# IEA-Advanced Motor Fuels ANNUAL REPORT 2022

## Brazil

Technology Collaboration Programme
by IEA

# Brazil

## *Drivers and Policies*

Brazil has had a long history with bioethanol since the 1970s, due to energy security reasons connected with the first oil crisis. As a result, the country has stimulated the production of ethanol and, since 2003, the use of hydrous ethanol in exclusive or fuel-flexible cars. Today, the allowed blend level of ethanol is 27% in regular gasoline (MAPA, 2015) and blend limits range between 18% and 27.5% (Law 13,033, 2014). Since 2005, Brazil also has 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 sector[1] and, in particular, the biofuels value chain, especially ethanol and biodiesel and, now, biogas. It is worth mentioning 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 official document driving Brazil's national policy framework for renewable energy is its Nationally Determined Contribution (NDC, UNFCCC, 2022) towards achieving the objective of the United Nations framework convention on climate change.

Under the Paris Agreement, Brazil committed to reducing its domestic GHG emissions to 37% by 2025 and has declared its intention to reduce 43% of its emissions by 2030, both based on 2005 levels. At the 2021 UN Climate Change Conference, Brazil signed the Glasgow Climate Pact, committing to the long-term objective of reducing its emissions by 50% by 2030 and 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 with the 2°C temperature goal, especially, in the energy sector, achieving 45% of renewables in the energy mix by 2030 (IEA, 2022).[2]

## *Advanced Motor Fuels Statistics*

### Transport

Figures 1 and 2 provide an overview of the energy used in transport in Brazil, categorized by different fuels/energy carriers. It is important to note that Brazilian statistics define biogasoline (E27) as anhydrous bioethanol blended with gasoline and that hydrous ethanol is used in dedicated or flex-fuel vehicles (FFVs). Bioethanol represented 45% by energy of combined gasoline and ethanol use in 2021 in Otto cycle engines.

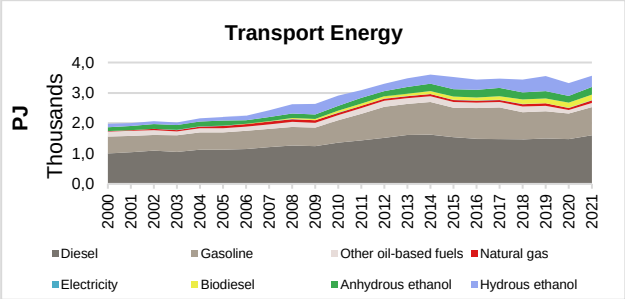
Transport fuel consumption in Brazil has stabilized over the past five years, and the use of biofuels has grown steadily over the past 20 years. In particular, the use of hydrous ethanol in FFVs has substantially increased. The consumption of anhydrous ethanol has grown with gasoline consumption, as 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 10.3% by energy of diesel consumption in 2021, as Figure 2 shows.

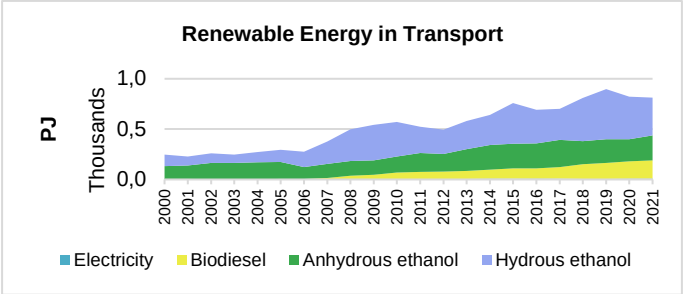
As also shown in Figure 1, electricity represents a share of 0.2% of total transport energy use in 2021. This is mostly in rail – there is no reporting of electricity used in road vehicles.

[1] The agriculture sector represents 27.4% of Brazil GDP (EPE, 2022)

[2] This includes:
- 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.




Figs. 1 and 2. Evolution of Transport Fuels in Brazil, 2000–2021
*Source: EPE, 2022a.*

Table 1 displays the growth of the Brazilian fleet from 2012 to 2021.

