

IEA-Advanced Motor Fuels ANNUAL REPORT 2023

BRAZIL



Brazil

Drivers and Policies

Brazil has a long history with bioethanol dating back to the 1970s. Initial bioethanol efforts were associated with energy security issues related to the first oil crisis. As a result, the country has stimulated the production of ethanol and, since 2003, the use of hydrous ethanol in dedicated or fuel-flexible vehicles (FFVs). Today, the allowed blend level of ethanol is 27% in regular gasoline (MAPA 2015), and blend limits range between 18% and 27.5% (Brazil 2014). Since 2005, Brazil has also imposed minimum levels of biodiesel in diesel fuel, according to the Brazilian Program of Production and Use of Biodiesel (PNPB). The environmental agenda has supported the agricultural sector¹ and, in particular, the biofuels value chain, especially ethanol and biodiesel and, now, biogas. Note that Brazilian federal states apply differentiated consumption tax rates for gasoline (in general, higher rates) and hydrous ethanol (in a majority of the states, lower rates). Two recent public policies promote the production and consumption of biofuels: (1) the National Biofuel Policy, named *RenovaBio* (Brazil 2017), operational since March 2020; and (2) the *Fuels of the Future Program* (Civil House 2021), created in 2021. The Brazilian Parliament is reviewing a proposal to increase these limits up to E35% when market feasibility can be verified and also considering biodiesel mix up to B20 by 2030 (Brazil 2024a).

The official document driving Brazil's national policy framework for renewable energy is its Nationally Determined Contribution (NDC) (UNFCCC 2022) toward achieving the objective of the United Nations framework convention on climate change.

Under the third revision of its NDC concerning the Paris Agreement, Brazil committed to reducing its domestic greenhouse gas (GHG) emissions to 48.4% by 2025 and has declared its intention to reduce 53.1% of its emissions by 2030, both based on 2005 levels (MMA 2023). Brazil is also committing to the long-term objective of becoming carbon neutral by 2050. Such measures continue to include all sectors of the economy, such as agriculture and energy, with transport in the latter sector. Brazil also intends to adopt further measures consistent and aligned with the 1.5°C temperature goal, especially in the energy sector (IEA 2023).²

Brazilian Policy Framework

The main policy instruments behind the evolutions that will subsidize the future growth of biofuels in Brazil include the following:

- The *Brazilian Alcohol Program (PROALCOOL)*, created during the 1970s by the Brazilian government to increase the ethanol blending level to 25% in gasoline (E25) and introduce hydrous ethanol (E100 — approximately 95% ethanol and 5% water) for use in dedicated vehicles.
- The *Brazilian Program for Production and Use of Biodiesel (PNPB)*, created in 2005 to further stimulate energy, economic, and social objectives, and foster feedstock production among small farmers.
- *Flex fuel technology*, established in 2003 to enable consumers to choose between E27 and E100.
- *Biofuel addition on petroleum products*. Since 2015, all automotive gasoline sold at retail contains, by mandate, a blend of 27% anhydrous ethanol, or E27.³ The government also mandated that biodiesel be added to fossil diesel: a final blend of roughly 11% in 2021 and, since April 2023, 12%.⁴

¹ The agriculture sector represents 23.8% of Brazil's gross domestic product (GDP) in 2023 (CEPEA 2024)

² Additional measures include the following:

- Expanding the use of renewable energy sources other than hydropower in the total energy mix.
- Expanding the use of non-fossil fuel energy sources domestically.
- Achieving 10% efficiency gains in the electricity sector by 2030.

In addition, in the transportation sector, Brazil intends to further promote efficiency measures and improve infrastructure for transport and public transportation in urban areas.

³ Gasoline premium contains 25% anhydrous ethanol, according to MAPA Ordinance N. 75 (MAPA 2015). However, it accounts for a very small fraction of fuel sales.

⁴ Blend definition in accordance with CNPE Resolutions ([MME 2023a](#)).

