imports a significant amount of refined petroleum products (Figure 15), accounting for 14% of total imports in 2022, the highest in Brazil's product basket.<sup>82</sup> Close to 53% of these imports come from the United States, 10% come from India, and 9% come from the United Arab Emirates.<sup>83</sup> Brazil's government intends to modernize and expand its refining capacity to reduce reliance on imports and increase the country's self-sufficiency in meeting refined product needs.<sup>84</sup>
- Brazil is a net importer of natural gas and liquefied natural gas (LNG). Nearly all of Brazil's natural gas in a gaseous state comes from Bolivia. Brazil has increased its imports of LNG to meet rising natural gas demand, increasing LNG imports by an average annual rate of 75% between 2012 and 2022. LNG is imported via coastal regasification terminals in Guanabara Bay and the Pecém Port.<sup>85</sup> In 2022, most of the country's LNG imports came from the United States (76%) and Qatar (14%).<sup>86</sup>
- Brazil relies on imports to meet its coal needs because of limited domestic coal production. In 2022, coal ranked as the second-highest import commodity in Brazil, accounting for 11% of total imports. The imported coal is primarily used in industrial processes that require specific coal qualities. Most of the domestic coal production in Brazil is used for power generation, but coal imports in Brazil are primarily used for steel making.<sup>87</sup> In 2022, Brazil primarily imported coal from Australia (33%), the United States (30%), and Colombia (17%).<sup>88</sup>
- Brazil is a net exporter of biofuels. In 2022, Brazil exported 24% of the world's ethanol, making it the world's highest ethanol exporter, which only accounted for 0.3% of Brazil's

total exports. As gasoline prices rose in 2022, so did demand internationally for cheaper E10 fuel (gasoline containing 10% ethanol).<sup>89</sup> As such, the volume of Brazil's ethanol exports increased by 25% in 2022 from the year prior. Of total ethanol exports in 2022, 31% went to South Korea, 29% to the Netherlands, and 19% to the United States.<sup>90</sup> Brazil's ethanol exports benefit from advantageous trade agreements, such as the Brazil-United States Ethanol Cooperation Agreement, which facilitates ethanol trade between the two countries.<sup>91</sup> Because of the favorable carbon intensity rating that Brazil's sugarcane ethanol receives under California's Low Carbon Fuel Standard (LCFS), California receives the majority of ethanol shipped to the United States. Brazil's ethanol is frequently shipped to the U.S. Gulf Coast and converted to ethyl tertiary butyl ether (ETBE) before being shipped to Japan.<sup>92</sup> Brazil's biodiesel exports remain low because of the high cost of production. Brazil's National Agency for Petroleum, Natural Gas and Biofuels continues to prohibit biodiesel imports except in "exceptional circumstances," limiting import volumes.

- Brazil has interconnected transmission grids that allow for the trade of electricity with neighboring countries. Electricity interconnections have been established with Argentina, Uruguay, Paraguay, and Venezuela, allowing for the import and export of electricity based on supply and demand conditions.<sup>93</sup> Brazil gets a large portion of its electricity from the Itaipu dam and exports excess electricity to neighboring countries. Argentina is Brazil's main electricity export market.<sup>94</sup> Brazil imports electricity from Uruguay to help meet peak electricity demand.<sup>95</sup>
- Brazil is a member of the Southern Common Market (Mercosur), which promotes energy integration among its member countries. This regional cooperation includes initiatives such as energy policy harmonization, energy infrastructure interconnection, and energy trade facilitation within the Mercosur bloc.<sup>96</sup>