Table 1. Growth of the Brazilian Fleet, 2012–2021

| Vehicle Stock | Unit | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Motor spirit cars | $10^6$ | 12,4 | 11,7 | 11,0 | 10,3 | 9,6 | 8,9 | 8,2 | 7,6 | 7,0 | 6,5 |
| Diesel oil cars | $10^6$ | 1,5 | 1,7 | 1,8 | 1,9 | 2,0 | 2,1 | 2,2 | 2,3 | 2,5 | 2,6 |
| Electricity cars | $10^6$ | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,002 |
| Other type of cars (hybrid) | $10^6$ | 0,000 | 0,001 | 0,002 | 0,003 | 0,004 | 0,007 | 0,010 | 0,021 | 0,038 | 0,066 |
| Flex fuel cars | $10^6$ | 17,8 | 20,7 | 23,2 | 24,9 | 26,0 | 27,1 | 28,3 | 29,6 | 30,0 | 30,4 |

*Source: EPE, 2022d.*

## *Policy Framework*

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

- **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 introducing 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, enabling 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% of 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]
- **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 greenhouse gas 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.
- **Federal and state tax differentiation** between renewables and fossil fuels[5], and establishing credit lines to support rural sugarcane producers and their cooperatives to select business plans and promote projects that contemplate the development, production, and commercialization of new industrial technologies for sugarcane biomass (E2G, gasification, and more).[6]

[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, 2023).
[5] Regarding federal taxes, Cide has been zeroed for ethanol since 2004, while for gasoline, the incident value is R$100.00/m³. Since 2017, the PIS/COFINS on ethanol imports and commercialization is R$241.81/$m^3$, and for gasoline, R$ 792.5/$m^3$. At the state level, ICMS has different rates in each Brazilian state. (EPE, 2022d)
[6] CPNE did all of this through CNPE Resolution number 07, of April 20, 2021.

- **Launch of the National Hydrogen Program (PNH2)** The Brazilian government identified the need to organize a strategy for developing the country's hydrogen economy, 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, INOVA-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).

## *Research and Demonstration Focus*

Brazil has several government-backed mechanisms providing support for biofuels R&D and demonstration plants. Public and publicly oriented support totaled over BRL 200 million (USD 38 million) in 2020,[9] 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. It is worth noting 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.

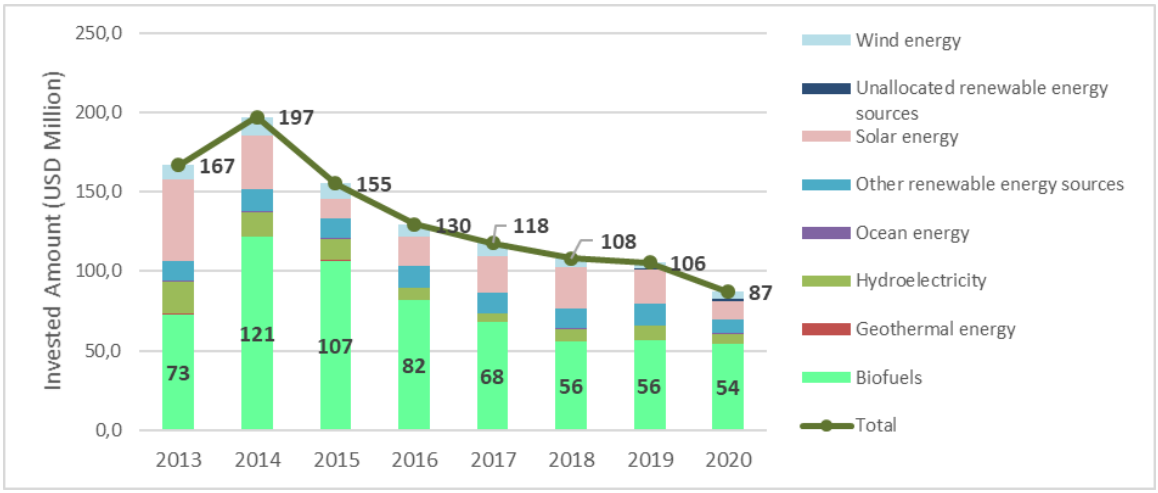



Fig. 3. Public Investments in Renewable Energy RD&I, 2013–2020
*Source: EPE, 2023.*

Figure 4 displays the total amount of public financing specific for the sugar-energy sector. In 2021, total disbursements of the Brazilian Bank for Economic and Social Development (BNDES) in the agricultural area for the cultivation of sugarcane totaled USD 78 million (or BRL 400 million)(BNDES, 2022).[10]

[7] Five thematic chambers were created to deal with different subjects: I - Strengthening of Scientific-Technological Bases; II - Training of Human Resources; III - Energy Planning – under the coordination of the Ministry of Mines and Energy; IV - Legal and Regulatory-Normative Framework; V - Opening and Growth of the Market and Competitiveness. The thematic chambers are responsible for formulating the Triennial Plan that will be approved in December by Coges-PNH2.