- *National Biofuel Policy (RenovaBio)* ([Law 13,576/2017](#)) (Brazil 2017), a state policy recognizing the strategic role of all types of biofuels in the national energy matrix, both for energy security and for the mitigation of GHG emissions. The policy includes the additional objective of reducing dependence on mineral diesel.
- *Fuels of the Future Program*, created in 2021, aims to further increase the use of sustainable and low-carbon fuels to decarbonize the national transport energy matrix.
- *Project of Law 4,516/2023* (Brazil 2024b), approved in the Brazilian Chamber of Deputies on 13 March 2024, this project of law, based on the discussions under the Fuels of the Future Program, proposes the increase of ethanol mixed in the gasoline from the current 27.5% to 35% and the increase of biodiesel mixed in diesel from the current 14% to 20% by 2030.
- *Federal and state tax differentiation* between renewables and fossil fuels,⁵ establishing credit lines to support rural sugarcane producers and their cooperatives to select business plans and promote projects that consider the development, production, and commercialization of new industrial technologies for sugarcane biomass (E2G [second-generation ethanol], gasification, and more).⁶
- *Consolidation of the National Hydrogen Program (PNH2)*. The Brazilian government organized and published a strategy for developing the country's hydrogen economy (Brazil 2023b), which would harmonize with other sources of its energy matrix.⁷
- *Brazil's membership* in the International Maritime Organization (IMO) and International Civil Aviation (ICAO)/Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).⁸
- *A pledged commitment to efficiency programs* such as INOVAR-Auto, INNOVA-E, and other governmental initiatives dedicated to improving motor fuel efficiency.
- *Federal government approval* of the framework of the Rota 2030 program (Law 13,755/2018) in December 2018 to foster efficiency and safety in vehicles produced in Brazil (Brazil 2018).
- *Provisional Measure 1,205* (30 December 2023) to Institutionalize the *Green Mobility and Innovation Program (MOVER)*, which offers a broader approach for mobility than Rota 2030. MOVER's goals include a well-to-wheel perspective, which will measure energetic efficiency and an objective for car manufacturers to use at least 50% recyclable components to achieve tax differentiation. After 2027, vehicles commercialized in Brazil will be evaluated using a "cradle to grave" life-cycle model. MOVER also includes a financial bonus for automakers who take into account some sustainable indicators.
- *Decree number 11,902* (30 January 2024), which restructures the Social Biofuel Seal and creates significant investments. Starting in 2024 with Brazilian real (BRL) 740 million, in 2026, BRL 1.6 billion will be allocated to strengthen biodiesel production and support family farming. This policy aims to strengthen family farming, especially in the North, Northeast, and semi-arid regions of Brazil. It also encourages the production of new crops, such as macaúba, and palm tree that is abundant in the Northeast of the country (Brazil 2024a).
- *Brazilian Sustainable Taxonomy*. At the end of 2023, the Brazilian government launched a public consultation about the Brazilian Sustainable Taxonomy, a document that consists of a classification system that defines — in a clear, objective and scientifically based manner — activities, assets and/or project categories that contribute to climate, environmental, and/or social objectives through specific criteria (Brazil 2023a).

⁵ Regarding federal taxes, Contribution for Intervention in the Economic Domain (CIDE) has been zeroed for ethanol since 2004, while for gasoline, the incident value is R\$100.00/m³. Between 2017 and the second half of 2022, the Program of Social Integration (PIS)/Contribution for the Financing of Social Security (COFINS) on ethanol imports and commercialization was R\$241.81/m³, and for gasoline, R\$ 792.5/m³. From the second half of 2022, tax changes were made that zeroed PIS/Pasep, COFINS, and CIDE and limited the ICMS (sales and service tax) for gasoline to between 17% and 18% in 21 states of the federation (Fecombustíveis 2022). At the state level, ICMS has different rates in each Brazilian state (EPE 2023d)

⁶ CPNE did all of this through CNPE Resolution number 07, 20 April 2021.

⁷ The Triennial Plan for H₂ 2024–2026 was approved in December 2023 by the Executive Committee of the PNH2 (Brazil's National Hydrogen Program).

⁸ CORSIA is a global market-based measure designed to offset international aviation CO₂ emissions in order to stabilize the levels of such emissions (ICAO 2023).