**Figure 13. Brazil's crude oil exports by region and country, 2022**

percentage of total crude oil exports

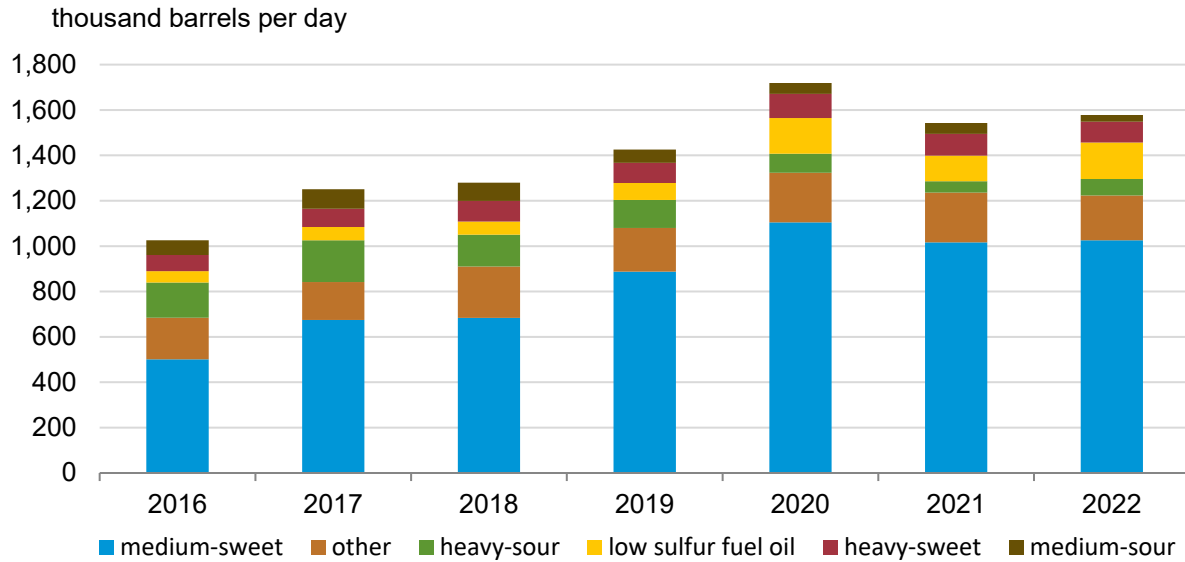


Data source: Global Trade Tracker, provided by Zen Innovations AG © 2023

Note: Some individual figures do not match the regional total because of rounding. Belgium, Bolivia, and Paraguay are excluded from the graph because they account for less than 0.0 barrels per day in 2022.



**Figure 14. Brazil's oil and gas exports, 2016–2022**

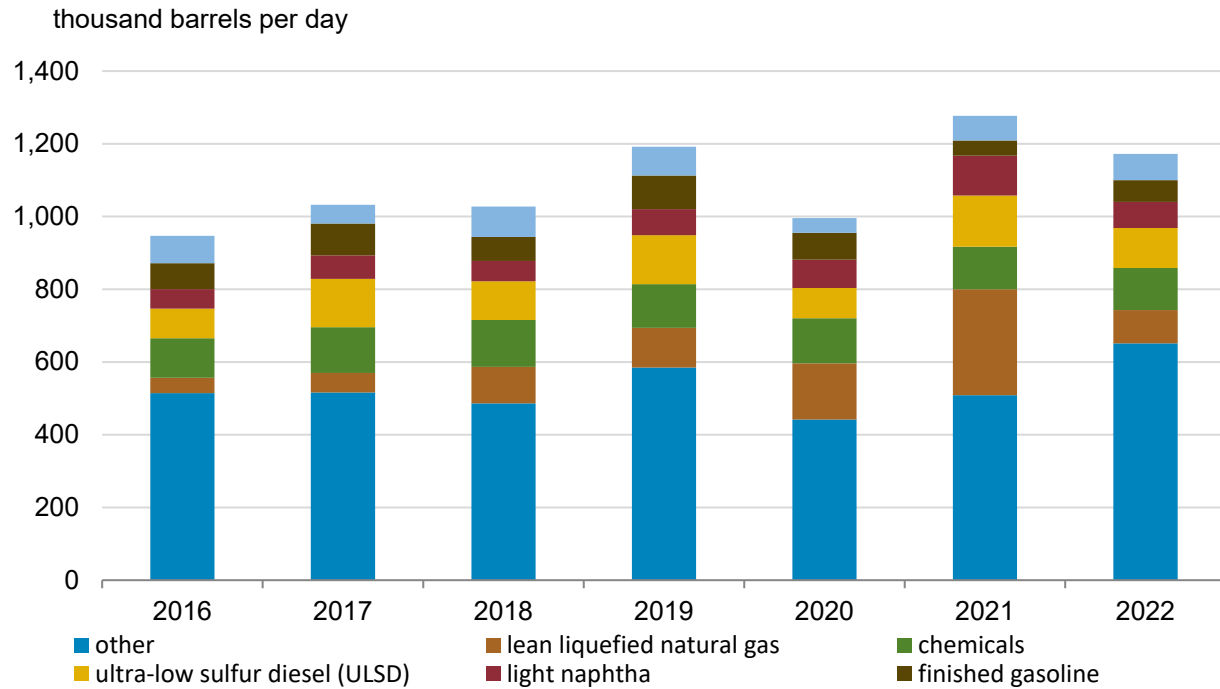


Data source: Vortexa Ltd.

Note: *Other* includes chemicals, biodiesel feedstock, blending components, finished gasoline, gasoil, olefins or other chemicals, light naphtha, high sulfur fuel oil, propane, diesel, light-sweet crude oil, ultra-low sulfur diesel (ULSD), other biodiesel or edible oils, jet fuel, vacuum gas oil (VGO), finished biodiesel, dirty feedstocks, butane, heavy naphtha, lube oils, and other naphthas.



**Figure 15. Brazil's oil and gas imports, 2016–2022**



Data source: Vortexa Ltd.

Note: *Other* includes full range naphtha, propane, medium-sour, gasoil, diesel, rich liquefied natural gas, dirty condensates, medium-sweet, clean condensates, jet fuel, heavy-sweet, biodiesel feedstock, olefins or other chemicals, low sulfur fuel oil, blending components, butane, other naphthas, heavy naphtha, lube oils, ethane, kerosene, heavy-sour, other biodiesel or edible oils, finished biodiesel, and bitumen.



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