[8] The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) is a global market-based measure designed to offset international aviation $CO_2$ emissions in order to stabilize the levels of such emissions (ICAO, 2023).

[9] The average 2022 USD to BRL exchange rate was 5.10 (Brazilian Central Bank, BCB, 2023).

[10] At the average 2022 USD to BRL exchange rate (BCB, 2023).

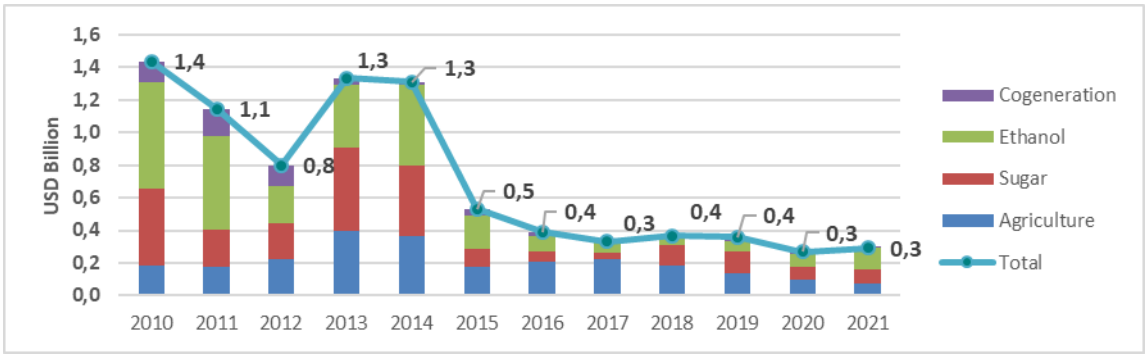



Fig. 4. Public Funding for Sugar-energy Sector
*Source: Constructed by EPE from data provided by BNDES (2022).*

## *Outlook*

Figure 5 consolidates the demand for fuel ethanol and other (non-energy) uses, which grows at an annual rate of 4.2%, reaching 44.6 billion liters in 2032, with the major increase coming from the demand for hydrated fuel. When added to exports, 2.2 billion liters, the total value of ethanol amounts to 46.8 billion liters.

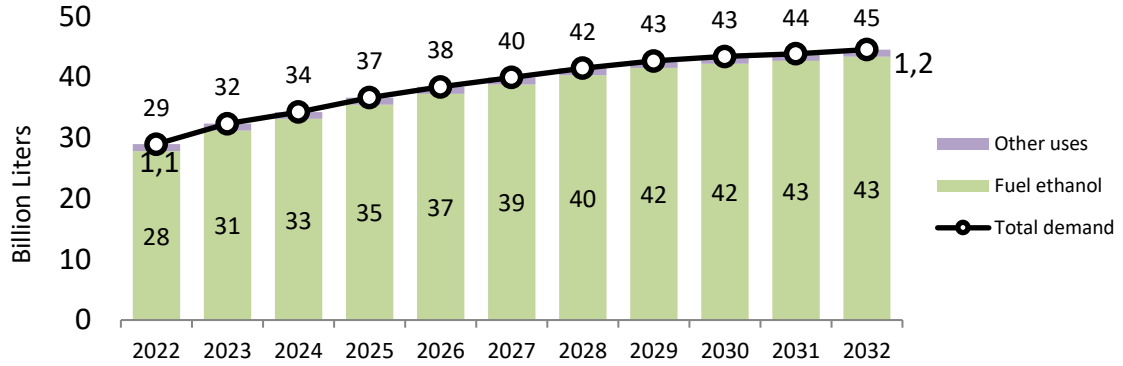



Fig. 5. Forecast of Total Ethanol Demand, 2022–2032
*Source: EPE, 2022b.*

The biodiesel demand projections of this study were obtained based on the forecast of the regional consumption of oil diesel type-B (EPE, 2022b) and the evolution of biodiesel blend (Figure 6).[11]