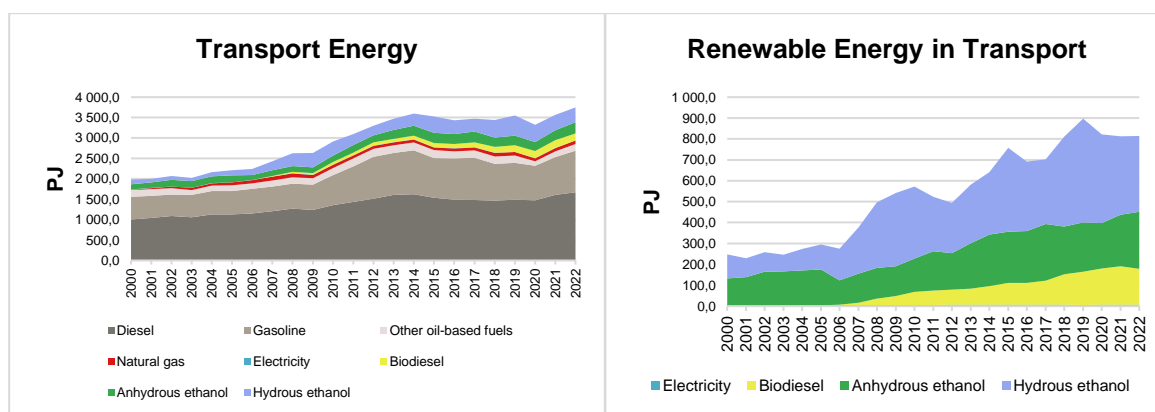
Advanced Motor Fuels Statistics

Transport

Figures 1 and 2 provide an overview of the energy used for transport in Brazil, categorized by different fuels/energy carriers. Note that Brazilian statistics define biogasoline (E27) as anhydrous bioethanol blended with gasoline and that hydrous ethanol is used in dedicated or FFVs. Bioethanol represented 38% by energy of combined gasoline and ethanol use in 2022 in Otto cycle engines.

Transport fuel consumption in Brazil has stabilized over the past five years, and the use of biofuels has grown steadily over the past 20 years. In particular, the use of hydrous ethanol in FFVs has substantially increased. The consumption of anhydrous ethanol has grown with gasoline consumption, as evidenced in Figure 1. Biodiesel was introduced in 2005 and has also steadily grown as a substitute for fossil diesel consumption, mainly for heavy-duty transport. On average, biodiesel represented 9.3%⁹ (by energy) of diesel consumption in 2022, as Figure 2 shows.

Also as shown in Figure 1, electricity represents a share of 0.2% of total transport energy use in 2022, maintaining the share of previous years. This is mostly in rail — Brazil has no reporting of electricity used in road vehicles.



Figures 1 and 2. Evolution of Transport Fuels in Brazil, 2000–2022 (Source: EPE 2023a).

Table 1 displays the growth of the Brazilian fleet from 2013 to 2022.

Table 1. Growth of the Brazilian Fleet, 2013–2022

Vehicle Stock	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Motor spirit cars	10 ⁶	11,7	11,0	10,3	9,6	8,9	8,2	7,6	7,1	6,5	6,0
Diesel oil cars	10 ⁶	1,7	1,8	1,9	2,0	2,1	2,2	2,3	2,3	2,4	2,5
Electricity cars	10 ⁶	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,001	0,004	0,012
Other type of cars (hybrid)	10 ⁶	0,001	0,002	0,003	0,004	0,007	0,010	0,021	0,038	0,057	0,085
Flex fuel cars	10 ⁶	20,7	23,2	24,9	26,0	27,1	28,4	29,7	30,2	30,7	31,0

Source: EPE 2023e.

⁹ In 2021 the Brazilian Energy Policy Council (CNPE) decided to reduce from 12% to 10% the mandatory blend of biodiesel for the entire year of 2022, in response to societal interest and diesel B price conditions. The 12% requirement was reinstated on 01 March 2023. The raise in demand and the blend reduction explains the share contraction from 10.3% in 2021 to 9.3% in 2022. Also note that from 2007 to 2021, biodiesel commercialization was accomplished through public auctions organized by ANP (Regulatory Agency for Oil, Natural Gas, and Biofuels). Since 01 January 2022, such commercialization occurs directly between producers and distributors (EPE 2023d).

Research and Demonstration Focus

Brazil has several government-backed mechanisms providing support for biofuels research, development, and demonstration (RD&D) plants. Public and publicly oriented support totaled more than BRL 250 million (USD 50 million) in 2022,¹⁰ which includes support in the form of loans, equity participation, and grants and is also available via the PAISS programme for ethanol and other biofuel production (including cellulosic ethanol) and drop-in biofuels (including aviation fuels). Note that, within the scope of the Fuels of the Future (Civil House 2021) Technical Chamber (CT-CF), the government created and launched lines of financing for biofuels. Figure 3 illustrates the annual distribution of public investments in renewable energy, including research, development, and innovation (RD&I), by source.

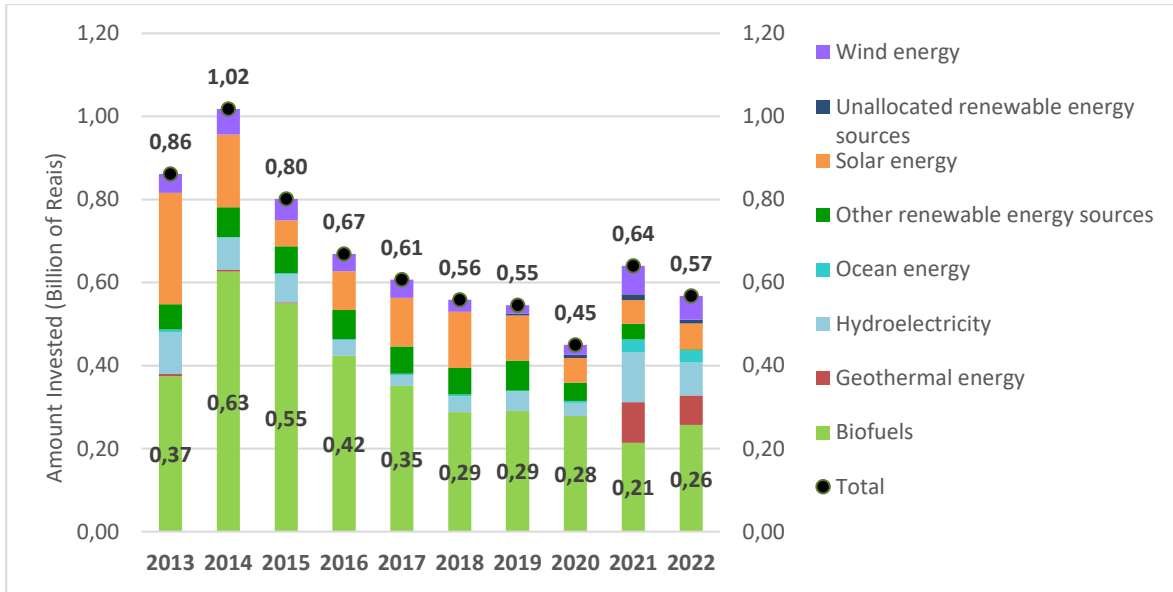


Figure 3. Public Investments in Renewable Energy RD&I, 2013–2022 (Source: EPE 2024).

Figure 4 displays the total amount of public financing specific to the sugar-energy sector. In 2022, total disbursements of the Brazilian Bank for Economic and Social Development (BNDES) in the agricultural area for the cultivation of sugarcane totaled USD 77.5 million (or roughly BRL 400 million) (BNDES 2023).¹¹