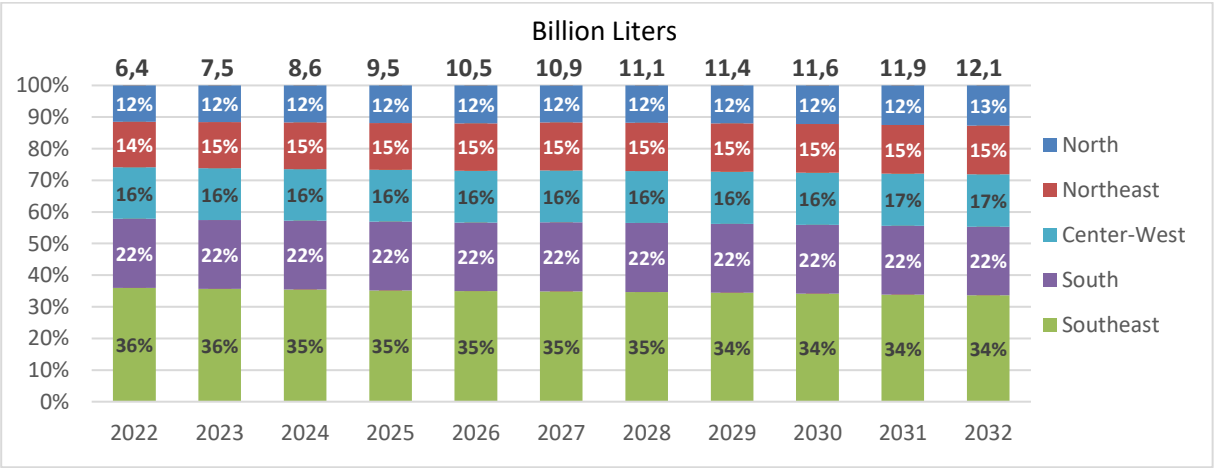



Fig. 6. Forecast of Total Biodiesel Demand with Regional Distribution, 2022–2032
*Source: Based on EPE, 2022c.*

[11] According to the recent CNPE definition on March 17, 2023 (MME, 2023), the biodiesel blend will change from 10% between January and March 2023 to 12% in April 2023, to 13% in April 2024, 14% in April 2025, and 15% in April 2026.

Projections for ethanol and sugar production presented in this study indicate a high amount of residues from this sector, which 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 34.9 billion Nm³ in 2032, representing 19.2 billion Nm³ of biomethane.

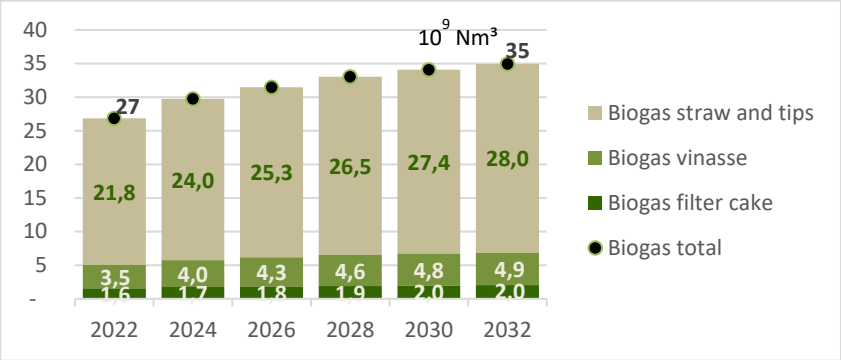



Fig. 7. Biogas Potential with Sugarcane Residual Biomass, 2022–2032
*Source: EPE, 2022b.*

By 2032, the Brazilian fleet should achieve 47.3 million vehicles, according to the EPE 10-Year Expansion Plan (EPE, 2022b).

## *Recent Developments*

Brazil has two commercial E2G plants (Granbio and Raízen), with a nominal production capacity of 60 and 42 million liters per year, respectively (GRANBIO, 2022) (RAÍZEN, 2022). Granbio's Bioflex-I has been in operation since September 2014; it is forecasted to reach nominal capacity by 2024 and to validate the E2G production patent in Europe (NOVACANA, 2022b; 2022c). Raízen's Costa Pinto unit produced 24 million liters in 2021. The company has already announced the construction of eight more plants, each with a capacity of 82 million liters. The plant located in Guariba is expected to start operating in 2023 (COSAN, 2021) (NOVACANA, 2022d). Raízen communicated agreements to sell 460 million liters of E2G over nine years, in addition to the possibility of having up to 20 operational E2G plants by 2031 (RAÍZEN, 2021a).

With regard to biogas, its participation in the internal supply of energy is still timid (0.12%), but it has shown accelerated growth: 22% per year over the last five years (EPE, 2022a).

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**Major changes**

As in other parts of the world, the Covid-19 pandemic had significant impact on individual mobility and fuel consumption in Brazil, resulting in a marked decrease in gasoline and ethanol demand in 2020 and a recovery only for gasoline in 2021. From mid-2021 through all of 2022, Brazil's successful vaccination campaign helped restore demand for road fuels to 2019 levels, with an increase in diesel consumption.