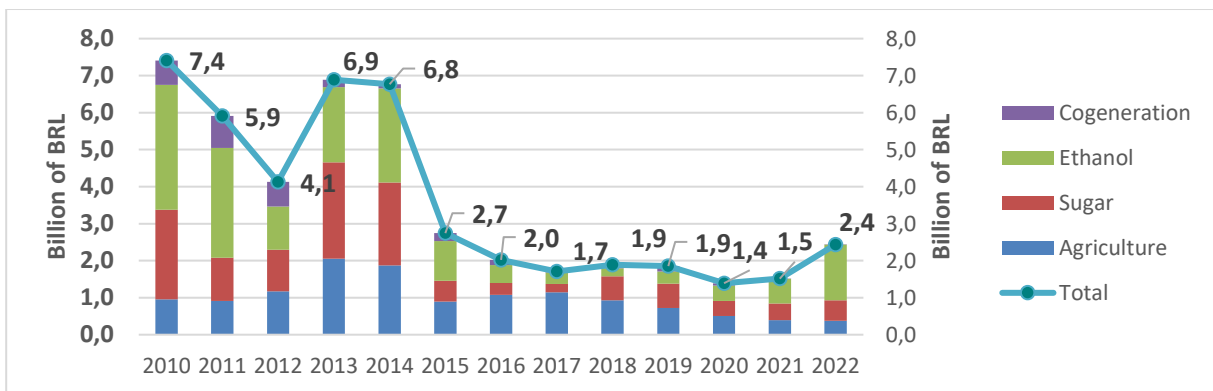


Figure 4. Public Funding for Sugar-energy Sector (Source: Constructed by EPE from data provided by BNDES [2023]).

¹⁰ The average 2022 USD to BRL exchange rate was 5.16 (BCB 2024).

¹¹ At the average 2022 USD to BRL exchange rate (BCB 2024).

Outlook

Figure 5 consolidates the demand for fuel ethanol and other (non-energy) uses, which grows at an annual rate of 3.3%, reaching 43.7 billion liters in 2033, with the major increase coming from the demand for hydrous ethanol fuel. When added to exports, 2.7 billion liters, the total value of ethanol amounts to 46.5 billion liters.

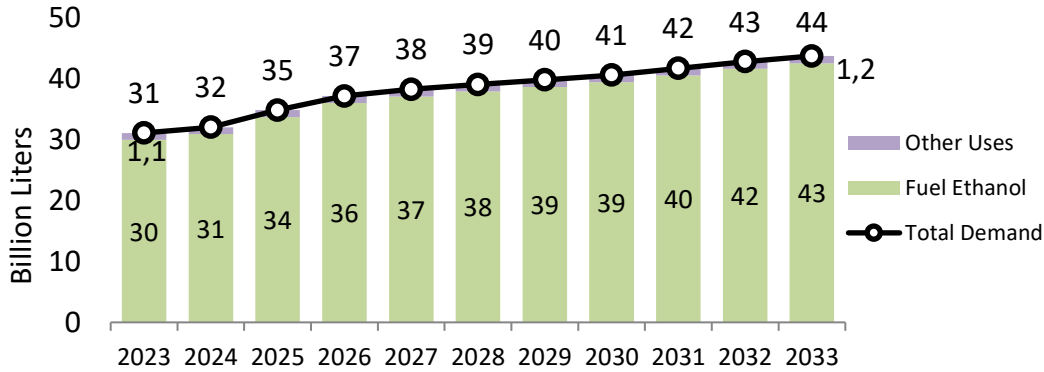


Figure 5. Forecast of Total Ethanol Demand, 2023–2033 (Source: EPE 2023b).

The biodiesel demand projections of this study were obtained based on the forecast of the regional consumption of oil diesel type-B (EPE 2023e) and the evolution of biodiesel blend (Figure 6).¹²

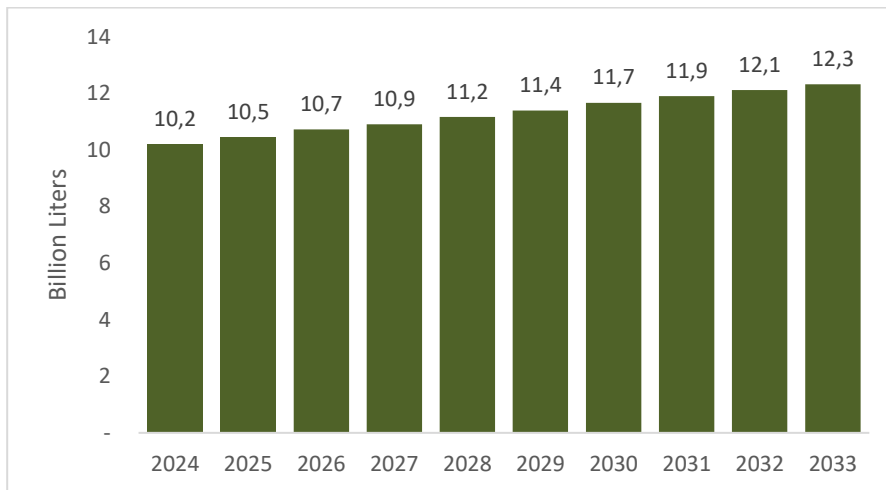


Figure 6. Forecast of Total Biodiesel Demand with Regional Distribution, 2024–2033 (Source: Based on EPE 2023e)

Projections for ethanol and sugar production presented in this study indicate a high amount of residues from this sector that can be used for biogas production. The methodology applied to this item considered both the vinasse and filter cake as part of the straw and tips to produce biogas, which will be destined for biodigestion. In this case, the technical potential of biogas from residual sugarcane biomass through monodigestion reaches 32.5 billion Nm³ in 2033, representing 17.9 billion Nm³ of biomethane.

¹² According to the CNPE definition on March 17, 2023 (MME 2023a), the biodiesel blend changed from 10% between January and March 2023 to 12% in April 2023, and following recent CNPE Resolution number 8, as of December 19, 2023 (MAPA 2023a; MAPA 2023b, Brasil 2024b), it will change from 13% to 14% in March 2024 and to 15% in March 2025.

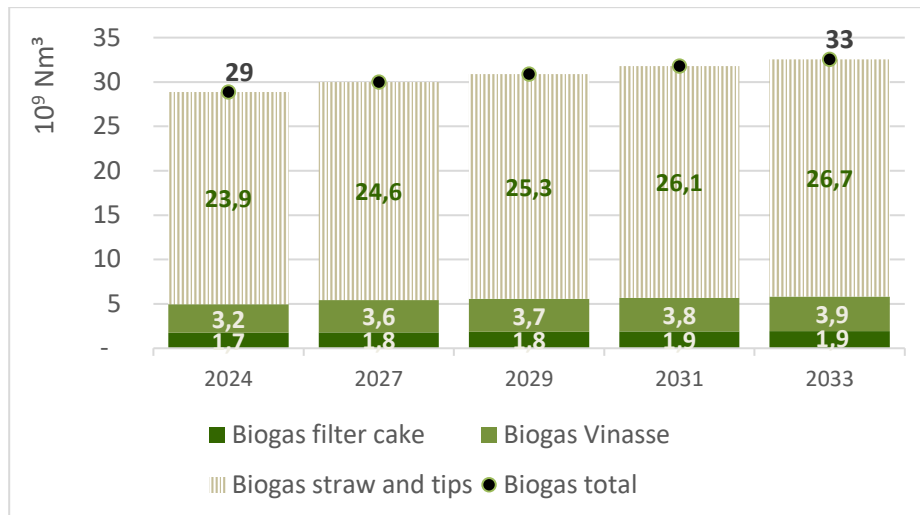


Figure 7. Biogas Potential with Sugarcane Residual Biomass, 2024–2033 (Note: Although identified as high potential, the different pattern on biogas from straw and tips indicates lower possibilities due logistic costs and conditions [Source: EPE 2023b]).

By 2033, the Brazilian fleet should achieve 50.4 million vehicles, according to the EPE (EPE 2023b).

Recent Developments

Brazil has two commercial E2G plants: GranBio's Bioflex-I commercial plants in São Miguel dos Campos (AL), with a nominal capacity of 30 million liters/year, and Raízen's, in Piracicaba (SP), with a capacity of 42 million liters /year (GranBio 2023a; Raízen 2024).

Bioflex-I has been in operation since 2017, and the company announced plans to expand its production capacity to 60 million liters by 2025. In 2022, this plant did not produce lignocellulosic ethanol and prioritized electricity generation (GranBio, 2023b). The validation of the production patent by European countries was also announced, allowing Brazilian companies to license the technology and the development and design of plants (NovaCana 2022a).

Currently, Raízen has five new E2G projects under construction, all with a capacity of 82 million liters per year at each facility. The company has three more projects with no announced location for implementation in 2026 and 2027. Raízen intends to sell lignocellulose ethanol to the foreign market, where it already has long-term contracts of 460 million liters over 9 years sold. The company managed to finance some of its new E2G plants using these already-sold long-term contracts as a guarantee (Globorural 2024; NovaCana, 2022b; UDOP 2023).

With regard to biogas, its participation in the internal supply of energy is still timid (0.14%), but it has shown accelerated growth: 18% per year over the last five years (EPE 2023a).

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